Can Cuts in Government Spending Be Expansionary?*

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1 Introduction

Can governments cut expenditures without generating a nasty recession? This question has become extremely relevant today, as many EU countries need to reduce the budget deficit but, at the same time, want to implement policies aimed at boosting a stagnating, if not contracting, economy.

While there is no agreement on the sign of fiscal multipliers, most economic models predict that cuts in government spending cannot themselves stimulate economic growth. However, some recent empirical findings point in the opposite direction, suggesting that, under certain circumstances, "expansionary contractions" can occur. Using a panel of OECD countries, Alesina, Favero and Giavazzi (2011) find that cuts in government spending are typically associated with a very mild recession but are sometimes accompanied by an expansion in output. The latter result is not valid for all countries analyzed in the paper but is instead limited to cases in which fiscal plans are not subject to reversals, and where private investments surge right after the cut in public spending. The latter finding suggests that the credibility of fiscal policy is crucial to generate "expansionary contractions", or at least to prevent recessions following government spending cuts.

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In this note we ask a very simple question: under which circumstances, in a model where agents make optimal inter- and infra-temporal decisions, can expansionary contractions occur? To answer this question we limit ourselves to situations in which public spending is pure waste, and the government must balance the budget in each and every period.[1] We consider three different scenarios. First, following Baxter and King (1993), we study the effect of changes in government spending when taxation is non-distortionary. Then, we augment this simple model with distortionary taxation (on both capital and labor).

The simple answer and the bottom line of this note is that expansionary contractions can only occur in two circumstances. First, in the presence of distortionary taxes on capital. Second, when distortionary taxes are levied on labor income, *and* the elasticity of intertemporal substitution (EIS) is high. While the substitution effect generated by the reduction in distortionary taxes on capital is always larger than the wealth effect associated with the reduction in government spending, this is not necessarily true for distortionary taxation on labor income. In fact, an expansionary contraction can be obtained by cutting taxes on wages only when the EIS is "high enough".[2]

Before answering the question above, in the next Section we thus focus on a crucial aspect of neo-classical models: that is, the role of σ.

2 The Role of σ and φ in the Neo-Classical Model

2.1 The Model

Throughout this note, we work with the standard neo-classical framework in which the representative agent solves the following problem:

$$\underset{\{C_t,N_t,K_{t+1}\}}{\text{Max}} \sum_{t=0}^{\infty} \beta^t \left(\frac{C_t^{1-\sigma}}{1-\sigma} - \chi \frac{N_t^{1+\varphi}}{1+\varphi} \right) \tag{1}$$

[1] The case of public spending that raises the productivity of the economy, for instance when public and private capital are complements, is analyzed, among others, in Aschauer (1989).

[2] Below, we will give precise conditions under which this can occur.

s.t.

$$C_t + [K_{t+1} - (1-\delta)K_t] \leq (1-\tau_t^w) W_t N_t + \left(1-\tau_t^k\right) R_t K_t - T_t \tag{2}$$

where C_t is consumption, N_t hours worked, K_t is capital, and τ_t^w, τ_t^k are the distortionary tax rates on labor and on capital income respectively, and T_t is a lump sum tax. Government revenues are given by

$$T_t + W_t N_t \tau_t^w + R_t K_t \tau_t^k \tag{3}$$

We assume that public spending (G_t) is pure waste, and that the government balances the budget in each and every period (it cannot issue debt). That is, in each and every period, the following equation must hold

$$G_t = T_t + W_t N_t \tau_t^w + R_t K_t \tau_t^k \tag{4}$$

2.2 The Role of the Parameters

We now briefly discuss the role of parameters φ and σ, focusing in particular on the latter, which will turn out to be crucial in determining the effects of shifts in government spending, when the latter is financed through distortionary taxes on labor income. The parameter φ is the inverse of the Frisch labor supply elasticity: it measures the elasticity of hours worked to the real wage keeping the marginal utility of wealth constant. For high values of φ, i.e. when the Frisch elasticity $\left(\frac{1}{\varphi}\right)$ is low, labor supply is very inelastic. That is, hours worked do not change much with the real wage. The opposite holds when φ is low (i.e., when Frisch elasticity is high): in this case, households respond substantially to changes in the real wage.

In neo-classical models, σ is the parameter that drives the accumulation path of capital: it is the inverse of the elasticity of inter-temporal substitution of consumption $\left(\frac{1}{\sigma}\right)$.[3] For low values of σ (i.e., when the EIS is high), agents are willing to postpone some consumption to the future if current investment opportunities are "attractive".[4] Importantly, σ also affects the consumption-leisure decision (*infra-temporal* trade-off). This is because, in equilibrium, the marginal rate of substitution

[3] For CARA utility functions, σ can also be interpreted as the coefficient of (constant) relative risk aversion, i.e., $\sigma \equiv -\frac{CU_{CC}}{U_C}$.

[4] What we mean by "low values" will become clearer below.

between consumption and hours worked must be equal to the real wage. Since the marginal utility of consumption depends on σ, the effect of a change in the real wage (e.g., due to a reduction in pay-roll taxes) on hours worked depends not only on φ, but also (and crucially!) on σ.

In the literature, there is no agreement on a value for σ which is usually calibrated between 0.5 and 2. As we show below, if σ is strictly greater than 1, in the presence of distortionary taxes on labor, reductions in government spending are always recessionary. Conversely, if $\sigma \leq 1$ and government spending is financed through distortionary taxes on labor income, expansionary contractions can take place.[5] Interestingly, this result depends crucially on the response of hours worked to shifts in government spending. For $\sigma \leq 1$, following a reduction in (distortionary) taxes on labor income, households are willing to work more (postponing leisure and consumption). Conversely, if $\sigma > 1$, when taxes decline, households work less and enjoy more free time.

Intuitively, when σ is low (i.e. $\frac{1}{\sigma}$ is high), households are willing to postpone consumption if attractive job (and investment) opportunities arise. On the opposite, if σ is high, it is "too costly" for households to postpone consumption, even if work becomes relatively more attractive. Note that σ affects the marginal utility of consumption: *ceteris paribus*, if σ increases (i.e., $\frac{1}{\sigma}$ declines) the marginal utility of consumption rises. Hence, when σ is high,[6] households may not be willing to work more, even if the real wage increases.

While the inter-temporal role played by σ is key, one should not disregard the importance that the latter parameter has in regulating the *infra-temporal* choice between leisure and consumption. When government spending falls, households experience a positive wealth effect that induces them to consume more and work less.[7] However, a reduction in G implies also a reduction in taxes. If taxation is distortionary, households are subject to two different forces that work in opposite

[5] In other two cases we consider below, instead, the value of σ does not matter for the response of the economy to cuts in government speding (G). When G is financed through lump sum taxes, contractions in public spending are always recessionary. Conversely, if G is financed through distortionary taxes on capital, output always increases following a reduction in government spending (and the associated taxes on capital).

[6] When it is strictly greater than 1.

[7] Indeed, in the neo-classical model leisure and consumption are complements: if the latter rises, so does the former. Thus, when consumption increases, hours worked fall.

directions. On the one hand, because of the wealth effect, agents would like to work less and consume more. On the other, the reduction in distortionary taxes increases the opportunity cost of leisure, making labor “more appealing”. In the presence of distortionary taxes on labor income, it turns out that the value of σ determines which of the two effects prevails. If $\sigma > 1$, the wealth effect dominates: households consume more and reduce the hours worked. When $\sigma \leq 1$ the opposite occurs. Finally, as we show below, when G is financed entirely through taxes on capital, the substitution effects always prevails over the wealth effect and so, as government spending falls, output rises.

In the next paragraph, to highlight the importance of the role played by σ in regulating the intra-temporal trade-off, we present a very simple model in which households do not make any inter-temporal decision: in each and every period agents solve the same static problem.[8] In this way, we can isolate the effect that σ has on the intra-temporal choice between labor and consumption.

2.3 Rule of Thumb Consumers

We consider an economy in which all households are liquidity constrained: they cannot borrow or lend and do not hold capital. In each and every period they consume their disposable income, given by their wage (net of taxes) times the hours they work. In this framework, the optimization problem of households becomes static. Firms produce using only labor according to a CRS production function in which, for simplicity, we fix TFP $A = 1$. Finally, the government finances its (pure waste) spending through distortionary taxes on labor income.

2.3.1 Household's Problem

The representative agent solves

$$\max_{\{C_t, N_t\}} \sum_{t=1}^{\infty} \beta^t \left(\frac{C_t^{1-\sigma}}{1-\sigma} - \frac{N_t^{1+\varphi}}{1+\varphi} \right)$$

[8] The original model is used in Galì, Lopez-Salido, Vallez (2007) in a more general framework.

s.t.

$$C_t = N_t W_t (1 - \tau_t) \tag{5}$$

Replacing the budget constraint (5) into the objective function (and noting that the problem is a static one), in each and every period the representative households solves the following problem

$$\max_{N_t} \frac{[N_t W_t (1 - \tau_t)]^{1-\sigma}}{1 - \sigma} - \frac{N_t^{1+\varphi}}{1 + \varphi}$$

The FOCs yield

$$[W_t(1 - \tau_t)]^{1-\sigma} N_t^{-\sigma} - N_t^{\varphi} = 0$$

$\Longrightarrow$

$$N_t = [W_t(1 - \tau_t)]^{\frac{1-\sigma}{\sigma+\varphi}} \tag{6}$$

Then, replacing (6) into the budget constraint, we get

$$C_t = [W_t(1 - \tau_t)]^{\frac{\varphi}{\sigma+\varphi}} \tag{7}$$

2.3.2 Firms and Government

The representative firm solves the static problem:[9]

$$\max Y_t - W_t N_t$$

s.t.

$$Y_t = A_t N_t^{\alpha}$$

If the production function is CRS and we assume that TFP is fixed and equal to 1, we simply get $Y_t = N_t$. In each period the firm hires the optimal amount of K and

[9] In all cases considered in this note, the firm's problem is always static: in period t the optimal amount of capital and labor hired do not depend on the "history" of the economy up to time t. Indeed, there are no adjustment costs (or other similar frictions), that would introduce an additional term in the firm's maximization problem, e.g. $(K - K^*)^2$ or $(N - N^*)^2$.

N given relative prices. The FOCs of the firm's problem trivially give us

$$W_t = 1 \tag{8}$$

The government finances its spending through distortionary taxes and must balance the budget in each and every period:

$$G_t = \tau_t W_t N_t \tag{9}$$

2.3.3 Equilibrium Conditions (FOCs)

We have 5 equations in 5 unknowns: $\{C, N, W, Y, G\}$

$$N_t = [W_t(1-\tau_t)]^{\frac{1-\sigma}{\sigma+\varphi}} \tag{10}$$

$$C_t = [W_t(1-\tau_t)]^{\frac{\varphi}{\sigma+\varphi}} \tag{11}$$

$$W_t = 1 \tag{12}$$

$$Y_t = N_t \tag{13}$$

$$Y_t = G_t + C_t \tag{14}$$

In this super-simple model, using the fact that the real wage is constant and equal to 1 in each and every period, and that $Y_t = N_t$ we have

$$N_t = [(1-\tau_t)]^{\frac{1-\sigma}{\sigma+\varphi}}$$

$$C_t = [(1-\tau_t)]^{\frac{\varphi}{\sigma+\varphi}}$$

$$N_t = G_t + C_t$$

2.3.4 Log-Linearized Model

Let us now consider the log-linearized version of the above model.[10] Below and throughout this note, we use lower-case variables to indicate percentage deviations of each variable from the steady state. We have

$$n_t = -\frac{\tau^{ss}}{(1-\tau^{ss})}\left(\frac{1-\sigma}{\sigma+\varphi}\right)\hat{\tau}_t \tag{15}$$

$$c_t = -\frac{\tau^{ss}}{(1-\tau^{ss})}\left(\frac{\varphi}{\sigma+\varphi}\right)\hat{\tau}_t \tag{16}$$

$$n_t N = C c_t + G g_t \tag{17}$$

Equation (15) above shows clearly that if $\sigma > 1$, a reduction in distortionary taxation has a negative effect on the hours worked and, consequently on output. Indeed,

$$\sigma > 1 \implies (1-\sigma) < 0$$

Hence,

$$\tau_t < 0 \implies n_t < 0$$

That is, as long as $\sigma > 1$, if the government reduces taxation (no matter if it is distortionary or not) households reduce the hours worked. Relating these findings to the discussion conducted in the previous paragraph, when $\sigma > 1$ the wealth effect prevails over the "incentive effect" generated by the reduction in distortionary taxes. The model presented in this Section is extremely useful because it allows us to neatly evaluate the role that σ plays in determining the sign of the fiscal multiplier.

3 Non-Distortionary Taxation

In this Section we drop the liquidity constraints and analyze the effects of a change in government spending (G) on the economy assuming that G is financed through lump sum taxes, and that labor supply is endogenous.[11] The representative agent solves the following problem:

[10] For a useful discussion on log-linearization techiques see Uhlig (1999).

[11] As mentioned above, we assume that public spending is pure waste.

$$\underset{\{C_t, N_t, K_{t+1}\}}{\text{Max}} \sum_{t=0}^{\infty} \beta^t \left(\frac{C_t^{1-\sigma}}{1-\sigma} - \chi \frac{N_t^{1+\varphi}}{1+\varphi} \right) \tag{18}$$

s.t.

$$C_t + [K_{t+1} - (1-\delta)K_t] \leq W_t N_t + R_t K_t - T_t$$

The government budget constraint is

$$G_t = T_t$$

Firms produce according to the following production function

$$Y_t = A K_t^{\alpha} N_t^{1-\alpha}$$

3.1 Summary of the Equations of the Model

We now present the FOCs, the steady state and the log-linearized model.

3.1.1 Equilibrium Conditions (FOCs)

$$\chi \frac{N_t^{\varphi}}{C_t^{-\sigma}} = W_t \tag{19}$$

$$C_t^{-\sigma} = \beta \left[C_{t+1}^{-\sigma} \left(R_{t+1} + (1-\delta) \right) \right] \tag{20}$$

$$Y_t = A K_t^{\alpha} N_t^{1-\alpha} \tag{21}$$

$$R_t = \alpha \frac{Y_t}{K_t} \tag{22}$$

$$W_t = (1-\alpha) \frac{Y_t}{N_t} \tag{23}$$

$$Y_t = C_t + G_t + K_{t+1} - (1-\delta)K_t \tag{24}$$

We have 6 equations and 6 variables (note that both A and G are exogenous).

3.1.2 Steady State

Consistently with the literature, we set the steady state value of $N = \frac{1}{3}$ (i.e. we assume that households work 8 hours per-day) and the ratio $\frac{G}{Y} = 0.2$. We evaluate the equilibrium equations in the steady state, writing them as a function of parameters only. Assuming $N = \frac{1}{3}$ allows us to treat it as a fixed and known parameter.

$$R = \frac{1}{\beta} - (1-\delta) \tag{25}$$

$$K = N\left(\frac{R}{A\alpha}\right)^{\frac{1}{\alpha-1}} \tag{26}$$

$$Y = \frac{R}{\alpha}K \Longrightarrow Y = N\left(\frac{R}{A\alpha}\right)^{\frac{\alpha}{\alpha-1}} \tag{27}$$

$$W = (1-\alpha)\frac{Y}{N} \Longrightarrow W = (1-\alpha)\left(\frac{R}{A\alpha}\right)^{\frac{\alpha}{\alpha-1}} \tag{28}$$

$$C = \left[\frac{N^{-(1+\varphi)}(1-\alpha)Y}{\chi}\right]^{\frac{1}{\sigma}} \Longrightarrow C = \left[\frac{N^{-\varphi}(1-\alpha)\left(\frac{R}{A\alpha}\right)^{\frac{\alpha}{\alpha-1}}}{\chi}\right]^{\frac{1}{\sigma}} \tag{29}$$

Once we fix $\frac{G}{Y} = 0.2$ we can recover the value of χ consistent with $N = \frac{1}{3}$ expressing the resource constraint as function of C (i.e. $C = Y - G - \delta K$).

$$\chi = \frac{\left(N^{-\varphi}(1-\alpha)\left(\frac{R}{A\alpha}\right)^{\frac{\alpha}{\alpha-1}}\right)}{[Y - G - \delta K]^{\sigma}} \tag{30}$$

Note that χ is expressed as a function of parameters only.

3.1.3 Log-Linear Model

$$\sigma\left(c_{t+1}-c_t\right)=\beta R r_{t+1} \tag{31}$$

$$\varphi n_t+\sigma c_t=w_t \tag{32}$$

$$r_t=y_t-k_t \tag{33}$$

$$w_t=y_t-n_t \tag{34}$$

$$y_t=a_t+\alpha k_t+(1-\alpha)n_t \tag{35}$$

$$y_t=c_t\frac{C}{Y}+g_t\frac{G}{Y}+(k_{t+1}-(1-\delta)k_t)\frac{K}{Y}$$

$$y_t=c_t\frac{C}{Y}+0.2g_t+(k_{t+1}-(1-\delta)k_t)\frac{K}{Y} \tag{36}$$

where steady state values are functions of parameters only.

3.2 Simulations

We now present the results of some simulations conducted in Matlab for the model considered above. We assume that the ratio $\frac{G}{Y}$ is reduced by 10% by decreasing government spending. That is, $\frac{G}{Y}$ falls from 0.2 to 0.18. Consistently with the literature we set $\delta=0.025$, and use the following set of values for σ and φ:

σ	0.5	1	1.5	2
φ	1.25	1.75	2.25	4.75

We conduct three different fiscal policy experiments: first, we consider the case of a *permanent* change in government spending, unexpectedly implemented in period 1. Then, we study the effects of a temporary reduction in public spending which takes place in period 1, and is reversed in period 2. That is, after period 2, the ratio $\frac{G}{Y}$ (and thus lump sum taxes) is restored to its original value. Finally, we investigate the extent to which agents anticipate fiscal policies announced in period t, but implemented only in period $t+k$. Specifically, we assume a permanent fiscal plan is announced in period 1 to be carried out in period 10. We also assume that the government can credibly commit to the announced policy change.

All simulations are conducted using the log-linearized model, so that results can be interpreted as percent deviations of each variable from its original steady state. The time horizon used consists of 100 periods.

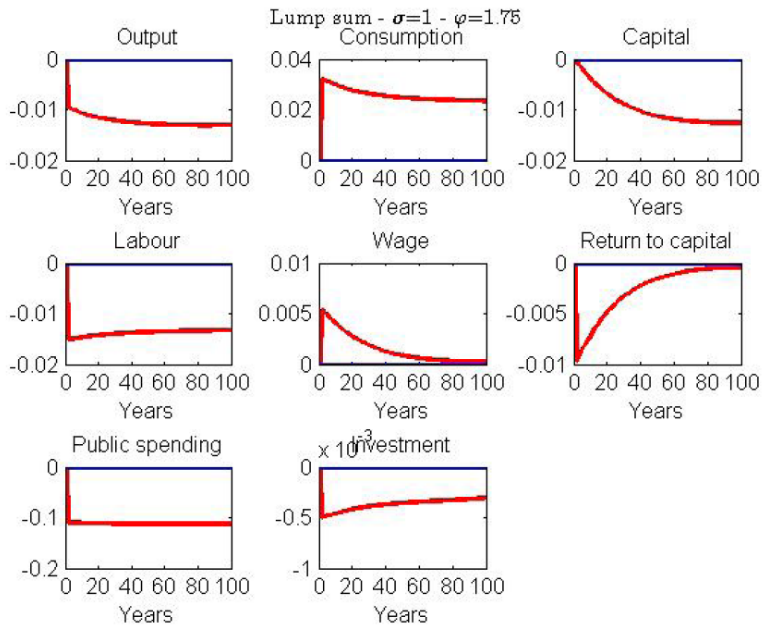
3.2.1 Permanent Shock

First, let us consider the case of a permanent reduction in public spending, unexpectedly announced and implemented in period 1. We present only the results for $\sigma = 1$ and $\varphi = 1.75$ (see Fig.1), but qualitatively our findings do not change with the values of the parameters.[12] A reduction in G is followed by an increase in C which, in turn, induces a reduction in hours worked.[13] As labor supply declines, the real wage increases, thus reducing incentives to invest (the ratio $\frac{R}{W}$ drops). Thus, investment (and so capital) fall too. The ultimate effect of a reduction in G on output is negative. Even though consumption goes up, this is not enough to boost output above its original value. These results are not particularly surprising, and closely mirror the findings by Baxter and King (1993).

[12] More generally, in all simulations conducted throughout our work results are qualitatively the same for any "reasonable" value of φ. Remember that when taxes are non-distortionary the results are independent of the value of the parameters.

[13] Recall that in neo-classical models consumption and leisure are complements, and so, if consumption increases, leisure must rise too. As a consequence, hours worked fall.

Fig.1 Permanent reduction in government spending (lump sum taxes; $\sigma = 1$): deviations from steady state



3.2.2 Temporary Shock

Let us now investigate the response of the economy to a temporary shock. In particular, we conduct the following "fiscal policy experiment": between period 1 and period 2 the ratio $\frac{G}{Y}$ is reduced by 10% by decreasing government spending. From period 2 onwards, public spending is set again to its original value. Fig. 2 presents the results:[14] consumption jumps substantially at impact, but then starts declining immediately after the shock, slowly going back to its original level. This reflects households' desire for *consumption smoothing*: instead of consuming more only in the first period (when more resources are available), households prefer to partly postpone their consumption in the future, so as to maintain their living standards as balanced as possible throughout their life. For this reason C remains higher than its original level even after public spending has returned to its steady state. As expected, hours worked move in the opposite, but symmetric, way: in

[14] As before, we present only results obtained using $\sigma = 1$ and $\varphi = 1.75$, but, again, our findings are not sensible to changing the parameters.

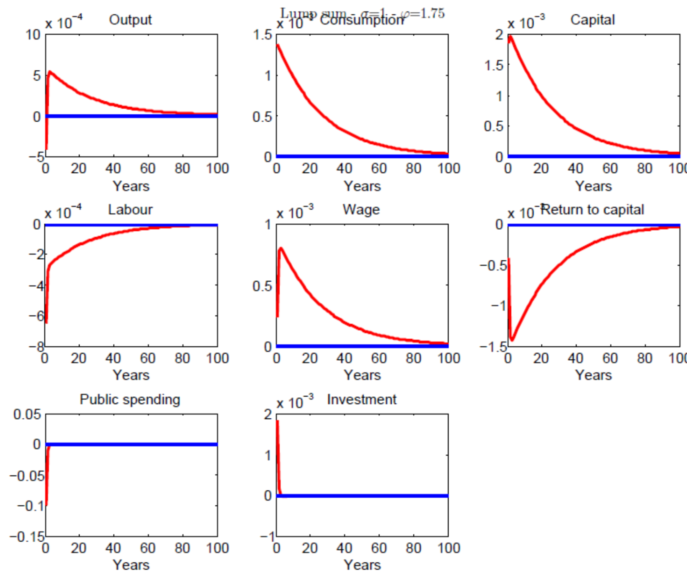
period 1 households reduce dramatically labor supply. However, hours worked start increasing right after the shock has occurred, and slowly go back to their original value (much later than period 2, though).

Fig. 2 also shows that private investment rises dramatically in period 1 but, as soon as government spending is again set at its original value, I goes back to its steady state (almost immediately). The initial rise in investments is consistent with the pattern of consumption: in the first period, households do not consume all the newly available resources, but, because of their desire for consumption smoothing, they increase savings (and thus investments), in order to consume relatively more in the future.[15] Finally, output falls immediately after the reduction in public spending; then, as soon as public spending is increased again, it rises above its steady state. After this positive jump, Y slowly converges back to its original steady state.

To conclude, temporary shocks have *no permanent effect* on the economy but nonetheless trigger interesting reactions by private agents that last more than just the time in which the fiscal plan is in place. As before, our findings are similar to the conclusions drawn by Baxter and King (1993).

[15] Whether households or firms undertake the investement decision is completely irrelevant in this model. Here, we are assuming that households invest and then rent capital to firms, but results would not change if firms were to carry out the investment decision directly.

Fig.2 Temporary reduction in government spending (lump sum taxes; $\sigma = 1$)



3.2.3 Fiscal Foresight: Anticipation

In empirical analyses of fiscal multipliers whether or not economic agents anticipate fiscal shocks is crucial to identify the causal effect of government spending: in particular, if agents respond to future shocks before the latter are actually in place, it may not be possible to recover the causal effect of fiscal policies using standard econometric techniques (e.g. VARs).[16] In this paragraph we address precisely the issue of anticipation: suppose that at time t the government (credibly) announces the implementation of a fiscal plan which, however, will be carried out only starting from period $t + k$. Will agents wait for the fiscal plan to be implemented before changing their behavior or, instead, will they start optimally adjusting their behavior already before the shock occurs? Intuitively, one would expect the latter scenario to take place, and this is indeed what we see in Fig. 3, where we plot the effects of a 10% reduction in the ratio $\frac{G}{Y}$ announced at time 1 and implemented in period 10. For brevity, we report only results obtained for $\sigma = 1$ (and $\varphi = 1.75$), but once again qualitatively, our findings do not change with the parameters

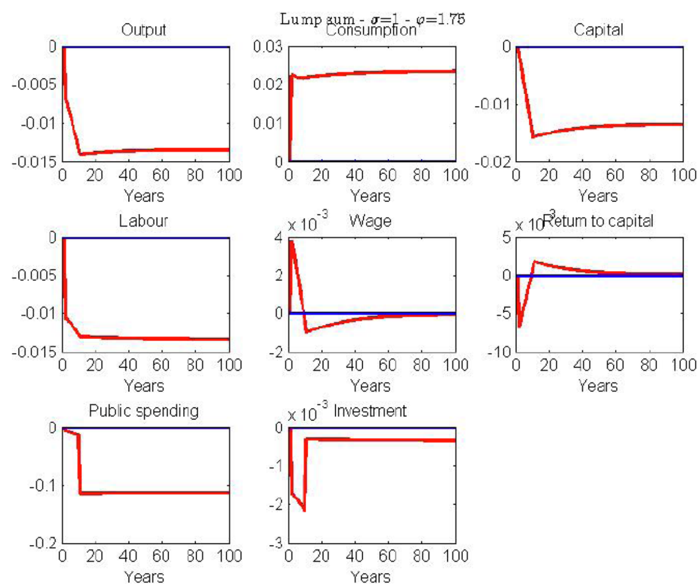
[16] See for instance Favero and Giavazzi (2012) and Leeper, Walker and Yang (2012).

Consumption jumps immediately in period 1: agents acknowledge that in the future (from period 10) more resources will be available, and thus start consuming more already from the moment in which the policy is announced. This is, again, a consequence of households' love for consumption smoothing. When the shock takes place (period 10) agents only slightly increase their consumption. The same argument applies to hours worked: when the policy is announced, labor supply drops. Then, at time 10, i.e., when the shock actually occurs, there is another (smaller) fall in hours worked. From that moment on, labor supply declines, very slowly converging to a new, lower, steady state.

Looking at the response of private investment we see that in period 1 I falls substantially, and keep on declining until period 10. As government spending is set to its new (lower) value, private investment rises dramatically, even though the new level remains lower than the original steady state. The increase in investment is reflected in the accumulation of capital: until period 10, capital falls, but then it starts to increase, converging to a new steady state, still lower than the original one. The fall in both hours worked and investments causes a substantial decline in output. As we can see from Fig. 3, during the first 10 periods the loss in aggregate output is remarkably large. After period 10, because of the partial increase in investment and in capital accumulation, output rises slightly, even though its new equilibrium level remains lower than the original one.

To conclude, what matters is not the date in which a fiscal plan is implemented but, conversely, the date in which it is announced: agents *immediately* respond to the announcement, and do not wait for the actual implementation. Note that we assumed that the fiscal plan is not reversed, and that the government can fully commit to it. However, as documented by Alesina, Favero and Giavazzi (2012), in practice, fiscal plans are often revised both before and during their implementation. Interestingly, the authors show that countries that are not able to commit to the announced plans are those that experience worse recessions when fiscal contractions occur.

Fig. 3 Permanent reduction in government spending with anticipation (lump sum taxes; $\sigma = 1$)



4 Distortionary Taxation

Assuming that government spending is financed through lump sum taxes is not very realistic: most of the times, taxes are distortionary. Hence, a reduction in public spending, usually accompanied by a reduction in taxation, can have a positive effect on output, driven by an "incentive effect" that may induce agents to invest and/or work more. The latter force works in the opposite direction of the wealth effect that households experience when government spending declines. As we show below, when government spending is financed entirely through distortionary taxes on capital, the substitution effect always prevails over the wealth effect, and so *expansionary contractions always occur*. Instead, more ambiguous results are obtained when public spending is financed (at least in part) through distortionary taxes on labor. In this case, whether the substitution or the wealth effect prevails crucially depends on the parameters of the model (and in particular on σ). For $\sigma > 1$, cuts in public spending, even if financed through distortionary taxes, are recessionary, whereas when $\sigma \leq 1$, a reduction in G is followed by an increase in output.[17] That is, *expansionary contractions may occur.*

In practice, governments can tax either capital or labor income (or both). The goal of this Section is not that of studying an optimal taxation problem. Instead, we ask a very simple question: what are the effects of cuts in government spending when taxes are distortionary? Below, we study two different scenarios: first, we assume that public spending is financed only via taxes on capital. Next, we investigate the case in which taxes fall entirely on labor income.[18]

4.1 Taxes on Capital

In this Section we investigate the effects of fiscal shocks on the economy when government spending is financed through distortionary taxes on capital.[19] Specifically, in each and every period the government budget constraint is given by

$$G_t = \tau_t^k K_t R_t \tag{37}$$

The representative agent solves the following problem

$$\underset{\{C_t, N_t, K_{t+1}\}}{\text{Max}} \sum_{t=0}^{\infty} \beta^t \left(\frac{C_t^{1-\sigma}}{1-\sigma} - \chi \frac{N_t^{1+\varphi}}{1+\varphi} \right)$$

s.t.

$$C_t + [K_{t+1} - (1-\delta)K_t] \leq W_t N_t + \left(1 - \tau_t^k\right) R_t K_t$$

As before, firms produce according to the following production function

$$Y_t = A K_t^{\alpha} N_t^{1-\alpha}$$

We now present the FOCs, the steady states and the log-linearized model.

[17] As it should be clear to you at this point, for $\sigma > 1$ the wealth effect prevails, while when $\sigma \leq 1$ the substitution effect dominates.

[18] It is trivial to extend the analysis to a situation in which G is financed using both taxes on capital and on labor income. For brevity, we omit such case.

[19] As before, we assume government spending is pure waste.

4.1.1 Equilibrium Conditions

$$\chi \frac{N_t^{\varphi}}{C_t^{-\sigma}} = W_t \tag{38}$$

$$C_t^{-\sigma} = \beta \left[C_{t+1}^{-\sigma} \left(R_{t+1}(1 - \tau_{t+1}^k) + (1 - \delta) \right) \right] \tag{39}$$

$$Y_t = A K_t^{\alpha} N_t^{1-\alpha} \tag{40}$$

$$R_t = \alpha \frac{Y_t}{K_t} \tag{41}$$

$$W_t = (1 - \alpha) \frac{Y_t}{N_t} \tag{42}$$

$$Y_t = C_t + G_t + K_{t+1} - (1 - \delta) K_t \tag{43}$$

The Euler equation (equation (39)) shows where the distortion comes from: distortionary taxes on capital introduce a wedge between net (after-tax) and gross returns to capital that alters the accumulation path of capital.[20] In particular, whenever τ^k is positive, investment, and thus capital will be lower than the efficient steady state level. This is also known as "*tax wedge*".

4.1.2 Steady States

As before, we set the steady state value of N equal to $\frac{1}{3}$. Also, we assume that the initial tax rate on capital is 0.15. Distortionary taxes imply a steady state return to capital (R) higher than in the model of Section 3.1 (i.e., there will now be a lower level of capital and thus of output, consumption and labor). In particular, we now have

$$R = \left(\frac{\frac{1}{\beta} - (1 - \delta)}{1 - \tau^k} \right) \tag{44}$$

All other steady state values can be recovered by looking at the same equations used above, replaced with the new value for the interest rate.

[20] Recall that the Euler equation determines the dynamics of the economy, and in particular of investment and consumption, over time.

4.1.3 Log-Linear Model

Compared to the case of lump sum taxation, now *the distortion affects the dynamic response* of the system through the (log-linear version of the) Euler Equation, which becomes

$$\sigma\left(c_{t+1}-c_t\right)=\beta R\left[\left(1-\tau^k\right)r_{t+1}-\tau^k\tau^k_{t+1}\right] \tag{45}$$

Also, we are no longer setting $\frac{G}{Y}=0.2$. Instead, we fix G by fixing the tax rate (at 15%). Recall that now government revenues are given by $R_tK_t\tau^k_t$, and the government always balances the budget, that is

$$G_t=R_tK_t\tau^k_t$$

Thus, if the government decides to cut expenditures, the tax rate will decline accordingly. The value of 15% used in our simulations is arbitrary, but note that, qualitatively, results do not depend on the magnitude of the tax.

The log-linearized expression for the budget constraint is equal to

$$y_t=c_t\frac{C}{Y}+g_t\frac{G}{Y}+(k_{t+1}-(1-\delta)k_t)\frac{K}{Y} \tag{46}$$

4.1.4 Simulations

In this paragraph, we present results of the simulations conducted in Matlab using the same parameter values as in Section 3.2.[21] As before, we study the response of the economy to a reduction in τ^k that takes place *i) permanently and unexpectedly* in period 1; *ii) temporarily,* between period 1 and period 2; *iii) in period* 10, but which is announced in period 1. As anticipated above, when G is financed entirely through distortionary taxes on capital, the fiscal multiplier is always negative, regardless of the choice of the parameters and/or of the "fiscal experiment" conducted.[22]

[21] As before, simulations are conducted using the log-linearized model, so that results can be interpreted as percentage deviation of each variable from its original steady state.

[22] Note that a negative fiscal multiplier implies that a reduction in government spending (accompanied by tax cuts) will lead to an increase in output.

Permanent Shock We start by considering the effects of a permanent and unexpected reduction in public spending. Specifically, we assume that in period 1 the tax rate τ^k is permanently and unexpectedly reduced by 10%, moving from 15% to 13.5%. Notably, for any value of σ, following a reduction in G (and thus in τ^k), output increases. Figs 4 and 5 present the results for $\sigma = 1$ and $\sigma = 1.5$ respectively, but our findings are robust to changes in the parameters, and the picture that emerges is always the same. At impact, consumption falls, whereas investments and labor supply rise, in turn generating a substantial increase in output. Shortly after, consumption becomes higher than its original value, mainly due to the extremely high level of output that is produced. Moreover, the new steady state level of capital is much higher than the original one.

For very low levels of σ (i.e., 0.5), the economy responds immediately, and suddenly reaches the new steady state.[23] This is not very consistent with the data: usually we observe a gradual and smooth change in investment, labor supply and capital following a reduction in public spending. Augmenting the model with adjustment costs to investment may help solve this problem, by introducing precisely the kind of smoothness usually observed in reality. For $\sigma = 1$, instead, the transition to the new steady state is more gradual. Also, even though labor supply initially increases, after some time it starts declining, reaching a level lower than the original steady state. This is in contrast with what happens for $\sigma = 0.5$. As discussed in Section 2.2, higher σ implies that households value present consumption more. Intuitively, as output increases, households start consuming more, and so they gradually reduce labor supply.[24]

As it emerges from Fig. 5, even when σ is higher that 1, households reduce consumption at impact, and increase both investment and hours worked.[25] Eventually, consumption rises, hours worked fall, and investment decline to some extent. But, once again, an expansionary contraction takes place. The only noticeable difference relative to the case of $\sigma \leq 1$ is in the *magnitude but not in the sign* of households' response to tax cuts. Specifically, the higher σ, the lower the initial reduction in consumption, and the smaller the increase in hours worked and investment. This

[23] Results not reported for brevity.

[24] As discussed above, recall that if consumption rises, so does leisure. Thus, labor supply falls.

[25] Results for the case of $\sigma = 2$, omitted to save space, are qualitatively the same as the ones presented in the main text.

is intuitive: when σ is higher, the wealth effect is stronger, and the substitution effect that induces households to postpone consumption to take advantage of better investment opportunities is dampened.

To sum up, the model predicts that, when G is financed entirely through distortionary taxes on capital, expansionary contractions always occur. So far, we have considered permanent and unexpected fiscal shocks. Similarly to what we did in Section 3.2, we now examine two other cases, namely *i)* temporary changes in public spending, and *ii)* permanent shifts in fiscal policy announced in period t but implemented in period $t+k$.

Fig.4 Permanent reduction in distortionary taxes on capital ($\sigma = 1$)

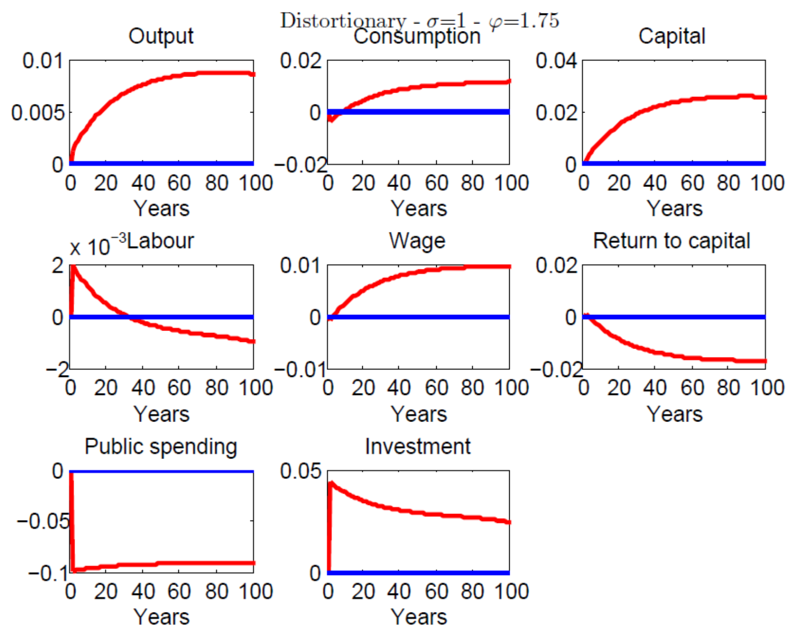
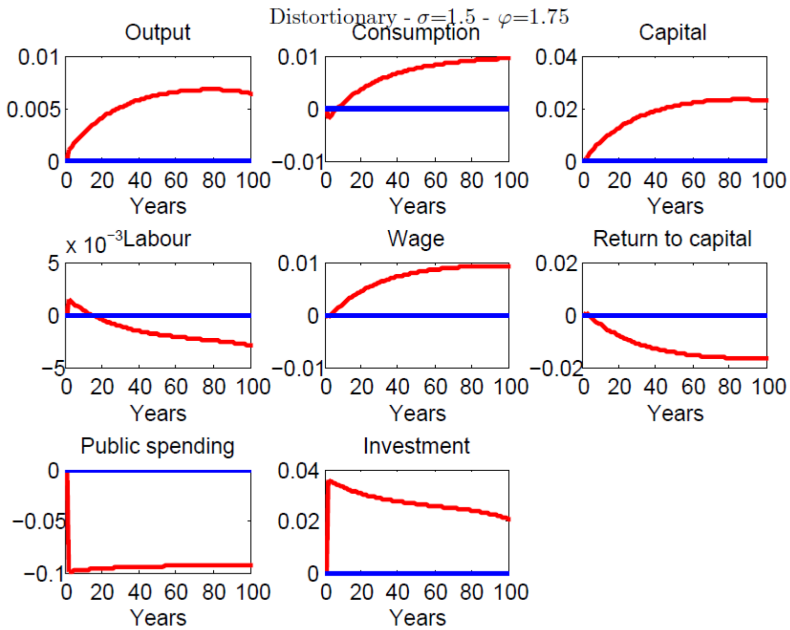


Fig.5 Permanent reduction in distortionary taxes on capital ($\sigma = 1.5$)



Temporary Shock We now investigate the effects of an unexpected and temporary reduction in public spending (and thus in the tax rate) that occurs between period 1 and period 2. That is, in the first period the tax rate is reduced by 10% (from 15% to 13.5%), and is restored to its initial value in the following period. Figs 6 and 7 show the response of the economy for $\sigma = 1$ and $\sigma = 1.5$ respectively. As expected, being the shock temporary, the system converges back to its original steady state. In both cases, when government spending (and thus the tax rate) is lower, hours worked and output fall (for $\sigma = 1$ the drop extremely small). Notably, as soon as G is restored to its original value, in period 2, output jumps above its original steady state. This is due on the one hand to the increase in labor supply that follows the negative wealth effect exerted by the increase in G, and on the other to the higher level of the capital stock, resulting from the surge in investment occurred in period 1.

As for the case of lump sum taxes (Section 3.2.2), the effects of the shock do not vanish immediately: even though government spending is set again to its original value in period 2, output goes back to its steady state very slowly. Moreover, as in the case of a the permanent shock, the response of the economy is qualitatively the same for all values of the parameters. Whether σ is greater or lower than (or equal to) 1 only affects the magnitude, but not the sign of the fiscal multiplier.

A couple of observations are in order here. First, note that when the change in government spending is temporary, the wealth effect experienced by households is smaller. For this reason, the "incentive" (substitution) effect that follows the reduction in distortionary taxation prevails, regardless of the value of σ. Second, as discussed in Baxter and King (1993), when taxes are higher, G is higher too, and thus opportunities for intertemporal substitutions are limited.[26] A temporary shock reduces the time in which the latter situation occurs. In our simulations the temporary fiscal shock lasts only one period: this too may explain why output rises (temporarily) after a temporary reduction in government purchases.

[26] It does not matter whether taxes are distortionary or not.

Fig.6 Temporary reduction in distortionary taxes on capital ($\sigma = 1$)

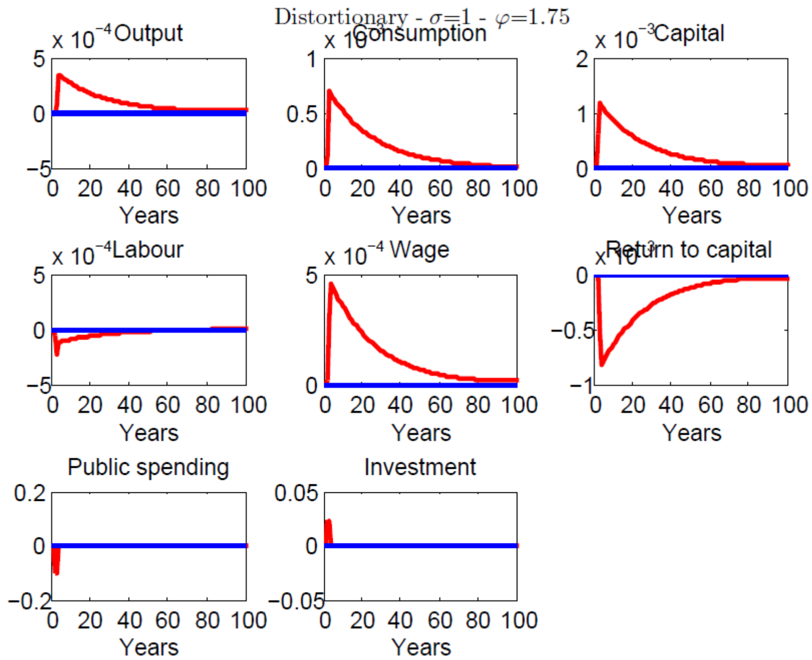
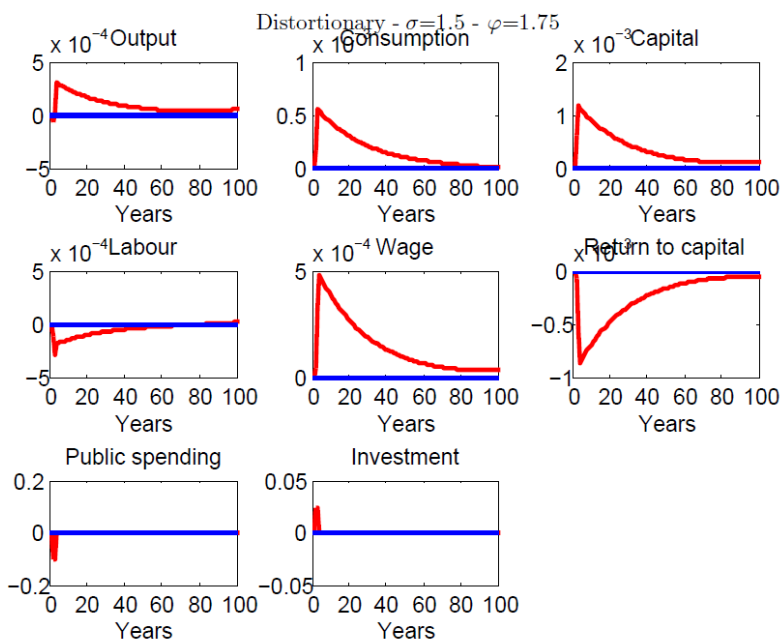


Fig.7 Temporary reduction in distortionary taxes on capital ($\sigma = 1.5$)



Anticipated Shock As for the case of lump-sum taxation, agents anticipate the effects of a plan that will take place in the future. Specifically, Figs 8 and 9 show the response of the economy to a permanent reduction in the tax rate on capital from 15% to 13.5% announced in period 1 and implemented in period 10. Once again, regardless of the value of σ, agents immediately increase hours worked, and cut consumption. The strongest increase in labor supply takes place before period 10. Similarly, investments rise substantially already before the plan is implemented. From period 10 onwards, the response of the economy to the fiscal shock mirrors what we already saw for the case of an unexpected shock: that is, output increases following a reduction in G, with a stronger response when $\sigma \leq 1$, especially for hours worked, due to a lower wealth effect.

Fig.8 Reduction in distortionary taxes on capital with anticipation ($\sigma = 1$)

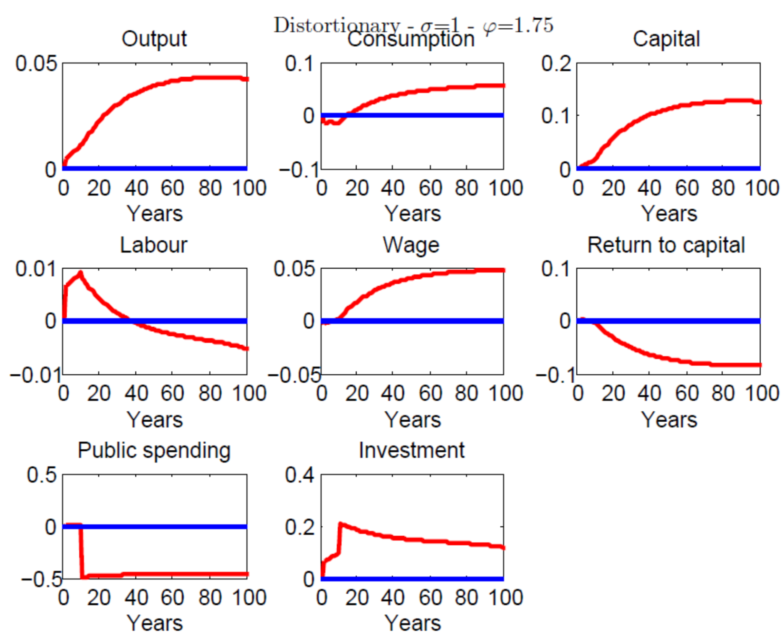
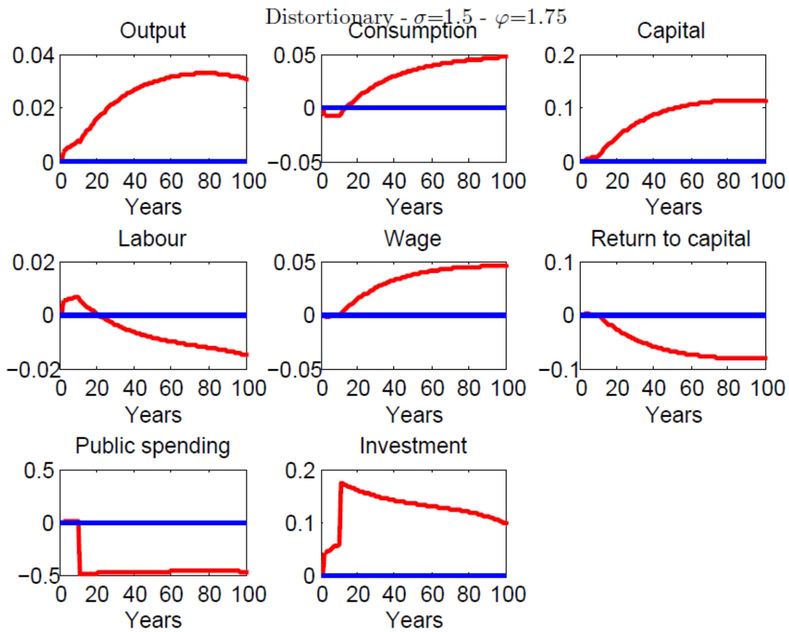


Fig.9 Reduction in distortionary taxes on capital with anticipation ($\sigma = 1.5$)



4.2 Taxes on Labor Income

We now investigate the effects of cuts in government spending when the latter is financed through taxes on labor income. In each and every period the government balances its budget, that is

$$G_t = \tau_t^w W_t N_t \tag{47}$$

The household's problem and firms' technology are the same considered in previous Sections. When taxes are levied on labor income, the accumulation of capital is not affected (i.e., the Euler equation of this model will be the same as equation (20)). However, the distortion is reflected in the intra-temporal optimality condition, i.e.

$$\chi \frac{N_t^{\varphi}}{C_t^{-\sigma}} = W_t(1 - \tau_t^w) \tag{48}$$

The message conveyed by the equation above is very similar to what we had in eq. (39): the presence of distortionary taxes now affects the infra-temporal decision between consumption and leisure. In particular, there is a wedge between the net (ex-post) real wage received by households and the wage paid by firms. This is also know as *labor-wedge*.

4.2.1 Log-Linearized Model

For brevity, we report only the log-linearized model, given by the following set of equations.

$$\sigma\left(c_{t+1}-c_t\right)=\beta R r_{t+1} \tag{49}$$

$$\varphi n_t+\sigma c_t=w_t-\widehat{\tau}_t^w\left(\frac{\tau_{SS}^w}{1-\tau_{SS}^w}\right) \tag{50}$$

$$r_t=y_t-k_t \tag{51}$$

$$w_t=y_t-n_t \tag{52}$$

$$y_t=a_t+\alpha k_t+(1-\alpha)n_t \tag{53}$$

$$y_t=c_t\frac{C}{Y}+\frac{G}{Y}g_t+(k_{t+1}-(1-\delta)k_t)\frac{K}{Y} \tag{54}$$

4.2.2 Simulations

Below, we repeat the analysis conducted in Section 4.1.4 to study the effects of a reduction in government spending.[27] Specifically, we set the steady state value of τ^w equal to 0.25, and assume that it is reduced by 20% (i.e., taxes on labor fall from 25% to 20%). As before, we first consider the case of a permanent and unexpected cut

[27] For brevity, we present only results for $\sigma=1$ and $\sigma=1.5$, with $\varphi=1.75$. As noted above, the value of φ is irrelevant, while the cases of $\sigma=0.5$ and $\sigma=2$ are similar to those of $\sigma=1$ and $\sigma=1.5$ respectively.

in the tax rate. Next, we study the effects of a temporary (unexpected) reduction in τ^w that takes place between period 1 and period 2. Finally, we assume that the government announces a reduction in public spending at time 1, but implements the fiscal plan only in period 10.

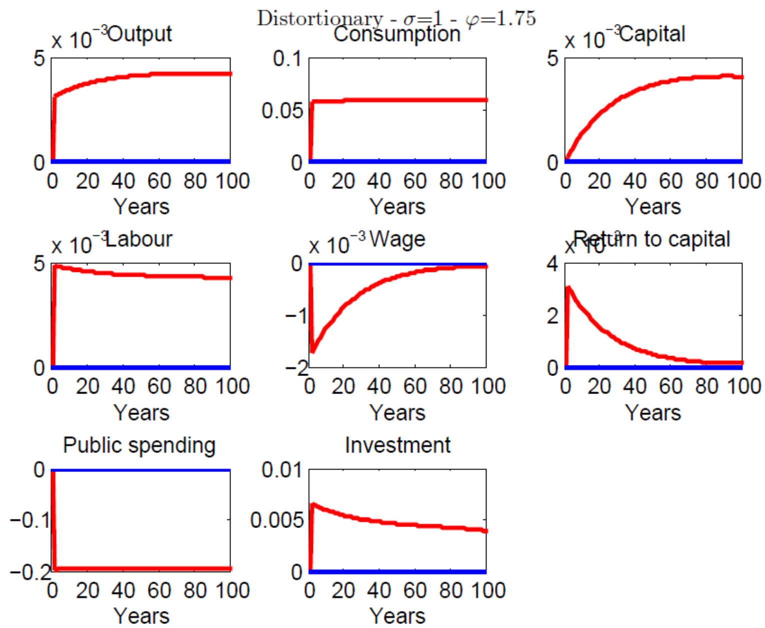
Anticipating our findings, now, the sign of the fiscal multiplier crucially depends on the value of σ. When $\sigma \leq 1$, a reduction in government spending increases hours worked, investment and output. Conversely, when $\sigma > 1$, cuts in public spending are recessionary. As discussed above, a reduction in government spending is always accompanied by tax cuts. Thus, as G declines, two different forces affect household's optimization problem. On the one hand, the reduction in G exerts a *positive wealth effect* on the household, inducing her to reduce hours worked, enjoy more leisure, and consume more. On the other, however, a reduction in distortionary taxes increases the net wage, inducing the household to work more through the *substitution effect.* The latter force prevails when $\sigma \leq 1$, while the former dominates when $\sigma > 1$.[28] In what follows, we present the results of the three fiscal experiments mentioned before.

Permanent Shock As just discussed, when the government permanently and unexpectedly reduces labor-income taxes, the ultimate effect on output depends on the value of σ. If $\sigma \leq 1$ (see Fig. 10), labor supply rises. As the tax rate declines, households' incentives to work increase and, when σ is low, this effect is stronger than the wealth effect produced by the reduction in government spending. Notably, the increase in hours worked generates a short-run multiplier that boosts investments.[29] Since in the neo-classical model labor and capital are *q-complements*, if the former rises, so does the latter. Following the rise in both capital and labor, output rises substantially. Differently from the case of taxes on capital, now, labor supply always remains higher than its original steady state. The reason is quite obvious: in this scenario, a reduction in the tax rate is equivalent to an increase in the (net) real wage, that is, the opportunity cost of leisure rises, and so households are willing to work more (as long as the wealth effect does not prevail). Also, in this case, consumption increases immediately: households need not reduce their consumption (and thus leisure) to work more, as their net income is higher.

[28] See the discussion conducted in Section 2.2 above.

[29] See also Baxter and King (1993).

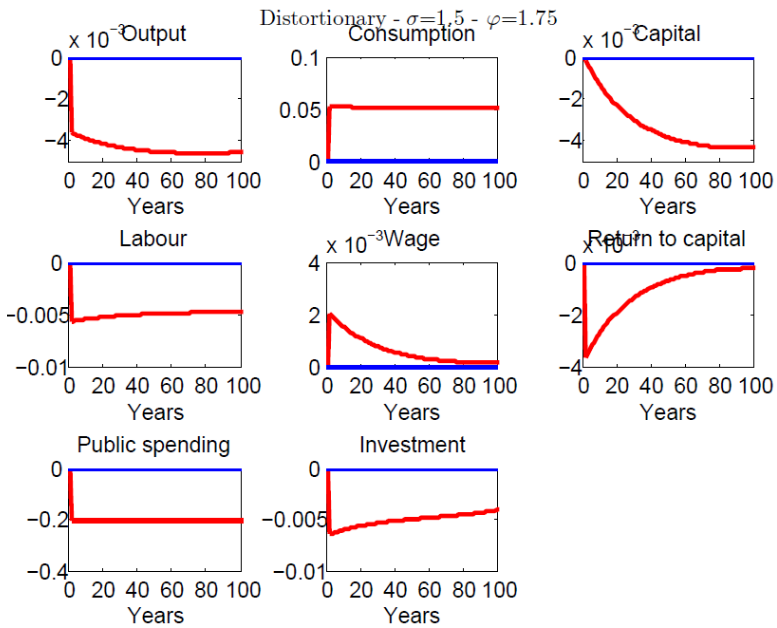
Fig.10 Permanent reduction in distortionary taxes on labor income ($\sigma = 1$)



As depicted in Fig. 11, when $\sigma > 1$, even though the reduction in the tax rate increases incentives to work, the wealth effect exerted by the reduction in public spending prevails. Thus, households reduce hours worked. Notably, the rise in consumption is much more pronounced than in the case of $\sigma \leq 1$. The decline in labor supply has a negative effect on investments, that fall substantially.[30] Hence, differently from what we had for taxes on capital, output declines following a reduction in government spending. This happens despite the fact that the distortion in the economy is reduced. The crucial mechanism goes through the wealth effect which in turn affects labor supply.

[30] Again, note the role that q-complementarity plays here.

Fig.11 Permanent reduction in distortionary taxes on labor income ($\sigma = 1.5$)



The main message that emerges from this analysis is that cuts in government spending can generate an expansion in output, but only if the incentive effect due to the reduction in the tax rate prevails over the (positive) wealth effect exerted by the reduction in spending.[31] This occurs if and only if $\sigma \leq 1$. Conversely, when $\sigma > 1$, a reduction in G generates a recession (even though public spending is financed through distortionary taxes).

Temporary Shock We now study the effects of a temporary reduction in taxes on labor income: between period 1 and period 2, the tax rate on wages falls from 25% to 20%. Then, it is again restored (permanently) to its initial value. Figs 12 and 13 show the results for the case of $\sigma = 1$ and $\sigma = 1.5$ respectively. In both cases, the temporary reduction in public spending has an immediate, positive effect on output, mainly driven by the rise in hours worked. When the tax rate is lowered,

[31] Recall that we are considering deviations around the steady state. That is, (cyclical) expansions in output should not be confused with long term economic growth.

labor supply rises dramatically, as households take advantage of the increase in the net wage. These results differ from what we just saw for the effects of permanent spending cuts with G financed through taxes on labor income. Instead, they are very similar to those obtained for the case of taxes on capital. Indeed, σ affects only the magnitude, but not the direction of the response.

Once the tax is restored to its original value, labor supply immediately goes back to its original steady state. To be precise, when $\sigma > 1$, hours worked fall even below the original steady state, and then, slowly converge back to it. The same happens to investment. For this reason, when $\sigma > 1$, the positive effect on output generated by the reduction in the tax rate between period 1 and period 2 vanishes sooner than for the case of $\sigma \leq 1$. However, also in the latter case, output goes back to its original steady state very quickly. To conclude, a temporary reduction in public spending and in labor income taxes generates a (temporary) increase in output (driven by the rise in labor supply) that is, however, very short-lived.

Fig.12 Temporary reduction in distortionary taxes on labor income ($\sigma = 1$)

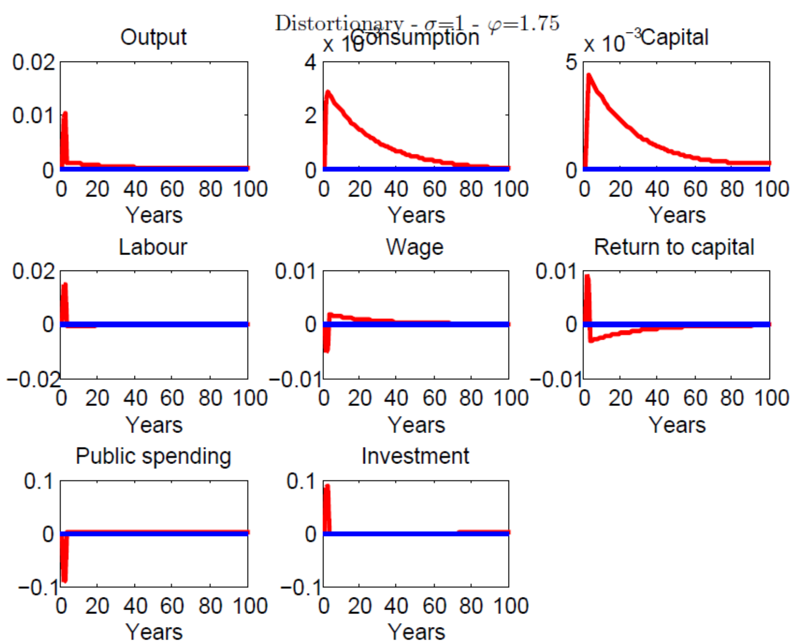
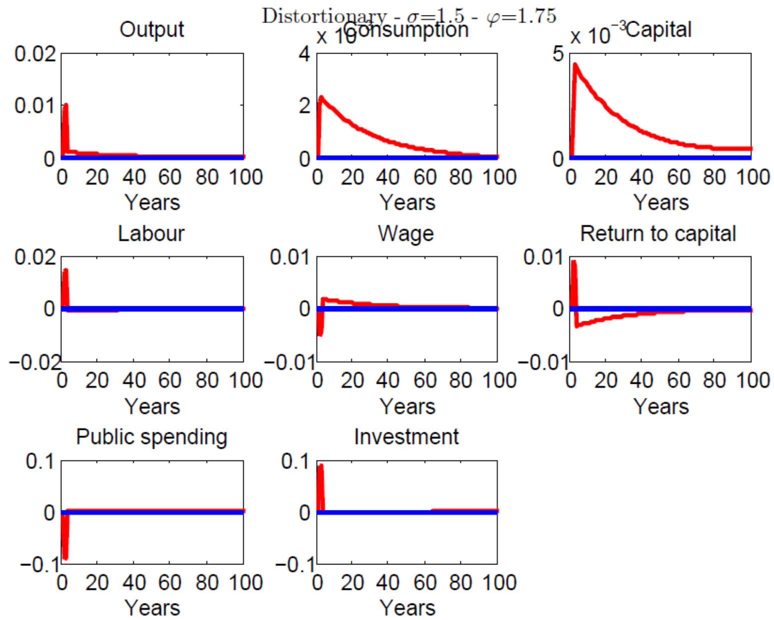
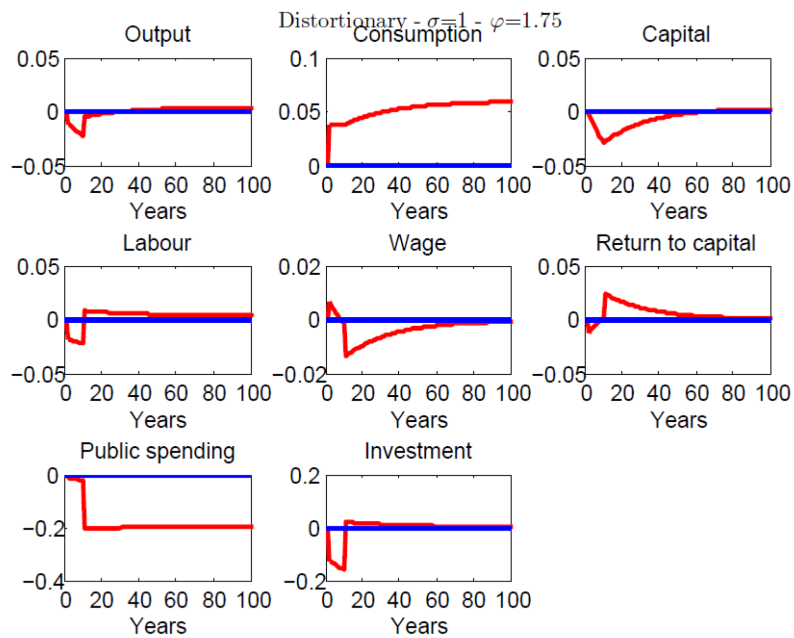


Fig.13 Temporary reduction in distortionary taxes on labor income ($\sigma = 1.5$)



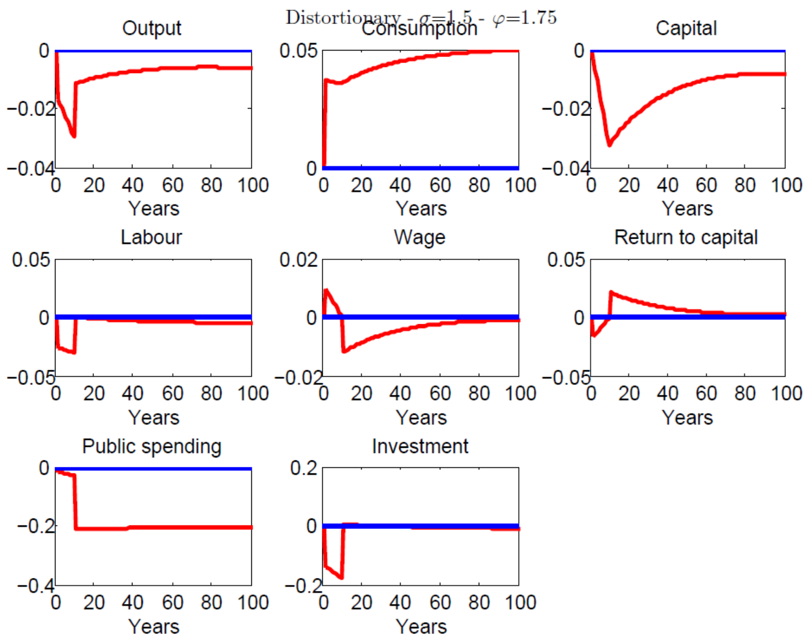
Anticipated Shock We now investigate the effects of a permanent reduction in τ^w announced in period 1 but implemented in period 10. Figs 14 and 15 show the results for $\sigma = 1$ and $\sigma = 1.5$ respectively. As depicted in Fig. 14, agents anticipate that from period 10 onwards it will become more profitable to work, and so they increase consumption and reduce hours worked between period 1 and period 10. Then, once the plan is implemented, hours worked rise substantially. The rise in labor supply generates a positive effect on investments: when the policy becomes effective, households start investing more. As a result, when $\sigma \leq 1$, the ultimate effect of a reduction in the tax rate is that of boosting output.

Fig.14 Reduction in distortionary taxes on labor-income with anticipation $(\sigma = 1)$



When $\sigma > 1$ (see Fig. 15), the initial response is very similar to the one depicted in Fig. 14: households anticipate that in the future working will be more profitable, because the tax rate will be cut in period 10. Thus, as soon as the plan is announced, households reduce hours worked and investments, while they increase consumption. After period 10, labor supply and investments rise, and then decline again to some extent. Ultimately, due to the positive wealth effect, the new steady state for labor and capital is somewhat lower than the original one. Hence, output falls following a reduction in the tax rate (and in public spending).

Fig.15 Reduction in distortionary taxes on labor-income with anticipation ($\sigma = 1.5$)



To conclude, the main message that emerges from this Section is very different from what we saw in Sections 3 and 4.1. Specifically, when government spending is financed through lump sum taxes (Section 3), reductions in G are always recessionary. At the other extreme, when public spending is entirely financed via distortionary taxes on capital (Section 4.1), expansionary contractions always occur. Finally, when government spending is financed through distortionary taxation on labor (as in this Section), expansionary contractions can take place only if $\sigma \leq 1$, i.e. only if the wealth effect is dominated by the substitution effect exerted by the reduction in the distortion. When $\sigma > 1$, instead, a reduction in public spending, even if accompanied by a decline in the distortionary tax rate, generates a recession.

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