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Assessing The Effects of Public Expenditure Shocks on the Labor Market in the Euro-Area

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Abstract

The core of the paper is a medium-scale DSGE model calibrated for the Euro-Area with a detailed fiscal sector including both public consumption and public investment. The financing of the spending can be tax-based or debt-based. In the case of a debt-funded expenditure expansion, I find strong negative multipliers on the unemployment rate for the public consumption shock, around -0.6% at the peak, and more ambiguous results for a public investment shock. In both cases, the effects on the unemployment rate are short-lasting. With a sensitivity analysis exercice, it is shown than the parameters included in households' preferences do not drammatically change the results in the case of the public consumption shock but the results are very sensitive to these parameters for the public investment shock. Finally, with the introduction of some distortive taxes and assuming that they fund the half of the deficit engendered by public spending expansion, I show that the multipliers little vary little even if the cumulated unemployment fiscal multiplier can become significantly positive with a raise of public investment.

Keywords: Fiscal multipliers, labor market, DSGE models, preferences, unemployment
JEL classification: E32, F77

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1 Introduction

The effects of fiscal policy is a very old question in macroeconomics. However, there is no real consensus about issues like the size of the fiscal multiplier in the short run, the transmission channels at the macroeconomic level or the potential cost of the fiscal policy on growth in the long run.

A very extensive literature has grown up since the late nineties and deals with the impact of the fiscal policy in the short run. Firstly, in the new-Keynesian paradigm, interesting questions have been investigated with the help of the well known DSGE models such as the size of the fiscal multiplier, the response of private consumption to a spending shock[1] , or the effectiveness of fiscal policy when the zero lower bound binds[2] . Secondly, numerous empirical studies try to measure the effects of fiscal policy, with a large debate on the best way to identify fiscal shocks. Surprisingly, no real consensus arises due to methodological discrepancies, notably concerning the response of private consumption to public spending shocks. The narrative approach primarily developed in Ramey and Shapiro (1998) concludes generally for a large decrease in private consumption. Conversely, in the SVAR approach initiated in Blanchard and Perotti (2002), public spending shocks lead to an increase in private consumption.

Especially, with the recent crisis, the strong rise of unemployment and the implementation of austerity plans in most developed countries, issues concerning the effects of the fiscal policy on the labor market particularly matter and are receiving new attention from economists.

Euro-Area countries currently face very high rates of unemployment (12.1% for the Euro Area in July 2013, sources Eurostat), especially for countries in which strong austerity plans have been implemented (26.26% for Spain at the second quarter of 2013, 26.9% for Greece). It is complicated to know exactly to what extent current fiscal contractions contribute to this sharp degradation of the unemployment rate. Investigating this issue requires a precise knowledge as to the effects of fiscal policy on the labor market.

Interestingly, the effects of fiscal policy on the labor market have been studied only since the 2000's. The reason is mainly methodological. First generation RBC/DSGE models did not allow for a good interpretation of the short-term dynamic of the labor market. These models include a Walrasian labor market which is not able to reproduce a performing description of the real behavior of the labor market. More recently, many papers reconcile the

[1] See Coenen and Straub (2005) or Gali, Lopez-Salido and Valles (2007) among others

[2] Hall (2009) for a recent contribution

two largest paradigms in modern theoretical macroeconomics : A DSGE structure with a job search model for the labor market *à la* Mortensen and Pissarides. Applied to fiscal matters, Mayer, Moyen and Stähler (2010) or Monacelli, Perotti and Trigari (2010) use this class of models for analyzing the effects of public spending shocks on the labor market.

Before summarizing more deeply the results coming from the literature, it is important to formulate a quasi-consensus found in the literature. Following a public spending expansion, we generally observe a co-movement of GDP, employment, real wages and labor force participation. However, concerning the rise in employment, Ramey (2012) qualified this result in the sense that we have to take into account the way the governement intervenes in the economy: *"[...] an increase in government spending raises total employment. However, the extent to which governement spending raises private employment depends on whether the increase in G is due more to an increase in purchases of private sector output or more to an increase in governement output and employment. We would expect private sector employment to raise in the first case but to fall in the seconde case"*. In my paper, I introduce no public employment but one non-productive spending and one productive public output, namely public purchases of private goods and public investment. As we will see throughout the paper, I observe a clear rise in *private* employment in the case of a (non-productive) public consumption but that the rise in employment is more ambiguous in the case of a public investment shock, confirming the idea developed in Ramey (2012). However, if Ramey argues that the negative effect on private employment is due to the use by the government of private ressources, in my model this is due to a strong and lasting rise of the real wages. On the contrary, the co-movement highlighted hereinabove is always observed in the case of a public consumption shock.

The issue more closely concerns the response of the unemployment rate for which the existing studies face difficulties to provide a unified answer. Since both employment and labor force participation would rise following a public spending shock, the total effect on the unemployment rate is uncertain. Mayer, Moyen and Stähler (2010) develop a large-scale DSGE model with a labor market *à la* Mortensen et Pissarides and investigate what parameters of the model drive the response of the unemployment rate to a public spending shock. The main conclusions of this paper are that the drivers are: the degree of price stickiness, the degree of wage stickiness, the introduction of non-Ricardian households and the financing of public spending (debt or taxes). The authors conclude in a positive effect of the fiscal expenditures shocks on the unemployment rate. This result would be confirmed in some empirical studies and notably in Bruckner and Pappa (2012). Using the Blanchard-Perotti SVAR approach for a panel of OECD countries, the authors find a significant increase in employment, the labor force participation

and the unemployment rate. Then, they turn to a theoretical exercice, that is a new-Keynesian approach with matching frictions, and argue that a positive response of the unemployment rate can be generated by introducing a labor supply decision and heterogeneity in the pool of workers.

However, some other papers find significantly different results and conclude for a rather strong decrease of the unemployment rate. Monacelli, Perotti and Trigari (2010) explore both empirically and theoretically the response of the labor market to public spending expansions. The authors use a Choleski decomposition to identify the fiscal exogeneous innovations in the US economy. The empirical findings indicate a large decrease of the unemployment rate with a peak at -0.6%. However, developing a new-Keynesian model with matching frictions, they argue that the model hardly reproduces this fact, suggesting a lower unemployment fiscal multiplier, around -0.2%.

Finally, Ravn and Simonelly (2008) (RS hereinafter)...

In this paper, I use a new-Keynesian model very close to the one developed in Gali, Smets and Wouters (2012), except for the fiscal side of the model, more developed here. Gali, Smets and Wouters (2012) suggest another way to describe a non-Walrasian labor market, by linking the unemployment rate and the mark-up on wages. Following the authors, this model respects the original insight behind the Phillips curve and allows us to split between labor supply shocks and shocks on the wage markup. If the authors admit that their description of the labor market can be unrealistic, they argue that their labor market block is a simple device being able to replicate well the real behavior of the labor market and especially of the unemployment rate over the business cycle. In my model, I introduce public consumption and public investment but also two distortive taxes: a tax on consumption and a tax on the labor revenue of households.

The contribution of the paper can be summarized as follow. Firstly, considering the lack of consensus for the response of the unemployment rate, the aim of the paper is to contribute overall to this growing literature providing new results. Secondly, the model is calibrated for the Euro-Area, following the posterior distributions found in Smets, Warne and Wouters (2013) in which the authors estimate the Gali-Smets-Wouters model for the Euro-Area. To my knowledge, no study concerning the effects of public spending shocks on the labor market has been dedicated to the Euro-Area, except Pappa (2009) but this empirical study does not include the unemployment rate. Even if in my paper the model is not estimated, this calibration-based exercice can provide some results for the Euro-Area. Thirdly, I conduct a sensitivity analysis using the *Global Sensitivity Analysis Tool Box* developed by the Dynare team. I focus on households' preferences but also discuss the

potential role of the other parameters in the model.

The main results are as follow. For a public consumption shock, I find a strong decrease of the unemployment rate in the line of Monacelli, Perotti and Trigari (2010), with a peak at -0.6%. This result is for a deficit-financed public spending increase. I argue that even if the values of some parameters are changed, it is unlikely that the model produces a positive response of the unemployment rate. In the case of public investment however, the results are more mixed. The unemployment rate decreases just at the shock by about 1% but the computation of the cumulative multipliers for ten periods indicate that we could finally expect a lower effect on the unemployment rate and even a positive (or at least non-significant) response of the unemployment rate.

Concerning the importance of the values given to the parameters in households' preferences, if the importance is significant but low in the case of a public consumption shock, these changes strongly modify the multipliers in the case of a public investment shock. Overall, the effects of public investment seem to depend much more on the calibration of some parameters.

Finally the introduction of both taxes is investigated and both taxes have a significant impact on the multipliers. In the simulation exercice, I assume in turn that each tax funds the half of the deficit generated by spending. The tax on consumption raises the positive response of labor force participation via the existence of a wealth effect of consumption on the labor supply decision. Thus, the tax on consumption tends to diminish the unemployment fiscal multiplier. In the case of public consumption, the multiplier remains clearly negative but in the case of public investment, the addition of the consumption tax can generate positive effects on the unemployment rate. For the labor revenue tax, the latter decreases the marginal utility for work thus crowds out the labor force participation. The unemployment fiscal multipliers are thus always negative and higher when the labor revenue tax is introduced.

Section 2 presents the complete derivation of the model. Section 3 presents the results and discusses what elements drive the response of the unemployment rate. A fourth section concludes this paper.

2 The DSGE model

The model described in this paper is a medium-scale DSGE model with a detailed fiscal sector. The model is similar to Gali, Smets and Wouters

(2012) except the fiscal side and notably the introduction of taxes and public investment. Concerning Gali, Smets and Wouters (2012), the authors add to the Smets and Wouters (2007) structure the unemployment theory developed in Gali (2011). For the labor market side, the unemployment rate is observable and the nominal wage inflation is linked to the fluctuations of the unemployment rate.

2.1 Households

2.1.1 Optimizing process and FOCs

There is a continuum of Ricardian households on the interval $[0, 1[$ maximizing their preferences given the following lifetime utility function for the household i:

$$E_0 \sum_{t=0}^{\infty} \beta^t U_t(\tilde{C}_t(i), L_t(i)) = E_0 \sum_{t=0}^{\infty} \beta^t \left(log\tilde{C}_t(i) - \frac{X_t \Delta_t(i) N_t(i)^{1+\phi}}{1+\phi} \right) \quad (1)$$

The households earn utility from consumption $\tilde{C}_t(i)$ and disutility of labor $N_t(i)$. $\tilde{C}_t(i)$ contains habit formations for consumption such as: $\tilde{C}_t(i) = C_t(i) - hC_{t-1}$ with C_{t-1} the aggregate (average) past consumption.β^t is the discount factor and ϕ denotes the labor elasticity of substitution. X_t is a preference shock, increasing current disutility from working. I assume this shock to be common to all the households.

For simplicity purposes, I can delete the subscript i for the next equations representing the problem as that of a representative agent. Defining the aggregate labor supply as $l_t = \int_0^1 l_t(i)\,\mathrm{d}i$ and assuming there is a perfect risk-sharing for consumption between all the households in the spirit of Merz (1995), allow me to rewrite the optimization program for the representative household as:

$$E_0 \sum_{t=0}^{\infty} \beta^t (log\tilde{C}_t - \frac{X_t \Delta_t N_t^{1+\phi}}{1+\phi}) \quad (2)$$

Also, I can write out that $C_t(i) = C_t$.

Δ_t introduces the wealth effect on labor force participation. Thus,Δ_t is function of consumption, such as:

$$\Delta_t = Z_t / \tilde{C}_t \quad (3)$$

with $Z_t = Z_{t-1}^{1-\nu}(C_t - hC_{t-1})^{\nu}$. Z_t can be seen as a smoothed consumption

index allowing different degrees of wealth effect to be implemented on the labor supply. If consumption hikes above its steady-state value, the marginal utility of labor decreases which tends to a lower labor force participation. In the polar case that $\nu = 1$, the wealth effect is strong and the preferences are similar to the King-Plosser-Rebelo (1988) preferences and in the other polar case, that is with $\nu = 0$, there is no wealth effect, thus consumption and labor are perfectly additively seperable as in the Greenwood-Hercowitch-Huffman (1988) preferences.

The households face the following budget constraint:

$$(1+\tau_t^c)P_tC_t+P_tI_t+\frac{E_tB_{t+1}}{1+R_t} \leq (1-\tau_t^w)W_tN_t+B_t+R_t^kV_tK_{t-1}-f(V_t)V_tK_{t-1}+Div_t \tag{4}$$

P_t is the general level of prices, R_t the quarterly nominal interest rate, W_t is the nominal wage and B_t is the government bonds held by the households. They also invest in capital, I_t representing the level of investment and K_t the accumulated capital. They loan this capital to the firms at the rate R_t^k. V_t is the degree of capital utilization and $f(V_t)$ is a function characterizing the cost for the households of a change in the degree of capital utilization. Finally, Div_t is the profit of firms redistributed to the households.

The capital accumulation is described by the following law of motion:

$$K_t = (1-\delta)K_{t-1} + \epsilon_t^i[1 - S(\frac{I_t}{I_{t-1}})]I_t \tag{5}$$

with $S(\frac{I_t}{I_{t-1}}) = \frac{\psi}{2}\left(\frac{I_t}{I_{t-1}}\right)^2$ an investment cost with ψ a fixed cost. The effectively workable capital $\tilde{K}_t$ is defined as $\tilde{K}_t = V_tK_{t-1}$.

Maximizing (1) with (4) and (5) yield the FOCs respectively for consumption, debt, investment, capital accumulation and capital utilization such as:

$$\lambda_t = \frac{U'_{C,t}}{P_t(1+\tau_t^c)} \tag{6}$$

$$\lambda_t = \lambda_{t-1}(1+R_t) \tag{7}$$

$$\lambda_tP_t = \Omega_t\epsilon_t^i(1-S(\frac{I_t}{I_{t-1}})-S'(\frac{I_t}{I_{t-1}})(\frac{I_t}{I_{t-1}}))+E_t\Omega_{t+1}\epsilon_{t+1}^i(1-S'(\frac{I_{t+1}}{I_t})(\frac{I_{t+1}}{I_t})^2) \tag{8}$$

$$\Omega_t = \beta E_t[\lambda_{t+1}(R_{t+1}^kV_{t+1} - P_{t+1}f'(V_{t+1})) + \Omega_{t+1}(1-\delta)] \tag{9}$$

$$\frac{R_t^k}{P_t} = f'(V_t) \tag{10}$$

where λ_t and Ω_t are respectively the Lagragian multipliers corresponding to the budget constraint and to the capital accumulation equation.

Including (6) in (8) allows us to obtain the consumption Euler equation:

$$\frac{U'_{c,t}}{U'_{c,t+1}} = \frac{1+R_t}{\Pi_{t+1}} \frac{1+\tau^c_t}{1+\tau^c_{t+1}} \tag{11}$$

2.1.2 Labor force participation, Wage setting and unemployment rate

Firstly, I define the marginal rate of substitution between consumption and leisure such as:

$$MRS_t = \frac{(1-\tau^w_t)U'_N}{(1+\tau^c_t)U'_C} = \frac{W_t}{P_t} \tag{12}$$

By replacing the utility by its functional form, I obtain:

$$(1-\tau^w_t)W_t/P_t = X_t \tilde{C}_t \Delta_t N^\phi_t \tag{13}$$

$$(1-\tau^w_t)W_t/P_t = X_t Z_t N^\phi_t \tag{14}$$

Workers (or, similarly, representative unions) are allowed to set the nominal wage since they all offer a differentiated kind of labor, leading to a monopoly power environment in the labor market. Similarly to the price-setting for the firms described later, the workers face a certain degree of nominal wage rigidity introduced à la Calvo (1983). The workers maximize their nominal wage denoted by W^*_t in order to maximize their utility, subject to a sequence of isoelastic demand schedules exuding from the firms and subject to their flow of budget constraints.

Following Calvo (1983), the workers can only reoptimize their nominal wage at each period with a probability $(1-\theta^w)$, independantly of the number of periods since they last reoptimized their wage. In this model, when the worker cannot reoptimize the nominal wage, there is a partial indexation of the nominal wage on past inflation, the degree of indexation being defined by the parameter γ^w. The wage at the period k of a worker who has not reoptimized his wage since the period t is of the form $W_{t+k/t} = W_{t+k-1/t}(\Pi^p_{t-1})^{\gamma^w}(\Pi^p)^{1-\gamma^w}$ with Π^p the level of inflation at the steady-state. Since I assume a zero steady-state inflation such that $\Pi^p = 1$, the nominal wages are only indexed on past inflation.

The sequence of isolelastic demand schedules are defined such as $N_{t+k/t} = \left(\frac{W_{t+k/t}}{W_{t+k}}\right)^{-\epsilon^w} N_{t+k}$. The first condition for the wage setting maximizing pro-

cess is expressed as [3] :

$$\sum_{k=0}^{\infty}(\beta\theta_w)^k E_t\left[\left(\frac{N_{t+k/t}}{C_{t+k}}\right)\left(\frac{W^*_{t+k/t}}{P_{t+k}}-\frac{\epsilon^w}{\epsilon^w-1}MRS_{t+k/t}\right)\right]=0 \tag{15}$$

where $\frac{\epsilon^w}{\epsilon^w-1}$ corresponds to the wage mark-up desired by the workers. The last step is to introduce the previous condition in the following law of motion of the aggregate nominal wage that takes accounts of the automatic indexation of the nominal wage on past infation, that is:

$$W_t=[\theta_w(W_{t-1}(\Pi^p_{t-1})^{\gamma_w})^{1-\epsilon^w}+(1-\theta_w)(W^*_t)^{1-\epsilon^w}]^{\frac{1}{1-\epsilon^w}} \tag{16}$$

Concretely, the wage dynamic is based on the fluctuations of the effective mark-up with rapport to the natural mark-up $\frac{\epsilon^w}{\epsilon^w-1}$. In this case, the effective markup is expressed as:

$$\frac{W_t}{P_t}-MRS_t \tag{17}$$

The mark-up is linked to the unemployment rate and is equal to ϕU_t with U_t defines unemployment.

In order to give a clear definition to unemployment, the final step is to make clear the definition of the labor force participation in the model. Following Gali, Smets and Wouters (2012), I assume that a worker (i) will agree to participate in the labor market and to find a job if its utility towards the labor revenue is superior to the disutility of work, that is:

$$\left(\frac{1}{C_t-hC_{t-1}}\right)\left(\frac{W_t(i)}{P_t}\right)\geq X_t\Delta_t L^{\phi}_t(i) \tag{18}$$

where $L_t(i)$ denotes the labor supply for the worker (i). Re-expressing the equation (18) and saturing this condition, the (aggregate) labor force participation is defined by:

$$\frac{W_t}{P_t}=X_tZ_tL^{\phi}_t \tag{19}$$

Finally, unemployment is defined merely as the difference between the labor force participation and employment, such as:

$$U_t=L_t-N_t \tag{20}$$

Equation (19) allows us to obtain the labor supplied by the households, namely the labor force participation. This specification for the labor supply allows us to analyze different changes on parameter values. Firstly, the

[3] A total derivation of this step can be found in Erceg, Henderson and Levin (2000)

parameter ϕ captures the sensitivity of the labor supply to both the real wage and the smoothed consumption. Moreover, changes on the parameter ν included in Z_t uniquely describes the sensitivity of the labor supply to consumption.

2.2 Firms

2.2.1 Final goods firms

In this two-sector model, the final goods firms do not produce anything but package the different goods (i) produced at the intermediary level in a final homogeneous commodoty Y_t sold to the households and to the government. If I assume than the intermediary firms are in a monopolistic environment, the final packagers are in a perfectly competitive environment.

For simplicity purposes, I do not include an exogeneous shock on the aggregator function as is done in Smets and Wouters (2007) for instance. The firms seek to maximize their profit such as:

$$\max_{Y_t(i),Y_t} P_t Y_t - \int_0^1 P_t(i) Y_t(i)\,\mathrm{d}i \tag{21}$$

$$s.t. \left[\int_0^1 G\left(\frac{Y_t(i)}{Y_t}\right)\,\mathrm{d}i\right] = 1 \tag{22}$$

where G is a function characterising the demand for the different goods i. In the spirit of Kimball (1995), I assume that G is increasing and strictly concave. Combining the two first-order conditions, the demand for an intermediary commodity i is:

$$Y_t(i) = Y_t G'^{-1}\left[\frac{P_t(i)}{P_t}\int_0^1 G'\left(\frac{Y_t(i)}{Y_t}\right)\frac{Y_t(i)}{Y_t}\,,di\right] \tag{23}$$

Thus, the demand for an input (i) is negatively function of its relative price $\frac{P_t(i)}{P_t}$.

2.2.2 The indermediary sector

A continuum of differentiated intermediate firms over [0,1[produce goods in a monopolistic competition and thus are allowed to set their price constrained by a Calvo sticky-wage process. Their production technology is a standard Cobb-Douglas function to which is added the public accumulated capital. The final firm then purchases a basket of the intermediate goods and retails a package of the goods at the consumers.

The technological process of the productive firms is defined by the following

Cobb-Douglas function:

$$Y_t(i) = \epsilon_t^a \tilde{K}_t^{\alpha}(i) N_t^{1-\alpha}(i)(K_{t-1}^g(i))^{\alpha_g} \tag{24}$$

Where $\tilde{K}_t$ is the effective capital used for production defined by $\tilde{K}_t = V_t K_{t-1}$. As said previously in the paper, the public capital enters the production function assuming that this governement investment is productivity-enhancing for the private sector. The degree of productivity of the public capital in the production process is captured by the parameter α^g. As discussed in Leeper, Walker and Yang (2010), there is no evidence about the real value of this parameter. This is particularly annoying since giving different values to this parameter change significantly the effects of a public investment shock. The latter has a demand effect and also a supply effect by affecting the level of production of the intermediary firms. The value given to α^g will affect the response of prices and so the responses of the interest rate, private consumption and so on. I decide in this paper to set $\alpha^g = 0.05$, that is an acceptable value oftenly used in some related papers.

The profit of the firm is expressed as:

$$\Pi_t^f(i) = P_t(i)Y_t(i) - W_t N_t(i) - R_t^k \tilde{K}_t(i) \tag{25}$$

Maximization of (25) subject to (24) gives the following FOCs for capital and labor, such as:

$$\frac{\partial \Pi_t^f(i)}{\partial N_t(i)} = 0 \Leftrightarrow (1-\alpha)\epsilon_t^a \tilde{K}_t^{\alpha} N_t^{-\alpha}(K_{t-1}^g)^{\alpha_g} = \frac{W_t}{P_t}\nabla_t \tag{26}$$

$$\frac{\partial \Pi_t(i)}{\partial K_t(i)} = 0 \Leftrightarrow \alpha\epsilon_t^a \tilde{K}_t^{\alpha-1} N_t^{1-\alpha}(K_{t-1}^g)^{\alpha_g} = R_t^k \nabla_t \tag{27}$$

where ∇_t is the Lagrangian multiplier associated with the technological constraint (24). By rearranging equations (26) and (27) I find the demand function for each input, such as:

$$\tilde{K}_t = \frac{W_t}{P_t}\frac{N_t}{R_t^k} \tag{28}$$

By using and rearranging the two previous FOCs, the marginal cost for the firms can be expressed as:

$$MC_t = \frac{(R_t^k)^{\alpha}\left(\frac{W_t}{P_t}\right)^{1-\alpha}}{\alpha^{\alpha}(1-\alpha)^{1-\alpha}\epsilon_t^a (K_t^g)^{\alpha_g}} \tag{29}$$

2.2.3 Price setting

Each firms seeks to maximize its future flow of profits by setting the optimal price $P_t^*(i)$. Under Calvo pricing, there is only a fraction $(1-\theta^p)$ that can reoptimize their price at each period. Similarly to the wage-setting, I assume that in the absence of reoptimization, there is a partial indexation of prices on past aggregate inflation with a degree of indexation γ^p. In Smets and Wouters (2007), the authors assume that there is also an indexation on long term inflation at a degree $1-\gamma^p$. For simplicity purposes, I assume that the steady-state is non-inflationist thus I neglect this term in the following price-setting mechanism. The optimisation problem for a firm (i) is:

$$maxE_t \sum_{k=0}^{\infty} \theta^p \frac{\beta^k \lambda_{t+k} P_t}{\lambda_t P_{t+k}} [P_t^*(i)(\Pi_{l=1}^k \pi_{t+l-1}^{\gamma^p}) - MC_{t+k}] Y_{t+k}(i) \tag{30}$$

subject to the demand function of the final firms for the individual commodity (i) function of the level of the aggregate demand and of the real price for the commodity (i):

$$Y_{t+k}(i) = Y_{t+k} F'^{-1} \left(\frac{P_t(i) X_{t,k}}{P_{t+k}} \int_0^1 G' \left(\frac{Y_t(i)}{Y_t} \right) \frac{Y_t(i)}{Y_t} \, \mathrm{d}i \right) \tag{31}$$

where $X_{t,k}$ denotes the automatic indexation on past inflation. Since the indexation only begins at the second period, $X_{t,k} = 1$ for $k = 0$ and $X_{t,k} = \Pi_{l=1}^k \pi_{t+l-1}^{\gamma^p}$ for all the following periods.

Maximization of (30) subject to (31) yields the following first-order condition:

$$E_t \sum_{k=0}^{\infty} \theta^p \frac{\beta^k \lambda_{t+k} P_t}{\lambda_t P_{t+k}} Y_{t+k}(i) \left(X_{t,k} P_t^*(i) + (P_t^*(i) X_{t,k} - mc_{t+k}) \frac{G'(F_{t+k})}{G'^{-1}(H_{t+k}) G''(F_{t+k})} \right) = 0 \tag{32}$$

with $F_t = G'^{-1}(H_t)$ and $H_t = \frac{P_t(i)}{P_t} \int_0^1 G' \left(\frac{Y_t(i)}{Y_t} \right) \frac{Y_t(i)}{Y_t} \, \mathrm{d}i$.

Finally, the law of motion of the general level of prices, P_t, is defined as:

$$P_t = (1-\theta^p) P_t(i) G'^{-1} \left[\frac{P_t(i) \int_0^1 G' \left(\frac{Y_t(i)}{Y_t} \right) \frac{Y_t(i)}{Y_t} \, \mathrm{d}i}{P_t} \right] + \theta^p \Pi_{t-1}^{\gamma^p} P_{t-1} G'^{-1} \left[\frac{\Pi_{t-1}^{\gamma^p} P_{t-1} \int_0^1 G' \left(\frac{Y_t(i)}{Y_t} \right) \frac{Y_t(i)}{Y_t} \, \mathrm{d}i}{P_t} \right] \tag{33}$$

2.3 Market clearing condition

In order to obtain an equilibrium on the market for goods and services, the aggregate demand for goods is defined such as:

$$Y_t = C_t + I_t + V_t + C_t^g + I_t^g \tag{34}$$

2.4 Economic policies

The monetary policy is introduced in the usual manner, namely a Taylor rule. The nominal interest reacts to the variations of output and to the price inflation, such as, in log:

$$r_t = \rho^r r_{t-1} + (1-\rho_r)(\Phi^y \Delta y_t + \Phi^\pi \pi_t^p) \tag{35}$$

where ρ^r is a degree of inertia of the nominal interest rate and $\Delta y_t = y_t - y_{t-1}$. Φ^y and Φ^π define respectively the weight given in the Taylor rule for the stabilization of the output and of the inflation rate.

As previously said, the fiscal spending is composed of public purchases of goods and services and public investment, respectively defined by C_t^g and I_t^g. The financing of this spending is assumed to be partly tax-based and partly debt-based.

The total spending for the government G_t is defined by:

$$G_t = C_t^g + I_t^g \tag{36}$$

Each spending is introduced as an AR(1) shock, such as in logs:

$$c_t^g = \rho^{c,g} c_{t-1}^g + \epsilon_t^{c,g} \tag{37}$$

$$i_t^g = \rho^{i,g} i_{t-1}^g + \epsilon_t^{i,g} \tag{38}$$

where $\rho^{c,g}$ and $\rho^{i,g}$ are the parameters defining the duration of the exogeneous shocks.

Two taxes are levied by the government: a tax on consumption and a tax on labor income. Introducing such taxes is interesting because both will change the optimal choice of the households for consumption and labor supply. Introducing a lump-sum tax is not very informative since a lump-sum tax will only change the size of the multiplier but not the decisions for consumption and labor supply which are the focus of this work.

The budget constraint in nominal terms for the government is expressed as:

$$P_t C_t^g + P_t I_t^g = P_t \tau_t^c C_t + \tau_t^w W_t + P_t D_t \tag{39}$$

with D_t the deficit of the government. The accumulation of debt is predetermined such as:

$$B_t = (1+R_t) B_{t-1} + D_t \tag{40}$$

Many empirical studies tend to conclude for the consideration of the levels of debt and deficit when the government chooses its fiscal standing: the

government tries to sustain a given level of debt. A deficit-sustainability objective for the government is introduced in the working of the fiscal sector. The adjustment variables are the two taxes and each one responds to the level of deficit, such as in logs:

$$\tau_t^c = \rho^{\tau,c}\tau_{t-1}^c + \alpha^{\tau,c}d_t \tag{41}$$

$$\tau_t^w = \rho^{\tau,w}\tau_{t-1}^w + \alpha^{\tau,w}d_t \tag{42}$$

with $\alpha^{\tau,c}, \alpha^{\tau,w} \in [0;1]$. These parameters represent the degree of reaction of the taxes to the level of deficit. The introduction of such rules is relevant theoretically to mimic the real behavior of a government. It is also relevant to introduce a degree of inertia in the tax-rules, defined by the parameters $\rho^{\tau,c}$ and $\rho^{\tau,w}$ since tax rates can not change dramatically in a few quarters.

For public investment, the law of motion of the public capital accumulation is similar to the capital accumulation of private capital. For simplicity purposes, I assume that the depreciation rates of capital are identical across sectors.

$$K_t^g = (1-\delta)K_{t-1}^g + \left(1 - S\left(\frac{I_t}{I_{t-1}}\right)\right) I_t^g \tag{43}$$

3 Calibration, simulations and analysis

3.1 Some comments about the calibration and the sensitivity analysis exercise

The model developed in Gali, Smets and Wouters (2012) is estimated for the US. In a recent IMF working paper, Smets, Warne and Wouters (2013) estimate the same model, but for the Euro-Area, aiming to deal with the forecast performances of the new-Keynesian model. Some differences arise concerning the mean posterior produced by the estimations, notably the Euro-Area has a larger price and wage rigidity than the US (respectively θ_p and θ_w), a higher elasticity of substitution of the labor supply ϕ and a higher share of capital α in the production function.

Concerning the degree of habit formation for consumption, two values are tested. These habits can be very strong (around 0.8) but the degree varies according to the estimations: for instance, Smets, Warne and Wouters (2013) find for the Euro-Area $h = 0.65$. In this paper, I set initially $h = 0.65$ but simulate also with a low value, $h = 0.3$. The inverse of the elasticity of the labor supply ϕ is set to 2. This parameter mainly drives two transmission channels: firstly the wealth effect of consumption on the labor supply (but

Parameter	Value
h	0.65
ϕ	2
ψ	6
δ	0.025
β	0.995
c_y	0.5
i_y	0.2
g_y	0.2
v_y	0.1
ig_y	0.1
α	0.18
M_p	1.48
Θ_p	0.5
γ_p	0.5
κ	10
γ_w	0.16
Θ_w	0.5
ξ_w	1.5
Θ^y	0.19
Θ^π	1.25
ρ^r	0.9
α^τ	0.5
Ξ	0.5
α^g	0.05

Figure 1: Initial calibration of the model

also the sensitivity of the labor supply to the real wages). Secondly, the wage equation indicates that the higher the elasticity of the labor supply, the higher the effect of the unemployment rate on wage setting. In order to assess the importance of this parameter, the model is simulated also with $\phi = 0.5$. This is a lower level in relation to estimates in the literature but a plausible value characterizing a strong elasticity of the labor supply. As previously said in the third section, the parameter ν allows us to implement different degrees of wealth effects of private consumption on the labor supply. In Gali, Smets and Wouters (2011), the value of the parameter depends drastically on the fact that the model is estimated with the unemployment rate as observable or not: I initially set $\nu = 0.4$. In order to test a high level of wealth effect, I also simulate the model with $\nu = 1$, increasing the role of the response of the private consumption on that of the labor force participation.

3.2 Case of a government consumption shock funded by debt

Parameter	Baseline value	Tested value
ν	0.4	1
ϕ	2	0.5
h	0.65	0.3

Figure 2: Changes in parameter values for the different simulations

3.2.1 Baseline results

In this subsection, public spending is assumed to be financed entirely by debt. The case of public shocks funded by distortive taxes is addressed in subsection 3.4.

A fiscal consumption shock tends to hike both employment and the labor force participation and that is the case in this model. The shock raises the total demand addressed to the firms, thus the demand for each input as well, that is capital and labor. Following this increase in the labor demand, the unemployment rate decreases and the real wages increases. Facing this additional demand, firms set higher prices according to the degree of price rigidity leading to a higher inflation. The central bank reacts by raising its interest rate, thus households' consumption decreases. With the introduction of the preferences *à la* Jaimovich and Rebelo (2009) allowing for a smoothed wealth effect on the labor force participation, a lower consumption causes an higher labor force participation already boosted by the rise of the real wages.

The cumulative multipliers in figures 4 and 5 are computed following Mountford and Uhlig (2009). For instance, the cumulative multiplier after k quarters for output following a public consumption expansion is equals to:

$$\frac{\sum_{i=1}^{k}\left(\prod_{i=1}^{k}(R_{t+i-1})^{-1}\right)\Delta Y_{t+i-1}}{\sum_{i=1}^{k}\left(\prod_{i=1}^{k}(R_{t+i-1})^{-1}\right)\Delta C^{g}_{t+i-1}} \tag{44}$$

The GDP fiscal multiplier is around 1 when the shock occurs, which is a reasonable value in relation to the literature.

With the baseline calibration, the rise of the labor demand exceeds the rise of the labor supply, thus the unemployment rate decreases. As illustrated

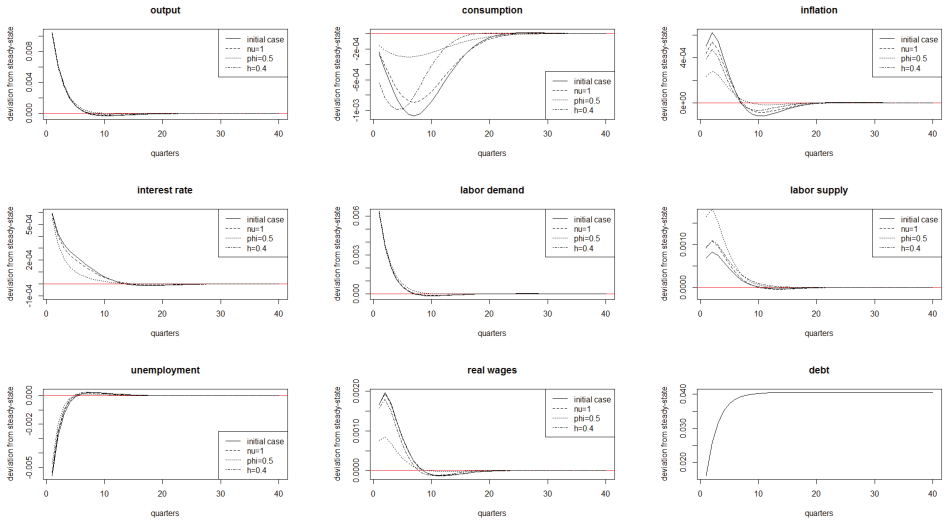


Figure 3: Effects of an increase of public consumption (corresponding to 1% of GDP)

	Baseline value	$\nu = 1$	$\phi = 0.5$	$h = 0.3$
1st period	1.04%	1.04%	1.04%	1.02%
5 periods	2.31%	2.32%	2.36%	2.25%
10 periods	2.29%	2.33%	2.48%	2.29%

Figure 4: Cumulative GDP multipliers for a 1% of GDP increase of public consumption

in figure 3, the unemployment rate falls by 0.56% and the peak of this effect is at the first period. In comparison with the literature, I find strong (negative) multipliers for the public consumption shock close to Monacelli, Perotti and Trigari (2010) and to a lesser extent to Ravn and Simonelli (2008). A common result in this literature is that the effects on the unemployment rate are short-lasting. This is the case in this simulation with a life time for the effect of about 10 periods. Regarding the labor force participation, two effects drive the response: the rise of the real wage and the fall of private consumption. Figure (3) indicates that the response of the real wage is very short-lasting, leading to a fast return of the unemployment rate to its steady-state, even if the response of private consumption is longer-lasting. For the labor demand, the highly temporary response is due to the response of the real-wage and to the effect of the supplementary exogenous demand deeply dampened by the strong U-shaped decrease in private consumption. The U-shape of private consumption is obtained by introducing a degree of habit formation for consumption, corresponding to a real rigidity on consumption.

	Initial case	$\nu = 1$	$\phi = 0.5$	$h = 0.3$
1st period	-0.56%	-0.54%	-0.47%	-0.53%
5 periods	-1.02%	-0.94%	-0.75%	-0.89%
10 periods	-0.94%	-0.87%	-0.71%	-0.80%

Figure 5: Cumulative unemployment multipliers for a 1% of GDP increase of public consumption

This is the labor demand which drives the unemployment fiscal multiplier. The labor demand increases by 0.65%. Figure 3 indicates that the labor supply has a weaker reaction, having a peak of 0.17% even in the situation where the labor supply is strongly elastic ($\phi = 0.5$). In such a configuration, this model argues in favor of a co-movement of labor demand and labor supply, but it is unlikely that labor force participation exceeds labor demand and thus that the model produces a positive response of the unemployment rate.

3.2.2 Focus on parameters for households' preferences

In order to analyze the robustness of these results, let us take a look at the different alternative calibrations. The aim is to address the importance of the model parameters introduced in households' preferences. The four scenarios are: a simulation with the baseline calibration. Then, I introduce a higher wealth effect on the labor supply by setting $\nu = 1$ instead of $\nu = 0.4$ initially. Thirdly, I set $\phi = 0.5$ instead of $\phi = 2$ which amounts to introducing a stronger elasticity of substitution since ϕ denotes the inverse of the elasticity of substitution of the labor supply. Finally, I initially set a rather strong degree of habit formation in consumption with $h = 0.65$, I investigate the case of a lower real rigidity on consumption by setting $h = 0.3$. The IRFs for each calibration are presented in the figure 3.

The cumulative unemployment fiscal multipliers (Figure 4) indicate that the introduction of theses large changes in the value of ν, ϕ and h does not dramatically change the effects at the medium run of the public consumption on the unemployment rate. However, the effects are different according to what parameter is considered. The most influencing parameter is the inverse of the elasticity of substitution ϕ. A rise in this elasticity dampens the unemployment fiscal multiplier by increasing the reaction of the labor supply (by about 100%) to a higher real wage and a weaker consumption. The parameter ϕ has an additional effect through the nominal wage setting. ϕ positively influences the response of the nominal wage to a change in the

wage mark-up. Thus, the lower the elasticity of substitution, the lower the reaction of the nominal wage to a change in the wage-mark-up, thus to the unemployment rate. As a consequence, the real wage hikes less strongly than in the initial case, constraining the rise in labor supply. The way ϕ is included in the wage setting dampens the initial positive effect of a higher elasticity of substitution of labor on the unemployment rate. If the volatility of the labor supply doubles when introducing a strong elasticity of substitution, the final effect on the unemployment rate is significant but low since the labor supply has a weak initial dynamic.

Concerning the parameters h and ν, the changes in their values has some significant but low effects on the total effect of the consumption shock on the unemployment rate. Introducing a lower real rigidity for consumption ($h = 0.3$), the latter reacts more quickly to the shock, increasing more quickly the labor supply through the wealth effect. Introducing a strong wealth effect of private consumption on the labor supply ($\nu = 1$), this increases more and partially absorbs the negative effect of the shock on the consumption. If introducing these calibration changes affects the impact of public consumption shock on the unemployment rate, the changes in the values are large and the consequences on the multipliers are weak. Indeed, I attempt to argue that the results concerning the unemployment fiscal multipliers are quite robust to changes on the values of the parameters introduced in households' preferences. Even if I can introduce different dynamics for the labor supply, the amplitude of these changes is sufficiently low to observe large and negative effects on the unemployment rate in all cases. One will see that this result does not hold anymore in the case of a public investment shock. For public investment, changes in values for these parameters engender very different multipliers. In the next subsection, I investigate more deeply what parameters drive the response of the unemployment rate following the shock by achieving a global sensitivity analysis.

3.2.3 What parameters drive the unemployment fiscal multiplier? A sensitivity analysis

I compute the following sensitivity analysis using the Dynare program and more precisely the "Global Sensitivity Analysis Toolbox". Dynare runs a Monte Carlo process from the structural model generating 3000 data (and I offset the 1000 first draws). Then, with the prior for the parameters as given (first and second moments, the distribution shape), Dynare analyses the importance of each parameter for each variable and for each shock.

The results are summarized in Figure 6. The parameters included in households' preferences affect the response of the unemployment rate, labor de-

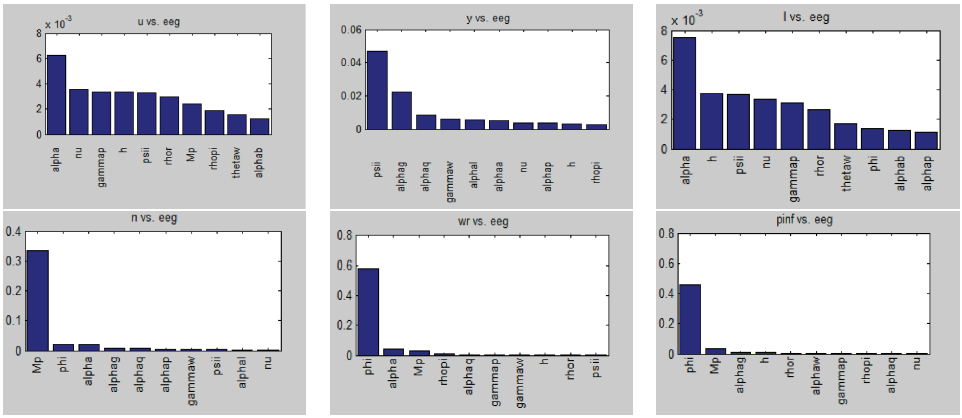


Figure 6: Sensitivity analysis results to the government consumption shock.

mand and labor supply but are not predominant: other parameters are of interest. Especially, deep parameters like the degree of price stickiness strongly drive the unemployment fiscal multiplier. Also, two structural parameters are important concerning the response of the labor demand: the fixed cost in the production function Mp and the share of labor $(1 - \alpha)$. For the degree of return to scale, I initially set $Mp = 1.48$: this is the value estimated in Smets Warne and Wouters (2012). This is a plausible but high value. This parameter is most likely to take a lower value than a higher one. It drives the response of the firms to a supplementary demand. The higher the value of this parameter, the lower the increase of the demand for capital and labor by the firms following a positive demand shock. If I decrease the value of Mp, the labor demand tends to be higher following the public expenditure shock than in the initial case. Since I already use a high value for this parameter, there is no chance that this parameter could explain and produce positive response of the unemployment rate in response to positive fiscal shocks.

For the value of the parameter α which defines the share of capital (and thus of labor) in the production function, I set $\alpha = 0.18$. This value can vary among countries but not widely. It is unlikely that this parameter can take extreme values allowing for a positive response of the unemployment rate.

The sensitivity analysis indicates that this model tends always to predict a negative effect of fiscal policy on the unemployment rate following a public consumption shock.

3.3 The case of a public investment shock

3.3.1 Baseline results

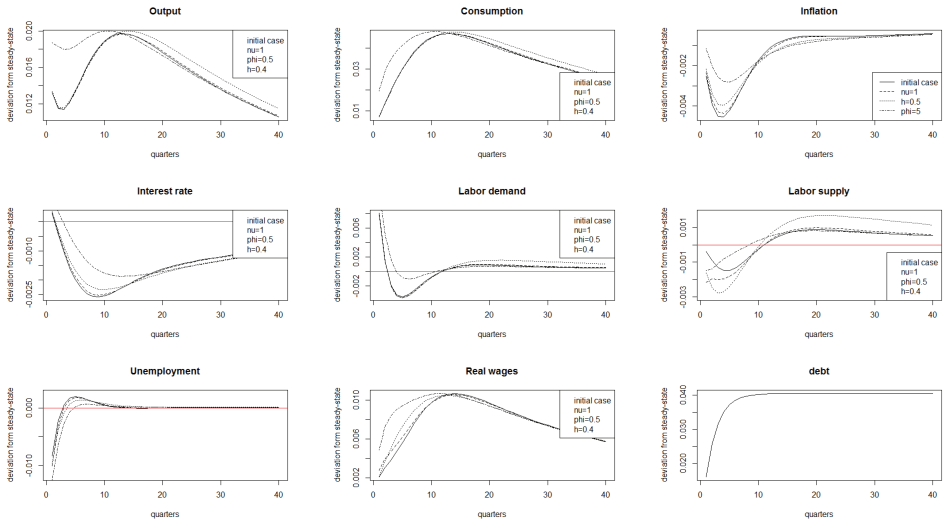


Figure 7: Effects of an increase in public investment (corresponding to 1% of GDP)

The effects of a rise in public investment are clearly different from government consumption, even if both tools partly share some transmission channels. Public investment is introduced in the total demand function like government consumption. A rise of government investment has the same demand effect as a rise in government consumption. Public investment also has a specific feature in the sense that public capital has a productive effect on the supply side of the model. Indeed, public capital enters as an input in the production function. As a consequence, public capital negatively influences the marginal cost of firms. The markup on price hikes, and therefore firms reduce prices. The interest rate decreases and private consumption hikes. Thus, the GDP fiscal multiplier for public investment is higher than for public consumption and the effects on the GDP are much longer-lasting

	Initial case	$\nu = 1$	$\phi = 0.5$	$h = 0.3$
1st period	1.33%	1.33%	1.34%	1.87%
5 periods	6.11%	6.10%	6.17%	9.04%
10 periods	14.34%	14.26%	14.36%	18.46%

Figure 8: Cumulative GDP multipliers for a 1% of GDP increase in public investment

	Initial case	$\nu = 1$	$\phi = 0.5$	$h = 0.3$
1st period	-0.84%	-1%	-0.96%	-1.25%
5 periods	-0.63%	-1.02%	-1.25%	-2.22%
10 periods	-0.09%	-0.47%	-0.72%	-1.94%

Figure 9: Cumulative unemployment multipliers for a 1% of GDP increase in public investment

than in the case of the government consumption shock as shown in figure 7 and implicitly in the IRFs figures 8 and 9.

Concerning the response of the labor market, I find greatly different dynamics for all the variables. The large increase in consumption significantly dampens the rise in labor force participation. However, the response of the labor force participation is longer-lasting in this simulation. This is due to the large and permanent rise in real wages. On the demand side, employment has a very different shape than in the case of the public consumption shock. Labor demand increases strongly just after the shock but the gradual increase in the real wages finally engenders a negative response of employment. The total effect on employment in the short run is more ambiguous for public investment. As is said in the introduction, the rise in employment and thus its comovement with real wages and labor force participation is less clear in the case of productive public spending, as highlighted in Ramey (2012). The model used here confirms the conclusion of this paper: with a large rise in real wages, the response of employment is ambiguous and, combined with a rise in labor force participation, we can expect positive unemployment fiscal multipliers.

3.3.2 Sensitivity analysis

Concerning the four alternative calibrations tested, figure (9) shows that the changes in the values of the parameters included in households' preferences have a great effect on the unemployment fiscal multipliers. Especially, with $h = 0.3$, the cumulative multiplier is clearly negative with a multiplier equal to -1.94% for ten periods. A conclusion is that in the case of public investment, the results are very sensitive to the values of these 3 parameters, contrary to the case of the public consumption expansion.

3.4 Introduction of taxes: does it significantly change the multipliers?

Until now, I assumed that the spending expansion was debt-based. I now introduce two taxes, namely a tax on consumption and a tax on labor rev-

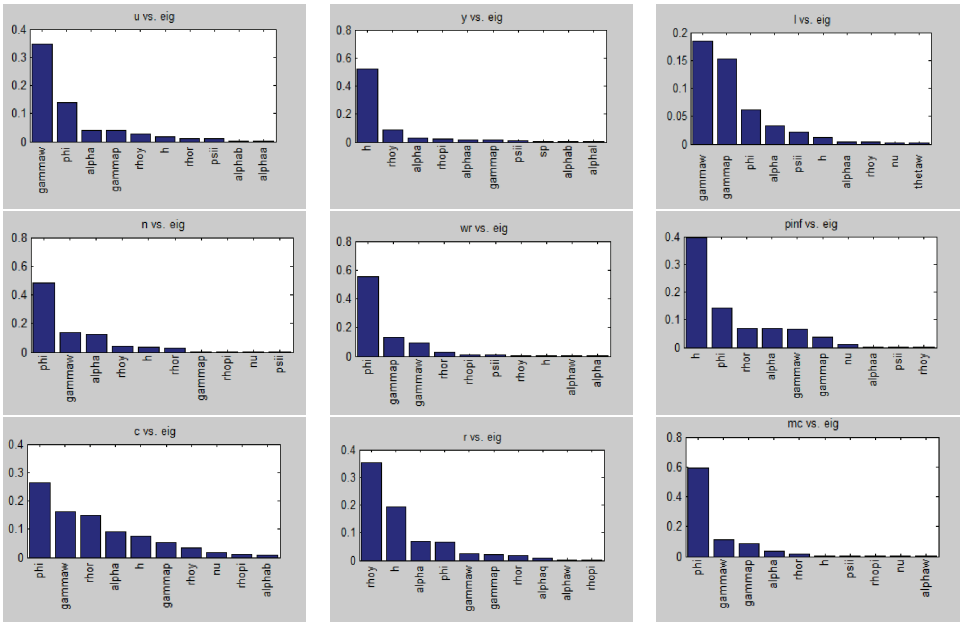


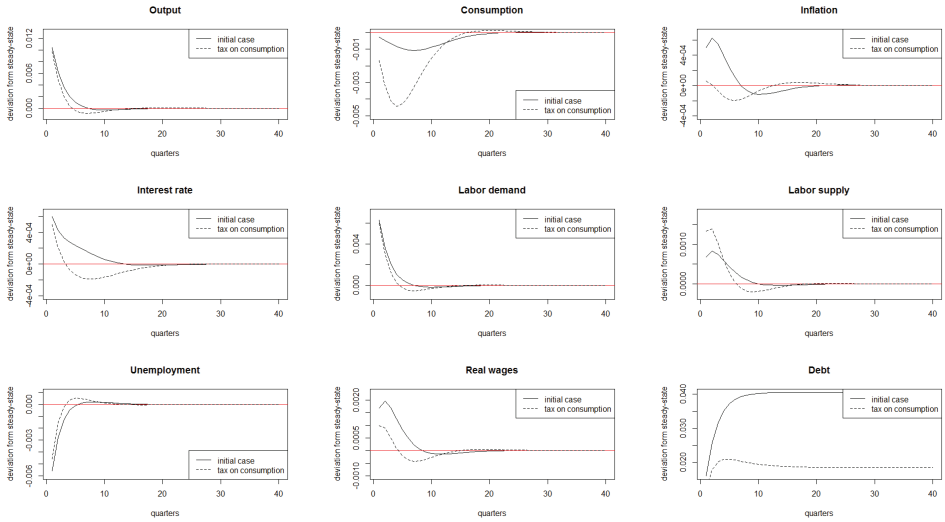
Figure 10: Sensitivity analysis results for the government investment shock.

enue. As said previously, taxes are introduced as simple rules and react to the variations of the deficit. According to the values given to $\alpha^{\tau,c}$ and $\alpha^{\tau,w}$, different scenarios of financing are testable. In this section, I attempt to investigate whether the introduction of the taxes in order to fund the spending expansion can produce positive unemployment fiscal multipliers. The tax on consumption can be seen as a relevant choice to investigate the case of a tax decreasing the demand and having a direct negative effect on the GDP. The tax on labor income is directly related to the labor force participation.

For both taxes, the methodology is the same. I set the parameters $\alpha^{\tau,c}$ and $\alpha^{\tau,w}$ in order to obtain a deficit two times lower than in the case of the totally debt-based expenditures. I then analyze whether the cumulative unemployment fiscal multipliers are still negative in these cases. For the next IRFs, I reproduce the cases with and without the tax in order to make the comparison easier.

3.4.1 The tax on consumption

With a tax on consumption, the public expenditure reduces much more private consumption. This crowding-out effect tends to decrease the positive effect of public consumption shock on GDP. A consequence is a lower hike of employment. Moreover, since private consumption drops sharply, the labor



Lecture: The solid line represents the initial case where spending is funded by debt. The dashed line is the case with tax on consumption.

Figure 11: Introduction of tax on consumption

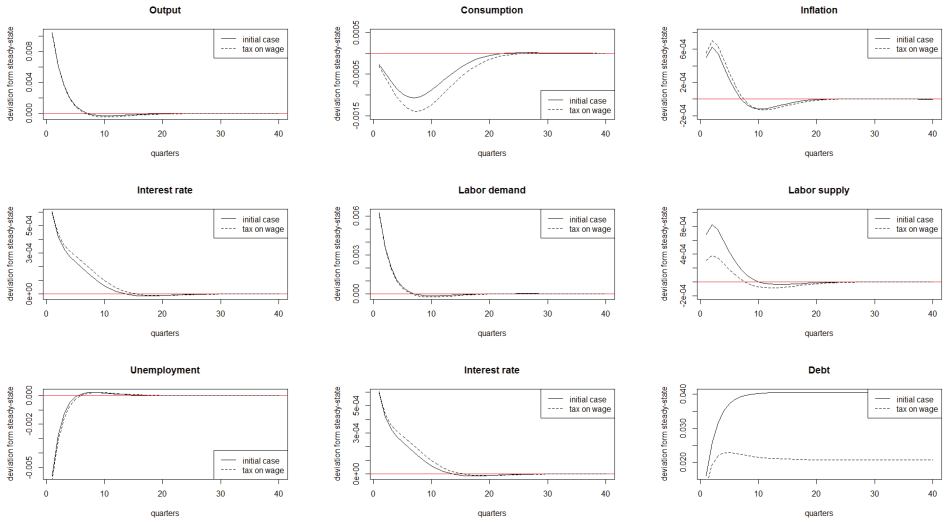
supply increases more on impact via the wealth effect. The tax rule is set in order to absorb half of the deficit which can be seen as a strong desire by the governement to sustain the level of deficit within the context of a countercyclical fiscal policy. Even in the case of this assumption, the unemployment fiscal multiplier remains strongly negative.

3.4.2 The tax on labor income

In this case, the tax on labor income produces a higher unemployment fiscal multiplier. With the tax, the marginal utility from working is lower, thus the households address a lower labor supply. However, the drop in disposable income reduces private consumption causing a lower GDP fiscal multiplier and a lower labor demand than in the initial (debt-based) case. The consequence on the labor supply is larger in absolute value than the consequence on the labor demand, producing higher negative effects on the unemployment rate in the case of a shock partly funded by a tax on labor income.

3.5 Comparison of the results with the existing literature

Two contradictory results emerge from the recent papers dealing with the effects of fiscal policy on labor market. In Ravn and Simonelli (2008)



Lecture: The solid line represents the initial case where spending is funded by debt. The dashed line is the case with the tax on labor income.

Figure 12: Introduction of the tax on labor income.

and Monacelli, Perotti and Trigari (2010), the unemployment rate tends to decrease when a positive public expenditures shock occurs. Similarly, Bermperoglu, Pappa and Vella (2013) investigate the cost of public spending cuts and find that the unemployment rate increases following cuts on public consumption, investment and employment. Only cuts on public wages could engender a lower unemployment rate. On the other hand, Mayer, Moyen and Stähler (2010) and Brückner and Pappa (2012) conclude for a significant rise in unemployment rate. However, all these papers share a same conclusion: conditional to public spending shocks, there is a comovement of hours worked, the employment rate and the real wages (see also Monacelli and Perotti (2009) and Pappa (2009)). The point is to know if the unemployment rate follows the same pattern or not. The key variable is the response of the labor force participation. All the papers considering this variable conclude for a hike of the labor force participation following a governement spending shock but the papers diverge with respect to the size of this rise. Brückner and Pappa (2010) argue that the labor force participation increases strongly (more than employment) leading to a positive effect on the unemployment rate.

In my paper, the obtained unemployment fiscal multipliers are very close to those found in Monacelli, Perotti and Trigari (2010). The authors estimate the effects of a public spending shock on key variables for the labor market using the well-known Blanchard and Perotti SVAR approach. The

unemployment fiscal multiplier they estimate is equal to -0.6%, quite similar to the multiplier I found in this paper. Monacelli, Perotti and Trigari (2010) then develop a New-Keynesian model with a Mortensen and Pissarides structure for the labor market. For the labor market, the authors explicitly model a participation choice for the workers to enter the labor market. They conclude that their theoretical model hardly reproduces the stylized facts observed in the SVAR specification. The version of the Gali, Smets and Wouters model used in this paper reproduces quite faithfully the IRFs found in Monacelli, Perotti and Trigari (2010) for the unemployment rate, employment and the real wage. However, one weakness of this model is that it cannot make explicit some labor market variables like the job finding probability or the vacancies-unemployment ratio for instance.

Ravn and Simonelli (2008) use a SVAR approach to investigate the dynamic of the labor market following a range of shocks and notably a government spending shock. The IRFs are significantly different from those presented here. One reason could be the fact Ravn and Simonelly (2008) consider an aggregate spending shock while I simulate the model with two subcomponents of public expenditure, namely public consumption and investment. Since I omit notably governement social transfers and public employment, one could argue that comparisons are biased but it is unlikely that this bias produced in itself such different results. Firstly, the SVAR predicts protracted effects of the public spending shock on the labor market while the DSGE model simulated in the paper sets off short-lasting effects. For instance, Ravn and Simonelli (2008) conclude for a (very large) gradual decline of the unemployment rate and that the peak of this decrease is obtained 3 years after the shock. This hump-shaped dynamic is in contradiction with the monotonic dynamic of the unemployment rate in my DSGE model. In addition, the size of the unemployment fiscal multiplier is significantly higher in Ravn and Simonelli (2008) than in the present paper.

Variable	RS (2008)	Public consumption	Public investment
Consumption	0.87	-0.26	0.95
Investment	0.68	0.88	0.86
Employment	0.66	0.91	0.20
Unemployment	-0.79	-0.97	0.15
Real wages	0.31	0.87	0.95
Labor force participation	/	0.15	0.57

Ravn and Simonelly (2008) compute the conditional and unconditional cross-correlations of the variables in relation to output. I reproduce the conditional cross-correlations for both public consumption and investment shocks and also the conditional cross-correlations found in Ravn and Simonelli (2008) in figure (13). The model used in this paper produces very dif-

ferent cross-correlations in comparison with the results expounded in Ravn and Simonelli (2008). The difference concerning consumption is easy to explain. In RS, consumption increases following the public spending shock while I obtain a negative response of consumption which is a common result in DSGE models in the absence of special features in the model such as non-Ricardian households or complementarity between private and public consumption for instance. [4] I find a very strong correlation between output and employment in the case of a public consumption shock and also a very strong negative correlation between unemployment and output. These correlations are higher but comparable with those found in Ravn and Simonelli (2008). In the case of the public investment shock, the correlations for employment and unemployment with respect to output are largely lower and positive for unemployment. The productive effect of public investment in comparison to public consumption leads to very different dynamics for the labor market. In either case, the DSGE model produces a very strong correlation between output and the real wages. This can be easily observed in the IRFs: in the case of the public consumption shock, responses for both output and the real wages are short lasting while they are protracted when a public investment shock occurs. In both cases, the real wages are clearly procyclical.

4 Conclusion

I show in this paper that public consumption boosts employment and labor force participation, and decreases unemployment without ambiguity, even when introducing VAT. Results are robust to changes on the parametrization of the households preferences. For public investment, the results are mixed, we can expect a raise in unemployment rate. The enhancing effects on employment are less clear. Furthermore, the parametrization of households' preferences in the case of a public investment is of first importance, since the public investment shock engenders a large rise in consumption.

This model contains two transmission channels of fiscal policy on labor supply: the rise in the real wage and the wealth effect *via* the introduction of consumption in the labor supply equation. A third transmission channel is not present in this model: a "call effect". This means that when employment increases, the probability of finding a job is higher: some inactive people can choose to return to the labor market. This transmission channel could be present in a job search model for the labor market but in any case in this

[4] An extensive literature investigates the response of private consumption to public spending shocks, see for instance Linnemann and Schabert (2004), Coenen and Straub (2005) or Gali, Lopez-Salido and Valles (2007).

present model. A call effect could reduce the size of the multiplier, but regarding the multipliers found in this paper, the call effect would have to be very large in order to obtain a positive response of the unemployment rate after a rise in public consumption.

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