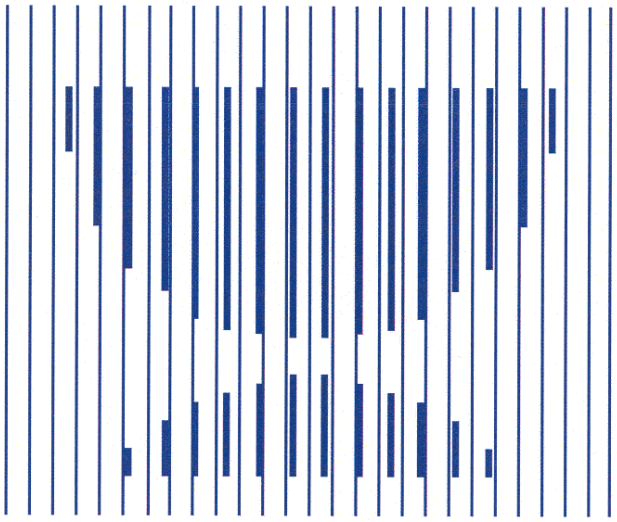
CBO MEMORANDUM

LABOR SUPPLY AND TAXES

January 1996



CONGRESSIONAL BUDGET OFFICE

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CONGRESSIONAL BUDGET OFFICE
SECOND AND D STREETS, S.W.
WASHINGTON, D.C. 20515

This Congressional Budget Office (CBO) memorandum considers how much the economy's supply of labor may change in response to adjustments in federal tax rates. It summarizes results from the empirical literature for men and women and presents ranges of estimates, or "elasticities," based on those findings. Those estimates reflect not only the changes in hours worked by participants in the labor force but also movements in the economy's overall rate of labor force participation.

Frank S. Russek of CBO's Macroeconomic Analysis Division prepared the memorandum under the direction of Robert Dennis and Douglas Hamilton. The manuscript benefited from useful suggestions by Robert Arnold, James Blum, Douglas Elmendorf, James Horney, Richard Kasten, Mark Killingsworth, Marvin Kosters, Joyce Manchester, Angelo Mascaro, Robert Moffitt, Daniel Mont, William Randolph, John Sabelhaus, Frank Sammartino, Kent Smetters, Robert Triest, Bruce Vavrichek, David Weiner, Christopher Williams, and Jeffrey Zabel. John Romley and Jennifer Wolfson provided research assistance. Leah Mazade edited the memorandum with the assistance of Christian Spoor. Linda Lewis prepared the final version of the manuscript.

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INTRODUCTION AND SUMMARY

Despite substantial differences among industrialized economies, one salient feature common to all of them is that workers generate most of each nation's income. In the United States, for example, total compensation of workers amounts to roughly 69 percent of national income. In unified Germany, the share is about 65 percent; in Japan, it is roughly 67 percent.[1]

Because labor plays such a significant role in generating income, policymakers have long been interested in understanding the factors that influence decisions about work and especially how government policies affect those decisions. In particular, interest has focused on the effects of taxes on labor. Those taxes now account for roughly 70 percent of all federal revenue, and some people argue that substantial reductions in them could increase labor supply.

To analyze fully the effects of taxes on the labor market is a complex task. Taxes on labor influence workers' decisions about how much labor to supply to firms and firms' decisions about how much labor to employ. In other words, a complete analysis must address the effects of taxes on both labor supply and labor demand. Furthermore, the supply of labor involves not only how many hours men and women work but also the quality of that work, people's decisions about education and training, and their selection of an occupation. A full assessment would have to include those effects, although measuring them is extremely difficult.[2]

It is beyond the scope of this memorandum to discuss all of those issues. Instead, as a first step, the memorandum focuses on the supply side of the labor market and addresses a simple macroeconomic question: how do taxes on labor affect the total number of hours that all people are willing to work? For the economy as a whole, it is the total number of hours that contributes to the nation's overall production of goods and services, and that total depends on both the number of people who choose to work and their average hours of work each year. Labor taxes can have different effects on those two variables.

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1. Organization for Economic Cooperation and Development, *National Accounts: Main Aggregates*, vol. 1, part 3 (Paris: OECD, 1995).

2. Because of institutional constraints on the workweek, people may respond to higher taxes by changing the quality of their work or the amount of skills they acquire, rather than the number of hours they work at their job. If so, taxes would affect the supply of labor in ways that are not captured by statistics on labor force participation and the number of hours people work.

Four major conclusions emerge from this memorandum:

- Reducing marginal tax rates would probably increase the labor supplied to the economy, although the statistical evidence on that point is not conclusive.

- A reduction in tax rates that raised after-tax hourly wages by 10 percent would probably increase the total supply of labor by between zero and 3 percent.

- About half of that increase in the total supply of labor would stem from people joining the labor force; the rest would reflect decisions by working people to increase their hours on the job.

- Taxes on labor affect the labor supplied by married women more than the labor supplied by men, single women, and female heads of households.

The empirical literature on labor supply contains a large amount of statistical uncertainty. Some estimates are statistically biased as a result of errors in measuring hours of work and after-tax earnings. Other biases arise from selecting an incorrect model of labor supply, from basing estimates only on data for working people, or from using an inappropriate empirical technique for obtaining the estimates. Even when they are not biased, estimates may be so statistically imprecise that much larger or smaller ones cannot be rejected. The conclusions reported in this memorandum must therefore be viewed as tentative, and they may be revised in the future.

HOW TAXES AFFECT LABOR SUPPLY: THE THEORY

Contrary to popular opinion, economic theory in the absence of empirical evidence cannot predict whether cutting taxes will increase the economy's supply of labor. To be sure, reducing the marginal tax rate--the rate that a person pays on the earnings from an additional hour of work--increases the after-tax return from that labor. By itself, that effect would increase the number of hours that a person was willing to work. But lower taxes also increase a worker's disposable income, which means that the worker would be able to achieve the same level of income with fewer hours of work. In the end, the effect of taxes on hours of work is uncertain because it depends on those two forces, which push workers in opposite directions.

Economists have given names to those two counteracting pressures. The first--the so-called substitution effect--measures the tendency of workers to work more

when their after-tax marginal wage rate goes up (or to work less when their after-tax marginal wage rate goes down).[3] In other words, people "substitute" work for leisure when the relative return from work increases; they substitute leisure for work when that return decreases. (For some people, substitution might mean changing the number of hours they work; for others, it might mean deciding to enter or leave the labor force.) The second force--the so-called income effect--measures the tendency of workers to work less when their disposable income goes up. That response occurs because leisure is like other desirable goods: people tend to want more of it when they have more income and can afford to take time off.

Economists measure the substitution effect of a tax change by holding disposable income constant through statistical techniques and observing how changes in marginal tax rates affect the supply of labor. In some cases, a tax change itself can help isolate that effect. Consider, for instance, what would happen with a reduction in marginal tax rates that was fully financed by eliminating some tax deductions. The lowering of marginal rates would increase workers' take-home pay for additional hours of work. But because they had lost some deductions, workers' overall tax liabilities would be unchanged--in effect, their disposable income would be held constant. Thus, only the substitution effect would be operating, and the policy would unambiguously increase the number of hours people were willing to work.

Similarly, economists measure the income effect of a tax change on the supply of labor by holding after-tax wage rates constant through statistical techniques and observing the results of changes in disposable income. Increasing personal exemptions or expanding tax deductions are examples of tax changes that produce such a result on their own. Such changes would increase workers' disposable income but would not affect their take-home pay for additional hours of work.[4] Thus, only the income effect would operate, and the tax changes would unambiguously reduce the number of hours people were willing to work.

When a tax structure is progressive, as is the personal income tax in the United States, the income and substitution effects of changes in tax rates will vary by income tax bracket. For example, a change in the lowest tax rate will have both income and substitution effects for people in the lowest tax bracket, but it will have only income effects for those in higher brackets. By contrast, a change in the top

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3. For an analysis of the substitution effects of tax rates, see Andrew B. Lyon, "Individual Marginal Tax Rates Under the U.S. Tax and Transfer System," in David F. Bradford, ed., *Distributional Analysis of Tax Policy* (Washington, D.C.: AEI Press, 1995), pp. 214-247.

4. The examples assume that the tax change is financed by increasing the deficit or cutting government purchases of goods and services. Note that under the Budget Enforcement Act of 1990, a decrease in taxes must be financed by either cuts to mandatory spending or increases in other taxes. Such changes could have income effects on the supply of labor (see Appendix A).

tax rate will have both income and substitution effects for people in the highest bracket but neither an income nor a substitution effect for those in lower brackets. The effects of changes in personal income taxes and payroll taxes (for Social Security and Medicare's Hospital Insurance program) are discussed more thoroughly in Appendix B.

HOW LABOR SUPPLY RESPONDS TO TAX CHANGES: THE EVIDENCE

Because economic theory cannot predict how changes in taxes will affect the supply of labor, economists rely on empirical studies of how people actually behave to determine those effects. Most empirical studies are based on data for people with a range of (among other things) wage rates, incomes, and demographic characteristics. The studies use statistical methods to control for other factors that affect decisions about work and so isolate the effects of changes in after-tax wage rates.

A large number of such studies have been conducted (see Appendix C), but only a handful of them provide estimates of how taxes would affect both the average number of hours people worked and the total number of workers. Moreover, although readers can sometimes construct an estimate of the total effect by using the method outlined in Appendix D, most studies do not provide enough information to do so.

Defining the "total wage elasticity" is necessary before discussing the studies in detail.[5] The total wage elasticity measures the percentage change in total hours of work that would result from a 1 percent change in workers' after-tax wage rates. Thus, if the total wage elasticity was 0.2, a 10 percent increase in after-tax wage rates would increase total hours of work by 2 percent. Part of that response would be due to workers' choosing to work more hours; the other part would come from people joining the labor force.

The total wage elasticity can be broken down into two other elasticities: one for participation and one for average hours. The participation elasticity is the percentage change in the number of people in the labor force as a result of a 1 percent change in after-tax wage rates; the average-hours elasticity is the corresponding percentage change in the average hours of workers. Economists sometimes use the participation elasticity to estimate how taxes influence the number of people in

5. Despite the importance of total wage elasticities (because they include both participation and average-hour responses), empirical research in labor economics has focused on another type of elasticity, so-called structural measures. Those elasticities describe the total labor-supply response only when changes in labor force participation can be ignored (see Appendix C).

the labor force. Economic theory rules out a negative participation elasticity because rational people will not stop working entirely if they receive a pay raise (although they may reduce the number of hours they work or decide to retire earlier). However, the average-hours elasticity can be positive or negative.

If the total wage elasticity was negative, an increase in after-tax wage rates would decrease the supply of labor. In that case, reductions in tax rates, which increase after-tax wages, would actually cause the number of hours worked to fall. As discussed in the previous section, that drop would occur if the income effect dominated the substitution effect. The phenomenon is also known as a "backward-bending" labor-supply curve.

Income and substitution effects can also be expressed as elasticities that add up to the total wage elasticity. The income elasticity is the percentage change in total hours worked from a 1 percent change in disposable income, holding the after-tax wage rate constant. The substitution elasticity is the percentage change in total hours from a 1 percent change in after-tax hourly wage rates, holding disposable income constant. Thus, if the total wage elasticity was 0.2 and the income elasticity was -0.1, the substitution elasticity would have to be 0.3 (that is, 0.2 minus -0.1). The substitution elasticity could not be negative because a negative elasticity would imply that rational employees would work more when their hourly wage fell, even if they were fully compensated for the loss in their disposable income (without working more). The income elasticity can be positive or negative, but it is usually negative.

One drawback of any elasticity that summarizes the labor supply of a large group is that it describes the average behavior of the group--that is, of people with average after-tax wage rates and incomes. Consequently, such an elasticity may not adequately describe the labor-supply behavior of people whose after-tax wage rates and incomes are well above or below average. That limitation can be especially important when analyzing changes in tax policy that affect high- and low-wage groups differently.

Labor-Supply Elasticities for Men

Very few studies look at how taxes affect both the average number of hours men work and their participation in the labor market. Implicitly or explicitly, the available empirical research has largely assumed that all men are working and that men do not significantly change their participation in the labor force in response to changes in after-tax wage rates or income. That assumption may have been justified in the past, when rates of participation by men were high, but those rates

have declined in recent years, making that assumption somewhat more questionable today.[6]

The limited evidence on the total wage elasticity for men suggests that it is small, on the order of -0.1 to 0.2 (see Table 1). In other words, a 10 percent increase in after-tax wages could raise the total hours of male workers by 2 percent (as indicated in the study by Juhn, Murphy, and Topel), or it could cause them to reduce their hours of work by 1 percent (based on Boskin's results). Going beyond the results in Table 1, Juhn, Murphy, and Topel found that low-wage workers were relatively more sensitive to changes in after-tax wage rates than were high-wage workers. In any case, the studies in Table 1 narrowly bracket a response of zero for all men. With so few estimates, however, elasticities outside the cited range cannot be ruled out.

The responsiveness of men's participation in the labor force appears to have risen over time. Boskin's 1973 estimates suggested that the participation elasticity for men was zero. That finding supported the assumption made in most of the earlier literature that the participation response of men could be ignored. More recent work by Zabel, however, suggests that participation by men rises in response to higher after-tax wage rates. Moreover, the study by Juhn, Murphy, and Topel concludes that this result is especially true for low-wage workers. Indeed, among those workers, the participation response accounts for most of the adjustment in their supply of labor when wage rates change.

Labor-Supply Elasticities for Married Women

More information is available on the total wage elasticity for married women because the empirical literature has given more attention to the participation response of women. (Because the rates of labor force participation for women have been significantly lower than those for men, women could be more affected by changes in policy.) Like the studies of men's labor supply, studies of women's labor supply seldom report the total wage elasticity or provide enough information for readers to derive it.

Among studies that provide estimates of the total response--or enough information to construct them--the wide ranges for wage and income elasticities make it difficult to isolate the true values with much confidence (see Table 1). Those wide ranges can be narrowed somewhat by focusing on the relatively recent

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6. Heckman recently argued that most of the labor-supply response of men, as in the case of women, probably reflects changes in participation. See James J. Heckman, "What Has Been Learned About Labor Supply in the Past Twenty Years?" *American Economic Review*, vol. 83, no. 2 (May 1993), pp. 116-121.

TABLE 1. TOTAL WAGE ELASTICITIES FOR MEN AND MARRIED WOMEN

Study	Total Wage Elasticity	Broken Down into: Substitution Elasticity	Broken Down into: Income Elasticity	Broken Down into: Average-Hours Elasticity	Broken Down into: Participation Elasticity
		Men			
Boskin (1973)[a]	-0.1	0	-0.1	-0.1	0
Juhn, Murphy, and Topel (1991)	0.2[b]	n.a.	n.a.	n.a.	n.a.
Zabel ([1993], 1995)[c]	0	0	0	-0.1	0.1
		Married Women			
Rosen (1976a)	2.3[d]	n.a.	n.a.	0.8[e]	1.5
Hannoch (1980)[f]	1.4	2.3	-0.9	0.4	1.0
Schultz (1980)[g]					
Tobit procedure	1.3	1.3	0	n.a.	n.a.
Other procedure[h]	1.0	1.0	0	0.1	0.9
Triest (1990)[i]					
Working and non-working	1.2	1.5	-0.3	0.8	0.4
Working only (corrected for bias)	0.3	0.5	-0.2	0.2	0.1
Eissa (1995)[j]	0.8	n.a.	n.a.	0.5	0.3
Zabel (1993)					
Tobit procedure[k]	0.6	0.9	-0.3	0.4	0.2
Generalized Tobit[l]	n.a.	n.a.	-0.3	n.a.	n.a.
Zabel ([1993], 1995)[c]	1.2	1.7	-0.5	0.4	0.8

SOURCE: Congressional Budget Office based on various studies (see the bibliography for full citations).

NOTE: The total wage elasticity can be calculated by adding the substitution and income elasticities or by adding the average-hours and participation elasticities. When studies reported total wage and income elasticities, CBO calculated substitution elasticities for them as noted in the table; the one exception was Boskin, who reported a substitution elasticity in his study.

n.a. = not available.

a. Elasticities reported in Boskin's Table 4.4 for "prime-age" white husbands.
b. Weighted average of elasticities reported in Juhn, Murphy, and Topel's Table 9.
c. Mean model estimates reported in Zabel's Table 4, based on a permanent change in after-tax wages.
d. See Rosen's summary on p. 503.
e. Based on Table 1 of McDonald and Moffit (1980).
f. Taken from Hannoch's Table 6.18.
g. See Schultz's Table 1.6; results are weighted by age and race.
h. Taken from separate regressions for participation and hours worked in Schultz's Table 1.6.
i. Estimates reflect an application of the McDonald-Moffit decomposition to the results in Triest's Tables 4 and 5.
j. These are the middle of the ranges from Eissa's unnumbered table on p. 30. The total wage elasticity ranged from 0.6 to 1.0, and the participation elasticity ranged from 0.2 to 0.4.
k. Estimates reflect an application of the McDonald-Moffit decomposition to the results in Zabel's Table 2.
l. The estimate is from Zabel's Table 4.

studies by Triest, by Eissa, and by Zabel, who base their estimates on more recent data. Because the participation rate for women has risen substantially over the past decade, estimates using more recent data are probably more representative of the effects of changes in current and future tax policy on the labor supply of married women. Those studies generally find smaller total wage elasticities than did the earlier studies, in large part because the estimates of women's participation elasticities have declined over time. That drop may be due to the overall rise in labor force participation by women over the past several decades.

Analyzing the potential biases in the newer studies can further narrow the ranges. Consider first the study by Triest, which provides two quite different estimates of the total wage elasticity: 0.3 and 1.2.[7] On the one hand, the larger estimate probably overstates the response because it was generated by using a model that excluded some variables (such as the fixed costs of working) whose absence could cause too much of the participation response to be attributed to changes in wages. On the other hand, the smaller estimate probably understates the response because it is based on data for working women only. Although the model attempts to correct for the statistical bias that arises from excluding nonworkers, it may still be biased because it does not adequately capture the participation response of all women. The bias in the smaller estimate probably is not as significant as the bias in the larger one; thus, the smaller estimate probably is more accurate.

Eissa's study estimates that the total wage elasticity for married women lies somewhere in the range of 0.6 to 1.0. But the range of her estimates may overstate the total wage elasticity. Her study was based on the relative responses of different income groups to the Tax Reform Act of 1986 (TRA-86). To obtain estimates of wage elasticities, she compared the labor-supply responses of people in the 99th percentile of the income distribution with the responses of those in the 75th percentile, whose taxes were much less affected. However, the difference between the two sets of responses probably reflects substitution elasticities more than total wage elasticities because TRA-86 both lowered marginal tax rates and broadened the tax base by eliminating a variety of deductions. Thus, TRA-86 kept after-tax income fairly constant for most groups, which would tend to eliminate the income effect of the tax changes.

The two studies by Zabel together produce a range of 0.6 to 1.2 for the total wage elasticity of married women. The upper end of that range is based on estimates from a model that focuses on the supply of labor during a lifetime. It is theoretically superior to other approaches but may be more sensitive to errors in

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7. Those estimates were calculated by applying the McDonald-Moffit decomposition (described in Appendix D) to the estimates reported by Triest in his Table 5.

the data. In any event, the larger estimates that Zabel reports have little statistical precision and, despite their size, are not significantly different from zero. The estimates that support the lower end of the range have more statistical precision but are not precise enough to rule out estimates much closer to zero.[8]

Overall, the results from the studies indicate that the total wage elasticity for married women may be at least 0.3 and perhaps as large as 0.7. But with so few estimates to draw on, little statistical support exists for any range. As a result, the evidence presented here cannot reject elasticities outside that range with much statistical confidence.

Labor-Supply Elasticities for the U.S. Economy

Labor-supply elasticities for the whole economy can be calculated by weighting the separate estimates presented earlier for the labor supply of men and women. Male workers account for roughly 60 percent of the economy's total hours of work, married women who are not heads of households account for roughly 25 percent, and unmarried women and female heads of households account for the rest. Although there is little evidence on the total labor-supply response of unmarried women and female heads of households, the calculation presented below assumes that those groups have responses similar to men's.

Based on those assumptions, the evidence suggests that a 10 percent increase in after-tax wages would raise total hours of work by between zero and 3 percent (see Table 2 on page 11). About half of the increase in the supply of labor would come from people joining the work force; the remainder would reflect an increase in the annual number of hours each person worked. Married women would account for most of the response: they would increase their hours of work by between 3 percent and 7 percent. By comparison, men, unmarried women, and female heads of households would hardly change their behavior.

Those estimates may somewhat overstate the responsiveness of the economy's labor supply because they leave out how married men and women respond to changes in a spouse's after-tax wage rate. In theory, a decrease in the wage rate of one spouse could raise the amount of labor supplied by the other. Although the theory applies to both spouses equally, most empirical studies find that women are

8. The lower estimate is based on applying the McDonald-Moffitt decomposition (described in Appendix D) to the Tobit-type estimates presented by Zabel (1993) in his Table 3. The restrictions in Tobit-type estimates can impart an upward bias to structural elasticities because the response in hours worked by participants is assumed to be the same as the participation response. But that bias may not be very significant for total labor-supply elasticities, which incorporate both types of responses.

more likely than men to respond to changes in their spouse's hourly wage.[9] In either case, the evidence generally suggests that this intrafamily effect would moderate the increase in the economy's supply of labor that would result from a general decrease in tax rates.

CONCLUSION

Although statistical estimates of how men and women would respond to changes in taxes on labor are subject to considerable uncertainty, the evidence suggests that a reduction in tax rates could affect the economy's supply of labor. Taking into account potential biases and statistical imprecision, the total wage elasticity for the labor supply of the economy seems to range somewhere between zero and 0.3. However, elasticities outside that range cannot be ruled out.

9. For example, see Mark Killingsworth, *Labor Supply* (Cambridge: Cambridge University Press, 1983), Table 3.4; and Jerry A. Hausman and Paul Ruud, "Family Labor Supply with Taxes," *American Economic Review*, vol. 74, no. 2 (May 1984), pp. 242-248.

TABLE 2. SUMMARY OF LABOR-SUPPLY ELASTICITIES (Expressed as ranges)

		Broken Down into		Broken Down into	
	Total Wage Elasticity	Income Elasticity	Substitution Elasticity	Average-Hours Elasticity	Participation Elasticity
Men	-0.1 to 0.2	-0.1 to 0	0.1 to 0.2	-0.1 to 0.1	0 to 0.1
Married Women	0.3 to 0.7	-0.3 to -0.2	0.6 to 0.9	0.1 to 0.3	0.2 to 0.4
All People	0 to 0.3	-0.2 to -0.1	0.2 to 0.4	-0.1 to 0.1	0.1 to 0.2

SOURCE: Congressional Budget Office, derived from estimates reported in Table 1.

NOTE: These ranges reflect uncertainty about the empirical estimates reported in this memorandum and may be revised in the future as new information becomes available. Thus, estimates outside these ranges cannot be rejected with much confidence.

APPENDIX A: HOW THE FINANCING OF A CUT IN LABOR TAXES AFFECTS LABOR SUPPLY

Under the provisions of the Balanced Budget and Emergency Deficit Control Act of 1985 (the Balanced Budget Act), the loss of revenue from reducing income tax rates must be offset by cuts in mandatory spending (other than Social Security) or by increases in other types of taxes to prevent a rise in the deficit. Changes in Social Security taxes are not subject to those provisions, but various rules and points of order in the House and Senate effectively limit actions that would decrease surpluses in the Social Security trust fund.

Taken by itself, a reduction in taxes on labor generates offsetting income and substitution effects on the supply of labor. But measures to finance a tax cut may also have income effects--ones that might offset the direct income effects of the cut. For example, a reduction in entitlement spending to finance a tax cut lowers the income of the recipients of that spending. As a result, the substitution effect of cutting taxes on labor becomes more important, and the policy is more likely to increase the supply of labor. In general, however, analyzing offsetting income effects can be quite complicated, especially when they involve such factors as the effects of higher taxes on capital and potentially different responses by workers in different age groups.

Reducing Federal Spending to Finance Lower Labor Taxes

Financing a cut in tax rates on labor by lowering spending could generate an offsetting income effect on the labor supply of people who lost income as a result. Reducing entitlements, for example, would cause income for specific groups in the society to drop, an effect similar to increasing taxes on those groups. Reducing federal purchases would increase the supply of labor only if consumers viewed those purchases as substitutes for private consumption.[1]

Consider what would happen if a reduction in Social Security benefits financed a cut in Social Security taxes. Initially, cutting benefits would lower the income of retirees, most of whom are no longer in the labor market, so the resulting income effect would not increase the labor supply of retirees unless they decided to participate again. For workers who had not yet retired but were "forward-looking" (apt to plan ahead), reducing their future retirement income might make them retire later or, if they were not close to retirement, increase their labor supply. Alternatively, if retirement benefits were tied to current earnings,

1. In principle, the Congress could finance a tax cut by reducing discretionary spending (such as federal purchases), but that approach would not comply with current enforcement procedures of the Balanced Budget Act.

lowering the rate of benefits could discourage additional work. In that case, the drop in future retirement benefits would have a substitution as well as an income effect on the current supply of labor, both of which would tend to offset the direct effects of reducing the Social Security tax rate. Most empirical research, however, suggests that this intertemporal substitution effect is quite small.[2] For workers who were not forward-looking, the decrease in social insurance benefits would not have an effect, and their labor supply would be determined only by the substitution and income effects of the decline in Social Security taxes.

As an example of what might happen if reductions in income taxes could be financed by cuts in discretionary spending, consider a reduction in labor taxes that was financed through fewer purchases of goods and services by the federal government. That action would release resources from the public sector but would not have a direct effect on the supply of labor unless consumers viewed those federal purchases as substitutes for private consumption. In that case, reducing federal purchases would increase the supply of labor through an income effect. Financing the tax cut by decreasing public investment could lower future incomes, which might have some income effects on the current or future labor supply of some people. But the magnitude of those effects and the groups that would experience them are difficult to determine and would depend on the nature of the reduced public investment as well as any associated increase in private investment.

Raising Other Taxes to Reduce Labor Taxes

Raising taxes on income earned from capital to finance a cut in tax rates on income is an example of a revenue-neutral tax change that conforms with the pay-as-you-go provisions of the Balanced Budget Act. In the short run, a policy change of that kind would lower the current after-tax income of people who owned the existing stock of capital, which would cause them to increase their labor supply over and above the effects on their labor income of the reduction in tax rates. Thus, the overall outcome for an individual would depend on how much income he or she earned from labor as opposed to capital. People who had mostly capital income would experience more of an income effect, which would tend to increase their labor supply, because their after-tax income could actually decline as a result of this deficit-neutral tax change. Those with very little capital income would experience little, if any, offsetting effect.

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2. For example, see the review of empirical literature in David Card, *Intertemporal Labor Supply: An Assessment*, Working Paper No. 3602 (Cambridge, Mass.: National Bureau of Economic Research, January 1991).

Over time, the higher tax on capital income would discourage saving and capital formation. That effect in turn would lessen productivity and lead to lower-than-otherwise wage rates and income in the future. Those future losses could affect the current decisions of forward-looking individuals about how much they should work, especially those young enough to have most of their working lives ahead of them. For example, if people expected lower wages in the future, they might work more now, although most of the evidence suggests that this intertemporal substitution effect will not be large.

In summary, comprehensive efforts to gauge the impact of lower taxes on the supply of labor should include the effects stemming from how the tax reduction is financed. Failing to include those effects is likely to understate the overall effect. Reducing federal spending or raising other taxes is likely to lower current income for some groups, and that reduction will tend to increase the supply of labor. Quantifying those effects is extremely difficult, however, and beyond the scope of this memorandum.

APPENDIX B: INCOME AND SUBSTITUTION EFFECTS OF CHANGES IN PERSONAL INCOME AND SOCIAL SECURITY TAXES

Reducing tax rates in a progressive tax system can have income and substitution effects that differ in magnitude for people in different tax brackets. The size of the substitution effect depends on what happens to after-tax hourly wage rates and on how much people adjust their labor supply in response. The size of the income effect depends on what happens to total disposable income and on how much people respond to those changes. The overall effect on the supply of labor incorporates the sum of the two effects, but it also depends on how any revenue impact of the tax change is financed (see Appendix A).

Personal Income Taxes

The United States relies on a progressive system of personal income taxes, which means that additional income is taxed at progressively higher rates as workers move into higher tax brackets. Because of that progressivity, the percentage of additional income taken by taxes (the marginal tax rate) is larger than the percentage of total income taken by taxes (the average tax rate). Five marginal tax rates are currently in effect: 15 percent, 28 percent, 31 percent, 36 percent, and 39.6 percent.[1] The income brackets to which those rates apply depend on marital status and on whether married couples file joint or separate tax returns.

The tax code also provides a number of offsetting reductions to taxable income, such as personal exemptions and standard deductions. Tax filers can claim additional exemptions for dependents and, instead of choosing a standard deduction, may itemize their expenses for mortgage interest payments, property and state and local income taxes, and charitable contributions, to name but a few. In addition, the earned income credit (EIC) reduces the tax liability of certain low-income people with earnings. Because the EIC is a refundable tax credit, low-income filers can receive a payment even if they do not owe any federal income tax.

Various changes in the structure of the federal income tax can have different effects on the supply of labor because they involve different effects on after-tax wage rates and on disposable income for people in different tax brackets. Consequently, the effects of specific tax changes are best illustrated through a series of

1. Total effective marginal tax rates for certain high-income taxpayers can be higher than the statutory tax rates because of the limitation on itemized deductions and the phaseout of personal exemptions. In addition, the phaseout of the earned income credit raises the total marginal tax rate for low- to moderate-income families.

examples. In the examples, an increase in taxes would have an effect opposite to that of a tax cut.

Reducing the Top Marginal Tax Rate. Cutting the top rate would directly affect workers in the top rate bracket only and would raise their after-tax hourly wage by a larger percentage than their disposable income. Disposable income would not rise as much because the new tax rate would apply only to that part of a person's income that fell into the top tax bracket. For people at the bottom of the top rate bracket, who had just a small part of their income subject to the top tax rate, only the substitution effect would matter. For richer people, income effects would become more and more important as the proportion of their income subject to the top rate increased.

Most low-wage and medium-wage workers would not be affected by a reduction in the top marginal rate, although there would be a few exceptions. A change in the top rate could affect the labor supplied by a low-wage or medium-wage earner in a two-worker family with joint income subject to the top rate. In addition, young and middle-income people who expected to earn more in the future--which would ultimately put them in the top rate bracket--might alter their labor-supply behavior (including their decisions about acquiring more skills and education).

Reducing the Bottom Marginal Tax Rate. Cutting the lowest rate might increase the labor supplied by people in the lowest tax bracket, but it would unambiguously reduce the labor supplied by workers in higher tax brackets. Again, for people in the bottom tax bracket, the effects on labor supply would depend on the balance of income and substitution effects, although the empirical evidence suggests that they will probably increase the number of hours they work.

For people in higher tax brackets, cutting the lowest tax rate would reduce the supply of labor because after-tax income would unambiguously rise. But the tax change would not increase the after-tax wage for working an additional hour, so no substitution effect would operate for these groups.

Narrowing the Tax Base. Increasing the size of exemptions, expanding deductions, or adding credits would reduce tax liabilities without changing marginal tax rates for most people. Thus, narrowing the tax base would involve an income effect but no substitution effect on the supply of labor. Although economic theory does not rule out an abnormal response, the usual effect would be for people to devote more time to leisure and less time to work. (As Appendix A explains, however, the overall effect on the supply of labor depends on how the tax change is financed.)

Reducing the Earned Income Credit. The earned income credit subsidizes low-income workers through the federal income tax system.[2] For example, under the provisions adopted in the Omnibus Budget Reconciliation Act of 1993 (OBRA-93), a taxpayer with two children in 1995 received a 36 percent subsidy for every dollar of earnings up to $8,640.[3] No additional subsidy was paid for earnings when family income was between $8,640 and $11,290; after $11,290, the subsidy was phased out at a rate of 20 cents per dollar. Families with earnings of more than $26,673 were past the phaseout range and thus received no subsidy. (The rates at which the credit was phased in and out--and the limits on income--varied, depending on whether a family had one, more than one, or no children.)

A reduction in the subsidy rate of the EIC would weaken the incentive for nonworkers to join the labor force. For people who were already working but earning less than the full credit, reducing its rate would have opposing income and substitution effects on the supply of labor. A lower subsidy rate would reduce workers' after-tax hourly wage rates and their disposable income. For taxpayers who received the full subsidy or were in the phaseout range, reducing the rate of the credit would decrease disposable income without creating a substitution effect. Thus, a policy that cut the subsidy rate would tend to increase those taxpayers' supply of labor. For those who already earned too much to qualify for any part of the credit, reducing the credit rate would have no effect on labor supply.

Increasing the phaseout rate would have both income and substitution effects for workers with family income in the phaseout range. Raising the phaseout rate would remove some families from the credit altogether, and the resulting income and substitution effects would each tend to boost the labor supplied by those families.[4] For families who were still eligible for part of the credit, the policy would involve competing income and substitution effects. Workers with income outside the phaseout range would be unaffected.

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2. For a more comprehensive analysis of the effects of this tax subsidy, see Marvin H. Kosters, "The Earned-Income Tax Credit and the Working Poor," *American Enterprise*, vol. 4, no. 3 (1993), pp. 64-72. For Kosters's arguments in favor of reducing the subsidy, see his statement before the Subcommittee on Human Resources of the House Committee on Ways and Means, June 15, 1995.

3. In addition to raising the amount of the credit and its phaseout rates, OBRA-93 extended the EIC to some workers who do not have children and increased the amount they can earn before the credit is reduced.

4. Phasing out the credit at a faster rate would have a substitution effect in favor of leisure until the credit was fully phased out. Thereafter, the substitution effect would disappear, and leisure would become more expensive.

Social Security Taxes

The United States finances the Old-Age, Survivors, and Disability Insurance (OASDI) and Hospital Insurance (HI, or Medicare Part A) programs primarily through payroll taxes on working people. The current rates for OASDI and HI taxes are 12.4 percent and 2.9 percent, respectively. (Although by law the taxes are split equally between employees and employers, most economists believe that the employer portion of the tax is ultimately shifted to labor in the form of lower wages and reduced fringe benefits.)[5]

Unlike the federal income tax, no offsets (such as exemptions or deductions) apply to taxable earnings covered by payroll taxes, but earnings above a cap ($62,700 in 1996) are not taxed for OASDI. In the case of HI, there is no cap on taxable earnings. Thus, in contrast to the progressivity of the rates for personal income taxes, OASDI tax rates are regressive--that is, they are proportional on earnings up to the taxable ceiling and zero thereafter. But that regressivity is counterbalanced by the progressivity of OASDI benefits: the retirement benefits paid to low-income workers are larger fractions of their earnings than the benefits paid to high-income workers. The HI tax rate is the same for all taxpayers regardless of income, and Medicare benefits are the same for all retired people.

Raising OASDI Tax Rates. For workers earning up to $62,700 in 1996, increasing OASDI tax rates without changing benefits would affect the supply of labor in roughly the same way as would an increase in those workers' marginal income tax rates. Because workers pay OASDI taxes in addition to progressive income taxes, their after-tax wage rates for an additional hour of work would decline by a greater percentage than would disposable income. Although the impact on labor supply depends on the balance of income and substitution effects, empirical evidence suggests that the supply of labor will probably decline.

For people earning more than $62,700 in 1996, increasing the OASDI tax rate would not reduce their after-tax wage rates for an additional hour of work because earnings above $62,700 are exempt from that payroll tax. Thus, there would be no substitution effect pressing people toward more leisure. But people earning more than $62,700 would have less disposable income. As a result, increasing the OASDI tax rate would lead them to work more because of the income effect.

Eliminating the Ceiling on Taxable Earnings for OASDI. Eliminating the OASDI ceiling on taxable earnings would effectively add 6.2 percentage points to the statutory marginal income tax rate on earnings for people who made more than

5. Congressional Budget Office, *Economic Implications of Rising Health Care Costs* (October 1992).

$62,700 in 1996, and, over time, employers would shift their share of the tax to employees as well.[6] If the additional revenue was not used to finance larger OASDI benefits, such a policy would involve both substitution and income effects. The size of the income effect would depend on how much income a worker earned above the ceiling: the more a person earned, the bigger would be the effect. Nevertheless, since those workers would not pay higher OASDI taxes on the first $62,700 of their earnings, their disposable income would decline by a smaller percentage than would their after-tax hourly wage rates. The overall effect of eliminating the ceiling would depend on the balance between the offsetting income and substitution effects. The labor supply of workers earning less than the maximum taxable amount would not be much affected by that type of tax change.

6. OBRA-93 eliminated the maximum taxable income ceiling for HI.

APPENDIX C: STRUCTURAL ELASTICITIES FOR LABOR SUPPLY

Most of the empirical research in labor economics has focused on so-called structural elasticities. In contrast to the elasticities that measure the behavior of groups, structural elasticities measure the change in the number of hours a typical individual wants to work. They do not measure the total response of all men and women--those elasticities reflect the behavior of large and diverse groups of people and include changes in their average hours and their participation in the labor force.

Notwithstanding their different nature, structural elasticities are often confused with the elasticities that measure group behavior. Structural elasticities, for example, do not measure the change in the average hours of workers because they focus only on the response of workers who stay in the labor force rather than on the response of all people (including those who leave or join the labor force). In other words, structural elasticities exclude the impact that changes in labor force participation have on the average number of hours that participants work.

Although the elasticities based on structural models of labor supply do not measure total responses, they can be used in two ways to compute elasticities for the total responses of men and women. First, the effects of a change in policy can be simulated by using the structural model, and the results for all individuals can be combined to compute an average response that includes the effect of changes in labor force participation. Alternatively (as shown for a special case in Appendix D), elasticities for the total response can be computed by combining structural estimates with information about the probability of labor force participation. However, few researchers report the information needed for that computation.

A few well-known surveys summarize many empirical estimates of structural elasticities for the supply of labor. The summaries illustrate the wide range of views and the uncertainty about those elasticities, especially for married women. Because of that uncertainty, it is difficult to reject most of the estimates with much confidence. Although the surveys usually do not indicate the specific weight that should be given to each estimate (and the estimates that should be disregarded altogether), they generally convey the view that the labor supplied by a typical man is not very sensitive to changes in after-tax wage rates. The labor supplied by a typical married woman appears to be much more sensitive, although some research concludes that the difference between working men and women is negligible.

The wide range of elasticity estimates reflects not only differences in theoretical models, statistical techniques, and data sets, but also the many

problems encountered in empirical research on labor supply. For example, statistical biases appear to flaw the estimates whenever the researcher assumes that changes in after-tax wage rates have the same effect on decisions about participation and decisions about hours of work. Biased estimates can also result when the sample of people is restricted to those who are working, because the sample may not be representative. Another type of bias can occur when data, such as hours of work, are misreported or when data are missing and researchers have to use proxies. Such problems were present in many early studies and appear sometimes in recent research, although current studies generally address them more effectively.

With the aid of a few statistics, Tables C-1 and C-2 present the numerous estimates that the surveys report. For example, means and medians are measures of central tendency. The mean is a simple, unweighted average; the median is the middle estimate in a range of data with half of the estimates larger and half smaller. Of those two statistics, the median is less affected by extremely large or small estimates, so-called outliers. Standard deviations and interquartile ranges are measures of dispersion; they indicate whether the range of estimates is closely bunched or not. Like the median, the interquartile range--the middle 50 percent of the estimates--is less affected by outliers than is the standard deviation.

In general, the estimates of wage elasticities for men that the surveys report are smaller than those for women and often negative (implying a "backward-bending" labor-supply curve--that is, a declining rather than rising response to higher after-tax wage rates). In addition, the estimates for men show relatively less dispersion than those for women.

Structural Elasticities for Men

Most empirical studies of the labor supply of men report that structural estimates of the wage elasticity are small--and usually negative--implying that the income effect is stronger than the substitution effect. In other words, according to those estimates, equal percentage increases in after-tax wage rates and disposable income may slightly reduce the labor supply of a typical man. As economic theory predicts, the income elasticities are slightly more negative than the wage elasticities; thus, most studies find positive but not very large substitution elasticities. Although some studies have reported positive substitution elasticities that are fairly large, those findings are in the minority. Moreover, as discussed below, recent research has cast doubt on the validity of some of that research.

TABLE C-1. ESTIMATES FROM SURVEYS OF STRUCTURAL LABOR-SUPPLY ELASTICITIES FOR MEN

		Wage Elasticity					Income Elasticity				
		Central Tendency		Dispersion			Central Tendency		Dispersion		
Survey	Number of Estimates	Mean	Median	Standard Deviation	Range	Interquartile Range	Mean	Median	Standard Deviation	Range	Interquartile Range
Nonexperimental Data											
Borjas and Heckman (1979)[a]	9	-0.10	-0.15	-0.36 to 0.16	-0.32 to 0.55	-0.27 to -0.07	-0.33	-0.29	-0.52 to -0.13	-0.77 to -0.09	-0.38 to -0.23
Killingsworth (1983)[b]	12	-0.01	0.01	-0.13 to 0.10	-0.20 to 0.14	-0.14 to 0.07	-0.03	-0.06	-0.46 to 0.40	-0.99 to 0.70	-0.11 to -0.02
Hausman (1985)[c]	3	0.02	0	-0.04 to 0.08	-0.03 to 0.09	-0.02 to 0.05	-0.13	-0.11	-0.16 to -0.09	-0.17 to -0.10	-0.14 to -0.11
Pencavel (1986)[d]	14	-0.10	-0.11	-0.21 to 0.01	-0.29 to 0.14	-0.16 to -0.08	-0.20	-0.13	-0.44 to 0.04	-0.70 to 0.08	-0.29 to -0.02
Burtless (1987)[e]	26	-0.10	n.a.	-0.28 to 0.07	n.a.	n.a.	-0.39	n.a.	-0.73 to -0.05	n.a.	n.a.
Heckman (1993)[f]	14	-0.09	-0.09	-0.23 to 0.06	-0.31 to 0.16	-0.16 to 0	-0.14	-0.04	-0.41 to 0.12	-0.70 to 0.14	-0.24 to 0
Negative Income Tax Experimental Data											
Killingsworth (1983)[g]	18	0.02	0.01	-0.09 to 0.13	-0.19 to 0.21	-0.06 to 0.10	-0.08	-0.07	-0.16 to 0	-0.30 to 0.06	-0.12 to -0.03
Pencavel (1986)[h]	8	0.03	0.05	-0.11 to 0.16	-0.16 to 0.21	-0.10 to 0.12	-0.10	-0.09	-0.21 to 0.01	-0.29 to 0.02	-0.17 to -0.01
Burtless (1987)[i]	21	0	n.a.	-0.09 to 0.10	n.a.	n.a.	-0.08	n.a.	-0.17 to 0.02	n.a.	n.a.

SOURCE: Congressional Budget Office based on the above studies (see the bibliography for full citations).

NOTE: n.a. = not available.

a. See Borjas and Heckman's Table 1.
b. Data taken from Killingsworth's Table 4.3.
c. Based on Hausman's Table 5.1.
d. Data taken from Pencavel's Table 1.19.
e. See Burtless's Table 3.
f. These estimates are from an unpublished table.
g. Based on data from Killingsworth's Table 6.2.
h. Data taken from Pencavel's Table 1.21.
i. See Burtless's Table 3.

TABLE C-2. ESTIMATES FROM SURVEYS OF STRUCTURAL LABOR-SUPPLY ELASTICITIES FOR WOMEN

Survey	Number of Estimates	Wage Elasticities: Central Tendency: Mean	Wage Elasticities: Central Tendency: Median	Wage Elasticities: Dispersion: Standard Deviation	Wage Elasticities: Dispersion: Range	Wage Elasticities: Dispersion: Interquartile Range	Income Elasticities: Central Tendency: Mean	Income Elasticities: Central Tendency: Median	Income Elasticities: Dispersion: Standard Deviation	Income Elasticities: Dispersion: Range	Income Elasticities: Dispersion: Interquartile Range
Nonexperimental Data											
Killingsworth (1983)[a]	38	2.25	1.00	-1.24 to 5.74	-0.89 to 15.24	0.42 to 2.91	-0.11	-0.08	-0.30 to 0.09	-0.50 to 0.48	-0.18 to -0.01
Hausman (1985)[b]	4	0.95	0.84	-0.06 to 1.97	-0.16 to 2.30	0.53 to 1.26	-0.33	-0.39	-0.53 to -0.14	-0.50 to -0.05	-0.44 to -0.28
Killingsworth and Heckman (1986)[c]	43	2.03	0.76	-1.30 to 5.37	-0.89 to 15.24	0.42 to 2.64	-0.12	-0.08	-0.34 to 0.09	-0.89 to 0.48	-0.19 to 0.03
Burtless (1987)[d]	48	1.99	n.a.	-1.17 to 5.15	n.a.	n.a.	-0.03	n.a.	-0.46 to 0.39	n.a.	n.a.
Mroz (1987)[e]	21	0.89	0.59	-0.50 to 2.28	-1.50 to 4.39	-0.09 to 1.01	-0.03	-0.01	-0.06 to 0.10	-0.08 to 0.03	-0.04 to -0.01
Heckman (1993)[f]	11	0.37	0.13	-0.30 to 1.04	-0.27 to 2.10	-0.02 to 0.65	-0.13	-0.05	-0.30 to 0.03	-0.50 to 0.02	-0.19 to -0.04
Negative Income Tax Experimental Data											
Killingsworth (1983)[g]											
Wives	12	0.22	0.13	-0.14 to 0.58	-0.36 to 0.94	0.06 to 0.26	-0.34	-0.12	-0.85 to 0.18	-1.32 to 0.45	-0.68 to 0.01
Female heads of households	10	-0.05	-0.04	-0.19 to 0.09	-0.27 to 0.20	-0.11 to 0.04	-0.24	-0.24	-0.34 to -0.13	-0.46 to -0.11	-0.26 to -0.18
Burtless (1987)[h]											
Wives	20	-0.42	n.a.	-0.41 to 0.33	n.a.	n.a.	-0.15	n.a.	-0.37 to 0.06	n.a.	n.a.
Female heads of households	11	-0.04	n.a.	-0.16 to 0.09	n.a.	n.a.	-0.17	n.a.	-0.26 to -0.09	n.a.	n.a.

SOURCE: Congressional Budget Office based on the above studies (see the bibliography for full citations).

NOTE: n.a. = not available.

a. Data from Killingsworth's Table 4.3.
b. See Hausman's Table 5.6.
c. Based on Killingsworth and Heckman's Table 2.26.
d. Estimates are from Burtless's Table 3.
e. Elasticities derived from Mroz's Table 1.
f. Based on data from an unpublished table .
g. See Killingsworth's Table 6.2.
h. The data are from Burtless's Table 3.

Many of the estimates reported by the various surveys can be dropped from the group as a whole to obtain a smaller, more representative sample. Several arguments support such a move. First, many of the estimates are included in more than one survey and so are overrepresented by the surveys as a group. Second, a few estimates are extreme outliers that distort the main body of results. Third, several studies are based on data from other countries, and those results may not apply to the U.S. population. Finally, the estimates based on data for low-income participants in the negative income tax (NIT) experiments may not represent the response of a typical man. In addition, the estimates may be flawed because of difficulties in maintaining the scientific reliability of the experiments.[1]

In the reduced sample, the median estimate of the wage elasticity is roughly -0.1, and the range is roughly -0.3 to 0.1 (see Figure C-1). That median and range are not much different from most of those reported by the surveys in Table C-1. For the income elasticity, the median estimate is about -0.1, and the range is roughly -0.4 to 0.1. The median estimate of the substitution elasticity is essentially zero, and the estimates range from about -0.2 to roughly 0.2.

Recent studies have not significantly altered the general view conveyed by those estimates.[2] By most accounts, the labor supply of the typical man is not very sensitive to changes in after-tax wage rates. Nevertheless, the new research has helped to improve economists' knowledge in some key areas. Researchers, for example, have attempted to explain why some earlier studies reported very large estimates of substitution elasticities. In particular, McCurdy, Green, and Paarsch concluded that those large estimates could be attributed to theoretical assumptions embedded in some of the statistical techniques used to take account of the progressivity of tax rates. Without those assumptions, the techniques yielded estimates of the substitution elasticity that in many cases were negative--a result inconsistent with economic theory.[3]

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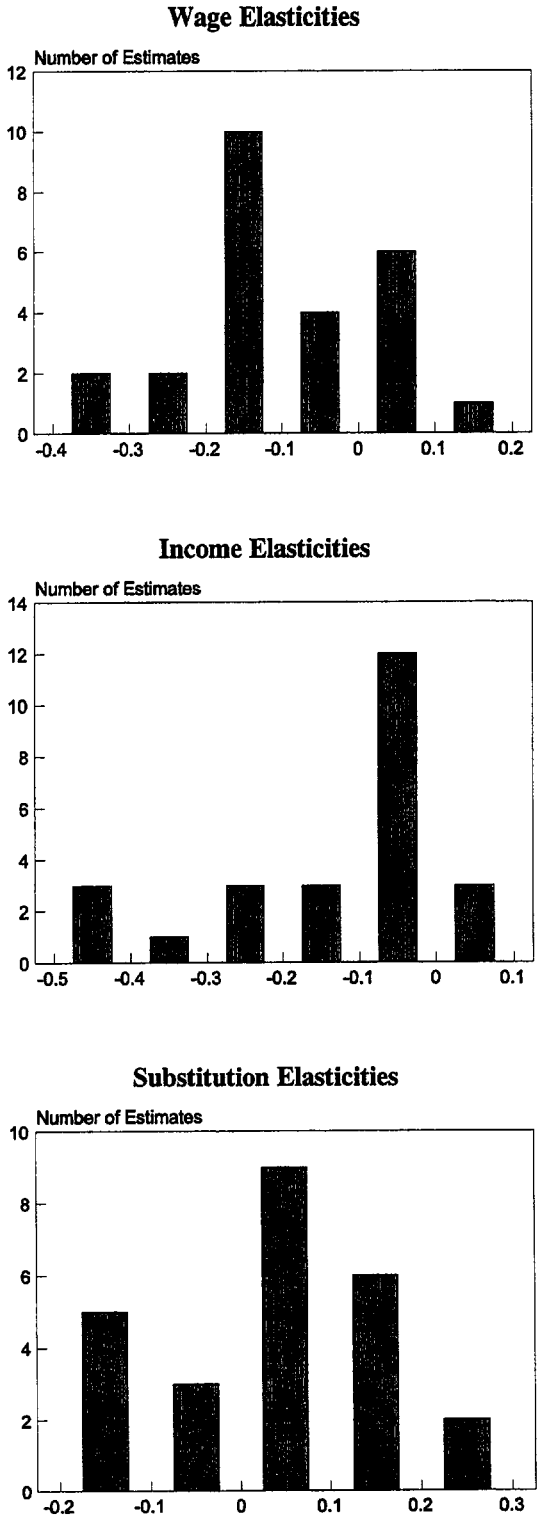
1. In some cases, the participants neither understood the rules of the experiment nor took them seriously. In addition, simultaneous changes in the welfare system contaminated the statistical results for some states. For a discussion of other problems with the NIT studies, see Gary Burtless, "Labor Supply: Evidence from the NIT Experiments," in Alicia Munnell, ed., *The Economic Effects of Taxes* (Boston: Federal Reserve Bank of Boston, 1986). Some researchers have concluded, however, that the estimates based on the NIT experiments are less dispersed than those based on nonexperimental data, although the central tendencies are similar. See Robert A. Moffitt and Kenneth C. Kehrer, "The Effect of Tax and Transfer Programs on Labor Supply: The Evidence from the Income Maintenance Experiments," in Ronald G. Ehrenberg, ed., *Research in Labor Economics* (Greenwich, Conn.: JAI Press, Inc., 1981).

2. For example, see Robert K. Triest, "The Effect of Income Taxation on Labor Supply in the United States," *Journal of Human Resources*, vol. 25, no. 3 (Summer 1990), pp. 491-516.

3. Thomas McCurdy, David Green, and Harry Paarsch, "Assessing Empirical Approaches for Analyzing Taxes and Labor Supply," *Journal of Human Resources*, vol. 25, no. 3 (Summer 1990), pp. 415-490.

FIGURE C-1. STRUCTURAL LABOR-SUPPLY ELASTICITIES FOR MEN



SOURCE: Congressional Budget Office based on a reduced sample taken from the studies reported in the surveys in Table C-1.

Other researchers have focused on some of the problems in the data.[4] For example, many earlier studies calculated wage rates by dividing the annual income of a survey participant by his or her hours of work. It appears, however, that people with high incomes tend to underreport their hours. As a result, estimates from those earlier studies overstated the wage rates of high-income people, which often caused their labor supply to appear backward-bending. Correcting that data problem tends to produce slightly positive wage elasticity estimates instead of the slightly negative ones recorded in earlier work.

Structural Elasticities for Women

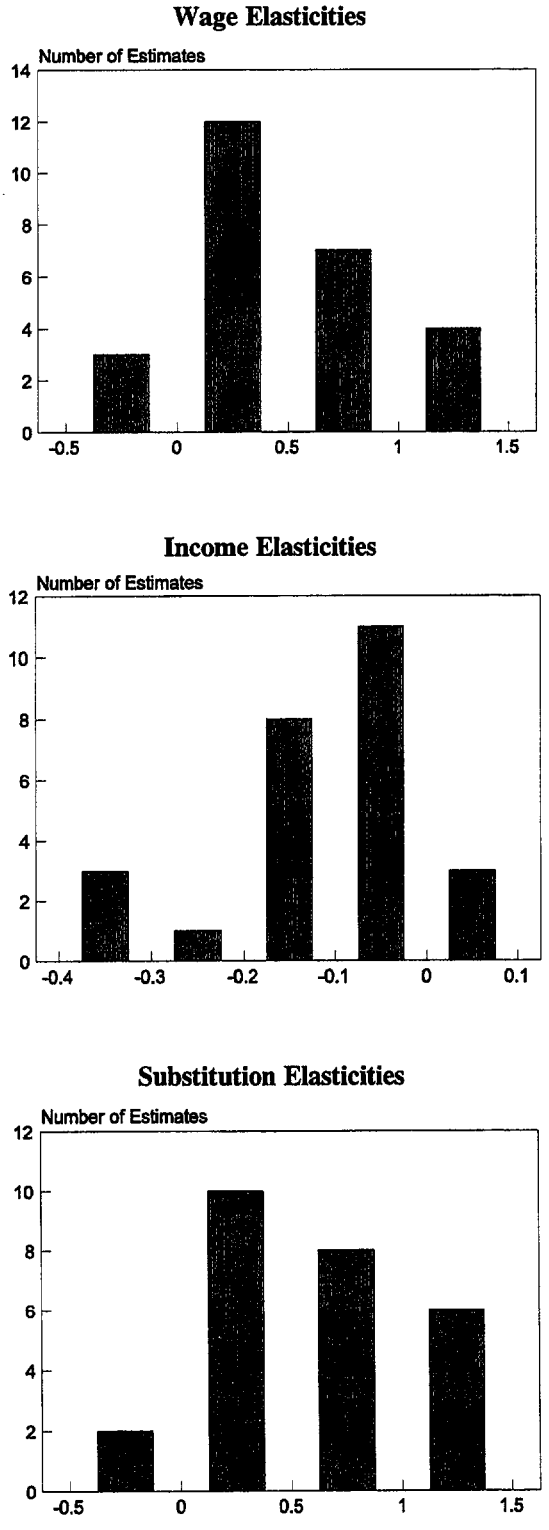
The estimates reported in the surveys generally indicate that the labor supply of a typical woman responds positively to lower tax rates and is much more sensitive than the labor supply of a typical man to changes in after-tax wage rates. But the estimates from different studies vary much more than those for men, perhaps reflecting larger differences among the data sets as a result of greater variation in the work-related characteristics of women. Some women are sole earners and heads of households; others are second earners in two-worker families. Moreover, a significant fraction of women do not work outside the home. That group in particular poses a statistical problem for researchers because of lack of data on the hourly wages those women would earn if they were employed.

As with the estimates for men, four kinds of estimates can be excluded from those reported in the surveys to obtain a smaller, more representative sample: (a) duplicate estimates appearing in more than one of the surveys, (b) extreme outliers, (c) estimates from studies that focus on other countries, and (d) estimates based on the participants in the NIT experiments. (Again, the results from the NIT studies may not be typical of all women and may be flawed because of difficulties with the experiments.) After excluding those four groups, the median of the remaining estimates of the total wage elasticity is about 0.4, and their range is about -0.3 to 1.5 (see Figure C-2). That median and range are smaller than those for many of the surveys summarized in Table C-2, which include some extremely large estimates. For the income elasticity, the median estimate is roughly -0.1, and the range is -0.4 to zero. Finally, for the substitution elasticity, the median is about 0.6, and the estimates range from -0.2 to 1.5.

Some recent research concludes that structural elasticities for the labor supply of women may be closer to those for men than many of the studies in the surveys

4. Chinhui Juhn, Kevin M. Murphy, and Robert H. Topel, "Why Has the Natural Rate of Unemployment Increased Over Time?" *Brookings Papers on Economic Activity*, no. 2 (1991), pp. 75-142.

FIGURE C-2. STRUCTURAL LABOR-SUPPLY ELASTICITIES FOR WOMEN



SOURCE: Congressional Budget Office based on a reduced sample taken from the studies reported in the surveys in Table C-2.

indicate.[5] Indeed, an important study by Mroz concluded that the elasticity for the typical married female worker is close to zero.[6] But most other recent studies continue to find that a woman's labor supply is significantly more sensitive than a man's, although the difference may not be as large as it once was.

Mroz examined the sensitivity of estimates of structural wage and income elasticities to a number of assumptions commonly adopted by other researchers. (His conclusions did not examine the sensitivity of estimates of the elasticity of labor force participation.) Mroz identified three reasons for the large structural wage elasticities for married working women that researchers found. First, many studies used a statistical procedure to obtain structural estimates that incorrectly confounded the structural elasticity with the participation elasticity. Second, large estimates resulted when wage rates were incorrectly treated as though they were not affected by many of the same factors that influenced the supply of labor. Third, large elasticities can arise when factors such as work experience are not properly included in equations to estimate the potential wage rates of nonworkers. After correcting for those problems, Mroz found that the large estimates of the structural wage elasticity essentially disappeared.

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5. Jeffrey E. Zabel, "The Relationship Between Hours of Work and Labor Force Participation in Four Models of Labor Supply Behavior," *Journal of Labor Economics*, vol. 11, no. 2 (April 1993), pp. 387-416; and Triest, "The Effect of Income Taxation on Labor Supply in the United States."

6. Thomas Mroz, "The Sensitivity of an Empirical Model of Married Women's Hours of Work to Economic and Statistical Assumptions," *Econometrica*, vol. 55, no. 4 (July 1987), pp. 765-800.

APPENDIX D: CALCULATING ELASTICITIES FOR TOTAL LABOR SUPPLY

Very few empirical studies of the supply of labor report so-called total elasticities that reflect the combined behavior of everyone, including people who join or leave the labor force (see Appendix C). Instead, what the studies report are structural elasticities that describe how many hours a typical person (with average preferences for work and leisure) would like to work at different wage rates and levels of income. Sometimes, however, a study provides enough additional information to use a procedure--the McDonald-Moffitt decomposition--to transform structural elasticities into total elasticities.[1] The Congressional Budget Office used that procedure to calculate some of the total wage and income elasticities for women that appear in this memorandum.

On an intuitive level, the procedure produces total elasticities from structural elasticities by adding a piece of information--the probability of labor force participation--that summarizes preferences for work and leisure. When everyone is working (100 percent labor force participation), the total elasticity equals the structural elasticity. But when some portion of the population is not working, the total elasticity is less than the structural elasticity in some models of labor supply. The intuitive reason is that an increase in after-tax wages does not alter the number of hours worked by people who remain outside the labor force.

Although a lower rate of labor force participation implies a smaller total elasticity, it also means that more of the total elasticity for the group reflects changes in participation. The reason is that a relatively low rate of participation implies a relatively large participation elasticity. In contrast, when the rate of participation is close to 100 percent, its elasticity is small, and less of the total elasticity is attributable to changes in the participation rate of the group.

In technical terms, the McDonald-Moffitt decomposition is based on the following Tobit equation for hours worked (simplified here by omitting individual subscripts on the variables):

$$(1) \quad h = X\beta + \eta \quad \text{if } X\beta + \eta > 0,$$
$$h = 0 \quad \text{if } X\beta + \eta \leq 0,$$

1. John F. McDonald and Robert A. Moffitt, "The Uses of Tobit Analysis," *Review of Economics and Statistics*, vol. 62, no. 2 (May 1980), pp. 318-321.

where h is the number of hours that an individual works; X is a matrix of explanatory variables such as after-tax wages, income, and demographic characteristics; β is the vector of structural parameters; and η is an independently distributed normal error term with a zero mean and constant standard error σ.[2] Equation (1) simply states that h has a positive value if the individual is working and a value of zero if the individual is not in the labor force.

The average (expected) number of hours worked by all individuals, Ey, including those for whom $h = 0$, is

$$(2) \quad Ey = Ey^*F(z) = X\beta F(z) + \sigma f(z),$$

where Ey^* is the average number of hours worked by individuals for whom h is greater than zero; z is the ratio $X\beta/\sigma$; $F(z)$ is the probability of participating in the labor force, calculated as the cumulative distribution of the normal variable z; and $f(z)$ is the density function of z. When everyone is working, $F(z) = 1$, $f(z) = 0$, and $Ey = Ey^* = X\beta$, which is the structural estimate of h.

As shown by McDonald and Moffitt, the derivatives of Ey can be broken down into two intuitive parts: the change in the probability of participating, weighted by the average hours worked by participants; and the change in average hours worked by participants, weighted by the probability of participating. For example, the derivative of Ey with respect to the logarithm of the (after-tax) wage rate, $\ln(w)$, can be expressed as

$$(3) \quad \partial Ey/\partial \ln(w) = (\partial F(z)/\partial \ln(w))Ey^* + (\partial Ey^*/\partial \ln(w))F(z).$$

That expression can be converted into an elasticity by multiplying through by w/Ey, setting $\lambda = f(z)/F(z)$, and noting that $\partial Ey/\partial \ln(w) = \beta_w F(z)/w$, where β_w is the coefficient of $\ln(w)$ from the Tobit equation. Thus, the total wage elasticity is

$$(4) \quad (\partial Ey/\partial \ln(w))(w/Ey) = \beta_w F(z)/Ey = \beta_w/Ey^* = \beta_w/(X\beta + \sigma\lambda).$$

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2. Decomposition for three other types of labor-supply models are presented in Jeffrey E. Zabel, "The Relationship Between Hours of Work and Labor Force Participation in Four Models of Labor Supply Behavior," *Journal of Labor Economics*, vol. 11, no. 2 (April 1993), Appendix D.

When everyone is in the labor force, $\lambda = 0$, and that expression for the total elasticity collapses to the expression for the structural elasticity, $\beta_w/X\beta$. In the Tobit model, the total elasticity is always less than the structural elasticity when participation is less than 100 percent. In less restrictive models, however, the total elasticity can exceed the structural elasticity.

That part of the total elasticity that results from changes in labor force participation is

$$(5) \quad (\partial F(z)/\partial \ln(w))Ey^*(w/Ey) = \beta_w\lambda/\sigma,$$

which is simply the elasticity form of the first half of the right side of equation (3). In addition, it is the elasticity of the rate of labor force participation, $(\partial F(z)/\partial \ln(w))(w/F(z))$. As the probability of participation approaches 100 percent, λ approaches zero, and the elasticity expressed by equation (5) approaches zero.

Finally, that part of the total elasticity that is due to changes in the average number of hours worked by participants is

$$(6) \quad (\partial Ey^*/\partial \ln(w))F(z)w/Ey = [\beta_w/(X\beta + \sigma\lambda)] - \beta_w\lambda/\sigma,$$

which is the elasticity form of the second half of the right side of equation (3), or the difference between the total elasticity and the participation elasticity. As participation approaches 100 percent, this "conditional" elasticity approaches the structural elasticity. Although conditional and structural elasticities both measure the labor-supply response of working people, the two kinds of elasticities differ because conditional elasticities include the impact of changes in participation on the average number of hours worked by participants. Because structural elasticities measure only the response of workers with average preferences for work and leisure--that is, those indicated by $\eta = 0$ in equation (1)--they exclude the effects of differences in the preferences of those who enter or leave the labor force.

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