[JOINT COMMITTEE PRINT]

JOINT COMMITTEE ON TAXATION TAX MODELING PROJECT AND 1997 TAX SYMPOSIUM PAPERS

PREPARED AND COMPILED

BY THE STAFF

OF THE

JOINT COMMITTEE ON TAXATION

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INTRODUCTION

On January 17, 1997, the staff of the Joint Committee on Taxation ("JCT staff") hosted a symposium entitled "Modeling the Macroeconomic Consequences of Tax Policy." This symposium presented the results of a year-long modeling experiment by economists noted for their work in developing models of the U.S. economy. The purpose of this experiment was to explore the predictions of a variety of models regarding the macroeconomic feedback effects of major changes in the U.S. tax code with a focus on evaluating the feasibility of using these types of results to enhance the U.S. budgeting process.

The modeling experiment focused on two generic proposals to restructure the U.S. income tax system: (1) a broad-based unified income tax, and (2) a broad-based consumption tax. Several modelers ran multiple simulations of these proposals to examine the effects of transition rules, monetary policy, and international capital flows on the analysis.

The participants in the modeling project are recognized for their work in this area and were drawn from the academic, commercial, and government sectors. The modeling participants were:

Roger E. Brinner, Executive Director, DRI Inc./McGraw-Hill
Eric Engen, Senior Economist, Federal Reserve Board of Governors
Jane G. Gravelle, Senior Specialist in Economics Policy, Congressional Research Service
Dale W. Jorgenson, Professor of Economics, Harvard University
Laurence J. Kotlikoff, Professor of Economics, Boston University
Joel L. Prakken, Chairman, Macroeconomic Advisers, LLC
Gary Robbins, President, Fiscal Associates, Inc.
Diane Lim Rogers, Principal Tax Analyst, Congressional Budget Office
Kent Smetters, Associate Analyst, Congressional Budget Office
Jan Walliser, Assistant Analyst, Congressional Budget Office
Peter J. Wilcoxen, Assistant Professor of Economics, University of Texas, Austin
John G. Wilkins, Principal, Coopers & Lybrand, LLC

This pamphlet[1] describes the modeling project, presents JCT staff observations on the tax model simulation results and possible future use of macroeconomic tax models, and includes the symposium papers submitted by the modelers and two discussants[2] and

[1] This pamphlet may be cited as follows: Joint Committee on Taxation, *Joint Committee on Taxation Tax Modeling Project and 1997 Tax Symposium Papers* (JCS–21–97), November 20, 1997.

[2] Discussants were Charles L. Ballard, Professor of Economics, Michigan State University; and David Reifschneider, Chief of Macroeconomic and Quantitative Studies, Federal Reserve Board.

the comments of the four JCT Revenue Estimating Advisory Board members[3] who participated in the symposium.

[3] Michael J. Boskin, Professor of Economics, Stanford University and the Hoover Institute; Robert D. Reischauer, Senior Fellow, the Brookings Institution; Harvey S. Rosen, Professor of Economics, Princeton University; and Joel Slemrod, Professor of Economics, University of Michigan.

I. OVERVIEW

Role of the Joint Committee on Taxation in the budget process

As set forth in section 8022 of the Internal Revenue Code of 1986, one of the duties of the Joint Committee on Taxation ("JCT") is to investigate the operation and effects of the Federal system of internal revenue taxes. A second mandate established in supplementary budget process legislation to the Congressional Budget and Impoundment Control Act of 1974 is that the JCT be the exclusive provider of revenue estimates to Congress of tax legislation "enacted or considered." The Congressional Budget Office ("CBO") reports those estimates to the relevant committees, including the House and Senate Budget Committees, for the purpose of helping them determine Budget Act points of order.[4] Budget rule determinations require yearly, "point" (single measure), revenue estimates within the time frame or "window" for which budget projections are required.

Review and updating role

In accordance with these duties, the JCT staff continuously reviews and updates its methodologies for estimating the revenue implications of proposed tax law changes. Included in this process is the consideration of economic behaviors that can significantly affect Federal revenues. The scope of these behavioral factors generally has been limited to microeconomic effects in the JCT analysis. Examples include an acceleration of capital gains realizations in response to reductions in capital gains tax rates, and increases in consumption of gasoline in response to a reduction in the motor fuels tax.

The JCT has not, in general, included economic effects that relate to the overall macroeconomy—known as macroeconomic effects. Macroeconomic effects include: changes in gross domestic product ("GDP") which can affect the size of various tax bases such as for income and indirect business taxes; changes in interest rates resulting from changes in the supply and demand for credit which can change the shares of earned and unearned income within national income, the net flow of interest, dividends, and traded goods from abroad, and the flow of government interest payments to the private sector; and changes in employment and inflation which can affect payroll receipts and tax brackets.[5] The rationale for this limited scope is twofold: (1) the majority of the provisions considered

[4] The JCT's budgetary role as established in section 201 of the Congressional Budget Act is as follows: "For the purposes of revenue legislation which is income, estate and gift, excise, and payroll taxes (i.e., Social Security), considered or enacted in any session of Congress, the Congressional Budget Office shall use exclusively during that session of Congress revenue estimates provided to it by the Joint Committee on Taxation."

[5] Also, these macroeconomic impacts may affect government spending such as entitlement payments, but these are not within the purview of the JCT.

by the JCT staff are narrowly constructed and are unlikely to have measurable macroeconomic effects; and (2) there has been substantial uncertainty about the magnitude, and on occasion the direction, of macroeconomic effects of more broadly designed policy changes in the first few years after enactment.[6]

Recently, however, there has been increased interest in major tax restructuring proposals. In addition, the JCT staff has been asked for revenue estimates covering an extended budget period. Both of these developments have helped to raise interest in incorporating macroeconomic effects in budget and revenue analysis.

In January 1995, the issue of whether the JCT's estimating methodology should be revised to include macroeconomic aggregates was the subject of a joint hearing of the House and Senate Budget Committees.[7] The consensus of the expert economists at the hearing was that economists have not yet developed models of the economy that can predict the timing and magnitude of macroeconomic effects with enough accuracy to justify including them in revenue estimates. It was generally agreed that it would be inadvisable to try to incorporate macroeconomic effects into revenue estimates without further study and experimentation.

As part of its review and updating roles, the JCT announced plans in the spring of 1995 to make further explorations of the feasibility of incorporating macroeconomic effects in revenue estimates. In a May 18, 1995 letter to the Chairmen of the House Committee on Ways and Means and Senate Committee on Finance, the JCT Chief of Staff announced a number of initiatives. In particular, the JCT staff would secure access to various outside macroeconomic models to assess their usefulness in performing macroeconomic analysis of tax law change. (A copy of the letter to the Chairman of the House Committee on Ways and Means appears in Appendix A; an identical letter was sent to the Chairman of the Senate Committee on Finance.) This pamphlet reports on one step in this process, in which outside researchers were asked to apply their models to two generic tax restructuring proposals, and to report their findings as they relate to budget scoring matters.

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[6] See Joint Committee on Taxation, *Discussion of Revenue Estimation Methodology and Process* (JCS–14–92), August 13, 1992.

[7] See Joint Committee on Taxation, *Methodology and Issues in the Revenue Estimating Process* (JCX–2–95), January 23, 1995.

II. THE MODELING PROJECT

A. Project Design

Revenue estimates are projections of the change in receipts to the Federal Government due to proposed tax law changes. Revenue estimates provided to Members of Congress by the JCT staff are used in the budget process to gauge the compliance of proposed tax legislation with yearly revenue targets set forth by Congress as part of its budget resolution process. The JCT staff designed the modeling project described in this pamphlet to advance the understanding of the potential accuracy and speed with which estimates of the macroeconomic effects of tax policy changes can be produced.

In April 1996, the JCT staff invited a group of academic, commercial, and government economists to participate (pro bono) in the modeling project.[8] Participants included Roger E. Brinner, DRI/McGraw-Hill ("DRI"); Eric Engen ("E–G"), Federal Reserve Board of Governors; Jane G. Gravelle, Congressional Research Service ("Gravelle"); Dale W. Jorgenson, Harvard Univesity ("J–W"); Laurence J. Kotlikoff, Boston University ("AKSW"); Joel L. Prakken, Marcroeconomic Advisers ("MA"); Gary Robbins, Fiscal Associates ("Robbins"); Diane Lim Rogers, CBO ("F–R"); Kent Smetters, CBO ("AKSW"); Peter J. Wilcoxen, University of Texas ("J–W"); Jan Walliser, CBO ("AKSW"); and John G. Wilkins, Coopers & Lybrand ("C–L").

The goal of the project was to identify sources of variation in predicting the effects of a major change in tax policy on the level of national output and on other macroeconomic variables. Most of the participants in this project had already used their models to simulate some form of consumption-based tax reform. They had in their earlier work, of course, made their own assumptions about both the exact nature of the tax restructuring and the accompanying fiscal and monetary environment. In order to isolate the similarities and differences in results arising from the structures and assumptions of the different models, JCT staff worked with participants to standardize both the restructuring proposals to be simulated and the accompanying fiscal and monetary "framework" assumptions. This working group developed two generic tax restructuring proposals that could be simulated by all participants, along with several variations from these proposals that several sub-groups could also estimate (described in detail below in "II. B. Income Tax Restructuring Proposals"). In addition, the JCT staff and the participants agreed on a set of common assumptions about the paths of State and local and Federal Government spending, monetary policy, and government deficits (described in detail below in "II. C. Common

[8] Biographical summaries for those modelers who participated in the JCT Tax Symposium appear in Appendix B.

Framework Assumptions") to be followed, as closely as possible, in all the simulations.

JCT staff and the modelers met three times to define the proposals, to formulate a framework for the simulations, and to discuss preliminary results. The working group also developed prototype tables for displaying the results of the different simulations in a common format, in order to facilitate cross-model comparisons. In general, the output of the simulations reported the effects of the tax restructuring proposals on levels of national production (GDP), investment, capital stock, employment, wages, and interest rates that were projected to result from the implementation of the tax proposals. These effects, a subset of which are summarized in tables appearing in Part IV, are reported as changes in the level of these variables relative to their projections under a current law "baseline" economy.

The work culminated in a JCT Tax Symposium on January 17, 1997, which was open to the public. A paper reporting key model features and highlighting simulation results was presented by each modeling group. Two economists who had not been involved in the modeling project, but who are knowledgeable about the types of simulations being done, were invited to comment on the results presented by the participants. In addition, four economists who are members of the JCT Revenue Estimating Advisory Board conducted a panel discussion of the lessons of this project for incorporating macroeconomic effects in revenue estimating. Part VI of this pamphlet contains the papers presented by the participants and discussants, as well as transcripts of the remarks by the JCT Advisory Board members.

B. Income Tax Restructuring Proposals

Modeling participants agreed to simulate two types of tax restructuring proposals: a broad-based unified income tax and a consumption tax. Depending on modeling capabilities, the participants could simulate the consumption tax as either a value-added tax ("VAT") or as a consumption-based "flat" tax. This choice was provided in order to minimize the burden on participants whose models had not been originally configured to simulate one or the other of the consumption tax proposals. The two variations were designed to have economically equivalent tax bases. The proposals were assumed to become effective beginning January 1, 1997. Simulations were to be extended into the future for 10 to 50 years, depending on the capability of the model.

1. Unified income tax

The unified income tax proposal includes three types of change to the tax code: (1) integrating the corporate and individual income taxes; (2) broadening the tax base; and (3) flattening the individual income tax rate schedules.

The corporate and individual income tax systems is integrated by repealing the taxation of dividend income and excluding from capital gains the pro rata share of retained earnings in the taxable income of corporate stockholders. This insures that corporate income is treated the same as other income by the tax system (i.e., subject to only one level of tax).

The tax base is broadened by (1) repealing all personal itemized deductions and personal tax credits, and replacing them with a tax credit calculated as the product of the calculated flat rate and the taxpayer's tax credit base;[9] and (2) eliminating present-law deductions and exclusions for non-wage compensation, including employer-paid contributions for health insurance, pension plans, Keogh, and section 401(k) plans, life insurance, parking, meals, and contributions to payroll tax, as well as employee contributions to individual retirement arrangements ("IRAs") and section 401(k) plans.

The tax rate schedule is "flattened" by levying a single tax rate on all taxable income of both individuals and corporations. The tax rate is generated in the simulations to maintain a path of government spending and deficits outlined in the fiscal assumptions below.

2. Consumption-based tax

Both consumption tax alternatives replace the present-law individual and corporate income tax systems. The consumption tax alternatives provide the same special tax credit to individuals that is provided for the unified income tax proposal described above, except, of course, that the credit rate is set equal to the tax rate derived in the consumption tax simulations.

The first consumption tax alternative imposes a subtraction-method VAT on the excess of the value of sales of goods and services over certain business expenses for domestic businesses enterprises. Eligible expenses include the cost of business inputs from other enterprises, including purchases of property (specifically, tangible capital investments excluding land), and a carryforward of net operating losses ("NOLs") generated on or after the effective date for the new tax system. No deduction is allowed for employee compensation or interest expense. No interest accrues on NOL carryforwards. The VAT is applied to sales to non-profits and governments. This proposal also imposes a special tax assessment, at the VAT rate, on the compensation paid by State and local governments, and non-profit institutions.[10]

The second consumption tax alternative, the consumption-based flat tax, in theory, falls on the same base as the VAT. The only difference between the two forms is that under the flat tax, wages paid are deductible by the employer and taxable to the wage earner at the flat rate. As under the unified income tax and the VAT, non-wage compensation is not deductible by the employer. Compensation paid by non-profits and government entities is subject to the special assessment described above.[11]

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[9] The tax credit base is the smaller of the individual taxpayer's wages and self-employment earnings or $10,000 plus $5,000 for each dependent of the taxpayer (the present-law rule providing that a dependent could not claimed by more than one taxpayer would be retained). Thus, a married couple is comprised of two individuals taxpayers and therefore, could have a tax credit base of up to $20,000, plus $5,000 for each dependent.

[10] The Federal Government also would be subject to this tax in theory, although here the tax would represent both a receipt and an expenditure of equal magnitude, and would, therefore, not have any net budget effect.

[11] The ability of businesses to use the full value of their expensing deduction differs substantially between the flat tax and the VAT. Under the VAT, the tax base of each taxable establishment is substantially greater than its flat tax counterpart because the business-level tax base would include the full amount of value added by labor which, under the flat tax is taxed on

Continued

To ensure, for comparison purposes, that the tax bases of the alternative consumption taxes conform with each other as much as possible, certain elements of the two consumption taxes are assumed to be identical. For example, both versions would impose a border tax on imports and exclude exports from taxation, an approach that is often applied in VAT proposals but is not typically applied in flat tax proposals. Both assume the same standard income tax credit system, a typical component of flat taxes but unusual for VAT systems. As a consequence, neither proposal matches any existing legislative proposal.

3. Transition relief

Without transition relief, major tax proposals may have large disruptive macroeconomic effects during the transition from one tax system to the next. For example, a switch to a consumption tax would end depreciation deductions for capital in existence prior to the tax law change ("existing" capital), and consequently would raise the tax burden on owners of this capital. Thus, transition relief for those most heavily burdened by a tax law change often is incorporated in actual tax restructuring legislation. Transition relief, however, can slow the effects of the proposed tax change and delay and reduce the macroeconomic impacts. Because of the importance and likelihood of transition relief, several participants ran consumption tax simulations with and without transition relief to provide information about the short- and long-run consequences of including transition relief in tax restructuring.

In the interest of promoting uniformity in assumptions, JCT staff provided a common set of proposals for transition relief: (1) present-law depreciation deductions for existing investments are retained; (2) deductions for NOL carryforwards that pre-date 1997 are retained; and (3) certain interest payments retain their present-law tax treatment.[12] Several participants were unable to incorporate this type of transition relief in their models and instead simulated a tax on wages only which approximates the exemption of all existing capital from taxation, a more generous transition rule.

C. Common Framework Assumptions

Where possible, participants followed a common set of assumptions designed by the JCT staff and participants about the levels and paths of government spending, the deficit, monetary policy, and tax rates, as described below. In many cases, deviations from the common assumptions were assessed to have little substantive effect on the outcomes of the simulations. However, for some, it was determined that the deviations could have a significant impact on the magnitude of the final results.

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a personal basis. The result is that the flat tax gives rise to a substantially larger amount of new NOLs compared with the VAT. However, most of the simulation models in the JCT project did not attempt to simulate the role of NOLs on a going-forward basis. This omission has at least two effects on the flat tax simulations: (1) the simulated tax base tends to be understated; and (2) the cost of capital tends to be understated because delayed use of an NOL is an implicit increase in the cost of capital when NOL carryovers do not accrue interest.

[12] Under this rule, interest expense would continue to be deductible and interest income would continue to be taxable to the recipient for interests payments on any underlying debt instrument that was issued prior to January 1, 1997.

Assumptions for Federal taxes and outlays

JCT staff requested that, for the period from 1996 through 2005, modelers replicate present-law baseline deficits and government outlays projected by the CBO in *The Economic and Budget Outlook Update,* published in August 1995. For years subsequent to 2005, both government outlays as a percentage of GDP and the deficit as a percentage of GDP were to be held constant at their 2005 levels.

While most of the models were calibrated to the National Income and Product Accounts ("NIPA"), which include measures of government activity, several models used indexes especially created for the model and did not have the ability to incorporate an explicit government deficit. Models that were not capable of matching the CBO projections attempted to maintain the relationship between the GDP, government spending, and the deficit in roughly the proportions used in the referenced CBO forecast. This would substantially control for variations due to differing assumptions about government fiscal policy. Even for those models that required a balanced budget assumption, the key assumption was that the real deficit remain unchanged between the present-law baseline simulation and the tax policy simulations.

Tax rate determination

The tax rates for the alternative restructuring proposals were not provided by the JCT staff, but are endogenous to the simulations; they are set to maintain "deficit neutrality" relative to present law. That is, it was assumed that the Federal Government provides the same levels of real services plus real transfers that are provided in the present-law baseline, and that real tax revenues are just sufficient to fund these expenditures less the present-law deficit, adjusted for inflation. This was done in order to distinguish the macroeconomic effects of tax policy changes from those due to a change in the deficit.

Note that tax revenues here include the payroll tax; any increase in aggregate wages due to either higher wage rates or more hours worked will directly increase the tax base for the payroll tax. As a result, the deficit-neutral rate for the replacement tax will be lower because of any additional revenues raised by the payroll tax. This effect was significant in many of the simulations.

Unlike other Federal outlays, it is anticipated that the real interest expense of servicing the Federal debt will fluctuate in the restructuring simulations, not because of changes in the deficit, but because of changes in the interest rate applied to the Federal debt. For example, if tax restructuring reduces interest rates, then the tax rate in each year is lowered to offset for the induced savings in Federal interest outlays.

Over the span of the projection period, tax rates are adjusted to retain this deficit neutrality roughly on a year-to-year basis. However, to allow for possible significant fluctuations in revenues during the first five years after tax restructuring, budget neutrality could be relaxed to achieve cumulative budget neutrality by the end of the fifth year. It was expected that such fluctuations would be likely to occur in the models (C–L, DRI, MA) that incorporated demand fluctuations in their simulations. This phenomenon proved to have substantial influence on the short-run results of these models. (See Part II. D. for a discussion of the design of these models.)

State and local taxes

Because the simulations were intended to model the incremental effects of Federal tax changes, JCT staff initially asked the modelers to assume that State and local tax systems would not be changed to mirror changes in the Federal tax structure. To comply with this assumption as well as to neutralize the macroeconomic impacts of State and local taxation and expenditure policy, modelers forced their simulated State and local sectors to maintain the same fiscal surpluses as in their baseline projections by adjusting State and local spending and revenues. In particular, they adjusted to a changing revenue base by changing outlays and/or all taxes and fees proportionately. As with the Federal deficit targets, State and local surplus targets were adjusted to retain this surplus neutrality roughly on a year-to-year basis. To allow for possible significant fluctuations in GDP during the first five years after tax restructuring, this surplus neutrality could also be relaxed to achieve cumulative neutrality by the end of the fifth year.

However, the F–R and J–W did not have separate sectors for State and local governments and they were unable to follow this assumption. To the extent that lower tax rates induce significant behavioral responses within these models, the lowering of rates in the State and local sector may significantly overstate the magnitude of the economic consequences that are attributable to the Federal tax restructuring alone.[13]

Monetary policy

The modelers assumed that, both under the present-law baseline and under the proposals, the Federal Reserve Board ("Fed") pursues a policy of stabilizing unemployment at the lowest rate that is consistent with price stability. This assumption was specified to minimize the effects of short-term demand disruptions. It is relevant only to the three models in which unemployment is allowed to vary. In these models, Fed attempts to stabilize unemployment did not completely eliminate short-run economic unemployment fluctuations. For those models that incorporated such fluctuations, the JCT staff asked for separate simulations showing the effects of changing monetary policy reaction regimes aimed at achieving stabilization.

Role of the rest of the world

The response of international capital flows may significantly affect the timing and amount of domestic savings and investment that result from changes in the U.S. tax system. It was apparent during working group meetings that there was little agreement among participants as to what this response is likely to be, and even less ability to vary assumptions about this response within many of the models. With the exception of MA and DRI, the models

[13] Several participants, including those who modeled only one government sector, maintained that significant Federal tax reform would by necessity engender significant State and local reform, and therefore modeling changes in both would yield a more accurate projection of economic consequences.

had the capability of portraying the U.S. either as a totally closed economy (with no net international capital flows, or no net change in international capital flows), or as a small, open economy in which capital flows adjust to equilibrate foreign and domestic interest rates. (MA and DRI use a reduced-form empirical representation between the two extremes.) Neither of these paradigms represents a very accurate description of the U.S. economy. Since some of the models (Robbins, Gravelle, E–G) were able to run simulations using both paradigms, this variation was left as an open assumption, with those who could run simulations both ways encouraged to do so.

Announcement effects

In order to simplify the modeling exercise, the simulations assume that the tax restructuring is enacted and become effective on January 1, 1997, and that economic agents would be unable to anticipate that such a restructuring would occur. Thus, the simulation exercise does not reflect any changes in economic behavior in anticipation of tax restructuring. Neither the JCT staff nor the modelers expect that it would be reasonable to make such an assumption in providing a revenue estimate of an actual legislative proposal.

Compliance

Both the present-law tax system and a restructured tax system can be expected to fall short of full compliance with the tax code. Although some proponents of tax restructuring predict that compliance would improve under a consumption-based tax system, others contend that it could become worse. For purposes of abstracting from this issue, participants agreed to assume no change in compliance rates under the proposal simulations relative to the present-law baseline.

D. Participants' Models

Participation in the project

In selecting participants for the modeling project, JCT staff identified a number of groups of economists who were known to be active in the modeling of the national economy for purposes of analyzing the macroeconomic effects of tax policy. Among these, representatives of several types of models were sought out to ensure a breadth of analysis.

Neoclassical growth models (Gravelle, Robbins)

Neoclassical growth models are based on a series of equations specifying the determinants of supply (amount produced) of goods and services and demand (quantity purchased) for this output. Supply is determined by production technology and the availability (cost) of the factors of production, labor and capital. The supply and demand equations include assumed behavioral elasticities which the modelers choose based on their findings from empirical studies in the economic literature. Prices adjust such that demand always equals supply. Thus, even in the short run, the result is that supply determines the amount of output, and demand determines the nominal price level. These models are useful in analyzing the supply-side effects of disturbances to the economy, but provide no information about the time path of demand adjustment because labor and capital are always assumed to be fully employed. Policy changes move the economy from the existing market equilibrium to a new market equilibrium.

Econometric forecasting models (C–L, DRI, MA)

Econometric forecasting models are built on a similar long-run neoclassical growth structure of supply and demand equations. They are designed, however, to predict the short-run demand adjustment path to the new neoclassical equilibrium in response to a policy change that disrupts the old equilibrium. They model changes in demand for a fairly disaggregated array of products, based on recent history of observed relationships between incomes, prices, and demand for these sectors. Because changes in the money supply have a large effect on these relationships, these models incorporate monetary policy assumptions. This is the only class of models that provides a short-run, disequilibrium analysis of the reaction of macroeconomic aggregates to tax policy. In the short run, projected changes in aggregate demand can overshadow supply responses in these models.

Intertemporal models (AKSW, E–G, J–W, F–R)

Intertemporal models come from the neoclassical growth tradition, but they start from a more theoretically pure set of assumptions, deriving their demand and supply equations from underlying equations that describe how consumers make consumption decisions ("maximize utility") and how firms make production decisions ("maximize profits"). This perspective allows them to model how households and firms make decisions involving trade-offs between present and future actions. The participants in the JCT project use two different approaches to model this trade-off. J–W uses infinitely-lived representative agents who make decisions based on the present discounted value calculations of relevant variables over an infinite time-horizon. AKSW, E–G, and F–R models use overlapping generations of decision-makers who make their intertemporal decisions with the knowledge that they have finite lives and may or may not want to make bequests to future generations. Like neoclassical growth models, these models provide much information about long-run macroeconomic effects rooted in determinants of supply, but provide little information about the adjustment path because they move from equilibrium to equilibrium. Figure 1 provides a brief summary of the major characteristics of each model.

FIGURE 1

BRIEF MODEL DESCRIPTIONS

Model (Presenter)	Fullerton-Rogers (Diane Lim Rogers)	Auerbach-Kotlikoff-Smetters-Walliser (Kent Smetters, Jan Walliser)	Engen-Gale (Eric Engen)
Model type	Computable General Equilibrium lifecycle with exogenous bequests; myopic expectations	Computable General Equilibrium lifecycle with bequest motives; perfect foresight	Computable General Equilibrium lifecycle with uncertain bequests; myopic expectations
Household Sector	Labor supply and consumption decisions separately modeled for 12 income classes and 60 age categories	Labor supply and consumption decisions separately modeled for 12 income classes and 55 age categories	Labor supply and consumption decisions separately modeled for 3,000 lifetime income realizations (with random component) and 70 age categories; discrete choice of work/no work
Business Sector	Production decisions made by 18 industries, 2 business entity types, and 5 input categories	Production decisions made by one aggregate producer; average marginal tax rate based on disaggregated model of present law economy	Production decisions made by one aggregate producer; average marginal tax rate based on disaggregated model of present law economy
Government Sector	No separation between Federal, state & local taxes Government spending and deficits in simulations track baseline levels	Federal, state and local taxes separately modeled; interest payment on Government debt, and amount of Government spending in simulations track baseline levels	Federal, state and local taxes separately modeled; deficit/GDP and Government spending/GDP constant in simulations, baseline
Other Economic Assumptions	Full employment equilibrium (no demand-side effects, no monetary sector); no change in net international capital flows	Full employment equilibrium (no demand-side effects, no monetary sector); no change in net international capital flows	Full employment equilibrium (no demand-side effects, no monetary sector); consumption tax modeled both with small open economy (international capital flows change to equalize before-tax rates of return) assumptions and closed economy assumptions

FIGURE 1 (continued)

BRIEF MODEL DESCRIPTIONS

Model (Presenter)	Gravelle (Jane Gravelle)	Fiscal Associates, Inc. (Gary Robbins)	Jorgenson-Wilcoxen (Peter Wilcoxen)
Model type	Neoclassical growth; full employment equilibrium (no demand-side effects); adaptive expectations	Neoclassical growth; full employment equilibrium (no demand-side effects); adaptive expectations	Computable General Equilibrium infinitely lived; perfect foresight
Household Sector	Consumption and labor supply decisions made by 6 income groups; 3 family size categories	Consumption and labor supply decisions made by one aggregate household; 165 average marginal tax rates determined from 165 household types	One aggregate household makes labor supply and savings decisions; consumption allocation across goods based on 672 households distinguished by income, family size, race, and geographic variables
Business Sector	One aggregate production sector ; average marginal tax rate on capital reflects current law corporate tax and business tax deductions, and housing deductions	One aggregate production sector; average marginal tax rate from 72 industries; 46 inputs; 2 business entity types	Production decisions made by 35 industries; 2 business entity types short and long run horizons
Government Sector	Federal, state and local taxes separately modeled; Government spending and deficits in simulations track baseline levels	Federal, state and local taxes separately modeled; Government spending and deficits in simulations track baseline levels	No separation between Federal, state & local taxes deficit/GDP and Government spending/GDP constant in simulations, baseline
Other Economic Assumptions	No monetary sector; consumption tax modeled both with closed economy and small open economy (international capital flows change to equalize before-tax rates of return) assumptions	No monetary sector; international capital flows adjust to equalize after-tax rates of return unified income tax modeled both with rate of return equalization and closed economy assumptions	Full employment equilibrium (no demand-side effects, no monetary sector); no change in net international capital flows; real goods flows change according to changes in exchange rates

FIGURE 1 (continued)

BRIEF MODEL DESCRIPTIONS

Model (Presenter)	Macroeconomic Advisers, LLC (Joel Prakken)	DRI/McGraw Hill, Inc (Roger Brinner)	Coopers & Lybrand, LLC (John Wilkins)
Model type	Neoclassical growth unemployment rate allowed to fluctuate; demand effects modeled; adaptive expectations	Neoclassical growth unemployment rate allowed to fluctuate; demand effects modeled; blended forward-looking and adaptive expectations	Neoclassical growth unemployment rate allowed to fluctuate; demand effects modeled; adaptive expectations
Household Sector	Consumption determined by aggregate household based on 8 age groups; labor supply determined by 8 age groups and gender	Consumption determined by aggregate household; labor supply determined by 3 age groups, gender, family size	Consumption decisions made by 20 income groups, and 6 family size groups. Labor supply decision from one aggregate supplier of labor; average marginal tax rates based on a database of 250,000 individual income tax returns and other household financial data
Business Sector	Production decisions by 1 non-farm business sector; government, farms, and housing separately modeled; and non-profits and households	Production decisions made by 72 industries producing 19 consumption items, 8 investment items, 9 export items, and government purchases; based on cyclically adjusted input/out data	Production decisions made by 51 industries, and 12 types of business entities based on input/output data average marginal tax rates based on large database of corporate income tax returns
Government Sector	Federal, state and local governments separately modeled; deficit/GDP held constant over long run; path of real Federal Government expenditure (excluding interest) in simulations tracks levels in baseline	Federal, state and local taxes separately modeled; real Government spending and full employment deficits in simulations track baseline levels	Federal, state and local taxes separately modeled; Government spending and full employment deficits in simulations track baseline levels
Other Economic Assumptions	Unemployment rate allowed to fluctuate; alternate simulations conducted for different monetary policies; international capital and real goods flows fluctuate with exchange rate and interest rate changes (results in short-run outflow of foreign capital, long-run inflow)	Unemployment rate allowed to fluctuate; alternate simulations conducted for different monetary policies; international capital and real goods flows fluctuate with exchange rate and interest rate changes (results in short-run outflow of foreign capital, long-run inflow)	Unemployment rate allowed to fluctuate; monetary policy targets full employment international capital and real goods flows fluctuate with exchange rate and interest rate changes (results in short-run outflow of foreign capital, long-run inflow)

III. JCT SYMPOSIUM

The JCT symposium comprised presentations by the modelers and comments from additional discussants, followed by views from several members of the JCT's Revenue Estimating Advisory Board (the "Advisory Board"). The major purpose of the symposium was to illuminate the current state of the art of macroeconomic tax policy modeling in general, with a secondary focus on the modeling of major tax system restructuring. Each of the papers by the modelers describes the structure of their models and the model predictions for the effects of various types of tax restructuring on the economy. The papers by the discussants, and the comments by members of the JCT Advisory Board, in contrast, draw from the information in these papers to analyze the contributions these models can make to the forecasting of the macroeconomic effects of tax proposals.

The modelers were divided into two panels. The first panel included the authors of the four intertemporal models. A discussion of the results of this panel was then provided by Professor Charles Ballard.[14] The remaining modelers presented their findings in a panel with a followup discussion by Dr. David Reifschneider.[15] The discussants critiqued the models with an emphasis on the following issues:

- the relative strengths of existing modeling technology in making short-run versus long-run predictions;
- the level of uncertainty associated with sensitivity of model results to key behavioral assumptions; and
- the suitability of models for evaluating macroeconomic responses to more limited tax change proposals.

Following presentation of the symposium papers, Professor Michael J. Boskin, Dr. Robert D. Reischauer, Professor Harvey S. Rosen, and Professor Joel Slemrod—all members of the JCT's Revenue Estimating Advisory Board—provided their views on the project. They were asked to comment on the implications of the modelers' results with regard to the future of dynamic revenue estimating. Their discussion centered on the following topics:

- the feasibility of incorporating macroeconomic effects in year-by-year revenue estimates;
- the feasibility of developing a rule for identifying types of proposals for which macroeconomic effects should be included;
- the feasibility of incorporating short-run disequilibrium effects in revenue estimates; and
- the prudence of incorporating macroeconomic effects in revenue estimates in isolation from direct and indirect outlay effects.

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[14] Professor Charles L. Ballard, Michigan State University. Biographical material is presented in Appendix B.

[15] Dr. David Reifschneider, Chief of Macroeconomic and Quantitative Studies, Federal Research Board. Biographical material is presented in Appendix B.

The written submissions to the JCT staff from the modelers and discussants, and the comments of the participating Advisory Board members are presented in Part VI.

IV. LESSONS FROM MODEL SIMULATION RESULTS

The primary purpose of this section, like that of the modeling project as a whole, is to highlight inferences that may be drawn from the papers presented in Part VI about the strengths and weaknesses of existing macroeconomic models in their ability to forecast the effects of tax policy. Section A briefly summarizes the range of results produced by the symposium participants. Section B provides an analysis of the sources of differences and similarities in these results. Section C concludes with some observations about the implications of this analysis for revenue estimating.

A. Simulation Results

The interaction between tax policy and the economy is quite complex. Consequently, it is necessary to examine the time paths of a wide range of economic factors in each model in order to analyze completely how each model simulates this interaction. Modelers were asked to provide information about the time paths of such variables as interest rates, absolute and relative prices, imports and exports, changes in the taxable base and tax rates, and various behavioral parameters, as well as to report on major economic outcomes in the form of changes in the capital stock, the savings rate, labor effort, and GDP. As evidenced by the wide disparity of reported economic detail in each of the papers in Part VI, the models have differing capacities to generate this level of detail.

Tables 1 through 5 provide a summary of some major results produced in the simulations by all nine modeling groups; specifically, they show changes in GDP, the capital stock, labor effort (employment), and the domestic saving rate forecasted in each of the simulations.[16] Section B discusses some of the economic factors that determine these changes within each model. The tables have been organized to highlight areas of interest such as contrasts between the consumption and unified income tax and between short-run, and medium- and long-run results. They also highlight the importance of transition relief, monetary policy, and international capital flows in the simulations. The following summarizes the tables and some of the conclusions that can be drawn from them.

Medium- and long-run results (Table 1)

Table 1 compares the medium- and long-run results of the consumption tax (both the VAT and the flat tax variations, depending on the model) and the unified income tax.[17] For the consumption tax proposals, the table shows that the effects on GDP are gen-

[16] DRI figures in Tables 1–5 were revised after submission of their paper appearing in Part VI. Consequently, the figures in Tables 1–5 may not agree with those in the DRI (Brinner) paper.

[17] Descriptions of the individual for DRI simulations and their results appear in the modelers' submitted material in Part VI.

erally positive over the medium and long run, although the magnitude of these effects vary widely. One exception to the positive results was reported in the DRI simulation of the VAT which produced a decrease in GDP over the medium term.

From the medium- to long-run perspective, the consumption tax produced a stronger positive growth effect than the unified income tax for the models that ran both simulations. Except for one "low" sensitivity simulation carried out by F–R and the DRI VAT simulation, each model indicated that its consumption tax simulation produced results that were more positive than its unified income tax counterpart. In fact, even the direction of the unified income tax macroeconomic effects is not clear: some simulations led to a level of GDP that was lower than the baseline level in the long run.

Short-term impacts (Table 2)

Table 2 provides a comparison of short-run effects across models. Of special note are the results of the macroeconomic forecasting models—DRI, MA, and CL—which, unlike the other models, allow for disturbances in aggregate demand by allowing for unemployment, and monetary policy considerations. Over the first few years of the simulation, the transitory fluctuations in the demand for investment or consumption goods and services can dominate the slower acting responses of capital or labor that may eventually lead to increases in productivity and output capacity. This dominance can produce short-run net effects that have the opposite sign of the longer run effects. The results during the first few years are important because they are integral to the five- or ten-year budget window for which budget scoring is presented.

Compared to the longer-term results for the consumption tax, shown in Table 1, the short-term effects are less consistent. DRI and MA—two of the three disequilibrium models—forecast negative GDP impacts in the short run for the consumption tax proposal, while all of the models that do not attempt to consider demand-side issues forecast positive GDP effects. Suggesting the temporary nature of these effects, the MA simulation and one of the DRI simulations turn positive by the year 2005. The short-run unified income tax effects continue to be mixed, as they were over the longer periods (see Tables 1 and 2), with some showing a positive impact and others showing a negative impact.

Transition tax relief (Table 3)

Table 3 displays the effect of providing transition tax relief when switching to the consumption tax. Modelers picked one of the two transition methods described earlier. In most of the simulations that address this issue, allowing a transition period delays, and in some cases reduces, the macroeconomic benefits of the consumption tax.

Alternative monetary policy (Table 4)

Table 4 demonstrates the importance of the Fed in assessing the effects of major tax restructuring. The results show that plausible alternative Fed reactions to the effects of tax law change can significantly affect responses of the economy. In particular, Fed policy assumptions which are more accommodative of initial price-level changes and, therefore, more stimulative to the economy early on eventually significantly alter the longer run growth path of GDP. In Table 4, the more accommodating Fed policies are labeled "Managed Reserves" in the MA simulations, and are labeled "Generous Fed Reaction" in the DRI simulations. More restrictive monetary reactions are reported to reduce substantially real GDP between 2005 and 2010 relative to their baseline Fed assumption in the DRI results. For the MA results, the period between 2005 and 2010 continues to be a period of substantial fluctuation for both regimes.

International capital flows (Table 5)

Table 5 illustrates the effects of varying assumptions about the flow of foreign capital into the U.S., which supplements U.S. savings in financing domestic investment. The results fluctuate significantly, depending on assumptions about the openness of global capital markets and the substitutability of portfolio choices for both domestic and foreign investors. Gravelle, Engen, and Robbins each produced two simulations, one, of a closed economy and the other, of a fully open economy. The first simulation from each modeler, labeled "no net change in international capital flows," assumes the U.S. is a closed economy that relies on domestic saving alone to finance investment and growth. The second simulation assumes the free flow of capital across international borders. While the magnitude of the results differ from model to model, comparison of the two simulations from each model shows that the assumption of freely flowing capital can increase the model's GDP response from 50 to 130 percent by 2010. While it is generally agreed that neither assumption is wholly realistic for the U.S., the simulations provide a sense of the influence that consideration of international capital flows can have on estimates of tax law changes.

Table 1.—Simulation Results: Medium-Run and Long-Run

[Percent differences from current tax code baseline]

Summary variables	Net change international capital flows	Consumption tax[1]			Unified income tax[2]		
		2005	2010	Long run	2005	2010	Long run
Real GDP:							
Fullerton-Rogers—low[3]	No			1.7			1.8
Fullerton-Rogers—high[4]	No			5.8			3.8
Auerbach, Kotlikoff, Smetters & Walliser	No	4.0	5.0	7.5	−1.7	−2.1	−3.0
Engen-Gale	No	1.8	2.1	2.4	−0.2	−0.3	−0.5
Jorgenson-Wilcoxen	No	3.6	3.3	3.3	1.6	1.4	1.3
Macroeconomic Advisers (transition relief[5])	Yes	1.4	1.3	5.4			
Robbins	Yes	16.4	16.9		14.6	15.4	
DRI Inc./McGraw-Hill	Yes	4.7			−1.1		
DRI Inc./McGraw-Hill—("VAT")	Yes	−4.2					
Gravelle	No	0.7	1.0	3.7	0.6	0.7	1.8
Coopers & Lybrand	Yes	1.2			1.1		
Capital Stock:							
Fullerton-Rogers—low[3]	No			5.2			5.4
Fullerton-Rogers—high[4]	No			23.8			11.8
Auerbach, Kotlikoff, Smetters & Walliser	No	14.0	19.1	31.5	−4.2	−5.9	−10.5
Engen-Gale	No	7.0	7.6	9.8	−0.7	−1.0	−1.6
Jorgenson-Wilcoxen	No	0.9	0.6	0.3	−2.0	−2.3	−2.6
Macroeconomic Advisers (transition relief[5])	Yes	4.3	4.8	13.2			
Robbins	Yes	47.0	57.2		38.8	48.6	
DRI Inc./McGraw-Hill	Yes	13.7			−1.5		
DRI Inc./McGraw-Hill—("VAT")	Yes	−0.7					

Table 1.—Simulation Results: Medium-Run and Long-Run—Continued

[Percent differences from current tax code baseline]

Summary variables	Net change international capital flows	Consumption tax[1] 2005	Consumption tax[1] 2010	Consumption tax[1] Long run	Unified income tax[2] 2005	Unified income tax[2] 2010	Unified income tax[2] Long run
Gravelle	No	1.7	2.7	11.2	0.5	0.9	4.1
Coopers & Lybrand	Yes	1.5	...	...	1.1	...	...
Labor Effort[6]							
Fullerton-Rogers—low[3]	No	...	...	−0.1	...	...	−0.1
Fullerton-Rogers—high[4]	No	...	...	0.0	...	...	0.3
Auerbach, Kotlikoff, Smetters & Walliser	No	0.1	0.1	0.0	−0.9	−0.8	−0.4
Engen-Gale	No	0.1	0.1	0.1	0.1	0.1	0.1
Jorgenson-Wilcoxen	No	6.8	6.6	6.8	5.1	5.0	5.2
Macroeconomic Advisers (transition relief[5])	Yes	−0.3	−0.5	1.7	...	...	...
Robbins	Yes	4.2	4.3	...	4.2	4.3	...
DRI Inc./McGraw-Hill	Yes	1.2	...	...	−1.2	...	...
DRI Inc./McGraw-Hill—("VAT")	Yes	−4.3	...	...	...	...	...
Gravelle	No	0.2	0.2	0.3	0.7	0.7	0.7
Coopers & Lybrand	Yes	1.0	...	...	1.0	...	...
Saving Rate[7]							
Fullerton-Rogers—low[3]	No	...	...	0.1	...	...	0.1
Fullerton-Rogers—high[4]	No	...	...	0.6	...	...	0.3
Auerbach, Kotlikoff, Smetters & Walliser	No	3.9	3.3	1.4	−1.2	−1.0	−0.4
Engen-Gale	No	1.0	0.9	0.7	−0.1	−0.1	0.1
Jorgenson-Wilcoxen	No	−1.0	−1.0	−1.0	−1.4	−1.4	−1.3
Macroeconomic Advisers (transition relief[5])	Yes	−0.2	−0.6	1.1	...	...	...
Robbins	Yes	−3.7	−4.9	...	−2.6	−2.8	...

DRI Inc./McGraw-Hill	Yes	−1.4	....	....	0.9	....	....
DRI Inc./McGraw-Hill—("VAT")	Yes	0.9	....	....	....	....	....
Gravelle	No	0.8	0.7	0.5	0.2	0.2	0.3
Coopers & Lybrand	Yes	−0.1	....	....	−0.1	....	....

[1] Consumption tax with income tax credit—bifurcated, "flat" consumption tax unless noted as a subtraction method value added tax ("VAT").

[2] Unified income tax with income tax credit.

[3] Assumes leisure-consumption (intratemporal) and intertemporal elasticities both are 0.15.

[4] Assumes leisure-consumption (intratemporal) and intertemporal elasticities both are 0.50.

[5] Transition relief allows retention of present law depreciation for existing investments, and of interest deductions and continued deducation of pre-tax change NOL carry-forwards.

[6] Generally represents hours worked or employment.

[7] Percentage point change in the net domestic saving rate.

Table 2.—Simulation Results: Short-Term Effects

[Percent difference from current tax code baseline]

Summary variables	Net change international capital flows	Consumption tax [1]					Unified income tax [2]				
		1997	1998	1999	2000	2005	1997	1998	1999	2000	2005
Real GDP:											
Fullerton-Rogers—low [3]	No	1.2	....	....	....	....	1.3	....	....	....	....
Fullerton-Rogers—high [4]	No	5.8	....	....	....	....	3.6	....	....	....	....
Auerbach, Kotlikoff, Smetters & Wallister	No	1.2	1.7	2.1	2.4	4.0	−0.9	−1.0	−1.1	−1.2	−1.7
Engen-Gale	No	0.8	1.1	1.3	1.4	1.8	0.0	0.0	0.0	−0.1	−0.2
Jorgenson-Wilcoxen	No	3.4	3.6	3.6	3.7	3.6	1.1	1.3	1.5	1.6	1.6
Macroeconomic Advisers (transition relief [5])	Yes	−1.8	−2.0	1.1	4.2	1.4	....	....	....	....	....
Robbins	Yes	7.8	12.4	14.7	14.0	16.4	5.9	9.9	12.1	11.9	14.6
DRI Inc./McGraw-Hill	Yes	−0.3	−1.2	−1.2	−0.8	4.7	−1.5	−4.1	−5.1	−5.3	−1.1
DRI Inc./McGraw-Hill ("VAT")	Yes	−2.3	−7.7	−11.2	−12.5	−4.2	....	....	....	....	....
Gravelle	No	0.1	0.2	0.3	0.3	0.7	0.5	0.5	0.5	0.6	0.6
Coopers & Lybrand	Yes	0.2	0.3	0.3	0.7	1.2	−0.2	0.2	0.4	0.5	1.1
Capital Stock:											
Fullerton-Rogers—low [3]	No	0.0	....	....	....	....	0.0	....	....	....	....
Fullerton-Rogers—high [4]	No	0.0	....	....	....	....	0.0	....	....	....	....
Auerbach, Kotlikoff, Smetters & Wallister	No	1.9	3.8	5.5	7.2	14.0	−0.5	−1.0	−1.5	−2.0	−4.2
Engen-Gale	No	1.4	2.9	4.1	5.3	7.0	−0.1	−0.2	−0.3	−0.4	−0.7
Jorgenson-Wilcoxen	No	0.3	0.6	0.7	0.8	0.9	−0.6	−1.0	−1.3	−1.5	−2.0
Macroeconomic Advisers (transition relief [5])	Yes	−0.3	−1.2	−1.4	−0.2	4.3	....	....	....	....	....
Robbins	Yes	7.7	12.9	17.7	21.2	33.2	3.0	7.9	12.0	14.8	25.8

DRI Inc./McGraw-Hill	Yes	0.0	0.3	1.2	2.7	13.7	−0.1	−0.7	−1.9	−2.8	−1.5
DRI Inc./McGraw-Hill ("VAT")	Yes	−0.1	−1.1	−2.8	−4.6	−0.7	....	....	....	....	....
Gravelle	No	0.0	0.2	0.5	0.7	1.7	0.0	0.1	0.1	0.2	0.5
Coopers & Lybrand	Yes	0.2	0.4	0.5	0.7	1.5	0.0	0.2	0.3	0.5	1.1
Labor Effort [6]:											
Fullerton-Rogers—low [3]	No	0.3	....	....	....	....	0.3	....	....	....	....
Fullerton-Rogers—high [4]	No	3.7	....	....	....	....	2.2	....	....	....	....
Auerbach, Kotlikoff, Smetters & Wallister	No	2.5	1.0	0.4	0.1	0.1	−1.0	−1.0	−0.9	−0.9	−0.9
Engen-Gale	No	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.1
Jorgenson-Wilcoxen	No	6.8	6.9	6.9	7.0	6.8	3.0	3.8	4.3	4.6	5.1
Macroeconomic Advisers (transition relief [5]	Yes	−0.8	−2.2	−0.6	2.3	−0.3	....	....	....	....	....
Robbins	Yes	0.8	4.9	6.3	4.6	4.2	0.6	4.0	5.3	4.1	4.2
DRI Inc./McGraw-Hill	Yes	−0.2	−0.9	−1.4	−1.6	1.2	−0.6	−2.6	−3.8	−4.5	−1.2
DRI Inc./McGraw-Hill ("VAT")	Yes	−0.6	−4.3	−7.7	−9.8	−4.3	....	....	....	....	....
Gravelle	No	0.1	0.1	0.2	0.2	0.2	0.7	0.7	0.7	0.7	0.7
Coopers & Lybrand	Yes	0.0	0.1	0.1	0.4	1.0	0.2	0.0	0.2	0.4	1.0
Saving Rate [7]:											
Fullerton-Rogers—low [3]	No	1.6	....	....	....	....	1.5	....	....	....	....
Fullerton-Rogers—high [4]	No	10.7	....	....	....	....	4.9	....	....	....	....
Auerbach, Kotlikoff, Smetters & Wallister	No	3.7	4.6	4.8	4.8	3.9	−1.4	−1.4	−1.3	−1.3	−1.2
Engen-Gale	No	1.8	1.7	1.4	1.1	1.0	−0.3	−0.3	−0.2	−0.2	−0.1
Jorgenson-Wilcoxen	No	−0.2	0.4	−0.7	−0.7	−1.0	−2.2	−1.9	−1.8	−1.6	−1.4
Macroeconomic Advisers (transition relief [5]	Yes	−1.1	−1.2	0.2	1.2	−0.2	....	....	....	....	....

Table 2.—Simulation Results: Short-Term Effects—Continued

[Percent difference from current tax code baseline]

Summary variables	Net change international capital flows	Consumption tax[1]					Unified income tax[2]				
		1997	1998	1999	2000	2005	1997	1998	1999	2000	2005
Robbins	Yes	1.2	0.6	−0.1	−1.7	−3.7	3.2	1.8	0.6	−0.6	−2.6
DRI Inc./McGraw-Hill	Yes	−0.1	0.1	0.0	−0.1	−1.4	1.2	1.1	1.4	1.7	0.9
DRI Inc./McGraw-Hill ("VAT")	Yes	2.8	2.3	2.9	3.8	0.9	....	....	....	....	....
Gravelle	No	0.8	0.8	0.8	0.8	0.8	0.2	0.2	0.2	0.2	0.2
Coopers & Lybrand	Yes	0.2	0.2	0.1	0.1	−0.1	0.0	0.1	0.1	0.1	−0.1

[1] Consumption tax with income tax credit—bifurcated, "flat" consumption tax unless noted as a subtraction method value added tax ("VAT").

[2] Unified income tax with income tax credit.

[3] Assumes leisure-consumption (intratemporal) and intertemportal elasticities both are 0.15.

[4] Assumes leisure-consumption (intratemporal) and intertemportal elasticities both are 0.50.

[5] Transition relief allows retention of present law depreciation for existing investments, and of interest deductions and continued deduction of pre-tax change NOL carry-forwards.

[6] Generally represents hours worked or employment.

[7] Percentage point change in the net domestic saving rate.

Table 3.—Simulation Results: Effects of Transition Relief

[Percent difference from current tax code baseline]

Summary variables	Net change international capital flows	Consumption tax [1]						
		1997	1998	1999	2000	2005	2010	Long run
Real GDP:								
Fullerton-Rogers—low (no transition) [2]	No	1.2	....	....	....	....	....	1.7
Fullerton-Rogers—low [2] (wage tax [3])	No	1.3	....	....	....	....	....	2.6
Fullerton-Rogers—high (no transition) [4]	No	5.8	....	....	....	....	....	5.8
Fullerton-Rogers—high [4] (wage tax [3])	No	4.3	....	....	....	....	....	4.7
Engen-Gale (no transition)	No	0.8	1.1	1.3	1.4	1.8	2.1	2.4
Engen-Gale (wage tax [3])	No	0.4	0.6	0.7	0.8	1.0	1.1	1.3
DRI Inc./McGraw-Hill (no transition)	Yes	−0.3	−1.2	−1.2	−0.8	4.7	....	....
DRI Inc./McGraw-Hill (transition relief [5])	Yes	−1.1	−2.2	−1.9	−0.8	5.1	....	....
Gravelle (no transition)	No	0.1	0.2	0.3	0.3	0.7	1.0	3.7
Gravelle (transition relief [5])	No	−0.2	−0.1	−0.1	0.0	0.3	0.5	3.7
Coopers & Lybrand (no transition)	Yes	0.2	0.3	0.3	0.7	1.2	....	....
Coopers & Lybrand (transition relief [5])	Yes	−0.5	−0.1	0.1	0.4	1.0	....	....
Capital Stock:								
Fullerton-Rogers—low (no transition) [2]	No	0.0	....	....	....	....	....	5.2
Fullerton-Rogers—low [2] (wage tax [3])	No	0.0	....	....	....	....	....	10.2

Table 3.—Simulation Results: Effects of Transition Relief—Continued

[Percent difference from current tax code baseline]

Summary variables	Net change international capital flows	Consumption tax [1]						
		1997	1998	1999	2000	2005	2010	Long run
Fullerton-Rogers—high (no transition) [4]	No	0.0	....	....	....	....	....	23.8
Fullerton-Rogers—high [4] (wage tax [3])	No	0.0	....	....	....	....	....	20.7
Engen-Gale (no transition)	No	1.4	2.9	4.1	5.3	7.0	7.6	9.8
Engen-Gale (wage tax [3])	No	0.8	1.6	2.3	3.0	3.9	4.3	5.6
DRI Inc./McGraw-Hill (no transition)	Yes	0.0	0.3	1.2	2.7	13.7	....	....
DRI Inc./McGraw-Hill (transition relief [5])	Yes	0.0	0.0	0.6	2.3	14.1	....	....
Gravelle (no transition)	No	0.0	0.2	0.5	0.7	1.7	2.7	11.2
Gravelle (transition relief [5])	No	0.0	0.1	0.2	0.3	0.8	1.3	11.2
Coopers & Lybrand (no transition)	Yes	0.2	0.4	0.5	0.7	1.5	....	....
Coopers & Lybrand (transition relief [5])	Yes	0.0	0.1	0.3	0.6	1.4	....	....
Labor Effort [6]:								
Fullerton-Rogers—low (no transition) [2]	No	0.3	....	....	....	....	....	−0.1
Fullerton-Rogers—low [2] (wage tax [3])	No	0.3	....	....	....	....	....	−0.2
Fullerton-Rogers—high (no transition) [4]	No	3.7	....	....	....	....	....	0.0
Fullerton-Rogers—high [4] (wage tax [3])	No	2.4	....	....	....	....	....	−0.6
Engen-Gale (no transition)	No	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Engen-Gale (wage tax [3])	No	0.0	0.0	0.0	0.0	0.0	0.0	0.0

DRI Inc./McGraw-Hill (no transition)	Yes	−0.2	−0.9	−1.4	−1.6	1.2	....	....
DRI Inc./McGraw-Hill (transition relief [5])	Yes	−0.5	−1.6	−2.0	−1.8	1.6	....	....
Gravelle (no transition)	Yes	0.1	0.1	0.2	0.2	0.2	0.2	0.3
Gravelle (transition relief [5])	No	−0.3	−0.3	−0.2	−0.2	−0.1	0.1	0.3
Coopers & Lybrand (no transition)	No	0.0	0.1	0.1	0.4	1.0	....	....
Coopers & Lybrand (transition relief [5])	Yes	−0.6	−0.5	−0.2	0.1	0.8	....	....
Saving Rate [7]:								
Fullerton-Rogers—low (no transition) [2]	No	1.6	....	....	....	....	....	0.1
Fullerton-Rogers—low [2] (wage tax [3])	No	2.1	....	....	....	....	....	0.2
Fullerton-Rogers—high (no transition) [4]	No	10.7	....	....	....	....	....	0.6
Fullerton-Rogers—high [4] (wage tax [3])	No	8.0	....	....	....	....	....	0.6
Engen-Gale (no transition)	No	1.8	1.7	1.4	1.1	1.0	0.9	0.7
Engen-Gale (wage tax [3])	No	1.0	0.9	0.8	0.7	0.5	0.5	0.4
DRI Inc./McGraw-Hill (no transition)	Yes	−0.1	0.1	0.0	−0.1	−1.4	....	....
DRI Inc./McGraw-Hill (transition relief [5])	Yes	−0.2	0.2	0.2	0.0	−1.6	....	....
Gravelle (no transition)	No	0.8	0.8	0.8	0.8	0.8	0.8	0.8
Gravelle (transition relief [5])	No	0.4	0.4	0.4	0.4	0.4	0.4	0.8

Table 3.—Simulation Results: Effects of Transition Relief—Continued

[Percent difference from current tax code baseline]

Summary variables	Net change international capital flows	Consumption tax [1]						
		1997	1998	1999	2000	2005	2010	Long run
Coopers & Lybrand (no transition)	Yes	0.2	0.2	0.1	0.1	−0.1	....	....
Coopers & Lybrand (transition relief [5])	Yes	0.1	0.2	0.3	0.3	0.0	....	....

[1] Consumption tax with income tax credit—bifurcated, "flat" consumption tax unless noted as a subtraction method value added tax ("VAT").
[2] Assumes leisure-consumption (intratemporal) and intertemporal elasticities both are 0.15.
[3] Transition relief is approximated using a wage tax.
[4] Assumes leisure-consumption (intratemporal) and intertemporal elasticities both are 0.50.
[5] Transition relief allows retention of present law depreciation for existing investments, and of interest deductions and continued deduction of pre-tax change NOL carry-forwards.
[6] Generally represents hours worked or employment.
[7] Percentage point change in the net domestic saving rate.

Table 4.—Effects of Alternative Monetary Policy

[Percent difference from current tax code baseline]

Summary variables	1997	1998	1999	2000	2005	2010
Real GDP:						
Macroeconomic Advisors[1]:						
Managed Reserves[2]	−1.8	−2.0	1.1	4.2	1.4	1.3
Fed Reaction Function[3]	−1.7	−1.4	2.3	2.4	2.8	2.1
DRI Inc./McGraw-Hill—("VAT"):						
DRI Assumption[4]	−2.3	−7.7	−11.2	−12.5	−4.2	......
Generous FED reaction[5]	−2.5	−7.6	−11.0	−12.1	−0.3	......
Capital Stock[6]:						
Macroeconomic Advisors[1]:						
Managed Reserves[2]	−0.2	−1.0	−0.9	1.3	9.3	9.5
Fed Reaction Function[3]	−0.2	−0.9	−0.4	2.0	3.3	5.5
DRI Inc./McGraw-Hill—("VAT"):						
DRI assumption[4]	−0.1	−1.1	−2.8	−4.6	−0.7	......
Generous FED reaction[5]	−0.1	−1.1	−2.8	−4.5	3.5	......
Labor Effort[7]:						
Macroeconomic Advisors[1]:						
Managed Reserves[2]	−0.8	−2.2	−0.6	2.3	−0.3	−0.5
Fed Reaction Function[3]	−0.8	−1.9	0.3	1.8	1.0	0.1
DRI Inc./McGraw-Hill—("VAT"):						
DRI assumption[4]	−0.6	−4.3	−7.7	−9.8	−4.3	......
Generous FED reaction[5]	−0.7	−4.3	−7.6	−9.6	−1.9	......

[1] Consumption Flat Tax with transition relief simulation.

[2] Monetary policy response that "manages"nonborrowed reserves so that after accommodating the initial price level increase, reserves are varied to steer unemployment back to the baseline level.

[3] Monetary policy response using historical Federal Reserve reaction function that responds positively to rises in unemployment and negatively to increases in growth and inflation.

[4] Monetary policy response that "manages" nonborrowed reserves so that after accommodating the initial price level increase, real monetary reserve growth over the next decade would be raised by 1% to accommodate the supply-side potential of an economy with greater capital formation.

[5] Monetary policy response that "manages" nonborrowed reserves so that after accommodating the initial price level increase, interest rates are lowered so that unemployment is promptly pushed back to baseline levels after 2000.

[6] Business capital stock.

[7] Generally represents hours worked or employment.

Table 5.—Simulation Results: Effects of Varying Assumptions About International Capital Flows

[Percent difference from current tax code baseline]

Summary variables	1997	1998	1999	2000	2005	2010	Long Run
Real GDP:							
Gravelle consumption tax[1]:							
No net change in international capital flows	0.1	0.2	0.3	0.3	0.7	1.0	3.7
Capital flows adjust to equalize world-wide rate of return	0.4	0.8	1.2	1.6	2.3	2.3	2.4
Engen-Gale consumption tax[1]:							
No net change in international capital flows	0.8	1.1	1.3	1.4	1.8	2.1	2.4
Capital flows adjust to equalize world-wide rate of return	0.9	1.4	1.8	2.0	2.6	3.1	3.5
Robbins unified income tax[2]:							
No net change in international capital flows	4.8	6.3	6.8	5.9	5.8	6.7	....
Capital flows adjust to return economy to pre-policy after-tax rate of return	5.9	9.9	12.1	11.9	14.6	15.4	....
Capital Stock:							
Gravelle consumption tax[1]:							
No net change in international capital flows	0.0	0.2	0.5	0.7	1.7	2.7	11.2
Capital flows adjust to equalize world-wide rate of return	1.3	2.5	3.8	5.2	6.8	6.8	6.9
Engen-Gale consumption tax[1]:							
No net change in international capital flows	1.4	2.9	4.1	5.3	7.0	7.6	9.8
Capital flows adjust to equalize world-wide rate of return	1.8	3.7	5.9	7.5	10.1	12.2	15.1

Robbins unified income tax[2]:							
No net change in international capital flows	1.5	2.5	3.4	3.9	5.9	7.9	....
Capital flows adjust to return economy to pre-policy after-tax rate of return	3.0	7.9	12.0	14.8	25.8	28.3	....
Labor Supply:							
Gravelle consumption tax[1]:							
No net change in international capital flows	0.1	0.1	0.2	0.2	0.2	0.2	0.3
Capital flows adjust to equalize world-wide rate of return	0.0	0.0	0.0	0.0	0.2	0.3	0.2
Engen-Gale consumption tax[1]:							
No net change in international capital flows	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Capital flows adjust to equalize world-wide rate of return	01.	0.1	0.1	0.1	0.1	0.1	0.1
Robbins unified income tax[2]:							
No net change in international capital flows	0.5	3.4	3.7	2.1	1.9	2.3	....
Capital flows adjust to return economy to pre-policy after-tax rate of return	0.6	4.0	5.3	4.1	4.2	4.3	....

[1] Consumption tax with income tax credit—bifurcated, "flat" consumption tax unless noted as a subtraction method value added tax ("VAT").

[2] Unified income tax with income tax credit.

B. Analysis of Simulation Results

The fact that all of the models project that tax restructuring in the form of a consumption tax will ultimately produce higher economic growth arises because all of the models are based on a set of commonly held assumptions about economic behavior. Even the three models that focus on short-run disequilibrium effects (MA, DRI, and CL) have these properties in the long-run. These properties include the following basic assumptions: reducing the cost of capital through less taxation of capital provides an incentive for additional investment; reducing the marginal tax rate on labor provides an incentive for increased labor effort; increasing the returns to labor through capital deepening can provide an incentive for more labor; and, (for models with detailed production sectors) reducing distortions in investment decisions by eliminating differential taxation of different types of capital promotes a more efficient allocation of resources.

The fact that the simulations project considerable variation in the magnitude and time path of this growth arises from a variety of sources. The extent to which a change in tax policy affects economic growth is determined by the magnitude of the change in policy and by the responsiveness of producers and households to that change. Economic modeling of these effects differs both because measurement of the tax policy change itself is problematic, and because modeling responses to that change differ. The variations in responses within these models arises from both major structural differences (such as whether or not a given model includes short-term disequilibrium effects or intertemporal considerations) and from differences in assumptions about key behavioral parameters (such as the assumed sizes of labor supply and savings elasticities).[18]

Characterization of the tax system

Ironically, one of the major difficulties in modeling the consequences of changes in tax policy arises from the complexity of the current tax system, which presents challenges to both measurement and modeling specification. In order to measure the effects of a change in tax policy, it is necessary to first accurately measure taxation under present law. Unlike many of the other sources of variations in modeling results, the present-law tax code is a known quantity; thus, it would seem to lend itself to uniform measurement across models. However, problems arise because the requirements of fully modeling the complexity of the U.S. tax code go far beyond the level of articulation of the consumption, labor, and capital sectors in any of the models participating in this experiment. In reality, the marginal tax rate on capital varies considerably depending on which industry the capital is in, the income level of its owner, the length of time it is held, and the way in which the in-

[18] In general, an elasticity defines the percent change in an economic variable that results from a percentage change in its price. Elasticities used here are: (1) Labor elasticity—percent change in labor effort with regard to a percent change in the real after-tax wage rate; (2) Savings Elasticity—percent change in the savings rate with regard to a percent change in the after-tax interest rate; and (3) Elasticity of Substitution—the percent change in the ratio of capital to labor that results from a percentage change in the price of capital relative to the price of labor.

come it generates is distributed to its owners. In addition, the marginal tax rate on labor varies depending on marital status, the number of dependents, income level, the age of the laborer, and numerous other factors.

For the most part, models that include production decisions by multiple industries, such as J–W, DRI, and MA, have consumption and/or labor decisions made by one representative household. Conversely, most models that include consumption and labor supply decisions by multiple households, such as AKSW, E–G, and Gravelle, have one aggregate producer. The concentration of disaggregated decision-making in either the production sector or the household sector is not accidental. Modelers limit the number of behavioral equations in order to facilitate the derivation of an equilibrium solution. Two models, F–R and C–L have both multiple production decision-makers and multiple consumption decision-makers; F–R also has multiple suppliers of labor. Both of these models sacrifice sophistication in other areas of modeling in order to achieve this differentiation.

The aggregated producer and household sectors in each of the models face average marginal tax rates derived from a data base including large numbers of agents. This provides an adequate level of detail for modeling generic types of tax policy initiatives, such as a switch from a pure income tax to a pure consumption tax. However, the modeling of tax policy changes from the actual present-law tax system is a more complicated task. Consequently, two models with relatively similar theoretical structures can produce very different results. For example, the AKSW and F–R models are structurally similar in many ways, but in their initialization of the present-law tax system, they have different measures of the existing tax base. The influence of this difference partly explains differences in their long-run results for the unified income tax simulations; both the low- and high- elasticity F–R simulations produce a long-run increase in GDP and the capital stock, while the AKSW simulation produces a long-run decrease in GDP and the capital stock.

The F–R model, for example, accounts for detailed substitution of resources from one sector to another and can show changes in overall economic efficiency of the allocation of national economic resources. While many models assume aggregate elasticities of substitution between capital and labor of 1.0 (as shown in Table 6), substitution of investments between the business sector and the residential housing sector are assumed to occur easily and without delay in the J–W model, adding to the positive effects of the tax change. In contrast, the C–L model includes factor substitution elasticities for each sector of the economy and generates a relatively low aggregate substitution elasticity between capital and labor (less than 0.3). This helps to diminish sensitivities to tax law changes. Similarly, the DRI model assumes a slow adjustment process as business capital substitutes for housing capital, which causes significant adverse impacts on household wealth held in the form of residential housing assets and consequently short-term adverse effects on GDP. (See DRI results in Table 2).

Model structure, work effort, and saving responses

Tables 1 through 5 include information about changes in the capital stock, the labor supply, and the saving rate in order to illustrate the range of behavioral responses by the factors of production that underlie the changes in GDP induced by tax restructuring. The range in factor responses is similar to the range in GDP responses, with a medium-run increase in labor effort due to a switch to a consumption tax that clusters between 0 and +1 percent, but includes values ranging from −4.3 percent in the DRI VAT simulation to 6.8 percent in the J–W simulation. Similarly, medium-run changes in the capital stock range from −0.7 percent for the DRI VAT to 47 percent in the Robbins consumption tax, with a loose cluster between approximately 1 and 4 percent. Differences in both model structure and assumed behavioral parameters help explain the wide range of results.

In terms of model structure, volatility in responses in the short- and medium-run over time and between simulations is typical of the models that include a monetary sector and provide for a disequilibrium adjustment path (MA, DRI, and C–L). More discussion of the impact of disequilibrium concerns appears below in the section on short-run adjustments and the monetary sector. Similarly, the large labor supply and capital stock changes in the Robbins model can be explained in part by the role that changes in international capital flows play in his model. More about this issue appears below in the section on international capital flows below.

This class of models has the characteristic that the responsiveness of labor and capital to both tax changes and the actions of other economic agents are based on exogenously imposed, constant labor and savings elasticities.[19] The other models in this experiment, referred to as "intertemporal models," include two different types of behavioral responses. The first type is the conventional intratemporal (within one period) substitution between work and leisure. The second type of behavioral responses include (1) the intertemporal substitution between current and future consumption, which affects the responsiveness of savings, and (2) the intertemporal substitutions between current and future leisure, which affects the responsiveness of labor.

This last response merits more explanation. Consumption in these models includes leisure. This implies that events that cause the cost of current consumption to rise relative to the costs of future consumption will cause a decline in current consumption, including leisure. The decline in current leisure means an increase in current labor effort. Through this mechanism, the intertemporal models provide people with additional reasons to change their labor effort: labor effort is responsive to anticipated changes in the price of future consumption which is reflected in interest rates, as well as to the after-tax rate of return on labor. As a result, the responsiveness of labor and capital in these intertemporal models is determined by the interaction between the intra- and inter-temporal parameters generated within the simulations, and is thus less easily measured than the exogenously imposed labor and saving elasticities.

[19] Constant elasticities were assumed by the MA, DRI, C–L, Robbins, and Gravelle models.

Behavioral sensitivities in models (Table 6)

Table 6 shows the behavioral parameters used in each of the models; those with the exogenously imposed elasticities appear on the top portion; those with the intertemporal parameters appear on the bottom portion. In general, the higher elasticity values lead to stronger macroeconomic effects. For example, Robbins' open economy simulation, which shows the largest GDP changes of any model, employs the largest direct elasticity, 1.0 for domestic savings. When combined with the Robbins assumption that net international capital flows from abroad increase by whatever amount is necessary to bring the after-tax rate of return on capital back to the baseline level, his simulations show growth in GDP and capital formation significantly larger than any of the other simulations. With the 1.0 savings elasticity, the Robbins closed economy simulation of the unified income tax (appearing in Table 5) continues to show higher growth than most of the other simulations. Robbins' assumptions contrast with savings elasticities of 0.2 to 0.4 for Gravelle, 0.2 for MA, and 0.4 for C–L. The range of elasticities for these latter three appears to be within a relatively wide range of estimates from the economic literature on these topics.[20]

The bottom portion of Table 6 shows the response parameters in the intertemporal models. Again, the models with higher response parameters generate larger GDP growth in their tax policy simulations. This is demonstrated directly by the two F–R simulations, which vary only in the size of the response parameter. Between the F–R "Low" (both intertemporal parameters set to 0.15) and "High" (both parameters set to 0.50) the long-run GDP impact varies by a factor of two. The largest labor effort response from the intertemporal models comes from the J–W simulation, which uses the highest intertemporal parameter.

[20] For surveys of literature results, see Jane G. Gravelle, *The Economic Effects of Taxing Capital Income,* 1994, and Congressional Budget Office Memorandum, "Labor Supply and Taxes," January 1996.

Table 6.—Behavioral Sensitivities Assumed in Models

Participants' model	Labor supply elasticity		Savings rate elasticity	Factor substitution elasticity
	Compensated	Uncompensated		
Macroeconomic Advisers	N/A	0.3	0.2	1.0
Robbins	N/A	0.2	[1] 1.0	1.0
DRI Inc./McGraw-Hill	N/A	0.2	0.2	1.0
Gravelle:				
Income tax	0.2	0.0	0.2	1.0
Consumption tax	0.2	0.0	0.4	1.0
Coopers & Lybrand	0.2	0.0	0.4	[2] <0.3

Participants' model	Intratemporal parameter	Intertemporal parameter	Factor substitution elasticity
Fullerton-Rogers:			
Low sensitivity	0.15	0.15	[3] 0.8
High sensitivity	0.50	0.50	[3] 0.8
Auerbach, Kotlikoff, Smetters & Walliser	0.80	0.25	1.0
Engen-Gale	[4] 0.80	0.30	1.0
Jorgenson-Wilcoxen	0.80	1.00	[5] 0.2

[1] Indicates elasticity within a closed economy. Note: the model's open economy assumption is that when net international capital flows are allowed, an infinite amount of savings becomes available for U.S. investment as long as real after-tax returns to capital are above baseline levels.

[2] The producers equipment portion of capital spending uses an elasticity of 0.3; the remaining structures portion uses a zero elasticity.

[3] Weighted average of elasticities that vary by industry within the model.

[4] The Engen-Gale model's labor supply assumption, which only allows a discrete choice between working full time and working at all, lowers the sensitivity of labor to changes in wages. As a result the approximate uncompensated labor supply elasticity is close to zero.

[5] Value-added weighted average of industry elasticities. The value of the median elasticity is 0.32.

The role of all the behavioral responses in the intertemporal models is determined by equations derived from basic microeconomic principles of utility-maximizing consumers and profit-maximizing producers. Thus, the proponents of these models claim that their model structure is based upon more theoretically pure, "deep parameters" than the exogenously imposed elasticities of the other models. Critiques of intertemporal approaches focus on the fact that by taking into account fundamental behaviors deduced from theory alone, these models provide no check on whether sensitivities are realistic. Complicating the use of intertemporal parameters, which also must be exogenously imposed on the models, is the fact that no clear consensus on the size of these deep parameters currently exists.[21]

Other factors that interact with these parameters and elasticities can also affect the results. Such factors include assumptions about whether households are farsighted or myopic with regard to their predictions of future income, and the degree to which savings is driven by precautionary or bequest motives rather than intertemporal motives. Myopic expectations in the F–R model, for instance, increase short-run responses relative to long-run responses because households do not anticipate that interest rates, raised by the tax law change, will return to baseline levels as capital formation increases. In contrast, AKSW show short-run results that are much smaller than long-run impacts, partly because of an assumption of perfect foresight by households.

The J–W infinitely-lived framework heightens the sensitivities of current work effort to the lowered present value of after-tax incomes to generations far in the future, leading to heightened short-term labor responses in order to offset lost future income. The assumed motivations for household saving also play an important role where set-asides for bequest reasons, assumed in the F–R model, reduce the sensitivity of saving and capital formation to changes in tax laws. The E–G assumption of savings set-asides to meet future uncertainties ("precautionary" saving motive) also reduces the savings response to tax law change.

The paper in Part VI by Ballard, which analyzes all four intertemporal simulations, stresses the importance of structuring these models so that the resulting composite behavioral elasticities are within the bounds of those estimated in the economics literature. Ballard acknowledges the considerable contribution to understanding the long-run dynamics of the economy made by intertemporal models, but points out that the simplifying assumptions in these models can cause too great a separation between the models and the economic realities they are trying to simulate.

This observation is particularly important in the context of assessing possible contributions of these models to the very applied process of revenue estimating. On the other hand, clarifying assumptions such as, for example, the precautionary savings motive in the E–G model and the use of multiple producers and consumers in the F–R model, represent significant steps toward improving the realism of model results.

[21] For a survey of temporal parameter estimates found in the literature see Alan Auerbach and Laurence Kotlikoff, *Dynamic Fiscal Policy*, Cambridge University Press, 1987.

Short-run adjustment

A number of factors cause variations in the reported results over the short run. Temporary demand-side effects are considered only by the DRI, MA, and C–L models. As a result, their estimates differ significantly from the general-equilibrium and intertemporal model results. These differences are illustrated in Table 2, which shows that real GNP declines under the flat tax in the DRI and MA simulations. These negative effects are due to several factors, including rigidities in labor and other markets, general price uncertainty, and adverse short-term wealth and income effects. In the DRI and MA simulations, these adverse demand-side effects in the short-run dominate changes from supply-side factors such as labor supply and capital formation.

It is often assumed that a consumption tax in the form of a VAT is economically equivalent to a flat tax, differing only in the point of collection of the tax when the tax bases are identical. This proposition is challenged in the DRI and MA analysis which highlights an important price-level distinction between the two consumption tax systems.

Monetary factors

Both the DRI and MA models identify a relationship between equilibrium prices and unit labor costs, in which changes in consumer prices are related directly to changes in unit labor costs. It is noteworthy that the flat tax and the VAT apply very different forces to this price-labor cost relationship. Under a flat tax, labor continues to pay the tax on wages, and so unit labor costs increase only to the extent that other labor compensation becomes nondeductible. Under a VAT, labor compensation is entirely nondeductible to businesses. Thus, assuming workers resist the lowering of their nominal wages, the VAT exerts markedly greater pressure on the general price level than a flat consumption tax.

This distinction between a VAT and a flat consumption tax supports the view that a VAT will require greater Federal Reserve accommodation to avert involuntary unemployment; while a flat tax may be consistent with greater initial price stability. This argument plays an important role, as demonstrated in the DRI simulations, in distinguishing between anticipated macroeconomic effects coming from the VAT versus the flat consumption tax.

The importance of the Fed's management of the transition to a new tax system is fully discussed in the DRI and MA papers. Some observers have maintained the view that the Fed's management of the transition may play the dominant role in determining the short-term dynamic effects of major tax restructuring; others suggest that international capital flows will play the primary role.

International capital flows

An important source of variation in the simulations results is the approach each model takes concerning international capital flows. While each model contains an implicit assumption relating to how tax policy affects the flows of capital into the U.S. economy, it is difficult to disentangle these effects from other interactions in the simulations.

Three of the participants, Robbins, Engen, and Gravelle, conducted sets of simulations that altered only the assumption about international capital flows. These contrasting simulations are highlighted in Table 5. Under the open-economy assumption, all three of these models project additional growth effects due to changes in capital flows that range from 44 percent to well over 200 percent by the year 2005, nine full years into the simulation. Although these differences are diminished (or reversed in the Gravelle simulation) over longer time spans, they remain large, in percentage terms, into the long run. In all three cases, the role of capital flows appears to accelerate the induced capital formation in the short- to medium-run period, although longer run effects are mixed. Although DRI, C–L, and MA simulations are based on an open economy, they do not provide an alternative simulation to help identify the role that the international sector plays in their results.

The most significant impact of the international sector appears in the Robbins simulations, in which international capital flows account for most of the capital formation induced by the tax policy. The strength of this result arises in part from Robbins' underlying assumption that capital will flow into the United States until the after-tax rate of return to capital returns to its pre-policy level. Engen and Gravelle use the more standard small open economy assumption that international capital flows into the United States until the before-tax rate of return on capital reaches its pre-policy levels. The three models differ in their view as to which simplifying assumption is a better baseline assumption: Gravelle and Engen view their closed economy simulations as their base case, while Robbins promotes the open economy simulation.

All of the models that attempt to simulate the role of the rest-of-the-world lack substantial detail in their portrayal of international taxation. The U.S. tax system levies a tax on the worldwide activities of U.S. taxpayers and provides a foreign tax credit for certain foreign income taxes paid. In addition, U.S. income earned by, and repatriated to, foreign taxpayers is typically subject to a U.S. withholding tax that varies from country to country based upon treaty agreements. The countries comprising the rest of the world also support their own unique systems of taxation for foreign income and foreign factors. This complex system of taxation is distilled down to a few simplifying assumptions in all of the models that attempt to portray international capital flows. This simplification is important in making the models manageable. However, the range of results directly induced by the treatment of international capital flows illustrates the sensitivity of the economy to international capital flows and the importance of improving the accuracy of predictions about actions in the international sector. International capital flows play a role similar to short-run, demand-side issues, injecting greater uncertainty in the reliability of the predictions. Unlike demand-side factors, however, this uncertainty persists strongly into the distant forecasting horizon.

Although an ambitious effort to model international capital flows may shed more light on the mechanics of the process, such an effort may be severely hampered by the complexity of modeling the foreign response to large variations in international capital flows.

Transition effects

The inclusion of transition relief for holders of existing capital in the consumption tax restructuring simulations significantly reduces the amount of projected economic growth resulting from restructuring. There are a number of reasons for this.

First, transition relief reduces macroeconomic impacts because relief requires a higher tax rate. As stated previously, two separate approaches were used to assess the effects of transition relief. The first approach involves detailed simulation of the specified transition proposal relating to depreciation of existing capital, NOLs, etc. The second approach imposes a wage tax as a proxy for the detailed proposal under the first approach. Both of these approaches initially reduce the tax base relative to full implementation of tax restructuring. Consequently, in order to enforce deficit neutrality, as required for the exercise, tax rates must be higher than tax rates calculated for the non-transition relief simulations, and this reduces incentive effects.

Second, transition relief creates differential savings effects across individuals and this can reduce the average rate of saving in the economy. The differential savings effects are most evident in life-cycle models such as the AKSW, F–R, and E–G models which track household saving rates that vary by age cohort. It is assumed in these models that older generations are capital income earners with lower saving rates—possibly even negative—while younger adults are generally wage earners with higher saving rates in preparation for old age. Indeed, one of the major determinants of changed aggregate saving rates resulting from the consumption tax restructuring in these models comes from burdening these two groups differently. For example, if tax burdens are redistributed from taxpayers with high savings rates to taxpayers with high consumption rates, as is the case with consumption tax restructuring, the aggregate national savings rate would rise even if individual saving behaviors were insensitive to tax law change. When transition relief is added to consumption tax restructuring, this redistribution effect is lessened, reducing the aggregate saving rate increase. Savings by the young are reduced while additional savings by the old are small, reducing average saving in the economy relative to tax restructuring without transition relief. Reducing the average saving gain from tax restructuring reduces capital formation and long-run economic growth.

C. Implications of Analysis for Revenue Estimating

The goal of the JCT modeling project is to use the modeling results of generic tax restructuring proposals to help answer questions about the quality of model-generated macroeconomic information and the value of this information in the context of the Congressional budget process. The preceding section analyzes the similarities and differences in the approaches to modeling these effects. This section narrows the focus to consider the implications of the JCT project for the specific task of providing the information necessary in the Federal budget process.

The broad consensus of all the modeling approaches, that moving from the present-law income tax base to a uniform consumption tax base will result in a long-run increase in GDP, capital investment, and labor effort, provides some assurance that economic analysis can provide useful qualitative information about the long-run macroeconomic effects of major tax policy changes. These simulations have provided a generally uniform view of the role of the tax system in the decision-making of consumers, workers, and investors. This information is valuable to the JCT staff in its continuing efforts to provide Members of Congress with qualitative information about the economic effects of major tax policy changes.

The models in this project provide a more integrated approach to budget estimation than currently prevails in the Congressional budget process. Examples of this are demonstrated in the determination of the budget-neutral tax rate in the simulations where (1) changes in labor effort induced by tax restructuring automatically feed into estimates of the receipts from the payroll tax; (2) tax-induced changes in interest rates have direct effects on the estimated cost of servicing the national debt; and (3) increases in savings, in the near term, reduce the tax base under a consumption tax. These types of interactions would generally be picked up in the present budget process on a regular basis through the periodic forecast revisions provided by CBO. They are not typically included in the scoring of specific tax (or spending) legislation.

The suitability of the models for forecasting the macroeconomic effects of tax policy changes for use in the budget process is more problematic. The problems arise both from the nature of the budget process itself, and from the nascent state of the economic art with respect to the modeling of the macroeconomic effects of tax policy.

The problems posed by the Congressional budget process can be divided into two categories: (1) the budget is produced for a short-to-medium time horizon, and requires corresponding short- to medium-term revenue estimates; and (2) the Congressional process of finalizing tax and spending proposals typically involves intensive, last-minute negotiations that require budget estimates for many policy variations, potentially under severe time limitations. This combination of requirements is of particular concern because revenue estimating for Congressional budget purposes requires point estimates of the projected change in tax revenues due to proposed changes in tax law for each of the years following enactment of the proposal.[22] One of the conclusions of the pre-symposium seminars is that none of the currently available models is capable of being adapted quickly for the modeling of numerous variations of tax policy changes. This observation may be in large part attributable to the simplified representation of the tax structure incorporated in most of the models.

The range of results from the simulations presented in section A., above, is indicative of the fact that there is no clear consensus within the economic profession as to the correct way to model and forecast the effects of tax policy changes on the macroeconomy. While the profession is in general agreement as to the direction of effects of certain types of changes once the economy has had time

[22] Point (single number) estimates are necessary to enable the Budget Committees to make judgments as to whether the proposed package of tax and spending changes satisfies certain Congressional "PAYGO" rules that specify exact offsets for tax cuts and entitlement spending increase.

to adjust (has reached long-run equilibrium in the models), it is not yet able to model these changes precisely on a yearly basis, particularly in the short-run, when the economy is not yet in equilibrium. It would be possible to narrow these differences in results by abandoning certain assumptions that appear in some of the models on the grounds that they are well outside of the mainstream of understood responses in the large body of economics studies.

However, there are many other areas of uncertainty in modeling tax policy changes that are not so easily resolved. First, there are significant differences between those models that attempt to model disequilibrium effects, and those that do not. These differences arise from the fact that the disequilibrium modelers take into account disruptions in demand, including involuntary unemployment, that are likely to arise from major tax policy changes. Because of these disruptions, the disequilibrium models obtain results for the short run that are substantially different from those of the other models.

It has been suggested by some that it is neither necessary nor desirable to attempt to model these demand-side disruptions. They argue it is not necessary because one can assume that, on average, the Fed will apply monetary policy options to maintain full employment. However, the simulations that target full employment using monetary policy suggested that (1) it would not be possible for the Fed to ensure full employment quickly in the face of a major tax restructuring because of the sluggishness of the response of various economic agents to its initiatives; and (2) it is very difficult to predict either the actions of the Fed or the timing and strength of reactions by firms and households to Fed policies with any degree of certainty. Reifschneider highlights these observations in his paper. The assumption that the Fed will try to maintain a full employment economy in the face of major tax reform is neither a completely foregone conclusion nor a guarantee that anything close to full employment will be achieved in the short run.

The uncertainty about domestic disruptions and the actions of the Fed is compounded by the additional uncertainty that arises over the possible actions of the international economy. The state of modeling international capital flows, including such considerations as changes in the exchange rate and actions taken by foreign governments to control flows of capital, is acknowledged by most of the modelers to be rudimentary and uncertain. As the separate simulations for open and closed economies demonstrate, short- and medium-run results are highly sensitive to the actions of the international sector.

It is important in the budget process to convey the possibility of major economic disruptions in the short run, because the short run is precisely the time frame considered formally in the legislative process. Policy makers might find it difficult to explain large discrepancies between their forecasted budgets and actual deficits in the face of large numbers of involuntarily unemployed workers and rising Federal debt service costs. Moreover, the depressing effects that major demand disruptions may have on the economy persist throughout the 10-year budget window in the only disequilibrium simulation (MA) that provides data for that period.

The discrepancy between long-run equilibrium and short-run demand effects may not be nearly so large for less sweeping tax changes. In such cases, the risks of ignoring disequilibrium and international effects may be moderate. There are, however, still unresolved issues with respect to modeling supply-side effects. The tax sector is not modeled completely enough in any of the models to reflect the differential effects of tax policy changes on taxpayers in different industries or with different socio-demographic profiles. In many cases, this lack of detail extends to the empirical literature from which behavioral parameters must be drawn. For proposals of a more modest scale, this more subtle modeling issue of the influence of redistribution of tax burden between taxpayers on the macroeconomic outcome is likely to be significant.

In addition, theory suggests that a complete understanding of tax policy initiatives would require understanding the trade-offs firms and households make between present and future actions. None of the existing intertemporal models includes all of the considerations that theory would indicate should be included; such considerations include precautionary savings, multiple decision makers in the household and production sectors, minimum consumption and maximum labor effort parameters, and endogenous bequest motives. The observed sensitivity of the results of the intertemporal simulations to these considerations suggests that the influence of these factors on the macroeconomic outcome is also likely to be significant.

Tax restructuring was chosen as the subject for this modeling exercise because it is assumed that this type of tax policy change would be the most likely to have the type of significant macroeconomic feedback effects that would ideally be incorporated in revenue estimates. The results of the modeling exercise demonstrated that it is precisely this large-scale type of change that presents the areas of greatest uncertainty for short-term estimates. Because of the continuing Congressional interest in major tax restructuring, it is necessary for the modeling of the disequilibrium effects of this type of proposal to be advanced as quickly and as thoughtfully as possible.

V. STRATEGY FOR THE FUTURE

The JCT staff is committed to continuing to advance the modeling of the effects of tax policy, with the eventual goal of incorporating, when appropriate, macroeconomic effects in revenue estimates of tax proposals. As discussed in Part IV, the modeling project suggests several areas in which currently available economic modeling technology needs to be improved before it will be useful in the revenue estimating process. In addition, there is considerable uncertainty about a number of behavioral assumptions that are integral components to all the models. Further, there are institutional constraints to estimating the macroeconomic effects of tax policy that need to be explored further. A three-part strategy for addressing these issues is discussed below.

Advance tax modeling technology

From a revenue estimating perspective, the models involved in this experiment generally lack sufficient articulation of the tax treatment either of different business sectors, of different types of households, or both, to simulate accurately the effects of a range of potential changes in the tax code. Some of the models lack detailed Federal fiscal policy or international sectors, and most lack explicit detailing of a near-term adjustment process. Additionally, there is a lack of consensus on fundamental behavioral responses to tax change.

To address these issues, the JCT staff will work toward developing a macroeconomic model prototype that incorporates reasonably detailed tax and Federal fiscal sectors. The JCT staff plans to examine further the range of models represented in the completed modeling project to determine how different model types might be adapted. This effort will include consulting with outside modeling experts as needed.

In particular, a detailed representation of the present-law income tax will be developed based upon tax return and other available data. JCT micro-simulation models of corporate and individual taxpayers can be used to determine the effects of tax proposals on such variables as the marginal tax rate on capital in different business sectors, and the marginal tax rate on labor for different household types. The JCT staff will work to identify analytically useful ways to aggregate this information into a form that may be incorporated in a model that has macroeconomic simulation capacity. Additionally, based on modelers' experiences, the prototype development will examine the possibilities for incorporating explicitly modeled monetary policy, international capital flows, and behavioral responses.

Examine behavioral issues

The modeling project reveals additional fundamental areas of uncertainty in forecasting tax policy consequences. These include making assumptions about the magnitude of taxpayer behavioral responses, and predicting reactions of the Fed and the international sector. JCT staff will invite outside economists to participate in working groups to study these issues more intensively, with the ultimate goal of either reducing uncertainty about these parameters or determining how to adjust for this uncertainty in the revenue estimating process.

An extension of this study effort may include additional modeling projects involving outside modelers. These subsequent modeling projects would address in greater detail central behavioral assumptions. JCT Revenue Estimating Advisory Board members have recommended two possible approaches for such additional research: (1) modeling a more specific type of policy change such as a large cut in taxation of income generated from capital assets or a revamping of the individual income tax structure; and (2) applying the models to past tax legislation such as the Economic Recovery Tax Act of 1981 and the Tax Reform Act of 1986 and comparing results to historical experience.

Coordinate institutional roles

Pursuant to provisions of the Congressional Budget and Impoundment Control Act of 1974, for budgeting purposes, the CBO produces a forecast of macroeconomic aggregates, including Federal Government receipts and expenditures. The JCT staff uses this forecast produced by CBO for its "baseline" assumptions about the path of the economy under present law as a starting point for all its revenue estimates. It has traditionally been the responsibility of CBO to revise annually the economic forecast used for budget purposes as part of the budget resolution process. These revisions are based on an analysis of tax and expenditure proposals taken as a whole. If the JCT staff were to begin unilaterally incorporating macroeconomic effects in estimates of specific tax proposals, CBO's expenditure scoring and JCT's revenue scoring could end up relying on incompatible underlying assumptions about the economy.

The JCT and CBO staffs are forming a working group to explore issues of coordination between the two agencies with respect to both institutional roles and the interaction between revenue and expenditure assumptions. The group will exchange information concerning macroeconomic modeling activities; study the interaction between expenditure and tax proposals in a macroeconomic context; and discuss issues of coordination as the modeling technology advances.

In the context of including possible macroeconomic effects, a further institutional constraint faced by the JCT staff relates to the number of tax proposals analyzed each year, and the speed with which these proposals must be estimated and modified during the legislative process. All participants of the modeling project agreed that it would be quite time-consuming to re-configure any of the existing models to analyze variations of a given set of tax proposals. It will be necessary to produce guidelines for determining which tax proposals would be appropriate for such macroeconomic analysis, and how to treat numerous variations on these proposals. This issue will be addressed by the JCT/CBO working group and by the JCT staff along with its consultants and Revenue Estimating Advisory Board.

The JCT staff anticipates that a substantial amount of time and effort will be required to complete the modeling foundation work necessary for the inclusion of macroeconomic effects into the formal revenue estimating process. The time frame over which this will be accomplished will be determined in part by the amount of resources the JCT staff has to devote to this effort, and by the other demands made on JCT staff in the legislative process. In the interim, the JCT staff will continue to provide qualitative analyses of the macroeconomic effects of tax proposals as requested by Members of Congress. The information gained during the modeling project will be incorporated into these analyses.

VI. SYMPOSIUM PAPERS AND COMMENTS

INTERTEMPORAL GENERAL EQUILIBRIUM MODELS

1. Diane Lim Rogers*

"Assessing the Effects of Fundamental Tax Reform With the Fullerton-Rogers General Equilibrium Model"

Introduction

As part of the JCT project on tax modeling, this paper examines the economic effects associated with fundamental tax reform using the Fullerton-Rogers general equilibrium life-cycle model. The results are based on simulations that replace current corporate and personal income taxes with comprehensive income, consumption, and wage taxes.

Although the various tax reform proposals come under many different labels, they share much in common in their economic effects. Most proposals move away from the taxation of capital income by adopting something more like a consumption base than like an income base. In addition, most proposals, whether consumption-based or not, move toward an efficiency-enhancing "flattening" of the rate structure, both in terms of lower rates and in terms of a leveling of rates across different goods and factors.

I. Description of the Fullerton-Rogers Model

The Fullerton-Rogers model specifies lifetime optimization on the part of consumers according to the life-cycle theory. Consumers maximize lifetime utility by borrowing and saving so that consumption is smooth relative to annual income. Capital markets are assumed to be perfect. Consumers are distinguished into twelve groups according to the levels of their lifetime incomes, which allows the analysis of the distributional effects of taxes. For each group, we have a separately-estimated lifetime wage profile, and separate amount for inheritance and bequest.

All groups have the same nested, lifetime utility function with several levels of decision-making. After consumers calculate the present value of the lifetime labor endowment ("lifetime income"), they decide how much of it to "spend" in each period. Then, within each period, consumers decide how to allocate that spending between leisure and consumption. That period's endowment minus leisure determines labor supply, and income minus consumption determines saving. The labor-supply response to a change in tax

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policy depends on the substitutability of consumption for leisure and the savings response depends on the substitutability of consumption across periods. The size of these responses can be altered by changing the values of certain parameters (elasticities of substitution) in the model.

In later stages of the utility-maximization problem, the consumer allocates that period's consumption among the available consumer goods. The model specifies minimum required purchases and shares of discretionary purchases for 17 different consumer goods by consumer age, resulting in consumption bundles that differ across age and lifetime-income categories.[1] Even though all consumers have the same utility function, those with low income spend relatively more on goods with high minimum purchases. Thus, the distribution of the tax burden depends on how the different groups spend their incomes, in addition to how they earn them. In addition, consumers can substitute between corporate and noncorporate versions of each consumer good. The imperfect substitutability of corporate and noncorporate goods explains their coexistence despite the higher tax burdens placed on corporate production under current tax law.[2]

Compared to a simpler life-cycle specification, two of the features on the consumption side work to produce a lower responsiveness of saving to changes in the rate of return. First, bequests are exogenously determined; hence, a large fraction of the capital stock (over 40 percent) is insensitive to relative price changes. Second, the specification of minimum required consumption at each age limits the degree of substitution across time (and for leisure as well).

The model also specifies a disaggregate production side, with corporate and noncorporate producers, 19 industries, five types of capital, and labor. The profit-maximizing decisions of producers are made on an annual basis. Producers can substitute between capital and labor as well as among different types of capital. Resources can flow between the corporate and noncorporate sectors. The switch to consumption tax and the greater neutrality of the tax system will affect economic efficiency by reducing the substitutions caused by taxes. In addition, the fundamental reform will contribute to tax incidence through effects on both sources and uses of income. The resulting redistribution of income can have feedback effects on economic variables such as saving and output. The model accounts for all of these effects in the general-equilibrium calculations.

The appendix to this paper provides a more detailed description of the Fullerton-Rogers model. For more detail still, see Fullerton and Rogers (1993).

II. Model Simulation Results

In the model's 1993 benchmark, the marginal tax rates on corporate and personal income are set at .395 and .25, respectively, based on economy-wide weighted-average calculations. The values for other tax parameters such as depreciation allowances and tax

[1] See chapter 5 of Fullerton and Rogers (1993) for a full description of the parametrization of this subutility function. Parameter values were estimated from the Consumer Expenditure Survey.

[2] Gravelle and Kotlikoff (1993) also model imperfect substitutability of corporate and noncorporate outputs.

credits are set to reflect tax law as of 1993. We choose to model the current personal income tax with a single marginal tax rate plus varying lump-sum grants. We thus capture the current level of progressivity, where average tax rates rise with income, but with the computational convenience of linear budget constraints.[3]

For the JCT exercise, six different tax replacements are considered, under two different parameterizations, for a total of twelve simulations. The six tax replacements are flat-rate (single marginal tax rate) income, consumption, and wage taxes, with and without exemption levels. All are comprehensive replacements in that their tax bases are as broad as possible and impose a single tax rate on everything in those tax bases. The two parameterizations vary the intertemporal and leisure-consumption elasticities of substitution. Under the "high elasticity" case, both elasticities are set to .50. Under the "low elasticity" case, both elasticities are set to .15.[4]

To characterize the tax replacements, we specify that consumption-based taxes are collected at the point of purchase, and wage and capital income taxes are collected from the firm. For tax reforms that involve an exemption, we again avoid the computational problem of nonlinear budget constraints by using linear tax schedules with negative intercepts identical for everyone. That is, the effect on progressivity of a $10,000 exemption is approximated by a lump-sum grant set equal to the tax rate times $10,000 per household. This specification allows a very low income household to have a negative tax liability, so our tax reforms with "exemptions" are more generous to low-income households than a true exemption would be.

Most of the current proposals for fundamental tax reform call for the wholesale repeal of federal income taxes and their replacement with the proposed alternative. Thus, the simulations replace both personal and corporate income taxes with versions of the taxes that are revenue-neutral on an annual basis.[5] The tax rates required for revenue neutrality are determined within the general-equilibrium framework. They depend not only on the size of the replacement tax base specified, but also on the behavioral responses generated by the tax replacement, which in turn depend on assumptions about the sizes of the relevant elasticities.

"Initial"-period results correspond to an equilibrium immediately following the tax change. "Long-run" results correspond to an equilibrium that is about 100 years after the tax change, by which time relative prices have remained unchanged (i.e., in "steady state") for about 35 years.[6]

The JCT requested results on a number of economic variables, but many of these variables are not relevant within the Fullerton-Rogers model. For example, the Fullerton-Rogers model imposes annual trade and budget balance, and specifies a unified government sector (with no separation of state and local from federal). Of

[3] See Fullerton and Rogers (1993) for greater detail on t he specification of the cost of capital and the characterization of the current progressive income taxes.

[4] The econometric evidence on savings and labor-supply responses surveyed in Randolph and Rogers (1995) seems to be more consisten with the lower-electricity assumptions.

[5] This neutrality accounts for changes in teh price level, so that the real value of government purchases is held constant.

[6] In fact, relative prices fluctuate very little after about 45 years following the tax change.

the requested variables, those that could be generated from the model are shown in Tables 0–6.

The Effects Associated With Tax Base

In general, the simulations reveal that differences across alternative replacement tax bases do cause some differences in the effects on economic variables, including economic efficiency, but in many respects the differences are quite small. The fundamental characteristic of all of these tax bases is one they share in common: they are all broader and more neutral than the current income-tax base. For this reason, any one of these tax base reforms would contribute positively to economic growth and steady-state welfare.

At a more detailed level, however, some interesting differences remain. One difference among the consumption, wage, and income bases is in the size of the tax base. At any point in time within an economy, the income base is larger than the consumption base (where the difference is savings), and the consumption base is larger than the wage base (where the difference is consumption of the return to existing capital). The initial replacement tax rates shown in Table 0 reflect these size differences. Under the standard (higher-elasticity) assumptions, the initial replacement tax rate under the proportional income tax is less than 16%, while those of the proportional consumption and wage taxes are close to 18% and 21%, respectively. Under the low-elasticity assumptions in this model, the difference between the income and consumption bases narrows, with initial rates of 14.4% and 14.8%, respectively, because the change in personal saving is lower when the intertemporal elasticity is lower. On the other hand, a low intertemporal elasticity implies that a larger share of the capital stock must be explained by intergenerational transfers of capital rather than life-cycle savings. With relatively more consumption from the return to inherited capital, the difference between the consumption base and the wage base widens. Thus, under low elasticities, the initial tax rates required for revenue neutrality are 14.8% for the consumption tax and 18.2% for the wage tax.

In the long run, however, the size of replacement tax bases and the required tax rates depend on how the economy has responded to the tax reform. These economic responses depend on what we assume about elasticities, but the sensitivity to these elasticities also differs across the alternative tax bases. Comparing the long-run replacement tax rates, we find that the higher elasticities eventually boost the size of the consumption base and allow it a lower long-run replacement tax rate, but slightly reduce the growth of the wage and income bases and thus reduce the decline in the long-run replacement tax rates. In this respect, the consumption base appears relatively more attractive under more generous assumptions about behavioral response.

Tables A–F emphasize the effects on capital accumulation and allocation. All of the simulations show increases in the overall capital stock (to varying degrees), and all suggest substantial reallocation of the capital stock across different sectors of the economy. First note the effects of the tax replacements on the costs of capital for the corporate, noncorporate, and owner-occupied housing sectors. For all tax reforms, the effective tax rate for corporate capital falls more than for noncorporate capital or housing capital. All reforms reduce the personal marginal tax rate, and all would eliminate the extra layer of tax on the corporate sector. Under both sets of elasticity assumptions, the effective tax rates fall more under the consumption tax or wage tax than under the income tax, since the income tax still applies to capital income.[7] Even the comprehensive income taxes reduce the cost of corporate and noncorporate capital due to the reduction in marginal tax rates, but increase the cost of owner-occupied housing because of the increased taxation of the flow of housing services.[8] Under all of the replacements, the net-of-all-tax rate of return to capital increases sharply initially but then declines as capital accumulates. This decline is greater under higher elasticities, because capital accumulates faster.

Tables 1-6 show that with other economic variables as well, the relative advantage of the consumption base over the other tax bases depends on what we assume about the savings and labor-supply responses. With high elasticities, the percentage increases in steady-state capital-labor ratios and labor productivity (output/labor) are largest for the consumption tax and smallest for the income tax. Under all of the proportional taxes, the relatively-high intertemporal elasticity of .50 produces huge increases in savings rates in the initial period (335%, 278%, and 202% for the consumption, wage, and income bases, respectively), yet more moderate increases in the steady state (20%, 18%, and 11% respectively). Changes in other economic variables such as labor supply and productivity are smaller. Note that initial-period responses are unrealistically dramatic in the Fullerton-Rogers model because the behavior of households is myopic in nature.[9]

Under low-elasticity assumptions, however, both the magnitude of these changes and the relative advantages of the consumption base decrease sharply. Both initial and long-run savings rates, and the long-run capital-labor ratio, increase least for the consumption base.

The Significance of Redistribution

Although a detailed description of tax burdens across households is beyond the scope of this paper, these patterns of tax incidence do affect the economic variables discussed here.[10] In particular, the

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[7] These effective tax rates are comparable across sectors and assets, but they are hard to compare across tax reforms because they depend on the level of the net rate of return, relative to the wage rate. Our numeraire is the net wage paid by firms, and the tax reforms are modelled as extra taxes paid by firms, so the gross wage rises. To maintain the relative costs of labor and capital to the firm requires an increase in the nominal price of capital.

[8] Under current law, owner-occupied housing is tax favored relative to rental housing and other forms of capital. Homeowners take mortgage interest deductions despite the fact that their imputed rental income is not taxed. The pure proportional income tax replacement does tax imputed rents.

Even though all of the proportional replacements remove the differential federal tax treatment of capital across sectors and asset types, a difference remains across corporate, noncorporate, and housing costs of capital because of the continued existence of property taxes.

[9] More specifically, the initial-period savings response is huge because people overreact to the initial-period increase in the net rate of return to capital. With myopic expectations, people change their savings behavior based on the assumption that the net rate of return will forever equal that initial value; i.e., they do not anticipate that the rate will come down as capital accumulates. See Ballard and Goulder (1985) for an analysis of the role of foresight in determining the size of savings response.

[10] A closer examination of the incidence of these tax replacements is found in Fullerton and Rogers (1996). In particular, that paper also discusses incidence across lifetime income categories, which is not discussed here.

intergenerational distribution of the tax burden is highly relevant, because of the differences in propensities to consume across households of different ages. If households behave as life-cycle consumers, any redistribution of income away from older generations toward younger ones will tend to increase the aggregate saving rate of the economy. This would seem to make the consumption tax the winner in terms of its stimulus to saving.

But surprisingly, it is not always true that the consumption tax that produces the largest increase in personal saving. Under certain conditions, the wage tax does. This result appears to contradict a prediction of Kotlikoff (1995). He argues that the positive effect on savings from a switch to a consumption tax is in large part due to the implicit tax on existing capital that takes from the old, with relatively large propensities to consume, and gives to the young with greater propensities to save. The wage tax does not include the redistributionary effect of the capital levy, so the increase in saving would be smaller. This result does indeed follow in a model that distinguishes households by age, such as in Auerbach and Kotlikoff (1987) and in Fullerton and Rogers (1993). In both of these models, the tax on existing capital helps boost saving through intergenerational redistributions.

But the income effects occurring as a result of fundamental tax reform are not merely redistributive in nature. The gains to some individuals do not have to be offset by losses to others; in fact, among age and income groups alive in the long run, everyone can be made better off. When people feel better off, they increase consumption of goods and services, and they increase their leisure time. Thus, the increases in saving or labor supply that result from the substitution effects (caused by decreased marginal tax rates) can be offset by decreases in savings and labor supply that result from positive income effects (also caused by decreased marginal tax rates). The fact that the consumption base is broader than the wage-income base implies that the marginal tax rates are lower under the consumption base, which in turn implies that the positive income effects are larger under the consumption base. The wage tax can produce greater increases in savings rates when income effects tend to dominate substitution effects. Thus, we see the wage tax producing a larger increase in the savings rate under the "low elasticity assumptions", in which case substitution effects are relatively less important. Under low elasticities we see the income effect dominating, implying that the higher marginal tax rate of the wage tax produces greater increases in labor supply and savings than does the lower marginal tax rate of the consumption tax.

Another reason why a wage tax could lead to larger increases in savings is that in*tra*generational redistributions may matter as well. In the Fullerton-Rogers model, savings propensities are a function of age alone, because everyone has the same lifetime utility function, so this is not an issue with the results presented here. But people differ not only by age but also by level of lifetime income, and a more general model might allow savings propensities to vary with *both* characteristics. More specifically, the tax on existing capital not only hits the old harder than the young, but also hits the lifetime rich harder than the lifetime poor.[11] If the capital levy hits the rich, and if the rich have higher propensities to save, the consumption tax might not necessarily help the savings response more than the wage tax.

For all of the replacements, the basic intergenerational pattern of burdens is similar—greater relative gains to the young. This pattern is expected for the switch to a consumption tax; but may be surprising for the switch to wage and income taxes. The usual story about intergenerational burdens for these tax changes is focussed on the sources side, namely, that switching from an income base to a wage-tax base redistributes from the young who are taxed on their wages to the old who are relieved of tax on their capital. But this sources-side story is based on a simple model with initial tax neutrality and consumer homogeneity. In this more-detailed model, however, the initial income tax is not neutral, so the switch to a more neutral wage or income tax can have various effects on relative prices of consumption goods. In addition, consumers of the same age are heterogeneous, so they buy different bundles of commodities. Thus the distributional patterns of tax burdens will depend on effects operating through the uses side as well.

In fact, the Fullerton-Rogers model suggests that the elderly can actually be made worse off by the switch to a more neutral tax, even a wage tax. The reason is that the relative prices of consumer goods change in a way that burdens the old more than the young. For example, the elimination of preferential treatment of housing raises sharply the cost of shelter. Also, the removal of capital taxation under either the wage tax or the consumption tax raises the relative price of labor-intensive goods such as health care and financial services. Even with the switch to a proportional income tax, the latter effect holds because of the removal of the double-taxation of dividend income. These changes in the relative prices of consumer goods cause intergenerational redistribution, because these goods are precisely the ones that make up a large fraction of older-households' budgets in our model.[12]

On net, under the wage tax, the elderly are only slightly worse off because this effect on the uses side is offset by the usual intergenerational effect on the sources-side of switching from an income tax to a wage tax. Under the income-tax replacement, the elderly are relatively worse off compared to the wage tax, because that sources-side story is not as strong.[13]

All of the replacements that use a consumption base, however, show a much more pronounced redistribution of income away from older generations, towards younger ones. Consumption taxes entail the greatest intergenerational redistribution, because of the tax on existing capital. These basic distinctions across tax bases in terms

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[11] In the Fullerton-Rogers model, the consumption and wage bases also differ due to the presence of bequests. The lifetime rich receive larger inheritances, which all their present value of consumption to exceed the present value of labor income. This feature also makes the consumption tax more progressive than the wage tax, and it reinforces the intragenerational effect on total savings that occurs when those with high savings propensities are hit by the capital levy.

[12] These uses-side effects are emphasized in Fullerton and Rogers (1997).

[13] Because the old have more capital income than the young, however, and because capital taxes fall more than labor taxes with the removal of the double-taxation of dividend income, even the switch to a neutral income tax provides some relative gain tot he old on the sources side.

of the patterns of intergenerational burdens do not change much with the values of elasticities.

The addition of annual exemption levels affects the pattern of burdens differently depending on which base is chosen. In particular, adding an exemption level to a consumption tax increases the intergenerational redistribution, while adding an exemption level to either a wage or income tax does not. The exemption requires a higher rate of tax for revenue neutrality, which strengthens the effect on the uses side just discussed. Prices rise more for the elderly. Moreover, this stronger intergenerational redistribution has important implications for saving and efficiency, as discussed below.

Effects on Economic Welfare

Most economists support fundamental tax reform because of the expected improvements in economic efficiency. The current income-tax system is highly distortionary, because it taxes income at different rates depending on the sources or uses of the income. Taxes on capital income are fingered as a major culprit, because: (i) capital income is difficult to measure accurately, and hence difficult to tax uniformly across different types of assets, and (ii) even with perfectly-uniform capital taxation, such a tax creates an intertemporal distortion. Established tax preferences such as the mortgage interest deduction also contribute to the distortions among different sources or uses of income. Hence, many economists believe that the most effective way to enhance the efficiency of the tax system would be to move toward a consumption-based tax with a flatter rate structure and broader, more neutral base.

To go all the way, we could move to a proportional, single-rate consumption tax. This switch can be said to have several distinct effects on efficiency. First, the "flattening" of the progressive tax rate structure reduces individual disincentives. Second, the leveling of the playing field is expected to reduce the distortionary effects of taxes. Third, the switch from an income base to a consumption base involves a reduction in the intertemporal distortion in exchange for a larger labor-supply distortion, and so may increase or decrease the inefficiency of the tax system. Most economists seem to expect a positive overall effect on efficiency from such a tax change, especially when combined with lower rates.

Calculations of welfare effects within the Fullerton-Rogers model (see Tables G and H) suggest that a switch to a proportional consumption tax will increase economic efficiency as long as the two elasticities are not too low.[14] The gains are fairly modest, however—less than one percent of lifetime income when defined using our method which calculates the present value of welfare changes relative to the present value of incomes over all generations. The efficiency calculation is smaller than are steady-state levels of util-

[14] Our efficiency measure is based on a present-value calculation across all generations. We discount at a rate of 4%, which is the net-of-all-tax rate of return in the model. discounting puts greater weight on the negative utility changes of older generations than on the positive utility changes of younger generations. A lower discount rate would thus raise the efficiency gain. This measure is somewhat arbitrary, as it does not reflect a formally-defined social-welfare function, and it does not employ the "lump-sum redistribution authority" of Auerbach and Kotlikoff (1987). For this reason, Tables G and H also show the utility changes to the steady-state generation only.

ity increases, because the losses of earlier generations are added, and indeed, given greater weight because of discounting.

The smaller efficiency gain under the wage-income tax indicates that the wealth component of the consumption base is important in contributing to whatever gains exist. The consumption base is larger than the wage base due to consumption out of existing capital, and the capital levy present under the consumption tax permits lower marginal tax rates and hence smaller economic distortions. While the efficiency advantage of the proportional consumption tax over the proportional wage tax remains under all of the elasticity assumptions, the advantage of the consumption tax over a broad-based income tax disappears if the intertemporal elasticity is low, and even if the labor supply elasticity is also low. In general, the efficiency gain from switching to a consumption tax is very sensitive to the value of the intertemporal elasticity.[15] Note that some other indicators of economic welfare, such as real output, and the real after-tax wage rate (both also shown in Tables G and H), suggest similar rankings among the various replacements.

Even a substantial gain in efficiency caused by a flattening of tax burdens would seem unsurprising and unsatisfying, however. If one role of taxation is redistributive, then we may want to consider tax replacement designs that maintain the current level of progressivity and at the same time improve efficiency. Surprisingly, the addition of exemption levels is not always efficiency-reducing. We would expect that because exemption levels necessitate higher tax rates for revenue neutrality, distortions would be greater and efficiency gains lower. The efficiency gains also depend, however, on the intergenerational redistributions mentioned earlier. Under a consumption tax base, because of the uses-side effects, the exemption level causes greater redistribution of income away from old to the young, and this effect works to enhance efficiency. In fact, when the leisure-consumption elasticity is low, the net efficiency gains are higher under the exemption-level version of the consumption tax, because the higher labor-supply distortion resulting from the higher marginal tax rate becomes less important than the income redistribution. In general, it appears that the efficiency gains associated with fundamental tax reform are more sensitive to differences in the nature of tax bases than to the differences in tax rates via exemptions. In particular, the capital-levy advantage of the consumption base seems to stand out.

Some caveats: Overall, the efficiency gains shown here seem rather small, in fact smaller than other economists have found. It should be emphasized that the efficiency calculations depend on the specification of our model as well as on certain assumptions built

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[15] The welfare gains associated with a switch from a progressive income tax to a proportional consumption tax are expected to be positively-related to the magnitude of the intertemporal elasticity because gains from the proportionality and the change in base are positively related to this elasticity. However, the gains are ambiguous with respect to the magnitude of the labor-supply elasticity because, while gains from proportionality are positively related to this elasticity, gains from the switch in base are inversely related to it. This is why the efficiency advantage of the consumption base is much more sensitive to the value of the intertemporal elasticity than to the value of the consumption-leisure elasticity.

Gravelle (1991) also finds that the efficiency gains associated with a consumption-tax replacement depend heavily on the intergenerational redistribution that takes place, and that the gains are more sensitive to the intertemporal elasticity than to the consumption-leisure elasticity. The Fullerton-Rogers model has been used to highlight these points as well (Randolph and Rogers, 1995, and Rogers, 1996).

into our present-value calculation of gains over all generations, both of which tend to point toward an understatement of efficiency gains. For example, our characterization of the benchmark income-tax system did not include graduated marginal tax rates, but just increasing average tax rates, so some of the gains from switching to flatter tax systems are likely to be understated. In addition, the "exemption-level" taxes modeled here are really negative-intercept taxes (proportional taxes plus lump-sum grants), so the tax treatment of lower-income households is more generous than under a true exemption-level tax. Thus, for revenue neutrality, overall marginal tax rates are higher in our simulations than would be the case without negative taxes. Since the present-value calculation of efficiency gains is dependent on our choice of a 4 percent discount rate, a lower rate would raise the weight on gains to later generations and thus raise the efficiency numbers. These are some reasons to expect that our efficiency numbers might err on the low side.

On the other hand, some other implicit assumptions could lead to overstatement in some of our efficiency gains. For example, Ballard and Goulder (1985) have shown that greater foresight on the part of consumers may lead to reduced efficiency gains associated with consumption-based taxation. We have assumed myopic expectations in our simulations. Also, in examining the various tax systems, we have ignored administrative costs and measurement problems. Under the comparison of proportional consumption and proportional income taxes, for example, we implicitly assume that capital income could be measured perfectly under the income tax. This is no doubt an unrealistic assumption. The finding here that the income tax is likely to be just as efficient under a low intertemporal elasticity holds only to the extent that truly neutral income taxation is possible.

III. Conclusion: Could the Model Be Used for Revenue Estimation?

At the most fundamental level, the Fullerton-Rogers model is simply a computational, bells-and-whistles version of the analytical Harberger (1962) model. It is not a macroeconometric forecasting model, and thus cannot be used to predict the actual effects of tax reform along with the changes in macroeconomic variables such as inflation or unemployment. Instead, it is designed to answer conceptual questions about the effects of tax reform on real incomes, prices, and factor allocations, all else equal—with *no* changes in such macroeconomic variables. The model assumes away all trade and budget deficits, market imperfections, transaction costs, factor immobility, and liquidity constraints. All its computations are based on the allocations that result once all markets are in equilibrium, and the model implicitly suggests that such equilibria are immediately attained. The model also specifies that households have myopic expectations about prices (people's expectations of future prices are simply current prices), so such expectations are only fulfilled once the model has found a new steady state. And the model is too stylized to capture many of the detailed changes to the tax code that could occur under tax reform. For all these reasons, the model is best suited for the analysis of the *long*-run effects of *major* tax restructuring. On its own, it is ill-suited for revenue forecasting.

As with the Harberger model, the real usefulness of the Fullerton-Rogers model comes in its ability to highlight how various economic parameters influence the effects of tax reform on relative prices and the allocation of resources. Harberger's model featured an analytical representation of what happens to the net return to capital relative to the wage rate, so that the influence of the various parameters (substitution elasticities, capital-intensity, etc.) could be seen directly in a formula. The Fullerton-Rogers model is too large to analytically solve, so it is numerically solved, and numerical sensitivity analysis (varying the values of the behavioral parameters) substitutes for analytical partial derivatives.

Although the model cannot stand alone as a revenue-forecasting model, it could provide an important piece of the answer. The more-limited role for this sort of model in the revenue-estimating process might be to provide predictions about changes in relative prices, which could then be fed into a forecasting model.

In the context of fundamental tax reform, the Fullerton-Rogers model has a comparative advantage in making several points, including the following:

- All proposals for fundamental tax reform, whether consumption-based or income-based, tend to reduce the overall effective tax rate on capital and hence encourage capital accumulation. But in addition to an overall increase in the capital stock, the mix of capital in the economy is likely to change because of the switch to more neutral taxes.
- Whether or not a consumption tax produces larger economic gains compared with a comprehensive income tax depends critically on how responsive people are in terms of intertemporal and labor-supply decisions. Lower responsiveness (in the form of lower elasticities of substitution) reduces the superiority of the consumption base.
- The economic effects of fundamental tax reform depend to a large extent on how incomes are redistributed across generations. This intergenerational incidence in turn depends not only on how different generations obtain their income and how much they save, but also on how they spend their money on different goods and services. This is because fundamental tax reform affects not only the relative returns to factors of production, but also relative goods prices.

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Appendix: The Fullerton and Rogers General-Equilibrium Model [16]

The Fullerton-Rogers model uses measures of lifetime income based on longitudinal data, and classifies households according to lifetime-income categories. Through its specification of consumer utility and industry production functions, the model is able to calculate the general-equilibrium effects of tax changes on the prices and quantities of goods and factors, and the subsequent effects on economic efficiency.

Lifetime Incomes

The Fullerton-Rogers model incorporates data on lifetime incomes, requiring longitudinal data for many individuals over many years. Although no data set exists which spans the entire lifetimes of individuals, the University of Michigan's Panel Study of Income Dynamics (PSID) has been asking the same questions of the same individuals now for over 20 years. From the PSID, Fullerton and Rogers drew a sample of 500 households that included 858 adult individuals, with information on wages, taxes, transfers, and various demographic variables for the years 1970-87. They included heads and wives in the sample, and for simplicity in defining the lifetime of a "household," they excluded households whose marital status varied over the sample period. For heads and wives separately, they estimated the wage rate as a nonlinear function of age, so that for each individual in the sample they were able to: (i) predict the wage rate for years that come after as well as before the sample period, (ii) multiply the actual or estimated gross-of-tax wage rate by a total number of hours per year (e.g. 4000) to get

[16] See Fullerton and Rogers (1993).

the value of the endowment, and (iii) calculate the present value of this endowment for each person. Thus, the level of well-being in the Fullerton-Rogers model is defined by *potential* earnings, including the value of leisure. These levels are used to classify households into twelve groups according to lifetime ability-to-pay, where a household's lifetime income is defined to be the average of the head's and wife's (if any) lifetime incomes. The groups are constructed by starting with the ten deciles, but the poorest 2 percent is separated from the next poorest 8 percent, and the richest 2 percent from the next richest 8 percent.

For a given level of lifetime income, the timing of income matters, because the shape of an individual's lifetime income profile determines the composition of annual income. Therefore, Fullerton and Rogers reestimate the nonlinear age-wage profile separately for each of the twelve groups. In addition, they estimate the time paths of personal income taxes paid and transfers received, in order to set up a consistent benchmark data set with a path of consumer spending out of total available net-of-tax income.

Model Structure and Parameterization

The general-equilibrium approach to tax analysis permits the accounting of the behavioral effects and excess burdens caused by taxes. It can capture the important influences of taxes on diverse household choices about labor supply, savings, and the consumption of different commodities. Utility maximization determines the demands for commodities and supplies of factors. The assumption of profit maximization on the part of producers determines the demands for factors and the effects of taxes on these demands. Solving for general equilibrium prices captures the net impact of taxes when these behaviors are considered simultaneously.

In the Fullerton-Rogers model, consumer decisions are made according to the maximization of lifetime utility. To begin, the individual calculates the present value of potential lifetime earnings. This endowment is supplemented by government transfers, reduced by taxes, discounted at the after-tax interest rate, and augmented by a fixed initial inheritance. For computational simplicity, the model specifies "myopic" expectations about future prices, so that the consumer expects the current interest rate to prevail in all future periods.

One part of the lifetime endowment must be saved for a bequest upon death. Fullerton and Rogers avoid the many possible motivations for individual bequests, or the many ways in which taxes might affect the size of those bequests. Instead, the Fullerton-Rogers model simply acknowledges that life-cycle saving by itself can only explain about half of the observed capital stock. In the model, part of the capital stock is attributable to the fact that individuals receive exogenous inheritances and are then simply required to leave comparable bequests at the end of life. Incidence results depend on the differences in these exogenous inheritances among groups. To achieve balanced growth, each group must add some additional savings to their inheritance before they make their bequest.

The rest of the present value of income is available for spending. Decisions are made in stages. In the context of fundamental tax reform, the first two stages seem most important because they define the saving and labor-supply responses.

At the first stage, the consumer chooses how much to spend each period. This choice depends on assumptions about the form of lifetime utility and the values of certain key parameters. Lifetime utility is specified as a "constant-elasticity-of-substitution" (CES) function:

$$U = \left[\sum_{t=1}^{T} a_t^{\frac{1}{\varepsilon_1}} x_t^{(\varepsilon_1 - 1)/\varepsilon_1} \right]^{\varepsilon_1/(\varepsilon_1 - 1)},$$

where T=60 (chronological age 79) is the individual's certain date of death, **ε**, is the intertemporal elasticity of substitution, and $\mathbf{x}_t$ is the amount of "composite commodity," a combination of a composite consumption good and leisure at economic age t (equal to chronological age minus 19). The weighting parameter, $\boldsymbol{\alpha}_t$, reflects the consumer's subjective discount rate, or rate of time preference, which is set at 0.005.

While the Fullerton and Rogers study used a central-case intertemporal elasticity equal to 0.5, in the present study that elasticity is varied from a low of 0.15 up to 0.5 in the examination of efficiency gains. The consumer's choice about how much to spend each period is also affected by changes in the net rate of return (which is set at 0.04 in the central case).[17]

At the second stage, the consumer allocates one period's "spending" between leisure and other consumption goods, according to the CES subutility function:

$$x_t = \left[\alpha_t^{1/\varepsilon_2} \bar{c}_t^{(\varepsilon_2 - 1)/\varepsilon_2} + (1 - \alpha_t)^{1/\varepsilon_2} l_t^{(\varepsilon_2 - 1)/\varepsilon_2} \right]^{\varepsilon_1/(\varepsilon_2 - 1)},$$

where is the amount of composite consumption good consumed at $\boldsymbol{t}$, $\boldsymbol{l}_t$ is the amount of leisure taken at $\boldsymbol{t}$, and $\boldsymbol{\varepsilon}_2$ is the elasticity of substitution between consumption and leisure.The decision about how much labor to supply depends on what is assumed about the value of the consumption-leisure elasticity of substitution. Fullerton and Rogers set this elasticity at 0.5 in their central case, but for the purposes of this study that elasticity is varied from 0.15 to 0.5 (just as the intertemporal elasticity is varied). In the general-equilibrium model, individuals can "buy" more leisure at a price equal to the foregone net-of-tax wage, instead of buying other

[17] Chapter 8 of the Fullerton and Rogers book discusses the sensitivity of incidence calculations to these parameter values. Chapter 4 of the current study emphasizes the importance of the international elasticity in determining the efficiency gains from a switch to consumption-based taxation.

goods. This choice is affected by taxes, and it also depends on age. Individuals in this model never fully retire, but the weight on leisure increases with age after they reach 60, in a way that reflects actual choices.

In the third stage, individuals decide how to allocate current consumption spending among 17 particular goods (such as food, alcohol, tobacco, utilities, housing, etc.), according to the subutility function:

$$\bar{c}_t = \prod_{i=1}^{N} (c_{it} - b_{it})^{\beta_{it}},$$

where N is the number of consumer goods (=17), and c_{ift} is the amount of consumer good is consumed at age t. This decision function is of the "Stone-Geary" form, which means that a consumer at a given age has to buy a set of 17 "minimum required purchase" amounts (b) and then allocates remaining spending according to a set of 17 "marginal expenditure shares" (***betta***). These 34 parameters are estimated for each of 12 age categories using data from the Consumer Expenditure Survey, as described thoroughly in the Fullerton and Rogers book. This Stone-Geary framework has several important implications. By making a portion of spending nondiscretionary, it reduces the sensitivity of total consumption and saving to the net rate of return. In addition, because discretionary income may be spent in proportions different from minimum requirements, actual purchase proportions depend on total income. Required spending is relatively high for housing and gasoline, while discretionary spending is relatively high for clothing, services, and recreation. Thus the rich and the poor buy different bundles, and bear different burdens on the uses side.[18]

In the fourth stage of the consumer's allocation process, the expenditure on each consumer good is divided by fixed coefficients among components drawn from a list of producer industries. No real "decision" is made here, but this step allows the matching up of consumption data using one definition of commodities with production data using a different definition. For example, expenditure on the consumer good "appliances" is composed of portions from metals and machinery, from transportation, and from the trade industry.

Then, in the fifth and final stage of the decision tree, the consumer takes the spending on each industry output and allocates

[18] This framework also allows Fullerton and Rogers to use the same utility function for everyone in the model. In previous efforts, rich and poor individuals spend in different proportions because they have different preferences. But then the rich and the poor differ in fundamental characteristics and not just by the amount of income they receive. With differences in utility functions, if the poor were to receive additional income, they would still spend it as if they were poor, according to their unchanged proportions. Fullerton and Rogers argue that it seems more natural that a poor person with more money would begin to behave like a rich person. That is, the primary distinction between rich and poor is the amount of income they receive. Therefore, in their model, everyone has the same preference parameters. The poor spend more on goods with high minimum required expenditures, because they are poor, and the rich spend more on goods with relatively high marginal expenditure shares.

it between the corporate sector and the noncorporate sector, according to the CES subutility function:

$$\bar{Q}_j = \left[\gamma_j^{1/\varepsilon_3} (Q_j^c)^{(\varepsilon_3-1)/\varepsilon_3} + (1-\gamma_j)^{1/\varepsilon_3} (Q_j^{nc})^{(\varepsilon_3-1)/\varepsilon_3}\right]^{\varepsilon_3/(\varepsilon_3-1)},$$

where Q_j^c is the amount of corporate production of producer good j, Q_j^{nc} is the amount of noncorporate production of producer good j, and ε_3 is the elasticity of substitution between corporate and noncorporate outputs in consumption. Corporate output is assumed to be slightly different from the noncorporate output in the same industry. Hand-carved furniture, for example, is not the same as manufactured furniture. The consumer chooses the amount of each, using a weighing parameter γ based on initial observed corporate and noncorporate shares of production within each industry, and using another elasticity of substitution (ε_3, which is set to 5.0 in Fullerton & Rogers' central case). This specification is consistent with the observed co-existence of both sectors within an industry, despite different tax treatments. If the outputs were identical, then a higher tax rate would drive one sector out of production. The degree of similarity is reflected in the elasticity of substitution. The other purpose of this specification is to capture ways in which changes in corporate taxes affect relative product prices and quantities demanded of the outputs of each sector.

A similar process characterizes producer behavior in each sector of each industry. Each output is produced by many competitive firms in multi-stage production functions with constant returns to scale. Also, for computational simplicity, there are no externalities, no adjustment costs, and no uncertainty in the model.

In the first stage of production, output is composed of a fixed coefficient combination of value-added and intermediate inputs. Each of the 19 industries uses the outputs of all other industries, in fixed proportions. Thus, changes in one product price affect many other product prices. In the second stage, value-added is a function of labor and "composite" capital, according to the function:

$$VA = \varphi\left[\zeta L^{(\sigma_1-1)/\sigma_1} + (1-\zeta)\bar{K}_t^{(\sigma_1-1)/\sigma_1}\right]^{\sigma_1/(\sigma_1-1)}.$$

The weighing parameters (ζ) are based on observed labor L and capital K in each industry, and the elasticity of substitution (σ_1) varies by industry (between 0.68 and 0.96, in Fullerton and Rogers' central case). Thus a tax on labor can induce the firm to use more capital instead, and vice versa. It also raises the cost of production, and thus output price, in any industry that uses a high proportion of the taxed factor.

In the third and final stage of production, composite capital is a CES function of five asset types (K_k)—equipment, structures, land, inventories, and intangibles:

$$\bar{K} = \left[\sum_{k=1}^{N_k} (\psi_k)^{1/\sigma_2} (K_k)^{(\sigma_2-1)/\sigma_2}\right]^{\sigma_2/(\sigma_2-1)} .$$

These types are defined by important tax differences such as the investment credit for equipment and the expensing of new intangible assets created through advertising or research and development. The weighting shares (Ψ_k) are again based on observed use of assets in each industry, and the response to tax differentials is again specified by an elasticity of substitution (σ_2,=1.5 in Fullerton and Rogers' central case).

Government in this model conducts several functions. It pays transfers to individuals according to the estimated lifetime transfer profiles discussed in the previous section. It produces an output for sale through an industry called "government enterprises," and it also produces a free public good through a composite combination of its use of labor, capital, and purchases of each private industry output. The weights in this combination are based on observed government purchases, and the elasticity of substitution is one. The level of this public good is held fixed in all simulations, as any tax change is accompanied by an adjustment that ensures equal-revenue yield. A final government function, of course, is to collect taxes.

Each tax instrument enters the model as a wedge between the producer's price and the consumer's price. The payroll tax, for example, applies an ad valorem rate to each producer's use of labor, so the gross-of-tax wage paid by the producer is higher than the net-of-tax wage received by the worker. Similarly, sales and excise taxes appear as ad valorem rates on each consumer good, so the gross-of-tax price paid by the consumer exceeds the net-of-tax price received by the seller.

The personal income tax is a little more complicated, in order to capture its progressive effect on tax burdens. The actual U.S. personal tax system imposes higher effective tax rates on higher incomes through a graduated rate structure with a changing marginal tax rate. Ideally, one would calculate the effects of individual choices at each different possible marginal tax rate in order to determine utility-maximizing behavior. For computational tractability, however, Fullerton and Rogers use a set of linear tax functions that approximate the U.S. system with a negative intercept for each group and a single marginal tax rate (0.25 in the 1993 benchmark). Although all individuals face the same marginal tax rate, average tax rates still increase with income due to the negative intercepts. Fullerton and Rogers do not model the myriad exemptions and deductions. These simpler, linear tax functions can replicate the observed data on personal taxes actually paid by each group.

The state and local property tax and the U.S. federal corporate income tax raise the producer's gross-of-tax cost of capital, for each asset type, relative to the investor's net-of-tax rate of return. The cost of capital corresponding to each type of asset depends on the statutory corporate tax rate (set at .395 in the 1993 benchmark), depreciation allowances at historical cost, the rate at which inflation erodes those allowances (set at .04), the rate of investment tax credit (set at zero after the Tax Reform Act of 1986), and the required net rate of return for the firm. This required rate of return depends, in turn, on the going market rate and the personal taxation of interest (at rate .246), dividends (.292), and capital gains (.13). The simulations described in this paper assume the "old view" of dividend taxation, where the personal-level taxation of dividends affects the cost of capital and marginal investments.[19] A similar cost of capital formula applies to the noncorporate sector. This treatment allows the producer's choice among assets to depend on relative tax rules, and the price of output in each industry to depend on the relative use of assets with different effective tax rates.

Other assumptions help to close the model in a way that accounts for all flows and that helps facilitate computation. The model ignores international mobility of labor or capital, but allows for trade of industry outputs. Also, the value of imports must match the value of exports; the government's expenditures and transfer payments must match tax revenue; and, the value of personal savings must match the value of investment expenditures. Producer investment is not the result of firms' intertemporal optimization, but instead follows personal savings from consumers' optimization. The amount of personal savings is growing over time, because consumers' labor earnings are growing through population and technical change. On the steady state growth path, the capital stock grows at exactly the same rate as the effective labor stock.

Data used within the Fullerton-Rogers model derive from many sources, adjusted to represent 1993 as the base year.[20] In addition to the survey data used to estimate wage profiles and preference parameters, we use the National Income and Product Accounts for an input-output matrix, labor compensation by industry, government purchases, and international trade. These published data are combined with other unpublished data on capital allocations and inheritances.

For some parameters, such as the elasticities of substitution, particular values are assumed. For other parameters, such as the Stone-Geary preferences, econometric estimates are used. Finally, some remaining parameters are "calibrated" from data on actual allocations. Demand functions and all initial prices and observed quantities are used to solve backwards for the value of the parameter that would make that quantity the desired one. This procedure establishes a "benchmark" equilibrium, with existing tax rules and prices, such that all consumers are buying the desired quantities

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[19] See Fullerton and Rogers (1993), pp. 210–213, for discussion of how adopting the alternative "new view" affects the efficiency and distributional effects of the various U.S. taxes.

[20] The benchmark specified in the Fullerton-Rogers book is based on earlier (1984) data.

and supplying the desired amounts of each factor, while producers are using their desired amounts of factors to produce the desired output.

Thus, using all these parameters together, one can solve for an equilibrium with unchanged tax rules that replicates the benchmark consistent data. This provides an important check on the solution procedure. From this benchmark, any particular tax rule can be altered and one can determine how much more or less the consumers want to buy of each good. The solution algorithm then raises the price of any good in excess demand, and lowers the price of any good in excess supply, until it finds a set of prices where the quantity supplied equals the quantity demanded for every good and factor. It "simulates" the effect of the tax change, to calculate all new prices, quantities, and levels of consumer utility. The measure of the change in tax burden is the "equivalent variation," the dollar value of the change in utility measured in terms of benchmark prices. Efficiency gains associated with a tax change are calculated as the present value of equivalent variation over all generations relative to the present value of lifetime incomes.

Table 0.—Tax Replacements, Tax Rates, and Efficiency Gains from the Fullerton-Rogers General-Equilibrium Model

Description of tax replacement	Tax rates under high-elasticity assumptions [1] (initial, long run)	Efficiency gains (as percent of lifetime income) under high-elasticity assumptions [1]	Tax rates under low-elasticity assumptions [1] (initial, long run)	Efficiency gains (as percent of lifetime income) under low-elasticity assumptions [1]
Comprehensive income tax (CIT)	.16, .14	.70	.14, .14	−.05
Progressive comprehensive income tax (PCIT)—has $10,000 exemption level	.23, .22	.61	.20, .20	−.06
Value-added tax (VAT)—consumption-based tax	.18, .14	.97	.15, .14	−.05
Progressive value-added tax (PVAT)—has $10,000 exemption level	.28, .20	.96	.21, .20	−.04
Wage tax (WT)—mimics a consumption-based tax w/transition relief	.21, .18	.86	.18, .17	−.20
Progressive wage tax (PWT)—has $10,000 exemption level	.35, .31	.70	.28, .26	−.89

[1] High-elasticity assumptions correspond to simulations using leisure-consumption and intertemporal substitution elasticities of .50. Low-elasticity assumptions use value of .15 for these elasticities.

Table 1.—Income-Tax Replacements Under High Elasticities (eps1=eps2=.50) (Fullerton-Rogers model—replace existing corporate and personal income taxes)

[All figures are percentage changes from baseline]

	Proportional income tax		Income tax w/exemption	
	Initial	Long run	Initial	Long run
1. Output (total domestic demand; includes intermediates)	+4.49	+4.61	+3.64	+3.77
2. Consumption as share of GDP	−6.69	+0.90	−5.56	+.076
3. Exports (& imports) as share of GDP	−16.20	−12.74	−20.15	−17.30
5. Government spending as share of GDP	−3.75	−5.43	−3.09	−4.52
6. Net investment (=net saving) as share of GDP	+201.5	+11.31	+167.3	+9.46
7. Capital stock	0.00	+14.09	0.00	+11.78
8. CCA (depreciation)	−7.89	+5.81	−8.11	+3.28
10. Residential capital stock	−10.03	+1.11	−9.61	−0.32
12. Labor supply	+2.98	+0.70	+2.17	+0.26
Capital/Labor ratio of economy	−2.81	+13.40	−2.04	+11.61
13. Real after-tax wage rate (w/p)	+14.92	+21.45	+8.82	+14.13
15. Real after-tax rate of return (r/p)	+35.07	+11.03	+27.90	+8.60
17. Price level (consumer prices)	+16.01	+9.77	+22.51	+16.81
23. Total wage income (line 12 x line 13)	+18.35	+22.31	+11.17	+14.43

Table 2.—Consumption-Tax Replacements Under High Elasticities (eps1=eps2=.50) (Fullerton-Rogers model—replace existing corporate and personal income taxes)

[All figures are percentage changes from baseline]

	Proportional consumption tax		Consumption tax w/exemption	
	Initial	Long run	Initial	Long run
1. Output (total domestic demand; includes intermediates)	+6.07	+6.03	+5.84	+5.81
2. Consumption as share of GDP	−11.53	+0.99	−12.63	+0.88
3. Exports (& imports) as share of GDP	−4.83	+0.06	−4.32	+0.79
5. Government spending as share of GDP	−4.65	−7.14	−4.32	−7.02
6. Net investment (=net savings) as share of GDP	+334.6	+19.58	+361.7	+21.46
7. Capital stock	0.00	+22.46	0.00	+23.81
8. CCA (depreciation)	−7.13	+14.87	−7.02	+16.29
10. Residential capital stock	−13.01	+4.38	−14.02	−4.41
12. Labor supply	+4.08	+0.52	+3.69	+0.01
Capital/Labor ratio of economy	−3.92	+21.82	−3.56	+23.81
13. Real after-tax wage rate (w/p)	+12.45	+24.61	+3.89	+18.73
15. Real after-tax rate of return (r/p)	+30.75	+0.48	+20.80	+8.71
17. Price level (consumer prices)	+18.54	+6.98	+28.31	+12.28
23. Total wage income (line 12 x line 13)	+17.04	+25.26	+7.72	+18.74

Table 3.—Wage-Tax Replacements Under High Elasticities (eps1=eps2=.50) (Fullerton-Rogers model—replace existing corporate and personal income taxes)

[All figures are percentage changes from baseline]

	Proportional wage tax		Wage tax w/exemption	
	Initial	Long run	Intial	Long run
1. Output (total domestic demand; includes intermediates)	+5.14	+5.41	+4.30	+4.66
2. Consumption as share of GDP	−9.50	+0.89	−9.48	+0.67
3. Exports (& imports) as share of GDP	−19.66	−14.15	−27.19	−21.31
5. Government spending as share of GDP	−3.97	−6.40	−3.23	−5.74
6. Net investment (=net saving) as share of GDP	+277.6	+17.81	+272.0	+19.43
7. Capital stock	0.00	+20.22	0.00	+20.72
8. CCA (depreciation)	−8.33	+11.44	−8.77	+11.23
10. Residential capital stock	−11.53	+3.98	−11.75	+3.70
12. Labor supply	+3.39	+0.30	+2.42	−0.61
Capital/Labor ratio of economy	−3.20	+19.99	−2.29	+21.59
13. Real after-tax wage rate (w/p)	+10.45	+20.18	−0.41	+9.32
15. Real after-tax rate of return (r/p)	+56.62	+18.84	+56.09	+18.25
17. Price level (consumer prices)	+20.70	+10.93	+33.86	+22.00
23. Total wage income (line 12 × line 13)	+14.19	+20.54	+2.00	+8.65

Table 4.—Income-Tax Replacements Under Low Elasticities (eps1=eps2=.15) (Fullerton-Rogers model—replace existing corporate and personal income taxes)

[All figures are percentage changes from baseline]

	Proportional income tax		Income tax w/exemption	
	Initial	Long run	Intial	Long run
1. Output (total domestic demand; includes intermediates)	+1.31	+1.86	+1.26	+1.84
2. Consumption as share of GDP	−1.65	+0.40	−1.57	+0.39
3. Exports (& imports) as share of GDP	−13.21	−12.37	−17.06	−16.17
5. Government spending as share of GDP	−1.41	−2.46	−1.34	−2.41
6. Net investment (=net saving) as share of GDP	+61.19	+3.78	+58.36	+3.83
7. Capital stock	0.00	+5.43	0.00	+5.44
8. CCA (depreciation)	−8.63	−3.44	−8.63	+3.41
10. Residential capital stock	−8.79	−4.69	−8.66	−4.60
12. Labor supply	+0.37	+0.01	+0.30	−0.05
Capital/Labor ratio of economy	−0.36	+5.43	−0.30	+5.50
13. Real after-tax wage rate (w/p)	+16.76	+18.98	+11.53	+13.79
15. Real after-tax rate of return (r/p)	+33.54	+24.91	+27.55	+19.45
17. Price level (consumer prices)	+14.19	+12.08	+19.56	+17.21
23. Total wage income (line 12 × line 13)	+17.19	+18.98	+11,87	+13.73

Table 5.—Consumption-Tax Replacements Under Low Elasticities (eps1=eps2=.15) (Fullerton-Rogers model—replace existing corporate and personal income taxes)

[All figures are percentage changes from baseline]

	Proportional consumption tax		Consumption tax w/exemption	
	Initial	Long run	Initial	Long run
1. Output (total domestic demand; includes intermediates)	+1.25	+1.76	+1.17	+1.72
2. Consumption as share of GDP	−1.72	+0.40	−1.66	+0.39
3. Exports (& imports) as share of GDP	−1.28	−0.85	−1.19	−0.77
5. Government spending as share of GDP	−1.47	−2.42	−1.38	−2.37
6. Net investment (=net savings) as share of GDP	+63.32	+3.54	+61.32	+3.53
7. Capital stock	0.00	+5.23	0.00	+5.23
8. CCA (depreciation)	−8.52	−3.52	−8.63	−3.52
10. Residential capital stock	−9.42	−5.41	−9.51	−5.58
12. Labor supply	+0.37	+0.00	+0.28	−0.06
Capital/Labor ratio of economy	−0.48	+5.12	−0.40	+5.18
13. Real after-tax wage rate (w/p)	+16.24	+18.71	+10.65	+13.36
15. Real after-tax rate of return (r/p)	+29.95	+21.66	+23.69	+16.17
17. Price level (consumer prices)	+14.73	+12.34	+20.54	+17.65
23. Total wage income (line 12 × line 13)	+16.61	+18.67	+10.91	+13.24

Table 6.—Wage-Tax Replacements Under Low Elasticities (eps1=eps2=.15) (Fullerton-Rogers model—replace existing corporate and personal income taxes)

[All figures are percentage changes from baseline]

	Proportional wage tax		Wage tax w/exemption	
	Initial	Long run	Initial	Long run
1. Output (total domestic demand; includes intermediates)	+1.32	+2.37	+1.29	+2.58
2. Consumption as share of GDP	−2.17	+0.43	−2.30	+0.42
3. Exports (& imports) as share of GDP	−15.74	−14.28	−21.98	−20.04
5. Government spending as share of GDP	−1.38	−3.09	−1.31	−3.29
6. Net investment (=net savings) as share of GDP	+77.44	+7.15	+80.91	+8.80
7. Capital stock	0.00	+8.69	+0.00	+10.19
8. CCA (depreciation)	−9.32	−0.70	−9.55	+0.54
10. Residential capital stock	−9.08	−2.98	−8.97	−2.11
12. Labor supply	+0.38	−0.10	+0.28	+0.22
Capital/Labor ratio of economy	−0.50	+8.68	−0.40	+10.32
13. Real after-tax wage rate (w/p)	+13.22	+17.08	+4.82	+9.42
15. Real after-tax rate of return (r/p)	+50.43	+35.24	+54.27	+34.56
17. Price level (consumer prices)	+20.59	+13.92	+27.25	+21.89
23. Total wage income (line 12 × line 13)	+13.59	+16.91	+5.06	+9.13

Table A.—Effects on Capital Accumulation and Allocation From Replacing the Income-Tax System With Comprehensive Income Taxes (Fullerton-Rogers Model, High Elasticities[1])

[In percent]

	Comprehensive income tax w/no exemption		Progressive comprehensive income tax w/exemption	
	Initial	Long run	Initial	Long run
Percent change in:				
Saving rate	+202	+11.3	+167	+9.46
Capital stock	0.00	+14.1	0.00	+11.8
Residential capital stock	−10.0	+1.11	−9.61	−0.32
Effective tax rate on corporate capital	−57.2	−54.4	−49.5	−47.6
Effective tax rate on noncorporate capital	−30.0	−24.6	−18.8	−15.1
Effective tax rate on owner-occupied housing	+13.6	+25.0	+25.6	+34.0
After-tax rate of return divided by after-tax wage rate (r/w)	+18.9	−7.55	+18.9	−3.77
Capital-labor ratio of economy	−2.81	+13.4	−2.04	+11.6

[1] Intertemporal and leisure-consumption elasticities set equal to .50.

Table B. Effects on Capital Accumulation and Allocation From Replacing the Income-Tax System With Consumption-Based Taxes (Fullerton-Rogers Model, High Elasticities[1])

[In percent]

	Comsumption tax w/ no exemption		Progressive consumption tax w/exemption	
	Initial	Long run	Initial	Long run
Percent change in:				
Saving rate	+335	+19.6	+362	+21.5
Capital stock	0.00	+22.5	0.00	+23.8
Residential capital stock	−13.0	+4.38	−14.0	+4.41
Effective tax rate on corporate capital	−77.1	−68.5	−76.9	−67.7
Effective tax rate on noncorporate capital	−58.7	−43.6	−58.4	−42.3
Effective tax rate on owner-occupied housing	−16.4	+10.5	−15.8	+12.7
After-tax rate of return divided by after-tax wage rate (r/w)	+16.3	−19.4	+16.3	−23.1
Capital-labor ratio of economy	−3.92	+21.8	−3.56	+23.8

[1] Intertemporal and leisure-consumption elasticities set equal to .50.

Table C.—Effects on Capital Accumulation and Allocation From Replacing the Income-Tax System With Wage Taxes (Fullerton-Rogers Model, High Elasticities [1])

[In percent]

	Wage tax w/no exemption		Progressive wage tax w/exemption	
	Initial	Long run	Initial	Long run
Percent change in:				
Saving rate	+278	+17.8	+272	+19.4
Capital stock	0.00	+20.2	0.00	+20.7
Residential capital stock	−11.5	+3.98	−11.8	+3.70
Effective tax rate on corporate capital	−80.8	−73.6	−82.6	−75.7
Effective tax rate on noncorporate capital	−65.2	−52.6	−68.4	−56.2
Effective tax rate on owner-occupied housing	−28.6	−5.31	−34.5	−11.8
After-tax rate of return divided by after-tax wage rate (r/w)	+43.4	−0.00	+58.5	+9.38
Capital-labor ratio of economy	−3.20	+20.0	−2.29	+21.6

[1] Intertemporal and leisure-consumption elasticities set equal to .50.

Table D.—Effects on Capital Accumulation and Allocation From Replacing the Income-Tax System With Comprehensive Income Taxes (Fullerton-Rogers Model, High Elasticities[1])

[In percent]

	Comprehensive income tax w/no exemption		Progressive comprehensive income tax w/exemption	
	Initial	Long run	Initial	Long run
Percent change in:				
Saving rate	+61.2	+3.78	+58.4	+3.83
Capital stock	0.00	+5.43	0.00	+5.44
Residential capital stock	−8.79	−4.69	−8.66	−4.60
Effective tax rate on corporate capital	−58.1	−57.2	−51.9	−51.2
Effective tax rate on noncorporate capital	−31.3	−29.5	−22.3	−20.9
Effective tax rate on owner-occupied housing	+12.8	+16.8	+22.2	+25.7
After-tax rate of return divided by after-tax wage rate (r/w)	+14.4	+4.99	+14.4	+4.97
Capital-labor ratio of economy	−0.36	+5.43	−0.30	+5.50

[1] Intertemporal and leisure-consumption elasticities set equal to .15.

Table E.—Effects on Capital Accumulation and Allocation From Replacing the Income-Tax System With Consumption-Based Taxes (Fullerton-Rogers Model, Low Elasticities[1])

[In percent]

	Consumption tax w/no exemption		Progressive consumption tax w/exemption	
	Initial	Long run	Initial	Long run
Percent change in:				
Saving rate	+63.3	+3.54	+61.3	+3.53
Capital stock	0.00	+5.23	0.00	+5.23
Residential capital stock	−9.42	−5.41	−9.51	−5.58
Effective tax rate on corporate capital	−76.5	−74.7	−76.5	−74.7
Effective tax rate on noncorporate capital	−57.6	−54.4	−57.6	−54.4
Effective tax rate on owner-occupied housing	−14.5	−8.75	−14.5	−8.68
After-tax rate of return divided by after-tax wage rate (r/w)	+13.2	+3.78	+13.2	+3.78
Capital-labor ratio of economy	−0.48	+5.12	−0.40	+5.18

[1] Intertemporal and leisure-consumption elasticities set equal to .15.

Table F.—Effects on Capital Accumulation and Allocation From Replacing the Income-Tax System With Wage Taxes (Fullerton-Rogers Model, Low Elasticities[1])

[In percent]

	Wage tax w/no exemption		Progressive wage tax w/exemption	
	Initial	Long run	Initial	Long run
Percentage change in:				
Saving rate	+77.4	+7.15	+80.9	+8.80
Capital stock	0.00	+8.69	0.00	+10.2
Residential capital stock	−9.08	−2.98	−8.97	−2.11
Effective tax rate on corporate capital	−80.0	−77.1	−81.5	−78.2
Effective tax rate on noncorporate capital	−63.8	−58.7	−66.4	−60.7
Effective tax rate on owner-occupied housing	−26.0	−16.5	−31.0	−20.1
After-tax rate of return divided by after-tax wage rate (r/w)	+34.6	+17.0	+49.1	+24.5
Capital-labor ratio of economy	−0.50	+8.68	−0.40	+10.3

[1] Intertemporal and leisure-consumption elasticities set equal to .15.

Table G.—Welfare Effects of Tax Reform (Fullerton-Rogers Model, High Elasticities[1])

[In percent]

	Comprehensive income taxes		Consumption taxes		Wage taxes	
	Propor-tional	With ex-emption	Propor-tional	With ex-emption	Propor-tional	With ex-emption
Percent change in output (initial, long-run) ..	+4.48, +4.61	+3.64, +3.77	+6.07, +6.03	+5.84, +5.81	+5.14, +5.41	+4.30, +4.66
Percent change in labor supply (initial, long-run)	+2.98, +0.70	+2.17, +0.26	+4.08, +0.52	+3.69, +0.01	+3.39, +0.30	+2.42, −0.61
Percent change in long-run real after-tax wage rate	+21.5	+14.1	+24.6	+18.7	+20.2	+9.32
Percent change in utility to steady-state generation	+1.90	+1.81	+3.33	+3.84	+1.84	+1.68
Overall efficiency gain (present value over all generations, based on 4 percent discount rate)	+0.70	+0.61	+0.97	+0.96	+0.86	+0.70

[1] Intertemporal and leisure-consumption elasticities set equal to .05.

Table H.—Welfare Effects of Tax Reform (Fullerton-Rogers Model, Low Elasticities[1])

[In percent]

	Comprehensive income taxes		Consumption taxes		Wage taxes	
	Proportional	With exemption	Proportional	With exemption	Proportional	With exemption
Percent change in output (initial, long-run)	+1.31, +1.86	+1.26, +1.84	+1.25, +1.76	+1.77, +1.76	+1.32, +2.37	+1.29, +2.58
Percent change in labor supply (initial, long-run)	+0.37, +0.01	+0.30, −0.05	+0.37, +0.00	+0.28, +0.06	+0.38, +0.10	+0.28, −0.22
Percent change in long-run real after-tax wage rate	+19.0	+13.8	+18.7	+13.4	+17.1	+9.42
Percent change in utility to steady-state generation	+0.70	+0.95	−0.04	−0.03	+0.77	+1.11
Overall efficiency gain (present value over all generations, based on 4 percent discount rate)	−0.05	−0.06	−0.05	−0.04	−0.20	−0.89

[1] Intertemporal and leisure-consumption elasticities set equal to .15.

2. Alan J. Auerbach, Laurence J. Kotlikoff, Kent Smetters, and Jan Walliser *

"Fundamental Tax Reform and Macroeconomic Performance"

The model utilized for these simulations has been developed jointly with David Altig. The views in this paper do not necessarily reflect those of the Congressional Budget Office. We thank Bob Dennis, Doug Hamilton, Diane Lim Rogers, John Sabelhaus, Frank Sammartino and John Sturrock for their helpful comments. We also thank several participants in the Conference namely, Eric Engen, Jane Gravelle, and Peter Taylor whose helpful comments and constructive criticisms during pre-Conference meetings resulted in a vastly improved paper.

I. Introduction

Fundamental tax reform would substantially alter the structure of incentives in the US economy. Understanding the consequences of shifting to a flat income or consumption tax therefore requires careful consideration of the changes in microeconomic behavior in order to assess the effects on macroeconomic variables. Our modeling approach accordingly starts with households and firms as the fundamental units of decision making in the economy. All changes in macroeconomic variables are then derived from changes in household labor supply, consumption, and saving decisions. Since the intragenerational distribution of income and wealth is important due to the progressive structure of the current tax system, we distinguish households by age and earnings class.

The Joint Committee on Taxation (JCT) asked participants of this conference to examine two basic tax reforms. The first reform involves moving from the current progressive income tax system to a flat (proportional) income tax with an exemption level equal to $10,000 plus $5,000 for each dependent. Such reform would flatten tax rates, remove the double taxation of capital income and eliminate many tax preferences including the housing interest deduction, additional personal itemized deductions, personal tax credits, the deductibility of state income taxes and the favorable (consumption) tax treatment of retirement saving accounts. The second reform involves moving from the current tax income tax system to a consumption tax with uniform tax rates. In this reform, expected capital income is exempted from taxation by a move to full expensing.

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Our numerical simulations reveal that the two reforms have very different implications for the economy. Under the income tax, most people earn less; and in the long run, the capital stock declines by 10.5 percent and the production of goods and services falls by 3 percent. Moving to a consumption tax, on the other hand, raises wage rates; the capital stock climbs 32 percent and output expands by 7.5 percent in the long run. Despite the fact that the flat income tax rate has a broader base (income minus deductions) than the flat consumption tax rate (consumption minus deductions), the tax rate in the consumption tax experiment eventually falls to 22.4 percent which is substantially below the long run tax rate of 25.0 percent in the income tax experiment. As the paper will explain, the difference stems from the fact that moving to a consumption tax (unlike moving to a proportional income tax) imposes a lump sum tax on existing wealth and eliminates the taxation of capital income.

The following section discusses the features of the substantially enhanced Auerbach-Kotlikoff life cycle model and our initial calibration. Section 3 explains the main results in light of our modeling approach. Although the model handles a great deal of complexities, it leaves out some portions of reality as reviewed in Section 4. This suggests viewing the model's results cautiously. Nonetheless, the simulation analysis reported herein does paint important brush strokes, even if broad ones.

II. The Model

Our simulation model is based on the Auerbach-Kotlikoff (1987) life cycle model. It features 55 overlapping generations. Each agent lives for 55 years (ages 20 to 75). The model calculates the rational expectations (perfect foresight in our deterministic model) steady states as well as transition paths of factor prices, consumption, labor supply, tax rates, and other economic variables. There are three sectors: households, firms, and the government. The model does not have a monetary sector and all variables are real variables. The simulation results presented in this paper also assume a closed economy.

The model makes a number of important innovations to the Auerbach and Kotlikoff model. First, the model incorporates multiple lifetime income classes. This feature affords an analysis of the *intra*generational distributional impact of fiscal policy in addition to the *inter*generational distributional impact analyzed by Auerbach and Kotlikoff (1987) and Auerbach (1996). Characterizing the intragenerational distribution of wealth and income also allows for a more realistic analysis of fiscal policy, since the macro impact of a tax cut may depend on the initial distribution of lifetime income endowments and bequests. Second, the model incorporates an intergenerational bequest motive with bequests distinguished by income cohort. Third, the model includes a tax deduction against wage income. This requires the consumer to solve the lifetime optimization problem with a kinked budget constraint. We handle this complicated problem by assigning virtual marginal tax rates to consumers locating at the kink. Fourth, the model is carefully scaled to dollar units which makes it easy to match the model tax rates (and its Social Security replacement rates) to actual data. Fifth, the model incorporates a more realistic hybrid tax system as well as a more realistic Social Security system with the statutory earnings ceiling and the statutory bend-point formula applied over covered earnings. Sixth, the model incorporates labor-augmenting technological progress.

The Household Sector

Our model is particularly rich in modeling household decision making. Households decide how much to consume and how much to work in each period for given current and future after tax wages and interest rates. Households may if they desire not supply any labor at all in a given year and thereby retire or withdraw from the labor force. Following the lead of Fullerton and Rogers (1993), we divide households into 12 lifetime income classes. Classes 1 and 12 reflect the bottom and top 2 percent of lifetime income with classes 2 and 11 making up the remaining 8 percent of the bottom and top lifetime income decile. Classes 3 through 10 represent the intermediate lifetime income deciles. Wages for each lifetime income class grow according to a predictable fixed age-wage profile. We estimated these age-wage profiles from the PSID. Our procedure differs from Fullerton and Rogers (1993) in two main points: First, we control for a "cohort-effect" by including a birth-year indicator in our regression. This removes the effect of wage growth over time. Second, we sort wage profiles by individuals rather than by household wage income.[1] (For this purpose we exclude nonworkers.) To see the difference, consider the following example. Suppose a person makes $100,000 per year and is married to someone who makes $20,000. In Fullerton and Rogers (1993), this household would be represented by a single agent who makes $60,000 per year since this is the amount of money available to each spouse if the household wage income is divided equally. In our model, on the other hand, the two agents would be modeled separately. Our procedure increases the dispersion of wage income which, under a progressive tax system, allows for a more accurate calculation of the tax rates faced by rich agents in the economy.

All households maximize a time-separable CES utility function with an intratemporal elasticity of substitution of 0.8 and an intertemporal elasticity of substitution of 0.25. The first parameter determines to what extent households are willing to substitute consumption for leisure in any given period while the second value determines how easily households substitute consumption (leisure) today for consumption (leisure) tomorrow. We also assume that households have a pure rate of time preference that is the value at which future utility from future consumption and leisure is discounted of 1.5 percent. These figures are the same as used by Auerbach and Kotlikoff (1987) who also review the relevant empirical literature. We incorporate an income class specific utility weight for bequests in our model in order to reflect the substantial differences in bequests across income classes. In particular we calibrate bequests in the initial steady state to reproduce the empirically observable size of bequests (Fullerton and Rogers [1993], p.99)

[1] Accordingly, we treat each agent as an individual when we apply the tax code later on.

by income class relative to mean income in the economy. Population growth is exogenous and set equal to 1 percent.

Production

Firms are perfectly competitive and employ labor and capital such that profits are maximized. There is only one production sector and therefore only a single good that can alternatively be used for investment and consumption. Firms in our economy produce according to a Cobb-Douglas technology. Since the production function is defined net of depreciation, we choose a capital share of 25 percent which accords well with most empirical research using this specification (see Auerbach and Kotlikoff [1987]). Technology is labor augmenting and grows at 1 percent per year.

Government

The government collects revenues for its spending on goods, services, transfers and interest payments via consumption taxes, wage taxes, income taxes, and capital income taxes. Each of these taxes may be modeled as proportional or progressive via a quadratic tax function. In addition, the government levies a payroll tax on wages to finance transfers to the elderly via Social Security and Medicare.

The Current Hybrid Tax System. We approximate the hybrid nature of the current US tax system by splitting the federal income tax into a progressive wage tax, a flat capital income tax, and a flat consumption tax. Following Auerbach (1996), capital income is taxed at a flat rate of 20 percent (a weighted average of the effective marginal tax rates on housing and non-housing capital) and we allow firms to expense 20 percent of new investment in order to reflect the accelerated deprecation allowance under current law. Together, these assumptions imply an effective marginal tax rate on capital income equal to 16 percent. Since contributions to pension funds under current law are part of labor compensation but receive consumption tax treatment, we levy a 2.5 percent tax on consumption and reduce taxes on wages accordingly. (The reader is referred to Auerbach [1996] for the derivation of these numbers.) An ordinary least squares regression is used to approximate the statutory wage tax schedule for individual filers with a quadratic function. The regression achieves a very good fit with an R^2 equal to 0.998. This function is then applied to wage income above the federal personal exemptions and standard deduction which, in total, equals $9662.[2] To account for itemized deductions, we used the IRS *Statistics of Income* to compute how itemized deductions (not including the mortgage interest deduction which was already factored into the 20 percent tax rate on capital income) rises with income. We find that itemized deductions increase by $0.0755 for every dollar of income above the combined standard deduction and exemption level. That estimate is derived from a regression with an R^2 of 0.99.

Our calibration also includes state and local taxes as well as the remaining federal taxes. State taxes are represented with a flat income tax of 3.7 percent. Consistent with NIPA values, we collect

[2] We add the standard $4,000 deduction, personal exemptions of $2,550 and exemptions of $3110 for the 1.2 children of an average agent in the model (consistent with the 1 percent population growth rate) to arrive at this figure. The computation of the marginal tax rate applied to wage income includes interest income.

an additional consumption tax of 8.8 percent which reflects indirect business taxes and excise taxes. Thus the total tax on consumption under current law is assumed to be 11.3 percent. We ignore property taxes following the view that property taxes equal benefits received at the local level.

Tax Evasion. Because we are using a very close approximation to the statutory code to parameterize our tax functions, we have, up to this point, ignored the possibility of evasion. Without any correction for tax evasion, government revenues in our model would be higher than those found in the NIPA accounts and indeed exceed their NIPA values by almost exactly the amount of tax evasion estimated by Slemrod and Bakija (1996). We corrected for evasion with a negative proportional income tax rate of 2.6 in the initial steady state which reduces the average and marginal income tax rates for all agents in the economy. (The marginal and average tax rates are still positive for all agents however since, at a minimum, everyone faces a flat state income tax of 3.7 percent.) For both tax reform experiments, we assume that evasion reduces the taxable base (income net of standard deductions and exemptions) by the same percentage before and after the reform.[3]

Social Security, Medicare, and Other Transfers. We calculate the OASI replacement rates for covered earnings using the statutory bend point formulas. Benefits are also scaled in order to reflect survivor benefits. The endogenous OASI payroll tax necessary to finance these benefits equals 9.8 percent which is close to the 1995 value of 10.52 net of the trust fund contributions of 0.7 percent of payroll.[4] Trust fund contributions are included in other non social security-related wage taxes. We assume that payroll taxes are only partly distortionary up to the maximum taxable earnings of $61,700. In particular, we set the perceived link between the present value of taxes and the present value of future benefits to 25 percent. Thus, agents consider only 75 percent of the payroll tax as a tax on labor.[5] Agents with labor supply above the maximum taxable earnings face a marginal payroll tax of zero, thus the payroll tax is non-distorting for them. We model Medicare (HI) as a non-earnings related transfer to agents age 65 and older and disability insurance (DI) benefits as a lump-sum transfer to agents below age 65. These benefits are financed through payroll taxes of 2.9 percent (HI) and 1.9 percent (DI) which equal their current statutory values. In contrast to the DI tax and the OASI tax, the HI tax is not subject to the earnings ceiling. In addition to modeling the social insurance system, we rebate about 1.8 percent of national income to agents as a (wage-indexed) lump sum transfer. This transfer accounts for other transfer programs as AFDC and Medicaid.

Government Debt Service. Finally, we select the level of government debt in the initial steady state to set the real interest payments on government debt equal to 1.5 percent of national income, its 1995 level. Targeting interest payments correctly is important

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[3] Since the taxable base shrinks due to higher exemptions in both experiments we set our downward adjustment of flat income taxes due to evasion to 1.4 percent after the tax reform. Note that this may be an optimistic approach if evasion occurs mostly among agents with higher income.

[4] See Social Security Administration (1995).

[5] See Auerbach and Kotlikoff (1987), Chapter 10, for more detail on this issue.

in order to accurately reflect any gains from lower debt service should interest rates fall after tax reform. Our model does not explain the equity premium and therefore has only a single interest rate, the (real) net rate of return to capital, which is substantially higher than the real rate of return to government bonds. The ratio of debt to national income is consequently about half of that observed for the US economy. The results would be the same if we used a lower interest rate for government debt that moved one-for-one with the real rate on capital.

Description of Initial Steady State

The model does a good job at generating endogenous values of variables which match their real-world counterparts. The generated economy lines up well with the actual economy even though most of the model's parameters are picked either according to the estimates in the literature or according to statutory code.[6]

In terms of aggregate values, we obtain an economy-wide average marginal tax rate on wage income equal to 21.5 percent which is close to the TAXSIM calculations reported in Auerbach (1996) while our economy-wide average tax rate on wage income equals 13.3 percent. Total government revenue net of payroll taxes, is 24.4 percent of NI (national income), matching the value found in the 1995 NIPA accounts less property tax revenue. The model generates a pre-tax interest rate equal to 9.6 percent. The net saving rate equals 5.3 percent. The capital-NI ratio is 2.6 which is close to the 2.8 value derived from the 1994 balance sheets published by the Federal Reserve Bank.[7] Simulated consumption comprises 73.2 percent of NI (whereas the actual value was 74.3 percent for 1995 in the NIPA accounts), net investment equals the saving rate of 5.3 percent (which equals its actual value at an economy-wide depreciation rate equal to 5.0 percent), and government spending on goods and services accounts for the remaining 21.5 percent which is equal to government revenues net of interest payments on the debt and the lump sum transfer noted earlier.

The wage rate of an individual at age 45, which corresponds to the peak earning age for all of the income classes, is $4.00, $14.70 and $79.53 for income class 1, income class 6, and income class 12, respectively. Class 1 represents the lifetime poorest, and classes 6 and 12 reflect median earners and the lifetime richest group. Annual labor income endogenously derived from leisure choices ranges between $9,700 and $160,000 at around age 45. The model generates a net national income per capita of all agents between ages 21 and 75 equal to around $39,000, which is very close to its empirical value of about $38,500 derived by dividing 1995 national income by the sum of the labor force and retired individuals.

The average tax rate on wage income, averaged across individuals of all ages in income class 12, equals 20.4 percent, while the

[6] The only real unobservable "free parameter" in the model is the weighting parameter placed on consumption versus leisure. We choose the value of this parameter—as is traditionally done—in order to generate a reasonable average 35 hour work week. All of the other utility parameter choices follow Auerbach and Kotlikoff (1987) who discuss their empirical foundation.

[7] Total reproducible assets equaled $15.6 trillion in the Fed's 1994 balance sheets. This included $5.8 trillion of residential structures, $2.5 trillion of consumer durables, $6.1 trillion of nonresidential fixed private capital and $1.2 trillion in inventories. National income equaled $5.5 trillion in 1994.

average marginal tax rate equals 29.5 percent with top marginal tax rates of 35 percent. For income class 6, these average and average marginal rates are 11.3 percent and 19.9 percent, respectively, while for class 1, the rates are 0 percent and 2.9 percent.[8] The proportion of income derived from wage and interest income across these groups also match the *SOI* data rather closely.

III. The Impact of Fundamental Tax Reform on Macroeconomic Variables

Unified Flat Income Tax

In accordance with the specifications given by the JCT, the first experiment replaces the progressive federal income tax with a flat income tax on wage income and capital income. The total of personal exemption and deduction is raised to $16,101.[9] Itemized deductions are eliminated. The OASDI and HI programs remain the same. Any positive or negative budget savings from changes in interest rates are reflected in replacement tax rates. Replacement tax rates are set to finance the same amount of government spending for goods and services in the new tax regime as in the initial steady state. The consumption tax is reduced from 11.3 percent to 8.8 percent to reflect the loss of the consumption tax treatment of retirement saving accounts. The expensing rate for investment remains at 20 percent. The state and local income tax rate is increased from 3.7 percent to 4.4 percent to reflect the loss of deductibility of state and local income taxes from the federal income tax base.[10] As described before, we assume that tax evasion as percent of the taxable base stays the same. Table 1 presents the effects of this tax reform on major macroeconomic variables. We assume that the reform is implemented on January 1, 1997. 1996 therefore represents the pre-reform economy.

Our results show that reform reduces the labor supply and the capital stock by 1.0 percent and 0.5 percent, respectively, in the first year of the transition. The saving rate drops from 5.3 percent to 3.9. In the simulations, a flat income tax rate of 23.5 percent is sufficient initially to finance government spending and the increase in the exemption level. After 9 years, the capital stock has dropped by 4.2 percent, labor supply has dropped by 0.9 percent and output has fallen by 1.7 percent. Eventually, the capital stock ends up 11.5 percent smaller than its original value and output and wage rates are reduced by 3.0 percent and 2.6 percent, respectively. Even in the long run the saving rate does not fully recover and remains at 4.9 percent (down from 5.3 percent). Furthermore, due to the decrease in the tax base, an income tax rate of 25.0 percent is needed in the long run which is higher than the rate needed immediately after the reform.

What accounts for these results? Essentially, the decline in labor supply and saving stems from the increase in marginal tax rates

[8] Lifetime poorest face a positive average marginal tax rate across their lifetime because of a few periods where those agents are at the 'kink' and face positive shadow marginal taxes.

[9] This is consistent with a non-refundable exemption of $10,000 plus $5,000 per dependent. Each agent has $(1.01)^{20} = 1.22$ dependents and so the exemption equals $10,000+ $5,000 $(1.01)^{20}$ = $16,100.95.

[10] Since the model has a single unified government sector it is irrelevant for the results that these additional revenues would in reality accrue at the federal level.

for a number of income classes under the reform. Although the reform repeals a number of tax preferences in the current system, that is not sufficient to finance the increase in the personal tax exemption. Only classes 1 and 2 will be totally exempt from taxes due to the higher deductions; the rest will face higher marginal tax rates on labor income over at least part of their life. In addition, the effective marginal tax rate on all capital (including housing) under the reform increases from 16 percent to 20.0 percent.[11] As a result of higher marginal tax rates, this reform proposal reduces the incentives to work and save which slows economic activity and causes the tax base to contract. That contraction of the capital stock and labor supply reinforces itself along the transition path of the economy as the shrinking tax base increases the marginal tax rates needed to finance government spending at its original level, leading to further contraction of the capital stock and labor supply.

Flat Consumption Tax

The second experiment involves moving from the current tax system to a consumption tax. Technically, the experiment is identical to the one described above except that firms can fully expense new capital investment. The results of this experiment are shown in Table 2.

Since the experiments presented in this paper assumes away adjustment costs, full expensing of investment will cause the value of existing capital to drop immediately.[12] With full expensing, new capital receives favorable treatment compared to existing capital. Thus, if the owners of existing capital offer their assets for sale, they have to compete with the tax favored investment in new capital. Because old and new capital are assumed to be perfect substitutes, the price of existing assets must fall by the amount of the tax incentive and the owners of old capital must experience a capital loss under a tax system that provides full expensing.

Our model shows that households react to the drop in their wealth by reducing their consumption of both goods and leisure. Put differently, they increase both their saving and their labor supply to make up for the lower value of their wealth. In addition to the wealth effect, the labor supply and saving responses can be explained as a result of intertemporal substitution. Since after-tax interest rates rise shortly after tax reform and then fall subsequently, people face incentives to work and save more assets shortly after the reform.[13] On the other hand, higher marginal tax rates on many people's labor income offset some of the positive effects on labor supply.

In the simulations, labor supply initially increases by 2.5 percent, which boosts output by 1.2 percent. At the same time, the removal of the capital income tax and the drop in the value of existing assets leads to an increase in the saving rate from 5.3 percent to 9.0 percent in the short run. Labor supply decreases slowly over

[11] Our model has only a single production sector and, thus, does not explicitly capture any substitution between housing capital and non-housing capital that tax reform might induce.

[12] In a model with a realistic level of adjustment costs, the initial labor supply response is attenuated because existing wealth would be partly (possibly fully) shielded from the lump-sum tax. See Auerbach (1996).

[13] Experiments which reduce the loss in wealth with some transition relief as, for example, a lump sum tax rebate let us believe that the wealth effect dominates the labor supply response.

time and its level in the long run barely exceeds its original level. In the medium and long run, the growth in output is mostly driven by capital accumulation. Four years after the reform, the capital stock is 7.2 percent larger, and by year 9, it has increased 14 percent above baseline. Eventually, the capital stock exceeds its initial level by 31.5 percent. Accordingly, output is 2.4 percent larger than baseline in year 4 and 4.0 percent larger in year 9. In the long run, output increases by 7.5 percent.[14] In response to the changes in long run factor supply, the interest rate falls from 9.6 percent to 7.8 percent and (before-tax) wages increase by 7.1 percent above the baseline.

Our findings indicate that the proportional tax rate on consumption would have to be initially 25.8 percent.[15] Note that this rate is tax inclusive. It is higher than the initial tax rate under the uniform flat income tax experiment reported earlier (because the consumption base is smaller than the income base) but is about 5 percentage points lower than what the tax rate would have been without a lump-sum tax on existing wealth.[16] Because the reform increases output, the consumption tax rate drops to 26.3 percent after 9 years and 22.4 percent in the long run. After around 30 years, the revenue from higher output overcomes the initial base narrowing and thus the replacement tax rate falls below that found in the flat income tax experiment. The economy grows above the baseline despite the increase in marginal tax rates on the labor income for many households. That result follows from the fact that a consumption tax removes the tax on capital income which stimulates saving and investment.

IV. Shortcomings of the Model

The model incorporates many complex details of the real economy and relies on only a few exogenous so-called "deep" parameters specifying the utility and the production function. We think that these features are especially important for assessing the effects of fundamental tax reform. However, as in any model, our model abstracts in some ways from reality. As a result, we urge a cautious interpretation of our exact quantitative results. We outline below some of the omissions we consider most important.

No Differentiation of Production Sectors

The model assumes a single production sector which produces both consumption and investment goods. Thus, the model cannot distinguish among different sectors. Other models used in this conference, specifically those of Fullerton and Rogers (1993) and Jorgenson and Wilcoxen (1997), feature multiple sectors and can therefore capture the substitution between housing and non-housing capital as well as the effect of reducing the tax-differential between corporate and non-corporate activities. We may therefore un-

[14] Our long run marginal tax rate including the additional consumption tax of 2.5 percent rate is roughly midway between the marginal rates found by Auerbach (1996) for the Armey-Shelby Plan and the Hall-Rabushka Plan experiments. Our predicted output growth also falls between the figures reported by Auerbach for his simulations.

[15] This is the statutory tax rate before taking evasion into account.

[16] The consumption tax base is about 75 percent of the size of that under the income tax base. Without the tax on existing wealth therefore the replacement tax rate would have to be about $\frac{3}{4}^{-1}$ times 23.5 percent (the initial tax rate under a uniform income tax), or about 31 percent.

derestimate possible efficiency gains in the flat income tax experiment which eliminates distortions among different types of capital.

No Borrowing Constraints

The overlapping generations model underlying our simulations allows consumers to borrow against future resources without constraint. Some empirical evidence, however, suggests that as much as 20 percent of the population faces binding borrowing constraints (e.g. Hayashi [1987], Mariger [1987]). Introducing binding borrowing constraints would not alter our results much because only the bottom 2 percent of earners in our model occasionally hold negative contemporaneous asset (net worth) positions.[17] Since this group accounts only for a tiny part of accumulated wealth, incorporating borrowing constraints would not significantly alter the results presented above.

The empirical evidence could also be interpreted as evidence for rule-of-thumb savers who consume a certain percentage of their income independent of future wages and interest rates. Incorporating such behavior would likely dampen the savings response to tax reform. It is unclear, however, how to derive such a rule-of-thumb. Additionally, such consumers may change their rule after a fundamental tax reform in unpredictable ways. Finally, most of our short-run results in the consumption tax experiments are driven by the labor supply response to the lump-sum tax on existing wealth rather than by a saving response. For example, in another experiment we performed (not reported) which partly shielded existing assets against taxation, gains to aggregate variables were significantly attenuated.[18]

No Uncertainty Regarding Wage Income and Longevity

Our model employs fixed wage efficiency profiles for each earnings class and does not incorporate wage income uncertainty. Since uncertainty about future wages may induce agents to build up a stock of precautionary wealth ("buffer stock") our model may overpredict the post-reform saving response because precautionary saving are not sensitive to changes in the interest rate (see, e.g., the contribution to this Conference by Eric Engen [1997]).

Our assumption of a certain lifespan until age 75 implies the availability of actuarially fair annuities (Blanchard [1985]; Feldstein [1988]). In reality those annuities do not exist and the lack of annuities should give rise to additional saving against longevity uncertainty which is not reflected in our model. However, Social Security and Medicare are both annuity programs. Since they re-

[17] Much of the borrowing in the actual economy is for homes and education. Home borrowing however does not lead to a negative net worth position and so many households in our economy with positive assets can be interpreted as having borrowed for a home. Borrowing which leads to a negative net worth involves mortgaging one's own future human capital. This typically takes the form of education loans which our model does not incorporate and so our model is presumably underestimating borrowing of this type.

[18] This implies that intertemporal substitution alone cannot explain the relatively strong responses in our model. Recall that we use an intertemporal substitution elasticity over *full* consumption (consumption and leisure) equal to only 0.25. Whereas Robert Hall (1978), for example, found that the intertemporal substitution elasticity over consumption *alone* is very small (around 0.10)—although subsequent work found larger values—Dale Jorgenson and Peter Wilcoxen (this conference), for example, use a value of 1.0, Eric Engen (this conference) uses 0.33 based on his own estimates and Diane Lim Rogers (this conference) considers both 0.15 and 0.50.

place a large part of income for the median earner, the lack of an annuity market may not distort our results to a major extent. Nonetheless, a realistic incorporation of longevity uncertainty would be a very useful extension to our model.[19]

No Explanation of the Equity Premium

It is theoretically unclear whether a model without *aggregate* level uncertainty should target the risk free rate of return or the rate of return to capital since the latter reflects a premium for uncertainty which itself has not been explained sufficiently (i.e., the so-called "equity premium puzzle"). Smetters (1996) shows that responses to fundamental tax reform depends crucially on which rate of return is targeted. Models, such as ours, which target the equity rate tend to produce larger responses than those targeting the risk free rate. However, without jointly explaining the risk free interest rate and the equity rate, this issue cannot be resolved.

V. What Accounts for the Differences in Results Among Models?

Although most of the models in this conference produce similar qualitative results, the models differ sometimes significantly in their quantitative conclusions, especially regarding the effects of the consumption tax. This section outlines what we believe are the key reasons why the simulation results of our model differ from both those of the other intertemporal models and from the reduced-form equation models.

Intertemporal Models

Jorgenson-Wilcoxen Model. The key difference between the J–W model and our model is the initial effects of the consumption tax on labor supply. The J–W model produces a 7 percent increase while our model produces a 3 percent increase. This, in turn, explains why the J–W produces a first-year increase in output equal to 4 percent, whereas our model produces only an 1 percent increase. The J–W model produces a large labor supply response because they assume that the utility of their representative agent can be represented by the natural log of full consumption, which implies an intertemporal substitution elasticity (IES) that is four times larger than the value that we use. Higher values for the IES increase the responsiveness of labor supply to changes in the after-tax rate of return to capital. This result occurs because agents choose to work more today in order to increase saving in an attempt to take advantage of the increase in the after-tax rate of return to capital.[20]

[19] Models featuring lifetime uncertainty need to explicitly solve the dynamic programming problem of children who anticipate a bequest which is not perfectly deterministic in either size or timing. We are not aware of any model that does so. If bequests are distributed lump sum across the entire population (as in some models) or confiscated by the government (as in some other models), longevity uncertainty only augments the rate of time preference.

[20] This effect is partly offset by the fact that the J–W model assumes away any intergenerational redistribution of wealth from old retirees to young workers. In our model, the intergenerational redistribution accounts for much of the labor supply response. The J–W model cannot reflect such redistributions because the entire household sector is represented as a single infinitely lived agent.

Fullerton and Rogers Model. Our model is most similar to the model of Fullerton and Rogers but differs in four important ways. Those differences explain why the long-run gains in output from a consumption tax are smaller in the F–R model, even when the F–R model assumes a value for the intertemporal substitution elasticity that is twice the size of ours. First, every agent in the F–R model faces the same marginal tax rate regardless of income. By contrast, our model has a progressive income tax system and som of the gains to output come flattening the current tax structur Second, intergenerational bequests are fixed in the F–R model an so they do not respond to changes in relative prices whereas bequests in our model are endogenous and respond to those chances. That feature reduces the sensitivity of total saving to the rate of return in the F–R model but enhances that sensitivity in our model. Third, the F–R model utilizes a Stone-Geary utility function that requires a minimum purchase of certain commodities in each period. Using a Stone-Geary utility function tends to reduce the long-run saving response somewhat since the consumer's choice is narrowed down to that between leisure and discretionary spending.[21] Fourth, our model, but not the F–R model, incorporates an initial level of government debt. A shift to a consumption tax produces lower interest rates that, in turn, reduces the government's cost of debt service. Because the policy changes are assumed to be revenue neutral, the government's debt level is unaffected by tax reform and so a reduction in debt service lowers replacement tax rates, which increases output in the long run.

Engen's Model. In Engen's model, precautionary saving accounts for about 60 percent of total wealth whereas it is non-existent in our model. As a result, saving in our model tends to be more sensitive to the after-tax interest rate in our model than in Engen's model.

Our model, however, includes saving for an intentional bequest that is distributed to one's heirs, whereas the Engen model incorporates an accidental bequest that is distributed evenly throughout the economy. The intentional bequest feature of our model may not be particularly important for most poor households and for some middle income class households but it is important for modeling the behavior of the wealthy top 10 percent of households who own almost 70 percent of the capital stock (Survey of Consumer Finances [1992]) and for whom precautionary saving may or may not be an important saving motive. The incorporation of an intentional bequest motive increases the sensitivity of saving to the after-tax interest rate and the distribution of bequests to one's own family members rather than to society at large would reduce saving for precautionary reasons.

The importance of both intentional bequests and precautionary saving has received great scrutiny in the literature and many economists come down on each side of both issues. Indeed, some economists believe that *neither* motive for saving is very important.

[21] Enforcing a minimum consumption level is important in the F–R model because the Inada condition—i.e., that marginal utility tends to infinity as consumption approaches zero—is not applied to each consumption item. It is unclear how important such a constraint would be in our model which enforces the Inada condition over total consumption. IN our simulations, the Inada condition already prevents consumption from becoming very small in any given period.

But most economists would probably agree that an ideal model would include both of these saving motives. Incorporating both features, however, is very difficult to do at this point. Yet both models render very similar qualitative though not identical quantitative results regarding tax reform.

Reduced-Form Equation Models

An advantage of the reduced-form equation models presented in this conference is their reliance on simple equations instead of complex mathematical programming problems, like those in our model. But that simplicity makes their models vulnerable to a significant criticism.

Elasticity Driven Models: Coopers and Lybrand, Gravelle, and Robbins and Robbins. The simulation results of the Coopers and Lybrand (C–L), Gravelle and Robbins and Robbins (R–R) models are primarily driven by the values they choose for the saving and labor supply elasticities. The authors gather those elasticities from the literature and from their own estimation. These elasticities are used instead of the intertemporal substitution elasticities and intratemporal elasticities in our model.

The critical assumption made by the C–L, Gravelle and R–R models is that these elasticities will remain constant after a policy change. But those saving and labor supply elasticities are *derived* parameters that combine both consumers' preferences and policy. In principle, those parameters will vary as policy is changed. (This criticism is called the "Lucas critique.") By contrast, the parameters in the intertemporal models the intertemporal substitution elasticities and intratemporal elasticities are "deep" parameters that describe household preferences and are not affected by changes in policy.

Simulation analysis suggests that the derived parameters can vary radically from one policy change to the next. For example, when we use our model to simulate the growth in pay-as-you-go Social Security over the past several decades, we find a *negative* relationship between aggregate consumption and wealth and a negative relationship between aggregate consumption and contemporaneous interest rates. The reason is that an increase in pay-as-you-go Social Security reduces wealth which, in turn, increases interest rates in our simulated economy. But the growth in Social Security also increases aggregate consumption as resources are transferred from higher saving workers to lower saving retirees. Clearly, saving elasticities whose values are estimated from historical variation in wealth and interest rates could be seriously biased. It is not surprising therefore that Joel Prakken found little historical relationship between labor supply and wealth, as he reported in this symposium. The major sources of historical variation would tend to produce correlations between consumption, labor supply and aggregate economic variables that are weaker than that we expect to observe under tax reform.

For the purpose of obtaining accurate parameters, what matters is not so much the length of sampling period or the size of the variations in aggregate variables in the historic times series but the *source(s)* of these variations. But there has not been anything close to fundamental tax reform in US history like the ones being considered for the JCT symposium.

An additional problem with the C–L, Gravelle and R–R models is that they ignore the lump-sum tax on existing wealth of a consumption tax. (Recall that this lump-sum tax was a significant contributor to the short-run increase in saving and labor supply in our model.) By ignoring this lump-sum tax, the predictions of those models about the responsiveness of the capital stock and output to tax reform will be biased downward.

The R–R model produces much larger increases in the capital stock and output in both the short and long run after a switch to a consumption tax than the other models. The reason is that the R–R model assumes that a move to a consumption tax will be met with a large net capital inflow that will equalize the *after-tax* interest rate across countries. But, as Jane Gravelle (1996) points out, the response of the capital inflow in the R–R model would be smaller if the R–R model had allowed for the fact that foreigners normally do not pay U.S. taxes on interest, dividends and capital gains.

The Large Macroeconomic Models. DRI and MA These two models are subject to the same criticisms as the above reduced-form equation models. Like the above models, both models assume that the parameters in their reduced-form equations would remain constant after a switch to a consumption tax. (They differ somewhat from the C–L, Gravelle, and R–R models in that their supply elasticities are chosen so their models track the historical performance of the economy; the other models choose their elasticities from the empirical literature.)

The consumption function used in the MA model is probably the most realistic of the two models because it is a reduced-form equation of the lifecycle model. The consumption function used in the DRI model is atheoretic. Nonetheless, even the MA model fails to satisfy the Lucas critique. The reason is that the model's reduced-form parameters are a function of the distribution of assets across different age cohorts. The MA model assumes that this distribution remains constant after a switch to a consumption tax whereas, in fact, the distribution changes significantly in all of the intertemporal lifecycle models discussed earlier, including our own. This assumption tends to bias the results of the MA model downward.

While both models attempt to include some measure of the lump-sum tax on existing wealth of moving to a consumption tax, neither model is able to properly capture the intergenerational redistributive aspects of moving to a consumption tax. That redistribution is a driving force in the intertemporal models. As a result, both the DRI and MA models predict gains to moving to a consumption tax that are smaller than those reported using our model.

VI. Conclusion

This paper evaluates two tax reform proposals in a extended and improved version of the Auerbach-Kotlikoff life cycle model with 55 overlapping generations. We find that replacing the current tax code with a flat income tax that does not exempt housing capital is likely to reduce the levels of the capital stock, output and wages in the long run. However, moving to a flat tax that exempts capital income from taxation would substantially raise output and wages. Our model exhibits relatively large increases in the labor supply due to the reduction of progressivity in the tax schedules and, most importantly, due to the lump-sum tax on existing wealth when moving to full expensing. Taxation of existing wealth reduces the consumption of all normal goods including leisure. Those increases in labor supply are likely to be greatly diminished if a consumption tax is combined with some kind of transition relief to ease the burden on people who hold existing assets.

Our model includes a large number of complex processes by explicitly solving for the exact transition path of an economy with 55 utility maximizing overlapping generations, each divided into 12 income classes. The model incorporates many important and complex aspects of reality but, as any model, excludes some parts of reality. Like the results of any simulation model therefore the results should be viewed cautiously. Nonetheless, the model seems to capture some important effects of tax reform due to its systematic footing in consumer optimization. Most notably, the model shows that a tax on existing assets can significantly increase labor supply and output in the short run, and demonstrates the importance of analyzing transition provisions in any proposal to reform the tax code.

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Table 1.—Flat Income Tax: With Deduction

	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2010	2025	2055	2145
Composition of National Income														
Consumption†	0.732	0.738	0.737	0.735	0.734	0.733	0.731	0.730	0.729	0.728	0.722	0.713	0.708	0.708
+ Net Investment†	0.053	0.038	0.039	0.039	0.039	0.040	0.040	0.040	0.040	0.040	0.042	0.045	0.047	0.047
+ Government†	0.215	0.215	0.215	0.215	0.215	0.215	0.215	0.215	0.215	0.215	0.215	0.215	0.215	0.215
+ Exports†	0	0	0	0	0	0	0	0	0	0	0	0	0	0
− Imports†	0	0	0	0	0	0	0	0	0	0	0	0	0	0
= Total Income*	1.000	0.991	0.990	0.989	0.988	0.987	0.986	0.985	0.984	0.983	0.979	0.973	0.970	0.970
Capital Stock, Labor Supply and Total Labor Income														
Capital Stock*	1.000	0.995	0.990	0.985	0.980	0.975	0.971	0.967	0.962	0.958	0.941	0.911	0.896	0.895
Labor Supply*	1.000	0.990	0.990	0.991	0.991	0.991	0.991	0.991	0.991	0.991	0.992	0.994	0.995	0.996
Labor Income*	1.000	0.991	0.990	0.990	0.988	0.987	0.986	0.985	0.984	0.983	0.979	0.972	0.970	0.971
Net Saving Rate														
Net Saving Rate	0.053	0.039	0.039	0.040	0.040	0.040	0.040	0.041	0.041	0.041	0.043	0.046	0.049	0.049
Factor Prices: Wage Rate and Interest Rates														
Before-Tax Wage*	1.000	1.001	1.000	0.999	0.997	0.996	0.995	0.994	0.993	0.992	0.987	0.978	0.974	0.974
After-Tax Wage‡	0.774	0.736	0.735	0.733	0.731	0.730	0.729	0.727	0.726	0.725	0.718	0.706	0.701	0.701
Before-Tax Interest	0.096	0.096	0.096	0.097	0.097	0.098	0.098	0.098	0.099	0.099	0.100	0.103	0.104	0.104
After-Tax Interest	0.079	0.074	0.075	0.075	0.075	0.075	0.076	0.076	0.076	0.076	0.077	0.079	0.079	0.080
Unified Government Debt														
Debt*	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Tax Revenue, Replacement Income Tax Rate and Payroll Tax Rate														
Revenue††	0.244	0.244	0.245	0.245	0.245	0.245	0.245	0.245	0.245	0.245	0.245	0.245	0.246	0.246
Replacement Tax Rate	n/a	0.235	0.235	0.236	0.237	0.237	0.238	0.238	0.239	0.240	0.242	0.248	0.250	0.250
Payroll Tax Rate	0.147	0.148	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.150	0.150	0.150	0.149	0.149

Notes.—

† The components of national income (NI) sum to income (i.e., they are not percentages of NI except, of course, for year 1996 when NI = 1.0).

* Because many aggregate variables grow without bound along the balanced-path equilibrium, these variables are represented as per-effective labor unit which implies that they remain constant in the baseline steady state. Variables with an * indicate that they are indexed with a baseline value of 1.00 in 1996.

‡ The After-Tax Wage rate is computed as $(1 - \tau)$. (Before-Tax Wage) where τ is the economy-wide effective average marginal tax rate on wage income.

†† Percent of base Total Income.

Table 2.—Flat Consumption Tax: With Deduction 1996

	1997	1998	1999	2000	2001	2002	2003	2004	2005	2010	2025	2055	2055	2145
Composition of National Income														
Consumption[1]	0.732	0.705	0.701	0.702	0.706	0.711	0.716	0.721	0.725	0.729	0.745	0.773	0.786	0.787
+Net Investment[1]	0.053	0.091	0.101	0.103	0.103	0.101	0.100	0.098	0.097	0.095	0.091	0.079	0.073	0.072
+Government[1]	0.215	0.215	0.215	0.215	0.215	0.215	0.215	0.215	0.215	0.215	0.215	0.215	0.215	0.215
+Exports[1]	0	0	0	0	0	0	0	0	0	0	0	0	0	0
− Imports[1]	0	0	0	0	0	0	0	0	0	0	0	0	0	0
=Total Income*	1.000	1.012	1.017	1.021	1.024	1.028	1.031	1.034	1.037	1.040	1.050	1.067	1.074	1.075
Capital Stock, Labor Supply and Total Labor Income														
Capital Stock*	1.000	1.019	1.038	1.055	1.072	1.087	1.102	1.115	1.128	1.140	1.191	1.276	1.312	1.315
Labor Supply*	1.000	1.025	1.010	1.004	1.001	1.000	1.000	1.000	1.001	1.001	1.001	1.000	1.000	1.000
Labor Income*	1.000	1.023	1.017	1.017	1.018	1.021	1.025	1.028	1.031	1.034	1.045	1.063	1.070	1.071
Net Saving Rate														
Net Saving Rate	0.053	0.090	0.099	0.101	0.101	0.099	0.097	0.095	0.093	0.092	0.086	0.074	0.068	0.067
Factor Prices: Wage Rate and Interest Rates														
Before-Tax Wage*	1.000	0.998	1.007	1.013	1.017	1.021	1.025	1.028	1.030	1.033	1.044	1.063	1.070	1.071
After-Tax Wage‡	0.774	0.711	0.699	0.699	0.702	0.708	0.715	0.720	0.725	0.731	0.749	0.783	0.797	0.799
Before-Tax Interest	0.096	0.097	0.094	0.093	0.092	0.090	0.090	0.089	0.088	0.087	0.085	0.080	0.079	0.078
After-Tax Interest	0.079	0.097	0.094	0.093	0.092	0.090	0.090	0.089	0.088	0.087	0.085	0.080	0.079	0.078
Unified Government Debt														
Debt*	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Tax Revenue, Replacement Income Tax Rate and Payroll Tax Rate														
Revenue[ff]	0.244	0.232	0.244	0.248	0.250	0.251	0.251	0.250	0.250	0.250	0.249	0.247	0.246	0.246
Replacement Tax Rate	n/a	0.258	0.276	0.280	0.279	0.276	0.273	0.269	0.266	0.263	0.252	0.233	0.225	0.224
Payroll Tax Rate	0.147	0.144	0.145	0.145	0.145	0.145	0.145	0.144	0.144	0.144	0.144	0.143	0.141	0.141

Notes.—
[1] The components of national income (NI) sum to income (i.e., they are not percentages of NI except, of course, for year 1996 when NI = 1.0).
*Because many aggregate variables grow without bound along the balanced-path equilibrium, these variables are represented as per-effective labor unit which implies that they remain constant in the baseline steady state. Variables with an * indicate that they are indexed with a baseline value of 1.00 in 1996.
‡The After-Tax Wage rate is computed as (1-τ) (Before-Tax Wage) where τ is the economy-wide effective average marginal tax rate on wage income.
[ff] Percent of base Total Income.

3. Eric Engen and William Gale*

"Macroeconomic Effects of Fundamental Tax Reform: Simulations With a Stochastic Life-Cycle, Overlapping Generations, General Equilibrium Model"

A primary goal of fundamental tax reform is to increase economic efficiency and expand the output of the economy, although improvements in fairness and simplicity are important goals for tax reform also. If fundamental tax reform stimulated increases in the capital stock and the supply of labor, then economic growth would tend to rise, at least in the short-run, and the long-run level of national output would be higher, helping to improve future living standards. In particular, concerns about declines in U.S. saving rates are an important catalyst for many proponents of tax reform. Net national saving has fallen from an average of 11½ percent of net national product in the 1950s through the 1970s to 6½ percent since 1990 (chart 1). While this is partially a consequence of the generally large deficits run by the federal government since the early 1980s, personal saving (as a percent of net national product) also has declined from an average of 6 percent in the 1950s through the 1970s to 4 percent since 1990. Reforming the tax system to a consumption based tax is often suggested as a vehicle for raising low U.S. saving rates.

The effects on saving, labor supply, and national output of fundamental tax reform—that is, either switching to a flat rate consumption tax or a flat rate comprehensive income tax—depend on several issues. First, the magnitude of the tax burden placed on saving and labor supply in the current tax system is crucial for determining the degree to which the tax distortion on these factors would be reduced under a fundamental change in the tax system. Second, the effect depends on how the after-tax returns to capital and labor would respond to tax reform and the sensitivity of saving and labor supply to changes in these after-tax returns. Third, the effect would be influenced by the redistribution of tax burdens across groups with different propensities to save and work, including any windfall gains and losses created in the transition to the new system.

These issues are examined using a simulation model of households behavior that is embedded in an overlapping generations, general equilibrium framework. The simulation model uses estimates of behavioral parameters and economic characteristics of households and the economy to develop quantitative predictions of saving and labor behavior and its response to various types of tax

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reforms. The existing U.S. tax system is modeled as a progressive tax with a base that is a hybrid between a consumption tax and an income tax. Our simulation results indicate that moving from the existing system to a flat-rate consumption tax would raise the long-term output by between 1 to 3½ percent, and boost the saving rate by between ½ to 1 percentage point of GDP. Alternatively, our simulation results indicate that moving from the existing system to a flat-rate comprehensive income tax would decrease long-term output by ½ percent, and have a negligible effect on the saving rate in the long-run.

The positive macroeconomic effects for switching to a flat rate consumption tax reflect the interaction of several effects. Moving to a consumption tax would reduce tax rates on new saving, raising the after-tax return to saving, and would lighten tax burdens on households that save more. Also, switching from a progressive tax structure with increasing marginal rates to a less-progressive flat tax rate structure lowers the marginal tax rate for many households. These effects tend to increase saving and labor supply. But this effect would be moderated by several factors. First, the current tax system already taxes a substantial portion of household saving as it would be taxed under a consumption tax. Funds placed in 401(k)s and other pension plans, Keoghs, and most Individual Retirement Accounts (IRAs) are tax-deductible at the time of the contribution and the earnings on these funds accrue tax-free. Contributions and investment earnings are taxed only when they are withdrawn. For saving that is tax-preferred in the current system, there is no first-order effect of switching to a consumption tax, as it already receives consumption-tax treatment. Moreover, if tax reform causes a drop in before-tax rates of return, as many forecast, returns to this category of saving would fall. Second, saving that is done for precautionary reasons is relatively insensitive to the rate of return, so a portion of household saving would be unresponsive to an increase in the after-tax return induced by tax reform. Third, a revenue-neutral switch to a consumption tax usually requires, at least initially, that average tax rates on labor supply be increased, which dampens the positive stimulus to labor supply from higher pre-tax wages that are a result of capital deepening. Fourth, transition rules may eliminate taxes on consumption financed with assets accumulated prior to tax reform. These transition rules would shift some of the tax burden from older cohorts with lower saving propensities to younger cohorts with higher saving propensities, which tends to reduce the positive saving effects of switching to a consumption tax.

The actual effects of switching to a consumption tax may be somewhat smaller than those indicated by the model because of several factors that are outside the scope of the simulation. For example, employer-provided pensions would lose their current tax-advantaged status under a consumption tax, and pension coverage and benefits would likely shrink. If these pensions are an effective method of generating "forced saving" (i.e., households do not offset their pension saving with decreases in their non-pension saving) then a reduction in pension coverage and benefits could decrease saving. Moreover, assets currently in pensions and other tax-sheltered saving face restrictions on withdrawals. It is unlikely that these restrictions would survive under a consumption tax, and their removal could cause a spurt in consumption as households gained access to some of these funds.

The remainder of this paper is organized in the following manner. Section I discusses the current tax treatment of saving and section II outlines its treatment under a fundamental tax reform. Section III presents our simulation model and results. Section IV discusses issues outside of the simulation model. Section V concludes.

I. Taxes and Saving: Current Law

In principle, the current U.S. tax system taxes household income at progressive rates. Labor income includes wages, salaries, and bonuses. Capital income includes interest, dividends, rent, and capital gains, minus depreciation. The corporation income tax also taxes corporate profits, resulting in the double taxation of corporate income.[1] In practice, the U.S. income tax contains numerous provisions that are consistent with a consumption-based tax, thus making the current system a hybrid rather than a pure income tax.[2]

Tax-Preferred Saving Accounts

The U.S. tax code currently provides a variety of tax-preferred retirement saving accounts.[3] The important features common to these saving accounts are that contributions are usually tax-deductible and, in all cases, investment income on the account balances accrues tax-free. Tax-deductible contributions and earnings are taxed at ordinary income tax rates only upon withdrawal. Withdrawals before the account holder reaches age 59° for unapproved purposes can trigger an added penalty. An individual can set up an IRA, a Keogh plan (if self-employed), or invest in a variable annuity. In addition, the cash value of whole life insurance the so-called "inside buildup" enjoys significant tax advantages; the premiums paid by individuals are not tax deductible, but the earnings on reserves are tax exempt. Employers provide tax-sheltered saving to employees through qualified defined-benefit (DB) and defined-contribution (DC) pension plans, which include 401(k) plans. Tax preferred savings accounts now constitute more than one-third of aggregate household financial assets (table 1). In 1994, the asset balances of IRAs and Keoghs are estimated to have been about $1 trillion, and the value of life insurance reserves were almost $500 billion. The value of qualified pension fund assets—including 401(k) plans—totaled approximately $5 trillion in 1994.[4]

Aside from saving in tax-sheltered accounts, U.S. net personal saving is negligible (table 2).[5] Over the last twenty years, while the

[1] The nature of the burden of the corporate income tax is affected by one's interpretation of the tax treatment of corporate dividend income. See Auerbach (1996) for more discussion of this issue.

[2] Aaron, Galper and Pechman (1988) discuss other issues involving hybrid income-consumption taxes.

[3] See Engen, Gale, and Scholz (1994) for more details on the structure of saving incentives.

[4] Estimates of the asset values for IRAs and Keoghs in 1994 are based on data from 1980 to 1992 provided by Employee Benefit Research Institute (1995). Data on life insurance reserves and pension assets are complied by the Federal Reserve Board (1995).

[5] These calculations are reported in Sabelhaus (1996). Retirement and life-insurance saving includes contributions plus reinvested earnings less withdrawls. Capital gains are excluded because they are also excluded from NIPA personal saving.

personal saving rate has declined, the rate of tax-preferred retirement saving has risen but other net personal saving has vanished.[6] In the 1970s, tax-preferred retirement and life-insurance saving comprised less than 60 percent of total personal saving. Since the mid-1980s, they have made up more than 100 percent of personal saving.

Tax-Preferred Assets

The current tax system does not fully tax income from whole classes of assets. For example, the interest paid on municipal bonds is untaxed by the federal income tax. More importantly, the imputed rent on owner-occupied housing is not subject to tax, the taxation of capital gains on home sales can be deferred, and up to $125,000 in capital gains on home sales is tax exempt for taxpayers age 55 and older.[7] In fact, all assets that generate returns as capital gains are tax favored in the individual income tax because the tax on capital gains is deferred until gains are realized, reducing the present value of taxes owed.[8] Moreover, the maximum rate on capital gains 28 percent is below the ordinary marginal tax rates faced by the recipients of a substantial portion of capital gains, and capital-gains assets enjoy a step-up in basis at death which bequeathed funds in saving incentive accounts do not receive. Thus, assets that generate returns in the form of capital gains can sometimes provide more favorable tax advantages than assets kept in tax-preferred savings accounts.

Unrealized capital gains on residential and investment real estate, noncorporate business equity, and stocks and mutual funds held outside retirement accounts constituted about 40 percent of household net worth in 1989 and 37 percent in 1992.[9] In 1989, about one-third of the gross asset value of households' mutual fund holdings and directly-held corporate equities (outside of retirement accounts) were unrealized capital gains.[10] Directly-held corporate equities and mutual funds comprised a growing proportion of household net worth over the last twenty years (table 3).[11] In 1989 almost 70 percent of the gross asset value of households' direct holdings of noncorporate businesses were unrealized capital gains.[12] Unrealized capital gains represented an estimated 46 percent of the value of primary residences in 1989.[13] Households held over $7 trillion in residential housing in 1994. In 1994, interest on

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[6] For example, see Congressional Budget Office (1993) for an examination of studies and evidence on the decline in U.S. saving rates.

[7] For a fuller explanation of the tax advantages for owner-occupied housing, see Capozza, Green, and Hendershott (1996) and Rosen (1985).

[8] The value of deferral of capital gains taxes in the individual income tax is considerable. At a discount rate of 6 percent, deferring tax five, ten, or twenty years reduces the present value of the ultimate tax payments by 25 percent, 44 percent, and 69 percent, respectively. However, the value of corporate equities are reduced by the corporate income tax.

[9] Kennickell and Starr-McCluer (1994)

[10] Kennickell and Wilcos (1992)

[11] Although some of these stock and mutual fund holdings are in tax-preferred saving accounts, a significant portion are not. Mack (1993) shows that about 15 percent of mutual fund assets were held in household-directed accounts (IRAs and Keoghs) in 1992. Moreover, the Employee Benefit Research Institute (1995) reports that $202 billion of IRA and Keogh assets in 1992 were held in self-directed stock borkerage accounts, which accounts for only 7 percent of the direct holdings of corporate equities recorded in households' balance sheets by the Federal Reserve Board (1995).

[12] Kennickell and Wilcox (1992).

[13] Kennickell and Wilcox (1992).

$388 billion in tax-exempt municipal bonds, about 2 percent of households' financial assets, was exempt from federal income tax.

These statistics indicate that the current tax system is not a pure income tax in its treatment of capital income. Instead, it is a complex hybrid income-consumption tax as a substantial proportion of households' assets and saving currently receives tax-preferred treatment similar to the tax treatment of saving under a consumption tax.

Taxes and Debt

In a comprehensive income tax, all capital income should be taxed and all interest expense should be deductible. Variants of a consumption tax that exempt interest income should also deny deductions for interest expense. The appropriate treatment of interest expenses in a hybrid income-consumption tax is unclear. The central problem is that allowing the deductibility of some, or all, of interest paid when not all capital income is taxed creates opportunities for tax arbitrage.[14]

The hybrid character of the current tax system is evident in its treatment of debt payments as in the taxation of income. The Tax Reform Act of 1986 (TRA86) phased out the deductibility of interest paid on consumer debt, but retained almost complete deductibility of interest paid on mortgage debt and investment loans. In 1994, home mortgages comprised about 76 percent of the $4.6 trillion in total household debt, or 13 percent of household net worth (table 3). Consumer credit, interest on which is not tax deductible, accounted for about 20 percent of household debt.[15] While the majority of household debt currently receives income-tax treatment, a substantial portion encounters consumption-tax treatment.

II. Household Saving under Tax Reform

A consumption tax either taxes consumption directly (a retail sales tax, for example) or allows a deduction from income for net saving. The deduction can be introduced in either of two ways. In the first approach net contributions to saving accounts and reinvested asset income are excluded from taxes, but net withdrawals are taxed.[16] Under the second approach, the net contribution is not tax deductible but investment earnings and withdrawals are tax exempt. Holding the tax rate constant, the two approaches reduce the present value of consumption possibilities by the same percent-

[14] Tax arbitrage can arise if the after-tax interest rate on debt is less than the after-tax rate of return on saving even if the before-tax interest are on debt is greater than the before-tax rate of return on saving. For example, borrowing funds that are allowed an immediate tax deduction for interest paid and investing the funds in an asset with income that is tax deferred can potentially generate an after-tax profit. Engen and Gale (1997) present recent evidence on the interaction between tax-preferred mortgage debt and tax-preferred 401(k) plans. Steuerle (1985) provides a general explanation of tax arbitrage.

[15] Evidence suggests that the shift in tax treatment of debt enacted as part of TRA86 led households to rely increasingly on mortgage debt, but appears to have done little in restraining total household debt. Engen and Gale (1997) present recent evidence on the interaction between tax-preferred mortgage debt and tax-preferred 401(k) plans. Steuerle (1985) provides a general explanation of tax arbitrage.

[16] These rules are similar but by no means identical to those governing current tax-preferred savings accounts such as IRAs or 401(k)s. For saving incentives, the contribution is deductible regardless of whether it represents a net increase in saving, and the withdrawal is subject to tax, regardless of whether it is used for consumption. Withdrawals from these accounts must be made after age 70½ according to a formula set forth in regulations.

age.[17] This equivalence is often used to suggest that wage taxes—which essentially tax saving according to the second approach—are equivalent to consumption taxes, which essentially use the first approach. However, there are at least two important differences between consumption taxes and wage taxes.[18]

Future consumption can be financed from only two sources: existing assets or future wages. Thus, the first difference is that the base of a consumption tax includes consumption financed from capital existing at the time of the tax reform, whereas the base of a wage tax would not. Consumption from existing capital includes not only consumption out of the return to previously existing capital (which would also be taxed under an income tax), but also consumption financed by cashing in the *principal* of previously existing assets. To the extent that the principal of previously existing capital did not receive a tax deduction when it was initially saved, it would not be taxed again when consumed under an income tax, but would be taxed a second time when consumed under a consumption tax. The tax levy on the principal of existing capital is economically important because it raises the consumption tax base and hence lowers the rate that has to be applied to other consumption. Moreover, this tax levy imposes more of the total tax burden on older cohorts with relatively low saving propensities while reducing the necessary tax burden on younger cohorts with relatively higher saving propensities.[19] Furthermore, if the levy is unanticipated, and if it is also believed that the imposition of a capital levy does not change the probability that a levy will be enacted in the future, then the levy raises substantial revenue in a distortion-free manner, and so improves the efficiency of the consumption tax. Nonetheless, it may be considered unfair. Allowing deductions for consumption financed by the principal of old capital would remove the levy. Switching to a wage tax would remove the levy as well as the tax on consumption financed from the return of existing capital.

A second difference between a wage tax and a consumption tax concerns the treatment of capital income from new saving. It is simplest here to assume there is no pre-existing capital. If everyone earns the same return—for concreteness, assume it is the risk-free rate of return—on their saving, there is no difference here between the wage tax and the consumption tax. Two people with equal wages would pay equal present discounted value of taxes under a wage tax or consumption tax, regardless of how much they saved. If everyone earns the same rate of return, saving more does not change the present value of consumption because the rate of return earned is exactly equal to the discount rate. The tax deduction for new saving under a consumption tax just offsets the present dis-

[17] A tax rate of t percent on withdrawals reduces consumption possibilities t percent. A tax on deposits at the rate of t percent reduces deposits, subsequent interest earnings, and amounts available also by t percent.

[18] The present value of taxes paid under a consumption tax and those paid under a wage tax would be equivalent if there were no existing assets at the time either tax was imposed, the interest rate was the same in both regimes, and the tax rates were set appropriately. However, the timing of tax payments would be different. See Bradford (1984, 1986, 1996) for more discussion of the general principles of consumption taxes.

[19] Older cohorts generally have accumulated substantial life-cycle and precautionary saving, and thus, are either accumulating little in additional saving or are dissaving. Younger cohorts are generally adding to their stocks of retirement and precautionary assets and have a higher propensity to save.

counted value of the future tax liability when this saving, plus a risk-free rate of return, is consumed.[20] Thus, the opportunity cost component of the return on saving (or the risk-free return to compensate for deferring consumption) is untaxed under a consumption tax or a wage tax.[21]

Now let rates of return vary across investments. To be specific, assume that risk is held constant, so returns vary only because one investor is more astute or productive in investing than another. In economists' parlance, one of the investors earns "rents" or excess returns. The key difference is that under a wage tax, these extra returns are not taxed, while under a consumption tax they are. To see this, note that, assuming that each investor saves the same amount, the investor who receives excess returns has a higher present value of consumption than the other. Under a wage tax, this difference does not matter; if each investor earned the same wage, they pay the same taxes. In contrast, under a consumption tax, the investor with excess returns raises the present value of his or her consumption and so raises the present value of consumption taxes paid. The portion of the overall return to capital over and above the risk-free return, controlling for risk, generates a positive present value of tax revenues.[22] Thus, both consumption taxes and wage taxes remove the tax distortion imposed by an income tax on the opportunity cost of saving, but the consumption tax captures taxes on excess returns to new capital investment, while a wage tax does not.[23]

III. Macroeconomic Effects of Tax Reform in a Simulation Model

In this section, we report the results of using a simulation model to examine the effects of switching from a progressive hybrid income-consumption tax to a flat-rate consumption tax. Simulation analyses are particularly helpful for analyzing policies where data are limited or unavailable and where the distinction between short- and long-term effects matters. Fundamental tax reform is such a policy because it involves changes outside the range of historical experience and economic behavior, and the short-term effects of a new tax system may be quite different from the ultimate impact.

The manner in which taxes affect saving, labor supply, and output in a simulation depends crucially on the model's assumptions concerning a household's motives for saving and working and the time horizon over which it plans. For example, in the simplest life-

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[20] The tax deduction for saving (S) reduces an individual's tax liability by tS, where t denotes the effective tax rate. If this saving earns a risk-free return equal to r, and the individual consumer the principal plus earnings after n years $(S(1+r_f)$, then the present-value of the future consumption tax liability is equal to $t(S(1+r_f)^n]/(1+r_f)^n)$, which equals tS. Thus, the capital income reflecting the risk-free return on this saving is untaxed under consumption tax.

[21] Under a consumption tax, the return to saving that compensates for risk is untaxed also. However, the analysis of this point is more complicated. See Bradford (1996) for a discussion.

[22] As before, the deduction for saving (S) reduces an individual's tax liability by tS, where t denotes the effective tax rate. If this saving earns a return of 4*, greater than the risk-free return or r_f, and the individual consumes the principal plus earnings after n years $(S(1+r^*(^n)$, then the prevent-value of the future consumption tax liability is equal to $t(S(1-r^*)_n]/(1+r_f)^n)$, which exceeds tS. Thus, capital income above the risk-free returns on this saving is taxes at rate 5 under a consumption rate t under a consumption tax, while capital income up to the opportunity cost is untaxed.

[23] See Bradford (1996) and Hubbard and Gentry (1996) for more discussion of this point.

cycle models, consumers are posited to save only for retirement.[24] Since the interest rate determines the price of future consumption relative to current consumption, changes in the interest rate alter life-cycle retirement saving. However, the theoretical effect of a change in the after-tax rate of return on saving is ambiguous. An increase in the after-tax return reduces the price of future consumption and leads to increased future consumption. But the increased return also reduces the amount of current saving necessary to support any given level of future consumption. The saving elasticity depends on the relative magnitudes of each effect.

Simulation studies that rely on a life-cycle framework and assume certainty in the economic environment usually imply a large, positive saving elasticity that is substantially greater than suggested by empirical evidence.[25] It is neither surprising nor convincing that such models predict large increases in aggregate saving from replacing a comprehensive income tax with a comprehensive consumption tax.[26]

The precautionary saving model adds to the life-cycle framework the realistic considerations that people may save not only for retirement, but also to protect themselves against such unforeseen future circumstances as a cut in wages, unemployment, disability, or illness, and that people may hold onto some wealth during retirement as a precaution against the possibility of outliving their financial assets. Recent theoretical developments suggest that precautionary saving can be a powerful influence on household saving behavior.[27] Empirical research, although somewhat mixed, generally has tends to confirm the importance of a precautionary saving motive.[28] The presence of precautionary saving has also been shown to provide at least partial resolutions to several features of actual consumption and saving behavior that are puzzles when viewed from the perspective of a certainty model.[20]

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[24] A motive to save for bequests can arise if it is assumed that households care about their heirs as well as themselves. If this concern bout their heirs is purely altruistic—that is, parents do not demand anything in return for their bequests—then the planning horizon for a saver an become infinite (Barro, 1974). However, the assumed intergenerational altruism underlying this bequest model is strongly rejected by the evidence. See Bernheim (1987), Altonji, Hayashi, and Kotlikoff (1992, 1995), and Hayashi, Altonji, and Kotlikoff (1996).

[25] Empirical estimates of the saving elasticity and simulated saving elasticities are discussed in more detail below.

[26] Feldstein (1978), Summers (1981), Evans (1983), Auerbach and Kotlikoff (1983, 1987), Auerbach, Kotikoff, and Skinner (1983), Seidman (1983, 1984), Hubbard and Judd (1986), Starrett (1988), McGee (1989), Gravelle (1991), Auerbach (1996), and Fullerton and Rogers (1993, 1996) are examples of studies that use a certainty verion of the life-cycle model for analysis of capital income taxation. Most of these studies report large increases in saving by switching to a consumption tax. For example, Summers (1981) reports that switching from an income tax to a consumption tax would raise consumer well-being by 6 to 16 percent of lifetime income, and boost the capital-income ratio 40 to 60 percent. Auerbach and Kotlikoff (1987) report substantial, yet smaller, gains to saving.

[27] Skinner (1988), Xeldes (1989), Caballero (1991), Deaton (1991), Carroll (1992), and Hubbard, Skinner, and Zeldes (1994, 1995), Engen (1993, 1994).

[28] The 1992 Survey of Consumer Finances (SCF) reported that the most frequently cited reason for saving by households in the survey was precautionary saving, which included, affirmative responses to "saving for reserves against unemployment" and "saving in case of illness." Forth-two percent of households cited precautionary reasons as an important reason for saving, while about 27 percent cited retirement as an important reason for saving (Kennickell and Starr-McCluer, 1994). Similarly frequency of responses to these saving question also were given in the 1986 SCF (Engen and Gale, 1993) and the 1989 SCF (Kennickell and McCluer, 1994). Other empirical research includes Carroll and Samwick (1995) and Engen and Gruber (1996), who also provide a literature survey.

[29] For example, precautionary saving can help explain the sensitivity of consumption to changes in current income and the relationship between consumption and income over the life cycle. See Deaton (1992) and Browning and Lusardi (1995) for surveys of these issues.

Because precautionary saving usually provides for short-term contingencies, it is less sensitive to changes in the rate of return than pure life-cycle saving. A model that incorporates precautionary motives for saving can imply a substantially smaller and more plausible saving elasticity (Engen 1993, 1994). Previous analysis of the effects of consumption taxes within a stochastic life-cycle model yields increases in saving that are as much as 80 percent smaller than those produced by a certainty life-cycle model (Engen 1994).

The Model

The simulation model used here modifies the standard life-cycle framework by having consumers face uncertain labor earnings and an uncertain lifespan. Individuals save for retirement and as a precaution against downturns in future earnings and outliving their assets. The model consists of six parts: (1) a framework for describing consumers' preferences for consumption, saving, and labor supply; (2) the budget constraints faced by consumers; (3) a formalization of the uncertainties facing consumers; (4) government taxes and spending structures; (5) an overlapping generations framework, which recognizes that the population consists of people of different ages, and (6) a production sector to close out the economy.[30]

People are assumed by the model to commence their life-cycle choices at age 21. The probability of dying increases with age, and the maximum life span is 90. Each year people maximize their expected well-being over the rest of their lifetime by choosing how much to consume and save; how to allocate their assets between a tax-preferred saving incentive account or a conventional, fully-taxed saving account; and deciding whether to work full-time or not at all.[31] No one intentionally leaves bequests, but accidental bequests occur because people cannot predict exactly when they will die. All accidental bequests are assumed in the model to be received as an equal lump-sum inheritance by all surviving members of the cohort that is age 50 Consumers are assumed to be risk averse and prudent, which means in the model that uncertainty about future earnings and lifespan leads to precautionary saving.[32]

Consumption can be financed in three ways: by after-tax labor earnings before retirement; by annuity income from Social Security, which people cannot collect until they are at least age 65 and have retired; and by balances in their two assets. Both assets earn the same certain pre-tax rate of return.[33] The return on conventional assets is fully taxed. For the saving incentive account, contributions are deductible and constrained by an annual limit, and contributions and investment earnings are not taxed until with-

[30] Description of many elements of this simulation model appear in Engen (1993, 1994), Engen and Gale (1993, 1996), and Engen, Gale, and Scholz (1994).

[31] To simplify the computation of the model, individuals are not given a choice of a range of hours to work.

[32] Uncertainty in the rate of return from saving would generate an additional precautionary saving motive. However, for most households, human wealth is substantially greater than financial wealth, and thus, uncertainty about expected wages is quantitatively more important than uncertainty about rates of return on assets. Skinner (1988) showed that empirically plausible interest rate uncertainty generates a only small amount of precautionary saving relative to labor earnings uncertainty.

[33] Because there are no excess returns to capital in this model, the issues concerning the treatment of capital "rents" under a consumption tax—discussed above—do not arise here.

drawn. Funds withdrawn before the account-holder reaches age 60 are subject to a 10 percent penalty.[34]

In the model, government revenues equal expenditures and finance social security benefits and a government-provided good that is allocated equally to all individuals. The baseline tax system is a progressive hybrid income tax, similar to the U.S. system, with increasing marginal income tax brackets, personal exemptions, and standard deductions.[35] Deductions for tax-sheltered saving are subject to an annual limit of $7,500. When the income tax structure changes, new income tax rates are determined in order to raise the same aggregate revenue in each year.

Cohorts of different ages are incorporated in an overlapping generations framework that accounts for mortality, and for population growth of 1 percent per year. The model contains a simple production sector that demands labor and capital from the household sector, and helps determine the pre-tax rate of return to capital and expected wages in the model. Labor productivity rises by an average of 1 percent per year. Workers are uncertain about their individual wages, but there are no business cycles in the model. This simple general equilibrium framework allows for feedback effects of broad tax policy changes in the return to capital and wages owing to changes in the capital stock while maintaining the focus of the analysis on individual saving behavior.

The Elasticity of Saving

Simulated effects of taxes on saving depend crucially upon the implied saving elasticity in the simulation model. However, a standard empirical benchmark for the saving elasticity is difficult to determine. Results from empirical studies using aggregate time-series data have been inconclusive.[36] The estimated elasticity of 0.4, based on research by Boskin (1978) and Boskin and Lau (1978), is usually considered an upper bound. Blinder (1975), Howrey and Hymans (1980), Carlino (1982), and Friend and Hasbrouck (1983) reported estimates close to zero. Wright (1967, 1969), Juster and Wachtel (1972), and Gylfason (1981) reached intermediate values. Bosworth (1984), demonstrating the fragility of these results, found a range of estimates from zero to small positive elasticities. Virtually no empirical study suggests a large saving response by households to changes in the after-tax return. But any study based on aggregate data faces formidable econometric problems. Some studies have used nominal rates of return rather than inflation-adjusted interest rates, and most studies have not used an after-tax rate of return. Moreover, estimating the saving elasticity is difficult with aggregate time-series data because of the problems involved in measuring changes in expected real after-tax returns and in holding constant the other factors that affect saving. In fact, the Lucas (1976) critique implies that a stable aggregate saving function may not even exist. The problems with studies based on time-series evidence introduces substantially uncertainty into de-

[34] We do not model the mandatory withdrawals required starting at age 70½ and the loan provisions of some 401(k) plans.

[35] A flat rate payroll tax that finances Social Security and a small sales tax are imposed also.

[36] Gylfason (1981), Bosworth (1984), Ballard (1990), and Gravelle (1994) provide surveys of this literature, and Bernheim (1996) discusses some of the econometric problems.

termining the empirical responsiveness of household saving to changes in the after-tax return.[37]

Many scholars have studied the effects of tax-preferred saving incentives using household-level data.[38] No consensus has emerged. It is not clear, in any event, what lessons could be drawn from the saving effects of IRAs and 401(k)s for fundamental tax reform. Shifting of existing assets and intended saving from taxable to sheltered accounts, so important in the analysis of saving incentives, is not a major issue in evaluating the effects of switching from the current tax system to a pure consumption tax. Furthermore, saving incentives have contribution limits; a consumption tax does not. Savers at the contribution limit for sheltered accounts face no marginal tax incentive to increase saving.[39] Contributors who are not at contribution limits face a marginal incentive to increase saving similar to that provided under a consumption tax, but no study of saving incentives has focused solely upon the marginal saving of non-limit contributors, controlling for any asset shifting, before and after the introduction of saving incentives.

An alternative to empirical estimates of the saving elasticity has been to simulate the saving elasticity in a stylized economic model.[40] For example, Summers (1981) found that within a multi-period certainty life-cycle model the interest elasticity of saving is usually large and positive—generally greater than 1 and often above 2.[41] Fullerton and Rogers (1993) calculate a saving elasticity of 1.3 in their baseline model which includes bequests, and the elasticity increases to above 2 when bequests are omitted. These studies are illustrative of the point that certainty life-cycle models usually generate implausibly large saving elasticities, and therefore

[37] Another empricial approach to estimating the sensitivity of saving to changes in the after-tax return has focused upon analyzing the relationship between the growth rate of consumption—rather than the level of consumption—and changes in the after-tax rate of return. Unfortunately, empirical analysis of this intertemporal elasticity of substitution for consumption does not yield any clear consensus on the responsiveness of savings to changes in its after-tax return. Bernheim (1996) provides a discussion of the econometric problems in estimating the intertemporal elasticity of substitution. Also, Engen (1993, 1994) shows that the savings elasticity can vary substantially even while holding constant the intertemporal elasticity of substitution depending on the importance of precautionary savings.

[38] Hubbard and Skinner (1995), Bernheim (1996), Engen, Gale, and Scholz (1996), and Poterba, Venti, and Wise (1996) provide surveys of the literature on saving incentives.

[39] Gale and Scholz (1994) show that most IRA contributors are constrained by the contribution limit. Evidence on the proportion of 401(k) contributions that are constrained by a contribution limit is generally unavailable. This issue is complicated by the fact that although the IRS imposes an annual dollar limit on 401(k) contributions, many workers face different lower limits because of nondiscrimination rules or rules set by their employer. However, given their higher contribution limits, it is likely that fewer 401(k) contributors than IRA contributors are constrained by a contribution limit.

[40] See Gravelle (1994) and Elmendorf (1966) for surveys of this literature.

[41] Evans (1983) showed that if individuals are assumed to have a negative rate of time preference—i.e., they value future consumption above current consumption—then the interest elasticity of saving can be smaller than in Summers' model. However, economists generally accept the premise of a positive time preference rate on the basis of observing positive interest rates. Both Evans (1983) and Starrett (1988) have suggested that a specific type of bequest motive can reduce the implied saving elasticity. Evans (1983) demonstrated that this result depends crucially on the assumption that bequests are made without taking account of the well-being of the recipient. An alternative approach is based on the assumption that households care about their heirs in a purely altruistic manner and the savers planning horizon becomes infinite. In this case, the predicted saving elasticity usually goes to infinity—small changes in the after-tax rate of return yield huge increases in savings. Without any guideline for determining the appropriate bequest motive, the effect of bequests on the saving elasticity is unclear. Starett (1988) also showed that an economic model that introduces a subsistence level of consumption for individuals this can decrease the saving elasticity. However, the amount of consumption necessities must rise proportionally with income and a high level of necessities—approximately 50 percent of average consumption—are required in order to generate a substantial decreases in the saving elasticity.

will overstate the increase in saving from switching to a consumption tax.[42]

In our precautionary saving model, the aggregate interest elasticity of saving when households are characterized as having an "average" amount of prudence is 0.26 if the real after-tax interest rate is 3 percent and 0.39 if the real after-tax interest rate is 5 percent (table 4).[43] Associated with these saving elasticities are aggregate household saving rates of 5.7 to 6.0 percent and aggregate asset/income ratios of 3.94 to 4.25 that are close to values actually observed. Households that are less risk averse than assumed in our baseline simulations save relatively less for precautionary reasons and relatively more for retirement. As a result, saving falls, but its sensitivity to the rate of return rises (table 4, columns 3 and 4). Households that are more risk averse save more for precautionary reasons, raising the aggregate saving rate and reducing the saving elasticity (table 4, columns 5 and 6).

The Elasticity of Labor Supply

In general, a change in tax policy that alters the after-tax wage has a theoretically ambiguous effect on individual labor supply owing to opposing income and substitution effects. Individuals must balance the competing objectives of increasing leisure by working less and increasing the consumption of goods by working more. Thus, the uncompensated after-tax wage elasticity of labor supply theoretically can be either positive or negative. Theory suggests that the compensated labor elasticity, which reflects only the substitution effect, should be positive (or nonnegative) as a higher after-tax wage makes work more attractive and leisure relatively more expensive. The magnitude of the compensated elasticity is positively related to the magnitude of the efficiency loss imposed by a tax. Theory also implies that income elasticity of labor should be negative (or nonpositive) since leisure is considered to be a normal good.

The econometric literature yields estimates of labor elasticities varying quite substantially in magnitude and sign. Of course, these studies have different measures of the wage, different data and time periods, different treatments of taxes, different ways of accounting for labor force participation, and their own functional forms. But, these estimates merely provide a benchmark for assessing what is a plausible labor supply elasticity.

Uncompensated wage elasticity estimates for males are usually close to zero, and may be positive or negative. Hausman's (1981) widely-cited estimates for male labor supply behavior, which explicitly account for the influence of taxes, find that the absolute values of the compensated wage elasticity and the income elasticity of labor supply are relatively large—approximately equal to 1— even though the uncompensated labor supply is approximately zero.

[42] Moreover, none of the previous studies of consumption taxes (see footnote 26) explicitly accounted for the fact that the current tax structure is a hybrid income-consumption tax where some savings already escapes taxation. The assumption of switching from a pure income tax tends to overstates the reduction in the tax distortion on savings from the current

[43] In a certainty version of the model (i.e., without precautionary savings), with the baseline parameter specifications in table 4, and both a 5 percent and 9 percent real rate of return, the resulting saving elasticities are high (1.94 and 1.47), and the savings rates (1.3 percent and 2.9 percent) and the asset/income ratios (0.87 and 1.96) are low relative to observed ratios (Engen and Gale, 1996).

These results suggest that the efficiency loss associated with taxes imposed on labor is quite large. However, MaCurdy, Green, and Paarsch (1990) estimate that the (compensated) wage elasticity of hours worked by primary wage earners is zero, and Triest (1990) estimates this elasticity to be only slightly greater than zero—between 0.03 and 0.06. Also, Mariger (1994) did not find a statistically significant relationship between changes in hours worked and changes in marginal tax rates legislated by the 1986 Tax Reform Act.

Uncompensated wage elasticity estimates for female labor supply are generally positive and larger in absolute value then those found for men. This is consistent with economic theory and intuition which suggests that the labor supply of secondary wage-earners should be more responsive than primary wage-earners to changes in the after-tax wage. For example, Triest (1990) estimated a wage elasticity of hours worked for secondary wage-earners between 0.4 to 1.2, which is similar to other studies of secondary wage-earners.

A potential drawback to cross-section studies of labor supply is that they assume that preferences for work are uncorrelated with human capital. However, it is likely that people with a below average distaste for work tend to accumulate above average amounts of human capital and thus have higher after-tax wages. Therefore, cross-section studies may tend to incorrectly attribute taste effects on hours worked to wages, thereby overstating labor supply elasticities.

The model's assumption of a discrete labor supply choice—either work full time or no work—simplifies the computation of the model. However, assuming that individuals do not have a choice of a full range of hours to work may not be a limiting assumption. In summarizing the empirical literature on labor supply, Heckman (1993) notes that labor participation decisions appear to be more responsive to wage and income changes than hours-of-work decisions. Thus, this assumption probably allows the model to capture the most important labor supply response. Moreover, hours-of-work restrictions and fixed costs in real world labor markets may make this a more appropriate assumption compared to allowing a continuous choice of hours of work. The aggregate labor supply elasticity generated by our model is small and close to zero (usually around 0.1), which is close to empirical estimates.[44]

Macroeconomic Effects

The simulations indicate that replacing the current hybrid tax with an immediate, permanent, and unanticipated consumption tax would boost saving, labor supply, and real output (table 5). Our initial simulation (line 1 under each subheading in table 5) examines the effects of replacing the current tax with a flat rate consumption tax without transition relief for existing capital. This simulation also assumes that all changes in saving show up as changes in U.S. domestic investment; i.e., it is a closed economy.

Based on these assumptions, our model indicates that real output would rise in the short run (consumption falls but investment in-

[44] See Engen, Gravelle, and Smetters (1997) for more discussion about the importance of labor supply responses in dynamic simulation models of tax reform.

creases) and is almost 2½ percent higher in the long run. The saving would rise immediately by almost 2 percent of GDP, but the surge would subside and settle down to an increase of 0.7 percent of GDP. The capital stock is almost 10 percent higher in the long run. Labor supply is only slightly higher because of the small labor elasticity implied in the model.

The presence of tax-preferred saving in the baseline hybrid tax system tempers the gains in saving from switching to a consumption tax. Prior to tax reform, approximately half of the saving in the model is in the tax-preferred asset. These accounts provide tax treatment for saving similar to a consumption tax. In addition, these accounts restrict access to funds placed in these investment vehicles, and therefore, are more likely to attract long-term retirement saving which tends to be more interest sensitive. In contrast, short-term precautionary saving, which is unsensitive to the interest rate, tends to accumulate in taxed, but liquid, saving instruments. Removing the tax on assets held for precautionary reasons has a relatively small effect on saving.

Because saving incentives are available under current law, people would respond in different ways to a consumption tax. Some savers currently have exhausted opportunities to save in tax-sheltered accounts. If their additional (or "marginal") saving bears the full brunt of the current capital income tax, conversion to a consumption tax would increase their net yield from the current after-tax rate of return to the pre-tax rate of return under the new system. If the saver has not exhausted opportunities to save in sheltered accounts, the saver would earn the pre-tax rate of return on the margin before tax reform. Eliminating the capital income tax has no first-order effect for such "infra-marginal" savers. However, if, as our simulations suggest, the pre-tax rate of return falls as other people increase saving, then the second-order (general equilibrium) effect for infra-marginal savers is likely to *reduce* saving. The positive effect we find on overall saving is the difference between the increase in saving by the "marginal" group of savers and reductions in saving by the "inframarginal" group.

The effects of this type of tax change on household well-being would be unevenly distributed across age groups at the time of the reform (Engen and Gale, 1996). The very oldest age cohort suffers a welfare loss as their tax burden rises because consumption under current income tax law is untaxed to the extent that it is financed by assets accumulated from already taxed income. Under the new law, all of their consumption would be taxed. The welfare gains rise inversely with age. Compared to older workers, younger workers benefit from longer periods of accumulation under the new system and have less accumulated capital that is subject to full taxation under the new system.

This initial consumption tax simulation imposes an unrealistic assumption on economic behavior. All of the additional saving in this simulation would be invested in the United States. Although domestic rates of return fall, this simulation does not allow investors to seek higher returns abroad. In fact, U.S. investors have been earning returns abroad similar to those they earn at home. They might well invest much of any increase in saving in foreign assets. To illustrate the range of possible effects, we present another simulation (line 2, table 5) that restricts the model by fixing the pre-tax interest rate at its baseline value, a result that can occur in our model only if all increased saving flows abroad; effectively, this assumes that the U.S. is a small open economy. Thus, we would expect that the "real-world" results should be somewhere between the open and closed economy cases.[45] The results of this simulation show that saving, the capital stock, and real output increase by more than in the closed economy simulation.

Allowing transition relief (line 3, table 5) for existing capital would require a higher tax rate to preserve revenue neutrality, and the efficiency gains from taxing existing capital are lost. As the simulations show, this is an important assumption. The long-run increase in real output drops to a little over 1 percent. Moreover, the gains in the saving rate and capital stock are about as half the size of those calculated when there is no transition relief.

In general, these simulations suggest that a consumption-base tax reform would increase saving and output, but have only a small effect on labor supply. Our results are not as large as those produced by some other models principally for three reasons. We take explicit account of the hybrid character of the current tax system and the presence of consumption tax elements in what is called an income tax. We also incorporate precautionary saving, which reduces the implied saving elasticity. Furthermore, our model's discrete labor choice implies a small labor elasticity. These considerations should be integral to the analysis of tax reform, and they all reduce the saving response to tax reform.

These factors also help explain our simulations of switching to a flat rate unified income tax (line 4, table 5). The positive effect on capital and labor of lower marginal rates are essentially offset by the negative effect of removing tax preferences for saving. In the long-run output is slightly lower (½ percent) but the saving rate is virtually unchanged.

Simulation models have advantages in studying saving behavior because they formalize complex and interactive responses, but they suffer from at least two important shortcomings. First, not all economic agents behave as formal economic models say they will behave. Second, the results exclude consideration of a variety of issues that would make the model excessively complicated or unwieldy or that cannot readily be modeled. These problems should come as no surprise, as the purpose of an economic model is to extract the most important elements of a situation and omit others. We turn now to a variety of issues not included in our model that we think would be important in appraising the effects of tax reform on saving and economic welfare.

IV. Issues Outside the Simulation Model

The simulations can be thought of as including voluntary DC plans, such as 401(k)s, but not more traditional (mandatory) DC plans or any DB plans. Contributions and earnings in the omitted

[45] The before-tax interest rate could remain constant with increased domestic investment if tax reform, technological change, or some other effect increased domestic demand for capital. We have not included these effects in our model. In addition, a large increase in capital exports would necessitate a shift in the U.S. current account balance that could occur only if U.S. terms of trade deteriorated. Our model does not include these effects either.

plans accounted for a significant share of personal saving over the last decade. These plans would be adversely affected by tax reform. Given the importance of pensions in household saving, the omission of pensions from the model is an important issue.

Pensions are treated favorably relative to other forms of saving under the tax system. Pension contributions are generally tax-deductible and the earnings accrue tax free. Withdrawals are taxed as ordinary income. Under a consumption tax, all saving would receive equivalent treatment, except that other saving would likely not be exempt from payroll taxes, while pension contributions would likely remain exempt from payroll taxes.

While the decline in tax-favored status would reduce interest in pensions, there may be other reasons why employees or employers might wish to retain pensions. Per person administrative costs are smaller for pension plans that apply to large groups than for individuals who make their own arrangements. DB plans encourage long-term attachment to a given job. Pensions offer deferred benefits and so may be relatively more attractive to employees who have long-term planning horizons, a characteristic many employers find attractive in workers. Pensions can also be used to encourage workers to retire at times management thinks appropriate. Some managers feel an obligation to make sure that employees accumulate sufficient income for a decent retirement, even if employees do not wish to save. However, it is uncertain how compensation arrangements would adjust if employers wanted to continue to offer pensions but employees preferred to control their own retirement saving.

Pensions currently are subject to extensive regulation concerning coverage, asset management, minimum and maximum funding rules, pension insurance, vesting rules, limits on the size of benefits, and equitable distribution of benefits among employees. Frequent rule changes in recent years have further raised the cost of compliance.[46] For these reasons, it is unclear, first, how the removal or reduction of the tax preference will influence firm decisions to maintain pensions and employee decisions to accept pensions, and second, how a change in pensions will affect overall saving.

In Engen and Gale (1996), we discuss these issues more fully and provide some calculations (outside of the simulation model) of the potential magnitude of these effects. We reach three conclusions First, the effect on pensions, even adjusting for the induced increase in non-pension saving, could offset much or all of the increase in saving projected by our simulation model. Second, the pension system could shrink significantly under plausible assumptions. Third, fears that tax reform will largely eliminate the pension system can not be supported using the parameter estimates in the literature. Moreover, there are other pension issues, such as pension withdrawal restrictions, that these calculations did not address.

Current regulations generally prohibit pension beneficiaries from gaining access to funds before particular ages or unless they change jobs. Employees normally may not withdraw funds from de-

[46] See Shoven (1991), Hay-Huggins (1990), or Gale (1994).

fined contribution pension plans unless they change jobs, and sometimes not even then. Rules limiting access to defined benefit assets are even more restrictive. The rationale for all of these restrictions would come into question under a consumption tax, because all of the tax advantages enjoyed by current pensions would be generally available. While it is possible that regulations limiting access to funds accumulated before the new tax took effect would remain in force, they might well be relaxed or suspended. If so, households may have access to some retirement funds previously closed to them. While most households might leave such funds alone, some might use them to finance current consumption. It is hard to know exactly how much consumption would result, but the increase could be considerable. In 1992, pension reserves totaled $4.5 trillion. Most of these assets were either in DB plans or in group insurance contracts within DC plans, funds which may not be readily available to pension holders even in the absence of withdrawal restrictions. But about $500 billion were in private non-401(k) DC pension funds (excluding funds allocated to group insurance contracts). If these non-401k DC assets became accessible without any penalty, and households consumed as little as four percent of these assets in the first year after adoption of a consumption tax, the increase in consumption, $20 billion, would be equal to about one-quarter of a percent of GDP, which would cut into any increase in saving created by a consumption tax.

If tax reform reduces pre-tax interest rates, then at the same time that they would lose their tax-preferred status, defined benefit plans would also face a deterioration in their funding status, as liabilities would rise due to the simple mechanics of discounting. A second issue is the status of non-discrimination rules under tax reform. Under an income tax, non-discrimination rules attempt in principle to ensure that the benefits of the tax preference for pensions are equitably distributed across workers. Many analysts believe that the rules have the effect of raising saving by encouraging pension contributions among those who would otherwise be least likely to contribute to pensions or any other saving. Under a consumption tax, however, there is no longer any tax preference for pensions, so at least the tax rationale for having non-discrimination rules would disappear. If the rules were eliminated, this would reduce pension regulation tremendously, but also might cause employers to drop pension coverage or reduce pension incentives—such as matching contributions—for certain groups of workers.

The macroeconomic impact of tax reform likely would be influenced by a number of additional factors other than pensions. Some of these factors may boost the positive output and saving effects of tax reform while others may tend to dampen any increase in output and saving.

First, because saving is a net concept encompassing the accumulation of both assets and debt, a properly-designed consumption tax could encourage saving not only because it reduces the tax on the return to saving but also by not allowing interest on borrowing to be tax-deductible. However, if political realities require that the mortgage interest deduction be maintained under a new consumption-type tax, then not only would tax reform not discourage household borrowing but it also increases the possibilities of tax arbitrage (Engen and Gale, 1997).

Second, an important feature of recent tax reform proposals is that they usually involve removing the double taxation imposed by the current corporate income tax. Integration of the individual and corporate tax systems could be achieved under either an income tax or a consumption tax. However, the positive benefits of corporate tax.[47] However, the positive benefits of corporate tax integration under either tax system include removing the double taxation on capital income from the corporate sector and eliminating this tax distortion on the allocation of capital and corporate financing decisions.[48]

Third, tax reform could end the relatively generous tax treatment now accorded to owner-occupied housing relative to other assets. The elimination of this tax distortion could lead to a more efficient allocation of capital yielding positive economic benefits in the long-run. However, the relationship between housing values and other financial assets held by households is uncertain. For example, Skinner (1994) and Hoynes and McFadden (1994) find little relationship between house values and other financial assets. Engen and Gale (1997) find no offset between house values and 401(k) plans, although they find a significant offset between mortgage debt and 401(k) plans.

Fourth, we have not modeled the interaction between inflation and the tax code. Accounting for this would raise effective tax rates in the current system. Moving to a consumption tax resolves issues that arise concerning the tax treatment of the inflationary component of capital income so that the fall in the effective tax rate on capital income would be larger if inflation were accounted for, and the impact on saving may be larger as well.[49]

Fifth, moving to a consumption tax would remove the "lock-in" effect on assets that generate capital gains. This could create a short-term binge of consumption, similar in nature to the impact of removing the early withdrawal restrictions on pensions discussed above. It is estimated that in 1994 about $1 trillion in unrealized capital gains in stocks and mutual funds (outside of retirement accounts) was held by households.[50] If households consumed as little as four percent of these unrealized capital gains in the first year after adoption of a consumption tax, the increase in consumption, $40 billion, would be equal to about one-half of a percent of GDP, which would cut substantially into any increase in saving created by a consumption tax.

Sixth, we have modeled the effects of a consumption tax that is immediate and completely unanticipated. These features influence the magnitude of the "lump-sum" tax levy on existing capital that is an important component of the saving and efficiency effects of

[47] See U.S. Department of the Treasury (1992) for discussion and proposals to integrate the corporate income tax.

[48] See Auerback (1996) for more discussion of these issues.

[49] See Feldstein (1996) for more discussion of this issue.

[50] In 1994, the household sector held $1.1 trillion in mutual funds and $2.9 trillion in corporate equities (Federal Reserve Board, 1995). It is estimiated that about 15 percent of mutual fund assets and approximately 7 percent of corporate equities were in self-direct retirement savings accounts—IRAs and Keoghs. (See endnote 12.) Thus, household held about $3.6 trillion in stocks and mutual funds (outside of retirement accounts) which about one-third, or $1.2 trillion, is estimated to be unrealized capital gains (Kennickell and Wilcox, 1992).

tax reform. Allowing for a phased in and/or anticipated move to a consumption tax would tend to reduce the impacts on saving. For example, households would have the incentive to spend down a portion of their existing assets in anticipation of moving to a consumption tax, reducing saving and diminishing the efficiency gains from the tax levy on existing capital following tax reform.[51]

Seventh, some economists have suggested that saving decisions are strongly influenced by psychological or behavioral factors not normally included in economic analyses, and doubt that people have the time-consistent preferences assumed in life-cycle models. Recent "behavioral" models of saving have assumed that people have conflicting preferences.[52] One set of preferences is that of a farsighted, patient planner while the other set of preferences characterizes a myopic, impatient spender. Tax policy that supports one set of preferences over the other can have a large effect on saving. Bernheim (1996) explains how public policy could encourage saving by changing the way saving decisions are framed, facilitating simple mental calculations, providing education, and encouraging agents that have a selfish interest in promoting saving by others. Bernheim notes, for example, that to the extent that the tax system favors the development of institutions to encourage saving (for example, pensions) and to the extent that these institutions affect saving in a positive manner, moving to a consumption tax might have only a small positive impact and possibly a negative impact on saving.

V. Conclusion

Our formal analysis indicates that, in a closed economy, a consumption-based tax reform could increase real GDP by about 2-½ percent and bolster the saving rate by almost 1 percentage point of GDP. These effects would likely be somewhat larger if international capital flows are taken into account. If transition relief is part of the switch to a consumption tax the effects on output and saving decline significantly.

Our analysis does not capture all the potential effects of tax reform. In particular, curtailments in the private pension system could offset much of whatever increase in saving occurs generally. A spurt in consumer spending caused by both releasing the withdrawal restrictions on pension accumulations and removing the tax-induced lock-in effect on unrealized capital gains could also reduce the saving impact, at least for a period. Finally, if one considers the possibility that other groups will lobby for and win the continuation of current tax advantages, the marginal tax rates necessary to sustain revenue would rise still more, and the potential increase in output and saving could be smaller. Thus, while a carefully designed tax reform may be able to boost output and saving modestly, a poorly designed reform could have a negligible effects.

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[51] The possibility that a lump-sum tax levy on existing capital would raise savers' subjective assessment of the probability of another tax levy in the future could reduce the positive impact of tax reform on savings.

[52] See Thaler and Shefrin (1981), Shefrin and Thaler (1988), and Liabson (1995).

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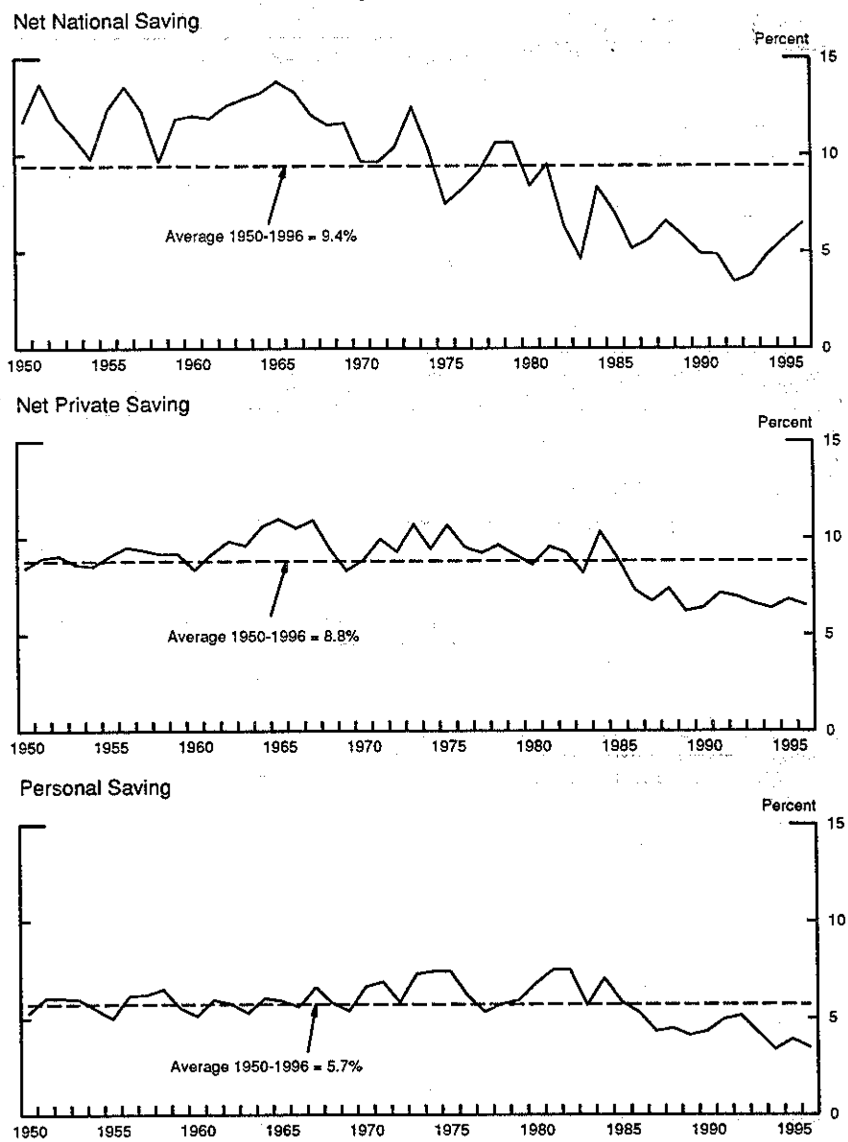
Chart 1

U.S. Saving Rates

As a Percentage of Net National Product



Source: National Income and Product Accounts.

Table 1.—Tax-Preferred Saving Incentive Accounts and Household Financial Assets

[1976–1994]

Type of asset (percent of household financial assets)	Time period—			
	1976–80	1981–85	1986–90	1991–94
IRA and Keogh Assets	n.a.	1.4	3.4	4.8
Life Insurance Reserves	4.0	3.0	2.6	2.7
Pension Reserves	14.1	18.3	23.6	27.6
Total Saving Incentive Assets	18.1	22.8	29.7	35.1
Total Financial Assets (percent of net worth)	66.8	67.3	71.7	75.4

Sources: Federal Reserve Board, *Balance Sheets for the U.S. Economy 1945–94*, 1995. Employee Benefit Research Institute, *EBRI Databook on Employee Benefits*, 1995.

Table 2.—Decomposition of U.S. Personal Saving

[Percent of Net National Product, 1971–1993]

	Time period—			
	1971–80	1981–85	1986–90	1991–93
Net Personal Saving	7.2	8.1	5.8	5.9
Retirement	3.7	6.7	5.7	5.6
Pensions	3.7	5.4	4.4	4.2
Individual	n.a.	1.3	1.3	1.4
Life Insurance	0.5	0.3	0.6	0.5
Other	3.0	1.1	−0.5	−0.2

Sources: Sabelhaus (1996).

Table 3.—Tax-Preferred Assets, Debt, and Household Net Worth

[1976–1994]

Type of asset or debt (percent of net worth)	Time period— 1976–80	1981–85	1986–90	1991–94	Percent of asset value attributable to unrealized capital gains* 1989
Stocks + Mutual Funds	9.6	9.0	11.2	16.3	32.8
Noncorporate Business Equity	19.2	17.6	13.9	11.0	68.8
Residential Housing	33.3	33.9	32.4	30.8	46.1
Tax-Exempt Bonds	0.9	1.3	2.1	2.0	....
Mortgage Debt	9.3	9.4	11.6	12.9	....
Consumer Debt	4.1	3.8	4.3	3.8	....

Sources: Federal Reserve Board, *Balance Sheets for the U.S. Economy 1945-94,* 1995.
*Kennickell and Wilcox (1992).

Table 4.—The Interest Elasticity of Saving and Saving Rates in the Precautionary Saving Model

	Household preferences for saving					
	Baseline parameter specification		Less prudent households		More prudent households	
	(1)	(2)	(3)	(4)	(5)	(6)
	r=0.03	r=0.05	r=0.03	r=0.05	r=0.03	r=0.05
Aggregate saving elasticity	0.26	0.39	0.40	0.64	0.15	0.22
Aggregate saving rate (percent)	5.7	6.0	4.9	5.8	6.7	6.8
Aggregate asset-income ratio	3.94	4.25	3.44	4.08	4.68	4.71

Source: Engen and Gale (1996), household preferences: baseline: intertemporal elasticity of substitution = 0.33, relative risk aversion coefficient = 3, time-preference rate = 0.04; less prudent: intertemporal elasticity of substitution = 0.5, relative risk aversion coefficient = 2, time-preference rate = 0.04; more prudent: intertemporal elasticity of substitution = 0.2, relative risk aversion coefficient = 5, time-preference rate = 0.04.

r = Real after-tax rate of returns to capital.

Note.—Both the saving rate and the asset-income ratio are calculated relative to household's after-tax income.

Source: Engel and Gale (1996).

Table 5.—Fundamental Tax Reform Switch from a Hybrid Income-Consumption Tax to a Consumption Tax or a Comprehensive Income Tax

	Time period—						
	1997	1998	1999	2000	2005	2010	Long run
Real GDP (percent change from baseline):							
Consumption tax[1]	0.8	1.1	1.3	1.4	1.8	2.1	2.4
Consumption tax—open[2]	0.9	1.4	1.8	2.0	2.6	3.1	3.5
Consumption tax—transition[3]	0.4	0.6	0.7	0.8	1.0	1.1	1.3
Income tax[4]	−0.0	−0.0	−0.0	−0.1	−0.2	−0.3	−0.5
Capital Stock (percent change from baseline):							
Consumption tax[1]	1.4	2.9	4.1	5.3	7.0	7.6	9.8
Consumption tax—open[2]	1.8	3.7	5.9	7.5	10.1	12.2	15.1
Consumption tax—transition[3]	0.8	1.6	2.3	3.0	3.9	4.3	5.6
Income tax[4]	−0.1	−0.2	−0.3	−0.4	−0.7	−1.0	−1.6
Labor Supply (percent change from baseline):							
Consumption tax[1]	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Consumption tax—open[2]	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Consumption tax—transition[3]	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Income tax[4]	0.0	0.0	0.0	0.0	0.1	0.1	0.1
Saving Rate (percentage point change from baseline):							
Consumption tax[1]	1.8	1.7	1.4	1.1	1.0	0.9	0.7
Consumption tax—open[2]	2.3	2.2	2.0	1.6	1.4	1.3	1.1
Consumption tax—transition[3]	1.0	0.9	0.8	0.7	0.5	0.5	0.4
Income tax[4]	−0.3	−0.3	−0.2	−0.2	−0.1	−0.1	−0.1

Source: authors' calculations.
[1] Flat rate consumption tax—no transition relief, closed economy.
[2] Flat rate consumption tax—no transition relief, open economy.
[3] Flat rate consumption tax—transition relief, closed economy.
[4] Flat rate unified income tax—closed economy.

4. Dale W. Jorgenson and Peter J. Wilcoxen*

"The Effects of Fundamental Tax Reform and the Feasibility of Dynamic Revenue Estimation"

In this paper we analyze the impact of fundamental tax reform on U.S. economic growth over the next quarter century. We consider two alternative approaches to tax reform. The first is a flat rate consumption tax, similar to the one proposed by Hall and Rabushka (1985) and introduced in the 104th Congress by Majority Leader Dick Armey and Senator Richard Shelby. The second is an income-based value added tax, also with a flat rate. These taxes would be substituted for existing individual and corporate income taxes at federal and state and local levels. A full description of the two proposals is given by the Joint Committee on Taxation (1996). The goals of the study were twofold: to determine the effects of tax reform and to assess the feasibility of dynamic revenue estimation. In the remainder of the paper we present a short description of our model, an explanation of how we used it to assess the effects of tax reform, a summary of our results and some conclusions about both tax reform and revenue estimation.

I. An Overview of the Model

Our results are based on simulations of U.S. economic growth under alternative tax policies constructed using an intertemporal equilibrium model of the U.S. economy. The model is an extension of our earlier work on environmental regulation and has been continuously revised and updated since it was first published in 1990.[1] The version used for these simulations incorporates the detailed representation of the U.S. tax structure presented by Jorgenson and Yun (1991). We present a detailed description of the model and summarize a variety of applications in Jorgenson and Wilcoxen (1993); in this section we summarize the key features of the model influencing our analysis of tax reform.

The model disaggregates the production side of the economy into the thirty-five industries listed in Table 1. Each of the 35 industries is represented by an econometrically estimated nested transcendental logarithmic unit cost function. At the function's top level, output is produced using capital, labor, energy and materials (KLEM). Capital and labor are both primary factors purchased directly from households. Energy and materials are translog aggregates of intermediate goods. The parameters in the cost functions are estimated using a set of consistent input-output tables we con-

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[1] Jorgenson and Wilcoxen (1990).

structed for this purpose which span the period from 1947 through 1985.

The model also includes final demand submodels for consumption, investment, government spending, exports and imports. The consumption submodel distinguishes among 1344 types of households based on family size, age and gender of household head, region of residence, race, type of residence, and sex of household head, as shown in Table 2. We represent household behavior using the three-stage intertemporal optimization problem shown schematically in Figure 1. At the first stage, each household allocates full wealth (the sum of financial wealth, discounted future labor earnings and an imputed value of leisure time) across different time periods according to its rate of time preference and its intertemporal elasticity of substitution. We formalize this decision using a representative agent who maximizes an intertemporal utility function subject to an intertemporal budget constraint. In this version of the model we use a utility function which imposes the restriction that the intertemporal elasticity of subsitution be unity. The time preference rate is econometrically estimated using the Euler equation approach and is equal to about 0.0288, or 2.9%. The allocation of full wealth across time determines consumption and saving in each period.

Once households have allocated full wealth they begin the second stage of their optimization: deciding on the mix of leisure and goods to consume in each period. As in the intertemporal allocation, we simplify the representation of household preferences between goods and leisure by the use of a representative consumer. The representative consumer has a translog intraperiod indirect utility function which depends on the prices of leisure and an aggregate consumption good. The estimated parameters in the model are such that the Allen elasticity of substitution between goods and leisure is about 0.8. We then derive the consumer's demands for leisure and goods in each period as a function of prices and the amount of full wealth allocated to the period. This produces an allocation of the household's time endowment, which is given exogenously, between leisure time and the labor market. Thus, the second stage of the consumer model determines labor supply.

In the simulations presented below the structure of existing taxes on labor income plays an important role. We approximate the tax code by a simple progressive tax that consists of a large zero bracket amount, which is exempt from tax, followed by a flat marginal rate that applies on all income above the zero bracket. The marginal tax is about 27 percent, which is the average marginal tax rate in our dataset. Average taxes on labor income are much lower, about 13%, because of the substantial large zero bracket.

The third stage of the household optimization problem is the allocation of consumption expenditures among capital, labor and the 35 commodities. At this stage, we depart from the representative consumer assumption and instead follow the methodology of Jorgenson, Lau and Stoker (1982) by formulating a system of individual household demand systems which can be aggregated. We then distinguish between 1344 household types noted above. For each of these we follow the approach of Jorgenson and Slesnick

(1987) by using a nested translog tier structure to represent demands for individual commodities.

Our investment model is based on the Q theory of Tobin (1969). We require that the present value of the returns expected on an extra unit of capital be equal to the purchase price of a new capital good.[2] We also assume there is a single capital stock in the economy which is perfectly malleable and can be reallocated between industries and final demand categories, including housing and consumer durables, at zero cost. This implies that capital will shift between uses until the after-tax rate of return is equated across the economy. New capital goods are produced out of individual commodities according to a production function estimated from historical data, so the price of new capital will be determined by commodity prices. The price of capital goods and the discounted value of future rental prices are brought into equilibrium by adjustments in the term structure of interest rates. Finally, the quantity of investment done in each period is determined by the amount of savings made available by households.

The two remaining final demand categories are the government and the foreign sector. Government consumption is determined from the income-expenditure identity for the government sector. We compute total tax revenue by applying exogenous tax rates to appropriate transactions in the economy. We then add the capital income of government enterprises (determined endogenously) and nontax receipts (exogenous) to tax revenue to obtain total government revenue. We take the value of the fiscal deficit to be exogenous and add it to total revenue to obtain total government spending. To arrive at government purchases of goods and services, we subtract interest paid to domestic and foreign holders of government bonds together with government transfer payments to domestic and foreign recipients. We allocate the remainder among commodity groups according to fixed shares constructed from historical data.

Our treatment of the foreign sector includes a set of import and export demand equations for each commodity. For the purposes of domestic tax reform, however, the most important aspect of our foreign sector model is that we take the current account deficit, and hence the capital account surplus, to be exogenous. Since the fiscal deficit and the capital account surplus are both exogenous, any changes in investment must be financed by changes in domestic saving.

II. Modeling Fundamental Tax Reform

In order to analyze the economic impact of changes in tax policy, we simulate the growth of the U.S. economy with and without changes in these policies. The first and most difficult step is to generate the base case—a simulation based on the assumption that current tax policy continues unchanged. We then produce alternative simulations based on substitution of the consumption or flat income taxes for the existing income tax. Finally, we compare the base case with the alternative cases in order to assess the economic impact of fundamental tax reform.

[2] We assume that there are no internal costs of adjusting the capital stock.

The first step in constructing the alternative cases is to specify as precisely as possible how the proposed changes would affect the tax system. A useful starting point for the definition of the consumption tax base is Personal Consumption Expenditures (PCE), as defined in the U.S. national income and product accounts. The taxation of services poses important administrative problems reviewed in the U.S. Treasury (1984) monograph on the value added tax. The rental equivalent value of the services of owner-occupied housing is included in PCE, but the services of consumers' durables are excluded. Both could be taxed by the "prepayment method" described by David Bradford (1986).

Housing and consumers' durables must be included in the tax base in order to reap the substantial economic benefits of putting household and business capital onto the same footing. Under the prepayment method purchases of consumers' durables by households for their own use would be subject to tax. This would include automobiles, appliances, home furnishings, and so on. In addition, new construction of owner-occupied housing would be subject to tax, as would sales of existing renter-occupied housing to owner-occupiers.

The prepayment of taxes on services of owner-occupied housing would remove an important political obstacle to substitution of a consumption tax for existing income taxes. At the time the substitution takes place all owner-occupiers would be treated as having prepaid all future taxes on the services of their dwellings. This is equivalent to excluding mortgage interest from the tax base, as well as returns to equity, which might be taxed upon the sale of residence with no corresponding purchase of residential property of equal or greater value.

Implementation of a flat rate income tax is very similar to that of a flat rate consumption tax. In defining the tax base economic depreciation rather than investment would be excluded from the tax base. Slemrod (1996) has pointed out that a income-base value added tax could be administered in the same way as a consumption-base tax by excluding the present value of economic depreciation, as proposed by Auerbach and Jorgenson (1980), rather than investment from the tax base. For example, purchases on capital account could be converted to Auerbach-Jorgenson depreciation allowances and deducted from value added.

In this paper we focus attention on long-run dynamics of fundamental tax reform. Concerns about progressivity could be addressed by adopting the methodology proposed by Feenberg, Mitrusi and Poterba (1997) for measuring the change in tax burdens in terms of levels of consumption of different households. This would make it possible to assess progressivity of the proposals in terms of consumption rather than income, as in the distributional tables produced by the Joint Committee on Taxation.

Since state and local income taxes usually employ the same tax bases as the corresponding federal taxes, it is reasonable to assume that the replacement of income taxes at the federal level would be followed by replacement at the state and local level. For simplicity we have considered the economic impact of replacement at all levels simultaneously. Since an important advantage of a fundamental tax reform is the possibility, at least at the outset, of radically simplifying tax rules, it does not make much sense to assume that these rules would continue to govern state and local taxes, even if federal taxes were replaced.

Nearly two decades of economic dispute over the economic impact of the federal deficit have failed to produce consensus. This dispute could continue well into the next century and occupy the next generation of fiscal economists, as it has the current generation. An effective device for insulating the discussion of fundamental tax reform from the budget debate is to limit consideration to deficit neutral proposals. This device was critical to the eventual enactment of the Tax Reform Act of 1986 and is, we believe, essential to progress in understanding the economic impact of fundamental tax reform.

Finally, we hold net foreign investment constant, while allowing exchange rates to adjust. It might appear that elimination of taxes on capital income under a flat consumption tax would reduce net foreign investment by providing foreigners with incentives to acquire assets in the U.S. and domestic residents residents to sell foreign assets. However, the rise in exports that would result could require a substantial increase in net foreign investment. Within our modeling framework there is no way to assess the relative importance of these two economic forces, so that we assume that they will balance out.

III. The Effects of Tax Reform

We summarize our conclusions in a series of charts. We begin by examining a revenue neutral substitution of a flat consumption tax for existing taxes. Figure 2 shows that the required consumption tax rate would need to be initially about 23 percent. Of this, the federal rate would be approximately eighty percent of the total, or 18 percent. The remaining 5 percent would be the rate needed to replace state and local income taxes. Over time the rate gradually declines slightly and converges to around 22 percent.

The primary effect of the reform is to change the supplies of the economy's two primary factors, labor and capital. Figure 3 shows the time paths of labor and capital under the consumption tax expressed as percentage deviations from the base case. Labor supply increases sharply because the consumption tax raises real after-tax wages substantially at the margin. The reason is that the average marginal tax rate on labor income under the current tax system is fairly high (including all federal, state and local income taxes it comes to about 27%) and it is replaced by lower tax with a larger base. The consumption tax rate is comparable to the average tax paid on labor income but is much lower than the marginal rate. The immediate increase in labor supply probably overstates the true short run effect because our model does not include any labor market frictions. Workers are able to move from one industry to another, or into and out of the labor force altogether, without transactions costs.

Figure 3 shows that the reform would have only a small positive effect on the capital stock but this masks a very substantial shift of capital out of housing and consumer durables and into business capital. The shift comes about because the consumption tax would eliminate the mortgage interest deduction while providing more favorable tax treatment of business investment than exists under current law. This would cause a large reallocation of capital as shown in Figure 4. Household capital would decline by about 10 percent and business capital would increase by about 12 percent. The reallocation happens immediately (that is, beginning in the first period after the change in tax systems) because we allow free mobility of capital between uses. This probably overstates the short run movement of capital out of housing.

Figure 5 shows the effect of the consumption tax on real GDP. GDP would increase by almost 3.3 percent in the first year relative to the base case due to the increase in labor supply,. This would rise gradually to a peak of 3.7 percent in 1999 and then decline to a long run level almost identical to the initial value of 3.3 percent over the next quarter century. Figure 6 shows that the composition of GDP would initially shift from consumption toward investment. Real investment would initially rise by 4.9 percent, relative to the base case, and then gradually fall to zero within the next decade. Consumption would initially rise by 2.9 percent and would eventually rise to a slightly higher proportion of the GDP than under the existing tax system.

Although GDP increases, the consumption tax does not increase overall welfare: the equivalent variation corresponding to it is essentially zero. The increase in GDP is brought about by higher labor supply and increased investment. This requires lower consumption of goods and leisure, particularly in the early years of the simulation, and tends to lower welfare and offset the effect on GDP.

Since producers would no longer pay taxes on profits or other forms of income from capital under a consumption tax, and workers would no longer pay taxes on wages, prices received by producers, shown in Figure 7, would fall by an average of around eight percent. Figure 8 shows that industry outputs would rise by an average of more than five percent. Although production would rise in all industries, economic activity would be substantially redistributed.

A revenue-neutral substitution of a flat rate unified income tax for existing taxes would produce slightly different results. As show in Figure 9, the tax rate would be about 0.5 percent lower in each year. The reason is simply that the tax base would be larger because depreciation deductions would take less out of the tax base than the consumption tax approach of expensing all new investment. Put another way, these rates reflect the inclusion of net investment, as well as consumption, in the tax base under the unified income tax.

The impact of a unified income tax on the level of economic activity is even more modest than that of a consumption tax. Figure 10 shows that GDP initially rises by slightly under 0.7 percent, but the impact gradually increases to more than 1.6 percent in 2002 and then subsides toward a long-run level of 1.4 percent. Figure 11 shows the effect of the tax on the composition of GDP. The income tax initially depresses investment by almost ten percent, but this decline falls to around four percent in the long run. The decline in the overall capital stock is due to the elimination of the mortgage interest deduction and the resulting decline the housing capital.

Consumption initially jumps by more than four percent, but this declines toward a long-run level of around two percent.

Under the flat income tax, differences in taxes on capital and labor incomes are eliminated and marginal tax rates are lowered substantially. Figure 12 shows that the initial impact is to reduce prices at the producer level by an average of eight percent, while Figure 13 shows that, unlike the results for the consumption tax, this is associated with increases in outputs of some industries and decreases in others.

IV. Conclusion

Substitution of flat rate consumption or income taxes for existing taxes would be the most drastic change in federal tax policy since the introduction of the income tax in 1913. Therefore, it is somewhat surprising that the economic impacts we have summarized would be so modest. In fact, in the case of the consumption tax it appears that the major gain from tax reform would be a reduction in the substantial compliance costs associated with the existing tax system, estimated to range from $100 to $500 billion per year. These benefits are large and are not captured by our model.

Our study reaches mixed conclusions on the question of dynamic revenue estimation. On one hand, our model and most others based on general equilibrium analysis are probably not suitable for very short term analysis. The model assumes too much mobility of labor and capital to be able to represent the economy well over very short periods of time. In addition, general equilibrium models will generally be far less detailed than one might like for revenue estimation. Although our model contains over 1000 consumer groups, which is large for a general equilibrium model, that is far less than could be attained with microsimulation. However, it is quite clear from our results that fundamental tax reform will produce very substantial effects on factor supplies and on relative prices, and these effects can only be captured by general equilibrium analysis. Thus, general equilibrium models have an important role to play in the analysis of fundamental tax reform, particularly when examining effects over the medium to long term, but they should not be the only tool used for dynamic revenue estimation.

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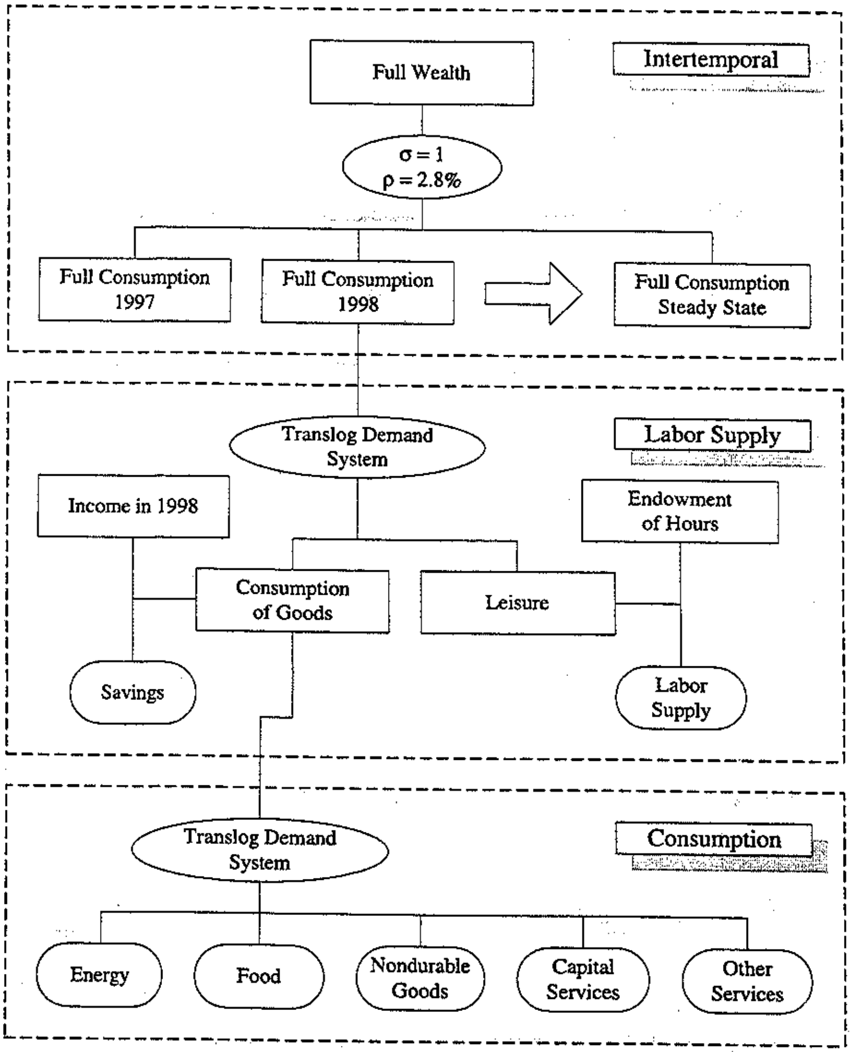
Table 1.—List of Industries

Number	Description
1	Agriculture, Forestry and Fisheries
2	Metal Mining
3	Coal Mining
4	Crude Petroleum and Natural Gas Extraction
5	Nonmetallic Mineral Mining
6	Construction
7	Food and Kindred Products
8	Tobacco
9	Textile Milling
10	Apparel and Fabricated Textile Products
11	Lumber and Wood
12	Furniture
13	Paper and Allied Products
14	Printing and Publishing
15	Chemicals
16	Petroleum Refining
17	Rubber and Plastic
18	Leather
19	Stone, Clay and Glass
20	Primary Metals
21	Fabricated Metals
22	Non-electrical Machinery
23	Electrical Machinery
24	Transportation Equipment and Ordinance
25	Instruments
26	Miscellaneous Manufacturing
27	Motor Vehicles
28	Transportation
29	Communications
30	Electric Utilities
31	Gas Utilities
32	Trade
33	Finance, Insurance and Real Estate
34	Services
35	Government Enterprises

Table 2.—Demographic Attributes of Households

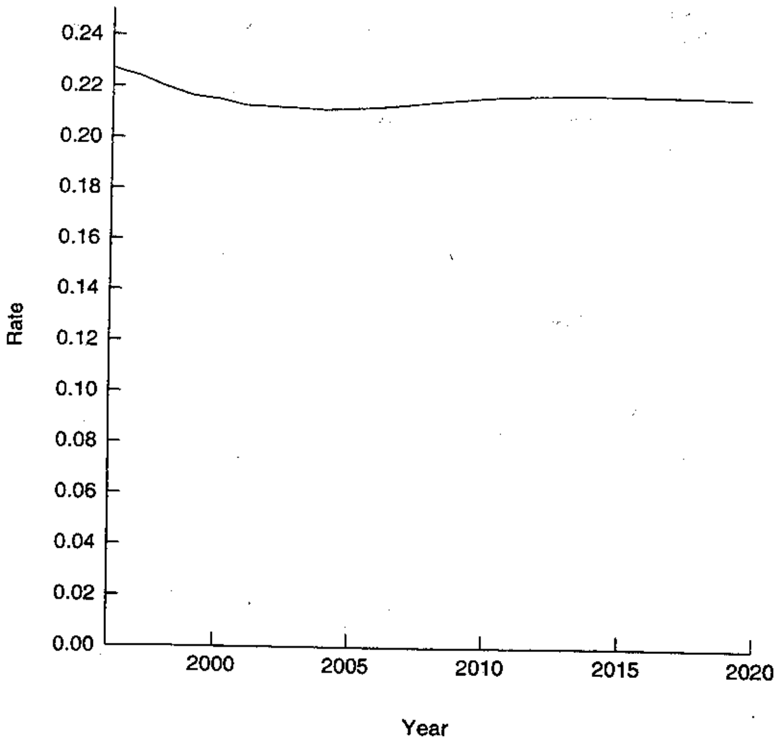
Attribute	Categories
Family Size	1, 2, 3, 4, 5, 6, 7+
Age of Head	16–24, 25–34, 35–44, 45–54, 55–64, 65+
Region of Residence	Northeast, Midwest, South, West
Race	White, Nonwhite
Residence	Farm, Non-farm
Sex of Head	Female, Male

Figure 1: The Structure of the Household Model



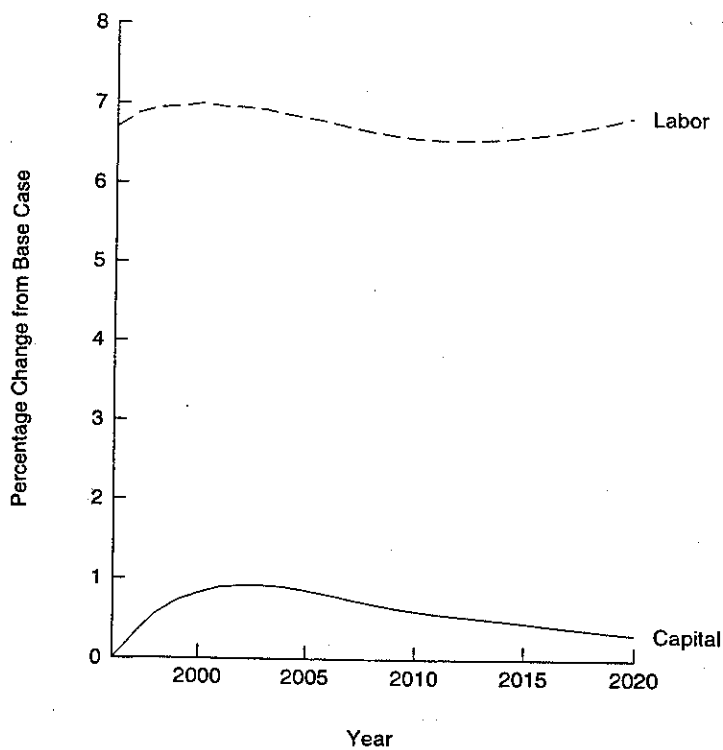
Jorgenson/Wilcoxen

Figure 2: Expenditure-Neutral Tax Rate Under the Consumption Tax



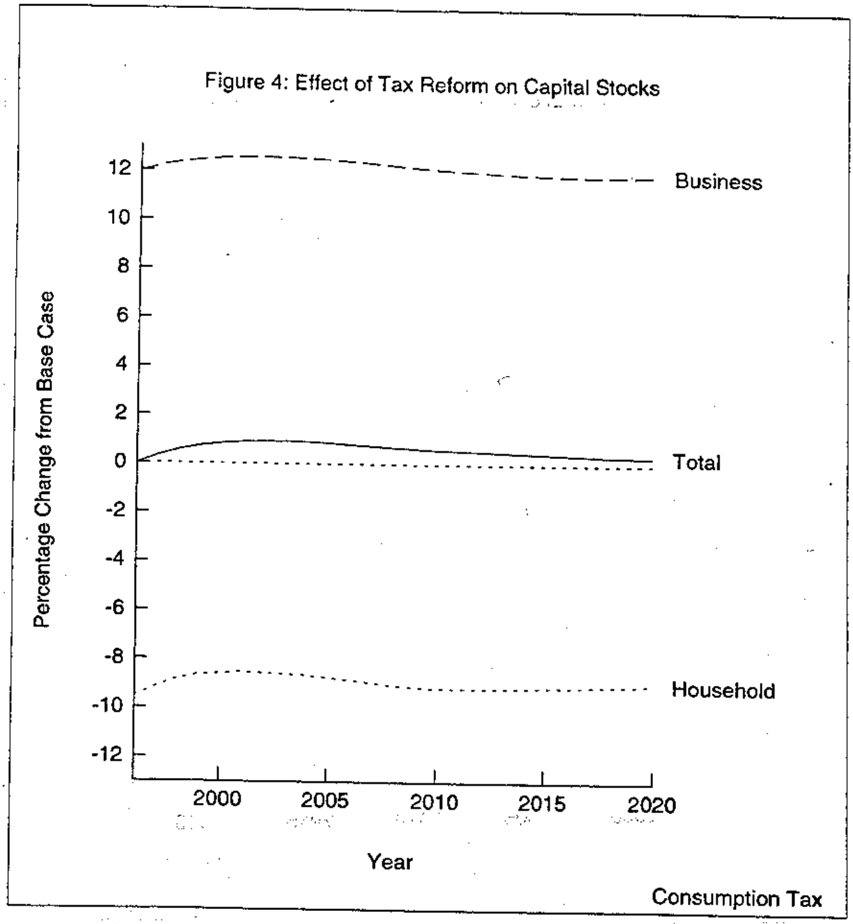
Jorgenson / Wilcoxen

Figure 3: Effect of Tax Reform on Factor Supplies



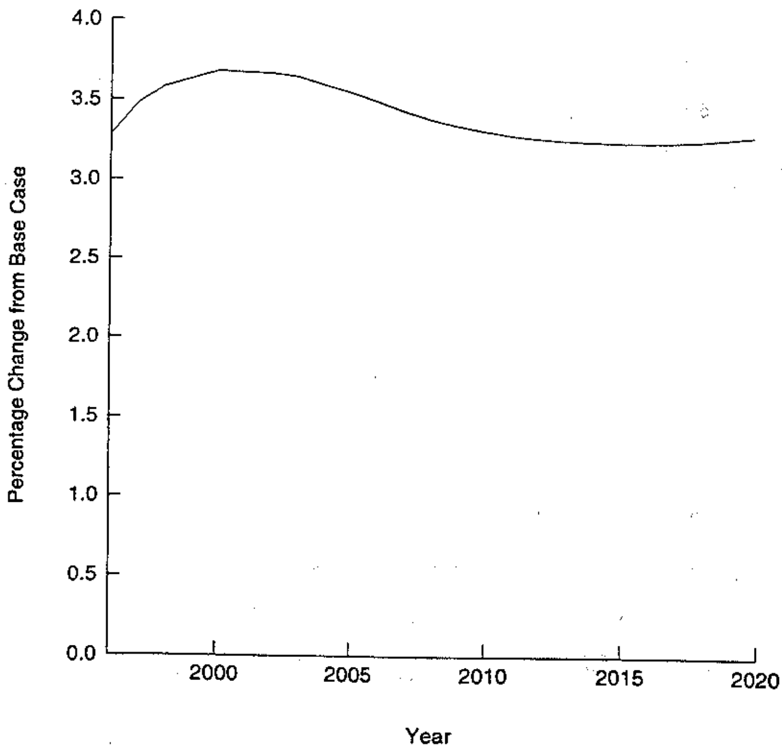
Consumption Tax

Jorgenson/Wilcoxen



Jorgenson/Wilcoxen

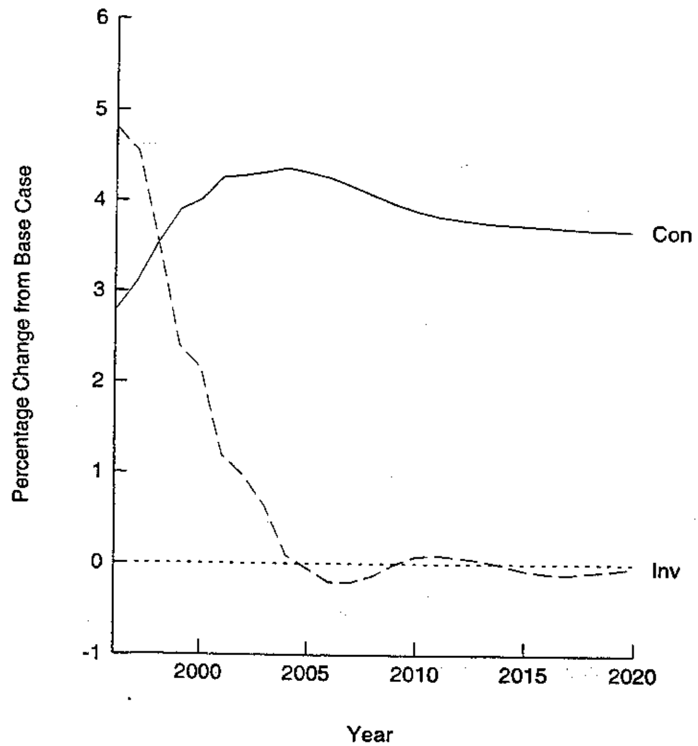
Figure 5: Effect of Tax Reform on Real GDP



Consumption Tax

Jorgenson/Wilcoxen

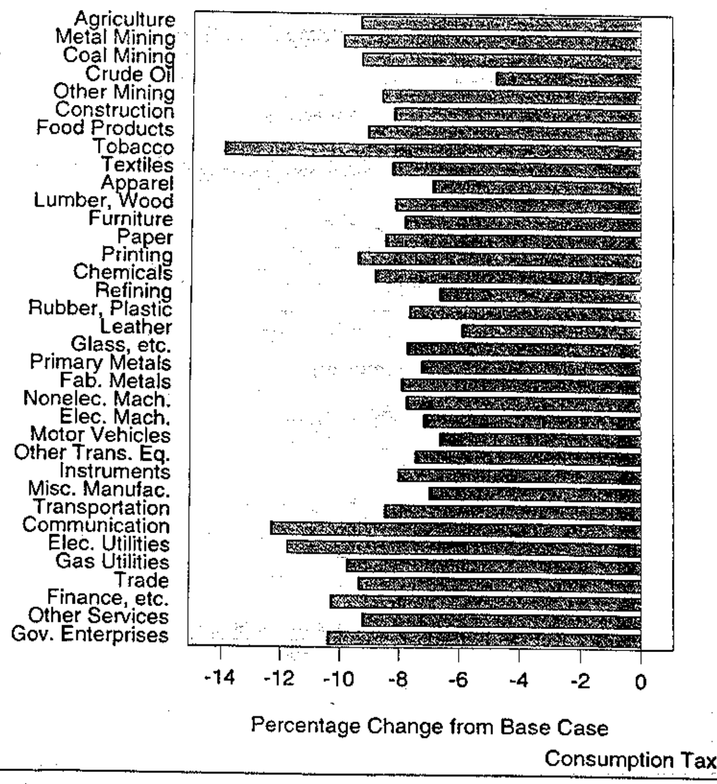
Figure 6: Effect of Tax Reform on Consumption and Investment



Consumption Tax

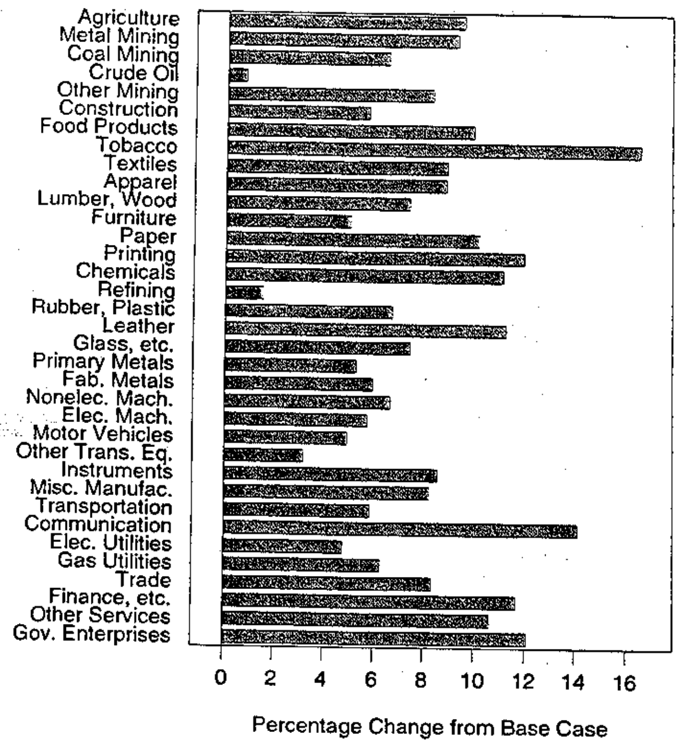
Jorgenson/Wilcoxen

Figure 7: Effect of Tax Reform on Prices in 1996



Jorgenson/Wilcoxen

Figure 8: Effect of Tax Reform on Industry Output in 1996



Consumption Tax

Jorgenson/Wilcoxen

Figure 9: Expenditure-Neutral Tax Rate Under the Unified Income Tax

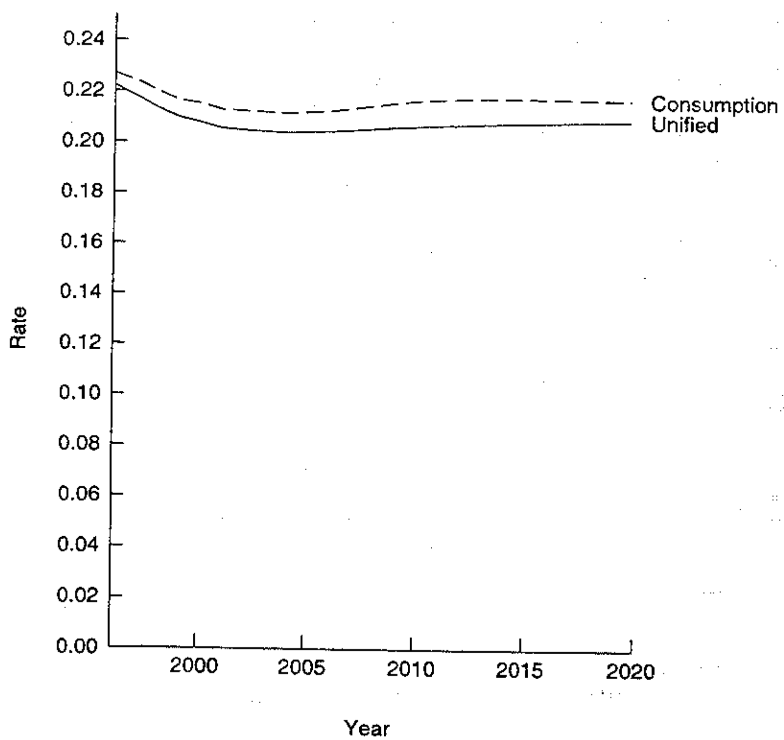


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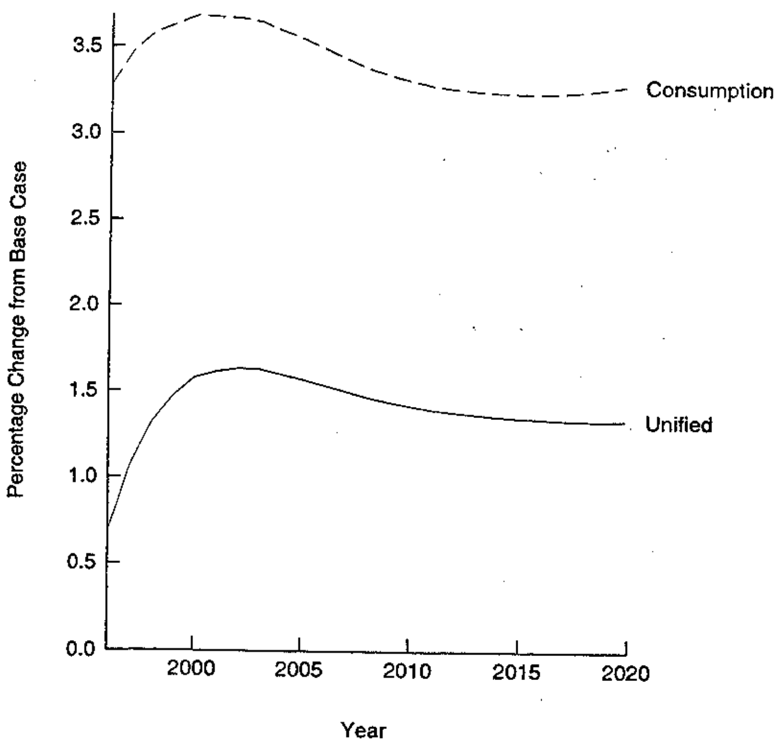
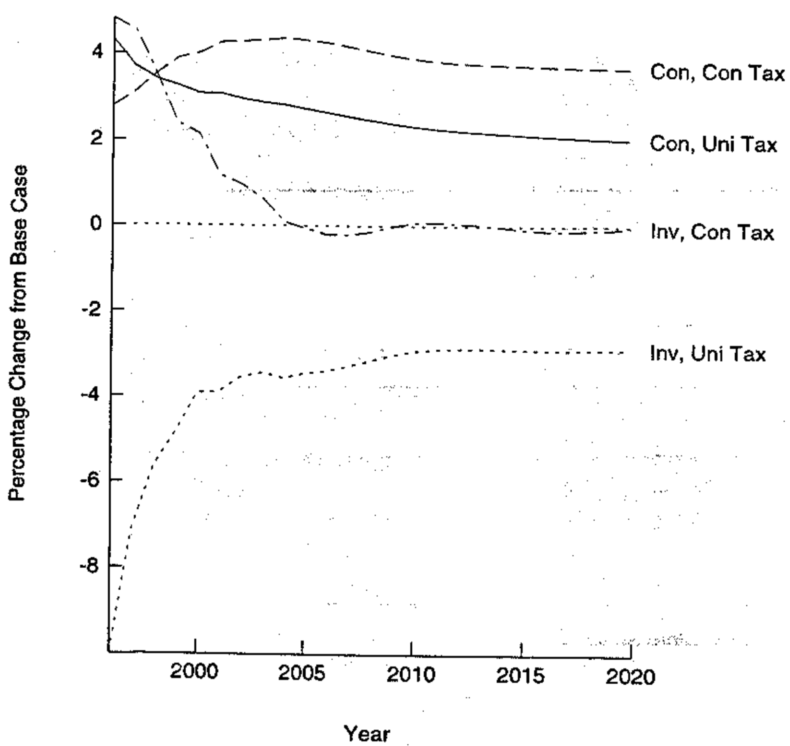
Figure 10: Effect of Tax Reform on Real GDP



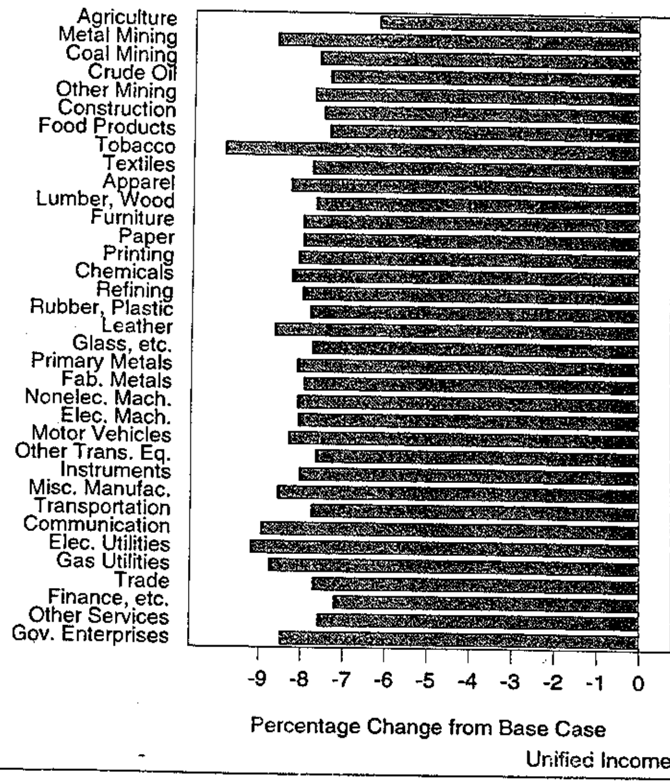
Jorgenson/Wilcoxen

Figure 11: Effect of Tax Reform on Consumption and Investment



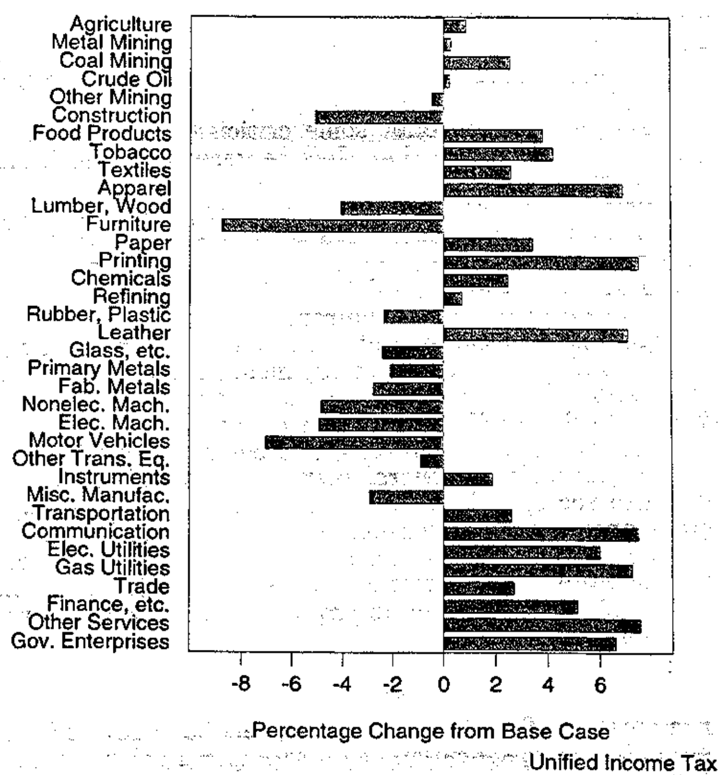
Jorgenson/Wilcoxen

Figure 12: Effect of Tax Reform on Prices in 1996



Jorgenson/Wilcoxen

Figure 13: Effect of Tax Reform on Industry Output in 1996



5. Discussion, Charles L. Ballard*

"Comments on Intertemporal General Equilibrium Models"

The Joint Committee on Taxation has commissioned studies of fundamental tax reform, from the authors of four well-known intertemporal general equilibrium models. These studies are Auerbach, Kotlikoff, Smetters, and Walliser (1997, hereafter, AKSW), Engen and Gale (EG, 1997), Jorgenson and Wilcoxen (JW, 1997), and Rogers (1997, hereafter FR, because the paper by Rogers is an application of a model developed jointly with Fullerton). Each of the four models is impressive in many ways. Each is the result of years of effort. Although I will offer some criticisms of these models, it is important to remember that they represent a significant advance over the models that were available 20 years ago. For example, Feldstein's (1978) paper focuses on two-period life-cycle models. The models used in preparing these papers for the Joint Committee on Taxation are all tremendously more rich and complex than was the two-period model of Feldstein. We still have a long way to go, but we have come a long way already.

I begin with a discussion of the differences among the models in their *sectoral* structure. However, most of my paper is devoted to a discussion of the *dynamic* aspects of these models, with special reference to the implied elasticities of savings and labor supply. My central theme is the importance of creating simulation models that generate plausible behavioral responses. Unless significant care is devoted to the specification of the model, it is possible to generate savings and labor-supply responses that are far beyond those that would be predicted by the econometric literature. Some of the most significant differences among these four models are in the degree to which the authors have attempted to keep the elasticities within a plausible range.

I. Sectoral Effects

The creators of all four of these models have devoted a great deal of effort to the specification of intertemporal decisions. In addition, FR and JW have a disaggregated production structure. This allows them to address a number of issues that cannot be addressed by AKSW or by EG. Both FR and JW report on some of the sectoral re-allocations that occur as a result of fundamental tax reform. The results indicate that these sectoral re-allocations can be substantial.

The FR model is the only one of the four that has both disaggregated production and an overlapping-generations structure.

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This is commendable, since it allows FR to explore issues that cannot be explored by any of the other modelers. One case in point is that FR reports on the difference between sources-side effects and uses-side effects. The older consumers in the FR model tend to consume certain kinds of services more than their younger counterparts do. Based on the FR model, Rogers reports some very interesting results that depend on these differences in the propensities to consume different goods.

In addition, the disaggregated structures of the FR and JW models would allow them to investigate a number of questions that have not been addressed explicitly here. For example, they could decompose the gains from tax reform into the portion attributable to intertemporal changes and the portion attributable to intersectoral changes. In addition, the models of FR and JW could be used to assess the differences between a flat value-added tax and a value-added tax with different rates on different commodities.[1] Consequently, the FR and JW models have an advantage over the AKSW and EG models, for certain purposes.

However, a great deal of the emphasis in this Conference is on changes in the economy-wide aggregates of labor and capital. These issues could reasonably be addressed within a one-sector model. Thus, for some purposes, the AKSW and EG models are not at a disadvantage. I will focus the rest of my remarks on the ways in which these models deal with the development of factor supplies over time.

II. The Methodology of Intertemporal Simulations

When I teach about taxes, I always emphasize the crucial importance of elasticities and tax rates, regardless of whether I use complicated mathematical models or simple supply-demand diagrams. If we model the tax rates correctly, and if we model correctly the elasticities of the taxed activities, then we will get the correct answers, in terms of government tax revenues, excess burdens, and tax incidence. If we use incorrect tax rates or elasticities, we will get incorrect answers.

This suggests that simulation modelers should ascribe great importance to the specification of tax rates and elasticities. In general, the economics profession has done a fairly good job of specifying tax wedges, and the same is true of the papers presented here. With a few small exceptions, I believe that these four papers have done a careful job of specifying the relevant tax rates. Unfortunately, I am less favorable in my assessment of the modeling of elasticities.

The correct methodology for specifying elasticities should be something like this: (1) Search the econometric literature for the best available estimates of the key behavioral elasticities. (2) Build a model that comes reasonably close to matching these elasticities and other important aspects of the economy being modeled. In the past few decades, however, many modelers have turned this methodology on its head. A prime example of this unfortunate meth-

[1] In most of the countries that have a value-added tax, there is wide variation among the tax rates applied to different commodities. Ballard, Scholz, and Shoven (1987) use a model that has some of the same ancestry as the FR model, and find that the differentiated VATs are likely to have welfare effects that are substantially worse than those of the flat-rate VATs.

odological reversal is found in Summers (1981). He picks a very particular form of the lifetime utility functional, and combines it with a highly unusual earnings profile, in a setting in which there are neither bequests nor uncertainty. Summers then gathers these disparate elements together in a simulation model, and claims that the savings elasticities that fall out are realistic. This claim is carried on in spite of the fact that the resulting elasticities are an order of magnitude larger than most of the elasticities that have been estimated econometrically.

As a result of this methodological reversal, Summers comes up with a model that greatly overstates the elasticity of savings. All of the papers presented at this Conference have many laudable features, and they all go beyond the simple model of Summers in at least a few important ways. Nevertheless, some of these papers suffer from the same problem, and are based on models that greatly overstate the elasticities of saving and labor supply. I have considerable skepticism about the results of any model that misses the factor-supply elasticities by a wide margin.

One of the most important lessons to come out of this literature is that it is not sufficient to report on utility function parameters (such as the intertemporal substitution elasticity). It is entirely possible for a modeler to choose a set of utility-function parameters that seem "reasonable", and yet produce a model that generates bizarre factor-supply elasticities. The real proof of the usefulness of an intertemporal simulation model lies in whether the implied factor-supply elasticities make sense. If the implied factor-supply elasticities are outlandish, then the results of the model are suspect, regardless of how "reasonable" the utility-function parameters may appear to be. Of the four models presented here, only EG makes explicit statements about the implied factor-supply elasticities. This is a method that should become standard in the future.[2]

III. The Econometric Evidence on Factor-Supply Elasticities

This is not the place for a comprehensive review of the econometric literatures on labor supply and savings. However, given my emphasis on the importance of specifying the elasticities correctly, it is appropriate to review those literatures briefly.

Summaries of the savings literature can be found in Gravelle's book (1994), my paper (1991), and elsewhere. Most estimates of the savings elasticity are fairly close to zero, and some are negative. Very few of the estimates could reasonably be called large. After years of studying this literature, I am willing to believe that the

[2] When I stress the need to build simulation models that are consistent with elasticity estimates from the econometric literature, I am assuming implicitly that the econometric estimates are a meaningful guide. Of course, the econometric estimates are based on data from the past, whereas the simulation models are trying to project what will happen in the future. One of the authors has suggested that the econometric literature is not a meaningful guide, because the fundamental tax reforms simulated for this Conference are so dramatically different from anything that we have observed in the past. I disagree. First of all, the last few decades have seen very substantial variation in tax policy. For example, during my lifetime, the marginal income tax rate for those at the top of the income scale has varied from 28% to 91%. More importantly, if we were really to reject the possibility that the econometric literature can be used as a guide, it would be be absolutely necessary to provide sensitivity analysis over an enormous range of factor-supply elasticities. If one really believes that the low elasticity estimates from the econometric literature are useless, then it is unacceptable to restrict one's attention to simulations based on elasticities that range from large to enormous. However, all of the authors provide sensitivity analysis over a fairly limited range of parameter values.

savings elasticity is positive, but I become uncomfortable with elasticities greater than 0.2, and very uncomfortable with elasticities greater than 0.5.[3]

As for labor supply, the evidence for low elasticities seems even stronger. The last generation has seen a huge number of empirical studies of labor-supply behavior. Virtually all of the studies find the uncompensated elasticity for men to be close to zero.[4] For women, there is more uncertainty about the best estimate of the labor-supply elasticity. Some early studies of the labor supply of women found large elasticities. Influenced by some of these studies, Ballard, Fullerton, Shoven, and Whalley (1985) used a central-case value of 0.15 for the weighted-average labor-supply elasticity for the United States economy as a whole. However, experimental studies of labor supply tend to generate smaller elasticity estimates for women. (See, for example, Burtless (1987).) If I were to choose central-case values for the overall labor-supply elasticities today, I would choose 0.05 or 0.10 for the uncompensated elasticity, and something around 0.20 for the compensated elasticity.[5]

IV. The Specification of Savings Responses in Intertemporal Models

Of all of the general-equilibrium models that have been used to simulate the transition caused by a capital-deepening policy change, only one has been designed to allow the modeler to control the savings elasticity directly. This is the "GEMTAP" model. (See Ballard, Fullerton, Shoven, and Whalley (1985) for a detailed description of the model, or Fullerton, Shoven, and Whalley (1983) for an application to consumption taxation.) Because GEMTAP allows the modeler to specify the savings elasticity, it has a degree of realism that is absent from most other intertemporal general equilibrium models. Certainly, a model like GEMTAP has some distinct advantages in terms of short-run revenue estimates.

However, GEMTAP's dynamic structure is essentially an infinite repetition of a two-period problem. Thus, the standard version of this model is unable to assess intergenerational issues. Moreover, consumers in the model maximize subject to a current income constraint, rather than a lifetime wealth constraint. From the perspective of economic theory, it is significantly more attractive to have consumers who maximize subject to a lifetime wealth constraint. Consequently, most of the intertemporal general equilibrium models of the last decade have used structures that differ from that of GEMTAP. The type of intertemporal GE model that has become most common has an additively separable lifetime utility func-

[3] A zero savings elasticity does *not* imply that capital income taxation generates no welfare losses. (See Feldstein (1978).) If the savings elasticity is zero, there can still be a substantial amount of substitutability between consumption in different periods. For example, Fullerton, Shoven, and Whalley (1983) find fairly significant effects from the adoption of a consumption tax, even when the savings elasticity is aero. Not surprisingly, however, higher savings elasticities are associated with higher welfare gains.

[4] A comprehensive survey of the literature can be found in Killingsworth (1983). Juhn, Murphy, and topel (1991) find some evidence of elasticities as high as about 0.3 for low-wage men, but the weighted average for all men in their study is still quite small.

[5] All of the elasticity estimates reported in this paragraph are for the elasticities of labor supply with respect to the wage rate. there is virtually no empirical evidence on any elasticities of labor supply with respect to the interest rate. Any simulation model that generates a large elasticity of labor supply with respect to the interest rate is shooting in the dark. I will return to this point below.

tional, an isoelastic instantaneous utility function, no adjustment costs, and no uncertainty. The theoretical purity of these models is laudable, but it comes at a cost: In these models, the savings elasticity is a residual, which can be extremely difficult to control. A model such as this is likely to generate extremely large savings elasticities, even though there is no basis for this type of response in the econometric literature.

The avenue through which these large savings responses occur is called the "human wealth effect" by Summers. When a capital-deepening policy change is undertaken, the rate of return increases. Consumers in these models begin their decision process by calculating the present discounted value of their lifetime wealth. With a higher interest rate, they find that this present value has fallen. In other words, the consumer is made poorer by the increase in the rate of return. The consumer responds by reducing consumption, i.e., by increasing savings. Since savings is much smaller than consumption, even a relatively modest decrease in consumption can lead to a relatively large increase in savings.

If a simulation model is to be much more than an arcane mathematical exercise, the modeler must do something to try to bring the elasticities down to realistic levels. This can be done in any of several ways, including the following:

- The consumer's lifetime can be shortened, so that the human wealth effects do not accumulate over so long a period.
- The parameters of the consumer's instantaneous utility function can be altered.
- Uncertainty can be introduced.
- The modeler can incorporate adjustment costs in the investment process.

One additional problem for the savings elasticities has to do with labor-supply responses. If a model with a lifetime wealth constraint has leisure (as well as consumption) in the instantaneous utility function, then the human wealth effect will cause the consumer to reduce both current consumption and current leisure. In other words, the consumer will not only consume less, but will also work more. In some cases, the elasticity of labor supply with respect to the net rate of return can be extremely large, and this can greatly increase the savings elasticity. If the model has a labor-supply choice of this type, then this problem must also be addressed, or else there will be a great danger of generating implausible elasticities.

Clearly, one type of model that is likely to have difficulty with factor-supply elasticities is the infinite-horizon model. In addition to being unable to address intergenerational issues, the infinite-horizon model gives the consumer the longest possible period over which to re-allocate wealth. The paper by JW, presented at this Conference, has an infinite-horizon structure with a labor-supply choice. As suggested in the previous paragraph, this can allow the model to generate some extremely large labor-supply responses. In fact, in simulations of the consumption tax, the JW model generates a 6.6% increase in labor supply in the first period. This is far greater than the labor-supply responses in most of the other models presented at this Conference, and it appears to be a very unrealistic response.

Interestingly, the savings responses reported in the JW paper appear to be plausibly small. This appears to be the result of intersectoral shifts within the JW model economy. Thus, it appears that the labor-supply results of the JW model are more problematic than their savings results.[6] Unfortunately, it is difficult to know the exact value of the factor-supply elasticities in the JW model, since the authors do not report them. (This is a problem for the AKSW and FR papers, as well.) I would urge all of these authors to expand their reporting and discussion of the factor-supply elasticities.

In some of their writings, JW mention that the rate of return is fixed in the long run in an infinite-horizon model, which means that the long-run savings elasticity is undefined. However, this statement is not very useful. Certainly, if we are interested in short-run revenue estimation, it is not of much help to know that the rate of return will eventually settle down to its base-case level. In addition, the long-run effects of a policy change on GDP and welfare will be driven substantially by the response in the early years. If we are to evaluate models of the type used by JW and the other authors represented at this Conference, it will be very useful for the modelers to report the *impact* savings elasticity (i.e., the elasticity of first-period savings with respect to the first-period rate of return), or some other *short-run* elasticity. This was done by Ballard and Goulder (1985) for an infinite-horizon model, and the results are not very encouraging. In an early critique of the Summers model, Starrett (1982) suggests the use of a Stone-Geary "minimum required consumption level" as a way of reducing the excessive sensitivity of savings. Even with extremely high levels of the minimum required consumption level, the Ballard-Goulder model still generates impact savings elasticities of two or more. These values are highly questionable, in light of the econometric evidence.[7] If an infinite-horizon model can ever be adjusted to give realistic elasticities for both labor supply and savings, it will probably require considerable effort.

As noted above, one way in which to reduce the human-wealth effects is to shorten the consumer's time horizon. However, if we shorten the length of life from infinity to the 50 or 55 years that are common in overlapping-generations life-cycle (OLGLC) models, it is still possible to get extremely large and very unrealistic savings responses. This is demonstrated vividly in the original paper by Auerbach and Kotlikoff (1983), in which the impact effect of the move to a consumption tax is to increase the savings rate from 10 percent to 42 percent! Since the time when that result was generated, the models of Auerbach, Kotlikoff, and their colleagues have undergone substantial improvements.[8] The AKSW paper presented

[6] In fact, given the large labor-supply responses in the JW model, it is unusual for the savings responses to appear so small.

[7] In my 1990 paper for the Heidelberg Congress on Taxing Consumption, I report impact elasticities of savings of more than 30, for an infinite-horizon model. In fact, in certain unpublished experiments, I have found that the infinite-horizon model can generate impact savings elasticities in excess of 100. I believe that this is unrealistic in the extreme.

[8] One major improvement in the AKSW model is the inclusion of bequests. Several authors, including Kotlikoff and Summers (1981) have shown that mere life-cycle savings are insufficient to explain the capital stock, so that bequests are likely to be responsible for a very substantial portion of the capital stock. It is very encouraging to see that bequests have now become a

Continued

at this Conference appears to be substantially less elastic than its ancestor. Nevertheless, in my opinion, the AKSW model is still unrealistically elastic. Thus, even though a lifetime of 50 or 55 years can help to reduce the intertemporal responses somewhat, it will not solve the problem by itself. In order to bring the savings elasticity under control, it will be necessary to do more than merely shorten the lifespan to a half century. The OLGLC model has a tremendous advantage, because it allows the modeler to address a whole host of intergenerational issues that cannot be addressed in an infinite-horizon model. However, it will still require effort to get OLGLC models to give believable results.

Earlier in this section, I listed some of the ways in which the excessive intertemporal sensitivity of these simulation models might be controlled. The second way is to alter the utility function parameters. In all four of the models presented here, the intertemporal substitution elasticity is an important parameter. Davies (1981) surveys the attempts to estimate this parameter, and finds it most likely that the correct value is fairly low, perhaps in the vicinity of 0.25. Hall (1988) finds values close to zero. JW use a value of 1.0, which is quite high. This suggests that JW might be able to exert greater control over the sensitivity of their model by reducing the value of this parameter. FR use a value of 0.5 in some of their simulations, and a value of 0.15 in the others. In my opinion, the results of the "low-elasticity" simulations of FR are much more plausible than the results of their "high-elasticity" simulations, even though the high elasticities are used in their "standard" case. The FR paper cites earlier work by Randolph and Rogers (1995), suggesting that the low elasticities do conform better with the econometric literature. Even in its low-elasticity version, the FR model can still generate fairly large impact savings effects.[9]

Another way in which excessive intertemporal sensitivity can be controlled is to introduce uncertainty into the model. Uncertainty is a central feature of the EG model. Because consumers in that model are uncertain about both their earnings profiles and their length of life, they engage in precautionary saving. This is an important advantage of the EG model, since there is ample evidence that precautionary motives explain at least an important portion of saving behavior. This allows EG to deal with a variety of issues that cannot be addressed in any of the other models considered

standard part of OLGLC simulation models: AKSW, EG, and FR all allow for bequests. In the original work of Auerbach and Kotlikoff, one of the most important results was that the elderly were harmed very badly by the move to a consumption tax. Part of this effect had to do with the fact that these early models had no bequests. With no bequests, the model must constrain consumers to do a tremendous amount of dissaving at the very end of life. This exaggerates the harm done to the elderly from the transition to a consumption tax. In a model with bequests, the consumer's wealth profile will be much flatter, and the losses for the elderly are likely to be greatly reduced. (See Seidman (1984) and Kim (1996).) The papers presented at this Conference still do find that the transition is unfavorable to the elderly, relative to the young, but it appears that this effect is no longer as severe as it was in a model with no bequests.

[9] Rogers suggests that part of the large savings effect in the earlier periods of simulations with the FR model may be due to myopia. The consumers in the FR model are myopic, so that they do not realize that their additional saving will drive down the rate of return. Therefore, they save more than they would have saved if they had perfect foresight. I have used models that can have either myopia or perfect foresight. (See Ballard and Goulder (1985), and Ballard (1987a).) Based on that experience, I believe that this effect of myopia is probably fairly modest. Of course, the way to determine the size of the effect precisely within the FR framework would be for FR to develop a perfect-foresight variant of their model, so that the comparison could be more direct.

here. For example, EG are able to consider the consumer's choice between liquid and illiquid assets.

From the perspective of the theme developed in my remarks, one of the most important advantages of the EG model is that uncertainty causes consumers in their model to have more realistic intertemporal responses. EG are to be commended for dealing head-on with the issue of excessive intertemporal sensitivity. They report savings elasticities that are less than 0.4, and thus much more consistent with the econometric evidence.

V. The Specification of Labor-Supply Responses in Intertemporal Models

In a static model, it is straightforward to calibrate the uncompensated and compensated labor-supply elasticities to any desired values. (For details, see Ballard (1987b).) Even in the GEMTAP model, which has some dynamic features, it is still possible to pin down these elasticities precisely. However, it is much more difficult to control the labor-supply elasticities in dynamic models of the type featured in these four papers.

In each of the models reviewed here, the consumer's lifetime utility functional is the discounted sum of the instantaneous utilities that are derived in each period. The instantaneous utility in each period is a function of goods consumption and of leisure. On the surface, this type of structure is very appealing. However, as mentioned earlier, this structure can lead to some very unusual results. When a policy change leads to an increase in the rate of return, the consumer finds that the present discounted value of his or her lifetime wealth is reduced. As a result, the consumer desires to decrease current consumption. Since current consumption is a composite of goods and leisure, the decrease in current consumption leads to an increase in labor supply, as well as to a decrease in goods consumption. The labor-supply responses are problematic in themselves, since there is scant evidence of a large labor-supply response to the rate of return. In addition, the labor-supply responses can exacerbate the problem of excessive savings responses, which can already be a serious problem in its own right, even in a model with perfectly inelastic labor supply.

How might the modelers control these unrealistic labor-supply responses? One way, of course, would be to use a model in which labor supply is completely exogenous, as was done by Auerbach and Kotlikoff (1983). In fact, if given the choice between a model with perfectly inelastic labor and one with highly elastic labor, I would choose the former, because it would give more believable results. However, it would be better yet to develop models that can mimic the modest (but non-zero) elasticities that are found in the empirical literature.

Another avenue to controlling the labor-supply elasticities is to alter the value of the elasticity of substitution between consumption and leisure, which is an important parameter of the instantaneous utility function in models such as these. If we compare the "high-elasticity" results in the Rogers paper with the "low-elasticity" results, it appears that reducing the value of the intratemporal substitution elasticity can have a substantial effect on the labor-supply responses in the FR model. In judging the two sets of results, I find the labor-supply results for the low-elasticity case to be more believable. It would be good to see further sensitivity analysis with respect to the elasticities in the FR model, and it would be good if they would report on the implied labor-supply elasticities.

The AKSW model uses a value of 0.8 for the intratemporal substitution elasticity. This seems high, and it may be one reason why the labor-supply elasticities in the AKSW paper seem large. In particular, the results of AKSW on the labor-supply effects of a proportional income tax are unusual. It would be good to see the AKSW team use a significantly lower value of the intratemporal substitution elasticity, and it would be good if they would report on the implied labor-supply elasticities.

The labor-supply responses can also be controlled by varying the parameter that specifies the total endowment of time. All of these models begin by specifying the consumer's endowment of time. The model consumer then decides how to allocate this endowment of time between labor and leisure. In much of their work, AKSW have based their choice of leisure endowment on the idea that a person has 5000 hours per year that can be allocated freely, and FR have tended to use 4000 hours per year. In my view, this emphasis on the number of hours available is unfortunate. It would be better to avoid using the leisure endowment parameter as an end in itself. Instead, the leisure endowment parameter should be used as a means to the end of controlling the elasticities.

The amount of leisure generated by a simulation model is uninteresting, whereas the labor-supply elasticity is of crucial importance. Therefore, the endowment of time has no real meaning, in and of itself. If a simulation model were to generate an amount of leisure that seems reasonable, but if the elasticities were outlandish, then the results of the model must be viewed with great caution. On the other hand, if a simulation model were to generate an amount of leisure that seems odd, but if the elasticities are correct, then the model's results will be valuable.

In a static model, the Slutsky decomposition tells us that the (absolute value of the) total income elasticity of labor supply should increase when the time endowment increases. In a number of papers, I have used this information to calibrate the total income elasticity of labor supply very precisely.[10] As mentioned above, my view of the econometric literature is that the correct value of the total income elasticity is small, equalling perhaps -0.05 or -0.10 or -0.20. In order to generate elasticities that are as small as these, it is necessary to specify a relatively small endowment of time. In my own papers, in order to get the desired values of the total income elasticity (which are low in absolute value), it has usually been appropriate to use a leisure-endowment ratio of less than 1.5.[11] In some cases, ratios of less than 1.2 are used.

In the GEMTAP model, the standard leisure-endowment ratio was 1.75. This is associated with a total income elasticity of about -0.33, on average, which is quite large. In models like those of FR and AKSW, the ratio of total time to time actually worked in the

[10] For example, see Ballard (1987b), or Ballard (1990a), or Ballard and Coddeeris (1996).

[11] I am defining the leisure-endowment ratio as the ratio of the total endowment of time to the amount of time that is supplied in the labor market in the base-case scenario.

labor market is often something like 2.0 or 2.5. Values like these are likely to give very large total income elasticities.

The last two paragraphs have focused on the use of the leisure-endowment parameter to control the total income elasticity of labor supply in a static model. In dynamic models such as the ones featured here, there is another, related problem. As mentioned before, policy changes that lead to increased rates of return can lead to large increases in labor supply in models such as these. This effect can be reduced by reducing the leisure endowment. For example, see Ballard and Goulder (1985).

VI. Where Do We Go From Here?

Each of the four models featured here has many strengths, but they all have weaknesses as well. In these remarks, I have emphasized the weakness that I believe to be most prominent— many of the simulations are based on models in which the underlying factor-supply elasticities are excessive. If I had to choose a favorite among the models presented here, it would probably be the low-elasticity version of the Fullerton-Rogers model. The Engen-Gale model would be a close second.

It should be noted that none of these models deals in a serious way with issues of administration and compliance. In fact, fundamental tax reform would probably lead to a substantial reduction in the costs of administering and complying with the tax system. Administration and compliance costs would be reduced somewhat if fundamental tax reform were to take the form of a comprehensive income tax, and they would be reduced even more if the reform were to take the form of a consumption tax.

It will not be easy to incorporate administration and compliance costs into simulation models such as these. Nevertheless, we should always keep in mind that these models are likely to understate the gains from fundamental tax reform. I also urge the researchers to think about whether issues of administration and compliance can be built into their models.

None of these models deals with short-run macroeconomic fluctuations. Consequently, these models can only serve as one input into the process of revenue estimation. Nevertheless, I believe that these models do have the potential to be a valuable part of the revenue-estimation process. In order to maximize the usefulness of these models for revenue estimation, it would be best to combine their best features. It is possible to envision a model that generates reasonable factor-supply elasticities, and which combines (1) the disaggregated production of FR or JW, (2) the overlapping-generations structure of AKSW or EG or FR, and (3) very careful modeling of the details of the income tax system, as seen especially in AKSW or EG. Considering the tremendous advances in intertemporal general equilibrium modeling in the last 20 years, it is possible to hope that models combining all of these features may be developed in the not-too-distant future.

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NEOCLASSICAL GROWTH AND DISEQUILIBRIUM MODELS

1. Joel L. Prakken*

"Simulations of a Flat Tax With the Washington University Macro Model"

About The Washington University Macro Model

In the short-run, the Washington University Macro Model (WUMM) is best described as an IS-LM model with sticky wages and prices. Fluctuations in GDP result primarily from variations in aggregate demand around a level of potential output that, in the near term, is nearly invariant. In the long-run, however, prices and wages are fully flexible, and the level of aggregate demand converges to a level of aggregate supply that is determined by the stock of capital and the supply of labor. The decisions of households and firms depend explicitly on after-tax prices and rates of return, rendering potential output importantly dependent on the tax code. The equilibrium forms of the model's key equations all rest on the microeconomic foundations of profit and utility maximization. The actual values of the underlying parameters, as well as the model's dynamic responses, are estimated using post-war quarterly data. Below are summarized those features of the model that prove especially important in interpreting the results of our simulations.

Aggregate Demand. The consumption function is based on a life-cycle theory of household behavior, the empirical specification of which parallels that original developed by Ando and Modigliani. Consumer spending depends upon the average age of the consuming population, real disposable labor income, real disposable asset income, real transfer payments and real net worth. The latter is divided into two components: equities, and all other forms. In simulation, wealth is calculated by adding to lagged wealth the current flow of saving and current capital gains. In the long-run, the elasticity of the personal saving rate with respect to the real after-tax rate of return is roughly +0.2. However, the saving rate also depends importantly on the composition of personal income, since the propensities to consume (MPCs) are different out of each type of income. In particular, the MPC out of after-tax labor income is relatively high, while the MPC out of after-tax asset income is relatively low. This difference proves important in our simulations because initially because the flat tax shifts the composition of disposable income away from labor income towards capital income.

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The equations for business fixed investment, decomposed into equipment and structures, are based on the neoclassical theory of investment developed by Jorgenson. The desired stocks of business capital, derived from a Cobb-Douglas production function (i.e., a unitary elasticity of substitution between capital and labor) depend on the demand for output of the private nonfarm business sector, and the user costs of capital. Capital is "putty-clay" in nature. Hence, the capital stock adjusts considerably faster to a change in demand for output than to a change in user cost. This differential speed of adjustment proves important in determining the initial response of business fixed investment to the introduction of the flat tax. The desired stock of housing depends on demographics, real disposable income, and the user cost of housing.

The demand for exports depends on rest-of-world GDP and the real exchange rate, the latter defined as the price of exports times the nominal exchange rate divided by rest-of-world prices. The real exchange rate depends upon the international differential in the real interest rate which, over time, is gradually eliminated (up to a risk differential) by the gradual transfer of wealth from debtor to creditor. The demand for imports depends upon domestic income and the price of imports relative to the price of domestically produced goods & services.

Excepting interest on the debt, government spending is exogenous. The model treats the federal government as separate from state & local governments, and carries the full level of detail on government found in the National Income and Product Accounts (NIPAs).

Aggregate Supply. Potential output of the private nonfarm business sector is determined by the Cobb-Douglas production function in equipment, structures and that part of the civilian labor force employed in the private nonfarm business sector. Exogenous technical advance is disembodied and labor augmenting. The labor force is an increasing function of real after-tax hourly compensation, with an elasticity of +0.28. Output of government is proportional to exogenous government employment. Output of the housing sector is the flow of housing services derived from the residential capital stock. Output of households and institutions is exogenous. Potential GDP is the sum of potential output in the private nonfarm business sector and the outputs of the other four sectors.

Wage-Price Dynamics. The price level is modeled as markup over smoothed unit labor costs, which in turn are determined by the cost curve derived from the model's production function. Nominal hourly compensation is determined by an expectations-augmented Phillips curve that is vertical in the long run and is estimated in "wage-wage" form. Together the markup equation and the Phillips curve govern the short-term dynamics of wages and prices, which prove especially important in simulating the near-term effects of a consumption-based tax. The markup depends upon the consumption tax (more on this below), but the specification of the Phillips curve implies that any one-time increase in the price level occasioned by the tax does not kick off a wage-price spiral for a given level of the unemployment rate.

In the long run, the markup equation serves only to pin down the equilibrium real wage by aligning it with the marginal product of labor, while the price level is basically determined by the money stock via a Fisherian equation of exchange in which the velocity of money is an increasing function of the after-tax rate of return. It is via the Phillips curve, which assures long-run flexibility in prices and wages, that the transition from short-run fluctuations in aggregate demand to long-run changes in aggregate supply is accomplished.

Interest Rate Determination. In the short-run, the (real) interest rate is determined either by the supply and demand for money or, alternatively, a Federal Reserve "reaction function." In the long-run, the equilibrium real interest rate is one that equates desired saving and investment. Investment is broadly defined to include purchases of consumers' durables and housing as well as business capital, and saving includes not only private saving but government deficits (or surpluses) and foreign capital inflows (or outflows).

Tax Rates. In addition to the top statutory federal tax rate on corporate income (currently = 35%), the model carries separate measures of economy-wide federal "average marginal" income tax rates for wages (= 23.8%), interest (= 24.7%), dividends (= 28.8%) and personal capital gains (= 25.7%). These have been calculated historically from the *Statistics of Income* as income-weighted averages struck across tabled schedules of personal marginal tax rates, with an allowance that some portion of personal asset income accrues in tax-deferred investment vehicles. There is also an average personal income tax rate used in the calculation of disposable income, and this is set to be consistent with the marginal rates.

Income. The model carries all the detail on income shown in the National Income and Product Accounts and usually required by the federal agencies for purposes of formulating budget projections and scoring of tax legislation. This detail includes: wages and salaries, fringes, employer and employee contributions for social insurance (i.e., payroll taxes), personal interest income, personal dividend income, farm and nonfarm proprietors' income, rental income of persons, personal transfers, corporate profits, depreciation, IVA and the capital consumption adjustment.

The Baseline Solution

We began by constructing a baseline solution from 1997 through 2025, or 29 years. It roughly parallels the CBO baseline through 2006. Thereafter, spending on entitlements is gradually reduced relative to "current service" levels sufficiently to prevent much of an increase in the real interest rate and to stabilize (roughly) the ratio of federal debt to GDP. There is a marked slowing in economic growth after 2010, as the potential labor force is projected to decelerate dramatically when "baby boomers" reach retirement age. If we do not retrain the growth of entitlements then, the ratio of debt to GDP starts rising exponentially and the model eventually explodes.

WUMM is nonlinear, but not enough to make the choice of a baseline much of an issue in that regard. What does matter, however, is the size of the debt along the baseline path. In our experience, simulations of tax reform involve important changes in the equilibrium interest rate. The resulting impact on interest payments, and hence the deficit, depends crucially on how much debt is outstanding. With federal debt at roughly 40% of GDP—as in our baseline—the effect of a change in interest rates on the deficit twenty five years hence is huge. We view this as an important reality to be confronted when dynamically scoring proposed tax policy.

The Tax Proposal

In our simulation, in 1997 we replace the combined personal/corporate income tax with a bifurcated value added tax (VAT) that, in static terms, is intended to raise the same revenue as the income tax it replaces. Businesses compute their taxes by subtracting from revenues their capital investments plus the costs of materials, straight wages and pension contributions. Deductions are not allowed for other fringe benefits, for payroll taxes or for interest expense. Individuals then pay the tax on wages and pension distributions above a generous family allowance that introduces some progressivity to the tax. No personal taxes are collected on asset income or capital gains. Households, however, lose all other deductions, including those for charitable donations, mortgage interest and state & local taxes. Imports and exports are taxed on a "destination basis". The tax base is equivalent to the sum of personal consumption expenditures (other than space rent on housing) plus government consumption (other than depreciation of fixed capital) less the aggregate family allowance. During the transition to the new tax, businesses are allowed to write off investments in "old" capital and inventories, as well as any outstanding net operating losses, along a schedule suggested to us by the Tax Committee. (More on this below.) Since firms and households face the same tax rate, this sort of restructuring often is referred to as a "flat tax", although it does differ in detail from both the familiar Hall-Rebushka plan and similar proposals currently being entertained by Congress.

In principle, the bifurcation of the VAT should not influence the long-run outcome of our simulations, determining only at which point the tax is collected. However, it significantly reduces the initial rise in prices (more on this below) that otherwise would be associated with a VAT, and so has a very big effect on the dynamic time path followed by the economy from the old to the new steady state. The extent of any initial price increase also has important immediate implications for the distribution of the real tax burden between the owners of stocks and bonds.

The Revenue Neutral Tax Rate

At the end of 1996 our baseline simulation shows the sum of private and government consumption to be $5721 billion, while combined personal and corporate income taxes (taken from the National Income & Product Accounts, but excluding Federal Reserve profits) is $874 billion. Thus, were there neither a family allowance nor relief for old capital, a value added tax of 15.3%, = 874/5721, *statically* raises the same amount of *nominal* revenue as the current income tax. The value of the family allowance, supplied to us by JCT, is $1600 billion. Reducing the tax base by the family allowance raises the revenue neutral tax rate to 22.2%, = 874/(5721-1600). Finally, the JCT estimates that the undepreciated stock of fixed capital is roughly $5000 billion, the stock of inventories is $1000 billion, and outstanding NOLs are $500 billion. If, as suggested by the Committee, old fixed capital is depreciated by straight line over fifteen years, old NOLs by straight line over ten years, and old inventory by straight line over five years, the effect is to further reduce the tax base by an amount that initially comes to $583 billion, raising the revenue neutral tax rate to 24.7%, = 874/(5721-1600-583). Eventually, as old capital and NOLs are written off, the rate gradually falls until, in the sixteenth year, nothing old is left on the books and the statically revenue neutral rate is the same as if there was no relief for old capital.

Even without transitional relief for old capital, the statically revenue neutral rate declines gradually over time for two reasons. *First,* there is a modest tendency in our baseline for corporate income taxes to fall as a share of GDP. *Second,* and more important, the family allowance, as suggested by the JCT, is indexed to prices, not wages. Since there is technical advance in our solutions, wage income gradually distances itself from the aggregate family allowance in the alternative solutions, effectively raising the tax base relative to GDP. Ignoring, for the moment, tax relief for old capital, the statically revenue neutral VAT rate falls from 21.2% in 1996 to 18.5% in 2025. About one third of this decline is attributable to the declining importance of income taxes in our baseline, the rest to the declining importance of the aggregate family allowance in the alternative solution. Including relief for old capital, the revenue neutral rate declines from 24.7% to 18.5%.

Special Modeling Issues

WUMM was not initially flexible enough to simulate the flat tax under the guidelines set forth by the Tax Committee. Therefore, it was necessary to modify the underlying code to introduce the VAT in the right places in the right way. For the most part, this tinkering was straightforward, but there are two changes that warrant special attention.

The Initial Price Rise. One very important issue is the extent of any initial rise in prices associated with the new tax. When, as under the current income tax, firms are allowed to deduct all labor costs, labor market conditions for profit maximization can be used to derive a proportional relationship between equilibrium prices and unit labor costs:

$$ln\mathrm{P} = ln\mathrm{ULC},$$

where P is the price level and ULC is unit labor costs. (For convenience, the constant term in the equation has been omitted.) If, however, under the flat tax, firms can deduct only a portion, β, of labor costs, the formula becomes:

$$ln\mathrm{P} = ln\{ (1-\beta\tau)/(1-\tau) \} + ln\mathrm{ULC},$$

where τ is the is the flat tax rate. For example, under a straight VAT, $\beta = 0$ and the price level goes up by a percentage amount that roughly equals the VAT rate. In our baseline, however, β is roughly equal to 0.82. Hence, under the flat tax, with τ equal = 0.25 (including relief for old capital) there would occur, *ceteris paribus*, an initial rise in price of between 5% and 6%. This is the mechanism by which firms attempt to shift to workers the burden of the lost deduction for fringe benefits and payroll taxes. In principle, the increase in the after-tax cost of fringe benefits should encourage workers to reduce β by opting to take compensation in the form of straight wages rather than fringes that are no longer tax-exempt. How fast this might happen is hard to know. Furthermore, shifting the mix of compensation towards wages subjects them to the combined federal payroll tax of over 15% (not to mention any state & local payroll charges) and this, too, is borne largely by labor. Therefore, fringe benefits probably would not disappear, only shrink in importance. Except for an initial rise in β intended to prevent a decline in real payroll taxes (more on this below), we do not change β in our simulations.

Proprietors' Income. One difficulty in modeling the flat tax is that the National Income and Product Accounts, on which the structure of WUMM is based, classify tax collections as "personal" or "corporate", while the flat tax distinguishes between taxes collected from "business" and "wage earners." In the National Accounts, taxes on proprietors" income are classified as personal, whereas under the flat tax they might naturally seem to be classified as business. In principle, some of proprietors' income should be thought of as profits on non-corporate capital that, under the flat tax, would be collected from businesses. The rest of it should be thought of as imputed labor income earned by non-corporate workers that, were it declared as such, would be collected from individuals. We do not have the data to make this decomposition, and so are forced to treat proprietors income as either entirely net business income or entirely as compensation. We decided on the latter, since estimates from our consumption function suggest that the propensity to consume proprietors' income is the same as the propensity to consume wages and salaries. Furthermore, proprietors would have incentive under the flat tax to report at least some of their income as wages in order to shield it from taxation by claiming the family allowance. In the end, the distinction should not be very important provided that one is careful (as we were!) to make sure that no part of proprietors' income is taxed more than once.

Design of the Simulation

The basic procedure for designing the simulation is as follows. Set the flat tax rate equal to its revenue neutral value while defining the business tax base as consumption, less wages and pension contribution, less depreciation of old capital, inventories and NOLs. Set the corporate income tax rate equal to zero. Set the personal average tax rate equal to the revenue neutral flat rate while simultaneously redefining the personal tax base to exclude asset income, capital gains and the aggregate family allowance. Set equal to zero the marginal personal tax rates on interest, dividends and capital gains. And, finally, set the personal tax rate on wages equal to the flat rate; the initial rise in price handles the taxation of fringe benefits and the loss of the payroll tax deduction. There are, however, other elements of design, most of which were suggested by the Committee, that warrant special mention.

All government outlays are indexed. As just described, introduction of the flat tax raises the price level. Under current law, the nominal value of most government transfer payments would rise proportionately, protecting the real consumption of entitlements. However, in order to isolate better the partial effects of reforming the tax code, and under the guidelines provided by the JCT, we also raise the nominal values of *discretionary* government outlays to prevent their real value from declining in what would, *de facto,* amount to a contractionary fiscal policy on top of the tax reform. Also, as noted above, the family allowance is indexed to the price level.

The treatment of payroll taxes. In our simulations, one of the ways that workers ultimately pay for the lost deductions of fringe benefits and payroll taxes is via a decline in "pre-tax" real compensation that arises because the imposition of the tax raises the price level relative to the level of nominal compensation. Payroll taxes are based on the nominal straight wage and, given the specification of our Phillips Curve, are not effectively indexed to the price level. Hence, they decline in real value under the VAT. Therefore, a tax rate that is revenue neutral in *real* terms must be set high enough to cover not just the (real) income tax it replaces but the associated reduction in the real value of payroll taxes, too. Ultimately, we decided not to raise our VAT rate the additional one percentage point or so required to cover the initial reduction in real payroll taxes. Instead, we immediately raised the share of labor compensation devoted to wages by an amount sufficient to prevent the decline.

No flat tax at the state & local level. Because the Committee is interested in dynamically scoring changes in the Federal tax code, state & local governments are assumed not to adopt the flat tax. But this limits the potential gain in GDP. In addition, since one of the reasons to adopt the new tax system is to replace the complexity of the income tax, failure to do so at the state & local level means that businesses and firms still have to keep dual records.

Disposition of the endogenous fiscal dividends. At least in our simulations, potential GDP eventually rises and, with it, tax revenues. Given the baseline path of government spending, this creates a "fiscal dividend" the disposition of which significantly effects the long-run outcome of the experiment. For example, if the government consumes the dividend—say, by raising entitlements relative to our baseline—the effect is to drive up the real interest rate, partially undermining the long-run gain in output. If saved by the government, the dividend becomes available to finance additional private sector investments in capital, thereby raising potential output by increasing productivity and boosting the real wage. If government returns the dividend to the private sector by reducing the tax rate, the effect again is to raise potential output, but this time primarily by expanding the supply of labor, not the wage rate. The reason is that, once the flat tax is adopted, changes in the marginal rate no longer effect the user cost of capital, but they do have an impact on the after-tax compensation received by households. The effect on potential output of saving the fiscal dividend could be larger than the effect of lowering the tax rate because doing the latter also encourages current consumption, while doing the former does not.

Fiscal dividends arise at both the federal and the state & local levels. Following the guidelines offered by the JCT, we disposed of the state & local fiscal dividend by gradually raising exogenous components of state & local consumption and transfers, and the federal dividend by gradually reducing the tax rate relative to its statically revenue neutral path. Therefore, at least in our first simulation experiment (see below), government deficits and debt vary little from the baseline by design. We believe, however, that part of the reason for reforming the tax code is to generate a dynamic fiscal dividend that government would save in anticipation of the coming entitlement crunch. Probably, politicians would let the extra growth help shrink the deficit.

Assumed monetary responses. We ran our experiment two ways. In the first, we initially raised the level of the exogenous nominal monetary aggregate (in this case, nonborrowed reserves plus extended credit) proportionately with the initial rise in the price level. Thereafter, in the "out years" of the simulation, we judgmentally varied reserves to steer the economy back towards the baseline path of the unemployment rate. This guarantees that any change in GDP that emerges in the long-run can be correctly interpreted as a change in *potential* output. The results of this experiment are reported in Figures 1 through 4.

In the second experiment, we again initially raised the level of reserves proportionately with the initial rise in the price level. Then, we allowed subsequent changes in short-term interest rates to be determined mechanically by a "reaction function" that tends to raise interest rates if growth and/or inflation proceed faster than in the baseline, but tends to lower interest rates if the unemployment rate rises above the model's estimate of the non-accelerating inflation rate of unemployment. In this second experiment, we left all other settings as in the first case, the point being to learn something about the impact of monetary assumptions on not only the short-run dynamic response of the macroeconomy to the tax reform, but also the longer-term change in real GDP. The results of this experiment are reported in Figures 5 through 8.

Experiment No 1: Managed Reserves

The first phase: consumption and housing contract. The aggregate price level immediately (1997) jumps by about 3.5%. While real personal disposable asset income rises with the elimination of personal taxes on interest, dividends and capital gains, overall real disposable income falls because of the taxation of fringe benefits and payroll contributions. This works to reduce consumption demand, as does the shift in disposable income away from labor sources where the marginal propensity to consume is relatively high. Since old capital is granted transitional tax relief, net worth rises sharply as rising equity values offset falling housing wealth. On balance, however, consumption comes under immediate downward pressure. The same is true of residential investment, where the effect of declining income is powerfully re-enforced by a sharp rise in the after-tax cost of single-family (i.e., owner-occupied) housing that arises because neither mortgage interest nor property taxes are deductions under the flat tax. The cost of nonresidential fixed investment falls sharply, but given the putty-clay nature of capital, the dominant near-term effect is a negative "accelerator" associated with the decline in consumption and residential investment. Consequently, even business fixed investment initially declines. As a result, in the second year real GDP has fallen about 2% below the baseline value, and the unemployment rate has risen about a percentage point above its. The pre-tax real interest rate initially is largely unchanged because of the initial increase in reserves.

The second phase: a boom in net investment. Next, the economy recovers, powered by a large increase in net investment spending arising from the initial decline in the user cost of business capital, particularly from 2000 through 2002. In 2001, real GDP is 4.7% above its baseline value, and the unemployment rate falls to 2.4%, four percentage points below the baseline. Prices accelerate, rising nearly 10% above the baseline as the pressure to produce capital goods drives up wage costs faster than the resulting rise in capacity (and hence productivity can) can lower them.

The third phase: towards the steady-state. The boom in net investment gradually diminishes, unemployment rises back towards the baseline, and thereafter monetary policy is used to keep the unemployment rate close to its baseline path. The gradual increase in potential output becomes increasingly easy to discern. By 2025, with the unemployment rate basically identical to its baseline value, real GDP is over 5.4% higher; 1.7 percentage points of that comes about via an expansion of the labor force encouraged by an increase in the real after-tax wage. The rest is in productivity, which has risen thanks to a 26% increase in the stock of nonresidential fixed capital. Potential output is still rising modestly at the end of the simulation because the tax rate is gradually declining to give back the endogenously generated federal fiscal dividend. This is encouraging a slight expansion of the civilian labor force. Note, however, that a sustained increase in the labor force does not emerge until well into the simulation. This is because, with relief for old capital, initially the flat tax rate is set above the baseline value of the marginal tax rate on wages; furthermore, real compensation initially is under downward pressure from the new taxation on fringes and payroll taxes. All this encourages an initial contraction of the labor supply. Later, as the flat rate gradually declines and as the real wage rises relative to the baseline, the labor force does expand. The real after-tax interest rate has increased 63 basis points; the real before tax rate of return has declined 109 basis points. As productivity rises, the price level gradually drifts down and, by the end of the simulation is 4.1% above the baseline—not much different than immediately after the initial rise.

Note that this experiment does not show a big gain in revenue. This is by design, since we were instructed by the Tax Committee to lower the flat tax rate below the statically revenue neutral rate (if necessary) in order to maintain the real federal deficit close to its baseline value. Therefore, any "dynamic revenue gain" shows up not as a reduction in the deficit, but as a gradual reduction of the flat tax rate relative to its statically revenue neutral value (see "disposition of the fiscal dividend", above). For example, in this simulation, the flat rate is eventually reduced to 16.4% in the year 2025, two full percentage points lower than the statically revenue neutral value of 18.5%

Experiment No 2: A Reaction Function

In this experiment, the reaction function was allowed to determine the evolution of interest rates. We do not argue that the policy rule, which was estimated from past Fed behavior, describes accurately how the Central Bank would actually conduct monetary policy upon the replacement of the income tax with the flat tax. Rather, the purpose of this experiment is to investigate whether and how much the conduct of monetary policy affects the outcome of the simulation over a period even as long as twenty-five years.

The main thrusts of the simulation are similar to those described in the first experiment: an initial contraction of output centered on consumption and housing, followed by a boom in investment and then a more gradual easing towards a new steady-state. However, with the reaction function activated, the paths of output and the interest rate resemble an oscillating sine wage that is gradually damped. What is most interesting, however, is that the average level of the interest rate is considerably higher in this experiment than in the first one, primarily because the reaction function "leans" very hard against the spurt of growth and inflation, as well as the decline in the unemployment rate, caused by the boom in net investment.

The implications of this are pretty startling. For one thing, the gain in potential output over the period is significantly reduced. Consider, for example, GDP in 2018, a year during which, in both of our experiments, the unemployment rate just equals its baseline value. When monetary policy was conducted by managing reserves, the resulting increase in actual (and potential) output was 3.9%. Under the reaction function, the corresponding rise in GDP is a much smaller 1.7%. The budgetary impact is even more eye-popping. With comparatively lower GDP and comparatively higher interest rates, the deficit and the debt in this simulation run much higher than in our first experiment. For exactly the same tax and spending rates that held the deficit very close to its baseline value in our first experiment, here the federal deficit in 2025 is $450 billion bigger than in the baseline.

Some Concluding Thoughts

Our experiments shed some light on two issues. *First,* what longer-term macroeconomic gains might be realized from reforming the tax code? And, *second,* what, if anything, can be said about the prospects for dynamic scoring?

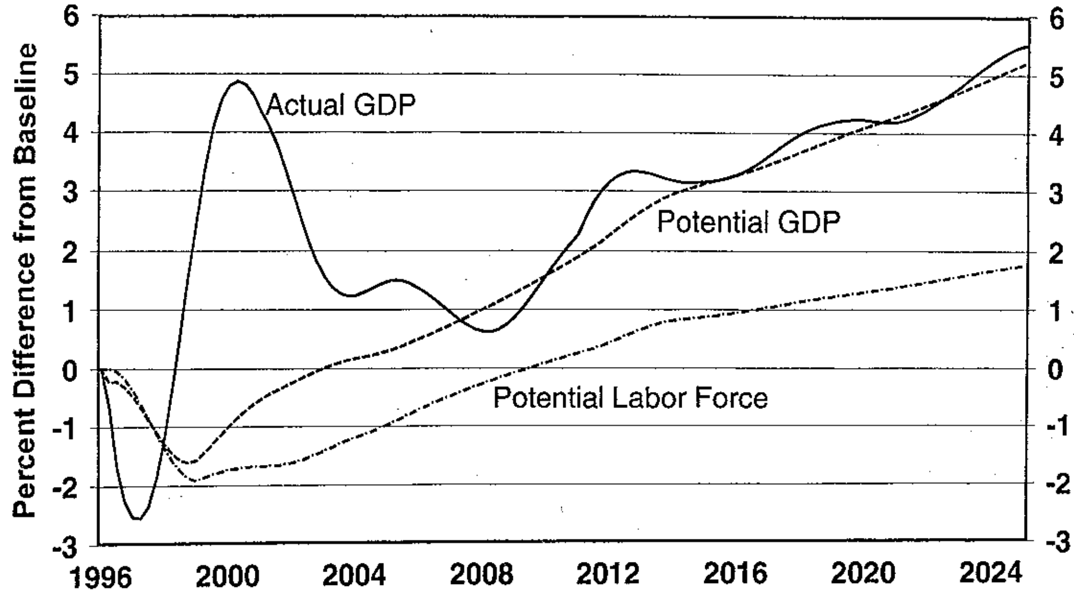
After participating in this symposium and having a chance to interact with all the other modelers for almost a year, it seems pretty clear to us that there exists broad agreement that switching to a consumption based tax will raise potential output. There is, however, uncertainty over the exact size of the gain. Most of this uncertainty comes from differences of opinion about the elasticities of saving, investment and labor supply with respect to changes in the tax code, and the "openness" of the US economy. But the estimated impact also depends crucially on how simulations are designed. Questions like what to assume about the conduct of state & local governments, what to do with the fiscal dividend, whether to grant transitional relief to old capital, how generous to make the family allowance, and how to manage the monetary response, all can make an important difference on the eventual outcome. While we are not uncomfortable presenting a simulation showing a 5% increase in GDP over a quarter of a century, we could use our model in an equally reasonable manner but with a different set of "design assumptions" to show a result that was either considerably larger or somewhat smaller. In this regard, policy makers wanting a single answer are bound to be disappointed.

When it comes to dynamic scoring, we wonder whether it is really practical. Perhaps some of my fellow participants in this symposium disagree, but my sense is that the equilibrium-type models represented at this symposium—which treat the price level as a numeraire with no real role for monetary policy, never show any unemployment, don't always specify whether a "period" is a quarter, a calendar year, a fiscal year, or a decade, may not distinguish between federal and state & local government, sometimes don't have government debt, usually don't have a rest-of-world, and seldom have the kind of detail on personal and corporate income and taxes that scorers are accustomed to using—cannot prove very helpful for scoring a detailed tax bill over a five or ten year window.

An econometric model like WUMM, which also is an equilibrium model in the long run, may seem better suited to that task but nonetheless presents difficulties of it own. It may not have all the buttons required to simulate particular tax proposals, and so might have to be frequently re-designed. Any change in taxes that deviates substantially from historical experience calls into question the relevance of the model's empirically estimated dynamics. The short-term disequilibrium nature of the model means that one must decide whether to score based on changes in actual income(probably not a good idea) or potential income (a better idea). Furthermore, in a model like ours, it is impossible to score a fiscal policy without making explicit a set of monetary assumptions—a problem that cannot be circumvented entirely by focusing on just potential output since, as our results here make clear, even over fairly long periods of time monetary policy can influence that, too.

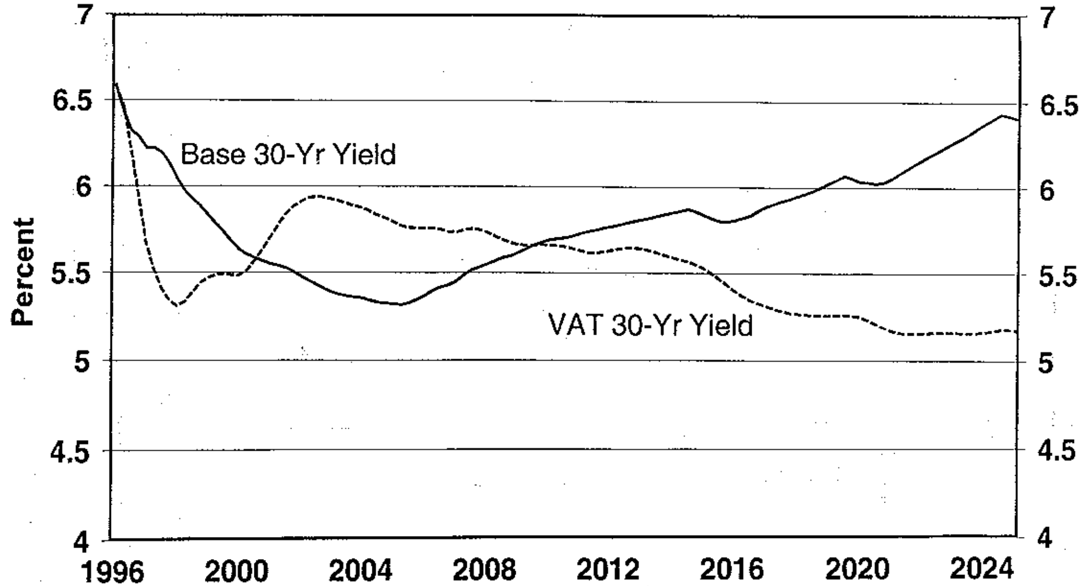
Then there are the larger, more philosophical questions. Whose model(s) based on which macro paradigm will be used? Who will make that decision? Will the models used tend to change with the political persuasions of those running Congress. Who will actually manipulate the models? The staffs at CBO and the various tax and budget Committees? Over the years, my experience with these staffs, several of which use WUMM, has been overwhelmingly positive. But these folks have lots of other things to do, so it stands to reason that they do not understand our model as thoroughly, and hence cannot use it as effectively, as we do and can. Will the scoring work thus be contracted out to us, and on what terms? How fast a turnaround is expected, or even possible? All these considerations suggest to us that dynamic scoring be approached cautiously as a cost/benefit problem. Static scoring is wrong, but has advantages: it can be done relatively quickly, and with relatively little potential for political manipulation. For all of its appeal, dynamic scoring will prove wrong, too. The relevant question is, more wrong? And, if not, is it better enough to warrant opening up its special can of worms?

FIGURE 1. IMPACT OF BIFURCATED VAT:
Accommodative Monetary Policy



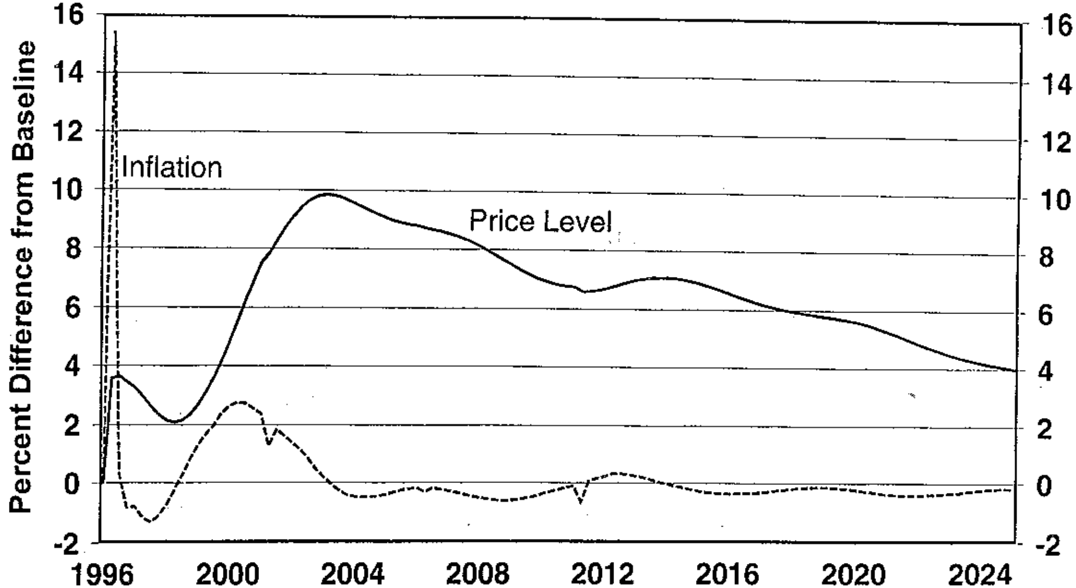
Source: Macroeconomic Advisers, LLC

FIGURE 2. IMPACT OF BIFURCATED VAT:
Accommodative Monetary Policy



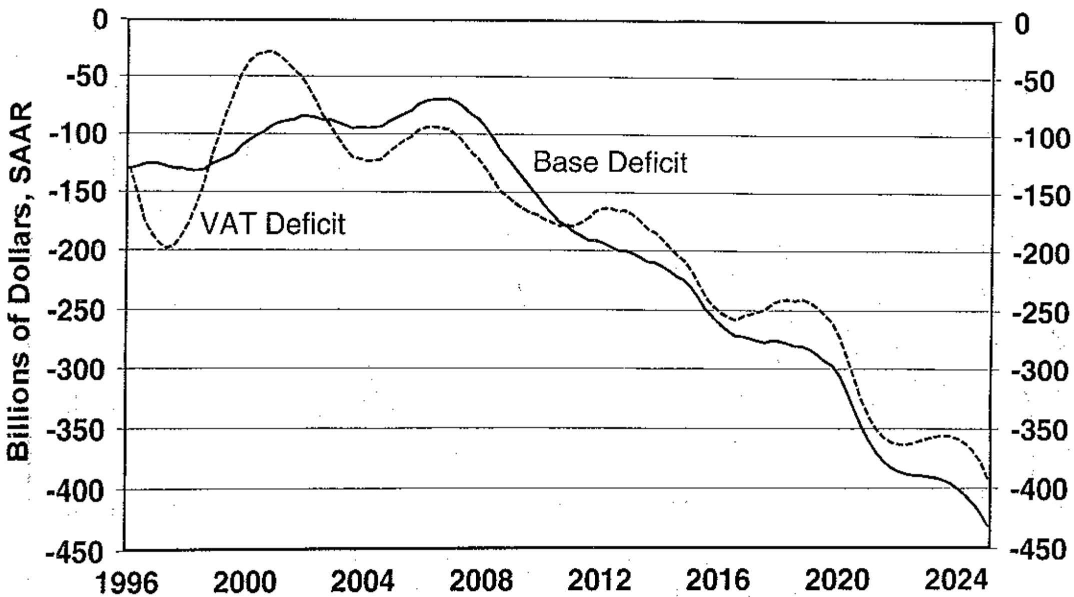
Source: Macroeconomic Advisers, LLC

FIGURE 3. IMPACT OF BIFURCATED VAT:
Accommodative Monetary Policy



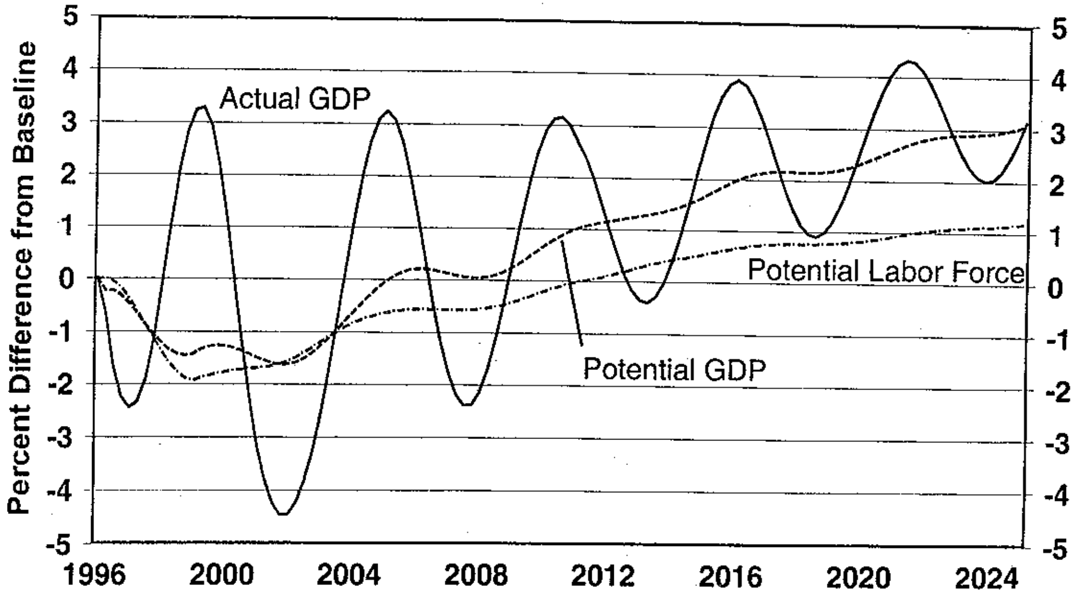
Source: Macroeconomic Advisers, LLC

FIGURE 4. IMPACT OF BIFURCATED VAT:
Accommodative Monetary Policy



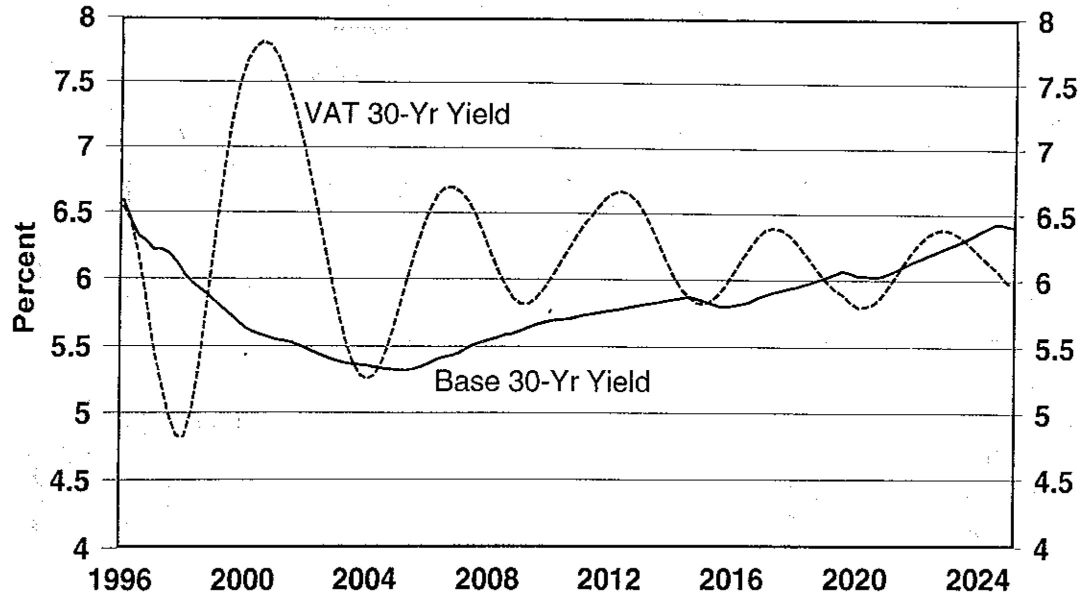
Source: Macroeconomic Advisers, LLC

FIGURE 5. IMPACT OF BIFURCATED VAT:
Monetary Reaction Function



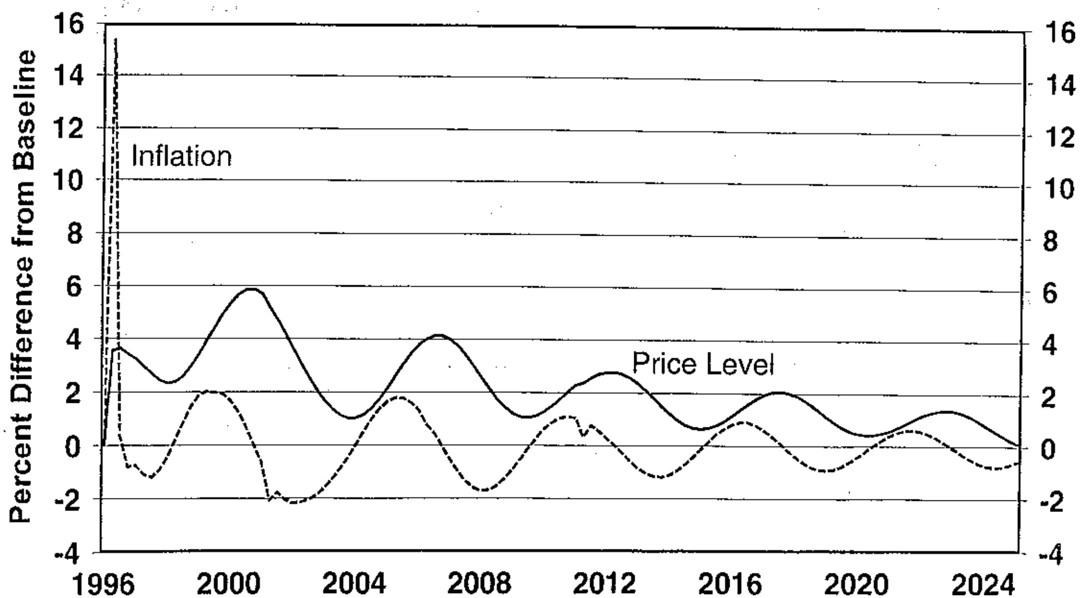
Source: Macroeconomic Advisers, LLC

FIGURE 6. IMPACT OF BIFURCATED VAT:
Monetary Reaction Function



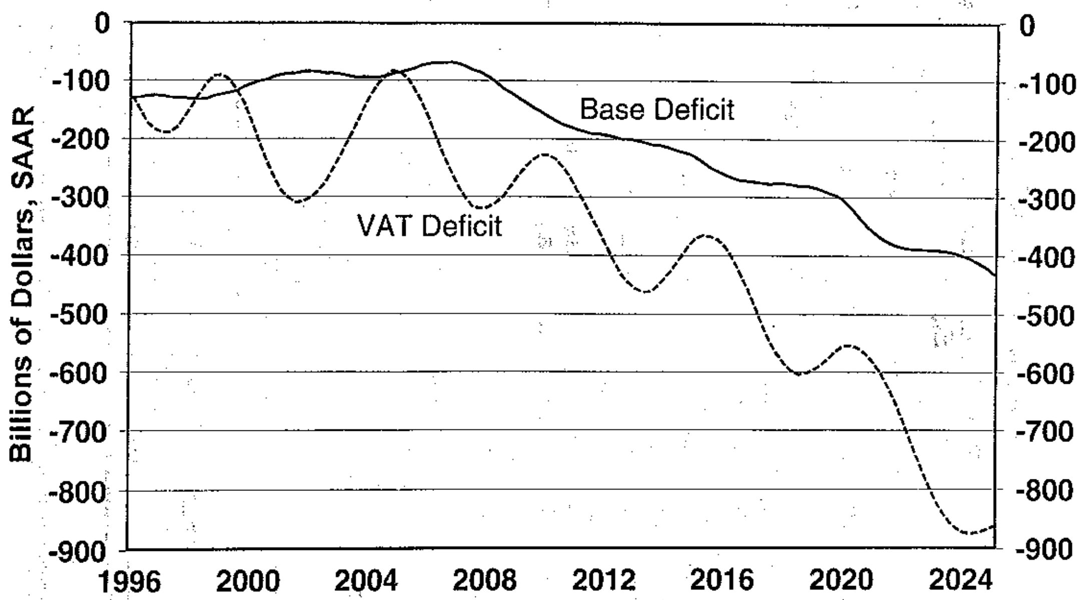
Source: Macroeconomic Advisers, LLC

FIGURE 7. IMPACT OF BIFURCATED VAT:
Monetary Reaction Function



Source: Macroeconomic Advisers, LLC

FIGURE 8. IMPACT OF BIFURCATED VAT:
Monetary Reaction Function



Source: Macroeconomic Advisers, LLC

2. Gary and Aldona Robbins*

"Tax Reform Simulations Using the Fiscal Associates' General Equilibrium Model"

I. Description of the Fiscal Associates' Model

We have developed a general equilibrium, neoclassical model of the U.S. economy that incorporates the effects of taxation.[1] A change in the tax system first alters incentives (or prices) to work, save and invest. Second-round effects, which are responses to price changes, produce changes in capital formation, labor participation, employment, output, growth and income. Changes in economic activity affect tax bases and, therefore, government revenue.

The model consists of seven major sectors: (1) production of private business output; (2) the labor market; (3) output of owner-occupied housing; (4) the price of land; (5) government revenues; (6) government spending and (7) household budget allocation. Brief summaries of these sectors follow along with the most important empirical equations.

Data for the Model

Constructed measures of income, output and the stocks of capital in real dollars along with tax rate information form the basis for the model. Briefly, we:

- Rearrange the national income and product accounts from the Commerce Department into five producing sectors: private business, households and institutions, owner-occupied housing, government enterprises, and general government. The price deflator for private business output translates nominal accounts into real dollars.
- Use a perpetual inventory method of accumulation which assumes geometrically declining efficiency to construct the stocks of capital. Basic data come from Commerce investment measures.
- Calculate average and marginal tax rates using a micro Tax Model.[2] Corporate taxes are modeled using a separate tax calculator which relates statutory tax parameters to reported taxable income and tax liabilities.

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*Gary Robbins is President of Fiscal Associates and John M. Olin Senior Research Fellow of the Institute for Policy Innovation. Aldona Robbins is Vice President of Fiscal Associates and Bradley Senior Research of IPI.

[1] For more discussion of the model see Gary and Aldona Robbins, *Account for Growth: Incorporating Dynamic Analysis into Revenue Estimation*, Lewisville, TX: Institute for Policy Innovation, TaxAction Analysis, Policy Report No. 138, July 1996.

[2] For detail see Gary and Aldona Robbins, *Cooking the Books: Exposing the Tax and Spend Bias of Government Forecasts*, Lewisville, TX: Institute for Policy Innovation, TaxAction Analysis, Policy Report No. 129, February 1995 and *Looking Back to Move Forward: What Tax Policy Costs Americans and the Economy*, IPI Policy Report No. 127, September 1994.

Sectors of the Model

(1) Production of Private Business Output

The largest and most important sector of the economic model is devoted to the production of private business output, which accounts for over three-fourths of the U.S. economy. Modeling how the private business sector operates requires describing the following: (1) how output is produced; (2) the amount of capital services that are used and their compensation and (3) the amount of labor services used and their compensation. The discussion that follows describes how our model handles these relationships.

The Production Function

Our model uses the Cobb-Douglas production function which tracks the output of the U.S. economy extremely well during the postwar period.[3] Inputs are combined in constant proportions or shares to produce output which empirical evidence shows to be two-thirds for labor and one-third for capital.

Technology

In addition to factor inputs, output also depends upon *technology*. Production functions commonly view technology as progressing at a constant rate and, therefore, *exogenous*, or outside the system. Our measure of technology tends to grow relatively smoothly over time, with a simple trend term explaining about 98.6 percent of technological change.

However, statistical evidence supports the notion that technology is not totally exogenous but depends on capital formation. Specifically, faster replacement of equipment (machines, computers, etc.) leads to faster application of new technology.[4] This finding, shown in the equation below, has been incorporated into our model. It means that higher rates of investment in equipment will increase output and growth above and beyond the increased availability of capital services.

Equation: Estimated Multi-factor Productivity Index

$$\mathbf{T=0.01139+0.79395\ ((Ice+Ine)/(Kce+Kne)-(Ice_{-1}+Ine_{-1})/(Kce_{-1}+Kne_{-1}))+T_{-1}}$$

(4.904) (5.186)

where **T** is the technology index, **Ice** and **Ine** are corporate and noncorporate investment in producers' durable equipment, and **Kce** and **Kne** are the stocks of corporate and noncorporate producers' durable equipment. T-statistics for the two estimated coefficients are shown in parentheses below. The equation, which indicates that total factor productivity increases faster during periods of more rapid accumulation of equipment, explains over 99 percent of

[3] The Cobb-Douglas production function is mathematically represented as $Q = A * L^{al} * K^{1-al}$ where Q is output, A is the technology term, L is labor, K is capital and *al* is labor's share of output. The model calculates a fixed *al* at each point in time to be consistent with historical or baseline data.

[4] Adding the rate of investment in equipment to trend significantly enhance the explanatory power of the equation. Investment in structures did not have any significant effect on explaining technical change. Experiments relating technology to all producers' fixed investment yields inferior results.

the variation in the technology index. However, this speed up or slowdown does not affect the long-term growth rate of technology because changes in the current period will eventually be offset later on.

Aggregate Capital Factor Input

The production function estimated in the model condenses the various types of capital (discussed below) into one aggregate input in the form of an index.[5] This structure maintains the characteristics of the production function. That is, the marginal value product of each individual input is consistent with its total compensation; there are constant returns to scale and diminishing returns to increasing one factor while holding all others constant.

Capital Demand Equations (Service Prices)

The demand for capital depends upon the costs of using its services. Capital costs, however, present measurement problems. Labor costs are relatively easy to measure because workers are paid for services provided at a point in time. In contrast, capital is usually sold as a unit, such as a generator, which provides a flow of services over several accounting periods.

A service or rental price translates the up-front cost and multi-period flow of services into a cost per period comparable to the wage rate for labor. For those assets with an active rental market the measurement of the service price is simply the cost of renting the asset. While there is such a market for most assets, the data is not systematically collected. We instead must infer the service prices by assuming that the payment is sufficient to cover all the costs associated with a particular investment—taxes, replacement of lost capacity and a normal return on the investment. The replacement of lost capacity can be calculated directly from the perpetual inventory accumulation.

We define the service price as an imputed measure of the cost of renting a specific type of capital for one period. Components of the service price are the normal return paid to the owners of capital, replacement costs and taxes on capital.[6]

Taxes on capital include personal income taxes on dividends, net business income, rental income, and interest; corporate income taxes and property or wealth taxes. The appropriate taxes on a particular type of capital are those on an additional unit of capital. That is, taxes must be expressed through a *marginal* rate. Furthermore, taxes on capital must include those imposed at all levels of government. Finally, taxes on capital must take into account the effects of tax depreciation.[7]

Some capital services are more costly than others. For example, equipment tends to have higher service prices than structures be-

[5] The index weights the logs of the measures of each stock by the share of total gross capital income imputed to that capital type. This treatment is identical to that given labor's share (*al*).

[6] For a technical derivation of the service price see Gary Robbins and Aldona Robbins, *Eating Out Our Substance (II): How Taxation Affects Investment*, Lewisville, TX: Institute for Policy Innovation, TaxAction Analysis, Policy Report No. 134, November 1995.

[7] We have developed marginal tax rates for capital under the major types of tax systems for both federal and state and local governments using our micro tax models. We also have constructed the present value of depreciation deductions for business income taxes.

cause equipment must be replaced much sooner. Tax effects also vary by type of capital.

To account for these differences, the economic model splits private business capital into the following six types of assets for the corporate and noncorporate sectors: equipment; inventories; nonresidential structures; nonfarm land; residential structures and farm land.

The twelve service price equations in the model are based on the equity-financed return to an individual investor. We use equity-financing because it is impossible to measure the cost of debt-financed investments accurately. As investment financing through debt increases, the lender will charge higher interest rates. Because the investor will adjust his financing to bring equity and debt financing costs into balance, we simply measure the equity-financed.

The appropriate marginal investor is the individual. While there are a number of different paths through which funds can be raised, the household sector is ultimately the only one which can expand the investment pool.

In general, the service price is a cash flow relationship. We have constructed each type of capital so that the discounted, aftertax cash flow from a marginal investment exactly equals the cost of the investment.

Each service price equation is expressed in terms of known tax parameters and an, as yet, undefined rate of return. Corporate and noncorporate rates of return for capital differ by a risk premium associated with the unincorporated sector. We measure the gross capital return to the corporate and noncorporate sectors. Using the service price equations, the stocks of each type of capital, gross capital return in the two sectors, and tax rates, we can solve for the rate of return to capital and the noncorporate risk premium.

Factor Income Equations

Factor incomes from the private business sector are derived from the first-order conditions for profit maximization. Labor compensation is determined by private business output less indirect taxes on output plus subsidies to private business. Capital income is determined by the remaining share of factor income. The amount of income going to corporations is determined by the service prices of corporate capital and the amount of each type of corporate capital.

Equilibrium Capital Stocks and Capital Cost Equations

The service price, along with the production relationship, determines how much capital businesses want to use. If the service price increases, due to higher taxes or replacement costs, businesses will want to hire less capital. If the service price goes down, businesses will want to hire more capital.

The supply of capital depends upon the *long-run*, normal return paid to owners of capital after inflation, replacement costs and taxes on capital. Empirical evidence shows that this real, aftertax rate of return to capital is virtually constant over time. An increase in the real aftertax return, caused by say a decrease in taxes, will induce investors to supply more capital until the return goes back down to its long-run level. Conversely, a decrease in the real aftertax return, caused by say an increase in taxes, will cause investors to cut back their investments until the return goes back up to its equilibrium value.

However, in the real world, adjustments to the stock of capital do not occur instantaneously. Businesses generally have to wait before new plant or equipment can be brought on line. Our model incorporates these delays using evidence from the past 35 years. For example, we find that only 20 percent of equipment orders from corporations can be filled within 365 days. Depending upon the type of capital, adjustments can take from two to ten years with an average of three years.[8]

The level of capital is determined by a stock adjustment process which relates the current service price of capital to its long-run cost. The *long-run cost of capital* is the service price formula evaluated at the average long-run rate of return. We used quarterly data to approximate the pattern of capital adjustment and then translate it into an annual pattern. The annual pattern is then used to estimate an annual adjustment equation.

The equation for corporate producers' durable equipment (PDE) shown below illustrates how the stock adjustment process was estimated. The measure of the desired stock of corporate PDE in the current period is total compensation to corporate PDE (ycexKce) divided by the long-run cost of corporate PDE (yce'). The term, **(yce(−1)xKce(−1))/yce'(−1)**, was the desired capital stock a year ago, **(yce(−2)xKce(−2))/yce'(−2)** two years ago, and so forth.

The coefficients on each of these terms represents how much of the desired stock of corporate PDE can be delivered in each time period. For example, the coefficient 0.22647 on the current period means that 22.6 percent of the change in the desired stock can be delivered within a year. Adding the second coefficient, 0.15816, to the first indicates that 38.5 percent of the change in the desired stock can be delivered in two years. Completing half the adjustment process takes about three years.

Equation: Estimated Stock of Corporate Producers' Durable Equipment

$$\mathbf{Kce = cKce + (.22647'yce'Kce/yce') + (.15816'yce(-1)'Kce(-1)/yce'(-1)) + (.11682'yce(-2)'Kce(-2)/yce'(-2)) + (.09592'yce(-3)'Kce(-3)/yce'(-3)) + (.08892'yce(-4)'Kce(-4)/yce'(-4)) + (.08927'yce(-5)'Kce(-5)/yce'(-5)) + (.09045'yce(-6)'Kce(-6)/yce'(-6)) + (.08592'yce(-7)'Kce(-7)/yce'(-7)) + (.06912'yce(-8)'Kce(-8)/yce'(-8)) + (.03354'yce(-9)'Kce(-9)/yce'(-9))}$$

where **Kce** is the stock of corporate producers' durable equipment (PDE), **yce** is the service price of corporate PDE, and **yce'** is the long-run cost of corporate PDE.

The model also allows the mix of capital to change over time. Changing tax policy, which affects some capital to a greater degree than others, will result in different responses by type of asset. For example, because tax depreciation schedules are biased against longer-lived assets, the mix of U.S. capital has moved toward short-

[8] On a weighted average basis, 33 percent of the adjustment occurs in the first year and 58 percent by the end of the second year.

er-lived assets. While allowing the mix to change, the model does keep the opportunity costs between each type of capital equal. In other words, the real aftertax return earned by investing an additional dollar in one type of capital is the same as investing one more dollar in any other type.

Private Business Capital Investment, Replacement and Revaluation Equations

Investment is the process by which the existing stock of capital moves toward the desired stock. In the model, investment occurs recognizing the delay constraints and changing mix discussed above. Private business investment is calculated as the change in each stock plus replacement based on the average rate of replacement.

Because all the stocks and income flows are in real terms, there is no need to revalue the stock of reproducible capital. Land, however, is allowed to change in price which gives rise to land revaluations.

(2) Labor Market

Businesses demand labor based on its compensation. Total compensation consists of the aftertax wage rate that workers must receive to supply labor and the taxes on labor income. As labor costs rise (fall), businesses are less (more) willing to hire workers. The level of labor services demanded is determined by total compensation divided by the real wage rate.

Compensation, or the income going to workers, is the number of hours worked times the total wage rate. Historically, labor's share has held remarkably constant at two-thirds of output.

Workers provide labor services based on their take-home pay after inflation. Higher real, aftertax wage rates mean a greater supply of labor. However, there are constraints on labor supply such as population size which ultimately limits labor force expansion. Incorporating such constraints into the labor supply relationship, we find a considerable initial response to an increase in the aftertax wage rate which subsequently dampens. Based on past labor supply behavior, shown in the equation below, a 10 percent increase in the real aftertax wage rate will increase labor supply by 2 percent in the long run.

Equation: Estimated Labor Hours Worked

$$\ln(\mathrm{Lt})=\mathrm{clt}+.04284'\ln(\mathrm{waft})+.23715'\ln(\mathrm{waft}(-1))+ .10033'\ln(\mathrm{waft}(-2))-.10883'\ln(\mathrm{waft}(-3)-.07933'\ln(\mathrm{waft}(-4)$$

where **Lt** is total hours worked and **waft** is the real aftertax wage rate. The equation explains 98.8 percent of the variation in hours worked. It indicates that a permanent increase in the aftertax wage rate of 10 percent would lead to a 0.5 percent increase in labor supply over the baseline in the first year, a 2.2 percent increase in the second year, a 3.5 percent increase by the third year, and a long-run increase of 3.7 percent.[9]

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[9] The equation was estimated in two steps, similar to the process used to estimate the pattern of capital adjustment. Quarterly data were used to estimate patterns and annual data the over-

Continued

(3) Output of Owner-occupied Housing

This sector of the model determines the rate of return to and the investment in owner-occupied housing. Owner-occupied structures, and the land on which they stand, make up 45 percent of the stock of U.S. capital, the largest share of the twelve types of capital listed above. Furthermore, the special tax subsidy to homeowners, which allows federal income tax deductions for home mortgage interest and property taxes, lowers the service prices on owner-occupied structures and land.

Output of the owner-occupied housing sector follows the development of the private business sector.[10] However, there is no labor component and only two types of capital land and residential structures.

(4) The Price of Land

This part of the model revalues land which is split into farm and nonfarm. Land prices are determined by total demand.[11] Farm and nonfarm prices are constrained to move away from baseline values in the same proportion as land in general. In other words, there is a variable conversion cost between one type of land and the other. Land prices then feedback into the service price relationships in the owner-occupied housing and private business sectors.

(5) Government Revenues

The government revenues sector determines the taxes that affect labor and capital and the revenue received by federal, state and local governments. Taxes imposed at all levels of government include personal income, corporate income, estate and gift, contributions for social insurance and indirect business taxes. Excise and custom duties occur at the federal level while sales and property taxes occur at the state and local level. Also included are the surpluses of government enterprises such as the Federal Reserve, U.S. Postal Service, and Federal Housing Administration.

To simulate a proposed change in tax policy, we must translate that change into its effect on tax rates. Here we are concerned with two types: marginal and effective. As discussed previously, marginal tax rates affect aftertax returns to labor and capital. The effective tax rate is the amount of revenue raised divided by the appropriate tax base. For example, a personal income tax that raised $100 billion on a base of $400 billion would translate into an effective rate of 25 percent.

Government revenues are calculated as the product of an average effective rate and a tax base. Effective rates are determined by the

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all level of response. The quarterly estimating equation relates the number of hours worked divided by the total number of hours available for persons 16 and o9lder, a form of a labor participation rate. Estimated quarterly coefficients were then translated into an annual equivalent using a geometric mean for the year.

Finallym, the annual equation is converted into changes around the baseline path. The constant term **clt** contains information on the baseline paths of population and the real wage rate. As the real wage rate deviates from the baseline, the supply of labor changes.

[10] However, we use a different internal rate of return to owner-occupied housing than that for private business. This reflects the empirical reality that the income measures we are trying to predict are Commerce Department imputations. We were confronted with two options: either allow the two rates to differ or provide our own estimate of the output of the owner-occupied housing sector. We chose the former.

[11] The price of land is the sum of the compensation of each type of land divided by its service price all divided by the number of acres.

historical rate to maintain past relationships between theoretical and reported tax bases. For personal income taxes, our tax calculator is used to calculate the change in aggregate taxes due to a tax change. This change is then used to adjust the baseline tax rate to yield an adjusted aggregate tax.

Simulations of tax changes are done by solving the core real model to provide updated measures of the tax bases in the tax models. The tax models then are used to provide updated measures of marginal and average tax rates in the core model. This process continues until convergence.

This sector also captures dynamic feedback effects. As total economic activity changes so do the tax bases and, therefore, tax revenue.

(6) Government Spending

In general, government spending is assumed to be set by legislation and, therefore, outside the model. Subsidies are treated as negative taxes. For example, if government provides a 10-percent subsidy for low-income housing, the amount of the subsidy increases (decreases) as the level of low-income housing increases (decreases).

Government surpluses or deficits are simply the difference between revenue and spending. Government debt is the accumulation of deficits over time.

(7) Household Budget Allocation

Our definition of household is broader than that of the Commerce Department because we have consolidated the value of land and corporate income and assets into the household allocation process. After households pay taxes, they must then decide how to allocate remaining income between consumption and saving. We use the relationship found in an earlier study on saving and taxation to make that allocation.[12]

Equation: Estimated Private Saving Rate

$$ln(\mathbf{srate})=\mathbf{1.08988'}\ (\mathbf{3n}(\mathbf{rbar})-ln(\mathbf{rbar}_{-1}))+ln(\mathbf{srate}_{-1})$$

(8.303)

where **srate** is the private saving rate and **rbar** is the real aftertax return to savings. The equation shows an elasticity of the private saving rate with respect to the return to savings of slightly over one. The t-statistic for the estimated coefficient is shown below. This equation is a simple difference equation which explains 82 percent of the variation in the saving rate.

We also estimated a more general Cochrane-Orcutt version of the equation and experimented with different sample periods. The estimated elasticities were very close to the one given above. In addition, the results are consistent with prior indirect estimates of the saving relationship employing a consumption function specification.

[12] Updating a 1978 study by Michael Boskin, we found that a 10 percent increase in the aftertax rate of return to capital will result in a 7 to 11 percent increase in private saving. See Gary Robbins and Aldona Robbins, *Eating Out Our Substance: How Taxation Affects Saving*, Lewisville, TX: Institute for Policy Innovation, TaxAction Analysis, Policy Report No. 131, September 1995.

Based on these results we have chosen to use the simple relation above to predict deviation from the baseline saving rate path, assuming an elasticity of one.

Using historical relationships, we further divide consumption into the output of the major producing sectors, that is, owner-occupied housing, households and institutions, government enterprises and private businesses. This information combined with the level of investment, government surpluses or deficit and output from previously described parts of the model allows us to derive the levels of net exports and net foreign investment, thereby completing the model.

Key Behavioral Assumptions

Assumptions of any model are key to the resulting outcomes. For example, if one assumes that employees will not change their hours worked if their take-home pay goes up or down, one should not be surprised to find that this model would predict no economic effects from increasing payroll tax rates. Although discussed as part of the model description, we reiterate the assumptions key to our model, or to any other for that matter that attempts to assess the effect of taxes on the economy.

(1) Labor and Capital Combine to Produce Private Output

As discussed above, we use a Cobb-Douglas production function to represent how labor and capital are combined to produce output. More labor and more capital result in more output. As the rewards to labor and capital increase, workers and investors are willing to increase their respective supplies.

(2) The Responsiveness of Labor

We assume that workers supply labor based on aftertax wage rates. Specifically, in deciding whether to work one more hour, workers evaluate how much of the additional wages they can take home after taxes and inflation. As such, what matters are *marginal* tax rates, not average. As discussed above, our examination of historical data suggests that the responsiveness, or elasticity, of labor supply is between 0.2 and 0.4. We have used 0.2 for this study, that is, a 10 percent increase (decrease) in the aftertax wage rate will increase labor supply by 2 percent.

(3) The Responsiveness of Investment

We assume that investors supply capital based upon the *long-run,* normal return paid to owners of capital after inflation, replacement costs and taxes. Again it is tax rates at the margin that matter.

We find that the real aftertax return to capital has been extremely stable, averaging 3.7 percent from 1954 through 1994 with a standard deviation of 0.5 percent. [See Figure 1.] More important, this stability has remained despite many substantial changes in investment tax rules. Although tax increases (decreases) temporarily caused the real aftertax return on capital to increase (decrease), adjustments in the stock of capital brought the rate of return back to its average level within five years. In short, the supply of capital behaves as if it is infinitely elastic over a period of 5 to 10 years.

A constant real aftertax return to capital implies that adjustments to the stock of capital occur through increases in domestic saving and through adjustments in the placement of capital worldwide. Experience of the last 45 years shows that a 10 percent increase in the real aftertax return to capital will produce a similar increase in domestic saving. The reverse is true for a decrease in aftertax return. [See Figure 2.]

Because internal saving is not sufficient to drive the aftertax return back to equilibrium within the observed adjustment period, the remainder must come from changes in international capital flows. Specifically, increases (decreases) in the real aftertax return result in less (more) investment abroad.

More generally, an increase in the rate of return to an asset due to lower taxes on capital in the United States is shared with all other investments even if they are not directly affected by the tax change. For example, suppose there is a tax cut for U.S. citizens who own physical assets in the United States. As they rearrange their portfolios to take advantage of the increased returns on the newly-favored assets, the rate of return on other assets which they liquidate also will increase, making them attractive to investors who can not directly take advantage of the tax change. In other words, a tax change that initially appears limited to the U.S. is in reality shared worldwide. Absent this linkage the real aftertax return to capital would not exhibit the constancy that it has.

Clearly, changes in the ownership mix of capital sited in U.S. has implications for tax collections. Adjustments from abroad, which involve changes in factor payments to foreigners, would be incorporated into U.S. tax bases. Increases in foreign ownership, for example, would lower the portion of dividends paid to U.S. citizens. However, these changes would be small in comparison to the increase in tax bases resulting from the higher growth due to more foreign investment in the U.S.

(4) Other Assumptions

Our model assumes that monetary policy determines the general price level. Simulations done with the model assume that the Federal Reserve will undertake whatever policies are necessary to maintain prices at their baseline levels. While alternative assumptions as to the behavior of the Federal Reserve could be incorporated, this is not normally done by official estimators because their purpose is to allow policy makers to decide among competing tax proposals. Guessing the future of course of monetary policy as a function of alternative tax policies is simply an added complication. We have followed the normal practice.

II. Model Simulation Results

We used the Fiscal Associates Model to simulate the economic effects of the following two proposals:

(1) a flat, unified income tax which brings individual and corporate marginal income tax rates to the same level and eliminates the double taxation of corporate dividends, and

(2) a savings-neutral flat tax which allows expensing for business investment.

Tables at the end of the paper show baseline levels of 30 key economic measures such GDP, stock of capital, hours worked and personal saving under present law for selected years between 1997 and 2010. The tables also show the levels and differences and percent changes from the baseline for three simulations: a savings-neutral flat tax with an open economy; a flat, unified income tax with an open economy and a flat unified income tax with a closed economy. More is said below about the third simulation.

We find that both proposals would boost gross domestic product significantly. The savings-neutral flat tax would increase GDP almost 17 percent over the baseline in 2010, the fourteenth year of the simulation. The unified income tax with an open economy would increase GDP over 15 percent in 2010.

The tax rates necessary to bring revenues into balance on a dynamic basis would be nearly 17 percent for the neutral tax and 15 percent for the unified income tax.

A better than 23 percent increase in the real, aftertax wage rate under both proposals would increase hours worked by 4.3 percent in 2010. This result implies a long-run labor supply elasticity of 0.18.

While more jobs and higher wages explain most of the boost in GDP, the total stock of U.S. capital would increase substantially. Under the unified income tax with an open economy the stock of capital would be 28 percent greater than the baseline in 2010 and 35 percent greater under the neutral, flat tax. These increases in capital formation are due to an immediate increase in the real aftertax return to capital of 55 percent in the case of the unified income tax and over 70 percent in the case of the neutral flat tax. The adjustment in the stock of capital would bring the real aftertax return almost back to its long-run value by the year 2010.

The simulations hold state and local governments harmless from the effects of federal changes. That is, state and local expenditures and tax revenues are kept at their baseline levels. Extra state and local revenues resulting from higher growth are assumed to be returned to taxpayers through measures such as rebates that would in themselves have no growth effects. If these extra revenues from higher growth were used to reduce marginal state and local marginal tax rates, the increase in GDP growth nationwide would have been one-sixth higher.

As discussed in the previous section, our model assumes an open economy. That is, international capital flows help maintain a stable rate of return to capital. Because our model results rely heavily on this assumption, we were asked to explore the effect of closing the borders to foreign investment. Under this structure, changes in the stock of capital would come about solely through changes in domestic saving."Closing the economy" reduced growth effects by over half. In the case of the unified income tax, GDP would increase by 6.7 percent versus 15.4 percent under an open economy in the year 2010. Hours worked would increase by 2.3 percent versus 4.3 percent, and the stock capital would be 8 percent higher versus 28 percent. However, the less robust adjustment in the stock of capital implies that the real aftertax return would remain 1.5 percentage points higher than its baseline value, or three standard deviations, fourteen years after the tax change.

III. Evaluating the Model's Strengths and Weaknesses for Use in Revenue Estimation

Official revenue estimates generally compare tax revenue for the next seven to ten years under present law and a proposed tax change. Our model is set up to produce the same type of results. It is designed to work off baseline (that is, present law) economic and revenue forecasts. Model simulations estimate changes in the baseline economy and revenues that would occur beginning in the year of the tax change. Model estimates reflect short-run adjustments in key economic variables (labor and capital) based on historical patterns. Short-run adjustments eventually settle down to long-run equilibrium values generally within ten to fifteen years.

Our model contains rich detail on taxes. An individual tax model, similar to that used by Treasury and the Joint Committee on Taxation, provides information on marginal tax rates by income source. Marginal tax rates on capital are derived from information on the tax treatment of over 4,000 types of capital assets. And, the model can easily be adapted to incorporate additional tax information if necessary. As a result, the model can handle tax proposals that are fairly specific, although the economic effects of ones with small revenue effects may not show up in today's $7.5 trillion economy.

Because detailed information on marginal tax rates is an integral part of the model, it can discriminate among different tax proposals. For example, simulation results would be very different for a proposed $100 billion tax cut if that cut were to occur through an increase in the personal exemption versus an across-the-cut in income tax rates versus a reduction in tax depreciation lives.

As discussed earlier, assumptions of any model are key to determining results. The assumptions we use are based on economic theory and historical evidence. Parameter values used in the model have been estimated from data over the last four decades. However, the model can be adjusted to reflect different assumptions as was done in the previous section by assuming that the U.S. economy was closed rather than open to international capital flows.

In sum, we believe that this approach offers the possibility for incorporating dynamic effects of tax policy changes into the routine practice of official revenue estimation.

Figure 1

Real Aftertax Rate of Return to Capital

Evaluated at the Margin

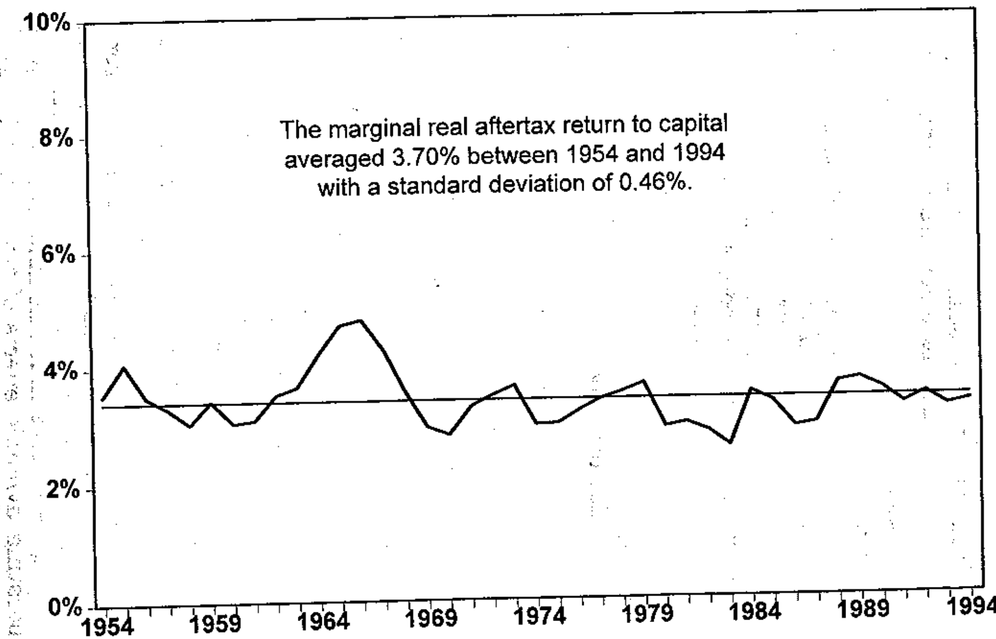
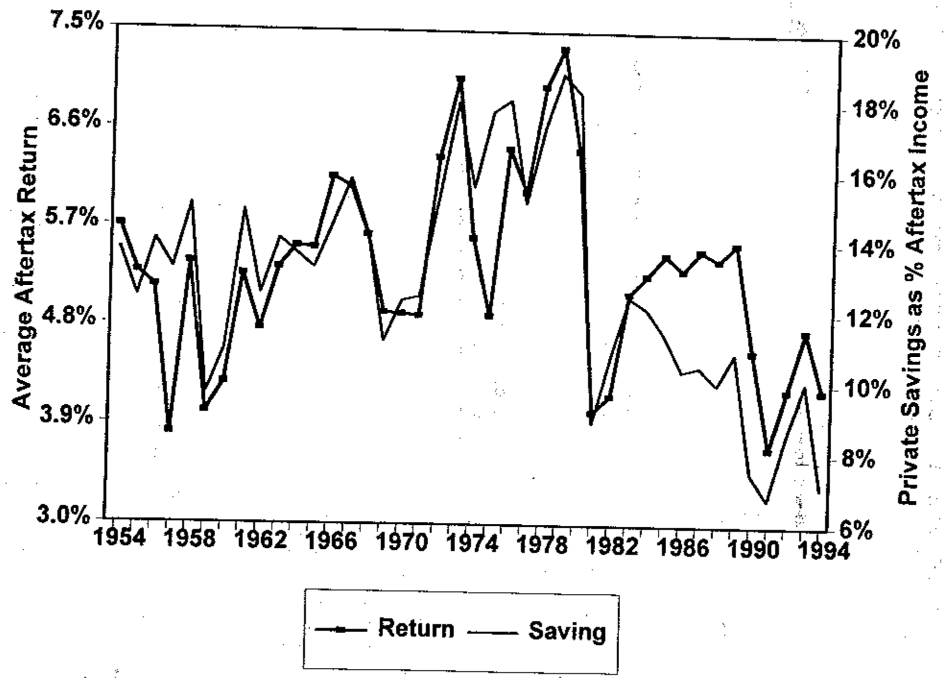


Figure 2

Private Saving Rate and the Return to Capital



Fiscal Associates, Inc. Summary Model Results—Flat Tax vs. Baseline Forecast

	1997	1998	1999	2000	2005	2010
1 Gross Domestic Product ($1987)						
Alternative	6,376.8	6,815.7	7,132.0	7,268.6	8,400.5	9,548.5
Present Law	5,917.7	6,066.2	6,218.6	6,374.4	7,214.9	8,165.6
Difference	459.1	749.4	913.4	894.1	1,185.6	1,382.9
Percent Difference	7.8	12.4	14.7	14.0	16.4	16.9
2 Consumption ($1987)						
Alternative	4,283.4	4,610.6	4,829.8	4,940.6	5,607.3	6,327.0
Present Law	3,924.2	4,024.8	4,132.1	4,244.1	4,869.1	5,568.8
Difference	359.2	585.8	697.7	696.5	738.2	758.2
Percent Difference	9.2	14.6	16.9	16.4	15.2	13.6
4 Net Exports ($1987)						
Alternative	(673.2)	(542.8)	(505.2)	(397.3)	(192.6)	20.6
Present Law	(17.1)	(11.5)	(7.7)	(5.2)	(0.7)	(0.1)
Difference	(656.1)	(531.3)	(497.5)	(392.1)	(191.9)	20.6
Percent Difference	3835	4630	6464	7598	27412	−21734
5 Government Purchases ($1987)						
Alternative	998.7	1,016.9	1,038.1	1,058.4	1,166.7	1,286.9
Present Law	998.7	1,016.9	1,038.1	1,058.4	1,166.7	1,286.9
Difference	(0.0)	(0.0)	0.0	0.0	(0.0)	0.0
Percent Difference	0.0	0.0	0.0	0.0	0.0	0.0
6 Gross private Domestic Investment ($1987)						
Alternative	1,767.9	1,730.9	1,769.3	1,666.9	1,819.1	1,913.9
Present Law	1,011.9	1,036.0	1,056.2	1,077.1	1,179.7	1,309.9
Difference	756.0	694.9	713.1	589.8	639.4	604.0
Percent Difference	74.7	67.1	67.5	54.8	54.2	46.1
7 Total Stock Of Capital ($1987)						
Alternative	18,036	19,310	20,545	21,586	26,124	29,153
Present Law	16,748	17,101	17,456	17,813	19,608	21,583
Difference	1,287	2,208	3,089	3,773	6,516	7,570
Percent Difference	7.7	12.9	17.7	21.2	33.2	35.1
8 Capital Consumption Allowances ($1987)						
Alternative	790.1	895.3	1,011.3	1,133.1	1,727.1	2,340.4
Present Law	790.1	833.1	878.3	924.6	1,174.6	1,488.5
Difference	(0.0)	62.2	133.0	208.5	552.5	851.9
Percent Difference	0.0	7.5	15.1	22.5	47.0	57.2

9 Residential Investment ($1987)						
Alternative	515.0	493.0	478.1	404.8	406.0	400.8
Present Law	283.1	291.0	296.7	302.5	331.1	367.5
Difference	231.9	202.0	181.4	102.3	74.9	33.2
Percent Difference	81.9	69.4	61.2	33.8	22.6	9.0
10 Residential Capital Stock ($1987)						
Alternative	5,990	6,352	6,689	6,947	8,159	9,126
Present Law	5,763	5,925	6,088	6,254	7,099	8,024
Difference	227	427	601	693	1,060	1,102
Percent Difference	3.9	7.2	9.9	11.1	14.9	13.7
11 Residential CCA ($1987)						
Alternative	131.0	140.0	148.5	156.4	185.3	208.5
Present Law	131.0	134.7	138.5	142.3	161.9	183.1
Difference	(0.0)	5.3	10.0	14.0	23.4	25.4
Percent Difference	0.0	3.9	7.2	9.8	14.5	13.9
12 Total Hours Worked						
Alternative	232.9	246.3	253.4	252.9	272.1	294.1
Present Law	231.2	234.7	238.3	241.9	261.1	282.0
Difference	1.7	11.6	15.1	11.0	11.0	12.0
Percent Difference	0.8	4.9	6.3	4.6	4.2	4.3
13 Real Aftertax Wage Rate						
Alternative	$11.37	$11.71	$11.97	$12.18	$13.19	$13.87
Present Law	$9.55	$10.06	$10.12	$10.24	$10.81	$11.26
Difference	$1.82	$1.65	$1.85	$1.94	$2.38	$2.61
Percent Difference	19.1	16.4	18.3	19.0	22.0	23.1
14 Real Pretax Wage Rate						
Alternative	$17.49	$17.68	$17.99	$18.42	$19.91	$21.03
Present Law	$16.42	$16.58	$16.75	$16.91	$17.77	$18.66
Difference	$1.07	$1.10	$1.25	$1.50	$2.14	$2.36
Percent Difference	6.5	6.6	7.4	8.9	12.0	12.7
15 Real Aftertax Return to Capital (Percent)						
Alternative	5.96	5.83	5.55	5.09	4.18	3.92
Present Law	3.48	3.52	3.52	3.51	3.57	3.60
Difference	2.48	2.31	2.03	1.58	0.60	0.31
Percent Difference	71.2	65.5	57.8	45.1	16.9	8.6
17 Private GDP Deflator (Price Level)						
Alternative	1.327	1.361	1.397	1.433	1.628	1.850
Present Law	1.327	1.361	1.397	1.433	1.628	1.850
Difference	0.000	0.000	0.000	0.000	0.000	0.000
Percent Difference	0.0	0.0	0.0	0.0	0.0	0.0

Fiscal Associates, Inc. Summary Model Results—Flat Tax vs. Baseline Forecast—Continued

	1997	1998	1999	2000	2005	2010
18 Government Debt						
Alternative	3,625	3,853	4,099	4,369	6,295	9,216
Present Law	3,625	3,853	4,099	4,369	6,295	9,216
Difference	0	0	0	0	0	(0)
Percent Difference	0.0	0.0	0.0	0.0	0.0	0.0
19 Federal Surplus or Deficit (−),						
Alternative	(190.2)	(189.3)	(203.4)	(221.4)	(365.8)	(545.2)
Present Law	(190.2)	(189.3)	(203.4)	(221.4)	(365.8)	(545.2)
Difference	(0.0)	0.0	0.0	(0.0)	(0.0)	(0.0)
Percent Difference	0.0	0.0	0.0	0.0	0.0	0.0
20 Net Federal Interest Paid						
Alternative	255.3	263.6	277.0	293.4	391.7	522.9
Present Law	255.3	263.6	277.0	293.4	391.7	522.9
Difference	0.0	0.0	0.0	0.0	0.0	(0.0)
Percent Difference	0.0	0.0	0.0	0.0	0.0	0.0
21 New Federal Income Tax Base						
New Base	3,288.6	3,419.0	3,560.6	3,529.1	3,874.7	4,374.5
Revenue	586.8	577.6	581.1	598.3	645.4	730.0
23 Labor Compensation						
Alternative	5,405.2	5,925.6	6,366.1	6,674.4	8,822.8	11,439.6
Present Law	5,035.4	5,297.3	5,572.9	5,862.5	7,555.2	9,739.1
Difference	369.8	628.4	793.3	811.9	1,267.6	1,700.6
Percent Difference	7.3	11.9	14.2	13.8	16.8	17.5
24 Federal Government Receipts less Contributions for Social Insurance						
Alternative	937.9	961.3	999.8	1,054.5	1,310.6	1,684.3
Present Law	982.6	1,036.7	1,095.0	1,152.0	1,462.6	1,888.1
Difference	(44.6)	(75.4)	(95.2)	(97.5)	(152.0)	(203.8)
Percent Difference	-4.5	-7.3	-8.7	-8.5	-10.4	-10.8
25 Federal Contributions for Social Insurance						
Alternative	690.2	756.7	812.9	852.3	1,126.6	1,460.8
Present Law	643.0	676.4	711.6	748.6	964.8	1,243.6
Difference	47.2	80.2	101.3	103.7	161.9	217.2
Percent Difference	7.3	11.9	14.2	13.8	16.8	17.5

26 New Federal Income Tax Rate						
Rate (percent)	17.84	16.89	16.32	16.95	16.66	16.69
27 Net receipts of factor income						
Alternative	(10.0)	(38.5)	(62.9)	(86.8)	(189.8)	(246.4)
Present Law	(10.0)	(10.3)	(10.5)	(10.8)	(12.1)	(13.7)
Difference	0.0	(28.3)	(52.4)	(76.1)	(177.7)	(232.7)
Percent Difference	0	275	498	706	1464	1703
28 Net foreign investment ($1987)						
Alternative	(711.6)	(610.0)	(597.2)	(513.7)	(414.0)	(259.8)
Present Law	(55.5)	(50.5)	(47.3)	(45.5)	(44.4)	(47.7)
Difference	(656.1)	(559.5)	(549.8)	(468.2)	(369.6)	(212.1)
Percent Difference	1182	1108	1161	1030	832	445
29 Gross Private Savings ($1987)						
Alternative	1,175.0	1,239.7	1,297.4	1,287.4	1,608.9	1,927.6
Present Law	1,075.1	1,104.3	1,134.2	1,165.3	1,339.1	1,535.6
Difference	99.9	135.3	163.3	121.6	269.8	392.0
Percent Difference	9.3	12.3	14.4	10.4	20.1	25.5
30 Personal Saving ($1987)						
Alternative	456.0	435.9	420.4	347.1	402.9	518.6
Present Law	323.4	329.0	334.8	342.8	414.7	499.1
Difference	132.6	106.9	85.5	4.2	(11.8)	19.5
Percent Difference	41.0	32.5	25.5	1.2	-2.8	3.9

Fiscal Associates, Inc. Summary Model Results—Flat Unified Income Tax vs. Baseline Forecast

	1997	1998	1999	2000	2005	2010
1 Gross Domestic Product ($1987)						
Alternative	6,268.9	6,669.7	6,970.7	7,134.1	8,268.7	9,426.4
Present Law	5,917.7	6,066.2	6,218.6	6,374.4	7,214.9	8,165.6
Difference	351.3	603.5	752.1	759.6	1,053.8	1,260.8
Percent Difference	5.9	9.9	12.1	11.9	14.6	15.4
2 Consumption ($1987)						
Alternative	4,059.6	4,425.9	4,683.1	4,804.3	5,533.3	6,290.4
Present Law	3,924.2	4,024.8	4,132.1	4,244.1	4,869.1	5,568.8
Difference	135.4	401.1	551.0	560.2	664.2	721.6
Percent Difference	3.5	10.0	13.3	13.2	13.6	13.0
4 Net Exports ($1987)						
Alternative	(204.4)	(475.9)	(408.3)	(299.7)	(176.6)	(1.1)
Present Law	(17.1)	(11.5)	(7.7)	(5.2)	(0.7)	(0.1)
Difference	(187.2)	(464.5)	(400.6)	(294.5)	(175.9)	(1.0)
Percent Difference	1094	4048	5206	5707	25116	1039
5 Government Purchases ($1987)						
Alternative	998.7	1,016.9	1,038.1	1,058.4	1,166.7	1,286.9
Present Law	998.7	1,016.9	1,038.1	1,058.4	1,166.7	1,286.9
Difference	0.0	(0.0)	0.0	0.0	0.0	0.0
Percent Difference	0.0	0.0	0.0	0.0	0.0	0.0
6 Gross Private Domestic Investment ($1987)						
Alternative	1,415.0	1,702.9	1,657.9	1,571.1	1,745.2	1,850.1
Present Law	1,011.9	1,036.0	1,056.2	1,077.1	1,179.7	1,309.9
Difference	403.1	666.9	601.7	494.0	565.5	540.2
Percent Difference	39.8	64.4	57.0	45.9	47.9	41.2
7 Total Stock Of Capital ($1987)						
Alternative	17,258	18,451	19,549	20,457	24,661	27,685
Present Law	16,748	17,101	17,456	17,813	19,608	21,583
Difference	510	1,349	2,093	2,644	5,053	6,101
Percent Difference	3.0	7.9	12.0	14.8	25.8	28.3
8 Capital Consumption Allowances ($1987)						
Alternative	790.1	877.8	981.1	1,089.1	1,630.1	2,211.4
Present Law	790.1	833.1	878.3	924.6	1,174.6	1,488.5
Difference	(0.0)	44.7	102.8	164.4	455.5	722.9
Percent Difference	0.0	5.4	11.7	17.8	38.8	48.6

9 Residential Investment ($1987)						
Alternative	322.0	516.8	463.8	388.6	409.1	406.2
Present Law	283.1	291.0	296.7	302.5	331.1	367.5
Difference	38.9	225.7	167.2	86.0	78.0	38.6
Percent Difference	13.7	77.6	56.4	28.4	23.5	10.5
10 Residential Capital Stock ($1987)						
Alternative	5,799	6,185	6,513	6,757	7,990	9,012
Present Law	5,763	5,925	6,088	6,254	7,099	8,024
Difference	36	260	424	503	891	988
Percent Difference	0.6	4.4	7.0	8.0	12.6	12.3
11 Residential CCA ($1987)						
Alternative	131.0	135.6	144.6	152.2	181.2	205.7
Present Law	131.0	134.7	138.5	142.3	161.9	183.1
Difference	(0.0)	0.8	6.1	9.9	19.3	22.6
Percent Difference	0.0	0.6	4.4	6.9	11.9	12.3
12 Total hours worked						
Alternative	232.6	244.0	250.8	251.9	272.0	294.3
Present Law	231.2	234.7	238.3	241.9	261.1	282.0
Difference	1.4	9.3	12.6	10.0	10.9	12.2
Percent Difference	0.6	4.0	5.3	4.1	4.2	4.3
13 Real Aftertax Wage Rate						
Alternative	$10.98	$11.44	$11.74	$12.00	$13.12	$13.90
Present Law	$9.55	$10.06	$10.12	$10.24	$10.81	$11.26
Difference	$1.43	$1.39	$1.62	$1.76	$2.31	$2.64
Percent Difference	15.0	13.8	16.0	17.2	21.3	23.4
14 Real Pretax Wage Rate						
Alternative	$17.22	$17.44	$17.74	$18.13	$19.58	$20.70
Present Law	$16.42	$16.58	$16.75	$16.91	$17.77	$18.66
Difference	$0.81	$0.86	$1.00	$1.21	$1.80	$2.04
Percent Difference	4.9	5.2	6.0	7.2	10.1	10.9
15 Real Aftertax Return to Capital (Percent)						
Alternative	5.41	5.40	5.21	4.87	4.15	3.92
Present Law	3.48	3.52	3.52	3.51	3.57	3.60
Difference	1.93	1.87	1.69	1.36	0.58	0.32
Percent Difference	55.4	53.2	48.2	38.8	16.1	8.8
17 Private GDP Deflator (Price Level)						
Alternative	1.327	1.361	1.397	1.433	1.628	1.850
Present Law	1.327	1.361	1.397	1.433	1.628	1.850
Difference	0.000	0.000	0.000	0.000	0.000	0.000
Percent Difference	0.0	0.0	0.0	0.0	0.0	0.0

Fiscal Associates, Inc. Summary Model Results—Flat Unified Income Tax vs. Baseline Forecast—Continued

	1997	1998	1999	2000	2005	2010
18 Government Debt						
Alternative	3,625	3,853	4,099	4,369	6,295	9,216
Present Law	3,625	3,853	4,099	4,369	6,295	9,216
Difference	0	(0)	0	0	0	0
Percent Difference	0.0	0.0	0.0	0.0	0.0	0.0
19 Federal Surplus or Deficit (−),						
Alternative	(190.2)	(189.2)	(203.4)	(221.4)	(365.8)	(545.2)
Present Law	(190.2)	(189.3)	(203.4)	(221.4)	(365.8)	(545.2)
Difference	(0.0)	0.0	(0.0)	0.0	0.0	(0.0)
Percent Difference	0.0	0.0	0.0	0.0	0.0	0.0
20 Net Federal Interest Paid						
Alternative	255.3	263.6	277.0	293.4	391.7	522.9
Present Law	255.3	263.6	277.0	293.4	391.7	522.9
Difference	0.0	0.0	(0.0)	0.0	0.0	0.0
Percent Difference	0.0	0.0	0.0	0.0	0.0	0.0
21 New Federal Income Tax Base						
New Base	3,282.6	3,527.0	3,714.1	3,777.8	4,286.6	4,927.4
Revenue	597.9	592.6	597.6	612.7	660.2	744.0
23 Labor Compensation						
Alternative	5,315.1	5,793.6	6,216.3	6,542.0	8,668.6	11,271.8
Present Law	5,035.4	5,297.3	5,572.9	5,862.5	7,555.2	9,739.1
Difference	279.6	496.4	643.4	679.4	1,113.4	1,532.8
Percent Difference	5.6	9.4	11.5	11.6	14.7	15.7
24 Federal Government Receipts less Contributions for Social Insurance						
Alternative	949.3	977.3	1,017.9	1,070.5	1,329.2	1,704.4
Present Law	982.6	1,036.7	1,095.0	1,152.0	1,462.6	1,888.1
Difference	(33.3)	(59.4)	(77.1)	(81.4)	(133.4)	(183.7)
Percent Difference	−3.4	−5.7	−7.0	−7.1	−9.1	−9.7
25 Federal Contributions for Social Insurance						
Alternative	678.7	739.8	793.8	835.4	1,106.9	1,439.4
Present Law	643.0	676.4	711.6	748.6	964.8	1,243.6
Difference	35.7	63.4	82.2	86.8	142.2	195.7
Percent Difference	5.6	9.4	11.5	11.6	14.7	15.7

26 New Federal Income Tax Rate						
Rate (percent)	18.22	16.80	16.09	16.22	15.40	15.10
27 Net receipts of factor income						
Alternative	(10.0)	(18.3)	(38.9)	(57.7)	(137.6)	(184.3)
Present Law	(10.0)	(10.3)	(10.5)	(10.8)	(12.1)	(13.7)
Difference	0.0	(8.1)	(28.4)	(46.9)	(125.5)	(170.6)
Percent Difference	0	78	270	435	1034	1249
28 Net Foreign Investment ($1987)						
Alternative	(242.8)	(523.0)	(476.4)	(386.9)	(345.8)	(219.3)
Present Law	(55.5)	(50.5)	(47.3)	(45.5)	(44.4)	(47.7)
Difference	(187.2)	(472.5)	(429.0)	(341.4)	(301.4)	(171.6)
Percent Difference	337	936	906	751	678	360
29 Gross Private Savings ($1987)						
Alternative	1,290.9	1,298.6	1,306.8	1,318.3	1,603.2	1,904.2
Present Law	1,075.1	1,104.3	1,134.2	1,165.8	1,339.1	1,535.6
Difference	215.9	194.3	172.7	152.5	264.1	368.6
Percent Difference	20.1	17.6	15.2	13.1	19.7	24.0
30 Personal Saving ($1987)						
Alternative	524.6	469.6	413.9	370.1	414.7	517.5
Present Law	323.4	329.0	334.8	342.8	414.7	499.1
Difference	201.2	140.6	79.0	27.3	0.1	18.4
Percent Difference	62.2	42.7	23.6	8.0	0.0	3.7

Fiscal Associates, Inc. Summary Model Results—Flat Unified Income Tax vs. Baseline Forecast, Closed Economy

	1997	1998	1999	2000	2005	2010
1 Gross Domestic Product ($1987)						
Alternative	6,204.2	6,446.8	6,640.7	6,750.4	7,635.0	8,708.7
Present Law	5,917.7	6,066.2	6,218.6	6,374.4	7,214.9	8,165.6
Difference	286.5	380.6	422.1	376.0	420.1	543.1
Percent Difference	4.8	6.3	6.8	5.9	5.8	6.7
2 Consumption ($1987)						
Alternative	3,999.3	4,229.6	4,397.9	4,489.6	5,112.8	5,898.4
Present Law	3,924.2	4,024.8	4,132.1	4,244.1	4,869.1	5,568.8
Difference	75.0	204.8	265.8	245.5	243.7	329.5
Percent Difference	1.9	5.1	6.4	5.8	5.0	5.9
4 Net Exports ($1987)						
Alternative	(17.1)	(11.5)	(7.7)	(5.2)	(0.7)	(0.1)
Present Law	(17.1)	(11.5)	(7.7)	(5.2)	(0.7)	(0.1)
Difference	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)
Percent Difference	0	0	0	0	0	2
5 Government Purchases ($1987)						
Alternative	998.7	1,016.9	1,038.1	1,058.4	1,166.7	1,286.9
Present Law	998.7	1,016.9	1,038.1	1,058.4	1,166.7	1,286.9
Difference	0.0	(0.0)	0.0	0.0	0.0	0.0
Percent Difference	0.0	0.0	0.0	0.0	0.0	0.0

6 Gross Private Domestic Investment ($1987)						
Alternative	1,223.4	1,211.8	1,212.5	1,207.6	1,356.2	1,523.5
Present Law	1,011.9	1,036.0	1,056.2	1,077.1	1,179.7	1,309.9
Difference	211.5	175.7	156.3	130.5	176.5	213.6
Percent Difference	20.9	17.0	14.8	12.1	15.0	16.3
7 Total Stock Of Capital ($1987)						
Alternative	17,000	17,529	18,042	18,512	20,757	23,288
Present Law	16,748	17,101	17,456	17,813	19,608	21,583
Difference	252	428	586	700	1,149	1,704
Percent Difference	1.5	2.5	3.4	3.9	5.9	7.9
8 Capital Consumption Allowances ($1987)						
Alternative	790.1	865.6	933.1	1,001.9	1,326.5	1,707.0
Present Law	790.1	833.1	878.3	924.6	1,174.6	1,488.5
Difference	(0.0)	32.6	54.8	77.3	151.9	218.5
Percent Difference	0.0	3.9	6.2	8.4	12.9	14.7
9 Residential Investment ($1987)						
Alternative	231.3	296.5	284.5	268.2	347.9	402.5
Present Law	283.1	291.0	296.7	302.5	331.1	367.5
Difference	(51.8)	5.5	(12.2)	(34.4)	16.7	35.0
Percent Difference	−18.3	1.9	−4.1	−11.4	5.1	9.5
10 Residential Capital Stock ($1987)						
Alternative	5,707	5,873	6,025	6,157	6,981	8,074
Present Law	5,763	5,925	6,088	6,254	7,099	8,024
Difference	(56)	(52)	(64)	(97)	(118)	50
Percent Difference	−1.0	−0.9	−1.0	−1.5	−1.7	0.6

Fiscal Associates, Inc. Summary Model Results—Flat Unified Income Tax vs. Baseline Forecast, Closed Economy—Continued

	1997	1998	1999	2000	2005	2010
11 Residential CCA ($1987)						
Alternative	131.0	133.4	137.3	140.8	158.5	183.3
Present Law	131.0	134.7	138.5	142.3	161.9	183.1
Difference	(0.0)	(1.3)	(1.2)	(1.5)	(3.3)	0.2
Percent Difference	0.0	−1.0	−0.9	−1.1	−2.1	0.1
12 Total Hours Worked						
Alternative	232.4	242.6	247.1	246.9	266.1	288.5
Present Law	231.2	234.7	238.3	241.9	261.1	282.0
Difference	1.2	7.9	8.8	5.0	5.0	6.4
Percent Difference	0.5	3.4	3.7	2.1	1.9	2.3
13 Real Aftertax Wage Rate						
Alternative	$10.81	$10.92	$11.06	$11.25	$11.87	$12.58
Present Law	$9.55	$10.06	$10.12	$10.24	$10.81	$11.26
Difference	$1.26	$0.86	$0.94	$1.01	$1.06	$1.31
Percent Difference	13.2	8.6	9.3	9.9	9.8	11.7
14 Real Pretax Wage Rate						
Alternative	$17.07	$16.98	$17.19	$17.52	$18.46	$19.46
Present Law	$16.42	$16.58	$16.75	$16.91	$17.77	$18.66
Difference	$0.65	$0.40	$0.44	$0.60	$0.68	$0.80
Percent Difference	4.0	2.4	2.6	3.6	3.8	4.3

15 Real Aftertax Return to Capital (Percent)						
Alternative	5.42	5.47	5.41	5.21	5.07	5.08
Present Law	3.48	3.52	3.52	3.51	3.57	3.60
Difference	1.93	1.94	1.89	1.70	1.50	1.47
Percent Difference	55.6	55.1	53.8	48.4	42.0	40.8
17 Private GDP Deflator (Price Level)						
Alternative	1.327	1.361	1.397	1.433	1.628	1.850
Present Law	1.327	1.361	1.397	1.433	1.628	1.850
Difference	0.000	0.000	0.000	0.000	0.000	0.000
Percent Difference	0.0	0.0	0.0	0.0	0.0	0.0
18 Government Debt						
Alternative	3,625	3,853	4,099	4,368	6,295	9,216
Present Law	3,625	3,853	4,099	4,369	6,295	9,216
Difference	(0)	(0)	(0)	(0)	(0)	(0)
Percent Difference	0.0	0.0	0.0	0.0	0.0	0.0
19 Federal Surplus or Deficit (−),						
Alternative	(190.2)	(189.3)	(203.4)	(221.4)	(365.7)	(545.1)
Present Law	(190.2)	(189.3)	(203.4)	(221.4)	(365.8)	(545.2)
Difference	0.0	0.0	0.0	0.0	0.1	0.0
Percent Difference	0.0	0.0	0.0	0.0	0.0	0.0
20 Net Federal Interest Paid						
Alternative	255.3	263.6	277.0	293.4	391.7	522.9
Present Law	255.3	263.6	277.0	293.4	391.7	522.9
Difference	0.0	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)
Percent Difference	0.0	0.0	0.0	0.0	0.0	0.0

Fiscal Associates, Inc. Summary Model Results—Flat Unified Income Tax vs. Baseline Forecast, Closed Economy—Continued

	1997	1998	1999	2000	2005	2010
21 New Federal Income Tax Base						
New Base	3,236.4	3,369.5	3,489.8	3,528.6	3,946.2	4,583.1
Revenue	604.1	613.7	629.3	650.0	723.8	817.1
23 Labor Compensation						
Alternative	5,263.5	5,608.7	5,931.0	6,196.8	7,996.1	10,387.7
Present Law	5,035.4	5,297.3	5,572.9	5,862.5	7,555.2	9,739.1
Difference	228.1	311.5	358.1	334.3	440.9	648.6
Percent Difference	4.5	5.9	6.4	5.7	5.8	6.7
24 Federal Government Receipts less Contributions for Social Insurance						
Alternative	955.6	999.6	1,052.3	1,112.0	1,409.9	1,810.5
Present Law	982.6	1,036.7	1,095.0	1,152.0	1,462.6	1,888.1
Percent Difference	(27.0)	(37.1)	(42.7)	(39.9)	(52.7)	(77.7)
Percent Difference	−2.7	−3.6	−3.9	−3.5	−3.6	−4.1
25 Federal Contributions for Social Insurance						
Alternative	672.1	716.2	757.4	791.3	1,021.1	1,326.4
Present Law	643.0	676.4	711.6	748.6	964.8	1,243.6
Difference	29.1	39.8	45.7	42.7	56.3	82.8
Percent Difference	4.5	5.9	6.4	5.7	5.8	6.7

26 Alternative Federal Income Tax						
Rate (Percent)	18.66	18.21	18.03	18.42	18.34	17.83
27 Net receipts of factor income						
Alternative	(10.0)	(10.3)	(10.5)	(10.8)	(12.1)	(13.7)
Present Law	(10.0)	(10.3)	(10.5)	(10.8)	(12.1)	(13.7)
Difference	0.0	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)
Percent Difference	0	0	0	0	0	0
28 Net Foreign Investment ($1987)						
Alternative	(55.5)	(50.5)	(47.4)	(45.5)	(44.4)	(47.7)
Present Law	(55.5)	(50.5)	(47.3)	(45.5)	(44.4)	(47.7)
Difference	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)
Percent Difference	0	0	0	0	0	0
29 Gross Private Savings ($1987)						
Alternative	1,286.5	1,280.1	1,290.4	1,296.2	1,515.6	1,749.2
Present Law	1,075.1	1,104.3	1,134.2	1,165.8	1,339.1	1,535.6
Difference	211.5	175.7	156.3	130.5	176.4	213.5
Percent Difference	19.7	15.9	13.8	11.2	13.2	13.9
30 Personal Saving ($1987)						
Alternative	523.4	469.8	442.6	417.1	506.4	606.3
Present Law	323.4	329.0	334.8	342.8	414.7	499.1
Difference	200.0	140.8	107.7	74.3	91.8	107.2
Percent Difference	61.9	42.8	32.2	21.7	22.1	21.5

3. Roger E. Brinner*

"Modeling the Macroeconomic Consequences of Tax Policy"

1. Introduction: Summary of Macroeconomic Lessons Learned Regarding Substitutions of Tax Systems

The modeling and simulation exercises organized by the Joint Tax Committee have provided some significant insights into the real challenges and opportunities that will be faced if the current U.S. personal and corporate income tax structures are replaced by a consumption-oriented tax system. Our explorations with the DRI Model, and the contrasts or similarities with results from other models, suggest several conclusions to us.

Long-run business capital spending would be materially enhanced by almost all of the tax change variants shifting the U.S. toward a consumption-based tax. The ability to immediately write off the cost of new plant and equipment against taxable business income, compared to current provisions allowing only phased depreciation, reduces the effective cost of long-lived investments quite significantly. *In the long run, this encourages more capital-intensive production and thus higher output per employee.* Greater capital intensity implies lower labor intensity, but this does not necessarily create unemployment because, other things equal, the Federal Reserve could choose to promote more rapid growth in total output to keep labor fully employed.

Stronger growth and an improved living standard are the explicit goals of the major tax proposals, but these goals are more difficult to achieve, or slower to arrive, than proponents may wish to acknowledge. Although the effective cost of business investment is promptly reduced by tax changes—spurring investment—prolonged weakness in real output due to inflation and transition problems is likely to reduce the need for business capacity—curtailing investment spending. In the opening one-to-five years of most of the tax change scenarios, the disincentives of weaker capacity requirements tend to exceed the incentives of lower effective costs. Models that ignore or minimize the transition problems will thus tend to produce rosier medium-term scenarios because they do not recognize the short-run losses in capital formation that become longer-lasting losses in national supply potential.

In the very long-run—perhaps 25 years or more—both macroeconomic and general equilibrium models will predict higher capital per worker and hence higher productivity; robust members of both classes of models are fundamentally guided by neoclassical models of investment (with the capital intensity determined by the relative costs of labor and capital), similar population and hence

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The replacement of income taxation with value-added taxation (in a traditional value-added tax or a flat tax) has the potential to create a severe inflation problem as the tax is introduced. In most variants, the taxes directly collected from the producer/employer rise while the taxes directly collected from the employee/household fall. To preserve or re-establish the required return on invested capital, the producer must pass these new taxes on to consumers in the form of higher prices or pass the taxes back to employees in the form of lower pre-tax wages and benefits. If employees do not immediately agree to pre-tax pay cuts, taking full recognition of the reduced income tax burden to be borne, then a nasty price-wage inflation cycle can be ignited. Many "general equilibrium" models ignore the transition problems, implicitly or explicitly expecting prompt nominal wage reductions, a pattern that does not seem consistent with historical responses to income tax changes.

The productivity benefits of greater capital intensity are slow to arrive, and cannot offset the immediate inflation pressures of new value-added taxes if major wage concession are not forthcoming. Therefore, the third general observation is that the nation's central bank, *the Federal Reserve, will probably be challenged to either accept a much higher price level or to impose higher unemployment on the economy,* or to compromise on an unsatisfactory combination of both of these negatives. "General equilibrium" models typically miss or understate this risk because they are not constructed to deal with short-run price and wage determination. All consistent models will eventually converge over five to ten years to a forecast with the price level tied to the liquidity provided by the central bank, thus higher inflation or even a higher price level is not a necessary long-run outcome of tax substitution. However, the best models will clearly identify and quantify the risk of labor market bargaining failing to produce the required nominal wage concessions unless pressured to so by higher unemployment. Such economic stagnation will also grossly retard capital formation, delaying or eliminating the growth and productivity benefits potentially stimulated by more favorable tax treatment of long-lived assets.

The economy will likely be subject to major waves of sectoral buying and selling pressure. A new value-added tax, in the absence of extraordinary wage concessions, will bring higher prices that are easily predictable in advance by the buying public. If the price of any durable good, from an expensive car to a simple box of frozen food, is expected to rise by 10 or 15% in the near future to cover a new tax, then a buy-in-advance mania will be followed by shopping-withdrawal after the tax becomes effective. The American public consistently behaves this way, waiting for bargains at Christmas, for department store clothing markdowns, and for special auto deals. The effect will be more pronounced with a new tax whose price effect and timing are easier to anticipate than current retail promotions. Few if any of the models quantify this shock because there are few historical parallels of the magnitudes under consideration here.

The prices of key assets would change substantially, creating major windfall gains and losses. As a key example, elimination of interest and property tax deductibility for owner-occupied homes would remove a valuable subsidy that is reflected in the price of land and, by extension, residences today. This subsidy raises the market price and quantity consumed, thus its sudden removal would generate huge windfall losses to current homeowners and would depress new construction activity. Market interest rates would not decline by a sufficient margin to buffer this shock. However, the use of scarce national savings to fund inflated land prices is not beneficial to the economy; allocation of these funds to productive investments would be preferable, but a long phase-out of the current benefit is almost certainly necessary. Prices of financial assets would also be subject to sharp shifts, depending on the exact formulation of the new taxes, the Federal Reserve responses, and the outcome of labor market negotiations. The uncertainty surrounding these outcomes, and the volatility of the economy during any transition, would tend to depress many prices until new trends emerge.

If there is a general theme of concern flowing from the simulations of many, diverse models, it is that a three-to-ten-year transition period could be quite difficult to predict and equally difficult to cope with as consumers, home-owners, employees and employers. A key to these problems is the decentralized economic decision-making in our free enterprise economy, coupled with very poor fundamental economics education.

As an example of the former class of problems—optimal microeconomic decisions producing problematic macroeconomic outcomes—employers and employees do not view individual pay or pricing actions as material to the overall price level that is the concern of the Federal Reserve. Such micro decisions in response to a new tax regime will probably not be concerned with the conflict of individual actions tending to create inflation with the ambitions of the Federal Reserve to stabilize prices. Therefore, individuals or businesses facing directly higher taxes will tend promptly to push up prices, and be unable to obtain or wait for offsetting lower costs from those obtaining effective tax cuts in a new regime.

As an example of the latter source of problems and conflict—weak economics information—the public and our politicians regularly assume that the burden of a tax is borne by the person or enterprise from whom the tax is directly collected; it is widely assumed that whoever writes the check to the Internal Revenue Service "pays" the tax, whereas the ultimate or true bearer of the tax burden is often quite different. There is little comprehension of how wages and prices are adjusted to shift taxes onto consumers, shareholders, or employees. Therefore the debate shaping any new tax will likely mistakenly focus on how direct tax bills will change for key income classes and voting groups; very little attention will be paid to the real income and asset changes that will occur as the economy settles into a new equilibrium. Very little effort will be made to inform all citizens so that the transition can be made with minimal friction, inflation, or unemployment.

It can be forcefully argued that the major differences in the simulations for any given model or class of models reflect differences in assumptions in these key areas. The differences do not relate solely to whether one model or class of models has better theoretical prop-

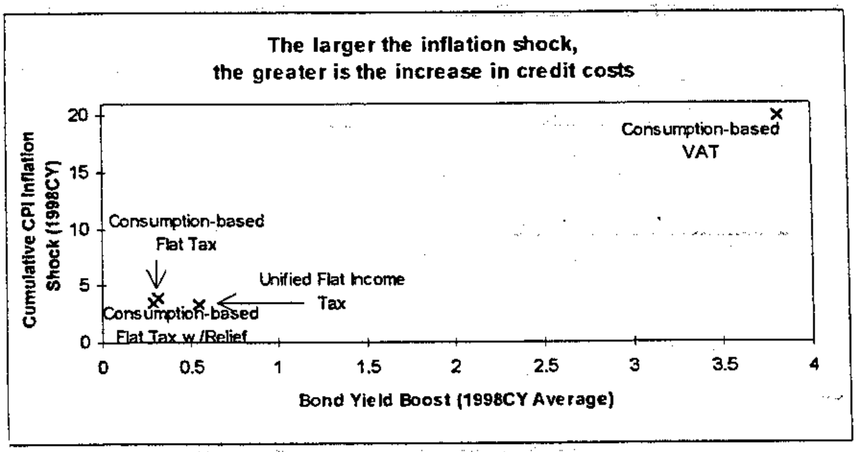
erties with economic agents adhering to logical behavior—all models assume rational behavior for the most part. The differences are in their descriptions of human behaviors by individuals and collective groups. Two focal points are the assumed character of pay negotiations and the reaction of the Federal Reserve (or general credit costs) to inflation. As a class, "computable general equilibrium" models tend to assume away many transition problems, somehow expecting a decentralized economy to have perfect foresight and avoid conflict. In contrast, the "econometric" models based on prior historical evidence tend to assume that pay is negotiated on a largely pre-tax basis for the employee, and that price and wage increases flowing from a shock tend to reverberate until general economic stagnation—perhaps intentionally created by the Federal Reserve to meet its mandate of pursuing price stability—forces restraint.

2. Summary of Simulation Results

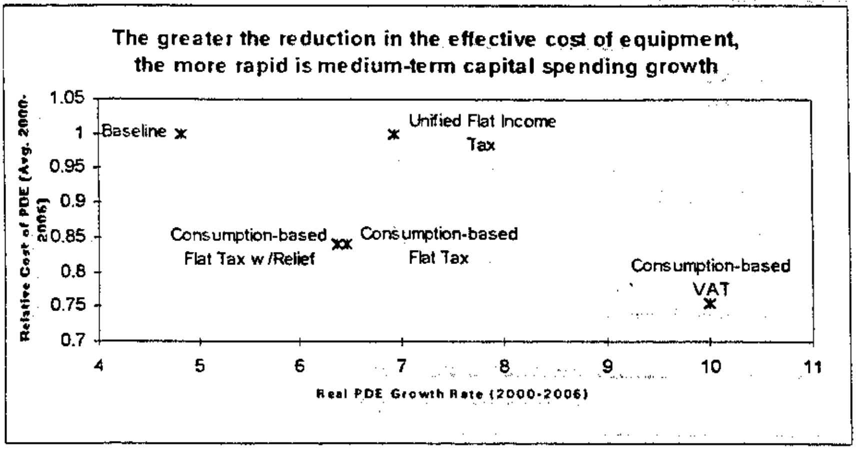
In general, replacing the current tax system with any of the proposed alternatives eventually leads to higher real output. Unfortunately, under every alternative, the path to this long-run improvement contains a period in which economic performance is worse than it would be under current law. This section briefly outlines the reasons for these results.

Price Impacts: According to microeconomic theory, firms set prices so that the after-tax price (or the after-tax marginal revenue) of a unit of output equals the after-tax marginal cost of producing it. Assuming no first-order change in wage rates or fringe benefits, each alternative tax system raises the after-tax marginal cost of production, and thus boosts prices.

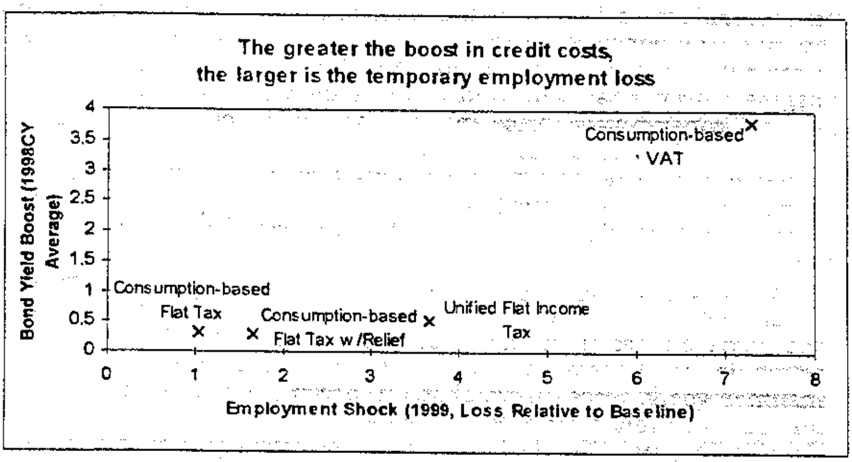
Under current law, all costs of production are deductible from the tax base, so the after-tax cost of production is the pre-tax cost times one minus the tax rate. Under the unified flat income tax, non-wage labor costs (such as fringe benefits) are no longer deductible from the business tax base, so the after-tax cost of using labor rises. This produces a price inflation shock, unless management can convince employees to bear this burden by accepting lower pay or benefits. Under the consumption-based flat tax, the short-run price effect is similar to that of the unified flat income tax: fringe benefits are no longer deductible from the tax base, although both wages and the purchase price of machinery and equipment are deductible. Under a value-added tax, no labor costs can be subtracted from the tax base, so prices must rise substantially.

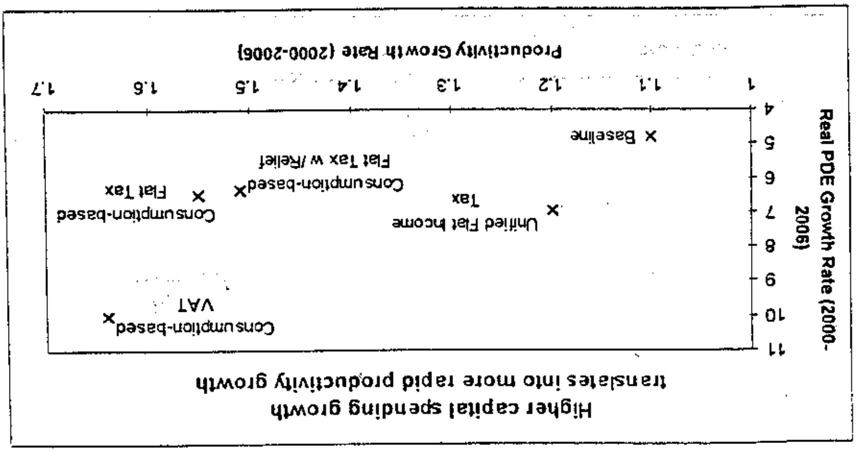


The inflation shocks resulting from the changes in tax regimes have substantial adverse effects. The Federal Reserve and private investors will push yields higher across the spectrum of yields. Inflation's demonstrably negative impact on credit costs and consumer attitudes promptly cuts consumer spending on durable goods. In addition, because housing purchases respond to nominal as well as real interest rates, a higher inflation rate reduces residential construction for any given level of real interest rates. These quickly generate negative accelerator consequences for business capital spending—overwhelming temporarily the tax-related incentives.



Supply Effects: In each of the alternative tax systems, the ratio of the after-tax cost of capital to the after-tax cost of labor significantly declines. The long-run impact will be a larger capital stock, and thus higher real output than in the baseline as the economy converges back toward full employment of its population. The long-run increase in the capital/labor ratio is largest in the alternative regimes that permit expensing of plant and equipment: the VAT and the consumption-based flat tax.





The DRI Model carefully tracks and depreciates investment and capital stocks by type: autos, computers, other business equipment, public utility structures, mining and petroleum structures, government infrastructure, and other private buildings. In addition, business research and development spending is endogenous and treated as a capital stock that influences total factor productivity.

Investment is the key link between tax policy and long-run performance. The full-employment labor force is little affected by the change in tax regimes. The labor force, within the DRI macro-econometric model, is sensitive to: the size of the U.S. adult population, the availability of jobs, and the after-tax real labor compensation. The real compensation term equals total compensation less employee-paid payroll taxes, multiplied by one minus the average marginal income tax rate and then divided by the chain-weighted personal consumption price index. The estimated elasticity of the labor force with respect to real pay is 0.2.

Housing: Real home prices can be expected to drop by the capitalized value of lost mortgage interest and property tax deductions: a 15% decline. (Appendix 3 discusses this price shock in greater detail.) This generates a major short-run disruption to construction, as the drop in prices creates large windfall losses for current homeowners and lenders. Expectations of further declines also keep some buyers temporarily out of the market. The home price decline is ameliorated in the VAT tax substitution because all consumer goods prices have shot up, accomplishing part of the required real or relative decline in home prices.

In the long run, the desired number of primary homes should be largely unchanged, although the loss of the huge federal subsidy for owner-occupied dwellings should reduce the outlays per home, the demand for second homes, the preference for owner-occupied versus rental housing, and the price of residential land.

Mortgage rates will be buffeted by a host of influences, ranging from adverse short-run inflation shocks to beneficial long-run increases in national savings. The new tax benefits for business capital spending raises the demand for funds to absorb some of these new national savings. Adding up all these demographic, tax subsidy, and financial factors, residential construction recovers to, and actually exceeds baseline levels within 10 years, partially replacing construction lost during the early years of the tax change.

A more long-lasting effect is the wealth effect from lower home prices. Owner-occupied homes make up a large share of personal wealth, so the 15% drop in prices reduces consumer wealth, and thus consumer purchases. Higher equity prices are not enough to offset this impact.

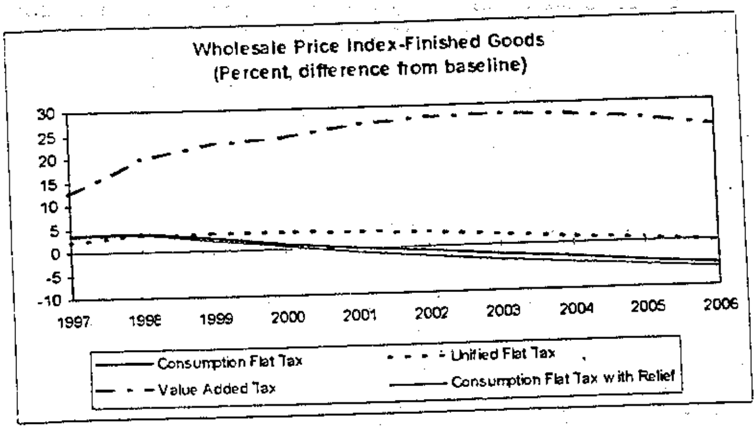
Federal Reserve Policy: The Federal Reserve is an independent agent of economic policy, subject to its own legislated goals and responsibilities. The primary objective is providing price stability, consistent with maximizing the long-run growth potential of the nation. As noted earlier, the new tax regimes would tend to boost short-run prices, antagonizing the Fed, as they attempt to prod the nation to higher investment and hence long-run productivity growth, supporting the Fed's mission.

Because a radical shift of the tax structure has not been previously attempted, the Fed's reaction cannot be known or reliably driven off previous, econometrically-estimated "reaction-functions." Instead, as a reasonable set of initial reactions, DRI assumed that the Fed would increase nominal national banking system liquidity by an amount proportional to any price level shock. In addition, DRI assumed that real monetary reserve growth over the next decade would be raised by 1% (0.1% per year) to accommodate the enhanced supply-side potential of an economy with greater capital formation.

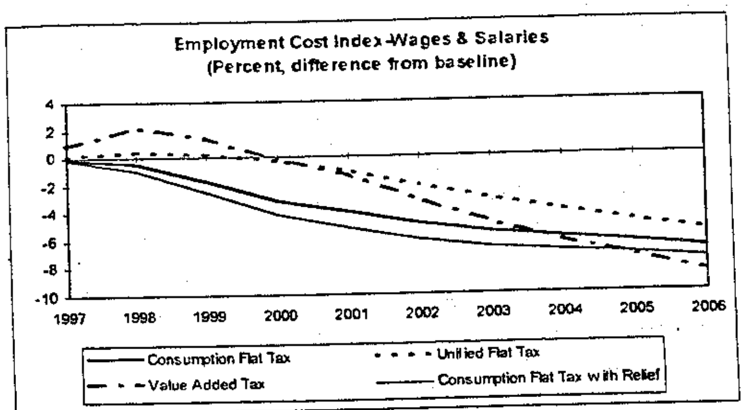
In the first year of the simulations, this still creates higher interest rates because inflation and risk premiums are raised by the new taxes, with only partial offsets in some cases due to different tax treatment of interest income. Thereafter, short-term yields are higher or lower depending on the business cycle situation (i.e. the demand for funds given incomes, inflation, and transactions) and the emerging structural changes in private and public saving behavior. Long-term yields respond similarly, but with more sensitivity to the structural than the cyclical phenomena.

The Joint Committee on Taxation requested all modelers to produce scenarios in which the central bank would adjust its policies such that unemployment rate would be promptly pushed back toward baseline levels after the year 2000. In the case of the VAT and FLAT tax substitutions, this required DRI to add substantial additional monetary reserves to offset the large initial recessionary shocks. This produces short-term interest rates that are exceptionally low, but perhaps not unreasonable in the particular circumstances of helping the nation absorb the repercussions of a major tax overhaul. The simulation results are separately reported.

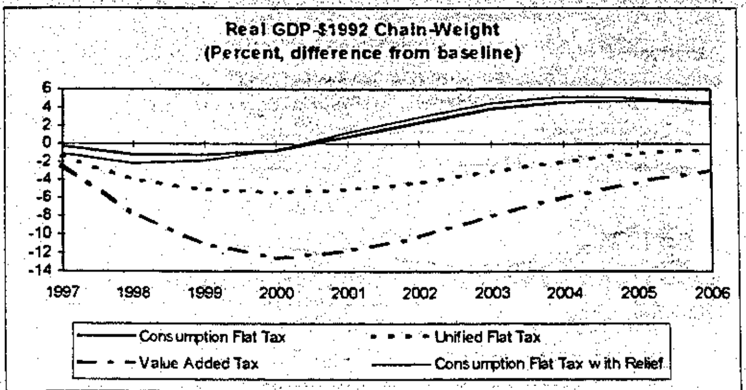
INCLUDING FEEDBACK EFFECTS, THE VAT WOULD BOOST WHOLESALE PRICES BY 25% WITHIN 5 YEARS, ASSUMING THE FEDERAL RESERVE TOLERATES THIS ADJUSTMENT



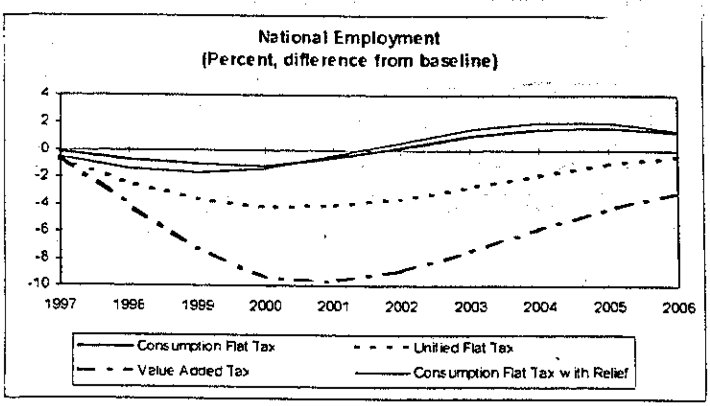
NOMINAL WAGES SLOWLY ADJUST DOWNWARD TO THE SHIFT FROM INCOME TO CONSUMPTION-BASED TAXATION



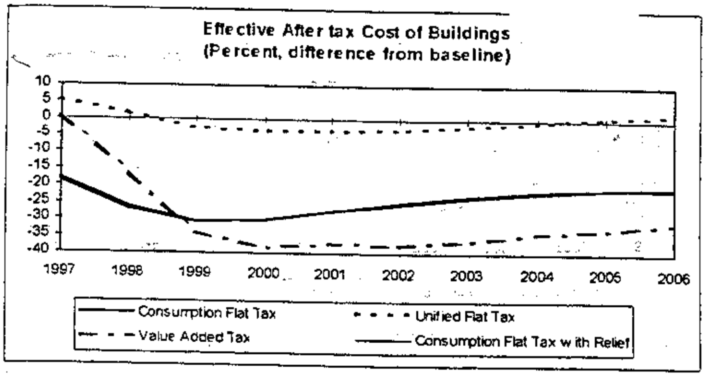
INFLATION SHOCKS LEAD TO TEMPORARY BUT LARGE REAL GDP LOSSES



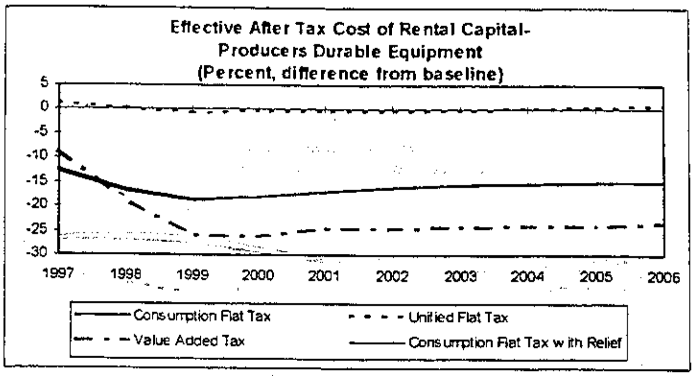
EMPLOYMENT LOSSES, AND EVENTUAL CONVERGENCE TOWARD BASELINE LEVELS, TRACK REAL GDP SHIFTS



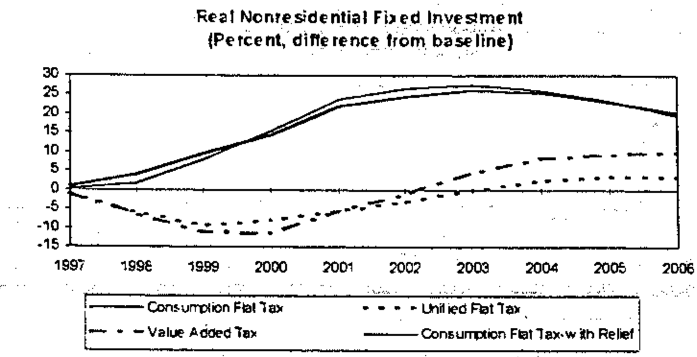
BY PERMITTING IMMEDIATE EXPENSING RATHER THAN SLOW DEPRECIATION, THE EFFECTIVE AFTER-TAX COST TO BUSINESS OF LONG-LIVED ASSETS SUCH AS BUILDINGS IS DRAMATICALLY REDUCED BY MOST OF THE ALTERNATIVE TAXES



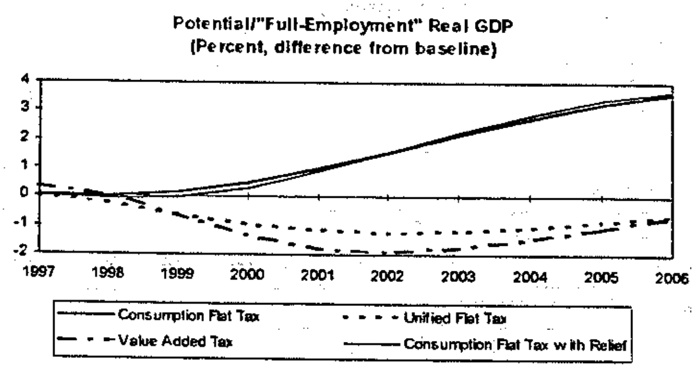
THE BENEFIT IS SIMILAR BUT NOT QUITE AS GREAT FOR PRODUCERS' DURABLE EQUIPMENT WITH AN AVERAGE LIFETIME OF SEVEN YEARS



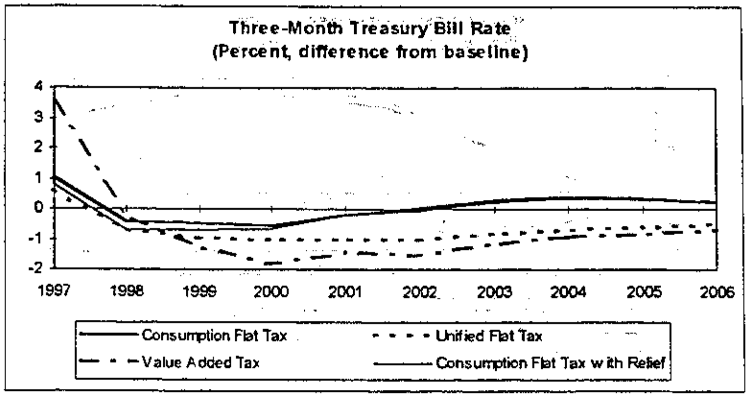
TOTAL REAL BUSINESS CAPITAL SPENDING RESPONDS TO THE CHANGED OUTPUT CAPACITY NEEDS (E.G. REAL GDP) AND RELATIVE COSTS



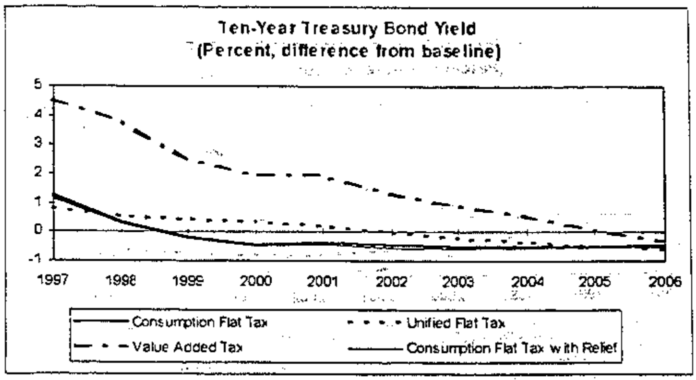
THE POTENTIAL OUTPUT (GDP) OF THE NATION SHIFTS IN LINE WITH THE NEW CAPITAL FORMATION PATTERNS; IN SUBSEQUENT DECADES, THE VAT AND FLAT TAX WOULD ALSO PRODUCE BENEFITS



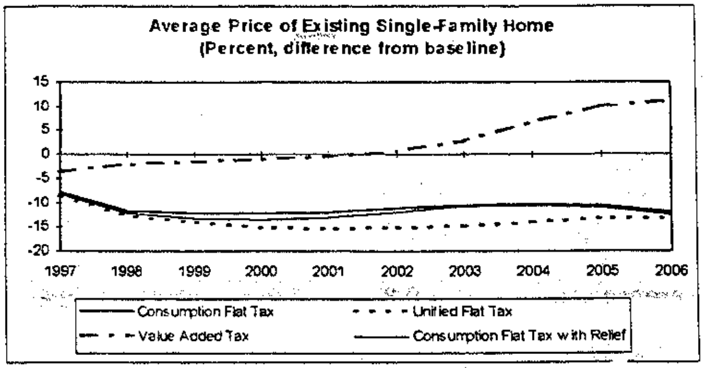
THREE-MONTH TREASURY BILL YIELDS SURGE WITH INFLATION, DECLINE WITH RECESSION, THEN CONVERGE TOWARD SUSTAINABLE RATES



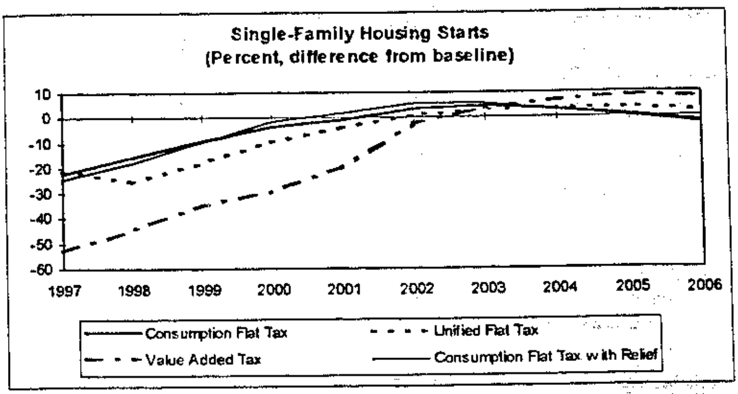
TEN-YEAR GOVERNMENT BOND YIELDS REFLECT SHORT-RUN AND LONG-RUN CREDIT CONDITIONS



THE LOSS OF THE CURRENT HUGE FEDERAL SUBSIDY TO OWNER-OCCUPIED HOUSING CAUSES REAL NEW HOME PRICES TO DECLINE SUBSTANTIALLY AND PERMANENTLY.—HIGHER OVERALL INFLATION IN THE VAT CASE EVENTUALLY OFFSETS THE NOMINAL PRICE DECLINE, BUT NOT THE REAL DECLINE



HIGHER RATES, ECONOMIC WEAKNESS, AND THE LOSS OF MORTGAGE INTEREST DEDUCTIBILITY CREATE MAJOR FIVE-YEAR PROBLEMS FOR RESIDENTIAL CONSTRUCTION



Macroeconomic Impacts of Substituting a *Consumption Flat Tax* for Current Inc. Taxes: Economic Performance Under New Tax Regimes (first lines) and Changes Relative to Baseline of Current Tax Code ($ billions and % different lines)

	1997	1998	1999	Average 2000–2005	2006
Employment & Income					
National Employment (1000s)	128.4	129.1	130.1	136.2	143.1
Difference	−0.1	−0.9	−1.4	0.6	1.9
Real GDP ($ billion)	7,044.0	7,147.4	7,303.9	8,058.8	8,817.1
Percent difference	−0.3	−1.2	−1.2	2.6	4.5
Potential/Full Employment Real GDP ($ billion)	7,092.2	7,247.7	7,412.5	8,080.6	8,813.3
Percent difference	0.0	0.0	0.1	1.9	3.6
Finance					
10-Year Treasury Bond Yield (%)	8.33	7.19	6.75	6.39	6.36
Change (%)	1.3	0.3	−0.2	−0.4	−0.5
National Exchange Rate	0.993	1.014	1.037	1.034	1.019
Percent difference	1.8	4.6	6.8	5.4	6.4
Prices and Wages					
Consumer Price Index:					
Inflation Rate	5.7	3.6	2.3	2.4	2.8
Difference	2.8	0.7	−0.6	−1.2	−1.1
GDP Chain-Weight Price Index:					
Index Level	1.15	1.191	1.213	1.287	1.383
Cumulative difference	2.0	3.2	2.5	−1.8	−5.4
Employment Cost Index-Wages:					
Index Level	1.306	1.341	1.367	1.483	1.639
Cumulative difference	−0.1	−0.5	−1.8	−5.0	−6.8
Real Business Investment					
Equipment ($ billion)	596.4	636.4	685.2	891.8	1058.3
Percent difference	0.1	0.9	4.7	18.1	17.1

Macroeconomic Impacts of Substituting a *Consumption Flat Tax* for Current Inc. Taxes: Economic Performance Under New Tax Regimes (first lines) and Changes Relative to Baseline of Current Tax Code ($ billions and % different lines)—Continued

	1997	1998	1999	Average 2000–2005	2006
All Structures ($ billion)	193.3	216.0	238.8	279.9	297.5
Percent difference	3.3	13.1	24.0	37.6	32.1
Accumulated Business Capital Stock ($ billion)	5,840.3	6,080.4	6,355.5	7,621.8	9,005.1
Percent difference	0.0	0.3	1.2	8.5	14.7
Effective Annual After-Tax Cost of Plant & Equipment (percent of purchase price, relative to output price):					
Basic Equipment (service life = 7 years)	15.9	15.0	14.6	14.3	13.9
Percent difference	−12.4	−16.5	−18.6	−16.2	−14.8
Buildings (service life = 40 years)	8.1	7.2	6.9	7.2	7.3
Percent difference	−18.2	−26.3	−30.6	−24.9	−20.6
Housing Summary					
Real Housing Construction ($ billion)	239.8	227.8	243.7	294.0	319.7
Percent difference	−12.7	−16.7	−12.0	4.7	7.4
Stock of Single-Family Housing (1000s)	75.0	75.7	76.5	79.8	83.2
Difference	−0.1	−0.3	−0.5	−0.5	−0.4
Mortgage Rate (%)	9.7	8.7	8.3	7.9	7.8
Change (%)	1.2	0.4	−0.2	−0.4	−0.5

Macroeconomic Impacts of Substituting a *Consumption Flat Tax* for Current Inc. Taxes: Economic Performance Under New Tax Regimes (first lines) and Changes Relative to Baseline of Current Tax Code ($ billions and % different lines)—Continued

	1997	1998	1999	Average 2000–2005	2006
Cost of Single-Family Housing as a percent of income (after-tax):					
Percent difference	3.6	2.3	1.5	1.1	0.8
Average Price of Existing Single-Family Home Sales ($1000s)	140.7	140.5	144.1	161.8	181.9
Change ($1000)	−12.2	−18.5	−20.2	−20.3	−24.6
Federal Government					
Federal Receipts ($ billion)	1,729	1,819	1,879	2,176	2,500
Difference	197	213	206	211	140
Federal Spending ($ billion)	1,885	2,013	2,095	2,363	2,714
Difference	208	251	252	181	98
Deficit ($ billion)	−156	−194	−216	−186	−214
Difference	−11	−39	−45	30	42
Cyclically Adjusted Deficit ($ billion)	−127	−136	−151	−160	−200
Difference	0	0	0	0	0

Macroeconomic Impacts of Substituting a *Consumption Flat Tax With Relief* Current Inc. Taxes: Economic Performance Under New Tax Regimes (first lines) and Changes Relative to Baseline of Current Tax Code ($ billions and % different lines)

	1997	1998	1999	Average 2000–2005	2006
Employment & Income					
National Employment (1000s)	128.0	128.2	129.3	136.6	143.3
Difference	−0.6	−1.8	−2.2	1.0	2.1
Real GDP ($ billion)	6,988.4	7,077.1	7,256.1	8,094.2	8,830.0
Percent difference	−1.1	−2.2	−1.9	3.0	4.6
Potential/Full Employment Real GDP ($ billion)	7,090.9	7,241.1	7,399.4	8,082.4	8,824.3
Percent difference	0.0	−0.1	0.0	1.9	3.7
Finance					
10-Year Treasury Bond Yield (%)	8.23	7.16	6.71	6.31	6.34
Change (%)	1.17	0.28	−0.24	−0.52	−0.47
Nominal Exchange Rate	0.992	1.022	1.051	1.042	1.028
Percent difference	1.8	5.3	8.3	6.3	7.3
Prices and Wages					
Consumer Prince Index:					
Inflation Rate ...	5.6	3.4	2.1	2.3	2.8
Difference	2.7	0.5	−0.9	−1.3	−1.1
GDP Chain-Weight Price Index:					
Index Level	1.15	1.19	1.21	1.28	1.37
Cumulative difference	1.9	2.9	2.0	−2.7	−6.3
Employment Cost Index-Wages:					
Index Level	1.30	1.34	1.36	1.47	1.63
Cumulative difference	−0.2	−0.9	−2.5	−6.0	−7.6
Real Business Investment					
Equipment ($ billion)	591.5	622.9	676.6	898.9	1054.1
Percent difference	−0.7	−1.3	3.4	19.0	16.7

Macroeconomic Impacts of Substituting a *Consumption Flat Tax With Relief* Current Inc. Taxes: Economic Performance Under New Tax Regimes (first lines) and Changes Relative to Baseline of Current Tax Code ($ billions and % different lines)—Continued

	1997	1998	1999	Average 2000–2005	2006
All Structures ($ billion)	192.3	210.5	233.1	283.6	296.0
Percent difference	2.8	10.2	21.1	39.5	31.4
Accumulated Business Capital Stock ($ billion)	5,837.0	6,060.5	6,320.4	7,631.3	9,026.8
Percent difference	0.0	0.0	0.6	8.6	15.0
Effective Annual After-Tax Cost of Plant & Equipment (% of purchase price, relative to output price):					
Basic Equipment (service life = 7 years)	15.8	14.9	14.5	14.3	13.9
Percent difference	−12.8	−17.0	−18.9	−16.1	−14.8
Buildings (service life = 40 years)	8.0	7.2	6.8	7.2	7.4
Percent difference	−19.0	−27.0	−31.1	−24.5	−20.2
Housing Summary					
Real Housing Construction ($ billion)	232.5	219.4	238.2	298.0	319.2
Percent difference	−15.3	−19.8	−14.0	6.1	7.2
Stock of Single-Family Housing (1000s)	74.9	75.7	76.5	79.8	83.2
Difference	−0.1	−0.4	−0.5	−0.5	−0.4
Mortgage rate (%)	9.6	8.7	8.2	7.8	7.7
Change (%)	1.1	0.3	−0.2	−0.5	−0.5

Macroeconomic Impacts of Substituting a *Consumption Flat Tax With Relief* Current Inc. Taxes: Economic Performance Under New Tax Regimes (first lines) and Changes Relative to Baseline of Current Tax Code ($ billions and % different lines)—Continued

	1997	1998	1999	Average 2000–2005	2006
Cost of Single-Family Housing as a percent of income (after-tax):					
Percent difference	4.1	2.7	1.7	1.0	0.8
Average Price of Existing Single-Family Home Sales ($1000s)	140.4	139.6	142.3	160.7	180.8
Change ($1000)	−12.5	−19.5	−22.0	−21.5	−25.7
Federal Government	1,708	1,796	1,864	2,171	2,474
Federal Receipts ($ billion)	176	189	191	206	113
Difference	1,886	2,018	2,098	2,342	2,685
Federal Spending ($ billion)	209	256	254	160	69
Difference	−178	−223	−234	−170	−212
Deficit ($ billion)	−33	−67	−63	46	44
Difference	−127	−136	−151	−160	−200
Cyclically Adjusted Deficit ($ billion) ..	0	0	0	0	0
Difference	4	0	−1	−1	−1

Macroeconomic Impacts of Substituting a *Unified Flat Tax* for Current Inc. Taxes Economic Performance Under New Tax Regimes (first lines) and Changes Relative to Baseline of Current Tax Code ($ billions and % different lines)

	1997	1998	1999	Average 2000–2005	06
Employment & Income					
National Employment (1000s)	127.7	126.8	126.7	131.7	140.5
Difference	−0.8	−3.2	−4.8	−4.0	−0.7
Real GDP ($ billion)	6,965.6	6,939.9	7,017.2	7,584.7	8,392.1
Percent difference	−1.5	−4.1	−5.1	−3.5	−0.6
Potential/Full Employment Real GDP ($ billion)	7,086.8	7,230.0	7,356.2	7,845.1	8,450.1
Percent difference	0.0	−0.2	−0.6	−1.1	−0.7
Finance					
10-Year Treasury Bond Yield (%)	7.85	7.41	7.35	6.73	6.22
Change (%)	0.8	0.54	0.41	−0.1	−0.59
Nominal Exchange Rate (%)	0.97	0.959	0.97	0.971	0.942
Percent difference	−0.6	−1.1	0.0	−1.0	−1.6
Prices and Wages					
Consumer Price Index:					
Inflation Rate	4.6	4.2	3.3	3.1	3
Difference	1.7	1.3	0.4	−0.5	−0.9
GDP Chain-Weight Price Index:					
Index Level	1.148	1.19	1.224	1.337	1.45
Cumulative difference	1.9	3.1	3.4	2.0	−0.9
Employment Cost Index-Wages:					
Index Level	1.308	1.354	1.394	1.521	1.66
Cumulative difference	0.1	0.4	0.2	−2.6	−5.6
Real Business Investment					
Equipment ($ billion)	590.2	594.6	598.8	741.6	922.8
Percent difference	−1.0	−5.7	−8.5	−1.9	2.1

Macroeconomic Impacts of Substituting a *Unified Flat Tax* for Current Inc. Taxes Economic Performance Under New Tax Regimes (first lines) and Changes Relative to Baseline of Current Tax Code ($ billions and % different lines)—Continued

	1997	1998	1999	Average 2000–2005	06
All Structures ($ billion)	184.9	178.2	169.9	199.1	239.7
Percent difference	−1.2	−6.7	−11.8	−2.3	6.4
Accumulated Business Capital Stock ($ billion)	5,834.4	6,017.3	6,162.6	6,829.5	7,782.5
Percent difference	−0.1	−0.7	−1.9	−2.6	−0.9
Effective Annual After-Tax Cost of Plant & Equipment (% of purchase price, relative to output price):					
Basic Equipment (service life = 7 years)	18.3	18.0	17.8	17.1	16.5
Percent difference	1.1	0.1	−0.7	−0.1	0.6
Buildings (service life = 40 years)	10.4	10.0	9.6	9.3	9.3
Percent difference	5.3	1.4	−2.7	−2.2	1.4
Housing Summary					
Real Housing Construction ($ billion)	241.0	208.5	214.5	260.5	303.5
Percent difference	−12.2	−23.7	−22.6	−7.3	1.9
Stock of Single-Family Housing (1000s)	75.0	75.7	76.4	79.5	82.9
Difference	−0.1	−0.4	−0.6	−0.8	−0.7
Mortgage Rate (%)	9.3	8.9	8.9	8.2	7.6
Change (%)	0.8	0.5	0.5	−0.1	−0.6

Macroeconomic Impacts of Substituting a *Unified Flat Tax* for Current Inc. Taxes Economic Performance Under New Tax Regimes (first lines) and Changes Relative to Baseline of Current Tax Code ($ billions and % different lines)—Continued

	1997	1998	1999	Average 2000–2005	06
Cost of Single-Family Housing as a % of income (after-tax):					
Percent difference	3.4	3.1	3.0	2.3	1.4
Average Price of Existing Single-Family Home Sales ($1000s)	139.7	138.8	141.0	155.4	179.2
Change ($1000)	−13.2	−20.2	−23.2	−26.7	−27.4
Federal Government					
Federal Receipts ($ billion)	1,524	1,569	1,630	1,971	2,383
Difference	−8	−38	−43	6	22
Federal Spending ($ billion)	1,705	1,834	1,943	2,275	2,634
Difference	28	72	99	94	18
Deficit ($ billion)	−181	−265	−313	−304	−251
Difference	−36	−110	−143	−88	5
Cyclically Adjusted Deficit ($ billion)	−127	−136	−151	−160	−200
Difference	0	0	0	0	0

Macroeconomic Impacts of Substituting a *VAT* for Current Income Taxes Economic Performance Under New Tax Regimes (first lines) and Changes Relative to Baseline of Current Tax Code ($ billions and % different lines)

	1997	1998	1999	Average 2000–2005	2006
Employment & Income					
National Employment (1000s)	127.9	124.8	121.9	125.3	136.7
Difference	−0.7	−5.2	−9.6	−10.3	−4.5
Real GDP ($ billion)	6,902.4	6,675.9	6,571.7	7,166.6	8,194.5
Percent difference	−2.3	−7.7	−11.1	−8.8	−2.9
Potential/Full Employment Real GDP ($ billion)	7,113.5	7,250.6	7,354.9	7,806.0	8,447.2
Percent difference	0.3	0.0	−0.6	−1.6	−0.7
Finance					
10-Year Treasury Bond Yield (%)	11.58	10.69	9.46	7.94	6.51
Change (%)	4.52	3.82	2.52	1.11	−0.31
Nominal Exchange Rate	1.034	1.098	1.159	1.084	1.006
Percent difference	6.0	13.2	19.5	10.5	5.0
Prices and Wages					
Consumer Price Index:					
Inflation Rate	12.8	10.3	6.9	4.4	2.6
Difference	9.9	7.4	3.9	0.9	−1.3
GDP Chain-Weight Price Index:					
Index Level	1.241	1.375	1.458	1.67	1.837
Cumulative difference	10.2	19.2	23.2	27.3	25.6
Employment Cost Index-Wages:					
Index Level	1.317	1.377	1.41	1.499	1.608
Cumulative difference	0.9	2.1	1.4	−3.9	−8.5
Real Business Investment					
Equipment ($ billion)	588.0	566.4	534.0	738.8	951.4
Percent difference	−1.3	−10.2	−18.4	−2.6	5.3

Macroeconomic Impacts of Substituting a *VAT* for Current Income Taxes Economic Performance Under New Tax Regimes (first lines) and Changes Relative to Baseline of Current Tax Code ($ billions and % different lines)—Continued

	1997	1998	1999	Average 2000–2005	2006
All Structures ($ billion)	186.2	200.9	210.5	226.3	283.1
Percent difference	−0.5	5.2	9.3	11.0	25.7
Accumulated Business Capitol Stock ($ billion)	5,832.7	5,995.5	6,102.7	6,801.1	7,946.2
Percent difference	−0.1	−1.1	−2.8	−3.1	1.2
Effective Annual After-Tax Cost of Plant & Equipment (% of purchase price, relative to output price):					
Basic Equipment (service life=7 years)	16.6	14.6	13.2	12.9	12.5
Percent difference	−8.6	−18.8	−26.0	−24.7	−23.6
Buildings (service life=40 years)	9.9	8.2	6.5	6.1	6.4
Percent difference	0.5	−16.7	−33.9	−36.2	−31.1
Housing Summary					
Real Housing Construction ($ billion)	190.8	144.0	159.6	229.7	315.9
Percent difference	−30.5	−47.3	−42.4	−18.5	6.1
Stock of Single-Family Housing (1000s)	74.8	75.2	75.8	78.5	82.0
Difference	−0.3	−0.8	−1.2	−1.8	−1.7
Mortgage Rate (%)	12.8	12.3	11.1	9.6	8.0
Change (%)	4.3	4.0	2.7	1.3	−0.2

Macroeconomic Impacts of Substituting a *VAT* for Current Income Taxes Economic Performance Under New Tax Regimes (first lines) and Changes Relative to Baseline of Current Tax Code ($ billions and % different lines)—Continued

	1997	1998	1999	Average 2000–2005	2006
Cost of Single-Family Housing as a % of income (after-tax):					
Percent difference	8.4	8.7	6.7	5.2	2.6
Average Price of Existing Single-Family Home Sales ($1000s)	147.0	155.9	161.6	188.0	229.4
Change ($1000)	−5.8	−3.2	−2.6	5.9	22.9
Federal Government					
Federal Receipts ($ billion)	1,598	1,825	1,959	2,687	3,453
Difference	66	219	286	722	1,093
Federal Spending ($ billion)	1,970	2,332	2,588	3,292	3,864
Difference	293	570	744	1,111	1,247
Deficit ($ billion)	−372	−507	−629	−605	−411
Difference	−227	−352	−458	−389	−155
Cyclically Adjusted Deficit ($ billion)	−283	−219	−191	−163	−200
Difference	−156	−83	−40	−4	0

3. Model Overview:

Theory and Properties of the DRI/McGraw-Hill Model of the U.S. Economy

Econometric models built in the 1950s and 1960s were largely Keynesian income-expenditure systems that assumed a closed domestic economy. High computation costs during estimation and manipulation, along with the underdeveloped state of macroeconomic theory, limited the size of the models and the richness of the linkages of spending to financial conditions, inflation, and international developments. Since that time, however, computer costs have fallen spectacularly; theory has also benefited from four decades of postwar data observation and from the intellectual attention of many eminent economists.

Theoretical Background

An Econometric Dynamic Equilibrium Growth Model: The DRI Model strives to incorporates the best insights of many theoretical approaches to the business cycle: Keynesian, neoclassical, monetarist, supply-side, and rational expectations. In addition, the DRI Model embodies the major properties of the *long-term* growth models presented by James Tobin, Robert Solow, Edmund Phelps, and others. This structure guarantees that short-run cyclical developments will converge to robust long-run equilibria.

In growth models, the expansion rates of technical progress, the labor force, and the capital stock determine the productive potential of an economy. Both technical progress and the capital stock are governed by investment, which in turn must be in balance with post-tax capital costs, available savings, and the capacity requirements of current spending. As a result, monetary and fiscal policies will influence both the short- and the long-term characteristics of such an economy through their impacts on national saving and investment.

A modern model of output, prices, and financial conditions is melded with the growth model to present the detailed, short-run dynamics of the economy. In specific goods markets, the interactions of a set of supply and demand relations jointly determine spending, production, and price levels. Typically, the level of inflation-adjusted demand is driven by prices, income, wealth, expectations, and financial conditions. The capacity to supply goods and services is keyed to a production function combining the basic inputs of labor hours, energy usage, and the capital stocks of equipment and structures. The "total factor productivity" of this composite of tangible inputs is driven by expenditures on research and development which produce technological progress.

Prices adjust in response to gaps between current production and supply potential and to changes in the cost of inputs. Wages adjust to labor supply-demand gaps (indicated by a demographically-adjusted unemployment rate), current and expected inflation (with a unit long-run elasticity), productivity, taxes, and minimum wage legislation. The supply of labor positively responds to the perceived availability of jobs, to the after-tax wage level, and to the growth and age-sex mix of the population. Demand for labor is keyed to the level of output in the economy and the productivity of labor, capital, and energy. Because the capital stock is largely fixed in the short run, a higher level of output requires more employment and energy inputs. Such increases are not necessarily equal to the percentage increase in output because of the improved efficiencies typically achieved during an upturn. Tempering the whole process of wage and price determination is the exchange rate; a rise signals prospective losses of jobs and markets unless costs and prices are reduced.

For financial markets, the model predicts exchange rates, interest rates, stock prices, loans, and investments interactively with the preceding GDP and inflation variables. The Federal Reserve sets the supply of reserves in the banking system and the fractional reserve requirements for deposits. Private sector demands to hold deposits are driven by household disposable income, business cash flow, expected inflation, and by the deposit interest yield relative to the yields offered on alternative investments. Banks and other thrift institutions, in turn, set deposit yields based on the market yields of their investment opportunities with comparable maturities and on the intensity of their need to expand reserves to meet legal requirements. The contrast between the supply and demand for reserves sets the critical short-term interest rate for interbank transactions, the federal funds rate. Other interest rates are keyed to this rate, plus expected inflation, Treasury borrowing requirements, and sectoral credit demand intensities.

Monetarist Aspects: The model pays due attention to valid lessons of monetarism by carefully representing the diverse portfolio aspects of money demand and by capturing the central bank's role in long-term inflation phenomena. The private sector may demand money balances as one portfolio choice among transactions media (currency, demand deposits, some savings deposits), investment media (bonds, stocks, short-term securities), and durable assets (homes, cars, equipment, structures). Given this range of choice, each medium's implicit and explicit yield must therefore match expected inflation, offset perceived risk, and respond to the scarcity of real savings. Money balances provide benefits by facilitating spending transactions and can be expected to rise nearly proportionately with transactions requirements unless the yield of an alternative asset changes.

Now that even demand deposit yields can float to a limited extent in response to changes in Treasury bill rates, money demand no longer shifts quite as sharply when market rates change. Nevertheless, the velocity of circulation (the ratio of money demand to nominal spending) is still far from stable during a cycle of monetary expansion or contraction. Thus the rigid monetarist link from money growth to price inflation or nominal spending is considered invalid as a short-run proposition.

Equally important, as long-run growth models demonstrate, induced changes in capital formation can invalidate a naive long-run identity between monetary growth and price increases. Greater demand for physical capital investment can enhance the economy's supply potential in the event of more rapid money creation or new fiscal policies. However, if simultaneous, countervailing influences deny an expansion of the economy's real potential, the model will translate all money growth into a proportionate long-run increase in prices rather than in physical output.

"Supply-Side" Economics: Since 1980, "supply-side" political economists have pointed out that the economy's growth potential is sensitive to the policy environment. They focused on potential labor supply, capital spending, and savings impacts of tax rate changes. The DRI Model embodies supply-side hypotheses to the extent supportable by available data, and this is considerable in the many areas that supply-side hypotheses share with long-run growth models. These features, however, have been fundamental ingredients of our model since 1976.

Rational Expectations: As the rational expectations school has pointed out, much of economic decision-making is forward looking. For example, the decision to buy a car or a home is not only a question of current affordability but also one of timing; the delay of a purchase until interest rates or prices decline has become particularly common since the mid-1970s when both inflation and interest rates were very high and volatile. Consumer sentiment surveys, such as those conducted by the University of Michigan Survey Research Center, clearly confirm this speculative element in spending behavior.

However, households can be shown to base their expectations, to a large extent, on their past experiences: they believe that the best guide to the future is an extrapolation of recent economic conditions and the changes in those conditions. Consumer sentiment about whether this is a "good time to buy" can therefore be successfully modeled as a function of recent levels and changes in employment, income, interest rates, and inflation. Similarly, inflation expectations (influencing financial conditions) and market strength expectations (influencing inventory and capital spending decisions) can be modeled as functions of recent rates of increase in prices and spending.

This largely retrospective approach is not, of course, wholly satisfactory to pure adherents to the rational expectations doctrine. In particular, this group argues that the announcement of macroeconomic policy changes would significantly influence expectations of inflation or growth prior to any realized change in prices or spending. If an increase in government expenditures is announced, the argument goes, expectations of higher taxes to finance the spending might lead to lower consumer or business spending in spite of temporarily higher incomes from the initial government spending stimulus. A rational expectations theorist would thus argue that multiplier effects will tend to be smaller and more short-lived than a mainstream economist would expect.

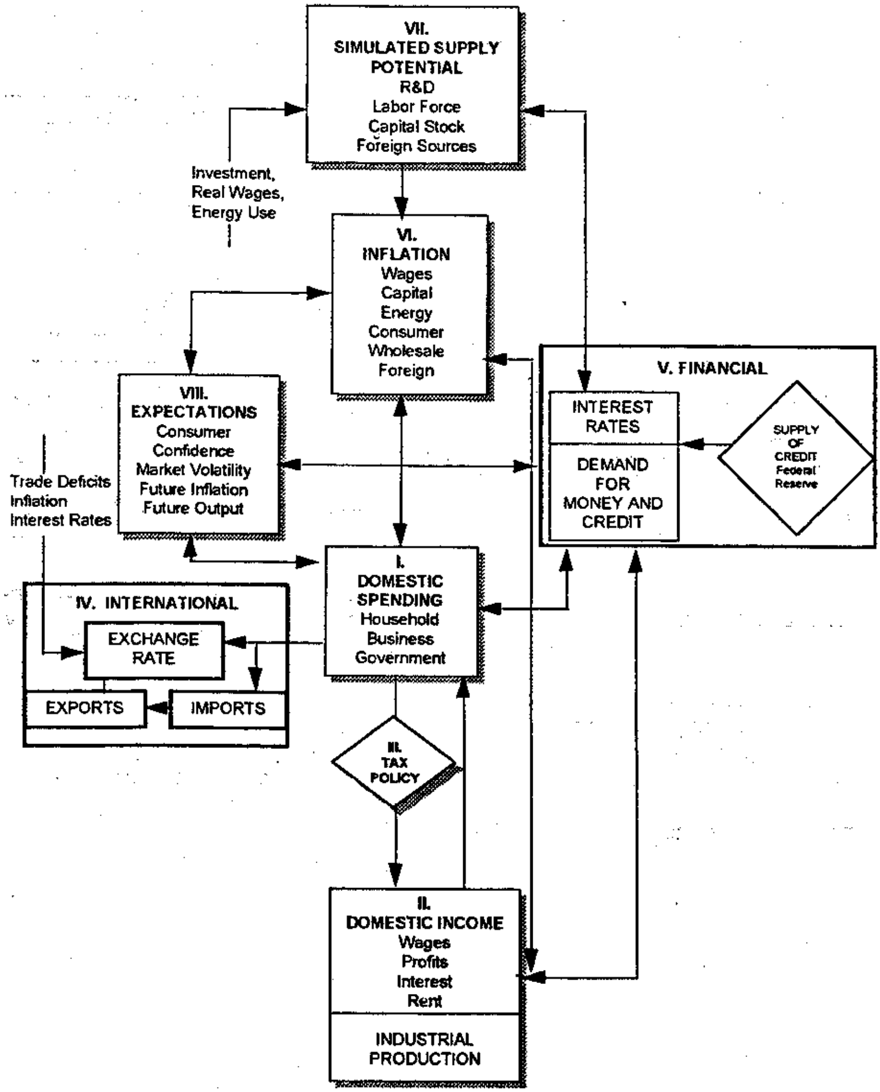
These propositions are subject to empirical evaluation. Our conclusions are that expectations do play a significant role in private sector spending and investment decisions; but, until change has occurred in the economy, there is very little room for significant changes in expectations in advance of an actual change in the variable about which the expectation is formed. The rational expectations school thus correctly emphasizes a previously understated element of decision-making, but exaggerates its significance for economic policy-making and model building.

The DRI Model allows a choice in this matter. On the one hand, the user can simply accept DRI's judgments and let the model translate policy initiatives into initial changes in the economy, simultaneous or delayed changes in expectations, and subsequent changes in the economy. On the other hand, the user can manipulate the clearly identified expectations variables in the model, i.e., consumer sentiment, inflation expectations, and interest rate volatility. For example, if the user believes that fear of higher taxes would subdue spending, he could reduce the consumer sentiment index. Such experiments can be made "rational" through model iterations that bring the current change in expectations in line with future endogenous changes in income, prices, or financial conditions.

Theory As a Constraint: The conceptual basis of each equation in the DRI Model was thoroughly worked out before the regression analysis was initiated. The list of explanatory variables includes a carefully selected set of demographic and financial inputs. Each estimated coefficient was then thoroughly tested to be certain that it meets the tests of modern theory and business practice. For example, unitary long-run elasticities are imposed at appropriate decision points during estimation. This attention to equation specification and coefficient results has eliminated the "short circuits" that can occur in evaluating a derivative risk or an alternative policy scenario. Because each equation will stand up to a thorough inspection, the DRI Model is a reliable analytical tool and can be used without excessive iterations. The model is not a black box: it functions like a personal computer spreadsheet in which each interactive cell has a carefully computed, theoretically-consistent entry and thus performs logical computations simultaneously.

The DRI Model captures the full simultaneity of the U.S. economy, forecasting over 1200 concepts spanning final demands, aggregate supply, prices, incomes, international trade, industrial detail, interest rates, and financial flows. Chart 1 summarizes the structure of the eight interactive sectors (noted in Roman numerals). Detailed documentation of the logic of each sector and the significant interactions with other sectors is available from DRI.

Chart 1
Overview of the DRI/McGraw-Hill Macroeconomic Model



4. Jane G. Gravelle*

"Simulation of Economic Effects for Flat Rate Income and Consumption Tax Proposals"

Summary

This paper presents the results of a model of the economic effects of three alternative tax proposals: a flat rate income tax proposal, a flat rate consumption tax proposal, and a flat rate consumption tax proposal with transition relief via basis recovery. These simulations were prepared upon request as part of the Joint Committee on Taxation modeling study. Both proposals allow a wage exemption/credit. Also presented are some results of two other simulations designed to provide more insight into the consequences of alternative approaches and assumptions. The first provides transition relief by exempting the return on old capital (by substituting a wage rather than a consumption tax for the current income tax); the second simulates a consumption tax in an open economy with perfectly mobile capital where the returns on U.S. investments are fixed by worldwide prices (e.g. interest rates). This latter simulation assumes a five-year adjustment period.

Simulation results are provided for a variety of variables, for the years 1997-2000, 2005, 2010, 2025, and the long-run steady-state. Output increases occur for both the income and consumption tax, but are more pronounced for the income tax in the short run and the consumption tax in the long run. The consumption tax shift, however, reduces output in the short and intermediate runs when transition relief is allowed. Consumption is reduced in the short and intermediate run for consumption taxes with and without transition relief, but not for the income tax. Using a wage tax for transition relief results in smaller effects in the short and long runs than use of basis recovery. Open economy assumptions for the consumption tax cause larger increases in output in the short run and smaller ones in the long run, as compared to a closed economy, although domestic consumption still declines in short run.

The model used is a neoclassical growth model which allows the capital stock to change over time through a savings response; labor also responds to the differences in the tax structure.

There are many unresolved issues and potential refinements associated with the simulations, including uncertainties about the behavioral parameters, the appropriate characterization of certain types of taxes, the need for more tax law details, and the consideration of the reallocation of the capital stock among different types of assets and investments.

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I. Description of Model

A. Model Type

The model is a standard neoclassical growth model. Tax changes influence labor supply and savings rates in a general equilibrium framework. The model includes a production function, labor supply functions, a savings rate determinant, and a process of capital accumulation. Labor and capital are fully employed. While labor supply can respond immediately to changes in prices and incomes, the capital stock changes slowly over time as the savings rate responds to changes in rates of return, and the overall savings amount responds to changes in income. The speed of capital accumulation is determined by the normal growth processes of the economy. For example, if the economy (and the capital stock) is growing at two percent a year, a doubling of the savings rate will increase the capital stock by two percent in the first year, approximately four percent in the second year, and so forth. The growth in the capital stock will gradually drive down the rate of return (dampening the savings response) and increase income (enhancing the savings response).

In the base case simulations, the economy is closed. As a sensitivity analysis, the model is also solved under the opposite extreme of an open economy, with perfectly mobile capital. An arbitrary five-year adjustment period is imposed to moderate the initial response.

B. Levels of Articulation of Different Sectors

1. Number of Household Types

There are eighteen household types supplying labor, corresponding to the existing six marginal tax rates in the economy for each type of tax return (joint, single, head-of-household). There is an aggregate savings rate.

2. Number of Industrial Sectors

There is a single aggregate production function, with labor supply the sum of the supplies of the eighteen households. There is a distinction, however, between business capital and owner-occupied housing; all increases in investment and capital stock are assumed to be in the form of business investment.

3. Detailed Description of Tax Rates

Tax rates in the model are set to reflect the effects of federal, state and local taxes (income, property, sales, payroll, excise).

Each household has an average and a marginal income tax rate on labor income, estimated from the 1993 Individual Statistics of Income. Taxpayers are grouped by initial marginal tax rate and the average tax rate and average income in each group is used for that class of taxpayer. These tax rates are then adjusted to reflect exclusions such as fringe benefits, employer payroll taxes, and noncompliance.[1] These same data were used to determine effective av-

[1] Payroll taxes are estimated based on average levels of wage income in each class; non-pension fringe benefits are based on data reported by the Treasury Department in assessing the increased tax on employers under the Army flat tax proposal, and pension benefits are in pro-

erage and marginal payroll taxes. Table 1 reports these tax rates, along with shares of labor income and the initial ratio of exemption to income for the new tax proposals (in solving the model these ratios fall as wage income rises).

The average marginal income tax, by these calculations, is 18.6 percent, while the average income tax is 10.5 percent, with the average about 56 percent of the marginal. The average-to-marginal ratio in the new simulation depends on the tax rate; for the income tax in the first year it is 64 percent. Hence by this overall measure the tax is flatter in an aggregate sense as well, although a considerable amount of progressivity remains.

The payroll and income tax rates are added together, but must be further adjusted to reflect federal excises and state and local sales and income taxes. Total sales taxes are estimated at 5.1 percent, of which 0.9 percentage points is federal excises; there is also an estimated 2.4 percent of state and local income taxes. These taxes are assumed to be roughly proportional. Assuming a fixed price level, these taxes are passed back in wages and thus the sales taxes are effectively deducted. Thus for individual S 2, the marginal tax rate is (.119 + .126)(1 − .051) + .051 +.024; the average tax rate is (0.067 +0.126)(1-0.051) +0.051+0.024. The federal average tax rate is (0.067 +0.126)(1-0.051) +0.009.

Capital income tax rates are based on the difference between the after tax return on capital and the pretax return, weighted across three types of capital: corporate, noncorporate, and owner occupied housing. These three types of capital initially account for 47 percent, 24 percent, and 29 percent of the capital stock respectively.

The after tax return is:

$$[f(i(1-t)-p)) + (1-f)E(1-v)$$

where f is the share financed by debt, t is the statutory tax rate (adjusted for compliance), E is the equity return in the corporate sector before personal tax, v is the rate of tax on corporate stock, and p is the inflation rate.

portion to income, with a ceiling of $30,000, multiplied by the coverage ratio as reported in Pension and Health Benefits of American Workers, May 1994, published by the U.s. Department of Labor, the Social Security Administration, the Small Business Administration and the Pension Benefit Guaranty Corporation. The rate is set to total these benefits in the national income accounts.

Table 1.—Average and Marginal Federal Income and Payroll Taxes, Labor Income Shares, and Initial Exemption as a Share of Income, by Taxpayer Class

Group	Marginal Income Tax (%)	Average Income Tax (%)	Marginal Payroll Tax (%)	Average PayrollTax (%)	Labor Income Share (%)	Exemption as a Percent of Income, New Tax Regime (Initial)
Single 1	0.0	0.0	13.8	13.8	0.9	(1)
Single 2	11.9	6.7	12.6	12.6	11.0	49.0
Single 3	22.6	12.0	12.4	12.4	9.0	17.0
Single 4	26.6	21.0	2.4	9.2	1.7	7.2
Single 5	32.5	28.0	2.6	5.6	0.4	2.7
Single 6	36.5	31.3	2.6	4.0	0.3	0.6
Joint 1	0.0	0.0	12.8	12.8	1.1	(1)
Joint 2	12.1	6.9	12.6	12.6	29.9	51.9
Joint 3	23.2	11.2	2.4	11.8	20.1	26.1
Joint 4	26.8	15.6	2.4	8.0	5.4	14.6
Joint 5	31.2	17.6	2.4	7.2	5.3	12.1
Joint 6	36.3	26.5	2.6	5.0	5.0	3.8
HofH 1	0.0	0.0	13.4	13.4	0.8	(1)
HofH 2	11.9	4.6	12.4	12.4	6.2	57.6
HofH 3	23.0	11.0	12.6	12.6	2.2	22.7
HofH 4	26.8	11.8	2.4	8.0	0.2	9.4
HofH 5	31.2	19.7	2.4	7.0	0.2	7.9
HofH 6	36.1	27.0	2.8	4.0	0.3	1.7

[1] Not applicable because of lack of tax liability. Tax rates are zero.

The pretax return is:

$$\text{Corporate Sector: } [f(i(1\text{-}u)\text{-}p))+(1\text{-}f)E]/[1\text{-}u^*]$$

$$\text{Noncorporate Sector: } [f(i(1\text{-}t)\text{-}p))+(1\text{-}f)E(1\text{-}v)]/[1\text{-}t^*]$$

$$\text{Owner Occupied Housing: } [f(i(1\text{-}xt)\text{-}p))+(1\text{-}f)E(1\text{-}v)]\ \text{-}yP$$

where u is the corporate tax rate, a * refers to the effective tax rate (adjusted for the deviation between tax and economic depreciation and compliance), x is the share of interest deducted (which is limited for owner-occupied housing), y is the share of property tax deducted, and P is the property tax rate as a percent of property value.

The statutory corporate tax rate adjusted for compliance is 31.25 percent; the effective rate is 30.4 percent. The derived marginal tax rate for individuals is 26 percent, and is the same for both effective and statutory rates, but it is adjusted for compliance to 20.8 percent. The tax on capital gains, which is responsible for a three percentage point rate of return, is 17.6 percent, adjusted for compliance, inflation, exclusion at death and deferral; the rate on dividends adjusted for compliance is 20.8 percent. Tax rates on the receipt of income are also adjusted to reflect the share of corporate stock and interest received by pensions (24 percent and 39 percent respectively). Seventy percent of interest on owner occupied housing is deducted, 50 percent of property tax is deducted, the property tax rate is 1.4 percent, and the inflation rate is a constant 3 percent.

The resulting overall effective tax rate on capital income is 23 percent.

In the simulations, the effective tax rate is the derived tax rate times the share that is business (79 percent of total capital income before behavioral response). Thus a 20 percent derived tax rate would result in a 16 percent effective tax rate on all capital income. For the consumption simulations, the rate is set to zero in the saving rate equation (although taxes are collected on business cash flow for purposes of revenue balance).

These tax rates must be adjusted by state and local property and income taxes, which are estimated at 18 percent; these taxes are deductible, so that the tax rate is 0.23(1-0.18) +0.18. There is also an additional tax of 0.9 percent reflecting estate and gift taxes.

These tax calculations do not account for the alternative minimum tax or the earned income tax credit.

Using these derived tax rates produces an overall average federal tax of 0.211 of net output (NNP) which is reasonably consistent with overall levels. Income tax rates are 12.2 percent of NNP, compared with 11.7 percent in the national income accounts.

In the open economy simulation, the values of i and E are fixed and the capital stock is exogenous. Domestic saving replaces imported capital over time.

C. Key Behavioral Assumptions in the Model (See Appendix for Equations of the Model)

1. Determinants of Labor Supply

Labor supply is the sum of the supplies of the eighteen households. Labor supply is subject to an income effect and a price effect. The percentage change in labor supply is the sum of the percentage change in the after-tax wage times the income elasticity (which is negative, causing labor supply to fall as income rises) and the percentage change in the after-tax marginal wage times the price elasticity (which is positive, causing the labor supply to rise as the marginal wage rises. These elasticities are both set at the absolute value of 0.2, and, since they are equal, the labor supply is not responsive to changes in the wage rate alone. Rather, labor supply responds to differences in average and marginal tax rates (a flatter tax causes an increase in labor supply).

2. Determinants of Investment

Net investment is determined by the private savings rate, which responds to the after-tax rate of return and the disposable income in the economy. The percentage change in the savings rate is the elasticity of savings times the percentage change in after-tax return. That elasticity is set at a constant 0.2 in the income tax simulation and 0.4 in the consumption tax simulation.[2] The percentage change in savings is the percentage change in the savings rate plus the percentage change in disposable income. The economy is assumed to be growing at a steady state of two percent; hence initial savings are two percent of the capital stock.

Gross investment is the sum of net investment plus depreciation, which is set at 3 percent of the capital stock.

The absolute value of government deficits is fixed so that savings is not influenced by government behavior. Federal government spending outside of interest payments is assumed to be fixed, and the tax rate is adjusted so as to keep the deficit fixed. Interest payments change exogenously with the interest rate. While the model does not explicitly consider the debt-equity choice, it does allow for the fact that a subsidy for interest currently exists at the firm level because of the deduction of the inflation portion of interest. The cost of capital would rise with the reduction or elimination of that tax even if there is no adjustment in savings or the capital stock. Thus, the interest rate is reduced initially to hold the cost of capital constant; it is also subsequently adjusted to reflect the change in the pre-tax cost of capital—an adjustment that reflects general equilibrium conditions and in theory could be positive or negative.[3] In general, this initial fall in the interest rate is the change in the tax rates associated with the deduction of interest, times the infla-

[2] The higher elasticity for the consumption tax simulation, which is at the upper end of empirical estimates of the savings elasticity, is chosen to reflect the theoretical expectation that there are some redistributional shifts in a consumption tax shift that should cause a larger savings response. Because these redistributional effects are delayed in the consumption shift with transition relief, the lower elasticity is use for that simulation except in the long run steady state.

[3] This issue of the interest rate is discussed in greater detail in a recent CRS report: *The Flat Tax and Other Proposals: Effects on Housing,* by Jane G. Gravelle, Report 96–379 E, April 29, 1996, pp. 12–13.

tion rate; this reduction is multiplied by the outstanding debt to obtain the effect on interest payments. (The inflation rate is fixed).

3. Determinants of GDP Growth

The steady state growth rate of the economy is 2 percent. The model is calibrated initially with 75 percent of Net National Product (NNP) attributable to labor income and 25 percent attributable to capital income. (All baseline assumptions are given in table 2). With a capital output ratio of 3.5 and a depreciation rate of 3 percent, GDP is 1.105 times NNP, and capital income accounts for about a third of total output. The production function is Cobb-Douglas (characterized by a unitary factor substitution elasticity). All simulations results are relative to baseline, so that the growth rate of GDP compared to the baseline is one-third of the growth of the capital stock above the baseline plus two-thirds of the change in labor supply. Labor supply can rise or fall depending on tax rate changes.

4. Interactions Among the Assumptions

Because the model is a general equilibrium model, changes in factor supplies cause endogenous changes in income, prices and required tax rates which in turn moderate supply responses. Because the labor supply is unresponsive to the wage rate (due to offsetting income and substitution effects) it is driven by the tax rate and by the rise in income relative to exemption levels. Higher tax rates that are required in the consumption simulations dampen the labor supply response. The tax rates are sufficiently high enough in the consumption tax with transition relief to cause a negative response in the short run. In the consumption tax simulations, the labor supply increases over time as income increases and tax rates fall. However, the tax rate does not fall over time in the income tax simulation because during the transition a declining amount of pension payments to individuals derived from previously deductible contributions continue to be taxed.

The capital stock increases over time, as induced savings accumulates. The actual amount in increased savings per year may either rise or decline over time because the increase in the savings rate declines over time as the rate of return declines (given the positive savings rate elasticity), but savings increases with the increases in income.

Table 2.—Base Case Assumptions

[All quantities are per dollar of NNP, NA means not applicable]

1. GDP	1.105
2. Consumption	0.623
3. Exports	NA (Closed Economy)
4. Imports	NA (Closed Economy)
5. Government Spending	NA/Fixed Except for Interest
6. Gross Investment	0.175
7. Capital Stock	3.5
8. Capital Consumption Allowances (all capital).	0.105
9. Residential Investment	NA, Aggregated Capital Stock[1]
10. Residential Capital Stock	NA, Aggregated Capital Stock[1]
11. Residential Capital Depreciation.	NA, Aggregated Capital Stock[1]
12. Labor	0.75
13. Real After-Tax Wage	average marginal $0.665, average $0.718
14. Real Before-Tax Wage	$1
15. Real After-Tax Rate of Return.	0.0445
16. Real Before Tax Rate of Return.	0.0714
17. Price Level	the numeraire, set at 1
18. Government Debt	NA, Fixed
19. Federal Deficit	NA, Fixed
20. Interest Payments on Federal Government Debt.	0.033
21. Before Credit Tax Base	Not calculated for baseline
22. After Credit Tax Base	Not calculated for baseline; for new regimes initially 0.572 for income tax, 0.475 for consumption tax, 0.372 for consumption tax with transition.
23. Aggregate Wages	0.75
24. Tax Receives—Federal Excluding Payroll.	0.124
25. Payroll Tax Receipts	0.081
26. Statutory Tax Rates	NA to Baseline, Multiple rates
27. Rest of World Factor Income Flows.	NA, Closed Economy
28. Rest of World Capital Flows	NA, Closed Economy
29. Private Saving (net)	0.07
30. Personal saving	No distinction between personal and private
31. Unemployment Rate	NA, Full Employment Model

[1] The model does identify owner-occupied housing which accounts for 29 percent of the initial capital stock. Owner occupied housing is fixed in all simulations, so that any additional investment is business investment; this assumption matters in the revenue equation because business investment is expensed and cash flows are taxed, while owner occupied housing is exempt from tax. Owner occupied housing might actually decline slightly in the short run, and could either decrease or increase in the long run.

This is a steady state growth model with a real growth rate of 2 percent per year and an inflation rate of 3 percent, for a nominal growth rate of slightly over 5 percent per year.

5. Behavior of Monetary Authority (No Money)

6. Behavior of the International Sector

In the base case, there is no international sector. There is, however, an open-economy experiment, in which the interest rate and the return on equity capital after the corporate tax (but before the personal tax) are fixed, except in the five year adjustment period where they are allowed to rise. During that period capital flows in from abroad until these values return to their initial levels, and the capital stock grows much more rapidly than in the closed economy case. Domestic consumption is, however, reduced by the payments on interest on foreign-owned capital, and the increased investment lowers the tax base in the case of the consumption tax, causing higher tax rates and a smaller labor supply response.

II. Model Simulation Results

A. Description of Results

The results of three simulations: the unified flat income tax, the consumption (VAT/flat) tax, and the consumption (VAT/flat) with transition relief, are shown in tables 3–5.

Both proposals allow a wage exemption/credit. Because of the nature of the model, which is a general equilibrium model where the rate of involuntary unemployment does not respond to tax revisions and where the capital stock is highly aggregated, the flat rate consumption tax is equivalent to a value-added tax with a wage credit.[4]

All of the proposals are characterized by a single tax rate, by a flat exemption of $10,000 for each taxpayer (and spouse, for joint returns), along with a $5000 deduction for children and other dependents.[5] Both proposals expand the tax base by eliminating itemized deductions and including fringe benefits appropriate to the particular tax base concept (a comprehensive income or a comprehensive consumption base). (Payments on behalf of workers for pensions and pension earnings are included in income under the income tax, with benefits not taxed, while benefits are taxed and payments and earnings exempt under the consumption tax. During the transition, however, pension benefits paid from previously deductible contributions are taxed under the income tax.)

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[4] There would, however, be important differences between a direct flat rate consumption tax like the flat tax proposed by Representative Armey and an indirect consumption tax such as a VAT that are not captured by this model. A VAT would shift the locus of taxes from individuals to businesses, which would be likely to create some significant short term dislocation, and which would probably need to be moderated as much as feasible via a price accommodation. This price accommodation would also cause the lump sum tax on existing capital that is an intrinsic part of the consumption tax base to be shared between debt and equity, while the Armey flat tax would impose the entire tax on equity capital. The price accommodation under a VAT would also effectively impose the lump sum tax on existing government securities held by the public by lowering the real value of those securities, and would also burden unindexed transfers.

[5] These exemption levels are assumed to keep pace with inflation and income growth; otherwise, they would asymptotically fall to zero over time.

Table 3.—Summary Variables: Income Tax Revision

[All results are percentage changes from baseline, except for tax base and rates, which are in percentages, the base relative to GDP]

Variable	1997	1998	1999	2000	2005	2010	2025	Long run
1. GDP	0.49	0.51	0.53	0.55	0.65	0.74	0.96	1.76
2. Consumption	0.45	0.48	0.50	0.53	0.64	0.75	1.02	1.97
6. Gross Investment	1.45	1.50	1.54	1.59	1.79	1.98	2.44	4.11
7. Capital Stock	0.00	0.07	0.14	0.21	0.54	0.85	1.59	4.11
8. CCA	0.00	0.07	0.14	0.21	0.54	0.85	1.59	4.11
12. Labor	0.71	0.71	0.71	0.71	0.70	0.69	0.67	0.67
13a. After-tax Wage (Marginal)	0.31	0.34	0.36	0.39	0.54	0.55	0.55	1.65
13b. After-tax Wage (Average)	−3.21	−3.18	−3.15	−3.14	−2.98	−2.98	−2.99	−1.93
14. Wage	−0.23	−0.21	−0.18	−0.16	−0.05	0.05	0.30	1.09
15. After-tax Return	14.64	14.52	14.41	14.31	13.81	13.38	12.40	9.74
16. Pre-tax Return	0.70	0.62	0.55	0.48	0.15	−0.15	−0.88	−3.22
20. Interest on Debt	−4.77	−4.76	−4.75	−4.74	−4.74	−4.71	−4.69	−4.64
21. Before-Credit Tax Base	77.4	77.3	77.2	77.0	76.5	76.2	75.4	75.2
23. Wage Income	0.48	0.50	0.53	0.55	0.65	0.74	0.97	1.77
24. Fed. Non-payroll Tax	−0.74	−0.74	−0.74	−0.74	−0.74	−0.73	−0.73	−0.72
25. Fed. Payroll Tax	−0.11	−0.10	−0.10	−0.09	−0.05	−0.02	0.07	0.39
26. Tax Rates	19.71	19.74	19.78	19.81	19.95	20.05	20.24	20.25
29. Private Savings	3.64	3.64	3.64	3.64	3.66	3.67	3.74	4.10

Table 4.—Summary Variables: Consumption Tax Revision, No Transition

[All results are percentage changes from baseline, except for tax bases and rates, which are in percentages, the base relative to GDP]

Variable	1997	1998	1999	2000	2005	2010	2025	Long run
1. GDP	0.10	0.17	0.25	0.32	0.67	0.97	1.72	3.65
2. Consumption	−1.13	−1.04	−0.94	−0.85	−0.41	−0.02	0.92	3.34
6. Gross Investment	4.65	4.79	4.92	5.05	5.67	6.22	7.57	11.15
7. Capital Stock	0.00	0.23	0.46	0.68	1.73	2.68	4.98	11.15
8. CCA	0.00	0.23	0.46	0.68	1.73	2.68	4.98	11.15
12. Labor	0.14	0.14	0.15	0.15	0.16	0.18	0.21	0.29
13a. After-tax Wage (Marginal)	−4.42	−4.35	−4.28	−4.21	−3.90	−3.61	−2.92	−1.13
13b. After-tax Wage (Average)	−5.08	−5.01	−4.94	−4.87	−4.56	−4.29	−3.61	−1.87
14. Wage	−0.05	0.03	0.10	0.17	0.50	0.80	1.52	3.39
15. After-tax Return	30.48	30.19	29.91	29.63	28.34	27.20	24.49	17.71
16. Pre-tax Return	0.14	−0.09	−0.30	−0.52	−1.50	−2.38	−4.46	−9.67
20. Interest on Debt	−9.15	−9.03	−9.22	−9.42	−10.32	−11.12	−13.02	−13.35
21. Before-Credit Tax Base	70.0	70.0	70.1	70.1	70.4	70.6	71.0	72.3
23. Wage Income	0.10	0.17	0.25	0.32	0.67	0.98	1.73	3.69
24. Fed. Non-payroll Tax	−0.62	−0.62	−0.62	−0.62	−0.62	−0.62	−0.64	−0.66
25. Fed. Payroll Tax	−0.33	−0.30	−0.27	−0.24	−0.10	0.03	0.33	1.12
26. Tax Rates	23.40	23.37	23.34	23.32	23.19	23.08	22.81	22.15
29. Private Savings	11.63	11.62	11.62	11.61	11.58	11.54	11.45	11.12

Table 5.—Summary Variables: Consumption Tax Revision, Transition

[All results are percentage changes from baseline, except for tax bases and rates, which are in percentages, the base relative to GDP]

Variable	1997	1998	1999	2000	2005	2010	2025	Long run
1. GDP	−0.20	−0.14	−0.09	−0.04	0.26	0.45	0.94	3.65
2. Consumption	−0.92	−0.86	−0.79	−0.72	−0.32	−0.07	0.54	3.34
6. Gross Investment	2.06	2.14	2.23	2.31	2.75	3.10	4.00	11.15
7. Capital Stock	0.00	0.10	0.21	0.31	0.81	1.28	2.53	11.15
8. CCA	0.00	0.10	0.21	0.31	0.81	1.28	2.53	11.15
12. Labor	−0.28	−0.26	−0.23	−0.21	−0.11	0.06	0.19	0.29
13a. After-tax Wage (Marginal)	−9.35	−9.33	−9.30	−9.28	−9.20	−9.08	−8.75	−1.13
13b. After-tax Wage (Average)	−8.00	−7.98	−7.96	−7.94	−7.86	−7.74	−7.42	−1.87
14. Wage	0.09	0.12	0.14	0.17	0.26	0.39	0.75	3.39
15. After-tax Return	29.94	29.84	29.75	29.65	29.28	28.77	27.39	17.71
16. Pre-tax Return	−0.28	−0.35	−0.43	−0.50	−0.78	−1.17	−2.23	−9.67
20. Interest on Debt	−9.15	−9.40	−9.46	−9.53	−9.77	−10.12	−11.08	−13.23
21. Before-Credit Tax Base	63.0	63.4	63.8	64.1	67.3	68.4	69.8	72.3
23. Wage Income	−0.19	−0.14	−0.06	−0.04	0.26	0.46	0.95	3.69
24. Fed. Nonpayroll Tax	−0.48	−0.47	−0.45	−0.51	−0.57	−0.59	−0.63	−0.66
25. Fed. Payroll Tax	−0.49	−0.47	−0.45	−0.42	−0.28	−0.19	0.02	1.12
26. Tax Rates	27.20	26.96	26.73	26.52	24.73	24.14	22.95	22.15
29. Private Savings	5.15	5.21	5.26	5.31	5.52	5.83	6.20	11.15

Also presented are simulations of a consumption tax which allows transition relief for the lump sum tax on old capital that arises with a shift to a consumption tax base. This transition relief is provided through recovery of basis. Basis recovery is assumed following the guidelines provided by the JCT: an undepreciated basis of $5 trillion, inventories of $1 trillion, and outstanding net operating losses (NOLs) of $500 billion, recovered respectively over 15 years, 5 years, and 10 years. This provision results in some relief for the recovery of principal, although that relief is not immediate. As a result, a tax is still borne on some of the earnings on the existing capital stock. The major effect of this relief is to require significantly higher tax rates in the transition; the long run steady state is not affected.

Initially, output rises more in the income tax simulation (one-half of a percent) than in the consumption tax simulation (one-tenth of a percent) and actually falls by two-tenths of a percent in the consumption simulation with transition. This difference occurs because the initial effects depend primarily on labor supply response, which is driven by the tax rate. Since the tax base is smaller under the consumption tax, and even smaller under the consumption tax with transition, the tax rates are lowest and the labor supply response highest in the income tax case.

Changes after the first year are negligible for the income tax, both because the capital stock expands more slowly than in the consumption tax case and because the income tax base shrinks slightly due to the decline in taxable pension benefits. Effects grow somewhat more quickly in the consumption tax case (and reverse in the consumption case with transition) because of the growth in the capital stock (although the year-to-year changes remain under a tenth of a percent). The growth in the capital stock directly increases output and also increases the tax base allowing a lower tax rate and a slightly higher labor supply. After ten years (2005) both the income and consumption shifts have resulted in an increase close to seven-tenths of a percent over base line, while output changes under the consumption tax with transition have become positive.

By 2025, some thirty years into the future, output has increased by 1 percent in the income tax case, by 1.7 percent in the consumption case, and 1 percent in the consumption tax with transition. Output will continue to grow—in the long run steady state the income tax will increase output by 1.8 percent, and the consumption tax (with and without transition) will increase output by 3.7 percent.

Of course, the greater growth in the consumption tax scenario is reflected in a decline in consumption that persists for the first 15 years or so. This consumption must be sacrificed in order to increase savings and increase consumption in the long run. The loss in consumption is part of the price of future higher output. Not reflected in the table is the loss of leisure which is the cost of greater output due to greater labor supply. This loss is greater in the income tax case than in the consumption tax case.

Tables 6 and 7 show truncated results for two other types of simulations that help to illuminate the model. The first is a simulation that allows complete transition relief by eliminating the business cash flow tax—relying only on a wage tax. The wage tax has larger negative effects in the short run, because the tax base is smaller and the tax rate is higher, and smaller effects in the long run both because of the higher tax rate and the lower savings elasticity assumed for the wage simulation. The capital stock increases by only half as much and the labor supply actually falls in the long run. This comparison also illustrates that the method of providing transition relief is important. With basis adjustment, the lump sum tax on old capital is partially relieved for initial capital owners and the taxes are made by spreading the burden to intermediate but not to long run generations. Using the wage tax approach requires permanently higher tax rates and spreads the tax burden to all generations.

Table 6.—Wage Tax Simulation

[All Results Are Percentage Changes from Baseline, Except for Tax Rates, which are in Percentages]

Variable	1997	1998	1999	2000	2005	2010	2025	Long run
GDP	−0.26	−0.22	−0.19	−0.16	0.00	0.14	0.50	3.11
Consumption	−1.02	−0.98	−0.94	−0.90	−0.71	−0.54	−0.11	2.59
Capital	0.00	0.10	0.20	0.30	0.76	1.19	2.27	10.43
Labor	−0.38	−0.38	−0.37	−0.37	−0.36	−0.35	−0.33	−0.18
Tax Rate	27.96	27.94	27.93	27.91	27.83	27.76	27.59	26.36

Table 7.—Consumption Tax Simulation, Open Economy, Five Year Adjustment Period, No Transition Relief

[All Results Are Percentage Changes from Baseline, Except for Tax Rates, which are in Percentages]

Variable	1997	1998	1999	2000	2005	2010	2025	Long run
GDP	0.40	0.81	1.22	1.64	2.30	2.30	2.31	2.38
Consumption	−1.05	−0.65	−0.36	−0.07	0.49	0.68	1.17	3.05
Capital	1.25	2.53	3.84	5.17	6.78	6.78	6.80	6.86
Labor	0.00	0.00	0.01	0.01	0.24	0.25	0.26	0.23
Tax Rate	24.68	24.67	24.65	24.63	22.54	22.49	22.37	21.80

The second is a simulation of a consumption tax that assumes an open economy, with a five-year adjustment period. This assumption causes larger effects in the short run, with an initial increase of four-tenths of one percent rising quickly to an increase of 2.3 percent. The long-run effects are, however, smaller than in the closed economy case. This open-economy assumption is an extreme one, with perfect capital mobility and perfect product substitution, treating the U.S. as a small country. In this case, the prices that face foreigners are fixed (allowing for a five year adjustment). This treatment does not fix the after tax real return to U.S. savers; rather it fixes the returns faced by foreigners, net of business taxes but before personal taxes (e.g. the interest rate and the return on corporate equity after corporate tax but before personal tax). Because the U.S. is a large country, even with perfect capital mobility there would be some adjustment of world prices, which would move the simulations back toward the closed economy model (perhaps a third of the way back). Imperfect portfolio substitution and imperfect product substitution (since foreign investors must be paid their returns in the form of U.S. production) would further move this simulation back towards the closed economy simulation. In addition, a greater substitutability of debt as compared to equity capital could cause the capital stock to contract rather than expand with an open economy simulation, since the loss of interest deductibility by firms raises the cost of capital. This occurs because the current tax treatment actually subsidizes debt financed capital at the firm level by allowing a deduction for the inflation portion of the interest rate.

B. Key Behavioral Reasons for Results

As noted above, the labor supply response, which is driven by the tax rate, dominates the short run results. Any rule that contracts the tax base (including the deduction of net investment in the case of the consumption tax and the additional deduction of basis under transition relief) and drives up the tax rate tends to mute or possibly reverse the labor supply response. Among other effects, the initial tax rate in the income tax simulation is lower because of the continuing taxation of pension incomes—for a period of time, contributions are not deducted and most pension income is still taxed. That effect fades away over time, however, and disappears entirely in the long run.

In the long run, the accumulation of capital becomes more important. The consumption tax produces larger long-run effects because the savings elasticity is assumed to be larger and because the tax rate on new investment is cut more. Both play a role. If the consumption tax were simulated using the lower savings elasticity of 0.2, the long-run effect would be an increase of 2.3 percent rather than 3.7 percent, largely because the capital stock would increase by 6.9 percent rather than 11.2 percent. Labor supply is affected minimally.

To illustrate the sensitivity of the results to the choice of elasticities, results for GDP and consumption are presented in table 8, for the first year and the long run steady state, using a variety of assumptions regarding labor supply and savings.

Table 8.—Percentage Change in Income (Consumption) for the Income Tax and Consumption Tax Revision, First Year and Long Run, for Alternative Elasticities

Labor supply elasticity	Savings elasticity	Income tax, first year	Income tax, long run	Consumption tax, first year	Consumption tax, long run
0.2	0.2	0.49	1.76	0.11	2.34
		(0.45)	(1.97)	(−0.45)	(2.21)
0.2	0.4	0.49	2.38	0.10	3.65
		(0.12)	(2.52)	(−1.13)	(3.34)
0.2	0.0	0.49	0.79	0.12	0.23
		(0.77)	(1.09)	(0.19)	(0.31)
0.4	0.2	1.01	2.66	0.24	2.68
		(1.26)	(3.21)	(−0.25)	(2.71)
0.4	0.4	1.01	3.21	0.22	4.06
		(0.91)	(3.29)	(−0.96)	(3.91)
0.4	0.0	1.01	1.67	0.27	0.51
		(1.60)	(2.31)	(0.42)	(0.70)

The results are also affected by the factor substitution elasticity, although the effects are negligible in the short run, since labor is not responsive to the wage rate and the capital stock has changed very little. There are effects in the longer run, however. If that elasticity is lowered from 1.0 to 0.5, the simulations for the base case for the income tax (with a savings elasticity of 0.2) decreases the output effect in the long run steady state from 1.76 percent to 1.55 percent. In the case of the consumption tax (with a savings elasticity of 0.4), the 3.65 percent increase is reduced to 2.62 percent.

This model does not capture efficiency gains, which would usually be relatively small and show up in part in the mix of goods. It is possible that efficiency gains associated with the reallocation of capital would be large enough to increase output slightly.

C. Importance of Specific Features of the Proposals

1. Low Income Relief

A flat rate tax with no low income relief would produce a significantly larger labor supply response (and a larger capital accumulation because of increased income). In the case of the income tax, output would rise by 1.55 percent in the first year (and consumption would increase by 2.02 percent). In the long run, output would increase by 4 percent (with a 4.93 percent increase in consumption). In the consumption tax case, output would initially rise by 1.56 percent (and consumption by 1.05 percent); in the long run output would rise by 6.01 percent (and consumption by 6.63 percent).

2. Transition Measures

As shown in the comparison tables, allowing basic recovery for the consumption tax would cause a contraction in short run output (in the first five years), although that contraction would be small. This effect arises largely from the higher tax rate required because of the revenue loss. Output would be substantially lower even quite far into the future, although that effect reflects largely the presumption of a smaller savings response due to the lack of intergenerational redistribution rather than the contraction of the tax base. There is no effect in the long run steady state.

3. Government Deficits

All deficits are fixed to be the same as in the baseline and have no effect on the outcome.

III. Evaluation of the Model's Strengths and Weakness

A. Short-Run vs. Long-Run Predictions

The strengths and weaknesses of this model can be understood most clearly by comparing it to the alternatives. Briefly, however, the strengths of the model are that it is aimed at consistency with empirical evidence on the fundamental supply responses in the economy (of labor and capital) and is simple enough to be tailored to the particular task at hand, examining the effects of a general structural tax change.

Its weaknesses are that it is not built up from fundamental economic building blocks (lifetime utility functions) and that it is highly aggregated so that it cannot evaluate effects across sectors. In addition, it does not deal with short run dislocations and adjustment costs because it is a full employment model.

The following discussion elaborates on these issues. First, the model can be contrasted with the more stylized life-cycle and infinite-horizon intertemporal models. While these models are also consistent with neoclassical growth theory, they are constructed from utility functions and the supplies and demands are derived from these functions. The model used in this study is basically a "reduced form" model that introduces direct supply elasticities for labor and savings. The more stylized models are more rooted in economic theory, but at the same time they are captive of their own assumptions and structure, some of which simply reflect familiar and simple mathematical forms. They may produce changes in capital and labor that are highly inconsistent with observations of these changes in the economy. The reduced-form model used in this paper can be tied to any direct empirical evidence on savings response and labor supply. In particular, the results are consistent with two important observations about the economy: the labor supply does not appear to change substantially with respect to changes in the wage or significant changes in the structure of taxes and the savings rate does not change very much with respect to changes in real interest rates or tax rules—at least not in a way that would cause significant short-term changes in the capital stock.

In essence, this modeling approach sacrifices theoretical purity for greater consistency with empirical evidence. Ideally, we would prefer a model that is fully derived from the basic theoretical building blocks of economic theory but that also predicts outcomes consistent with observations of the economy. It is not clear that we have yet developed such a model.

The model presented in this paper also differs from the macroeconomic models which also may have some neoclassical growth elements but which are focused primarily on short run disequilibrium effects. These disequilibrium models are also reduced form models that may have even less of a formal grounding in utility and production functions, since some relationships are developed for forecasting purposes. A disadvantage of the model presented in this paper is that it cannot take into account the disruption caused by changes in relative prices, income, and production in the short run that is likely, other things equal, to lead to some unemployment. (At the same time, existing disequilibrium models are not primarily designed to estimate the effects of structural tax replacement, but rather of general monetary and fiscal policies).

The model presented in this paper provides a reasonably good means of predicting the general magnitude of fundamental supply side responses that are consistent with the direct evidence of labor supply response and savings response. It does so in a general equilibrium framework that is consistent with observations of the nature of long-term growth paths. The sensitivity analysis also suggests that effects will not be dramatically different in an open economy or with reasonable variations in elasticities. Assuming that these responses persist, it also provides a reasonably good means of predicting longer-run effects as well. Fundamentally, the evidence suggests that these effects tend to be relatively small, and hence that any revenue feedback effects will be small, especially in the short run.

Because a major tax change is likely to be disruptive, the short run positive effects are actually likely to overestimate the actual effects. Since disruption is likely to be costly, positive effects may be smaller or may become negative effects. The disruption associated with a tax change that requires a significant price accommodation (such as a VAT) due to a shift in the point of collection of large amounts of revenue could be very serious and cause significant short run dislocation and declines in output.

B. Level of Uncertainty with Respect to Assumptions

1. Labor Supply

An extensive body of literature suggests that the overall labor supply is not very responsive to changes in relative prices.

Most studies of male labor supply response from statistical data are negative but only slightly so; estimates of female elasticity have varied substantially. These studies compare the labor supply of individuals at different wage levels, and there are many such studies. A recent CBO study placed the uncompensated elasticity in a range between 0 and 0.3, weighted for male and secondary earners (female) hours.[6] These reflected a range of −0.1 to 0.2 for male supply and 0.3 to 0.7 for female secondary earners supply. The substitution elasticities ranged from 0.2 to 0.4. Much of the response for secondary earners is in participation rates rather than hours worked. These ranges were based on certain studies that explicitly considered taxes. Other studies, mostly prepared by labor economists, referenced in the CBO paper tended to find in virtually all cases slightly negative responses for males, and higher but much more variable results for females. Rogers and Randolph indicate a range of −0.1 to 0.3 for their sensitivity analysis for the uncompensated elasticity.[7] A well-known general equilibrium tax model of the economy used a weighted average of 0.15 for the uncompensated elasticity, which appears to be at the high end of the ranges reported in that study; the range would be between −0.1 and 0.2, for a midpoint of 0.05.[8] In addition, many of these summaries reflect estimates for married women, who have tended to have higher elasticities than unmarried women who also make up a significant part of the labor force. Thus, these reviews are consistent with a roughly fixed uncompensated labor supply response, and a compensated elasticity of 0.2.

Note also that the response in the short run may be smaller than suggested by the cross section studies, because it is not easy to quickly change jobs or hours for many types of employees. Thus the labor supply response may be too large for the initial years of the simulation.

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[6] See "Labor Supply and Taxes," Congressional Budget Office Memorandum, January 1996.

[7] William C. Randolph and Diane Lim Rogers, "The Implications for Tax Policy of Uncertainty About Labor Supply and Savings Responses," *National Tax Journal,* Vol. 48, September, 1995, pp. 429–446.

[8] Charles L. Ballard, Don Fullerton, John B. Shoven and John Whalley, *AS General Equilibrium Model for Tax Policy Evaluation,* Chicago, University of Chicago Press, 1985.

There are some other kinds of evidence on labor supply response. For example, the hours worked per week and participation rate of prime-age men have changed very little over the post-war period, despite a substantial rise in the real wage and substantial changes in tax rules. Prior to that period there was a downward trend. Thus, it is difficult to envision a small positive response, and certainly not a large one, for this group. Participation has actually declined among men as a whole (although that partially reflects increased investment in education and the availability of retirement income).[9] Average weekly hours of work for women of prime working age have also remained constant or declined, although participation rates have risen (the participation trend may also reflect other factors).[10] These observations tend to rule out large labor supply responses, either compensated or uncompensated. These observations increase the reliability one might place on the relatively small labor responses drawn from cross section studies.

Allowing equal income and substitution effects, which makes the labor supply inelastic with respect to changes in the wage rate (although not with respect to tax rates), does tend to make labor supply responses a bit larger in the short run (when an expansion of labor supply tends to drive the wage rate down) and a bit smaller in the long run (when an expansion in the capital stock tends to raise the wage rate), if labor supply were assumed to respond positively to the wage rate. (The opposite effects occur if it were assumed to respond negatively). The assumption of equal income and substitution effects also, however, deals with a difficult problem of neoclassical growth models. Since the real wage tends to increase constantly over time, due to technological progress, labor supply would tend to increase without limit if substitution elasticities were larger than income elasticities and would tend to decrease without limit if the opposite were true. This problem does not present a technical problem with solving the model because of the way the solution methods are set up , but is a pervasive conceptual challenge to any growth model.

2. Savings

Empirical evidence on the savings elasticity indicates a small response, which some studies find to be negative, some positive, and many find not to be statistically significant.[11] There are theoretical reasons to believe that there would be a higher rate with a consumption tax because of the redistribution of income. The savings elasticity for the consumption tax case is set at 0.4, one of the higher values in the literature and the higher one reported by Michael Boskin in his 1978 study ("Taxation, Savings and the Rate of Interest," *Journal of Political Economy*, vol. 86, January, pp. S3–S27). The rate is set at 0.2 for the income tax, for the transition years with basis recovery, and for the wage tax.

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[9] See John Pencavel, "Labor Supply of Men: A Survey," In Handbook of Labor Economics, Vol. 1, Ed. Orley Ashenfelter and Richard Layard, New York, North-Holland, 1986, pp. 2–102.

[10] See Mark R. Killingsworth and James J. Heckman, "Female Labor Supply: A Survey," *Handbook of Labor Economics*, Vol. 1, Ed. Orley Ashenfelter and Richard Layard, New York, North-Holland, 1986, pp. 2–102.

[11] This literature is reviewed in Jane G. Gravelle, *The Economic Effects of Taxing Capital Income*, Cambridge Mass., MIT Press, 1994, chapter 2.

There are many reservations about the savings studies, which are very difficult to implement, particularly as they rely on time series evidence where it is difficult to control for all of the variables. Nevertheless, the evidence does strongly suggest that there will not be responses that are significant enough to change the capital stock markedly in the short run. The uncertainty about this effect does lead to some uncertainly in the longer run, although large elasticities do tend to be self correcting because the savings response is dampened as the capital stock increases and reduces the rate of return. Even moving the elasticity up to one would produce an increase of only 5.7 percent in output in the long run steady state for the consumption tax shift, as compared to the 3.7 percent predicted in the base case. (In the short run, output increases would actually be smaller, only 0.05 percent, because the larger savings response would reduce the consumption tax base. But the tax rate required would be only slightly different—23.98 percent rather than 23.38 percent). One cannot, by the way, rule out the possibility of a negative savings response in some cases; some studies have found such a result.

3. Capital Flows

The open economy experiment allows the testing of the limits of the open economy assumption for adjusting more quickly in the short run. The greatest uncertainty here is probably not whether the effect will be a much greater positive: relaxing the small country assumption and the assumptions of perfect substitution in investment and consumption would all tend to move the open economy results back towards those of a closed economy. Rather, there is a possibility that debt capital is more mobile than equity and that capital will flow out of the U.S. rather than into it. Nevertheless, the evidence on international capital flows does not generally suggest that they are large relative to the magnitude of the capital stock, again suggesting that open economy assumptions would make only a slight difference in the results.

4. Efficiency Gains

These effects are not considered but are likely to be small relative to output. Even studies that find relatively large efficiency gains would find small gains relative to output and many of these gains would be in the composition of output rather than the productivity of output. The model does assume a significant shift of capital into the business (taxed) sector.

5. Deficit

Deficits are held constant.

C. Suitability for Evaluating Limited Tax Proposals

This model could be easily adapted to other proposals if the effects on marginal and average tax rates on wages and on capital income can be estimated. A more limited proposal would simply have more limited changes. Its predictions are, however, limited to aggregate labor and savings supply responses, do not address microeconomic allocational and realization-of-income effects (e.g. changes in capital gains realizations). In a broad tax regime with uniform taxation of capital, these effects are not relevant, but they could be relevant with more narrow changes, particularly in the treatment of capital income. Previous experience with other models suggests that micro-responses can be modeled separately and the results can be added with little loss of precision, however. The model could also be applied to proposals that lose or gain revenue by allowing an increase in the deficit or assuming cuts in spending programs that do not have behavioral responses or whose behavioral responses are separately determined. A growing deficit would not allow a steady state solution, however.

Appendix

The model is set up to calculate values over time in terms of year-one output levels, to simplify calculation of percentage changes. Thus, it measures changes from the normal growth path. The price of the good is set at 1 and is the numeraire of the model.

Much of the detail in the model is aimed at differentiating across individuals with different income levels and different relationships between marginal and average tax rates. There are eighteen categories of individuals.

The production function is a Constant Elasticity of Substitution (CES) function:

$$(1)\quad Q_t = A\,[aK_t^{(1-1/S)} + (1-a)L_t^{(1-1/S)}]^{(1/(1-1/S))}$$

where Q_t is output at time t, K_t is the capital stock at time t, and L_t is labor at time t. S is the factor substitution elasticity in absolute value (the percentage change in the capital/labor ratio divided by the percentage change in the relative prices of capital and labor). A and a are constants.

The second through the 19th equations in the model are the labor supply functions:

$$(2) - (19)\quad L_{ti} = b_i\,[W_t(1-t_{mi})]^{E_S}\,[W_t(1-t_{ai})]^{E_I} \qquad i = 1\text{-}18.$$

L_{ti} is the labor supply of the ith class of individuals at time t, b_i is a constant, W_t is the wage rate at time t, t_{mi} is the marginal tax rate of the ith individual at time t, and t_{ai} is the average tax. E_S and E_I are the substitution and income elasticities (and hence E_S is the compensated labor supply elasticity). The income elasticity is negative. Labor is supplied in effective units that have a common wage rate.

There is also a savings rate relationship:

$$(20)\quad s_t = c\,[R_t(1-t_R)]^{E_R}$$

where s_t is the savings rate at time t, c is a constant, R_t is the rate of return at time t, t_R is the tax rate on capital income (weighted for the types of capital), and E_R is the savings elasticity (the percentage change in savings given a percentage change in the real after tax rate of return).

Finally, there is an equation describing the capital accumulation process:

$$(21)\quad K_{(t+1)} - K_t = [s_t(Q_t - T - dK_t) - nK_t]/(1-n)$$

where T is the overall tax, n is the steady state growth rate of the economy, and d is the depreciation rate. This formulation provides for savings as a percent of disposable income.

The model now contains twenty-four unknowns: output, eighteen labor supply quantities, capital in two periods, and the wage rate, rate of return, and savings rate.

To complete the model, profits are maximized; the production function is differentiated to obtain two first order conditions, which can be expressed as:

$$(22)\ K_t/L_t = [(a/(1-a))(W_t/(R_t + d))]^S$$

$$(23)\ K_t/Q_t = [at/(R_t+d))]^S A^{(S-1)}$$

Finally, in each period, the current capital stock, K_t, is held constant; once a solution is obtained for all other variables, the new capital stock is found and is then fixed for the next period. Thus, one variable, the capital stock, is known at the beginning of each years' simulation, and for any one simulation there are only 23 variables, corresponding to the 23 equations.

The model can also be solved for the long run steady state when the capital stock (adjusted for growth) is not changing. In that case, the left hand side of equation (21) is set to zero and there is a single capital stock. This form of the equation is also used for calibrating the model with the initial equilibrium.

When modeling the open economy exercise, the pretax rate of return is set exogenously by moving over five years, in equal increments to shift the current pretax return to one that reflects a fixed interest rate and return to corporate equity after corporate tax.

For the replacement exercises done in this study, tax rates are set in the model to hold the deficit fixed. All spending, except for interest on the debt, is fixed, so that the new tax rate is set so as to hold tax revenues net of changes in the interest on the debt fixed. Since income taxes are set at a flat rate in the new equilibrium, introducing a new variable, there is another equation that sets revenues at a fixed level. The tax rate varies from year to year.

This last equation varies for each type of tax simulation. Current revenues are the current tax rate on capital income, times the amount of capital income plus the current tax rate on labor income times the amount of labor income. The current tax rates are weighted to reflect, for the capital income tax, the different tax rates in different sectors including a tax rate close to zero for owner-occupied housing. For the tax on wage income, the tax is weighted to reflect individuals with no tax liability. In the new simulations:

(1) For the income tax simulation the single tax rate must be set, but it must still be adjusted for exempt or nontaxable income. The new tax rate, times the share of capital income taxed (owner-occupied housing is not taxed), times the amount of capital income, plus the new tax rate times labor income, times the share of labor income taxed (some individuals have incomes too small to tax), minus the cost of the wage credit for taxpayers with a tax liability, minus the savings from the fall in the interest rate, plus the change in taxes on interest on the public debt equals current tax revenue. The initial level of public debt is held constant relative to baseline output and the savings on interest payments are due to the decline in the interest rate.

(2) For the consumption tax simulation, the new tax base is also reduced by the deduction allowed for the net investment (for the share associated with business investments, since investment in owner-occupied housing is not expensed).

(3) For the consumption tax simulation with basis recovery, an additional revenue cost appears during the transition years to allow the recovery of depreciation, inventories, and Net Operating Losses.

(4) For the wage tax, there is no deduction for investment, and no loss from basis recovery, but the tax applies only to wages and not to capital income.

(5) For the open economy simulation of the consumption tax, the interest rate is fixed; investment imported from abroad is deducted from the tax base.

The model is calibrated to reflect measures of the U.S. economy. The calibration is unique to the set of elasticities chosen: a new calibration would be performed if new elasticities were chosen. All calibrations set the values in the economic aggregates to those observed in the economy as set out in Table 2.

The specific calibrations are as follows: first, set net product -- Q minus depreciation, or Q minus dK -- to one. Also set W equal to 1, labor supply equal to the labor share of income, 0.75, the capital stock at 3.5, and depreciation at 0.03.[12] Derive the pretax rate of return equal to 3.5 divided by capital's share of income, 0.25, and gross output given Q, d, and K. These values are used to set the constants, A and a, in the production function -- constants that depend on the factor substitution elasticity.

The real growth rate is set at .02. That growth rate generates the savings rate, s, out of disposable income, and allows (once the tax rate is measured) the setting of the constant c in equation (20). The growth rate is not

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[12] These values along with data on capital income tax rates, capital shares, and other values are based on a variety of existing models I have constructed; for more details, see Jane G. Gravelle, *The Economic Effects of Taxing Capital Income*, Cambridge, Mass., MIT Press, 1994. Note that the depreciation rate for the capital stock reflects a weighted average of equipment, with high rates, structures, with low rates, and land and inventories that do not depreciate.

important to the model solution except in that it produces the savings rate, which is important. The growth rate is slightly lower than recent performance in order to set a savings rate more consistent with observation.[13]

There are several caveats, unresolved issues, and potential refinements that might be considered:

How should pensions be treated for purposes of the capital tax? They are treated as marginal in this analysis, but there is a case for treating pension earnings as inframarginal. Treating them as inframarginal would cause a higher current capital income tax burden under current law (because the zero tax rates on pension earnings would not be included). As a result, the reductions in marginal tax rates in the simulations (because of the higher starting point) would be larger cut and a bigger savings response with taxation because of additional revenue.

Should payroll taxes be treated fully as taxes or should they be treated as contributions to retirement plans. Some intermediate case is probably appropriate. The level of taxes influences the initial net of tax wage and therefore the percentage changes that drive labor supply response. Not treating the payroll taxes as taxes would reduce the magnitude of the labor supply response

There is a theory that suggests that property taxes are not marginal because individuals "vote with their feet" to find a jurisdiction where they are compensated for the property taxes with services. If property taxes are treated as payments for benefits rather than taxes, the net after-tax return would rise and the supply response would be smaller.

There are many details of the tax law that are not considered, including the EITC, the AMT, losses, credits for deferred taxes, and a host of other provisions. The EITC in some cases unambiguously increases work, and in others decreases it, but in a different fashion from a normal tax.

This model does not allow explicitly for a reallocation of capital between owner-occupied housing and business, but rather assumes that the housing capital stock is fixed. This assumption is probably a reasonable one and not important to the final results, however.

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[13] This is a problem that arises from setting up an equilibrium model from an observed economy that is not necessarily in equilibrium.

5. John G. Wilkins*

"Dynamic Revenue Estimating: Can It Work? Simulations of the Effects of Three Alternative Tax Systems"

Introduction

Anticipating the profound impact of tax reform on the economy, Coopers & Lybrand L.L.P. (C&L) constructed a dynamic economic model that fully integrates the distributional analysis available from microsimulation tax models of households and businesses and the year-by-year economic forecasting capabilities of large-scale macroeconomic models.

The standard tool for estimating the revenue and distributional effects of tax law changes is a microsimulation model. Government bodies such as the staff of the Joint Committee on Taxation (JCT) and the Treasury Department's Office of Tax Analysis (OTA) employ microsimulation models when making revenue estimates of proposed tax law changes. While both JCT and OTA make reasonable assumptions about changes in behavior as a result of a particular tax proposal, the estimates are "static" in the sense that gross domestic product (GDP) and other macroeconomic variables are held constant. Although the omission of dynamic estimates is less important when tax law changes are minor ones, static estimates can produce a serious bias that can lead to misinformed tax policy decisions when major tax changes or fundamental tax reforms are being considered. An awareness of this shortcoming prompted the House of Representatives to amend clause 7 of House rule XIII earlier this year to permit the Chairman of the Committee on Ways and Means to request a "dynamic estimate of the changes in Federal revenues" under certain circumstances.

The standard tool for forecasting overall changes in the economy such as growth in GDP, or changes in inflation or interest rates, is the macroeconomic model. Macroeconomic models are used by government bodies for a variety of tasks such as generating economic forecasts upon which to base semiannual budgets. While macroeconomic models do not include detailed tax information and, as such, cannot directly estimate tax revenues by source, both JCT and OTA use economic forecasts to project their revenue estimates forward. They do not, however, determine how those forecasts—and hence future revenue projections—would differ if proposed tax laws are enacted. This missing step is the essence of a dynamic revenue estimate.

The C&L model combines individual and corporate microsimulation models with an 85-sector macroeconomic model to create a single integrated model that produces both "static" and "dynamic" es-

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timates of the effect of tax law changes on households, companies, industry sectors, or the economy as a whole. The C&L model begins with basic IRS tax data used to construct an individual microsimulation component, containing over 100,000 households and 250,000 persons. This information is then merged with detailed nontax data from other government sources. These data concern consumer spending, savings and assets and greatly enhance the kind of information that can be shown. On the corporate side, the C&L model again starts with all available IRS data, including about 4,000 entries grouped by 182 industrial sectors and 12 asset-size categories. By matching the IRS corporate data files with financial reporting information, the model creates 15,000 "synthetic" corporate tax returns and categorizes them by standard industrial classification codes. This added step of merging financial information and generating 15,000 tax returns sets the model apart from other microsimulation models that use only publicly available corporate tax data. In addition, the model tracks individual companies over a series of years, giving it the unique ability to accurately evaluate proposals which affect net operating losses, credit carryforwards, and transition rules.

The enhanced microsimulation components of the C&L model are then linked with the macroeconomic component. The heart of the macroeconomic component is an input/output model that unites 85 industrial sectors within the economy. Specifically designed to demonstrate the interrelationships between what one industry sells (output) and another industry purchases (input), it includes "tax enhancements" to facilitate the ability of the macroeconomic component to "speak" to the microsimulation components and produce meaningful estimates of tax changes.

Because of its unique modifications and micro/macro integration features, the C&L model produces dynamic, as well as the traditional static, revenue estimates of tax law changes without sacrificing the important distributional estimates that Members of the Congressional tax writing committees expect to see before making policy decisions. For example, the model can show who the winners and losers are, along with distributions of proposed tax changes sorted by household or adjusted gross income level, by corporate size, or by industry segment. Because the model fully integrates all sectors of the economy, even tax changes targeted to a single sector or group of taxpayers can be shown to affect all other sectors, not only direct suppliers and customers.

The JCT Simulations

In response to a request from the staff of the Joint Committee on Taxation (JCT), Coopers & Lybrand L.L.P. (C&L) simulated the dynamic effects of three alternative tax systems using its proprietary economic simulation model. The alternatives include a flat-rate unified income tax, a flat-rate consumption tax without transition rules, and a flat-rate consumption tax with transition rules. In the economic simulations, each alternative replaces the current personal and corporate income taxes on a year-by-year, budget neutral basis. To accomplish this, the tax rate for each alternative is adjusted annually throughout the 1997–2006 forecast period.

The flat-rate unified income tax was modeled as a variant of corporate tax integration. Dividends received, other than interest-type distributions from mutual funds, were excluded from taxable personal income and domestic intercompany dividends received were excluded from taxable corporate income. The flat-rate consumption tax included a personal-level tax on wages and certain retirement and other benefits and a modified subtraction-method value added tax imposed at the business level. The flat-rate consumption tax with transition rules was modeled according to JCT guidelines allowing for an outstanding stock of $500 billion of prior net operating loss (NOL) carryforwards, $5 trillion in basis of undepreciated assets and $1 trillion of existing inventory.

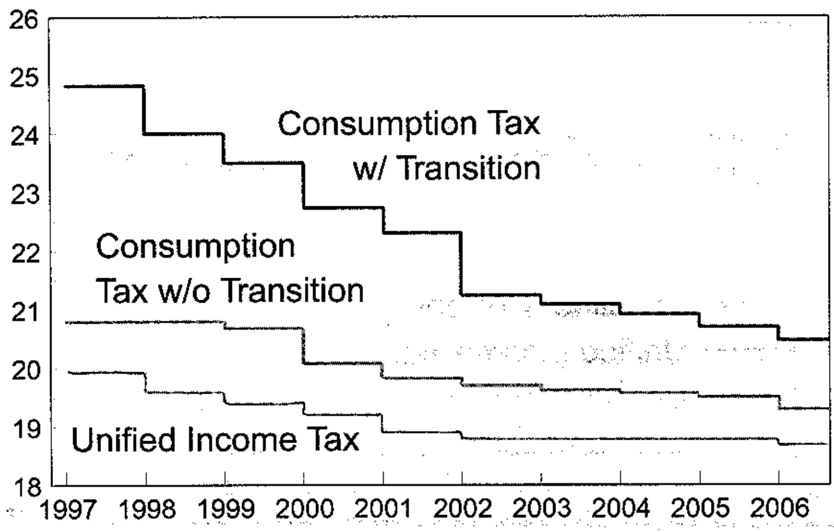
In addition to simulating the dynamic effects of the three alternatives described above, the C&L model produced "static" responses employing the types of assumptions generally used by the JCT in its analysis of tax law changes regarding changes in taxpayer behavior. However, under the "static" responses, it was further assumed that those changes would have no effect on economic activity or on the income earned by taxpayers. The importance of the value of dynamic scoring can be more clearly demonstrated by comparing the differences and distinctions that are produced from the dynamic and static simulations. In all cases, the "feedback" effect of macroeconomic components included in the dynamic estimates serves to reduce the sizable deficits that would result from scoring the tax alternatives under a static scenario.

Simulation Results

All three of the alternative tax systems were simulated using the same fiscal and monetary assumptions. Per JCT specifications for the three experiments, the tax rate under each alternative was adjusted annually to keep the federal budget deficit at the Congressional Budget Office (CBO) baseline levels throughout the 1997–2006 forecast period. For example, interest rate changes affecting federal interest payments and unemployment changes affecting payroll tax receipts were fully offset by changes in revenues from the alternative tax. Thus, as the economy grew, the tax rate was allowed to drop in order to maintain deficit neutrality as compared with the current-law baseline deficit.

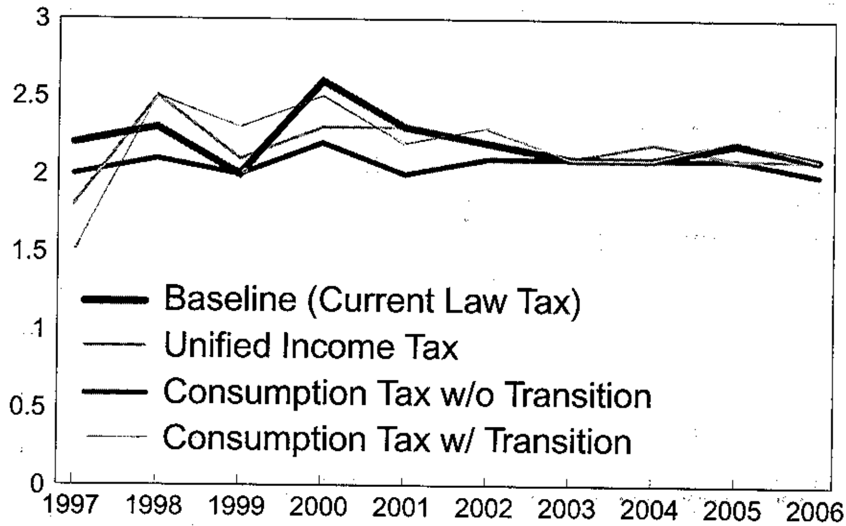
This phenomenon is shown on Chart 1, which summarizes the flat-tax rates required to maintain revenue neutrality on a year-by-year basis under the three alternative tax regimes. Tax rates under the three alternative tax systems gradually decline during the 1997–2006 forecast period as the economy outpaces the projected baseline forecast. Under the unified income tax, the flat-tax rate required for deficit neutrality is 19.9 percent in 1997 and drops to 18.7 percent by 2006. Under the consumption tax without transition rules, the deficit-neutral flat-tax rate starts at 20.8 percent and drops to 19.3 percent. The flat-tax rate for a consumption tax with transition rules would have to be 24.8 percent in 1997 in order not to increase the deficit, but could be lowered to 20.5 percent by 2006. The reason that this rate can be lowered so fast and remain revenue neutral is because the deductions under the transition rules would be large initially but would decrease throughout the forecast period.

Chart 1: DEFICIT-NEUTRAL TAX RATES



According to the C&L dynamic economic simulations, all three of the alternative tax systems would generate additional economic growth. By 2006, real output would be more than 1 percent above the baseline regardless of which alternative tax was imposed. Real output in 2006 would be slightly greater under the consumption tax alternatives than under the unified income tax alternative. Chart 2 shows the real growth rate under current-law and under the simulations over the 10-year forecast period. Although two of the simulations show a lower rate of growth in the initial year, all three simulations demonstrate that growth will be in excess of the baseline in virtually all of the forecast period. Although the projections converge toward the baseline growth rate by the year 2006, the growth over the previous decade ensures that there will be a permanent increase in the level of real output.

Chart 2: REAL GROWTH RATE 1997-2006 (PERCENT)



The effects of the three alternative tax simulations on the economy can be summarized with selected macroeconomic variables. Under all three tax alternatives the change in prices would be modest, with the rate of inflation actually falling by the year 2006. Interest rates in 2006 would be below the baseline. Real short-term rates would be down about 50 basis points and real long-term rates would be down about 20 basis points under all three alternative tax systems.

Lower interest rates and lower tax rates on capital income would stimulate investment. Under the consumption tax alternatives, investment in producer durable equipment, a tax-sensitive component of gross private domestic investment, would be 4.8 percent above the baseline in 2006. Under the unified income tax, investment in producer durable equipment would be 3.3 percent higher in 2006.

The size of the labor force in 2006 would be about 1.5 percent above the baseline under all three tax alternatives, but the total hours of employment would be up by only 1.1 percent. The lower increase in hours has two consequences: fewer full-time workers and more unemployed workers. This dislocation would be temporary, however; eventually, the increase in the labor force would be fully utilized.

Labor productivity in 2006 would be slightly above the baseline due to the larger stock of capital. Real private-sector output per hour would be up slightly less than 0.2 percent under the unified income tax and slightly greater than 0.2 percent under the consumption tax alternatives.

Personal savings would increase modestly over the baseline estimate under all three tax scenarios. The results of the three simulations indicate that throughout the forecast period the increase in personal savings would be less than 1 percent higher.

Chart 3 shows representative macroeconomic indicators for selected years under one of the alternative tax scenarios, the consumption tax without special transition rules.

Chart 3: SELECTED MACROECONOMIC CHANGES UNDER A CONSUMPTION TAX WITHOUT TRANSITION

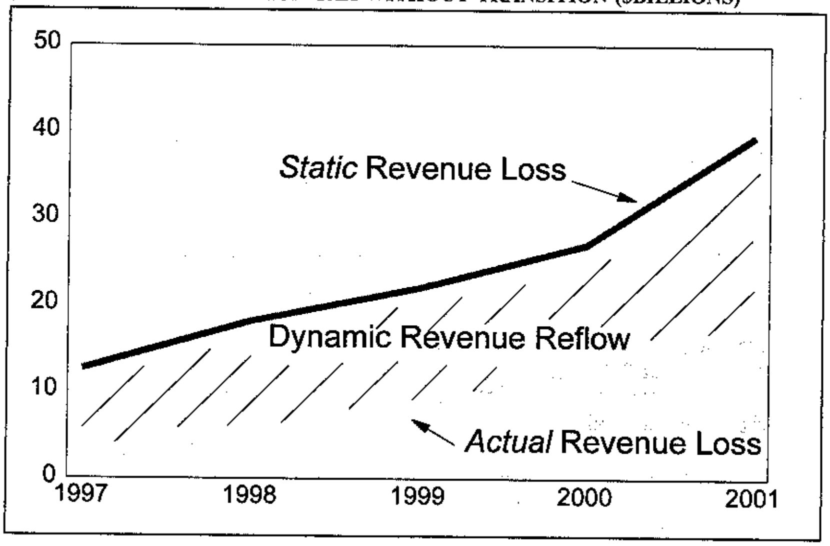
Macro Variable	1997	2001	2006
Inflation (% points)	---	0.2	-0.2
T-bill rate (basis points)	---	-30	-40
Personal Savings rate (% points)	0.9	0.7	0.5
Jobs (000)	-300	900	1,500

Due primarily to NOLs, the tax base in the corporate sector (i.e. the taxable C corporation base plus the taxable S corporation base) would differ from the aggregate "net" corporate tax base (including C and S corporations with current-year NOLs). In 1997 for example, the aggregate "net" corporate taxable base under the consumption tax was $265 billion without the transition rules and -$373 billion with the transition rules. The corporate base that was subject to tax in that year, that is, taxable income of corporations with positive income, was $1,081 billion under the regime without transition rules and $622 billion under the plan that included transition rules. Thus, under either consumption tax alternative, more than $800 billion in current-year NOLs could not be utilized to reduce current-year tax payments and would have to be added to the stock of NOLs carried forward to 1998. The stock of NOLs would continue to grow throughout the 1997-2006 period.

In addition to simulating the dynamic effects of the three alternatives described above, the C&L model produced static responses employing the types of assumptions normally used by the JCT and the OTA in their analyses of tax law changes. Assumptions regarding changes in taxpayer behavior in response to tax law changes were included but macroeconomic changes were not.

By generating both the traditional "static" estimates and the fully dynamic estimate, the additional change in receipts, or "dynamic revenue reflow," can be measured. Chart 4 shows the year-by-year totals of additional receipts generated by the change to a consumption tax. This is measured by the difference between the traditional "static" estimate of revenue loss and the dynamic actual estimate of revenue loss. For a consumption tax without transition rules in effect, the chart shows, for example, that the revenue loss would be estimated using traditional rules at about $12-1/2 billion in 1997 and would rise to nearly $40 billion by the year 2001. In contrast, the dynamically estimated revenue loss, which takes into account improvements in the economy which directly result from proposed tax regime, is only about $2 billion in 1997 and rises to only about $15 billion by 2001, the end of the forecast period. The difference between these two estimates—about $10-1/2 billion in 1997 and increasing to roughly $25 billion by 2001—represents additional tax revenues attributable to induced higher economic performance.

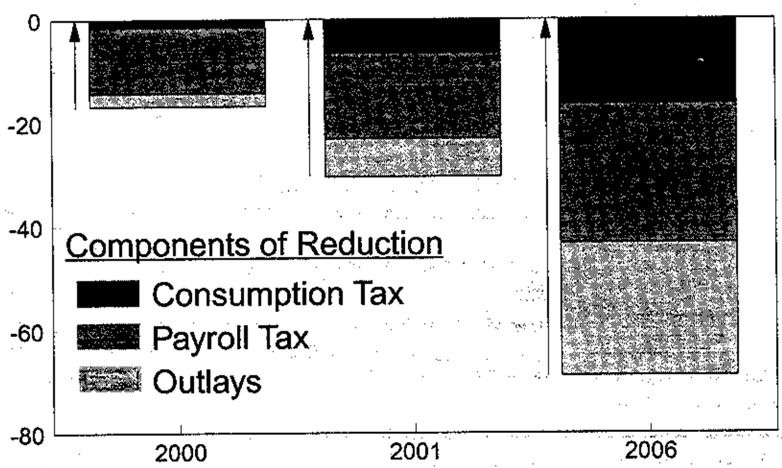
Chart 4: DYNAMIC AND STATIC REVENUE LOSSES CONSUMPTION TAX WITHOUT TRANSITION ($BILLIONS)



Another way of looking at the importance of dynamic versus traditional revenue estimates in this particular situation is to compare the results on the deficit. Although Chart 4 shows that the dynamic estimate of revenues is still a revenue loss under the consumption tax without transition rules, the dynamic estimate of the change in the deficit is zero by design. The remaining improvement in the government's overall fiscal picture is attributable to government spending being lowered once the economy is improved.

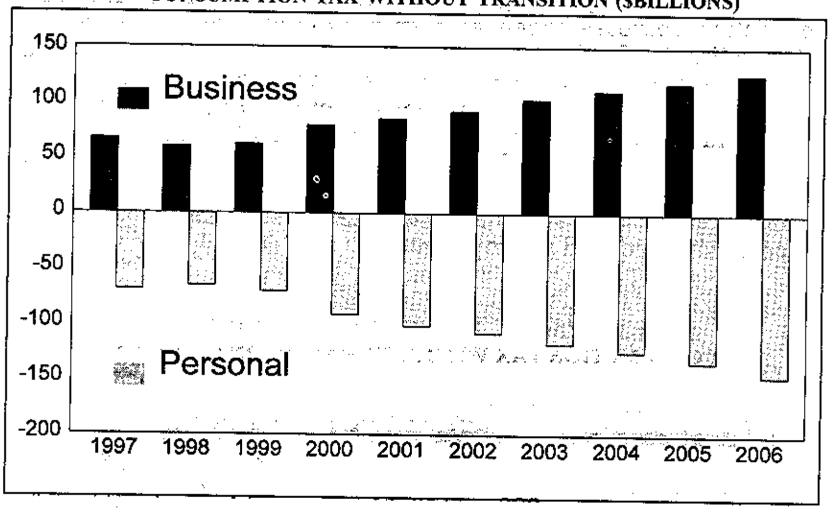
For the same consumption tax proposal illustrated in Chart 4, Chart 5 shows that the deficit would be estimated to grow significantly, ballooning an estimated $70 billion more in 2006 if the estimating methodology employs traditional estimating conventions that ignore macroeconomic dynamics. This chart also shows, for three selected years (2000, 2001, and 2006), how induced consumption tax revenues, induced payroll tax revenues from more employment, and induced spending cuts combine to eliminate that estimated deficit increase when economic dynamics are incorporated into the estimate. In the longer run (see the bar for the year 2006, for example), additional payroll taxes account for about 40 percent of the induced deficit reduction, consumption taxes for about 25 percent, and spending cuts for the remaining 35 percent. Payroll tax increases are generated by the induced rise in employment. Spending cuts are attributable primarily to lower interest payments on the debt and secondarily to smaller entitlement payments associated with reduced unemployment.

Chart 5: DYNAMIC REDUCTION OF STATIC DEFICIT CONSUMPTION TAX WITHOUT TRANSITION ($BILLIONS)



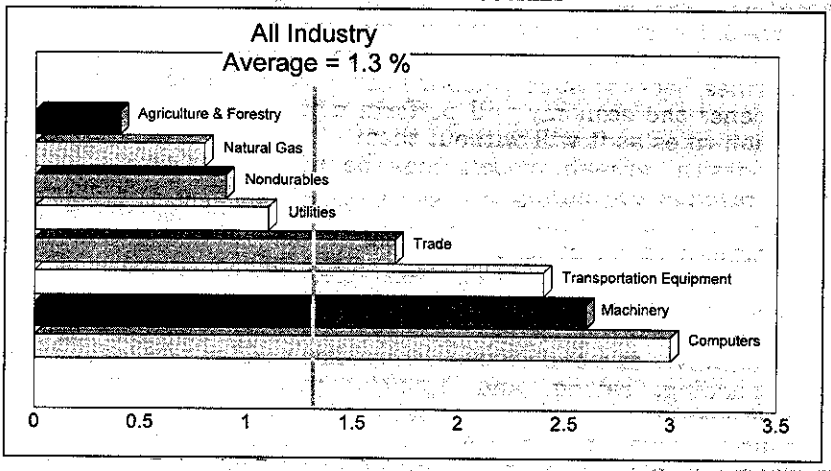
It is interesting to note that the results of the simulation indicate that the makeup of federal receipts will change under all of the alternative tax systems. Total personal receipts will decrease over the forecast period. At the same time, total business receipts, as measured by corporate profits tax and indirect business taxes, will increase. Chart 6 shows the year-by-year totals of business and personal tax changes generated under a consumption tax without transition rules.

Chart 6: BUSINESS AND PERSONAL TAX CHANGES CONSUMPTION TAX WITHOUT TRANSITION ($BILLIONS)



A distinguishing feature of the C&L model is its ability to examine the secondary effects that a tax law change may have on a particular set of taxpayers, such as an industry, its suppliers of goods and services, and its customers. Although the information is available from the C&L model's database using very narrow definitions of industries, for presentation purposes we have aggregated related sectors into larger industry groups. Chart 7 shows the percent change in output for selected industries under one alternative tax system, the consumption tax without transition rules in the year 2006. The average induced change in output for all industries in that year is estimated to be 1.3 percent. In general, industries engaged in the production of durable equipment enjoy above-average growth. For example, machinery and transportation equipment each expand output about 2.5 percent above what would have occurred in absence of a change in tax law. At the other extreme, the agriculture and forestry industry grows only 0.3 percent above baseline growth.

Chart 7: PERCENT CHANGE IN OUTPUT CONSUMPTION TAX WITHOUT TRANSITION, YEAR 2006 FOR SELECTED INDUSTRIES



Dynamic Revenue Estimating Recommendations

The symposium, "Modeling the Macroeconomic Consequences of Tax Policy," presents the results of a year-long study by a group of economists noted for their work in developing models of the U.S. economy. Although the different models can be roughly categorized as either neoclassical growth or intertemporal models, variations within those categories can be significant. For example, the C&L model allows unemployment to vary while other neoclassical models call for full employment equilibrium. There is also wide divergence among the models as to the detail of information regarding household, business and government sectors. Further, basic economic assumptions employed by the modelers in their simulations were diverse. The C&L model assumes that monetary policy targets full employment and that international capital flows fluctuate with interest rate changes.

It is not surprising that the model simulation results on key macroeconomic components as well as tax rates would differ. Consequently, it would be easy to dismiss the validity of this exercise by observing that reputable models can show different results for an identical set of circumstances or by claiming that the output of economic models is largely determined by critical assumptions that each modeler may elect to impose. This would be wrong. Close examination of the model results—especially within the two broad model categories established by the JCT—shows surprisingly similar answers whenever critical assumptions are the same.

Intertemporal general equilibrium models are excellent analytic tools that should be employed by policy makers for certain purposes. They help identify which policies put the economy on track for higher living standards in the future, sometimes decades down the road when the economy is again in an equilibrium state. These models may be less appropriate, however, for dynamic revenue estimating, because they generally are incapable of providing the short-term, year-by-year answers required and cannot, by definition, track the economy when full employment has been disrupted. Consequently, most such models also are less able to evaluate transition rules because such rules matter only in the short run; fifty years hence the economy will perform more or less the same with transition rules as it will without them.

Neoclassical growth models may be more appropriate for dynamic revenue estimating because they are generally designed to provide short-term, year-by-year results. If they have the further characteristic of not being constrained to full employment, they can capture the dislocations—for example, unemployment of resources—that frequently accompany major policy changes. The C&L model is of this type. It is enhanced by rich databases of 250,000 individuals and 15,000 corporations which provide detailed tax, spending, saving, and financial information. These same microdatabases enable dynamic results to be distributed by household income level or firm size or economic sector. This last feature is paramount because of the importance that Congress traditionally places on understanding the distribution of tax burdens before making significant tax law changes. For example, had the C&L model been available during the Reagan Administration, policymakers would have been able to look at the dynamic—and not merely static—distribution of tax burdens resulting from the marginal tax rate cuts, thereby answering the vexing questions about the true beneficiaries of those tax rate cuts.

Rather than pointing out the deficiencies of modeling macroeconomic consequences of tax policy, the disparate results point out the need for a consistent set of dynamic revenue estimating rules and conventions, similar to the standard set of rules and conventions long followed by the JCT and the Treasury Department's OTA when making conventional revenue estimates. For example, when making conventional estimates, nominal GDP and other macroeconomic aggregates are held constant so that an indirect business tax will produce an "income tax offset" since the income tax base must decline by the amount of the "wedge" placed between the income tax base and total GDP. For dynamic estimating, appropriate rules and conventions might include the following:

- interest rates will be adjusted to maintain the gap between actual and potential GDP,
- the Federal Reserve Board will be expected to maintain the money supply so as to prevent the overall price level from varying enough to impact inflation, and
- foreign interest rates will adjust by some fraction of any change in the U.S. rate.

Absent such a set of rules, different models are apt to provide very different answers and revenue estimators may be challenged about their ability to "cook" the answers to achieve particular results.

Overview of the C&L Model

The C&L economic simulation model is an integrated system comprised of a macroeconomic model linked to microdata on corporations and households. The microdata include about 15,000 separate corporations and more than 100,000 separate households. Tax calculators use the microdata to make detailed estimates of corporate and individual taxes and those estimates and other tax-related information (e.g., marginal tax rates) are passed back to the macroeconomic model and incorporated into the simulation dynamics.

The macroeconomic component of the C&L model is based on the INFORUM LIFT model at the University of Maryland, a "bottom-up" macroeconomic model built upon an input-output framework. The model is rich in industry detail and can simulate year-by-year changes in the economy on an industry-by-industry basis. Unlike many other macroeconomic models, its bottom-up structure simulates the dynamics of the overall economy as the aggregation of the dynamics of many industries. It is at the industry level that we have linked the macroeconomic model with the corporate microdata and corporate micro-level tax calculator.

The model has 51 gross product originating industries where the factor input requirements for 16 categories of value added (e.g., corporate profit, proprietors' income, interest expense, depreciation, labor compensation, etc.) are determined and allocated to 85 producing industries to produce 85 products for intermediate and final demand. For final demand, "bridge matrices" map the 85 products into 80 categories of personal consumption expenditures, 55 groupings of equipment investment, and 31 types of residential and nonresidential structures.

The model has 120 household "cells" (20 income classes by 6 household sizes). It is at the cell level that we have linked the macroeconomic model with the household microdata and the household micro-level tax calculator. The model allocates personal income to cells and then the model and the micro-level tax calculator estimate tax payments and disposable income on a cell-by-cell basis. The resulting distribution of disposable income subsequently affects the aggregate demand for each category of personal consumption expenditures.

Linking the Macroeconomic Model to the Calculators Micro-Level Tax Calculators

To make the macro model and the micro-level tax calculators work well together, two tasks had to be accomplished. First, differences between the Commerce Department's National Income and Product Account (NIPA) and the Internal Revenue Service's Statistics of Income (SOI) definitions of the components of income and deductions had to be bridged. Second, macro-level aggregates had to be disaggregated and allocated to businesses and households at the micro-level. For businesses, both the definitional bridge and the disaggregation scheme are done first at an industry level, then at a legal form of organization level, and finally at an entity level. For households, the definitional bridge is done entirely at the aggregate level. Household disaggregation is done first by income classes, then by individual households, and finally by taxpaying units within a household.

In linking the macro model to the corporate tax calculator, the bridge between NIPA corporate profit by industry and SOI corporate profit by industry is most critical. We used SOI variables to construct a proxy for NIPA domestic "corporate profit before tax" by industry. In general, to get from SOI "total receipts less total deductions" to the proxy for NIPA profit, foreign income was removed from each industry and put in the rest-of-the-world sector, domestic intercorporate dividend payments were removed to eliminate double counting of corporate income, and certain income items (e.g., capital gains) and cost items (e.g., bad debt deductions) were removed because NIPA does not recognized them.

The forecasted growth rates of corporate profits by industry from the macro model is used to grow each corporation's proxy of NIPA profits in the micro-level corporate tax calculator. Most other variables in the corporate tax calculator were grown based on the growth of the best proxy variable from the macro model. By treating certain variables in the tax calculator as residuals, the required "degrees of freedom" were maintained so that the income and expense accounts of each corporation add up properly throughout the forecast period despite differences in the growth rates of the component parts.

In linking the macro model to the individual tax calculator, the bridge between NIPA personal income and the tax concept of adjusted gross income (AGI) is most critical. Following Commerce Department's published reconciliation between personal income and AGI by source, we constructed a NIPA-defined measure of AGI. That measure includes the income that NIPA attributes to the "tax gap."

The growth in NIPA-defined adjusted gross income for each income class in the macro model is used to grow the AGI of tax filers and nonfilers in the same income class in the individual tax calculator. Each source of income in the tax calculator was grown using the best NIPA proxy. Wages and fringe benefits were treated as a residual so that, for each income class, the sum of the AGI components of income equaled AGI.

The Dynamics of the C&L Model

The macroeconomic component of the C&L model, based on the University of Maryland's INFORUM LIFT model, is one in which factors of production, such as labor, are seldom fully utilized. Moreover, product markets as well as factor markets are routinely in disequilibrium. In such a model, optimizing marginal conditions do not define the behavior of individuals and business. Instead, a set of empirically estimated equations of dynamic behavior "drive" the economy subject to a series of "adding up" conditions (e.g., the price of each product equals the sum of the costs of the intermediate inputs and factor inputs going into its production).

Like many other macroeconomic models, government deficits stimulate aggregate demand. But government deficits also raise interest rates, which not only lessens the stimulative effect, but also change the composition of aggregate demand (i.e., government spending crowds out investment more than it crowds out consumption).

The macro model has endogenous trade and capital flows that characterize an open economy. Net exports by industry vary with the value of the dollar. The value of the dollar adjusts whenever a difference exists between domestic and foreign real bond rates. The real domestic bond rate depends strongly on the demand for loanable funds (i.e., gross private domestic investment plus the net government deficit). Funds from abroad balance any discrepancy between domestic investment and national saving.

C&L has made two types of changes to the behavioral equations in the INFORUM LIFT model to make them more sensitive to changes in "tax wedges." First, where the initial specification assumed behavior was totally unresponsive to price, C&L added a price response. Second, where the initial specification assumed behavior depended on changes in the pretax price, C&L added a similar response for changes in the "tax wedge." The modifications affect:

- labor force participation (labor supply),
- personal saving rate,
- equipment investment by industry, and
  labor productivity.

As a result of the C&L modifications, economic behavior in the macro model is more tax-sensitive than it otherwise would be. Taxes affect the size of the labor force and the rate of personal saving as well as the level of equipment investment by industry.

In an attempt to quantify the responsiveness of certain kinds of behavior to price changes, we estimated point elasticities from the structural equations of the model. The estimated elasticities are as follows:

- *Uncompensated savings elasticity=0.4*

(defined as the percentage change in the personal saving rate relative to the percentage change in the nominal after-tax interest rate on T-bills)

- *Compensated labor supply elasticity=0.2*

(defined as the percentage change in labor force participation relative to the percentage change in the after-tax wage, compensated for the income effect)

- *Factor substitution elasticity (equipment)=0.3*

(defined as the percentage change in the equipment-labor ratio by industry, weighted by the stock of undepreciated equipment by industry, relative to the percentage change in the cost ratio of labor to equipment)

- *Factor substitution elasticity (structures)=0.0*

(defined as the percentage change in the structures-labor ratio relative to the percentage change in the cost ratio of labor to structures)

In comparing the reported elasticities in our model to those in other models, several conceptual differences are worth noting. First, the reported saving elasticity is an uncompensated elasticity, which is presumably smaller than the elasticity would be if it were compensated for the income effect. Second, the reported saving elasticity is measured relative to the change in the nominal after-tax interest rate. Measuring the saving change relative to the change in the real after-tax interest rate would cut the elasticity by about half. Third, the reported factor substitution elasticity only measures the capital-labor substitution that occurs within industries, which ignores the model's substitution of factors among industries. Thus, for example, the reported elasticity does not incorporate the increase in the aggregate capital-labor ratio that would occur in the macro model when capital-intensive industries expand their output relative to labor-intensive industries in response to a decline in the relative cost of capital to labor.

Special Assumptions for the JCT Simulations

All three of the alternative tax systems were simulated using the same fiscal and monetary assumptions.

In terms of fiscal policy, we assumed that, at the federal level, the tax rate under each of the alternatives would be adjusted annually to keep the federal budget deficit at baseline levels throughout the 1997-2006 forecast period. Thus, for example, when interest rate changes affected federal interest payments and when unemployment changes affected payroll tax receipts, those changes in the federal deficit were fully offset by changes in revenues from the alternative tax. At the state level, we adjusted the state personal income tax rate to keep the state deficit/surplus at baseline levels.

In terms of monetary policy, we made two important policy assumptions. First, we assumed that the Federal Reserve would adjust the growth rate of the money supply to keep aggregate prices near their baseline levels throughout the forecast period. For all three alternatives, the adjustments to the baseline monetary growth rate were very modest, averaging about 0.15 of a percentage point. Second, we assumed that the Federal Reserve would adjust the short-term interest rate to keep the GNP gap near baseline levels. To implement that policy, we introduced "add factor" adjustments to the T-bill rate equation in the model. The adjustments over the 1997-2006 forecast period went from 20 basis points to 60 basis points under the unified income tax, from 0 basis points to 50 basis points under the consumption tax without transition rules, and from 20 basis points to 60 basis points under the consumption tax with transition rules.

6. Discussion, David Reifschneider*

"Modelling the Macroeconomic Consequences of Tax Policy"

This Symposium seeks to answer a difficult question: What are the macroeconomic consequences of replacing the current income tax with a consumption tax? From the perspective of researchers in the field, this question involves interesting theoretical and empirical issues. But we are not here to discuss some abstract, academic problem. As I understand it, the goal of the Symposium is not to produce a set of theoretical papers about tax reform. Instead, our task is more prosaic, and much harder: We are here to show the practicality of using models to incorporate macroeconomic feedback effects in the revenue scoring of the proposals. The standard of proof we must meet is high, for using models in this way would have serious national consequences.

To this end, the various authors have attempted to develop realistic estimates of the economic consequences of a major overhaul of the tax system. In doing so, they have used a variety of modelling approaches. The result is a wide range of estimates. The width of this range is evidence that the economics profession cannot yet provide Congress with consensus procedures for dynamic revenue scoring. So, in a strict sense, the Symposium has fallen short of its goal.

Nonetheless, do the results of the Symposium suggest that future success is in the offing? Here the answer is less clear. I know that many of the participants in the Symposium are optimistic that, with further research and discussion, scoring procedures can be developed acceptable to most economists and defensible to the general public. However, I'm not so hopeful. I do agree that the mainstream of the profession probably has similar estimates of the long-term economic benefits of tax reform. Congress can and should use these estimates in debating the wisdom of revising the tax code (although there are serious deficiencies with the models used in such calculations). In contrast, I don't think that there is anything approaching a consensus on the short to medium-term effects—the period most relevant to the budget process. I hope to make my reasons for this belief clear in the rest of this commentary.

Before I do, however, I should first congratulate the authors of the five papers presented in this portion of the Symposium. Modelling the macroeconomic effects of replacing the current income tax code with a consumption tax is not easy, for the proposed changes are sweeping. Based on personal experience at the Federal Reserve using large-scale macromodels, I know that much time and effort is needed just to get the modifications to the tax code right, let

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alone to account for the many ways in which such changes would influence behavior in different sectors of the economy. The authors have obviously devoted a good deal of time, thought and effort to this question, and I found their papers interesting and informative. Their reports should be helpful in the debate over the costs and benefits of tax reform. I also applaud the organizers of the Symposium for their coordination of the project, especially regarding the attempt to make the various analysis as comparable as possible. Their efforts to have everyone adopt standardized assumptions about the precise nature of the proposed changes to the tax code, the stance of fiscal and monetary policy, and other features of the experiments were critical to the success of the project.

Now to my reasons for pessimism concerning the role of economic models in the budget process. Let me begin with the long-run benefits of tax reform, the area in which there is the greatest agreement. All five models in this section of the Symposium use a similar methodology to estimate the long-term impact of a switch to a consumption-based tax system—the neoclassical growth model. For example, the analysis presented in the Gravelle and Robbins papers is based directly on simulations of just such a model. The DRI and Macoreconomic Advisors studies also rely on such an approach, in that their analyses employ large-scale structural models—the DRI and WUMM models, respectively—whose steady-state behavior is anchored by a neoclassical core. The same is true for the Coopers and Lybrand model, in which the equations of the basic neoclassical growth model have been adjusted and augmented to capture some of the short-run dynamic characteristics of the economy.[1]

The use of neoclassical growth models in policy analysis has a long and honorable history, and this approach is probably used more than any other methodology to obtain ballpark figures for the economic consequences of changes in the tax code. The reason for its popularity is easy to understand: The model has a reasonable theoretical foundation, has parameters that can be readily calibrated to empirical evidence, and is easy to use. By design, such models ignore the transitory disequilibrium macroeconomic aspects of tax reform, and instead focus on its supply-side aspects—the changes in saving and investment incentives that yield benefits in the form of higher capital, output and consumption.

Using this methodology, what can we say about the long-term effects of a switch to a flat tax or VAX system? The five papers all suggest that the supply-side benefits of tax reform are essentially the result of two factors—increased labor force participation and capital deepening. Labor force participation potentially rises because the marginal after-tax return to working increases if consumption is taxed instead of income. Similarly, the incentive to invest and save is higher under a consumption-based tax system because capital spending can be expensed and household income, if saved, is tax-free.

Of the two effects, the latter is probably more powerful than the former. As Jane Gravelle points out, any labor force response to a rise in the after-tax real wage is likely to be minor, based on his-

[1] The dynamic structure of the Coopers and Lybrand model appears to be considerably simpler than that embedded in the structure of Macroeconomic Advisors' WUMM model or the DRI model.

torical evidence. Male participation rates in the United States have drifted down over the past 50 years despite a large increase in the real wage; microeconomic evidence also suggests that the wage elasticity of labor supply for males is essentially zero. Even allowing for some sensitivity on the part of women,[2] it is hard to have much confidence in any estimate of tax reform benefits that relies heavily on an increase in labor supply. In fact, I believe that both the Macroeconomic Advisors and Coopers and Lybrand studies overestimate the long-run contribution of increased labor force participation—modest as their estimates are—because their analysis fails to distinguish between income and substitution effects (in contrast to Gravelle). But rather than emphasize differences, I think it is more important to stress that here is an example of general agreement among economists—labor supply effects are likely to be limited.[3]

In contrast, a switch to a consumption tax could have very large effects on investment and the stock of capital, because the change would boost the rate of return on saving and decrease the after-tax cost of capital. All the studies in this portion of the Symposium (except Coopers and Lybrand) estimate long-run increases in the capital stock in excess of 10 percent. Similarly large increases are reported in the studies based on intergenerational general equilibrium models. Although the variance of the estimates of capital stock accumulation is greater than that found for labor supply effects, again I think that this is an area in which covergence is possible given further discussion and research. After all, the growth accounting structure is the same across all the different models—the general equilibrium approach merely provides a more elaborate theoretical foundation for the parameters of the neoclassical growth model—and additional theoretical and empirical work should provide tighter estimates of key parameters, such as the interest and wealth elasticities of saving.

Thus I'm optimistic that Congress could appoint an advisory commission to assess the long-run gains from tax reform and have confidence that the bulk of the economics profession would support it. Such a commission would probably conclude that a switch to a consumption-based tax would eventually yield a moderate rise in the level of real GDP, about 5 percent or so—a figure in line with most of the estimates discussed at the Symposium. But agreement on the long-run gains from tax reform would not imply support for incorporating significant supply-side effects into the revenue scoring process, because such effects would likely be small during the

[2] For example, there is a body of microeconomic evidence pointing to a non-trivial wage elasticity of labor supply for females, at least for some groups. In addition, the aggregate female labor force participation rate has risen dramatically since the late 1960s. But societal changes undoubtedly played a key role in the latter phenomenon; furthermore, the sign of the labor supply effect of tax reform is not obvious a priori, as the change would entail both income and substitution effects.

[3] Admittedly, the Robbins study shows substantial labor supply effects, as does the Jorgenson and Wilcoxen report in the earlier portion of the Symposium. But the Robbins' estimate is clearly an overstatement and is probably an artifact of their failure to deal with order-of-integration issues in the estimation of the labor supply equation. As for the DRI study, the long-run effect of tax reform on labor supply in their model is unclear from the simulation results. In passing, I think it is worth noting that experience outside the US may be helpful in setting this issue; to my knowledge, the introduction of VATs in Europe was not associated with any substantial change in labor force participation.

first years of the new tax regime, owing to the gradual nature of the capital accumulation process.

Common sense tells you that this pretty much has to be so: An increase in real GDP of 1 percent requires a 3 percent increase in the capital stock, and to raise the capital stock 3 percent in a year would require a 30 percent increase in the level of business investment. While big jumps in investment are not unprecedented, macro-level evidence suggests that such major short-run fluctuations are primarily associated with cyclical changes in sales expectations, not changes in the cost of capital. Changes in the latter (i.e., in relative prices and tax factors) appear to influence capital spending more gradually, probably because of time-to-build considerations and substantial adjustment costs.[4] Thus the revenue gains associated with supply-side effects are likely to be small in the first years following the proposed tax reform, even ignoring any initial macroeconomic disequilibrium effects that could potentially damp the speed at which new capital is installed.[5]

Even if such an advisory committee restricted itself to evaluating long-run gains, I still think it would be in danger of overstating our current ability to quantify the economic effects of tax reform. Why? Because all the models presented at the Symposium fail to deal adequately with the U.S. position as a large open economy. Most assume a closed economy, and examine the effects of openness only by limiting the responsiveness of domestic interest rates. The DRI and WUMM models are exceptions—they contain equations for the current account and the exchange rate—but even they do not incorporate the endogenous response of foreign economies to changes in domestic conditions. These limitations make it difficult to be certain about the long-term effects of a switch to a consumption-based tax. On one hand, treating the economy as closed understates the likely rise in the capital stock following tax reform, because access to international financial markets would moderate upward pressure on domestic interest rates. On the other hand, modelling the U.S. as a small open economy errs in the opposite direction, because it implies unchanged domestic interest rates and thus huge capital formation effects.[6]

In reality, U.S. is a large open economy whose credit demands influence world interest rates. However, international capital markets appear far from perfect—for example, international portfolio diversification is extremely limited, and domestic saving and investment are highly correlated. So neither polar assumption about

[4] However, this statement perhaps needs to be qualified, given firm-level evidence that major changes in the tax treatment of investment do have a substantial influence on the growth of capital spending in the year the changes take effect. For example, see Cummins, Hassett and Hubbard, "A Reconsideration of Investment Behavior Using Tax Reform as Natural Experiments," *Brookings Papers on Economic Activity*, Vol. 2, 1994, pp. 1–74. Nonetheless, even the Cummins-Hassett-Hubbard estimates suggest that the near-term effect of a switch to a consumption-based tax would be limited—boosting investment by on 10 percent or so initially. Furthermore, their results potentially overstate the short-term influence of tax reform because their estimates may include intertemporal substitution effects, which would not occur under tax reform if firms did not anticipate a return to the old tax system.

[5] The only way to obtain bigger output effects in the short run (as in the Robbins model) is to link trend total factor productivity growth and the rate of investment—a link for which there is little econometrics support once allowance is made for cyclical movements in capacity utilization.

[6] Although Gravelle presents simulations suggesting that this issue is not quantitatively important, I think her results depend on the tight link between domestic saving and investment in her model—a link which is broken in models that allow for international capital flows.

the openness and relative size of the U.S. economy is appropriate. Unfortunately, a more realistic treatment of capital flows and other open-economy issues probably requires the use of an empirical multi-country model, with all its attendant complexity. Still, such a model (several exist) could provide a framework for addressing important issues associated with tax reform overlooked by closed-economy models, including:

- the degree to which foreign capital flows moderate upward pressure on domestic interest rates, and the implications of such flows for the level of investment and output at home and abroad;
- the implications of capital mobility for the share of the U.S. capital stock owned by foreigners, and thus for the amount of domestic production that would be diverted abroad to service our foreign debt, instead of being available for domestic consumption and investment;[7]
- the influence of changing capital flows, productivity and interest rates on the long-run value of the dollar, and thus on trade flows and the price of consumer goods relative to domestic output (the latter influencing real household income); and
- the degree to which the domestic effects of tax reform would be moderated by accompanying changes to foreign tax laws, enacted perhaps to limit the diversion of foreign capital to the United States.

I should stress that multi-country models are not a panacea: Although it is only within the context of such models that we can address these issues, the models are not yet at the point that they provide satisfactory answers to all relevant questions (e.g., the determinants of the long-run value of the real exchange rate). Further research is needed.

Before leaving the issue of the long-run benefits of tax reform, I'd like to note one aspect of all five papers that bothers me: a focus on potential output gains rather than on the likely change in consumption. After all, the goal of tax reform is to raise the standard of living, not simply produce more. For several reasons, a given increase in GDP does not necessarily imply a similar rise in household income and consumption. In open economies, production gains achieved through imported capital entail a higher flow of payments to foreigners, and exchange rate considerations are important because tax reform would likely lead a secular depreciation of the dollar.[8] Both these factors lower the ratio of real income to output. On

[7] This particular channel is accounted for in the DRI and WUMM models, because they have equations determining the net foreign investment position, net factor income receipts from abroad, and the links between DGP, GNP and national income. In this regard both models have an important advantage over simpler closed-economy models. Unfortunately, having the proper accounting structure isn't sufficient to ensure that either model accurately gauges the magnitude of the debt service effect on the output/income wedge. For this to be true, it would be necessary to also model the endogenous response of foreign economies and its effect on the U.S. current account.

[8] With the switch to a consumption-based tax, a secular real depreciation of the dollar would be necessary to clear world market for U.S. production, assuming that U.S. goods are imperfect substitutes for goods made elsewhere. This follows because the relative price of domestically-made goods must fall by enough to boost the combined U.S. and foreign demand for our products to a level consistent with the rise in supply (where the latter is driven by increases in the domestic labor supply and in productivity). This effect is mitigated by a domestic bias in favor of U.S.-made goods, but probably not eliminated. Note that the terms-of-trade effects associated with exchange rate depreciation can be viewed as a reduction in the real income of U.S. house-

Continued

the domestic front, capital depreciation has a similar effect. As capital deepening raises potential output, the marginal product of capital falls, implying that a rising portion of each additional dollar in real GDP must go to depreciation. This increased overhead is subtracted from GDP to get national income, which is what households can tap for consumption. Eventually the net gain from boosting the capital intensity of production turns negative. Although at present the U.S. doesn't appear too close to the Golden Rule point, some of the increases in the capital-labor ratio discussed at the Symposium are so large that I suspect such effects could be important.

Now I would like to turn from the long-term benefits of adopting a consumption-based tax system to an area in which there is little consensus—the transitory disequilibrium effects of tax reform on aggregate demand, employment, inflation and interest rates. From the viewpoint of policymakers, these short to medium-term effects are extremely important because, as the DRI and the WUMM simulations illustrate, the transitory Keynesian aspects of the economy may dominate slow-acting supply-side responses during the first years of the new tax regime. In fact, transitory aggregate demand effects could well be of the opposite sign to neoclassical supply-side effects, implying falling tax revenues in the short run.[9]

The fundamental problem here is that there is little agreement among economists on how to model these disequilibrium effects. At one end of the spectrum are the proponents of traditional large-scale macromodels, such as those used by DRI and Macroeconomic Advisors. In their view, a model such as MA's WUMM has several strengths:

- it has a structure in accord with economic theory (at least in a general sense);
- it fits the data and replicates the main dynamic features of the U.S. economy, e.g., sluggish wage and price adjustment, the cyclical behavior of investment and productivity, the link between changes in inflation and the level of resource utilization;
- it has been road-tested and proven its usefulness through real-time forecasting; and
- it has a structure rich enough in detail to include the major channels through which complicated changes in tax policy influence the economy.

However, most economists are sharply critical of large-scale macromodels. In their view, the DRI and WUMM models are fatally flawed for three important reasons: (1) the correspondence between theory and model specification is weak; (2) the treatment of expectations (adaptive) is naive and subject the model to the Lucas critique; and (3) identification of the model for estimation purposes requires arbitrary exclusion assumptions. A sub-set of this group would add a further complaint, that (4) the theoretical

holds (relative to real GDP), because a fall in the dollar boosts consumption prices relative to the price of domestic output.

[9] The distinction made here between transitory demand effects and supply-side responses is somewhat artificial, as temporary swings in aggregate demand are typically associated with fluctuations in investment growth, which affect the size of the capital stock. My goal here is to distinguish between the GDP effects predicted by a simple neoclassical growth model (in which potential output expands smoothly and slowly) and the more complicated dynamics generated by models incorporating short-run Keynesian behavior.

underpinnings of such models are based on discredited theories of economic behavior (although others, such as the neo-Keynesians, would probably disagree).

Unfortunately, there is no alternative to traditional large-scale macromodels that is both supported by a majority of economists and useful for dynamic revenue scoring. For example, small-scale VAR models, which are widely used in forecasting, are poorly designed for policy analysis owing to their atheoretic structure. Real business cycle models are another possibility, but their use would be problematic given their inability to fit historical data, and their rejection by many for their unrealistic explanation of important macroeconomic phenomena such as cyclical fluctuations in employment and productivity. Of course, it is possible that a consensus model will emerge in the near future. Research into the dynamic system behavior of the aggregate economy has picked up in recent years, and some promising new approaches have appeared that allow for policy analysis in the context of dynamic models fitted to historical data.[10] But this work is still at an early stage.

Sometimes you hear the argument that transitory disequilibrium effects can be safely ignored—vitiating the need for a consensus dynamic macromodel—because the Federal Reserve could offset any transitory swings in aggregate demand through monetary policy. While I find this faith in the omnipotence of the Federal Reserve gratifying, it is unrealistic. Although a cliche, the lags in monetary policy are long and variable, and the FOMC operates in an environment in which the workings of the economy are imperfectly understood and the system is continually buffeted by random shocks.

Monetary control by its nature is a forward-looking process, because changes in short-term interest rates take time to affect real activity and inflation. If the Federal Reserve knew in advance exactly how the economy would respond dynamically to the adoption of a VAT or a flat tax, it could in theory compute the path of reserves or the federal funds rate would keep the economy expanding along its potential path. But for policymakers, it is an extremely difficult task to understand and predict the evolution of the economy under normal conditions. To do so in the face of sweeping changes to the tax code would be more difficult still, especially as the FOMC would have no historical experience with such a tax change to guide it.

I suppose this argument could be made about any unprecedented change in fiscal policy. However, a switch to a consumption-based tax poses some especially thorny issues for monetary policy. For one, as both Roger Brinner and Joel Prakken have pointed out, replacing the present income tax system with a VAT or a flat tax is potentially inflationary. Certainly, foreign central banks have worried about such a threat when similar tax changes have occurred outside the U.S. Of course, some argue that this problem is overstated, and that all the FOMC need do is calculate the increase in reserves needed to accommodate the initial jump in the price level, and from there set money growth at its old rate to keep unemploy-

[10] Examples of such research include the Federal Reserve's new large-scale model of the U.S. economy (designed to address many of the criticisms leveled at the other generation of structural models), and work by Leeper and Sims on policy-invariant structural VARs.

ment and inflation at acceptable levels. But this argument overlooks two practical issues.[11]

First is the issue of expectations. With the introduction of a VAT, there is a risk that a significant fraction of the initial hike in the price level could become incorporated into expected inflation. At worst you might have the situation described by an adaptive-expectations Phillips curve model of inflation, in which a significant portion of the initial price shock feeds through into inflation over the medium term. Fortunately, such models almost surely overstate the problem because they implicitly assume that the tax-induced spike in the price level would be treated the same as any other inflation surprise. Because this particular surprise' would be well publicized in advance, and firms and households would be told repeatedly to expect a one-time jump in prices, the initial change in the price level would probably not have much effect on expected inflation. Therefore, I think that DRI and Macroeconomic Advisors were correct to modify their Phillips curve specifications to eliminate this kind of effect. Of course, advance publicity wouldn't guarantee that inflation expectations would be unchanged. But European and Canadian experience suggests that such tax changes do not produce extended periods of higher inflation. Instead, inflation jumps and then returns to its previous level within a short time, without the need for a particularly tight monetary policy. Nonetheless, the Federal Reserve would need to be alert for any adverse inflation consequences.

The second issue (and by far the more difficult) concerns the determination of the stance of monetary policy consistent with stable inflation under the initial phase of the new tax system. If it were merely a question of increasing the level of reserves by enough to leave the real money stock unchanged in the face of the initial jump in the price level, the Federal Reserve could accomplish this by pegging the nominal federal funds rate during the first months of the changeover. But the actual problem would be much trickier than that, because it is highly likely that the level of the real interest rate consistent with short to medium-run inflation stability would shift—perhaps by a large amount, and in ways difficult to predict in advance. And even if such shifts could be perfectly anticipated, their likelihood undercuts the reasons for ignoring disequilibrium effects in the first place: Perhaps budget analysts could assume that output would grow at potential, but they still would need to project the transitory swings in interest rates consistent with stable growth and inflation.

One reason to expect transitory swings in interest rates and output is the initial jump in the price level: Owing to the existence of bonds and other nominal contracts, the rise in prices would redistribute income and wealth on a massive scale. Changes in the relative tax treatment of labor and capital income would complicate

[11] Sometimes the argument is made that monetary policy would not need to accommodate any jump in the aggregate price level, because nominal wages would fall immediately after the introduction of a VAT or flat tax (and so keep the real after-tax wage unchanged). Hypothetically, such a real wage adjustment mechanism would work as well as that embedded in the DRI and WUMM models, where a jump in output prices equilibrates the system. However, the weight of empirical evidence is against this type of adjustment. Wage inflation is much more sluggish than price inflation, and foreign experience with increases in VAT rates shows that little, if any, adjustment occurs through reductions in nominal wage rates.

these distributional effects. Given that the propensity to save appears to vary across different segments of the population, such reallocations of income and wealth would probably affect the level of aggregate demand. Unfortunately, how they would do so is not obvious. Furthermore, expectational effects would be at work, influencing the timing of any demand shift. Because the revisions to the tax code would be known well before they took effect—particularly for a VAT, which would require a new administrative system and thus a substantial lead time—investors and other agents would probably start to adjust even before the legislation passed. Policymakers would need to take these anticipatory effects (which are not incorporated into DRI's and WUMM's adaptive expectation simulations) into account when attempting to stabilize the economy.

As noted in the reports by DRI and Macroeconomic Advisors, there are many other reasons to expect transitory fluctuations in the underlying level of aggregate demand. For example, a switch to a consumption-based tax should lead to an investment boom, a factor that by itself would initially put upward pressure on capacity utilization and interest rates. On the other hand, ending the deductibility of mortgage interest might produce large declines in real estate prices and thus household wealth that, in turn, would put downward pressure on consumer spending, all else equal. Again, expectations would be a key factor in the timing and size of these effects, and would help to determine whether the initial net stimulus to the economy from tax reform is positive or negative. If, for example, land values were to adjust quickly to the loss of tax subsidies to housing, but households were slow to balance this loss in real estate wealth against the rise in the present value of their expected future after-tax income derived from other sources, then the initial macroeconomic effect of tax reform could well be contractionary.

This particular story may seem fanciful—under rational expectations, the two effects would roughly offset—but it must be kept in mind that the loss in housing wealth is directly observable, were as the rise in the present value of future income is not (and is difficult to compute and subject to considerable uncertainty, to boot). The important point is that, during the initial phase of the new regime, its effect on aggregate demand would be difficult to sign for a host of reasons. Given such uncertainty, prudence dictates that budget planners incorporate only modest estimates of feedback effects from transitory macroeconomic phenomena. But given the lack of consensus concerning the appropriate model of the dynamic economy—after all, the disequilibrium effects discussed at the Symposium come from models currently rejected by most economists—I don't believe that even a token nod in the direction of dynamic revenue scoring is merited.

SUMMARY DISCUSSION

1. Michael J. Boskin*

I've learned a lot from this symposium. While I will make some suggestions of additional things for you to learn more about, I believe it has been enormously valuable to force everybody to try to answer the same question.

The first lesson is that the question is much more complex than it might first seem. If you ask a bunch a economists what will happen to the economy if we adopted some fundamental tax reform, a subtraction method VAT or flat tax, it would seem to most people like a really very, clearly, carefully articulated question. Then you might ask well what variables did you analyze: real GDP, consumption, economic welfare and over what time horizon? What else is going on? What's the Fed doing? There are literally dozens and dozens of sub questions that have to be dealt with and judgments that have to be made to gain some degree of comparability among the attempts to try to answer these questions.

While the range of responses is large, there is a pretty reasonable qualitative consensus about what is likely to happen in the long run. For the real change in GDP, we may be looking at low estimates in the three to five percent range, moderate in the eight to ten percent range (although, there are some that are higher still). Once we get there, real GDP is permanently higher by that amount. A ten percent difference in GDP is considered a sizeable difference in the standard of living across countries. So, it is nothing to sit still about. We can argue whether the result is more likely to be four percent than nine percent, but we come out more or less in the same place for more or less the same reasons. The different models have been developed, improved and evolved over time because they were designed to help answer different, albeit at times related, questions. Some are designed to deal with issues of intergenerational equity, some are designed to focus on long run growth, some to focus on short run macroeconomic issues and so on.

It is important to understand that all the models have their strengths and weaknesses, some of which were discussed this morning. It is important to understand that some of the models have had to make accommodations to comply with the requirements imposed by the Joint Committee on Taxation to try to produce a simulation that is directly comparable. I think the modelers have done a good job in that regard.

Let me just lay out four or five basic economic issues that I think did not get enough attention. The first is, "what do we really care about?" Most economists are used to notions of economic welfare.

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Jane and others talked about this a little bit. It was implicit in the discussion of measuring consumption rather than GDP, for example. Welfare changes can differ substantially from GDP changes because in the short run much of the kick comes from increased labor supply which has an opportunity cost in terms of foregone leisure. Some of the models have some disaggregation; for example, they get some of their bang from reallocating capital from tax subsidized housing into more heavily taxed corporate fixed investments. As economists, we may be trying to account for that phenomenon with a welfare measure, which might be lower than the GDP measure once we net all that out. The average person on the street may view this quite differently; the benefits are that we're going have less investment in housing and more in the business sector and some second earners in families are going to leave home and leave their kids to day care and go to work. I think we have a lot of explaining to do about not only our modeling but the standards we use for comparison. The JCT was very very clear that they wanted certain macroeconomic variables measured and that is right for their purposes of estimating tax revenue. I think that it is important we lay out the welfare economics of tax changes as well.

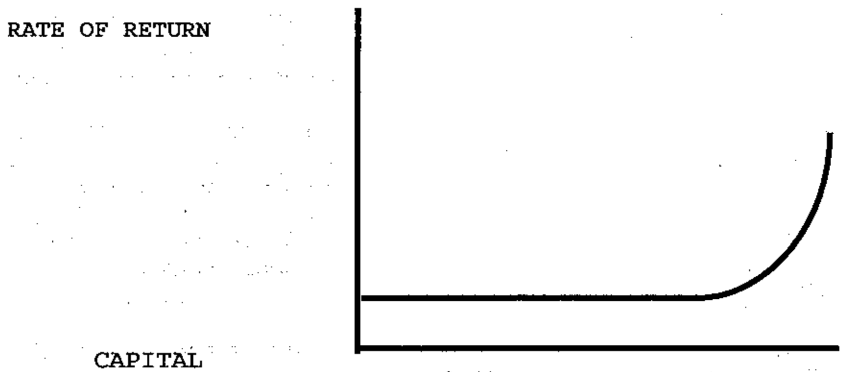
The second issue that Kent Smetters, and maybe one or two others, mentioned is that most of these models are not terribly well developed with respect to how they deal with risk and uncertainty. Kent mentioned the equity premium and the productivity of capital; that certainly is an important issue. These models differ in how they deal with myopia versus foresight. But one thing that was not stressed, regardless of what the model assumes about foresight, is whether people know what future tax rates are going to be. What do people really believe about the likely path of taxation; what is already in people's decision making about the likely path of tax reform? In many of these models, if you cycle the tax system through some reforms, you'd get very large effects. Even though you might think people were smart enough to average out that the tax system went back and forth every year or two years. That is something that I think is important. It has led a lot of us to argue that among the criteria that it would be wise although difficult to implement, to think about, with respect to tax reform, is whether we can get and keep it, and not get it and unwind it as we've done in the past, given how many tax reforms we've had.

I certainly agree that there is also the issue of administrative and compliance cost. One of the world's experts is to my right, and I'll let him pick up on that to the extent he wants to.

On the issue of the openness of the economy, I want to say a word or two. I am certain that the supply of capital to the United States looks like Figure 1.

FIGURE 1

SUPPLY OF CAPITAL TO THE U.S.



But I will also assert that we are quite uncertain as to what the units on the horizontal axis should be and the time frame they cover. We know that eventually the supply of capital to the United States has to become very inelastic because foreigners will not want to have all their wealth in dollar-denominated assets. But whether we can double the capital stock from where we are, we don't know. I view that as one of the really serious issues. Although I tend to be of the view that the supply of capital to the United States from abroad is pretty elastic for at least modest changes for a modest period of time. I do not think all the capital in the world would continue to come here forever. But I also do not believe that the closed economy models fully capture capital flows.

A couple of other points: Elasticities got a lot of attention. The ones that got the most attention were labor supply and saving. There, my views are not far off from what the people were saying before. I have not changed my mind much. Maybe some people think my savings elasticity estimates from two decades ago are high, maybe low, at 0.4, Larry Sumers was at 2.0 for awhile. Some people think zero is more accurate. But I think it makes sense for us to do sensitivity analysis so we can see what sort of difference it makes over quite a range. On the issue of labor supply, my views again are pretty conventional: low for prime age, first earners in families and much higher for second earners in families.

With that said, I want to get to some things that I think that were left out. One issue is if we make a fundamental change in our tax law, what will other countries do? That gets complex. Will the rest of the world put up with the United States luring capital from abroad by our tax changes?

The second point is something that has become important in the political system: the tax treatment of human capital. And it is also important because all the models tend to use constant returns Cobb-Douglas production functions for capital and labor. There are some variants on that theme. Empirically it is hard to conclude that increasing human capital is just like having more labor. It turns out human capital appears to be much more complimentary to capital than to labor. In the book I'm writing, on postwar growth with Larry Lau, we have concluded that technical changes is human- and tangible capital-augmenting, not labor augmenting. And that has rather important differences for how changes in capital formation will affect the economy. But at the very least, one of the arguments about the flat tax and some of the current proposals is that human capital is over-taxed relative to tangible capital—an argument I think which is probably wrong. Most of human capital investment is financed by foregone earnings which, after all, are expensed. In any event, the fact of the matter is that at some point we have got to start thinking about human capital as well as tangible capital and labor. I think that the way that it is being done in these models is referring to raw labor and the skills and showing up basically as just adding on to labor. I think that is wrong.

On the issue of time horizons and how elastic is domestic capital and over what time horizon—over a time horizon that extends well beyond the JCT's revenue estimating horizon. I have no problem with the supply of capital to the economy being very elastic over many generations as in the Jorgenson/Wilcoxen infinitely lived model. Write down the Hamiltonian and do a little arithmetic and you will wind up with a constant real net of tax rate of return equal to the true rate of time preference plus what economists call the elasticity of marginal utility (the rate at which the marginal utility of income declines) times the rate of technical progress.

What do I conclude from all this then? First, it seems to me the JCT cannot be asked to estimate the macroeoncomic effects of the more than 1,000 tax proposals on which they are asked to do revenue estimates. That would be unreasonable. For a proposal that is really fundamental, like the proposals talked about today, or a proposal which, for analytical, historical or econometric reasons, there is wide agreement that the effects are likely to be sizeable, relative to other things that are measured by the JCT, the JCT ought to provide that supplementary information. They have made a step already in that direction, providing qualitative information, which is a change in their procedures that I applaud. As I understand it, they may be requested under a House rule to go further into dynamic scoring. I would urge that they try to accommodate that to the best of their professional ability in the following way. I believe that it would be sensible, for a proposal as important as fundamental tax reform, for the JCT to be able to lay out a range of plausible values that might ultimately be the long run impact, even though a much greater uncertainty, I think, adheres to year to year revenue estimates. I think that it would be unfortunate if this supplemental information were not provided, because I think that Congress already has too many incentives to deal with the short run and ignore the long run. Some of our problems as mismeasured by our current accounting systems in the budget stem from that tendency. So, I think it would be good for Congress to know that there is widespread agreement that there would be an important improvement in the performance of the economy and living standards with some range of disagreement over how large that is, and to be given that range, for this kind of tax reform. They are going to need a lot of other kinds of information that these kinds of models are unlikely to provide. But I think that trying to move in that direction is the right way to go for large-scale, fundamental changes, not for the run-of-the mill minor amendments. If somebody ask you to do a veterinary deduction estimate, I doubt that would have any macroeconomic impact.

There is no one model that the JCT right now could implement and put into their daily activities to give year-by- year revenue estimates over five or ten years, but I think that it can go beyond the good step they have already taken and try to supplement the qualitative information with more quantitative information for these very fundamental proposals. Also in doing so, the JCT can highlight the kinds of things that are likely to reduce those benefits, for example, whittling away the purity of the reform and raising rates.

2. Robert D. Reischauer*

This symposium is a very important one and I, like others, want to commend the Joint Committee on Taxation (JCT) for undertaking the effort. The conference has been of significant educational value to policy analysts and policy makers. It should also encourage the small group of professional economist who are engaged in modeling the economic effects of fundamental tax reform to step up their level of activity and interact more cooperatively with one another. The past might best be characterized as an era of non engagement when models and modelers passed each other silently in the night each going independently on his or her own way.

Two, quite different, objectives have motivated this JCT exercise. The first of these was to provide policy makers with some appreciation of the long-run economic impacts, both good and bad, that fundamental change in the current tax system might have. Optimists might regard this as the search for the answer to the question, "How big and how certain is the pot of gold that lies at the end of the fundamental tax reform rainbow?"

The second objective of this exercise was to provide policy makers with more accurate estimates of the short-run economic consequences of big changes in the tax system and to explore their impacts on projected revenues over the next five years. The need for this arises because the macroeconomic forecasting models that are currently used to generate the economic assumptions that underlie budget projections do not do a very good job of incorporating the short-run, supply side effects of fundamental reform proposals.

What came through clearly both from the papers and the presentations made during the morning session of this symposium, is that all the models that were presented have some significant limitations when it comes to achieving either of the two objectives. It is probable that no single approach will ever be best at providing the answers to both of these questions. Nevertheless, the question before the JCT is whether the state of the art has developed to the point where it should be placing greater emphasis on the results of these models when it advises Congress. Would the debate be enriched or misled? On the one hand, if the output of these models were used more attention might be focussed on the long-run benefits of policy changes, benefits that are often ignored or given short-shift in current debates. In addition, the "more realistic" estimates of the short- and long-run economic consequences of reform generated by "experts" might replace the unsubstantiated assertions that policy makers now use in the debate. But, on the other hand, it is worth remembering that it is possible that such information could confuse the debate and muddy the decision-making process. The discussion this morning made it clear that the professionals

* Dr. Robert D. Reischauer, Senior Fellow, The Brookings Institution.

will present a wide range of answers to the same question. The conflicting assertions of politicians could be replaced by a confusing cacophony from the experts.

From the papers and presentation this morning, it should be clear, as others have already noted, that none of these models is ready for prime time. What is meant by that is that none is at the stage where it could be used in any of the formal estimating or score keeping procedure that the Congress relies on to maintain some semblance of fiscal discipline. There are five reasons for this negative assessment. First and foremost, a professional consensus has yet to emerge concerning the best approach to use try to answer either of the two questions raised previously. Second, even if there were a consensus about the best general approach, the model results would be highly uncertain. The discussion this morning made it clear that each model's results are highly sensitive to particular assumptions, be they certain assumed coefficients or structural forms. Even those experts who endorse a particular approach do not always agree about these assumptions.

Third, there is no way to validate or test the accuracy of these models. This is particularly true when one is examining the long-run effects of fundamental policy changes that fall well outside the historical experience. Providing policy makers with advice about the long-run based on the estimates of untested models may turn out to be little better than the practice of ancient times when priests gave policy advice based on their examination of the entrails of dead animals.

Fourth, none of the models has sufficient detail about the tax system to deal in a credible way with real world tax reform proposals. Congress is not going to make a decision between one pure type of taxation and another pure type. The current system is far from a pure income tax. The choice Congress will face will be between one hybrid system and another. It is not clear that the models presented today can handle adequately such a choice. All of the models will need a good deal more development before they can handle complex mixed systems.

Fifth, even if there were a consensus among economists about which approach was most appropriate and economists were fairly comfortable with the results that were produced by that approach because different models based on the approach generated similar estimates, the results would still be open to significant criticism because the models will unavoidably simplify the real world. Those interests which are disadvantage by fundamental tax reform are going to examine the models used make estimates in a very critical fashion. They will focus in on the unavoidable omissions and simplifications in the models and try to discredit them. The models will have to be able to withstand such attacks to be useful to policy makers.

How dejected should we be about this negative assessment? Not very. This is the case because there is very little possibility that Congress will ever approve, cold turkey, fundamental tax reform. Even if the political process did enact something that had the "fundamental tax reform" moniker, the legislation would undoubtedly contain a very long transition period during which substantial amounts of relief would be provided. That transition period and relief would be part of the legislation even if all of the nation's economists told Congress that the only way to ensure that the long-run economic benefits would be realized in a reasonable length of time was to keep transitional relief to a minimum. This is the case because a series of short runs must be traversed on the way to the long run and whether a policy maker lives or dies depends upon the public's assessment of his or her short-run actions. For members of the House of Representatives time is measured in two year increments, for Presidents in four year intervals, and for Senators somewhere between two and six year periods. If all policy makers were convinced that the benefits of fundamental tax reform could only be obtained by moving to the new system quickly and without significant transitional relief and they acted accordingly, they would be replaced by a different group within two years. The new group of policy makers would have run on a platform that promised transition relief or repeal of the reform altogether.

Considering this set of circumstances, what should the JCT do? First, it should encourage the academic and modeling communities to continue to improve these models. Second, it should convene a symposium every few years to assess the progress. If a consensus begins to develop concerning the appropriate ways to model the long term impacts of tax reform and the models begin to generate similar results, Congress could consider some more formal use of the model results, a use that would supplement rather than displace existing analysis. Third and finally, the JCT should stimulate a major effort to improve the capacity of standard macroeconomic models to handle incremental changes in tax system of the sort that Congress is most likely consider over the foreseeable future.

In conclusion, it is worth underscoring that much of the debate over the interactions between tax legislation and the economy—the dynamic scoring debate—which has been the impetus behind this conference represents a tempest in a teapot. The economic assumptions used to score tax bills, be they incremental or fundamental reforms, are those that underlie the congressional budget resolution. Congress approves those assumptions and tries to make them consistent with the resolution's policy assumptions. Congress is not going to decide suddenly one morning to take up fundamental tax reform. That decision is going to be made as the budget resolution is being formulated. The decision will be reflected in the resolution. The economic ramifications of the tax reform will be incorporated into the economic assumptions that underlie that budget resolution.

In this framework, the danger is not that policy makers will assume too little in the way of salutary effects of tax reform on the economy and hence the budget deficit. Rather it is that they will assume too much. The most likely scenario is that when the budget resolution is being put together an assumption will be made that a pure reform with little transition assistance will be enacted. The positive economic impact of this reform will be built into the budget resolution's economic assumptions. As the legislative process grinds on, interests will demand transition relief and more gradual implementation. When the measure is finally enacted, it will look more like incremental reform than fundamental reform but the salutary effects of fundamental reform will have been incorporated into the economic assumptions of the resolution. And so the real risk lies in the opposite direction from that which most advocates of dynamic scoring assume.

3. Harvey S. Rosen*

In a typical piece of econometric research, the author attempts to figure out how some kind of behavior responds to a change in an individual's economic environment. The result often is summarized by an elasticity. For example, if one raises wages by ten percent, by what percentage does labor supply increase? After computing the response, the investigator often steps back and asks "is this a big or is it a small response?" Usually there is some waffling here—whether a particular elasticity is big or small depends on the question you are asking, what your priors were when you started, and so on. The context in which one evaluates the estimates is critical. That is the spirit in which I approach the question of whether the estimates of the effects of fundamental tax reform in this morning's papers are close or not.

In one sense they are very close. As Roger Brinner pointed out this morning, if you look at a measure like long-run effects on GDP by the year 2005 or so, and then you exclude the highest and the lowest estimates, the range is about .3 to 4.0. Now if you put this in the context of the economic literature on how various kinds of consumption taxes would affect GNP, and you include theoretical, econometric, and simulation models, the numbers in the table are really very close to each other. That is, if you consider all the ideas that have been put forward about the desirability of moving to consumption taxation and the effects it would have, the range is much greater than the range in the table. It is in that sense that the numbers are quite close to each other.

Is this the only useful way to think about whether the estimates are very close? Asking this question brought back to mind the great capital gains debate of the late 80's and early 90's. At that time different estimating groups here in Washington were estimating the effects of capital gains relief on revenues. Given the universe of possible estimates for how a change in the capital gains tax rates would affect revenues, the estimates used by the various groups were quite close. The fact that JCT and the Office of Tax Analysis were very close was reflected in their estimates. Over a five year period, the Treasury staff showed roughly a $12 billion increase in revenues and the JCT showed roughly an $11 billion loss.

By academic criteria, these were close estimates. However, politically they were light years apart. The reason was that one estimate was above zero and one was less than zero. From the point of view of the political situation, the fact they were very close to each other from an academic viewpoint did not matter. One of the estimates meant that the proposal was a "win-win situation," as Treasury officials characterized it: the people who realized the capital gains would come out ahead, plus there was a revenue gain which would

* Harvey S. Rosen, Professor of Economics and Business Policy, Princeton University.

allow reduction of other taxes. On the other hand, if you believed the negative estimate, then one could argue that capital gains relief meant balancing the budget "on the backs of the working men and women of America." Politically, then, the difference between the estimates was enormous.

I have a feeling that if this fundamental tax reform became an active issue it would be a contentious one. This is not something that would just sail through. As Robert Reischauer suggested, it would be a difficult process politically, and therefore even small differences in legitimate opinion could translate into major differences in the political debate.

This is natural segue' to the second point I wanted to raise: are the estimates suitable for revenue estimating? Well, I agree with the statement from the Rogers paper, a statement that applies to all the models, I believe. Rogers said the real use of a model comes from its ability to highlight how various economic parameters influence the effects of tax reform on relative prices and the allocation of resources. As Bob Reischauer just said, there is simply not enough detail to do real-life revenue estimates. These models can provide tips to the revenue estimators by helping them to think about what information they need, but they cannot replace the actual revenue estimating process.

It is important for those of you who have not been involved in this type of process to understand that when revenue estimators do their work, they do not have some megamodel whose switches can be flipped in order to consider different proposals. As I learned when I was observing the process, the proposals are sufficiently different from each other that you cannot build a model that is big enough to embody every possibility as a special case. We might, for example, estimate the revenue of a beer tax that applies only to breweries that produce 100,000 barrels a year or more. This would require adjusting the model in a somewhat ad hoc way.

I think that a study that might be relevant in this context is the Treasury's Corporate Integration Tax Study, which includes both conventional revenue estimates and results from some simulation models, several of which were in the same spirit as the models presented this morning. I think that the two types of analyses hung together rather nicely. That is, if you wanted to learn something about the long run impact of the integration program, you could look at the chapter with the simulation models. On the other hand, if you wanted revenue estimates that take into account very detailed issues such as carryover of losses and so on, look at the chapter with revenue estimating models. I think that there is a role for the kinds of models we are discussing here, but they are not going to replace the conventional revenue estimating process.

The third question I would like to address is this: "are the models from this morning missing something important?" This is an opportunity for me to ride a hobby horse, and I will not let it pass! If you review the instructions that the modeling groups were given, one thing that comes through pretty clearly is that they could push the state and local sector aside. For example, the suggested outline for the modelers' presentations says nothing about assumptions regarding state and local behavior. What would happen if, to the contrary, there was some kind of response by state and local governments?

In 1994 the state and local sector spent 12 percent of gross domestic product, a number that exceeded gross non-residential private investment that year by almost $200 billion. Recall that one of the tax reforms being considered is a consumption tax. Now, as long as the elasticities of the taxed commodities are not zero, then the assumption that the states keep their tax rates the same is inconsistent with balanced budgeting for all the parties (or alternatively, constant deficits for all parties). So, something would have to give if the federal government started encroaching on the states' tax bases. For example, if the federal government increases its tax on some commodity, then less will be consumed; if states keep their rates the same, then they will be taking in less revenue. What would happen? One cannot say a priori. As usual, there are different effects in these kinds of models. One possibility is that the states might decide to raise their rates in order to maintain the same revenues. On the other hand, the states might not increase their rates, because as one keeps piling on taxes on a set of commodities, on the margin those taxes become more painful. (In terms of traditional neoclassical economics, one can think of this as the excess burden going up. In a political economy context, one can imagine that as the tax on some commodity goes up, on the margin, there is more and more political unhappiness.)

Given the two conflicting effects, we don't know what the states and the localities would do. What we do know is that the governors and mayors have lobbied very hard against Federal consumption taxes. So, in the spirit of suggesting things that might be useful to work on in the future, I think that attempts should be made to model state and local government behavior.

4. Joel Slemrod*

There are two questions facing us today. The first one is "what's the right answer to the question of how fundamental tax reform would affect the economy?" That is the economist's usual preoccupation. The second question is "what should the JCT do, given that nine economists will give nine different answers to this question, with a central tendency but at least one large outlier, and given that even within a particular model, results can vary a lot depending on assumptions?" For example, depending on the variant of the model, the Rogers model predicts that due to tax reform the capital stock could rise between five and 24 percent. In addition, all of the model results you have seen today came without standard errors. If the standard errors were computed accurately, my guess is that even though all the models predict a positive GDP kick from consumption tax reform, a reasonable confidence bound for most of the models would include a zero change in GDP.

How can we tell which model gets closest to the right answer? The traditional response to this question is to do econometric analysis to determine what the right parameters are. It is difficult, though, to do system-wide estimation, although, the Jorgenson/Wilcoxen model attempts this. Scores of parameters are required. But it is not only parameters that are required; fundamental modeling choices must also be made. Another approach is to "calibrate" the model, by assigning estimates to particularly important behavioral elasticities. However, computing each of these parameters has its own econometric problems.

We have heard a lot of metaphors, allegories and analogies today. I will add one more. Each of these models is particularly good at addressing one or more aspects of the problem, but none is very good at all aspects of the problem. The allegory I want to add is the one about the blind men and the elephant. Each blind man is next to one part of the elephant: the one that has got the trunk in his hand thinks the elephant is a snake; the one that has got his hand on the leg thinks it's a tree, and so on. Each of these models is like a blind man that accounts for one part of the elephant more carefully than others, and ignores or treats inadequately other parts of the elephant. The question facing us today is which model predicts best how far the elephant will move when somebody smacks it on the butt. Is it going to move slow, stay still or even move backward? That will, of course, depend on whether the economy is more like a snake or a tree.

I have a suggestion about how to evaluate to what extent each of these models gives the right answer to this question. My suggestion is to have these models do what I call "back forecasting." For

*Joel Slemrod, Professor of Business Economics and Public Policy and Professor of Economics, University of Michigan.

example, have the models predict the impact of the Tax Reform Act of 1986 (TRA86), which some predicted would lead to the "de-industrialization" of America, and see what happens. If these models were used in 1986 to predict the course of events, what would they have said? Of course, other things happened after 1986 that could not have been forecast in 1986; taking account of the other things is one of the points of formal econometrics. However, by back forecasting we might be able to see if some of these models predicted an economic scenario far from what actually occurred; if so, that should get us thinking that maybe this is not the model for forecasting the impact of the next tax reform. I would also use these models to back forecast the Economic Recovery Tax Act of 1981 (ERTA). In a way, that might be a cleaner exercise than dealing with TRA86, because ERTA was much less complicated than the Tax Reform Act of 1986, and the model builders would not have the problems of deciding which of many aspects of the very complicated TRA86 to try to build into the model.

The hypothetical tax reforms that the model builders have been asked to simulate are each very complicated changes in the tax system; that is true not so much because the alternative systems—the VAT, the flat tax or uniform income tax—are so complicated, but because the current system, being a hybrid of income and consumption taxes, and featuring an unintegrated system of personal and corporate income taxes, is very complicated. Clearly, some of theses models are not designed to handle all the complexities of the economy and of the current tax system—for example, some have virtually no foreign sector, some have no owner-occupied housing sector, and so on.

Another way to learn about the appropriateness of these models is to give them a simpler exercise than the complicated one we have given them. We could, for example, ask the model builders to simulate the effect of just reducing tax progressivity, holding everything else within our current tax system constant—or to just introduce expensing, with no other changes. Or to just do limited base broadening, say integration or elimination of itemized deductions. Because the radical reforms that the models have been asked to simulate are combinations of all these different exercises, it is hard to know what drives their results and it is hard to evaluate the results against what we think we know about the way the economy works.

Are there criteria which we can use to rule out some of the estimates, or some of the models? Are there some minimum standards we want to apply to the models? One possibility is to discard models for which the key elasticities have values which are beyond our best judgment's ninety-nine percent confidence interval. What about applying some consistency checks to the models? For example, in each of these models, are the long-run effects of a VAT the same as those of a proportional Hall-Rabushka flat tax? They should be; if they're not, there must be a logical inconsistency. My bet is not all of the models will pass this particular consistency check.

What about some minimum standards for model adequacy? For example, any qualifying model must have an international sector. That would not mean that we require a model of the U.S. as a small, perfectly open economy, but any qualifying model must consider the international ramifications of tax reform. Another standard might be that a model must have an owner-occupied housing sector, because that sector represents a very large fraction of total national capital. Or what about a series of logical extreme tests: for example, is the predicted change in labor supply from instituting a flat tax (holding unemployment at the natural rate, which is part of this exercise) three times higher than any annual change in the entire history of the United States? If so, we can probably safely discard the forecasts of such a model.

Another possible minimum standard is that the models be able to offer welfare conclusions. A cursory glance at the results of the models in this project suggests that they all predict that, in the long run, a consumption tax would lead to increased GDP. One might be tempted to conclude that all the model builders agree that therefore this is a good thing to do. That would be incorrect, however, because the increased GDP in these models probably comes from a combination of lower consumption in the short run (as people save more), a lump-sum tax on holding of existing assets, and less leisure. All of these things should be considered in the welfare analysis of whether a consumption tax is a good idea or not. Another way to put this point is to consider the predicted effect of moving beyond a zero tax on the normal return to capital (as in a consumption tax) to a 10 percent subsidy to savings. What would happen if we asked the model builders to simulate a 10 percent subsidy to savings? My guess is that the models would predict even bigger increases in GDP than the flat tax! What about a 50% subsidy to capital? At some point, we would have to say that just because long-run GDP is simulated to go up does not mean that this policy is a good idea for the economy. The Jorgenson/Wilcoxen model is an example of this. They predict that, in the long run, GDP will increase about 3½ percent if we were to adopt a consumption tax. However, according to their welfare analysis, to a first-order approximation the change in welfare from such a tax change would be approximately zero—on average people are neither better nor worse off.

If we cannot agree on which model of the economy is right, then what can we agree on? I believe it is very important to focus on getting an accurate description of the current tax system; for one thing, it may be less controversial and easier to get agreement on how to model what tax system we have now than on how a tax system change affects the economy. However, there are some key and controversial questions in this area. First of all, what is the current economy-wide average marginal effective tax rate on capital? These models have very different answers to that question. A paper I wrote several years ago with Roger Gordon suggested that the answer to that question was approximately zero; this means that the shift to a consumption tax on average would not reduce the average tax on capital that much. What is the marginal tax rate on labor and savings? In calculating the former, how is the Social Security payroll tax considered? One can model it as a distortionary tax or alternatively, as a payment for future benefits. What is the marginal tax rate on labor or on savings of high-income, sophisticated people who can afford very good tax accountants? We may well agree that it is not the statutory marginal tax rate, but what is it? This is an important question because, in moving to a flat tax, based either on income or on consumption, we need to know what effective rates high-income people face now, in order to understand what the impact of these changes will be.

The proceedings of this conference make for an interesting contrast with a conference on distributional analysis held in this town about three years ago, sponsored by the American Enterprise Institute Conference and organized by David Bradford. Many of you here today probably attended that conference, as well. The focus of that conference was to look carefully at the way the Joint Committee on Taxation (JCT), the Office of Tax Analysis (OTA) at Treasury, and the Congressional Budget Office do distributional tables; it was motivated by David Bradford's uneasiness with how well the methods that these agencies currently use reflect the state of economic thinking about how to do distributional analysis.

These distributional analyses face the same kind of, and similarly daunting, conceptual and data problems that apply to the question we are addressing today. At that conference, Michael Graetz argued that the JCT and other agencies should just get out of the business of producing distributional tables, because these tables produced, in his words, "the illusion of precision;" he argued that JCT should not provide distributional tables, but instead provide only qualitative distributional analysis, perhaps presenting how the tax burden of illustrative families would change. Graetz dismissed sensitivity analysis as sufficient to solve the problem that this illusion of precision creates.

I would characterize Graetz as recommending a "don't ask, don't tell" solution to this problem: JCT won't tell what the distributional implications might be, and they hope nobody asks. However, I think Graetz's suggestion ignores the fact that the official estimates do not exist in a vacuum. There are privately-produced models out there, some with axes to grind, and in their presence it is valuable for JCT and OTA to do serious, "unbiased" analysis of this kind of question.

What is the analogy to Graetz's suggestion for growth analysis? What is the "don't ask, don't tell" option for the economic impact of tax reform? Keep in mind that there are differences between the two issues, one being that under the budget rules, JCT has do revenue estimates but does not have to do distributional analysis. How could one avoid the illusion of precision in making estimates of the growth effects of tax reform? After all, saying the behavioral response is zero is quite precise, and thus does not avoid the illusion of precision any more than saying that the answer is precisely that nominal GDP would be 3 percent higher in five years.

What is the fundamental trade off here in deciding whether the JCT ought to "dynamic scoring," the second question of the day? Or, to put it another way, what are the costs of doing or not doing dynamic scoring? The cost of not doing it is introducing a bias against the kind of tax cuts which would stimulate more behavioral response; that kind of bias is not good for tax policy. The cost of doing dynamic scoring—abandoning the current revenue scoring methods—is that the current procedures put a brake on natural inclinations to provide economic assumptions that are favorable for fiscal largesse. How should we make this tradeoff? I am quite sympathetic to Mike Boskin's view that it doesn't make sense to do dynamic scoring for every variation of every proposal, but that it does make sense for major proposals to provide supplementary information about likely—not definite, but likely—growth effects.

By the way, I also believe that the JCT should provide simplification impact statements of tax proposals. On that note, let me say that if the Bradford conference on distributional tables was the first in a series of conferences, and this one on growth effects is the second, I look forward to the third in this series, which will naturally be about the effect tax changes have on the simplicity of the tax process and on the cost of complexity. Without having the luxury of having commissioned nine papers on the topic, I suspect that the potential savings in compliance costs due to fundamental tax reform are on the order of one-half of a percent of GDP. I am one hundred percent sure that the saving is positive; and I am 90 percent sure that it is more than one-tenth of a percent of GDP and less than one percent of GDP. This is smaller than many, but not all, of the point estimates of the growth effects of these fundamental tax reforms, but is less uncertain.

APPENDICES

Appendix A:

Letter From Kenneth J. Kies (Chief of Staff) to Chairman Bill Archer *

CONGRESS OF THE UNITED STATES,
JOINT COMMITTEE ON TAXATION,
May 18, 1995, Washington, DC.

Hon. BILL ARCHER,
Chairman, Committee on Ways and Means,
House of Representatives, Washington, DC.

DEAR MR. CHAIRMAN: This letter is to inform you of recent developments concerning the revenue estimating function performed by the staff of the Joint Committee on Taxation. Since assuming my position as Chief of Staff, I have devoted much attention to reviewing current methodology and discussing possible improvements with my staff and various outside experts.

As you know, there has been ongoing controversy about revenue estimating methodology and distributional methodology. For example, there have been suggestions that the Joint Committee has not taken taxpayer behavior into account adequately in preparing estimates. In addition, much debate has centered around whether the Joint Committee estimating methodology should attempt to incorporate the effects that tax proposals may have on Gross Domestic Product ("GDP") and other macroeconomic aggregates.

This debate was the focus of a joint hearing of the House and Senate Budget Committees on January 10, 1995, at which I testified concerning our revenue estimating methodology and was discussed at a hearing of the Senate Finance Committee on January 24, 1995. The consensus among witnesses at the January 10, 1995, hearing was that while some tax proposals may have significant effects on the long-run growth of the economy, economists have not as yet developed models of the economy that can predict the timing and magnitude of these effects with enough accuracy to justify including them in revenue estimates. There was some disagreement as to how long it would take to develop such models, but it was generally agreed that it would be inadvisable to try to incorporate macroeconomic effects into our revenue estimates without further study and experimentation.

In response to concerns regarding the Joint Committee revenue estimating process, I am making the following changes in the estimating process:

First, information regarding any significant behavioral assumptions underlying estimates of major tax proposals will now be included with our estimates if requested by the Member of Congress

*An identical letter was sent to Hon. William V. Roth, Jr., Chairman, Senate Committee on Finance.

submitting the estimate request. We included such information with the 10-year estimates of the Contract with America tax provisions that we released on February 6, 1995 (JCX–4–95).

Second, estimates of major tax proposals will now include a qualitative analysis of significant potential macroeconomic effects of the proposal, if any, if such an analysis is requested by the member of Congress submitting the revenue estimate request. Some discussion of these factors was also included in our 10-year estimates of the Contract with America tax provisions.

Third, estimates of major tax proposals will include significant aspects of modeling techniques used in the preparation of estimates to the extent requested by the Members of Congress submitting the revenue estimate request.

Fourth, we are instituting a new inventory and record keeping system for revenue estimate requests so that we can more efficiently process and monitor the progress of pending estimate requests.

Fifth, we will establish an advisory board of prominent economists familiar with macroeconomic modeling and other estimating issues to provide input to the staff on ways to improve the estimating process and estimating methodology.

Sixth, we shall continue to explore the feasibility of incorporating macroeconomic effects into our estimates. To further this end, we have begun a series of meetings with our counterparts in the Congressional Budget Office and with reputable outside economists. We also will be securing access to various macroeconomic models from several outside vendors to assess their usefulness in performing this type of analysis.

Seventh, we will make available to the public certain non-privileged elements of our estimating models.

Eighth, we will initiate a project to monitor the accuracy of our estimating process by selecting several estimates to study over a period of years following enactment.

I would appreciate the opportunity to meet with you to discuss our plans to improve the revenue estimating process.

Sincerely,

KENNETH J. KIES.

Appendix B:

Background on JCT Tax Model Symposium Participants

Alan J. Auerbach is Professor of Economics at University of California at Berkely, and a Research Associate of the National Bureau of Economic Research. He previously was Professor of Economics at the University of Pennsylvania. He received a B.A. from Yale University and a Ph.D. from Harvard University.

Professor Auerbach has served as Deputy Chief of Staff for the Joint Committee on Taxation. He is a Fellow of the Econometric Society and a member of the American Economic Association's Executive Committee. Professor Auerbach's numerous papers on investment, taxation, finance, social security, savings, and fiscal policy have appeared in a wide variety of journals. He is author, coauthor, or editor of six books, including the *Taxation of Capital Income, Handbook of Public Economics, and Dynamic Fiscal Policy.*

Charles L. Ballard has been on the faculty at Michigan State University since 1983. He received an A.B. in Economics from Princeton University in 1976, and a Ph.D. from Stanford University in 1983. In the 1980s, Professor Ballard consulted with the Office of Tax Analysis of the Treasury Department. Professor Ballard has been a Visiting Lecturer at Stanford University, the University of Melbourne (Australia), and the Helsinki School of Economics and Business Administration (Finland). His writings on the efficiency and distributional effects of tax policy proposals have been published in the *American Economic Review, Journal of Economic Perspectives, Journal of Public Economics, National Tax Journal,* and other journals and conference volumes.

Michael J. Boskin is Tully M. Friedman Professor of Economics and Senior Fellow, Hoover Institution, Stanford University. He is also Adjunct Scholar, American Enterprise Institute; and Research Associate, National Bureau of Economic Research. In addition, he is chairman of the Congressional Advisory Commission on the Consumer Price Index, a member of the Revenue Estimating Advisory Board of the Joint Committee on Taxation, and the Panel of Advisers to the Congressional Budget Office. He served as chairman of the Council of Economic Advisers (CEA) from 1989 to 1993.

Dr. Boskin received a B.A. in 1967 from the University of California at Berkeley, where he also received the M.A. in 1968 and the Ph.D. in 1971. In addition to Stanford and the University of California, he has taught at Harvard and Yale. He is the author of more than one hundred books and articles. He is internationally recognized for his research on world economic growth, tax and budget theory and policy, U.S. saving and consumption patterns, and the implications of changing technology and demography on capital, labor and product markets.

Roger E. Brinner is a member of DRI/McGraw-Hill's Executive Committee and Chief Economist for DRI/McGraw-Hill. Prior to joining DRI, he was a Professor of Economics at Harvard University, where he specialized in tax policy, inflation, and capital formation. He is currently a Visiting Professor of Economics at Massachusetts Institute of Technology. Dr. Brinner has Ph.D. and M.A. degrees from Harvard University, and a B.A. from Kalamazoo College.

Eric Engen is a Senior Economist in the Fiscal Analysis section at the Board of Governors of the Federal Reserve System. Before joining the Fed staff, he was an Assistant Professor in the Department of Economics at the University of California at Los Angeles. In addition, Dr. Engen also was a Faculty Research Fellow with the National Bureau of Economic Research. He received a B.S. in Natural Resource Economics from the University of Maryland in College Park and a Ph.D. in Economics from the University of Virginia.

William Gale is a Senior Fellow and the Joseph A. Pechman Fellow in the Economic Studies Program at the Brookings Institution. His research focuses on tax policy, saving behavior, and pensions. Before joining Brookings, Dr. Gale was an assistant professor in the Department of Economics at the University of California at Los Angeles and a Senior Staff Economist for the President's Council of Economic Advisers. Dr. Gale is the coeditor (with Henry Aaron) of *Economic Effects of Fundamental Tax Reform.* He has published in a variety of academic journals. He received a B.A. in Economics from Duke University and a Ph.D. in Economics from Stanford University.

Jane G. Gravelle is a Senior Specialist in Economic Policy at the Congressional Research Service (CRS), Library of Congress, where she has been since 1969. She has also served, on leave, at the Labor Department and the Treasury Department's Office of Tax Analysis and has taught at Boston University. At CRS, she specializes in taxation, particularly the effects of tax policies on economic growth and resource allocation. Recent papers have addressed consumption taxes, dynamic revenue estimating, investment subsidies, capital gains taxes, individual retirement accounts, enterprise zones, and corporate tax revisions.

Dr. Gravelle has published numerous papers in the academic journals and currently serves on the editorial board of the *National Tax Journal*. She is the author of a book, *The Economic Effects of Taxing Capital Income* (MIT Press, 1994). She received a B.A. and M.A. from the University of Georgia and a Ph.D. from George Washington University.

Dale W. Jorgenson is Frederic Eaton Abbe Professor of Economics at Harvard University. He has been a Professor in the Department of Economics at Harvard since 1969 and Director of the Program on Technology and Economic Policy at the Kennedy School of Government since 1984. He received a Ph.D. in Economics from Harvard in 1959.

Professor Jorgenson served as President of the Econometrics Society in 1987. He is the author and coauthor of more than two hundred articles and the author and editor of 18 books in economics, including *Aggregate Consumer Behavior and Measuring Social Welfare.*

Laurence J. Kotlikoff is Professor of Economics at Boston University and a Research Associate of the National Bureau of Economic Research. He received his undergraduate degree from the University of Pennsylvania and a Ph.D. from Harvard University. He has served as Senior Economist with the President's Council Advisers, as Associate Editor of the *American Economic Review,* and as consultant to the International Monetary Fund, the World Bank, the OECD, and several U.S. government agencies.

Professor Kotlikoff has published extensively in professional journals, and he is author or coauthor of six books, including *Generational Accounting, Dynamic Fiscal Policy,* and *What Determines Savings?*

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Prior to joining Cooper & Lybrand, Mr. Wilkins served as acting Assistant Secretary for Tax Policy, Department of the Treasury. He also served as Vice Chairman on Fiscal Affairs, Organization for Economic Cooperation and Development (OECD), Paris, where he was the Chairman of the OECD's revenue estimating group for 15 years. As Director of the Department of Treasury's Office of Tax Analysis, and, prior to that, Director of the Revenue Estimating Division, Mr. Wilkins had Treasury Department responsibility for revenue estimating.

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