Fiscal Policy Composition, Public Debt, and Economic Activity

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Abstract

This paper uses a dynamic general equilibrium model i) to investigate how changes to different spending and revenue items of the budget affect economic activity and public finance; and ii) to evaluate the welfare costs of alternative fiscal policy maneuvers. The paper shows that, unlike an increase in government purchases of final goods, an increase in public employment and transfers, can have a contractionary effect on the economy in the same way as a rise in tax rates. It also suggests that fiscal adjustments implemented by cutting spending items increase households' welfare and are more effective in reducing the primary deficit and public debt than are increases in tax rates.

1 Introduction

Episodes of large fiscal expansions and contractions have not been unusual in OECD countries. Since the mid-1960s, once every three years the primary deficit-to-GDP ratio changed on average by more than 1.5 percentage points per year.[1] The statistical evidence on various episodes of fiscal expansions and contractions shows that sharp changes in fiscal policy have been associated with quite different macroeconomic outcomes. Alesina and Perotti (1995, 1997a) suggest that fiscal policy composition plays a crucial role in determining the influence of such episodes: increases in public spending (especially transfers and government wage bills) and in labor taxes are more likely to induce a contraction in economic activity than are changes in other budget items. Despite the lively empirical literature that supports this finding,[2] not much theoretical work has been done to compare the effects of changing different fiscal policy instruments. Tax reforms have been studied extensively in the literature, and the general equilibrium effects of different taxes are well known, but the spending side of the budget has been largely overlooked.[3] Government spending is usually separated into spending on final goods and services, and public investment. Only recently, has attention shifted toward various components of the spending items classified in the governments' budgets as current spending. Finn (1998) considers public employment separately from public spending on final goods and services; Daveri and Maffezzoli (1999) analyze changes in unemployment subsidies. Both papers look at the general equilibrium effects of such policy changes. However, the former contribution studies only how well the model reproduces the features of the US business cycle, and the latter concentrates only on long-run effects.

The motivation of this paper is to contribute to this literature by setting up a dynamic general equilibrium model and investigating both the long and short-run effects of changing different spending and revenue items of the budget. More specifically, the paper i) analyzes how changes to labor and capital taxes, government purchases of final goods and services, transfers, and public employment affect the dynamics of the primary balance and public debt, private consumption, employment, private investment, and GDP; and ii) evaluates the welfare costs associated with alternative fiscal policy

maneuvers. In doing so, the paper also provides a theoretical analysis for the empirical evidence that suggests that fiscal stabilizations achieved by cutting public employment, the wages of public employees, and transfers are successful in reducing the debt-to-GDP ratio and inducing an economic expansion, whereas fiscal contractions implemented by increasing tax rates (especially taxes on labor income) are less so. Previous contributions to the literature cannot fully explain this empirical evidence, because they do not consider in the same framework all the various policy instruments, and because they either assume a balanced budget or study only long-run effects of policy changes.

The paper uses a standard neoclassical growth model and calibrates it with the average data of ten European countries from 1965 to 1995. It reaches interesting and important conclusions for policy analysis. First, unlike an increase in government purchases of final goods, an increase in public employment has a negative effect not only on consumption and leisure, but also on employment in the private sector, capital stock, and output even when the increase is financed by lump-sum taxes. Second, both increases in labor and capital taxes and in transfers have a negative effect on the macroeconomy. Third, increases in tax rates on capital income have a smoother effect than increases in labor taxes. Fourth, cuts in public employment and transfers are more effective in reducing the primary deficit and public debt than are increases in tax rates. Finally, fiscal adjustments implemented by cutting spending items increase households' utility both during the transition and in the long-run relative to their utility before the change in fiscal policy. The opposite occurs if tax rates are increased. The paper also shows that the magnitude of these effects is not invariant to the elasticity of the labor supply and to the initial values of the fiscal policy parameters, and that the negative relation between public employment and output can be reversed. If public employment has a positive effect on the productivity of capital and labor, an increase in this spending item can lead to higher, not lower, output. However, for most values of the parameters, households' welfare decreases even when this policy leads to higher economic activity. This suggests that whether a fiscal stabilization that cuts public employment can stimulate the economy without reducing households' welfare depends on the level of public employment, the services produced by public employees, and the effects that these services have on the private sector. To my knowledge, this result is new in the literature.

It suggests that empirical work should certainly take into account the differences between various categories of public employees and their productivity to evaluate the effects of public employment on the macroeconomy.

The paper is organized as follows. Section 2 presents the model and the parameters used for the calibration. Section 3 details the responses of output, employment, capital, consumption, primary deficit, public debt, and welfare to changes in the fiscal policy items discussed above. Section 4 presents some sensitivity analysis. The last section concludes.

2 The model

2.1 The set-up

To evaluate how changes in the composition of fiscal policy affect economic activity, the paper uses a standard neoclassical growth model with identical infinitely lived households, perfectly competitive firms, and a government.[4] Households have perfect foresight and derive their lifetime utility from the consumption of privately produced goods and from leisure. They work for the private and the public sector and use their total income to purchase consumption goods, and government bonds and to finance new investment. Additions to existing capital do not incur in installation costs, and investment in private capital and public bonds are perfect substitutes.

Firms produce output with a constant return to scale technology using capital and labor. Technological progress is labor augmenting, and grows exogenously at a positive rate.[5]

The government purchases final goods from the private sector, hires labor to produce services, and makes transfer payments to households. It finances its spending requirements by taxing labor and capital, and by issuing debt. Public spending on final goods subtracts resources from the private sector without influencing households' utility or the production of private goods. Hence any change in this spending item generates a wealth effect that influences the private sector's optimal choices. Services produced by public employees, by contrast, influence the economy through different channels. On one hand, wage payments to public employees reduce the resources available to the private sector

and generate wealth effects similar to those generated by changes in purchases of final goods. On the other hand, any change in government-hired hours of labor imposes constraints on the amount of labor available to the private sector. Thus it affects the production of private output as well through this additional channel. Moreover, departing from Finn (1998), the model allows public employment to influence the productivity of private labor and capital in the production of goods. This accounts for the fact that at least some public employees, for example, policemen, judges, and teachers, produce services that can have a positive effect on private production. Transfers and taxes are distorsive, generating wealth and substitution effects. Public debt, instead, is "ricardian" in the sense that, given its initial value and the values of the exogenous fiscal policy instruments, its time path does not affect equilibrium allocations. The model assumes that all other items of the budget are zero.[6]

The economy is closed to international trade in goods and assets.[7]

Given the assumption of technological progress and the use of functional forms for preferences and technology that support balanced-growth equilibria, the model can be simplified by transforming all quantity variables (except employment and leisure) into stationary ones, dividing them through the state of technological progress. Hence, without loss of generality, the paper presents only the specification for the detrended model. The transformed variables are written in lower case.

2.1.1 The household

The representative household has preferences over consumption and labor that are defined by a conventional isoelastic utility function:

$$\sum_{t=0}^{\infty} \widetilde{\beta}^t \frac{(c_t L_t^{\varphi})^{1-\sigma}}{1-\sigma} \qquad \sigma > 1, \qquad \varphi > 0 \tag{1}$$

where c and L are the household's consumption of goods and leisure, β is the subjective discount factor, and σ and φ are preference parameters. The stationary transformed model requires that $\widetilde{\beta} \equiv \beta x^{1-\sigma}$, where β is the true discount factor and x is the gross growth rate of technological progress.[8]

Available time in each period is normalized at unity, and the household can either work for the

private sector or for the government.

$$L_t = 1 - N_t = 1 - N_{pt} - N_{gt} \tag{2}$$

N is the household labor supply, and N_p and N_g the hours of work he supplies to the private and public sector respectively.

In each period, the household invests his income partly in capital, partly in public bonds, and faces a budget constraint that sets his total income equal to his total spending.

$$b_{t+1}x = (1 + r_t^b)b_t + (1 - \tau_{kt})r_t k_t + (1 - \tau_{Nt})w_t N_t + tr_t(1 - N_t) - c_t - i_t + ls_t \tag{3}$$

The equation for the capital accumulation process is described by (4):

$$k_{t+1}x = (1 - \delta)k_t + i_t \tag{4}$$

where i represents the household's investment in capital goods, b are public bonds, k capital goods, w is the hourly wage rate, r^b and r are the real rate of return of public bonds and capital respectively, and δ is the rate at which capital depreciates. ls are lump-sum transfers, τ_k is the tax rate on capital income, and τ_N is the tax rate on labor income. Income from public bonds is not taxed, depreciation allowances are zero, and there are no costs for installing new capital. Following Finn (1998) and Calmfors and Horn (1986), the paper assumes that the representative agent receives the same labor income whether he works for the private or public sector, and that firms determine the wage rate in a competitive labor market. Also, households receive transfers, tr, proportionately to hours of leisure. Transfers are not taxed.

The purpose of introducing a transfer for leisure is to study the effect of transfers on labor supply and economic activity, if it is taken to mimic the role that unemployment subsidies have in a non-competitive labor market. Alesina and Perotti (1997b), Daveri and Maffezzoli (1999), and Daveri and Tabellini (2000) show that in a monopolistic union model an increase in unemployment subsidies increases both workers' reservation utility and the wage rate the union sets in equilibrium. Since workers' outside option (i.e. unemployment status) improves, firms need to pay a higher wage rate to induce people to work. Similarly, in a competitive labor market, an increase in transfers for leisure discourages labor supply and puts pressure on the equilibrium wage rate. Alternatively, transfers

received for leisure can be seen as a tax on labor income. The only reason to keep tr separate from τ_N is that doing so allows us to measure the effect of the two policy instruments on the economy separately. As will be clearer in section 4, the quantitative effects depend also on the initial value of the fiscal policy parameters, and tr and τ_N in the OECD countries are substantially different.

Maximizing (1) subject to constraints (2), (3), and (4) and simplifying and rearranging terms, we obtain the household's intratemporal and intertemporal efficiency conditions governing his labor supply and investment (equations (5) and (6) respectively), and the relation between the rate of returns on public bonds and on capital (equation (7)).[9]

$$\varphi c_t = (1 - N_t)(w_t(1 - \tau_{Nt}) - tr_t) \tag{5}$$

$$c_t^{-\sigma}(1 - N_t)^{\varphi(1-\sigma)} = \beta c_{t+1}^{-\sigma} x^{-\sigma}(1 - N_{t+1})^{\varphi(1-\sigma)}(1 + (1 - \tau_{kt+1})r_{t+1} - \delta) \tag{6}$$

$$r_{t+1}^b = (1 - \tau_{kt+1})r_{t+1} - \delta \tag{7}$$

2.1.2 The firms

Firms are identical and perfectly competitive. They produce a homogeneous consumption good with capital and labor, taking prices as given. The production function is Cobb-Douglas:

$$y_t = k_t^a N_{pt}^{1-a}(SG)_t^\theta \tag{8}$$

where y represents output, k the capital stock, N_p the number of hours of work employed in the private sector, and a the capital share. SG are publicly produced services that affect the productivity of capital and labor.[10]

The representative firm employs labor and capital according to the marginal productivity rule.

$$(1 - a)\frac{y_t}{N_{pt}} = w_t \tag{9}$$

$$a\frac{y_t}{k_t} = r_t \tag{10}$$

2.1.3 The government

The government hires labor to produce services SG, with one unit of labor input per unit of output. Hence the number of hours employed, N_g, is equal to the services produced.

The government also purchases final goods g from the private sector and pays a transfer tr proportional to leisure and a lump-sum transfer ls. Public spending is financed by the revenue from labor and capital taxes and by issuing debt, b. Equation (11) describes the government budget constraint.

$$b_{t+1}x = b_t(1 + r_t^b) + w_t N_{gt} + (1 - N_t)tr_t + g_t - \tau_{Nt} w_t N_t - \tau_{kt} r_t k_t + ls_t \tag{11}$$

Government spending and tax rates are chosen exogenously . In each period, the government fixes the tax rates τ_N and τ_k and purchases final goods as a share of output $\overline{g}$, public employment as a share of available time $\overline{N_g}$, and transfers as a share of the wage rate, $\overline{tr}$.[11] Hence

$$g_t = \overline{g_t} y_t \tag{12}$$

$$N_{gt} = \overline{N_{gt}} \tag{13}$$

$$tr_t = \overline{tr}_t w_t \tag{14}$$

Given equations (12) - (14) and the tax rates τ_N and τ_k, the government issues new debt to satisfy its budget constraint, given by equation (11). The government also faces a no-Ponzi game constraint, $\lim_{T\to\infty} (\Pi_{t=0}^{T}(1 + r_t^b))b_T = 0$, which implies that the present value of government expenditures equals the present value of tax revenues plus the initial stock of public debt. Lump-sum transfers ls are set so that the government budget constraint is intertemporally balanced.[12]

Finally, in each period, equation (15) holds.[13]

$$y_t = c_t + i_t + g_t \tag{15}$$

2.2 Transitional dynamics

The competitive equilibrium for the economy described in section 2.1 is defined as a sequence of endogenous quantity and price variables $\{b_{t+1}, k_{t+1}, c_t, N_{pt}, N_t\ y_t, i_t, r_t, w_t, r_t^b\}$ that solve the first order conditions for the household's and firm's problems (equations (5) -(7), and (9)-(10) respectively) and equations (2)-(4), (8), (11)–(15), given the sequence of the exogenous variables $\{\tau_{Nt}, \tau_{kt}, \overline{g_t}, \overline{N_{gt}}, \overline{tr}_t, ls_t\}$, and the initial values of the predetermined ones $\{b_t, k_t\}$.

Numerical solutions of changes in any exogenous fiscal policy variable involve the computation of the long-run, balanced-growth path equilibria before and after the change occurs, and of the transitional dynamics between the two steady-state equilibria. Simplifying equations (5) - (15), we can compute the temporal equilibrium conditions using the following set of relations:[14]

$$\varphi c_t = (1 - N_{pt} - \overline{N}_{gt})(1-a)(k_t^a {N_{pt}}^{-a} \overline{N}_{gt}^{\theta})(1 - \tau_{Nt} - \overline{tr}_t) \tag{16}$$

$$\begin{aligned} c_t^{-\sigma}(1 - N_{pt} - \overline{N}_{gt})^{\varphi(1-\sigma)} &= \beta c_{t+1}^{-\sigma} x^{-\sigma}(1 - N_{pt+1} - \overline{N}_{gt+1})^{\varphi(1-\sigma)}(1 + ((1 - \tau_{kt+1}) \\ &\quad (a k_{t+1}^{a-1} {N_{pt+1}}^{1-a} \overline{N}_{gt+1}^{\theta})) - \delta) \end{aligned} \tag{17}$$

$$k_t^a {N_{pt}}^{1-a} \overline{N}_{gt}^{\theta} = c_t + k_{t+1} x - (1-\delta) k_t + \overline{g}_t k_t^a {N_{pt}}^{1-a} \overline{N}_{gt}^{\theta} \tag{18}$$

$$\begin{aligned} b_{t+1} x &= b_t(1 + ((1 - \tau_{kt})(a k_t^{a-1} {N_{pt}}^{1-a} \overline{N}_{gt}^{\theta})) - \delta) \\ &\quad + (\overline{N}_{gt} + (1 - N_{pt} - \overline{N}_{gt})\overline{tr}_t - \tau_{Nt}(N_{pt} + \overline{N}_{gt}))(1-a)(k_t^a {N_{pt}}^{-a} \overline{N}_{gt}^{\theta}) \\ &\quad - \tau_{kt}(a k_t^{a-1} {N_{pt}}^{1-a} \overline{N}_{gt}^{\theta}) k_t + \overline{g_t} k_t^a {N_{pt}}^{1-a} \overline{N}_{gt}^{\theta} + ls_t \end{aligned} \tag{19}$$

Equations (16) - (19) define a system of stationary non-linear difference equations that describe the dynamic behavior of the economy. The paths for employment in the private sector, consumption, and capital can be determined independently of b. The system of equations (16) - (18) is loglinearized

around the steady-state, and the solution for the endogenous variables is computed applying the method of Blanchard and Kahn (1980).[15] Equation (19), then, is used to compute the time path for b given its initial value. All other endogenous variables are computed using equations (2), (4), and (7) - (10).

2.3 Steady-state

Equations (20)-(27) define the steady-state equilibrium for this economy. Equation (6) shows that the rate of return on capital, and hence on public debt, is a constant along the balanced growth path.

$$r^* = \frac{1}{(1-\tau_K^*)}(\frac{x^\sigma}{\beta} - 1 + \delta) \tag{20}$$

This result can be replaced in (10) to obtain the constant output-to-capital ratio.

$$\frac{y^*}{k^*} = \frac{r^*}{a} \tag{21}$$

The capital accumulation equation (4) can be used to determine the constant investment-to-output ratio,

$$\frac{i^*}{y^*} = (x + \delta - 1)(\frac{y^*}{k^*})^{-1} \tag{22}$$

and (15) determines the consumption-to-output ratio.

$$\frac{c^*}{y^*} = 1 - \frac{i^*}{y^*} - \overline{g}^* \tag{23}$$

Equations (8) and (16) define the steady-state level of hours of labor employed in the private sector.

$$N_p^* = \frac{(1-\overline{N_g}^*)(1-a)(1-\tau_N^* - \overline{tr}^*)}{\varphi\frac{c^*}{y^*} + (1-a)(1-\tau_N^* - \overline{tr}^*)} \tag{24}$$

Finally, the steady-state relation between public expenditures, tax revenues, and public debt is described by:

$$\begin{aligned} \frac{b^*}{y^*}(x - (1-\tau_k^*)r - 1 + \delta) \;=\; & (1-a)N_p^{-1}(\overline{N_g}^* + (1 - N_p^* - \overline{N_g}^*)\overline{tr}^* \\ & -\tau_N^*(N_p^* + \overline{N_g}^*)) - \tau_k^* r^* \frac{k^*}{y^*} + \overline{g}^* + \frac{ls^*}{y^*} \end{aligned} \tag{25}$$

and equation (8) defines the steady-state capital stock, and output.

$$k^* = (\frac{y^*}{k^*})^{\frac{1}{a-1}} N_p^* \tag{26}$$

$$y^* = k^{*a} N_p^{*1-a} \overline{N_g}^{*\theta} \tag{27}$$

2.4 Welfare cost calculation

To compute the welfare cost of a particular policy, the paper follows Ohanian (1997) and calculates the additional level of consumption to give households so that their utility obtained with the policy change equals that in the pre-policy change case. More specifically, the paper finds the value of ξ that satisfies the following equation:

$$\sum_{t=0}^{J} \beta^t \left\{ \frac{((c_t^*(1+\xi))L_t^{*\varphi})^{1-\sigma}}{1-\sigma} - \overline{U}_0 \right\} = 0 \tag{28}$$

where $\overline{U}_0$ is defined as the utility level in the pre-change scenario: $\overline{U}_0 = \frac{(c_0 L_0^{\varphi})^{1-\sigma}}{1-\sigma}$, c_t^*, L_t^* are allocations at the time and after the policy change, and $J = 500$.

2.5 Calibration

The parameter values used to calibrate the model at a yearly frequency are shown in Table 1.

The calibration of the values for the technology and preferences' parameters follows the literature and sets $\alpha = 1/3$, $\delta = 0.1$, $\beta = 0.98$, $\sigma = 2$, and $\varphi = 2.675$. The remaining parameters are average data of ten European countries (Belgium, Finland, France, Germany, Italy, the Netherlands, Norway, Spain, Sweden, United Kingdom) in the period 1965-1995. Tax rates on labor and capital income are from Daveri and Tabellini (2000) and Daveri and Maffezzoli (1999) who provide an update of the series by Mendoza et al. (1994). The other data are from the OECD Economic Outlook n.62.

In the benchmark model, the tax rate on labor income, τ_N, is set to 36.67%, and that on capital income, τ_k, to 32.09%. $\overline{tr}$ is computed as the ratio of transfers to the compensation received by workers of the private sector and is equal to 25.17%. Government purchases of final goods as a share of GPD,

$\overline{g}$, is set 5.70%. Hours employed in the public sector, $\overline{N}_g$, are set equal to 16.76%, which is the value of public employment as a share of the labor force in the data.[16] In the initial steady-state, lump-sum transfers are set so that the initial value of the debt-to-GDP ratio is equal to 50.36%, the average value of the ten European countries between 1965 and 1995. Lump-sum transfers are then adjusted to ensure that the no-Ponzi game condition is satisfied.[17] The average real per-capita growth rate of output is set to 2.41%. Finally, we need to calibrate θ, the parameter that measures the productivity of public employment in the production of private goods. To my knowledge, there are no papers that calibrate the productivity of public workers. In the benchmark model, this paper assumes that public employment is not productive, and hence θ is equal to zero.

Section 4 checks the robustness of the results to most of the calibrated parameters of the model.

Table 1 also summarizes the steady-state values of employment, capital, investment, and consumption as a share of output. The variables generated by the model imply that, on average from 1965-1995, the capital-to-output ratio is equal to 1.33, investment as a share of GDP is 0.17, and consumption as a share of GDP is 0.78. In the data, the average capital-to-output ratio across European countries over the period 1965-1995 is 2.03, private investment as a share of GDP is 0.18, public investment as a share of GDP is 0.03, private consumption, net export, and government consumption are 0.58, 0.0014, and 0.19 respectively.[18] Thus the model implies a lower capital-to-output ratio, but it fits well the data of private investment and private consumption, both as a share of GDP. In fact, in the model, the ratio of consumption-to-GDP is the residual component of the national income identity being public investment, net export and government consumption net of $\overline{g}$ zero.

3 Policy experiments

This paper simulates a permanent, unanticipated, debt-financed change of each of the exogenous fiscal policy variables, keeping the others fixed at their initial steady-state level.[19]

3.1 Qualitative effects

Before presenting results of the numerical simulations, this section discusses briefly the principal channels through which fiscal policy instruments influence the economy in the model described in section 2.

3.1.1 Increase in $\overline{g}$

A 1% increase in public spending on final goods reduces resources available to the private sector and generates a negative wealth effect, which leads to a decrease in consumption and an increase in the supply of hours of work, assuming that consumption and leisure are both normal goods. Employment in the private sector, output, and investment increase on impact. Given that the level of the capital stock is fixed at the time of the policy change, the capital-labor ratio decreases, leading to a lower wage rate and higher rate of return on capital. Over time, the capital stock increases, driving the capital-labor ratio up. In the new long-run balanced growth equilibrium, the capital-labor ratio, hence w and r, is back to its initial value. Output, employment, and the capital stock are higher than in the pre-policy change equilibrium. The welfare costs due to a 1% increase in $\overline{g}$ are positive. In fact, consumption and leisure are lower than in the pre-policy change case, both during the transition and in the new steady-state equilibrium.

3.1.2 Increase in $\overline{N}_g$

A 1% increase in public employment reduces the wealth of the representative household. As in the case of an increase in $\overline{g}$, consumption and leisure decrease. However, the increase of the supply of hours of work matches only partially the increase in $\overline{N_g}$. There is also a shift of labor out of the private and into the public sector, and employment in the private sector decreases on impact. Given that the level of the capital stock is fixed at the time of the policy change, the capital-labor ratio increases, leading to a higher wage rate and lower rate of return on capital. Output in the first period of the transition is lower than its value in the initial steady-state, and investment decreases too.[20] As investment goes down, the capital stock decreases, further reducing output. But, as capital decreases, its rate of return

goes up. In the new steady-state, w and r are back to their initial values. Output, employment, and the capital stock are lower than in the pre-policy change equilibrium. The policy change generates positive welfare costs, because consumption and leisure decrease during the transition, and, in the final steady-state, will be lower than in the initial one. These conclusions can be reversed if one allows public employment to have a positive effect on the productivity of capital and labor in the production of private goods. In this case, even if employment in the private sector decreases, output increases and the economy expands.

3.1.3 Increase in τ_N or in $\overline{tr}$

A debt finance increase in either τ_N or $\overline{tr}$ has the same effect in this model. As discussed in section 2, the transfer for leisure is equivalent to a tax on labor income. Consider a 1% increase in τ_N. As is well known in the literature, income and substitution effects work in opposite directions: the first leads to a decrease in leisure, the second generates an increase in L. The response of the supply of hours of work and the equilibrium of the economy depend on the relative strength of the two effects. If the substitution effect dominates, leisure increases, and employment in the private sector decreases. A 1% increase in τ_N generates negative consequences for the economy similar to those due to an increase in non-productive $\overline{N}_g$. The welfare costs of the two policy experiments are, however, different. Both consumption and leisure decrease in the latter policy experiment, causing positive welfare costs. To the contrary, they move in opposite directions when taxes on labor income are increased. Hence welfare costs cannot be determined without simulating the model.

3.1.4 Increase in τ_k

A 1% increase in τ_k reduces the net-of-tax-marginal product of capital, discouraging saving. Consumption increases at the time of the policy change, driving up households' demand of leisure hours. Employment in the private sector, output, and investment decrease on impact. Over time, as the capital stock falls, its marginal product increases, saving becomes more attractive, consumption decreases, and the contractionary effect that the increase in τ_k has initially on employment, output, and investment is reduced. As equation (20) shows, in the new long-run balanced-growth equilibrium, r

is higher than its initial value. Capital, output, and employment will be lower than in the pre-policy change equilibrium.

3.2 Numerical solutions

Table 2 summarizes the effects on the macroeconomy and on public finance and the welfare costs of a 1% increase in each fiscal policy instrument. The model is simulated for 500 periods. Data are given as percentage deviations from the pre-policy change balanced-growth equilibrium. Impact effects correspond to changes at the time of the increase in the fiscal policy item. Long-run effects measure deviations between the post and pre-policy change balanced-growth equilibria.[21]

Capital, employment in the private sector, and output decrease on impact and in the long-run in response to increases in any fiscal instrument, except public spending on final goods. For example, a 1% increase in $\overline{N}_g$ leads to a decrease in N_p by 0.22% and in y by 0.14% at the time of the policy change. In the steady-state, y, k, and N_p decrease by 0.20%. A 1% increase in transfers for leisure and taxes on labor income have larger negative effects on the economy. In fact, a 1% increase in τ_N reduces on impact output and employment in the private sector by 0.62% and by 0.92% respectively, and reduces both variables by 0.86% in the steady-state. A 1% increase in the tax rate on capital income has a smoother effect. At the time of the policy change, output decreases by 0.10% and, in the new steady-state, it is 0.33% lower than in the initial one. The long-run effect of a 1% increase in τ_k on the capital stock is -0.80%.

Even though these numbers are small, the magnitude of the changes becomes more interesting when we consider that public employment increased by 44%, transfers by 84%, tax rates on labor income by 55%, and tax rates on capital income by 46% in the period under consideration. These numbers are also higher than (but not inconsistent with) those in Daveri and Maffezzoli (1999). They simulate the long-run effect of changes in tax rates on capital and labor, and changes in unemployment benefits on employment and growth in a model with labor market imperfections and endogenous growth. They find, for example, that increasing the labor tax by one percentage point, from 39% to 40%, reduces employment by 0.5%.

Let us consider, now, how changes to fiscal policy affect consumption and leisure. Private consumption decreases in response to each policy change. The only exception is when tax rates on capital income are increased: private consumption increases by 0.07% on impact. Hours of leisure decrease when $\overline{g}$ and $\overline{N}_g$ increase, owing to the negative wealth effect generated by these policy measures. On the contrary, leisure increases in the other cases, suggesting that the substitution effect dominates in the benchmark model.

Welfare costs are highest when $\overline{N}_g$ increases. In this case, to compensate households for the change in fiscal policy, consumption should increase permanently by 0.69%. Consumers would, instead, require a permanent increase in consumption by 0.03%, 0.33%, 0.48%, and 0.11% when $\overline{g}$, $\overline{tr}$, τ_N, τ_k are changed.

The bottom part of Table 2 shows the effect of fiscal policy on the primary deficit and public debt. Note that increases in tax rates on labor and capital income do not immediately cause a decrease in the primary deficit. The recession induced by the policy change leads to an increase in government spending and to a reduction in revenue both of which counterbalance the increase in tax rates. The primary balance starts improving two years after the increase in τ_k, and six years after the increase in τ_N. Public debt increases initially, and, after ten years, it is still higher than it was before the increase in tax rates.

Figures 1 and 2 plot the transitional dynamics induced by a 1% increase in $\overline{g}$ and $\overline{N}_g$, respectively, for the first 15 periods after the policy change. The dynamics of the capital stock, employment in the private sector, output, real interest rate, wage rate, consumption, and leisure are consistent with the discussion in section 3.1.1 and 3.1.2. The figures clearly show that changes in the two spending items have very different effects on the economy, not only along the balanced growth path equilibria, as suggested by Finn (1998), but also during the transition between the pre-policy and post-policy change equilibria. Therefore, it is extremely important to analyze changes in these two spending items separately, to determine the macroeconomic effects of a fiscal maneuver.

Figure 3 plots the effects on output, employment in the private sector, household's utility, and primary deficit of a fiscal contraction achieved through a 1% decrease in $\overline{g}$, $\overline{N}_g$, or $\overline{tr}$, or through a

1% increase in τ_N or τ_k. Consistent with the results of the empirical literature on fiscal adjustments, the composition of the stabilization matters for its outcome. A cut in public employment or transfers generates a boom in economic activity, increases households' utility, and achieves an improvement in the fiscal balance. A 1% decrease in government purchases of final goods has only minor effects on the economy. Fiscal adjustments achieved increasing taxation lead to a contraction in economic activity, and the decrease in the primary deficit is lower than the one from a decrease in $\overline{N}_g$, or $\overline{tr}$.

4 Sensitivity analysis

This section presents a sensitivity analysis to check whether the results hinge on particular values of the parameters chosen to calibrate the model. As discussed above, the model is simulated under the following scenarios. First, we consider the case in which fiscal policy variables are all set at their minimum and maximum values. Second, the model is calibrated using different values for the parameter φ to analyze how results depend on the elasticity of labor supply. Third, $\overline{N}_g$ is set as in Finn (1998). Finally, the coefficient measuring the productivity of public employment in the production of private goods ϑ is varied between 0 and 1. Fiscal policy experiments are the same as in section 3.

The qualitative nature of the results does not change when either the minimum or the maximum values of the fiscal policy variables are used to calibrate the model. The absolute value of the changes varies. It increases in the level of the fiscal policy variables. At a higher level of government purchases of final goods, public employment, transfers, tax rates on labor and capital income, a 1% increase in any of the budget items has a greater effect on employment, capital, output, and consumption. Hence, ceteris paribus, the effect on the economy of any fiscal reform implemented in 1995 is larger than that which the same reform would have had were it implemented in 1965.

Similarly, the effect of fiscal policy is to increase in the elasticity of the labor supply. As equation (5) shows, the elasticity of the labor supply is positively related to the parameter φ. In Gertler (1999) φ is equal to 1.5, a lower value than the one in Mendoza and Tesar (1998), which I used to calibrate the benchmark model. Setting φ equal to 1.5 smoothes the response of the economy to changes in fiscal policy, especially to changes in tax rates on labor income and transfers for leisure. For example,

if labor taxes increase by 1%, output decreases by 0.56% on impact and by 0.80% in steady-state. In the benchmark model, output decreases by 0.62% at the time of the policy change, and by 0.86% in the long-run. Setting φ to the value in Finn (1998) (i.e.: φ=3.35) has the opposite effect. Clearly, if φ is equal to zero, and hence the individual labor supply is perfectly inelastic, changes in tax rates on labor income and in transfers for leisure have no effect on the economy, which remains at its initial steady-state level. Changes in $\overline{N_g}$, and τ_K still influence the macroeconomy; however, the effects are much smaller than in the benchmark model.

Results related to the change in labor hired by the government also depend on the initial value of $\overline{N_g}$. Calibrating it with the value in Finn (1998) (i.e.: $\overline{N_g}$=0.0305) sharply reduces the effects on output, employment, capital, and consumption. In fact, a 1% increase in the ratio of hours employed in the public sector reduces output at the time of the policy change by 0.14% in the benchmark model, and by 0.02% using the value in Finn (1998). In the new steady-state, output is lower than in the initial one by 0.20% in the benchmark model, and by 0.03% if $\overline{N_g}$ is equal to 0.0305.

Changing the parameter θ has effects on the percentage of that capital, employment, output, and consumption deviate from the initial steady-state value only when public employment changes. As expected, the reduction of output is smaller if public employment contributes to the productivity of private employment and capital. What it is interesting is that, for certain values of the parameters, the policy experiment leads to the opposite result than the one described in section 3. Ceteris paribus, one still gets a negative effect on the economy when $\overline{N_g}$ increases if θ is smaller or equal to 1/9. For θ greater than 1/9, a 1% increase in $\overline{N_g}$ leads to an increase in output, capital, employment, and consumption. When θ is equal to 1, output increases by 0.9% on impact, and in the new steady-state it is 1.29% higher than in the initial one. Figure 4 shows the response of output, employment in the private sector, utility, and primary deficit to a 1% increase in $\overline{N_g}$, using different values for ϑ and φ. Note that households' utility decreases relative to his value before the increase in $\overline{N_g}$ except for $\theta = 1$. When $\theta = 1/3$, for example, the increase in consumption (not shown) is not enough to compensate the household for the decrease in hours of leisure due to the increase in hours of work hired by the public sector. The fiscal policy change has positive welfare costs even if it leads to higher economic

activity.

5 Conclusions

This paper studies the effects of fiscal policy in a dynamic equilibrium model with competitive labor markets. It shows that, unlike an increase in government purchases of final goods, an increase in public employment can have a negative effect on the economy even when the increase is financed by lump-sum taxes. Similarly, the economy contracts in response to increases in transfers and labor and capital tax rates. The paper also suggests that fiscal adjustments implemented by cutting spending items are more effective in reducing the primary deficit and public debt than are increases in tax rates. They also have a positive effect on households' utility both during the transition and in the long-run. However, these conclusions depend on the elasticity of the labor supply, on the initial values of the fiscal policy parameters, and on the assumption about the productivity of public employment. For certain values of the parameters, public employment is positively correlated with economic activity, when it enhances the productivity of private employment and capital. Hence, under certain circumstances, an increase in public employment benefits the economy.

There are several lines of research that this paper leaves open. First, it would be interesting to study if the conclusions of the paper change if we give up the assumption of perfect competitive labor markets. A unionized labor market that generates a positive unemployment rate in equilibrium seems more realistic and consistent with the evidence from the European countries. Second, the model can be extended to an open economy framework. This would enable us to study the effects fiscal policy on the economy through its impact on firms' competitiveness, following the analysis by Alesina and Perotti (1997b). Third, this paper considers only the effect of changes in five fiscal policy variables. It is certainly possible to study changes in other items of the government budget. Finally, the model can be used to perform some budget balance experiments to simulate the effects that fiscal policy will have in countries that joined the EMU, which, according to the Stability Pact, are required to achieve and maintain a balanced budget.

1. The author thanks Alberto Alesina, Tiziana Brancaccio, Peter Ireland, Tommaso Monacelli, Richard Neck, Fabio Schiantarelli, three anonymous referees, and participants to seminar at the 15th annual congress of the European Economic Association.

2. See Ardagna (2000b).

3. See, for example, Alesina et al. (1999), Alesina and Ardagna (1998), Ardagna (2000a), McDermott and Wescott (1996). See also , Giavazzi and Pagano (1990) and (1996) for an alternative explanation.

4. See , for example, Lucas (1990), and Mendoza and Tesar (1998) on tax reforms and Baxter and King (1993), and Ludvigson (1996) on the effects of changes in government spending and public investment.

5. See, for example, Baxter and King (1993), Finn (1998), Mendoza and Tesar (1998), and Ohanian (1997) for models that study fiscal policy in similar theoretical frameworks.

6. This assumption restricts the class of functional forms specification for preferences and technology that can be used to obtain balanced growth equilibria. See King et al. (1988).

7. The model's analysis of the effects that various fiscal policy items have on the economy is not exhaustive. For example, the model cannot be used to study the productivity effects of government capital because public spending on investment goods is zero. However, recent literature has highlighted that the response of the economy to fiscal stabilizations depends crucially on changes in government wage consumption, transfers, labor and capital taxation. Moreover, it suggests that government wage consumption, transfers, and labor taxes are crucial because of their influence on the economy through the labor market. Comparisons of effects from changes in g with those from changes in N_g very clearly show the importance of this channel. For these reasons, the paper concentrates on changes in government spending for final goods, and for public employment, transfers, labor, and capital taxation, setting the other items of the budget to zero for simplicity.

8. The model is calibrated using average data of ten European countries. Thus the closed economy assumption seems not too unrealistic in this context. An alternative is to consider the effect of fiscal policy in a two-country model as in Mendoza and Tesar (1998). This would allow us to analyze fiscal policy effects on the external sector, the role of openness in determining the impact of fiscal policy on the domestic economy, and spillover effects of

policy changes between the two countries. These issues are important. However, they do not come at no cost. First, to deal with them, one needs to complicate the model. Second, as Mendoza and Tesar (1998) show, the results become highly dependent on the assumption about fiscal policy in the foreign country.

9. $X_{t+1} = X_t x$ where X is the state of the technology, and x its gross rate of growth.

10. The effect of a change in government services SG on the productivity of private factors is the same as the one of a change in government spending in Barro (1990). However, the general equilibrium effects are different. In fact, this paper assumes that government services SG are produced by public employees, and this also imposes an additional constraint on the equilibrium level of employment in the private sector. See section 3.1 for a more detailed explanation.

11. One could also assume that the government chooses the number of hours of work and transfers in absolute terms. However, this choice would make the calibration of the model more cumbersome.

12. Because public debt is "ricardian", setting lump sum transfers so that the no-Ponzi game condition is satisfied affects only public debt's time path. Also, in most cases, alternative assumptions about the timing of changes in lump sum transfers influence only the magnitude of the response of public debt, but not the sign. Mendoza and Tesar (1998), and Ohanian (1997) allow distorsive taxes to change endogenously to satisfy the intertemporal government budget constraint. In this case, the solution of all the endogenous variables of the economy depends on which approach is used to ensure that the no-Ponzi game condition is satisfied. See also sections 2.1 and 2.5.

13. Note that government spending for public employees does not enter the economy's resource constraint directly, and does not appear on the rhs of equation (15). This spending item is not part of the public sector demand. But it influences production y from equation (8) because public employees produce services SG. It also affects consumption and leisure choices, because the household receives wN_g for the hours worked in the public sector.

14. Ardagna (2000b) presents the full set of temporal conditions.

15. Blanchard and Kahn (1980) give the explicit solution for linear difference models under rational expectations. Loglinearizing equations (16) - (18) around the steady-state, solving the loglinearized version of equation (16) for N_p, and substituting it into the loglinearized versions of (17) and (18), one obtains a system of two equations

in two unknowns: consumption c, and capital k. c is a jump variable and k is a predetermined variable. The formula on page 1308 is used to calculate their time path.

16. The OECD Economic Outlook does not provide data for hours worked in the public sector. Using public employment as a share of the labor force to calibrate $\overline{N}_g$, one assumes that there is the same proportion between bodies and hours employed in the two sectors.

17. Lump sum transfers from $t = 1, ...J$ are set to satisfy the following equation:

$$\{b_0(1+r_0^b) + w_0 N_{g0} + (1-N_0)tr_0 + g_0 - \tau_{N0} w_0 N_0 - \tau_{k0} r_0 k_0 + ls_0\}$$
$$+ \sum_{t=1}^{J-1} \{w_t N_{gt} + (1-N_t)tr_t + g_t - \tau_{Nt} w_t N_t - \tau_{kt} r_t k_t + ls_t\} \left\{ x^t (\prod_{s=1}^{t} (1+r_s)^{-1} \right\} = 0$$

Variables at $t = 0$ assume the value in the pre-policy change balanced-growth equilibrium.

18. 0.19 includes the ratio of government non-wage spending-to-GDP, ($\overline{g}$ in the model), which is equal to 0.057 in the data.

19. Note that, because public debt is "ricardian" in this model, a debt financed change of the exogenous fiscal policy instruments affects the macroeconomy in the same way as a lump-sum tax financed policy change.

20. If consumption decreased more than output, investment would increase. However, as section 3.2 shows, for reasonable parameters values, the fall in N_p and y dominates and investment falls.

21. For $Debt$ and $Debt/y$, the long-run effect shows the percentage deviation of the two variables relative to the pre-policy change equilibrium ten years after the policy change occurred. Because the no-Ponzi game condition is satisfied, in the last period for which the economy is simulated $(J = 500)$, public debt is zero, and hence the percentage deviation of $Debt$ and $Debt/y$ in the post-change equilibrium relative to the pre-change equilibrium is -100%.

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Table 1: Calibration

Preferences parameters			Technology parameters		
β	σ	φ	α	θ	δ
0.98	2	2.675	1/3	0	0.1

Macroeconomic and fiscal policy variables

	1965-1970	*1971-1975*	*1976-1980*	*1981-1985*	*1986-1990*	*1991-1995*	*Average*
Real per capita growth rate	3.94	2.79	2.58	1.47	2.69	0.64	2.41
Effective tax rates on labor income	27.42	32.67	36.69	39.12	41.5	42.6	36.67
Effective tax rates on capital income	23.79	27.44	33.67	35.95	36.88	34.8	32.09
Replacement rate	17.42	21.5	24.64	26.94	28.51	32.15	25.17
Public employment/labor force	12.99	15.15	17.13	18.25	18.82	18.71	16.76
Gov. non-wage consumption/GDP	4.83	5.26	5.71	5.93	6.08	6.57	5.70
Debt/GDP	41.25	37.45	39.51	52.5	59.04	70.54	50.36

Steady state variables

	1965-1970	*1971-1975*	*1976-1980*	*1981-1985*	*1986-1990*	*1991-1995*	*Average*
K/Y	1.25	1.36	1.27	1.42	1.19	1.63	1.33
I/Y	0.17	0.17	0.16	0.16	0.15	0.17	0.17
C/Y	0.83	0.83	0.84	0.84	0.85	0.83	0.83
Np	0.12	0.10	0.09	0.08	0.07	0.06	0.08

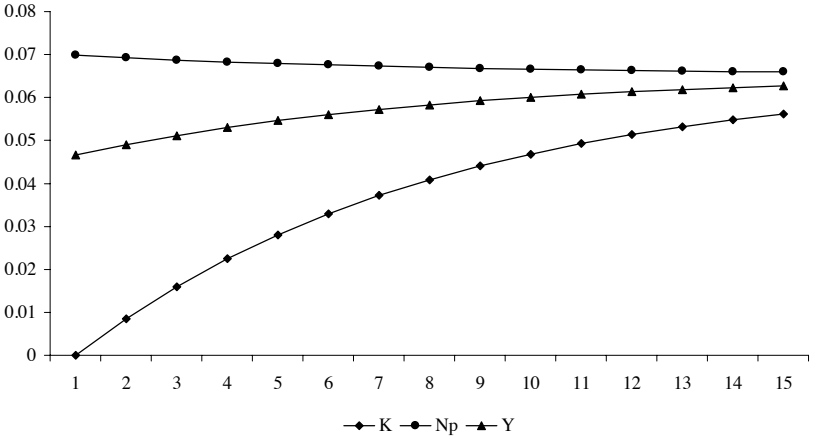
Countries in the sample: Belgium, Finland, France, Germany, Italy, Netherlands, Norway, Spain, Sweden, UK

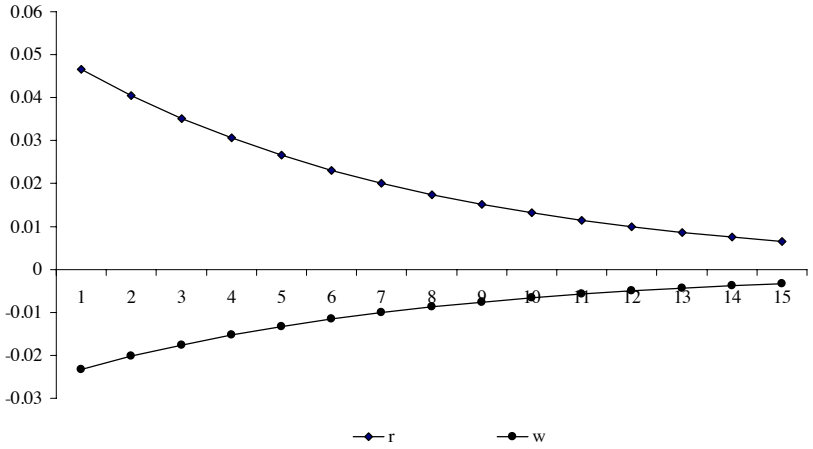
Table 2: Effects of 1% increase in fiscal policy items

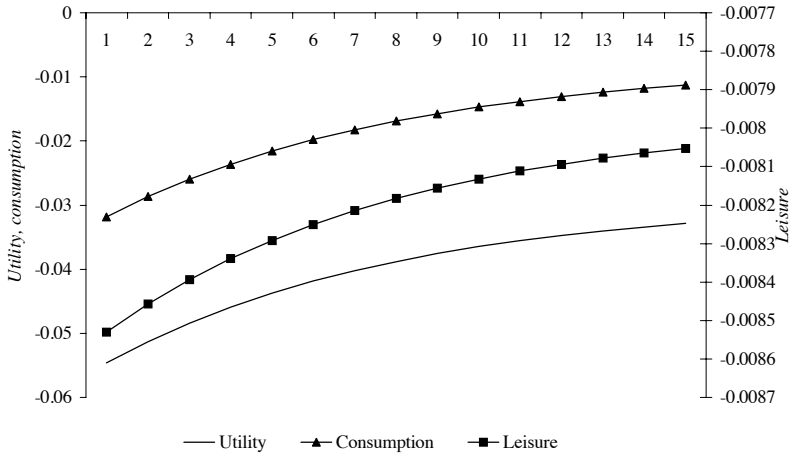
	Percentage deviation from pre-change balance growth path equilibrium									
	Impact effect	Long-run effect	Impact effect	Long-run effect	Impact effect	Long-run effect	Impact effect	Long-run effect	Impact effect	Long-run effect
	$\boxed{\Delta\bar{g}}$		$\boxed{\Delta\bar{N}_g}$		$\boxed{\Delta\bar{tr}}$		$\boxed{\Delta\tau_N}$		$\boxed{\Delta\tau_k}$	
Effect on macroeconomic variables										
y	0.05	0.07	-0.14	-0.20	-0.42	-0.59	-0.62	-0.86	-0.10	-0.33
k	0	0.07	0	-0.20	0	-0.59	0	-0.86	0	-0.80
Np	0.07	0.07	-0.22	-0.20	-0.63	-0.59	-0.92	-0.86	-0.14	-0.09
r	0.05	0	-0.14	0	-0.42	0	-0.62	0	-0.10	0.47
w	-0.02	0	0.07	0	0.21	0	0.31	0	0.05	-0.24
c	-0.03	-0.01	-0.13	-0.20	-0.38	-0.59	-0.55	-0.86	0.07	-0.23
L	-0.01	-0.01	-0.20	-0.20	0.08	0.07	0.11	0.10	0.02	0.01
Welfare cost	0.03		0.69		0.33		0.48		0.11	
Effect on public finance										
Primary deficit	-0.01	0.01	0.38	0.30	1.11	0.88	0.16	-0.16	0.03	-0.27
Primary deficit/y	-0.06	-0.05	0.52	0.51	1.54	1.48	0.78	0.71	0.12	0.05
Debt	0	-0.96	0	0.38	0	2.35	0	3.66	0	3.34
Debt/y	-0.05	-1.02	0.14	0.57	0.42	2.90	0.62	4.49	0.10	3.61

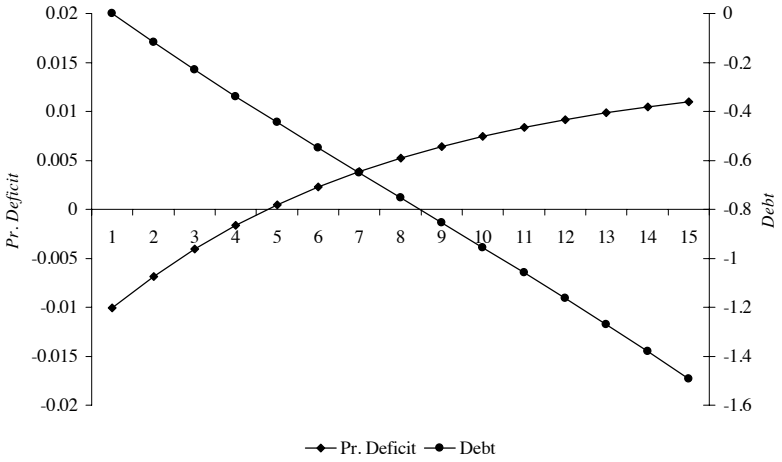
Data are given as percentage deviations from to the pre-policy change balanced-growth equilibrium. Impact effects correspond to changes at the time of the increase in the fiscal policy item. Long-run effects measure deviations between the post and pre-policy change balanced-growth equilibria. For Debt and Debt/y, the long-run effect corresponds to the percentage deviation of the two variables relative to the pre-policy change equilibrium ten years after the policy change occurred.
y = GDP, k = capital stock, Np = work hours in the private sector, r = real interest rate, w = wage rate, c = consumption, L = leisure hours.
The welfare cost of a policy is computed as the percentage change in consumption needed to equate lifetime utility after the policy change to lifetime utility in the pre policy change case.
Primary deficit: a positive change in the primary deficit means that the primary balance deteriorates with respect to its value in the pre-policy change balanced-growth equilibrium.

Figure 1: Effect of 1% increase in government non-wage consumption - benchmark model



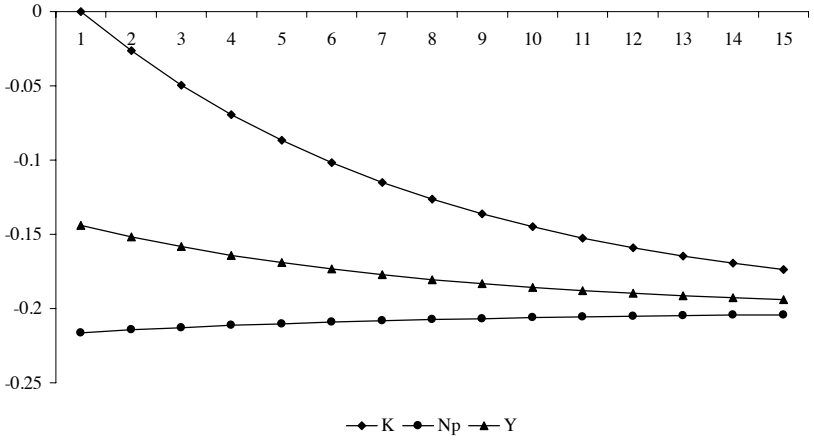


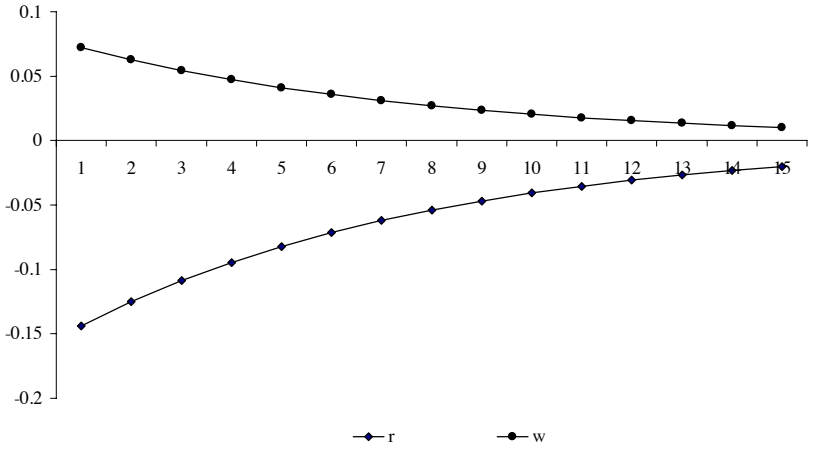


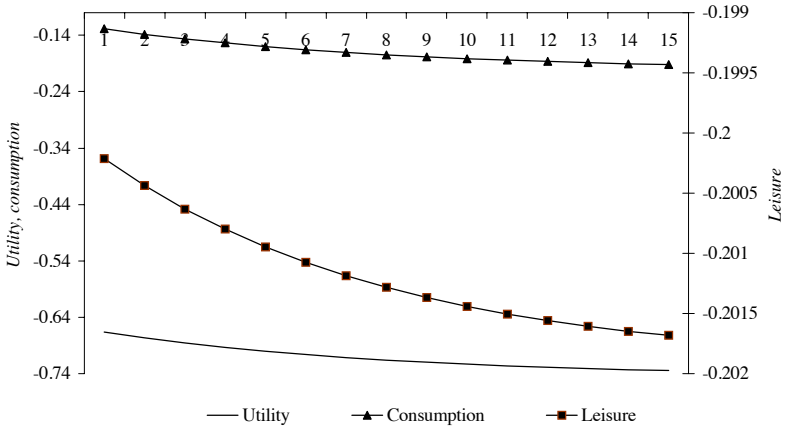


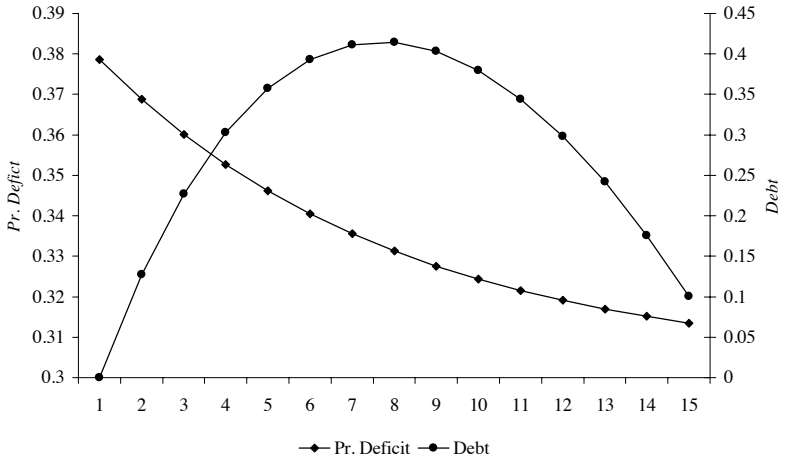
Data plotted are percentage deviation from the pre policy change balanced growth path equilibrium.
Pr. Deficit: a positive change in the primary deficit means that the primary balance deteriorates with respect to its value in the pre-policy change balanced-growth equilibrium

Figure 2: Effect of 1% increase in public employment - benchmark model



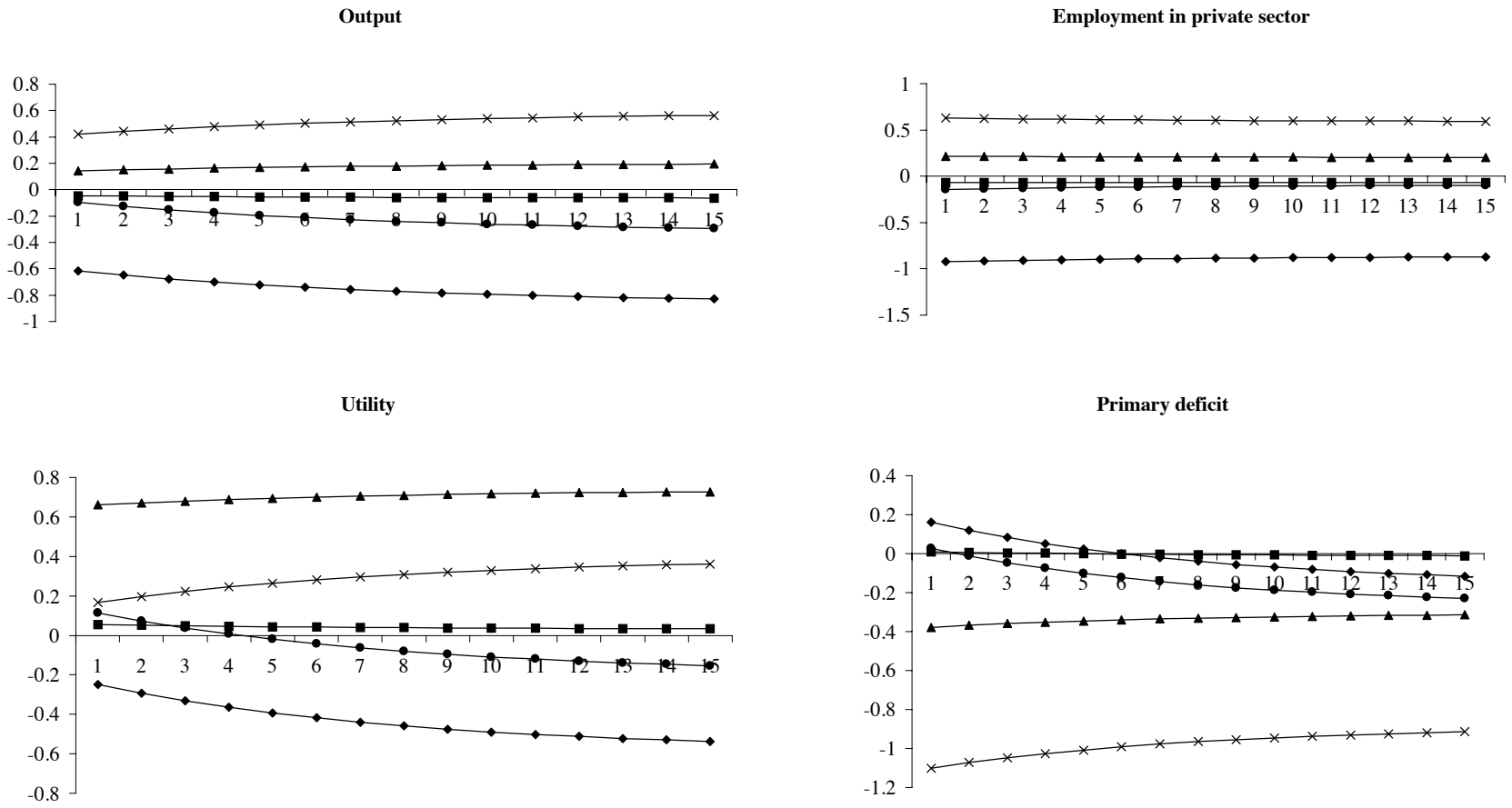






Data plotted are percentage deviation from the pre policy change balanced growth path equilibrium.
Pr. Deficit: a positive change in the primary deficit means that the primary balance deteriorates with respect to its value in the pre-policy change balanced-growth equilibrium.

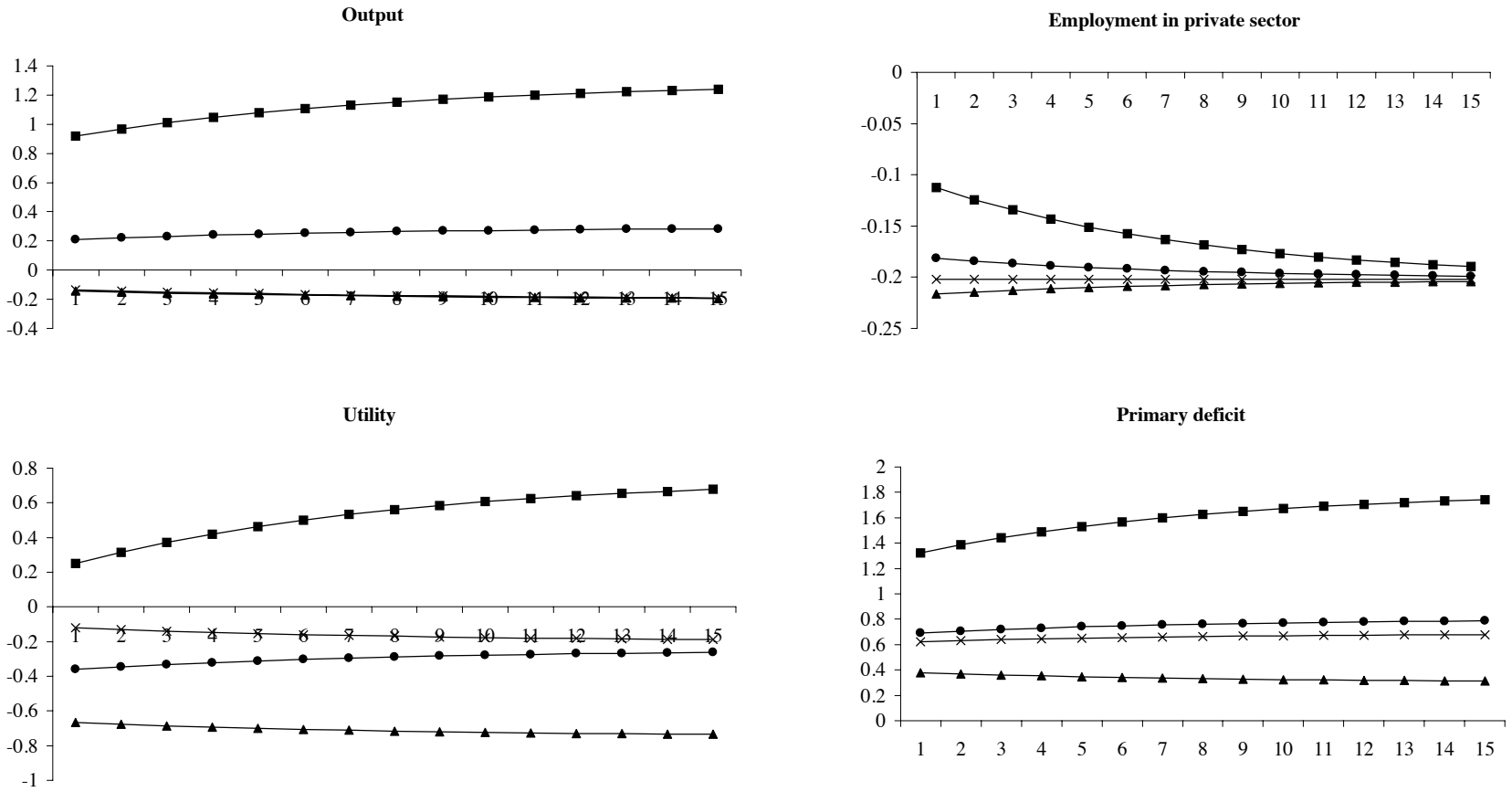
Figure 3: Fiscal contraction - benchmark model



Data plotted are percentage deviation from the pre-policy change balanced growth path equilibrium.
Pr. Deficit: a positive change in the primary deficit means that the primary balance deteriorates with respect to its value in the pre-policy change balanced-growth equilibrium

- ▲ Public employment -1%
- ■ Government non-wage consumption -1%
- ● Capital tax +1%
- ◆ Labor tax +1%
- ✧ Transfers -1%

Figure 4: Effect of 1% increase in public employment - sensitivity analysis



Data plotted are percentage deviation from the pre-policy change balanced growth path equilibrium.
Pr. Deficit: a positive change in the primary deficit means that the primary balance deteriorates with respect to its value in the pre-policy change balanced-growth equilibrium

- ▲ θ=0
- ■ θ=1
- ● θ=1/3
- x φ=0