February 27, 1999

Fiscal Retrenchments and the Level of Economic Activity*

Abstract

I analyze the effects of an expected future reduction in government spending on the current level of economic activity. In a closed-economy dynamic general equilibrium setup with nominal rigidities, it is shown that expected future cuts in government spending generate an increase in current GDP. Nominal rigidities are an essential feature for the emergence of such a result. With perfectly flexible prices but in an otherwise identical setup, an expected future decline in government spending entails no increase in the current level of economic activity.

JEL classification: E32; E62

Keywords: Government spending; Real activity; Nominal rigidities

Giovanni Olivei
Research Department, Federal Reserve Bank of Boston, Boston, MA 02106
Tel.: 617 973 3783. Fax: 617 973 3957. e-mail: giovanni.olivei@bos.frb.org

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*This paper is a revised version of Chapter 2 of my dissertation at Princeton University. I thank Kenneth Rogoff and Michael Woodford for helpful comments and suggestions. All errors are my own. The views expressed in this paper are the author's, and do not necessarily reflect those of the Federal Reserve Bank of Boston or the Federal Reserve System.

1 Introduction

With the self-imposed need for the countries participating in the European Monetary Union to adhere to the provisions of the "Stability Pact", Japan's attempt to revive its economy through a fiscal stimulus, and the drive toward a balanced budget in the United States, fiscal issues have again come prominently to the fore. While a positive fiscal multiplier has long been part of macroeconomists' core beliefs, the opposite presumption, that deficit reduction promotes growth in the short run, has taken hold in several policy circles.[1] The argument is usually based on the experiences of Denmark and Ireland during the 1980's, two countries where dramatic budget reductions were associated with growth, not recessions (cf. Giavazzi and Pagano (1990)).

While it is possible that many other things happened during these specific episodes that may render a causal argument from fiscal retrenchments to output expansions inconclusive, it is also true that a fair amount of evidence for OECD countries in the last three decades suggests that, in some circumstances, fiscal contractions can indeed be expansionary. Alesina and Perotti (1995, 1996) find that fiscal adjustments that were successful in inducing a long-lasting decline in the ratio of the (cyclically adjusted) primary deficit to GDP were accompanied by significantly higher output growth than the G-7 average. Moreover, Alesina and Perotti show that successful fiscal adjustments were those that relied on government spending cuts, and on either no increase or a decline in taxes on households.

[1] On this point, and on the importance of understanding how fiscal retrenchments affect the economy, see the following passage from Blinder (1997, pp. 242-43):
... the notion that what used to be called "contractionary" fiscal policies may in fact be expansionary is fast becoming part of the conventional policy wisdom ... Need I point out that the answer to the question of how deficit reduction can stimulate the economy is not "just academic"? It potentially affects the well-being of hundreds of millions of people around the globe. An answer would be a welcome addition to the "core of practical macroeconomics that we should all believe".

The explanations usually put forward to rationalize the unconventional result of expansionary fiscal contractions focus on the stimulus given to investment by the lower long-term real rate of interest, brought about by future reductions in budget deficits and the level of debt, and on the asset boom that a fiscal retrenchment may generate, which more than offsets the contractionary effects of reduced public spending. While these explanations may capture some of the features that appear to characterize actual episodes of expansionary fiscal contractions, they are based on partial equilibrium analyses and cannot be easily cast in terms of the stylized, general equilibrium, dynamic macro models with rational expectations and optimizing foundations now used for theoretical analysis and policy purposes (see, e.g., Rotemberg and Woodford (1997)).[2]

In this paper I contribute to the analysis of the effects of expected future public deficits by showing that in a standard general equilibrium model with nominal rigidities, expectations of future cuts in government spending can have an expansionary effect on the current level of economic activity. The introduction of sticky price dynamics into an otherwise standard framework changes the economy's response to government spending shocks, and the effects can sometimes be surprisingly different from those derived under the assumption of perfectly flexible prices. In the setup of the present paper, flexible prices would *not* allow future declines in government spending to have an expansionary effect on current output, other things equal. The unconventional conclusion that a credible reduction in future government

[2] Other interpretations of the Danish and Irish experience have used standard dynamic general equilibrium optimizing models to explain the strong expansion in private consumption associated with these episodes. A spending cut that is sufficiently large and persistent can signal a future reduction in the tax burden, and therefore an increase in personal disposable income. Bertola and Drazen (1993) have shown that even small spending cuts can produce a large increase in private consumption, if a regime shift is expected when government consumption has reached an "excessive" level. However, the increase in private consumption is financed through a worsening in the country's external position, and not through an increase in domestic output.

spending can stimulate the economy hinges not only on the presence of sticky prices, but also on the magnitude of some "deep" parameters of the model. For example, when nominal money is exogenously determined, a low elasticity of money demand (like the one usually estimated in actual data) is necessary for a future cut in government spending to generate an excess supply in the money market and prompt an increase in current output. A plausible parametrization of the model shows that the result that a future cut in government spending increases current economic activity is robust to different assumptions concerning the endogeneity vs. exogeneity of money, and to the introduction of capital accumulation into the analysis. While suggesting the possibility for the presence of a negative fiscal multiplier *in the short run*, the model outlined in this paper still implies a positive fiscal multiplier in the long run, as in the real model with nondistortionary taxes and no government investment detailed in Baxter and King (1993) and Turnovsky (1995, ch. 9).

The rest of the paper is structured as follows. Section 2 derives the effects of future changes in government spending on the current level of private consumption and output in the context of a standard closed economy model with nominal rigidities in the labor market. Section 3 considers an extension of the model to encompass capital accumulation with adjustment costs to the capital stock. While it is straightforward to solve the model presented in section 2 analytically, for the extended model with capital accumulation it is necessary to resort to simulations, although the intuition from the simpler setup carries over to this more complex case. Section 4 concludes and offers suggestions for future research.

2 A Model with No Capital Accumulation

In this section I describe an economy closed to foreign trade where nominal rigidities are introduced in the form of predetermined wages.[3] I first start with an economy with no capital accumulation, and I then extend the analysis to consider investment in the next section. The economy consists of a continuum of infinitely lived households that supply labor monopolistically to a representative competitive firm, which produces an intermediate good from the different types of labor. The intermediate good is used as an input in the production of a final good by another competitive firm, which sells its output to the households and the government.[4]

Since each household is a monopolistic supplier of labor, it has the power to set its wage, and I assume that the wage for period $t+1$ is set at the end of period t, before the shocks to the economy in period $t+1$ are observed. This way of modelling nominal rigidity has been illustrated, among others, by Blanchard and Kiyotaki (1987), Obstfeld and Rogoff (1996, ch.10), Corsetti and Pesenti (1998), and Rankin (1998), and it gives micro-foundations to the previous *ad hoc* models of Gray (1976) and Fischer (1977), in which equilibrium in the labor market, rather than being the outcome of an explicit optimization process, results from the assumption that the market clears in expectations. As is characteristic of this

[3] The introduction of richer models of price and wage rigidities has received considerable attention recently, and it would indeed be possible to add dynamics to this model's wage setting equation, for example by considering adjustment costs in changing the nominal wage. However, given that most wages are set for a year and a fiscal year seems to be the basic time interval for policy decisions, the shortcut of assuming wages to be predetermined should not be, to a large extent, an unrealistic approximation. Moreover, the presence of decreasing returns in the labor input in the present setup allows for an upward sloping, short-run aggregate supply schedule, in accordance with the general belief that while wages are set for a year, very few prices are.

[4] The presence of the intermediate good, a device introduced to simplify notation, can obviously be avoided. If this is the case, the firm producing the final good would choose the different types of labor optimally, as in Blanchard and Kiyotaki (1987). All the results derived in this section and in the next continue to hold when one dispenses with the assumption of an intermediate good.

type of models, the assumption that each household supplies labor to a representative firm, which employs a continuum of labor inputs, ensures that individual decisions *per se* have a negligible effect on the general level of prices and economic activity.

Denoting by λ the constant elasticity of substitution among different labor inputs, the linear homogeneous CES production function for the intermediate good is given by the following expression:

$$L = \left[\int_0^1 L(i)^{\frac{\lambda-1}{\lambda}} di \right]^{\frac{\lambda}{\lambda-1}}, \tag{1}$$

where $L(i)$ denotes the quantity of labor monopolistically supplied by household $i \in [0,1]$, and $\lambda > 1$. The firm producing the intermediate good maximizes profits in a competitive market

$$WL - \int_0^1 W(i)L(i)di,$$

subject to the production function in eq.(1), where $W(i)$ is the nominal wage for differentiated labor of type i, while W denotes the price index of the intermediate good.[5] The maximization problem yields the following demand for type i labor:

$$L(i) = \left[\frac{W(i)}{W} \right]^{-\lambda} L, \qquad i \in [0,1]. \tag{2}$$

Representative household i will take this demand function into account when maximizing utility. The firm producing the final good employs the intermediate good L as its sole productive input, according to the production function

$$Y = L^{\alpha}, \qquad 0 < \alpha \leq 1. \tag{3}$$

[5] At the zero profit symmetric equilibrium, the price index for the intermediate good is defined as follows:

$$W \equiv \left[\int_0^1 W(i)^{1-\lambda} \right]^{\frac{1}{1-\lambda}}.$$

Since the firm behaves competitively, the intermediate good must be paid its marginal product

$$\alpha L^{\alpha-1} = \frac{W}{P}.$$

The expression shows that when W increases, the price level P of the final good rises, too. When returns to scale in eq.(3) are constant, $P = W$ and P becomes preset whenever wages are set a period in advance. When $\alpha < 1$, P rises as the quantity of final output increases. This can be seen more clearly by combining the two previous equations, to obtain the following aggregate supply schedule

$$Y = \left[\alpha^{-1}\frac{W}{P}\right]^{-\frac{\alpha}{1-\alpha}}. \tag{4}$$

The economy-wide resource constraint is the one of a closed economy,

$$Y = C + G = C\exp(\gamma), \tag{5}$$

where C and G denote total private and public consumption respectively, and $\gamma \equiv \ln\left(Y/\left(Y-G\right)\right)$, with per capita real quantities equal to aggregate quantities. Since γ is increasing in the ratio of public spending to output, G/Y, it has the interpretation of an index of fiscal stance that shifts the demand curve faced by the firm producing the final good. Fiscal policy is assumed to be Ricardian in this setup, and it is then possible to consider, without loss of generality, a government that always runs a balanced budget:

$$G_t = \tau_t + \frac{M_t - M_{t-1}}{P_t},$$

where M is the total stock of money and τ are lump-sum taxes.

In each period, representative household i chooses the optimal sequence $\{C_s(i), M_s(i), W_{s+1}(i)\}_{s=t}^{\infty}$

resulting from the maximization of the intertemporal utility function

$$U_t = \mathrm{E}_t \sum_{s=t}^{\infty} \beta^{s-t} \left[\frac{C_s(i)^{1-\rho}}{1-\rho} + \frac{\chi}{1-\varepsilon} \left(\frac{M_s(i)}{P_s} \right)^{1-\varepsilon} - \phi \frac{(1-L_s(i))^{1-\zeta}}{1-\zeta} \right], \tag{6}$$

subject to the constraints

(a) $Q_t B_{t+1}(i) + M_t(i) = B_t(i) + M_{t-1}(i) + W_t(i) L_t(i) - P_t C_t(i) - P_t \tau_t(i)$,

(b) $L_t(i) = \left[\frac{W_t(i)}{W_t} \right]^{-\lambda} L_t$,

(c) $W_{t+1}(i)$ is chosen conditional on period t information set.

$B_t(i)$ is the nominal value of household i's bond portfolio at the beginning of period t. The only bond in the economy is a zero-coupon bond with a one-period maturity, and therefore Q_t is the bond's nominal price at time t for one dollar in period $t+1$. Moreover, $M_t(i)$ is the quantity of money held by household i at the end of period t, $\beta^{-1} - 1$ is the rate of time preference, $1/\rho$ and $1/\zeta$ are the elasticities of intertemporal substitution in consumption and in leisure respectively, $1/\varepsilon$ is (minus) the interest semi-elasticity of money demand, while ϕ and χ are positive parameters.[6] The information set at time t is given by all the variables in period t and in earlier periods.

The nominal rigidity, introduced by imposing that wages in period $t+1$ be set conditional on the information set at time t, is usually rationalized with the presence of an implicit cost in setting wages. It is assumed that the labor contract stipulates that the household will meet all demand for its labor input at the preset nominal wage. The presence of a markup of the wage over the marginal rate of substitution between leisure and consumption means that the representative household typically benefits from working additional hours. Only in

[6] Taking limits as ρ, ζ, $\varepsilon \to 1$, the specification for the period utility function encompasses logarithmic utility over consumption, leisure, and real money balances.

the presence of shocks to the demand for its labor that are large enough to raise the marginal rate of substitution above the current real wage, is the representative household's behavior constrained by the terms of the contract.

Maximization of U_t with respect to B_{t+1} gives the familiar Euler equation for private real consumption

$$Q_t = \beta \mathrm{E}_t \left\{ \frac{P_t}{P_{t+1}} \left(\frac{C_{t+1}(i)}{C_t(i)} \right)^{-\rho} \right\}. \tag{7}$$

The intertemporal Euler equation for money, derived from maximizing U_t with respect to M_t, can be combined with the consumption Euler equation to obtain the following equation for money demand

$$1 - Q_t = \frac{\chi P_t^{\varepsilon} C_t(i)^{\rho}}{M_t(i)^{\varepsilon}}. \tag{8}$$

The relationship holds in both stochastic and nonstochastic settings, since nominal bonds and currency share the same price-level risk. While the Euler consumption and money demand equations hold irrespective of the presence of nominal rigidities, the expression for the optimal wage at time $t+1$ conditional on the information at time t, derived from maximizing U_t with respect to W_{t+1}, is given by

$$W_{t+1}(i) = \frac{\lambda}{\lambda - 1} \frac{\mathrm{E}_t \left(\phi \Lambda_{t+1} \left(1 - L_{t+1}(i)\right)^{-\zeta} \right)}{\mathrm{E}_t \left(\Lambda_{t+1} \left(C_{t+1}(i)\right)^{-\rho} P_{t+1}^{-1} \right)}, \tag{9}$$

where $\Lambda = W^{\lambda} L$. The presence of the expectations operators stems from the assumption that the wage is predetermined one period in advance. This equation does not bind *ex post* in period $t+1$, but does govern wage setting in period t. If nominal wages were flexible, expectations would not enter in the expression, and the equation would say that the real wage is a markup $\lambda / (\lambda - 1)$ on the competitive supply wage, $-U_L / U_C$.

The economy's symmetric equilibrium in period t can be described in terms of aggregate supply and aggregate demand schedules. The aggregate supply schedule is given by eq.(4), while the aggregate demand curve is obtained by substituting eq.(7) into eq.(8), together with the economy-wide resource constraint, eq.(5):[7]

$$\frac{1}{P_t}\left(\left(Y_t \exp(-\gamma_t)\right)^{-\rho} - \frac{\chi P_t^{\varepsilon}}{M_t^{\varepsilon}}\right) = \beta \mathrm{E}_t \left(\frac{1}{P_{t+1}}\left(Y_{t+1}\exp(-\gamma_{t+1})\right)^{-\rho}\right). \tag{10}$$

The right-hand side of the expression is a function of expectations of period $t+1$ variables only, while the left-hand side contains period t variables. The relationship linking Y_t and P_t is negative, with γ_t, M_t, and expectations of period $t+1$ variables entering as shift terms. Note that while the supply side of the economy is linear in logarithms, the demand side is not, as one can see from the money demand relationship, eq.(8).[8] Approximation of eq.(8) in a neighborhood of a nonstochastic steady-state with a constant rate of growth in money supply and a constant share of public spending in output gives the following expression

$$q_t = \bar{i}\ln\frac{\bar{i}}{\chi(1+\bar{i})} + \ln\frac{1}{1+\bar{i}} + \varepsilon\bar{i}m_t - \varepsilon\bar{i}p_t - \bar{i}\rho c_t, \tag{11}$$

where lower-case letters denote natural logarithms of the respective upper-case variables, and $\bar{i}$ denotes the steady-state one-period net nominal rate of interest. The Euler consumption

[7] Note that, in a symmetric equilibrium, eq.(8) can be interpreted as an LM schedule which depends on the opportunity cost of holding money and on private consumption, while eq.(7) is a modified IS schedule, in which expectations about future private consumption are a shift factor in the position of the conventionally defined IS schedule. Aggregate demand is then derived by equating the IS and LM schedules, via the elimination of the one-period gross nominal interest rate, Q^{-1}.

[8] Obstfeld and Rogoff (1996, ch.8) show that it is still possible to obtain a closed-form solution when the interest semi-elasticity of money demand, $-1/\varepsilon$, is equal to -1 and money supply (but not necessarily other shocks) evolves according to a random walk with drift. However, given that the value of ε in what follows is going to play an important role, I am not constraining ε to be equal to unity from the start, and I resort instead to an approximation for eq.(8).

equation, eq.(7), can be written in logarithms as[9]

$$q_t = \ln\beta + p_t - \mathrm{E}_t p_{t+1} + \rho c_t - \rho \mathrm{E}_t c_{t+1}. \tag{12}$$

Combining eqs.(11)-(12), and noting that $c_t = y_t - \gamma_t$, yields an approximation for the economy's aggregate demand schedule

$$\varepsilon\bar{i}\left(m_t - p_t\right) = -\left(\mathrm{E}_t p_{t+1} - p_t\right) + \left(1+\bar{i}\right)\rho\left(y_t - \gamma_t\right) - \rho \mathrm{E}_t\left(y_{t+1} - \gamma_{t+1}\right), \tag{13}$$

where all constant terms have been omitted. This equation can be readily solved forward to obtain an expression for the price level as a function of current and future variables

$$\begin{aligned} p_t \quad = \quad & \frac{\varepsilon\bar{i}}{1+\varepsilon\bar{i}}\sum_{s=t}^{\infty}\left(\frac{1}{1+\varepsilon\bar{i}}\right)^{s-t}\mathrm{E}_t m_s - \frac{\left(1+\bar{i}\right)\rho}{1+\varepsilon\bar{i}}\left(y_t - \gamma_t\right) \\ & + \frac{\left(\varepsilon-1\right)\bar{i}\rho}{1+\varepsilon\bar{i}}\sum_{s=t+1}^{\infty}\left(\frac{1}{1+\varepsilon\bar{i}}\right)^{s-t}\mathrm{E}_t\left(y_s - \gamma_s\right). \end{aligned} \tag{14}$$

Note that when $\varepsilon = 1$, the expected future paths for output and government spending have no effect on the current price level p_t and, as one can readily show, on the price q_t of the one-period nominal bond. As explained in Obstfeld and Rogoff (1996, ch. 8), this happens because, other things equal, higher future output available to the private sector has two opposite effects on the demand for money. On one side, by reducing the household's desired savings, it raises the real and nominal interest rates, creating an excess demand in the money market that tends to push the current price level up. On the other side, by raising expected future money demand, it lowers expected inflation and consequently the nominal interest

[9] The omitted term, $\frac{1}{2}var_t\left(p_{t+1} + \rho c_{t+1}\right)$, is constant as long as the distribution of the shocks to the log of money and the log of government spending hitting the economy is i.i.d. normal. Here, I do not consider explicitly the variance-covariance structure of the model, although uncertainty concerning the magnitude of shocks to the economy could have potentially sizeable effects on the level of economic activity. For example, in the present setup one could show that higher variability in government spending results in a higher wage rate and a lower steady-state level of output. In a similar model, Rankin (1998) shows that monetary uncertainty combined with nominal rigidities depresses aggregate demand and hence output.

rate, creating an excess supply in the money market that tends to push the current price level down. When $\varepsilon = 1$, the two effects cancel out, leaving the price q_t of the nominal one-period bond unchanged.

The aggregate supply relationship, eq.(4), which is already log-linear and requires no approximation, is then equal to

$$y_t = \frac{\alpha}{1-\alpha} \left(\ln \alpha - w_t + p_t \right). \tag{15}$$

The nominal wage w_t in a symmetric equilibrium is derived from the first-order condition (9) together with the aggregate production function, $y = \alpha l$, and the economy-wide resource constraint, to obtain

$$w_t = \ln \frac{\lambda \phi}{\lambda - 1} + \frac{\nu}{\alpha} \mathrm{E}_{t-1} y_t + \rho \mathrm{E}_{t-1}(y_t - \gamma_t) + \mathrm{E}_{t-1} p_t, \tag{16}$$

where $1/\nu$ denotes the intertemporal elasticity of labor supply.[10] Taking expectations at time $t-1$ of the aggregate supply schedule, and noting that $\mathrm{E}_{t-1} w_t = w_t$, it is possible to write expected total output as follows:

$$\mathrm{E}_{t-1} y_t = \frac{\alpha \rho \mathrm{E}_{t-1} \gamma_t + \alpha \ln \frac{\alpha(\lambda-1)}{\lambda \phi}}{1 + \nu - \alpha \left(1 - \rho \right)}.$$

The expression shows that expected output increases with the expected index of fiscal stance. This happens because when government spending increases as a ratio of total output, private consumption decreases, albeit less than proportionately. For example, when α, ρ, and ν equal unity, a 1 percentage point expected decrease in γ lowers next period expected output by just one-half percentage point, the reason being that since government spending is costly

[10] A term which depends on the variance-covariance structure of the model has been omitted (cf. also footnote 9). Note that $\nu^{-1} \equiv \frac{1-\overline{L}}{\overline{L}} \zeta^{-1}$, where $\overline{L}$ is the steady-state share of the household's productive time devoted to market activities.

to the household but is not directly productive and does not affect the marginal physical productivity of labor, a decline in γ with its accompanying decline in taxes leads to an increase in private wealth and consumption (in this specific example the increase in private consumption is one-half percentage point), and consequently to a less than proportional decline in output.

At this stage, it is possible to solve explicitly for the level of current economic activity. Substituting eq.(14) into eq.(15), and solving for w_t as a function of the expected future paths of money and government spending at time $t-1$, gives the following expression:

$$\begin{aligned} y_t - \mathrm{E}_{t-1}y_t &= \frac{\alpha\varepsilon\bar{i}}{\alpha(\varepsilon-1)\bar{i}\rho}\xi\sum_{s=t}^{\infty}\left(\frac{1}{1+\varepsilon\bar{i}}\right)^{s-t}(\mathrm{E}_t - \mathrm{E}_{t-1})m_s + \frac{\alpha(1+\bar{i})\rho}{\alpha(\varepsilon-1)\bar{i}\rho}\xi(\mathrm{E}_t - \mathrm{E}_{t-1})\gamma_t \\ &\quad - \frac{(1+\nu-\alpha)}{1+\nu-\alpha(1-\rho)}\xi\sum_{s=t+1}^{\infty}\left(\frac{1}{1+\varepsilon\bar{i}}\right)^{s-t}(\mathrm{E}_t - \mathrm{E}_{t-1})\gamma_s, \qquad (17) \\ \text{where} \quad \xi &= \frac{\alpha(\varepsilon-1)\bar{i}\rho}{(1-\alpha)\left(1+\varepsilon\bar{i}\right)+\alpha(1+\bar{i})\rho}. \end{aligned}$$

Note that $\xi > 0$ provided that $\varepsilon > 1$, and the previous equation then shows that while the current level of economic activity is positively related to unexpected changes in current government spending, it is instead negatively related to unexpected changes in government spending over *future* periods. This means that, other things equal, a decline in the expected value of future government spending will raise today's level of total output.[11]

In order to shed light on this result, consider first the case in which wages are not preset a period in advance, but are instead perfectly flexible, and suppose that at time t agents learn of a regime shift in government spending that permanently reduces the expected ratio of public spending to output from period $t+1$ on. In this circumstance, output at time t

[11] Given that I have assumed that the variance-covariance structure of the model is constant over time, I am also implicitly assuming that the regime shift that takes place in the future changes the expected value of γ, but otherwise leaves second moments unaltered.

stays unchanged at the level

$$y_t = \frac{\alpha\rho\gamma_t + \alpha \ln \frac{\alpha(\lambda-1)}{\lambda\phi}}{1+\nu-\alpha(1-\rho)}.$$

The expression shows that current output is affected by changes in current government spending only. With $\varepsilon > 1$, the regime shift expected to occur at time $t+1$ entails an increase in the nominal rate of interest (and hence, a decline in q_t), the increase in the real interest rate being greater than the decline in expected inflation. Therefore, real money balances decrease to restore equilibrium in the money market, with private consumption and total output unchanged at time t.

When prices are sticky, the tendency for the nominal rate of interest to increase is even more pronounced than in the flexible price case if current private consumption does not change, because sticky prices cause a smaller decline in expected inflation. Moreover, the decline in current real money balances is not sufficient to offset the excess supply brought by the increase in the nominal interest rate. Thus, in order to restore equilibrium, current private consumption must increase. Obviously, this effect hinges on ε being greater than unity. When $\varepsilon < 1$ exactly the opposite outcome emerges: The increase in the real rate is more than offset by the decline in expected inflation, and the nominal interest rate decreases. With sticky prices, such a decrease causes an excess demand for real money balances which triggers a decline in private consumption. When $\varepsilon = 1$, the nominal interest rate does not change, and neither prices nor current private consumption move, regardless of the price adjustment mechanism.

It is then clear that a positive impact on current output from a future fiscal retrenchment requires in this model that $\varepsilon > 1$. Estimates of the interest semi-elasticity of money demand,

$-1/\varepsilon$, place the value at about -0.10 in U.S. data for the post World War II period (Stock and Watson (1993)). In a recent study that extends post World War II data through 1996, Ball (1998) estimates the U.S. interest semi-elasticity of money demand to be approximately -0.05 across different estimation procedures. To provide a rough impression of the potential size of the impact on output at time t of an unanticipated permanent fiscal retrenchment occurring at time $t+1$, note that the unexpected change in time t output is going to be equal, *ceteris paribus*, to

$$y_t - \mathrm{E}_{t-1}y_t = \frac{\xi}{\varepsilon\bar{i}}\left(\mathrm{E}_t c_{t+1} - \mathrm{E}_{t-1}c_{t+1}\right) = -\frac{\xi}{\varepsilon\bar{i}}\frac{1+\nu-\alpha}{1+\nu-\alpha(1-\rho)}\left(\mathrm{E}_t\gamma_{t+1} - \mathrm{E}_{t-1}\gamma_{t+1}\right),$$

where $\xi/\varepsilon\bar{i} < 1$ denotes the fraction of the steady-state change in private consumption by which private consumption, and therefore output, increase at time t. For $\bar{i} = 0.05$, $\alpha = 1$, $\rho = 1$, and $\varepsilon = 5$, this fraction is equal to approximately 0.76; therefore, with $\nu = 1$, a fiscal retrenchment from time $t+1$ on that reduces the ratio of government spending to total output permanently from 0.24 to 0.23 will increase output at time t by 50 basis points.[12]

Obviously, in this example the effect on period t output is maximized by assuming a perfectly horizontal short-run aggregate supply; nevertheless, even when $\alpha = 0.6$, the increase in output is still about 40 basis points. The reason for this result is that while the fraction $\xi/\varepsilon\bar{i}$ decreases monotonically with α, the steady-state level of private consumption is inversely related to α, as the above equation shows. The intertemporal elasticity of substitution in consumption also plays an important role in the previous computations. The smaller its

[12] A value of unity for ν implies that $\zeta = 2$ when the steady-state share of household's time devoted to market activities is equal to 1/3. A permanent reduction in the ratio of government spending to output from 0.24 to 0.23 corresponds to a permanent decrease in γ of 1.3 percentage points. Higher values for ε, consistent with the empirical studies cited in the text, would obviously increase the impact on current output, albeit at a rapidly decreasing rate.

value, the greater the household's incentive to smooth consumption. However, because the impact of permanent changes in government spending on the steady-state level of private consumption is directly related to the size of $1/\rho$, the initial jump in consumption is also decreasing with $1/\rho$. While many estimates of the intertemporal elasticity of substitution are below 0.5, few are much higher than 1; for this reason, the 40 to 50 basis-point increase in period t output computed in the example with a unitary elasticity of substitution should be interpreted as an upper boundary.[13]

While the model outlined thus far highlights the importance of the interest elasticity of money demand for the presence of a negative short-run multiplier, note that the same result would obtain if money were endogenous and the monetary authority followed an interest rate rule. To illustrate this point, consider the case in which the interest rate rule takes the simple form

$$q_t = \ln \frac{1}{1+\bar{i}} - \eta \left(p_t - p_{t-1}\right) - \eta \ln \frac{1}{1+\overline{\pi}} + x_t, \tag{18}$$

where x_t is a white-noise shock. The equation says that, aside from the random disturbance x_t, the monetary authority has a target $\overline{\pi}$ for inflation and will raise the one-period nominal interest rate whenever current inflation is above the target. In order to have determinacy of equilibrium in the presence of a Ricardian fiscal policy, it is necessary for the coefficient η in the monetary reaction function to be strictly greater than unity (see, e.g., Kerr and King (1996)). It is then straightforward to obtain an expression for current inflation by combining

[13] For example, when $\bar{i} = 0.05$, $\alpha = 0.6$, $\varepsilon = 5$, $\nu = 1$, and $\rho = 5$, the increase in period t output would be just above 25 basis points.

eqs.(12) and (18) and solving forward:[14]

$$
\begin{aligned}
p_t - p_{t-1} \quad = \quad & \ln(1+\overline{\pi}) + \frac{1}{\eta}x_t - \frac{\rho}{\eta}(y_t - \gamma_t) \\
& + \frac{\rho}{\eta}(\eta - 1)\sum_{s=t+1}^{\infty}\left(\frac{1}{\eta}\right)^{s-t}\mathrm{E}_t(y_s - \gamma_s).
\end{aligned} \tag{19}
$$

Since $\eta > 1$, the previous expression is analogous to eq.(14) when $\varepsilon > 1$, and shows that current inflation rises with an increase in expected future disposable income. As before, current output is thus negatively related to changes in expected government spending over future periods, the aggregate supply of the model being still characterized by eqs.(15)-(16).

In summary, irrespective of the way in which the money market equilibrium is modeled, nominal rigidities are crucial in generating the result that expected future fiscal retrenchments have an expansionary effect on current output. Absent nominal rigidities, expected future changes in public spending would translate into a movement in the real interest rate that leaves current private consumption, and therefore current output, unaltered.

3 A Model with Capital Accumulation

In this section, I augment the model outlined thus far with the introduction of investment into the analysis. Before doing so, I briefly recall how current output is affected by an unanticipated future fiscal retrenchment in a standard general equilibrium real model with capital accumulation and lump-sum taxes (see Fisher and Turnovsky (1992), and Turnovsky (1995, ch. 9)). The fiscal retrenchment entails a new steady-state where total output and the capital stock are lower, while private consumption is higher. With the capital stock being

[14] Given that money balances enter the representative household's utility separably, in the presence of an interest rate rule the money market equilibrium condition simply determines the nominal level of money balances, and since this condition plays no role in determining prices, output, and interest rates, it can be ignored for all practical purposes.

predetermined, the immediate adjustment at the time of the announcement is for private consumption to increase in response to the new information, for the usual intertemporal consumption-smoothing reasons, and the lower marginal utility of consumption decreases the number of hours worked by the representative household. Since government expenditures stay unchanged at the time of the announcement, investment and output drop, with capital and output starting to converge monotonically to their new lower steady-state levels.[15]

The introduction of capital accumulation into the previous section's setup is straightforward. I assume that the final good is produced from the intermediate good L and from capital, according to the following constant returns to scale Cobb-Douglas function

$$Y = L^{\alpha} K^{1-\alpha}, \tag{20}$$

where the stock of capital K is accumulated directly by the competitive firm that produces the final good. Since households own a constant share in the firm, they are the ultimate recipients of the services provided by capital. The existing capital depreciates at a constant rate δ. Investment is productive in the next period, and therefore the stock of capital at time t is predetermined. In particular, the evolution equation for capital is given by

$$K_{t+1} - K_t = \phi\left(\frac{I_t}{K_t}\right) K_t - \delta K_t, \tag{21}$$

where I denotes investment, and $\phi\left(I/K\right)$ is a positive, increasing, and concave function that embodies costs of adjustment for the capital stock. It is assumed that there are no average or marginal adjustment costs, locally to the steady-state, so that $\phi\left(\delta\right) = \delta$, and $\phi'\left(\delta\right) = 1$.

[15] Monotonic convergence occurs when the lag between the announcement and the time at which the fiscal retrenchment is enacted is relatively short. If the lag is of relatively long length, capital decumulation will overshoot its steady-state value, and thus the decrease in output will not be monotonic. Still, during the transition output will always be lower than its pre-shock level (cf. Fisher and Turnovsky (1992)).

The final-good-producing firm chooses labor and capital to maximize its total market value, equal to

$$V_t = \mathrm{E}_t \sum_{s=t}^{\infty} \beta^{s-t} C_s^{-\rho} D_s, \tag{22}$$

subject to eqs.(20)-(21), where $\beta^{s-t} C_s^{-\rho}$ is the marginal utility value to the representative household of an additional unit of profits during period s, and

$$D_s = Y_s - \frac{W_s}{P_s} L_s - I_s,$$

The first-order condition for investment is given by

$$C_t^{-\rho} = \phi' \left(\frac{I_t}{K_t} \right) \Psi_t, \tag{23}$$

where Ψ is the Lagrange multiplier for the capital accumulation equation. Ψ_t has an interpretation as the marginal utility of capital in place at the end of period t, and $\Psi_t C_t^{\rho}$ is the real value of an additional unit of installed capital (that is, the value of a small change in K_{t+1} within the constraint (21)). The condition states that the marginal value of capital equals the marginal cost of investment, or that the investment rate I_t/K_t is determined by the ratio of the shadow price of installed capital to the price of replacement capital. The first-order condition for capital is

$$-\Psi_t + \beta \mathrm{E}_t \left\{ C_{t+1}^{-\rho} (1-\alpha) \frac{Y_{t+1}}{K_{t+1}} + \Psi_{t+1} \left((1-\delta) + \phi \left(\frac{I_{t+1}}{K_{t+1}} \right) - \phi' \left(\frac{I_{t+1}}{K_{t+1}} \right) \frac{I_{t+1}}{K_{t+1}} \right) \right\} = 0. \tag{24}$$

This condition is an investment Euler equation, which states that the marginal utility of capital in place at the end of period t is the discounted sum of next period's marginal productivity of capital, weighted by the marginal utility of consumption, and of the marginal utility of next period's capital stock, which includes the contribution of an additional unit of K_{t+1} to lower installation costs in period $t+1$. Finally, the firm equates the marginal productivity of labor to its rental rate:

$$\alpha \frac{Y_t}{L_t} = \frac{W_t}{P_t}. \tag{25}$$

From eqs.(20) and (25) it is then possible to derive the aggregate supply schedule for the economy,

$$Y_t = K_t \left[\alpha^{-1} \frac{W_t}{P_t} \right]^{-\frac{\alpha}{1-\alpha}}, \tag{26}$$

while the economy-wide resource constraint is now described by the following equation,

$$Y = C + I + G = (C + I) \exp(\gamma), \tag{27}$$

with per capita real quantities equal to aggregate real quantities.

The optimization problems faced by the firm producing the intermediate good L, and by the representative household i, are the same as in the previous section, and therefore eqs.(2) and (7)-(9) continue to hold.[16] A symmetric equilibrium is given by the first-order conditions for the representative household and for the firm producing the final good, eqs.(7)-(9), and (23)-(25) respectively, by the economy-wide resource constraint, eq.(27), and by the expression for the evolution of the capital stock, eq.(21), together with the production function for the final good, eq.(20). Under the assumption of zero growth, with arbitrary $\overline{P}$ and for given values of $\overline{L}$ and $\overline{M}/\overline{P}$, it is straightforward to characterize the symmetric equilibrium steady-state.[17] In particular, given the assumptions on the shape

[16] The representative household i's budget constraint is modified as follows:

$$Q_t B_{t+1}(i) + M_t(i) = B_t(i) + P_t D_t + M_{t-1}(i) + W_t(i) L_t(i) - P_t C_t(i) - P_t \tau_t(i),$$

where D are the real profits of the final good producing firm.

[17] Imposing a specific steady-state value for $\frac{M}{P}$ is equivalent to calibrating the utility function parameter χ, while imposing a specific steady-state value for L is equivalent to calibrating the utility function parameter ϕ, as long as λ has been previously calibrated.

of the function $\phi(I/K)$, it follows from eq.(21) that $\overline{I}/\overline{K} = \delta$, and from eqs.(23)-(24) that $\overline{K}/\overline{Y} = (1-\alpha)/(\beta^{-1} - (1-\delta))$. From these two values one can compute $\overline{I}/\overline{Y}$, and thus also $\overline{C}/\overline{Y}$ for a given $\overline{\gamma}$. The steady-state values for $\overline{W}/\overline{P}$ and $\overline{K}/\overline{L}$ then follow from eqs.(26) and (20) respectively, while $\overline{Y} = \left(\overline{Y}/\overline{K}\right)^{-\frac{1-\alpha}{\alpha}} \overline{L}$. Off the steady-state path, the model consists of a system of nonlinear expectational difference equations. To solve the system, the equilibrium conditions are log-linearized in the neighborhood of the steady-state just illustrated. Derivation of the approximated equations is left to the appendix.[18]

The parameters of the model are calibrated in accordance with previous studies on the U.S. economy. Both the intertemporal elasticity of substitution in consumption and the intertemporal elasticity of substitution in labor are set equal to unity. The parameter $1/\nu$ has important implications in determining the output and consumption effects of government spending shocks, because the number of hours devoted to work activities depends on the level of consumption, with higher consumption reducing the marginal utility of income and work effort. Given that the unit of time is one year, I set β equal to 0.952. I use the benchmark value of $\overline{L} = 1/3$ as the steady-state allocation of hours to market activities, as advocated by Prescott (1986), which implies that $\zeta = 2$ for a unitary elasticity of substitution in labor. α is set equal to 2/3, while the annual depreciation rate is set equal to an annual 0.075. The share of government spending in total output is 0.20, as in Campbell (1994), while the interest semi-elasticity of money demand is set equal to -0.05, in line with the estimates reported in the previous section. I assume for simplicity a zero steady-state inflation rate, and no shocks to monetary policy. The near-steady-state analysis does not require the specification of a

[18] As in the previous section, it is assumed that the shocks to the economy are homoskedastic, and that the variance terms that would appear in the approximations are constant.

functional form for the adjustment cost function, $\phi(I/K)$. As already noted, the function is such that the model has the same steady-state as a model with no adjustment costs to capital. A parameter that must be specified is the elasticity of the marginal adjustment cost function, ς, which governs the response of I/K to movements in the ratio of the shadow price of installed capital to the price of replacement capital.[19] The calibrated value for ς is set equal to 0.5, in line with Chirinko's (1993) overview of empirical investment functions.

The exercise that I conduct throughout considers the effects of an unanticipated announcement at time t of a regime shift in government spending that permanently reduces the expected value of γ from period $t+1$ on. In order to assess the importance of introducing nominal rigidities, I first consider the case in which prices and nominal wages are perfectly flexible. Impulse-response functions for private consumption and total output are reported in figure 1, where time zero refers to the time of the announcement, while time one is the period when the permanent 1 percentage point reduction in government spending is actually implemented.[20] The figure shows that, at the time of the announcement, private consumption increases, while total output decreases. The increase in private consumption is brought about by a decline in the stock of capital. However, the increase in private consumption lowers the marginal utility of income, and as a result the representative household substitutes away from work and into leisure. For this reason, output starts declining at the time of the announcement. The initial output response is muted because of the introduction of adjustment costs in accumulating capital. With no adjustment costs, the impact on

[19] ς is thus defined as $\left(\overline{I}/\overline{K}\phi^{''}\left(\overline{I}/\overline{K}\right)/\phi^{'}\left(\overline{I}/\overline{K}\right)\right)$.

[20] I use the King and Watson (1995) MATLAB codes `reds.m` and `solds.m` to perform the simulations. All the simulations are available upon request.

private consumption would be much more pronounced, since in this case a higher portion of the capital stock gets depleted. The higher increase in private consumption would further reduce the household's incentives to work, and output would therefore decline by a more significant amount. Moreover, other things equal, a high value of the intertemporal elasticity of substitution in labor, $1/\nu$, would bring a more pronounced decline in real output through a lower work effort as a consequence of the increase in disposable income.

Figure 2 reports impulse-response functions for private consumption and total output for the case in which nominal wages are preset one period in advance. In this circumstance, the initial response of private consumption at the time of the announcement is larger than in the case in which nominal rigidities are absent. Part of the increase in consumption is still financed by depleting the capital stock, but, as the impulse-response for output shows, part is financed by increasing production. This happens because, in the short run, the household wage-setting equation does not bind *ex post*, so that no trade-off between labor and leisure is present.

Adjustment costs for the capital stock have an important role in the expansion of output at the time of the announcement. Absent such costs, the household would be able to raise consumption by depleting a higher fraction of the capital stock, thus smoothing its consumption path with no need for aggregate demand to increase. Still, it is always the case that, in the presence of nominal rigidities, private consumption exhibits a larger positive response on impact. This larger response may actually entail an increase in total output, as indicated in figure 2, provided there are costs in adjusting the capital stock.[21] It is important to

[21] There is no firm consensus in the literature about the value that the elasticity of I/K with respect to the ratio of the shadow price of installed capital to the price of replacement capital, ς, should take. Kimball (1995) argues for a value of about 5. With all the other parameters unchanged, carrying the simulations with

emphasize that in this context with exogenous money, the magnitude of ε, the inverse of the interest elasticity in money demand, still has to be greater than unity for a positive effect on current consumption to materialize. Of course, the presence of investment complicates the analysis, because the depletion of the capital stock necessarily translates into an increase in consumption of the same amount, irrespective of the value of ε. However, in equilibrium the total effect on private consumption at the time of the announcement will still be negative if ε is significantly less than one, since the decline in the nominal interest rate will necessitate a decline in consumption to restore equilibrium in the money market when prices cannot adjust fully.

Figure 3 considers impulse-response functions for private consumption and total output when wages are predetermined and money is specified as in eq.(18), in terms of an interest rate rule. The parameter η of the monetary policy rule is set equal to 2, and the future permanent cut in government spending is the only shock affecting the economy. The impulse-responses look very similar to those reported in the previous figure with exogenous money, and the results do not change significantly for a wide range of plausible values for the parameter η.

In summary, the simulations confirm the result that expected future fiscal retrenchments can have an expansionary effect on current output, but the effect is smaller in the presence of capital accumulation. This happens because the increase in private consumption can be financed in part by depleting the capital stock, with no need for output to increase. Note, however, that the analysis has been conducted under the assumption of nondistortionary taxation. If taxes on capital were distortionary, the reduction in the capital stock in the new steady-state would be smaller, and so also the increase in private consumption financed by

$\varsigma = 5$ would still give the result that total output increases on impact.

negative investment.[22] Avenues for future research on this topic should therefore explore the way in which the introduction of distortionary taxation affects this section's results.

4 Final Comments

While in the present model *future* cuts in government spending can be expansionary, a decline in current government spending will have the usual negative effect on the current level of economic activity, as one can see from eq.(17). This equation also shows that a permanent decline in public spending from period t on will decrease time t output by less than in the case of a temporary cut, provided the interest semi-elasticity of money demand is sufficiently small.[23] Therefore, in order for current output to increase in the presence of a fiscal retrenchment, it is necessary for agents to expect fiscal policy to be tighter in the future.

The result presented in this paper, that future cuts in government spending can generate an increase in current output, may help to explain why, in actual practice, several fiscal retrenchments have not been accompanied by a significant decline in output performance. While explanations that heavily rely on expectations may appear somewhat unsatisfactory because, after all, expectations are not directly observable, it is also likely that future budget policies do have an impact on agents' current decisions. The reason is that the public is generally well informed about future changes in budget policy, not only because federal budgets are usually approved well in advance, but also because a large part of the policy

[22] RBC studies on actual U.S. fiscal shocks, like the one of McGrattan (1994), show that changes in the capital and income tax rates can have powerful effects on macroeconomic activity.

[23] Eq.(17) refers to the model with no capital accumulation outlined in section 2. However, the same results will hold when investment is introduced into the analysis.

debate centers around the issues of spending and taxes, issues that matter greatly to the taxpayers and thus are the object of their close scrutiny.

The analysis of the effects of future reductions in government spending on the current level of economic activity was conducted under several simplifying assumptions. First, I have assumed that government spending is financed by lump-sum taxes. This seems like a natural benchmark for isolating the theoretical effects of changes in future government consumption on the current level of aggregate activity. Nevertheless, this is clearly not a natural assumption to make from the perspective of empirical work. As already noted, the introduction of distortionary taxation into the analysis should reduce the negative impact on investment of a future budget cut, a result that does not square well with the available evidence from actual episodes of expansionary fiscal contractions (see Alesina and Perotti (1995, 1996)). These episodes would in fact suggest that fiscal retrenchments stimulate not only private consumption, but also investment. Finally, I have assumed that households' preferences are additively separable across public and private consumption, and the extent to which the present results can be extended to allow for certain forms of nonseparabilities is still to be explored.

A Appendix

This appendix briefly describes the log-linear relationships that comprise the system in section 3. In the following, constants have been omitted and lower-case variables denote the natural logarithm of the corresponding upper-case variables:

$$
\begin{aligned}
\varepsilon\bar{i}\left(m_t - p_t\right) + \left(\mathrm{E}_t p_{t+1} - p_t\right) &= \left(1+\bar{i}\right)\rho c_t - \rho \mathrm{E}_t c_{t+1}, \\
w_{t+1} - \nu \mathrm{E}_t l_{t+1} &= \rho \mathrm{E}_t c_{t+1} + \mathrm{E}_t p_{t+1}, \\
-\rho c_t - \psi_t &= \frac{\varsigma}{\delta}\left(k_{t+1} - k_t\right), \\
\psi_t - \mathrm{E}_t\left(\beta\psi_{t+1} - (1-\beta)\rho c_{t+1}\right) &= \alpha\left(1-\beta\left(1-\delta\right)\right)\mathrm{E}_t\left(l_{t+1} - k_{t+1}\right), \\
l_t - k_t &= -\frac{1}{1-\alpha}\left(w_t - p_t\right), \\
\alpha l_t + (1-\alpha)k_t - \frac{\overline{C}}{\overline{\overline{Y}}}\exp(-\overline{\gamma})c_t - \gamma_t &= \frac{\overline{I}}{\overline{\overline{Y}}}\exp(-\overline{\gamma})\left(\frac{1}{\delta}k_{t+1} - \frac{1-\delta}{\delta}k_t\right).
\end{aligned}
$$

The first relationship is derived by combining the Euler equations for consumption and money, eqs.(7)-(8), while the second is the log-linear version of eq.(9). The next two equations are obtained from the first-order conditions for capital and investment, eqs.(23)-(24), together with the accumulation equation for capital, eq.(21), where the parameter $\varsigma \equiv \left(\overline{I}/\overline{K}\phi''\left(\overline{I}/\overline{K}\right)/\phi'\left(\overline{I}/\overline{K}\right)\right)$ is (minus) the elasticity of I/K with respect to the ratio of the shadow price of installed capital to the price of replacement capital. The last two equations are the log-linear versions of the aggregate supply schedule, eq.(26), and of the economy-wide resource constraint, eq.(27), respectively, where use has been made of eqs.(20) and (25).

When monetary policy is described by the interest rate rule in eq.(18), the first equation is replaced by

$$p_t - p_{t-1} - \frac{1}{\eta}(\mathrm{E}_t p_{t+1} - p_t) = -\frac{1}{\eta}x_t - \frac{\rho}{\eta}(c_t - \mathrm{E}_t c_{t+1})),$$

which can be readily obtained from eqs.(12) and (18). As noted in the main text, with a utility function separable in consumption and money balances, the money market equilibrium condition, eq.(8), simply determines the nominal level of money balances, and since this condition plays no role in determining prices, output, and interest rates, it can be ignored.

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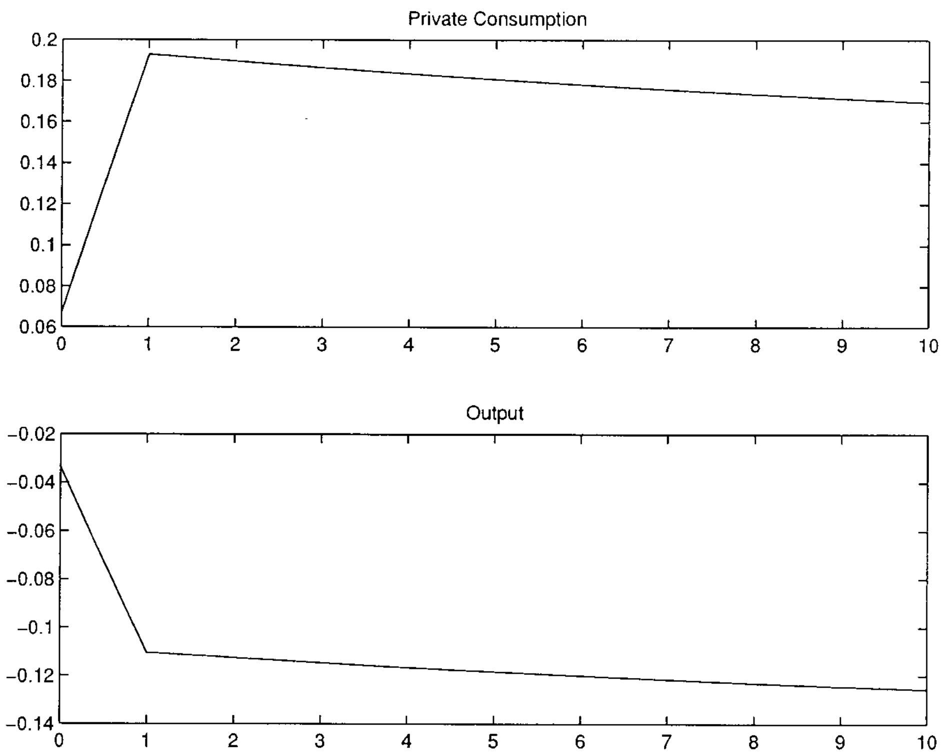
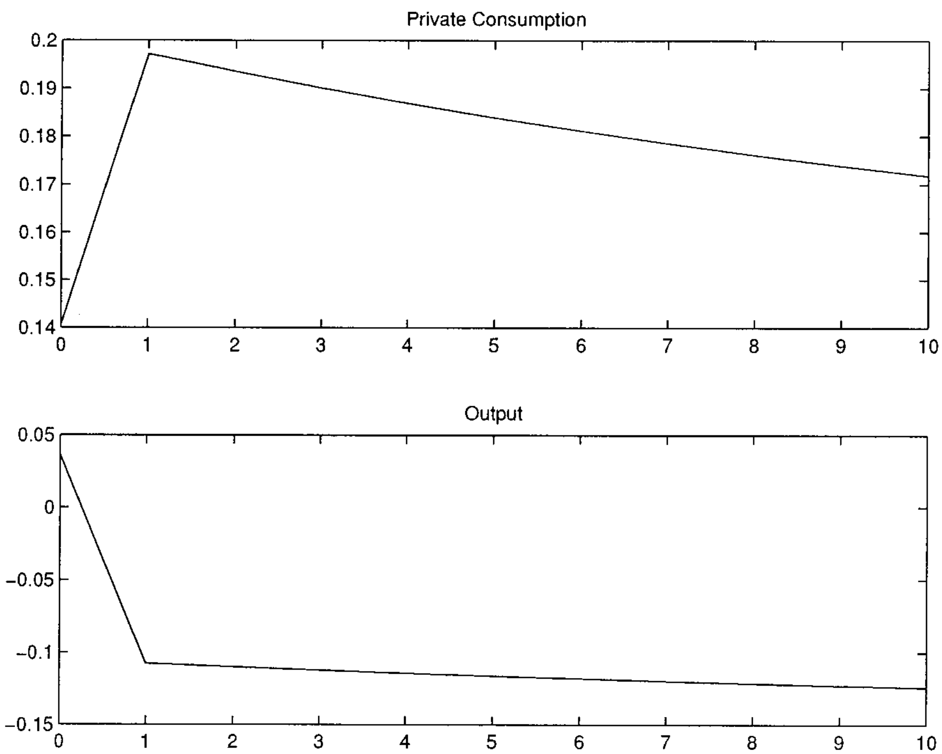
FIGURE 1
model with flexible wages



Note: The figure depicts impulse-response functions for private consumption and total output following an unexpected announcement at time 0 of a 1 percentage point permanent reduction in government spending, to be implemented from time 1 on. The case depicted is the one with no nominal rigidities. Calibrated parameters are given in Section 3 in the text.

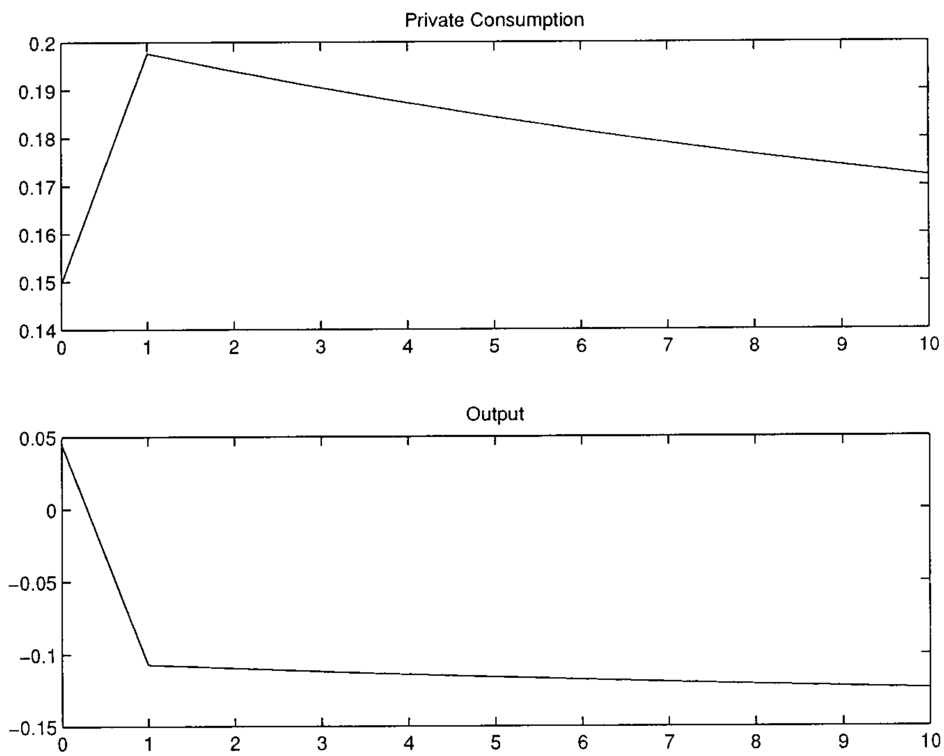
FIGURE 2

model with predetermined wages and exogenous money supply



Note: The figure depicts impulse-response functions for private consumption and total output following an unexpected announcement at time 0 of a 1 percentage point permanent reduction in government spending, to be implemented from time 1 on. The case depicted is the one with nominal rigidities and an exogenous money supply. Calibrated parameters are given in Section 3 in the text.

FIGURE 3
model with predetermined wages and endogenous money supply



Note: The figure depicts impulse-response functions for private consumption and total output following an unexpected announcement at time 0 of a 1 percentage point permanent reduction in government spending, to be implemented from time 1 on. The case depicted is the one with nominal rigidities and an endogenous money supply. Calibrated parameters are given in Section 3 in the text.