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Abstract:

Several contributions have recently assessed the size of fiscal multipliers both in RBC models and New Keynesian models. None of the studies considers a model with frictional labour markets which is a crucial element, particularly at times in which much of the fiscal stimulus has been directed toward labour market measures. We use an open economy model (more specifically a currency area calibrated on the EMU) with labour market frictions in the form of labour turnover costs and workers' heterogeneity to measure fiscal multipliers. We compute short and long run multipliers and open economy spillovers for five types of fiscal packages: pure demand stimuli and consumption tax cuts return very small multipliers; income tax cut and hiring subsidies deliver larger multipliers as they reduce distortions in sclerotic labour markets; short-time work (German "Kurzarbeit") returns negative short-run multipliers, but stabilises employment. Our model highlights a novel dimension through which multipliers operate, namely the labour demand stimulus which occurs in a model with non-walrasian labour markets.

Keywords: fiscal multipliers, fiscal packages, labour market frictions.
JEL classification: E62, H30, J20, H20

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1 Introduction

Many alternative estimates of the fiscal multiplier have taken the scene of the recent debate over the impact of fiscal stimuli in the time of crisis. Following the Romer and Bernstein [17] estimates of the impact of an increase in government spending on GDP and employment in the United States, several other authors have revised estimates of the so called fiscal multiplier offering less favorable scenarios (see for instance Cogan, Cwik, Taylor and Wieland [5], Cwik and Wieland [7], Uhlig [19], Christiano, Eichenbaum and Rebelo [4]). All of those studies have been conducted using stylized RBC or New Keynesian models and by referring mainly to the US economy. Moreover they have compared broad fiscal measures (increases in government expenditure versus tax cuts) with no references to specific targets such as the labour market. In most cases the analyses have neglected the spillovers induced by fiscal packages across countries (for an exception, see Corsetti, Meier and Müller [6]).

The purpose of this paper is threefold. First, we aim at reconsidering measures of the fiscal multiplier in a model with equilibrium unemployment along the extensive margin and with labour market frictions in the form of labour turnover costs which allow for an endogenous determination of hiring and firing decisions. Indeed the reference model is essential to judge the quantitative impact of a fiscal package. We show that labour turnover costs reduce the multiplier on traditional government spending. Second, we are interested in comparing the impact of fiscal packages with diverse targets; government spending can indeed be directed toward specific labour market targets such as hiring or wage subsidies. Third, considering that different countries have adopted diverse fiscal measures both in terms of size and targets, we are interested in evaluating the open economy spillovers. For this reason we use an open economy model. Importantly, in our model spillover effects materialize in two different ways: first, changes in government expenditure, by affecting domestic demand, have an impact on the dynamics of terms of trade; second, changes in terms of trade have an impact on relative wages and job flows across countries.

For this analysis, we use a two country model (more specifically, a currency area calibrated on the EMU) with labour market frictions in the form of firing and hiring costs. Worker flows and wages in our model are determined by a variety of indicators, such as unemployment benefits, firing and hiring costs, taxes. The combination of those indicators allows us to design several alternative scenarios of fiscal packages. The fiscal packages are meant to capture the actual plans approved by various countries; for this reason we allow for various type of taxes (on consumption, on labour income, on firms' profits and lump sum transfers) and various targets for government spending (traditional boosts of aggregate demand and hiring subsidies).

We assume temporary fiscal shocks[1] financed with future lump sum taxes and compute short run and long run multipliers and spillovers across countries for five types of fiscal packages: *pure demand stimulus, consumption tax cut, income tax cut, hiring subsidies, short-time work (German "Kurzarbeit").* Those measures are designed to replicate as close as possible the interventions undertaken by some representative countries. Of particular interest are the last two as they induce shift in the endogenous determination of hiring and firing thresholds and thereby affect average productivity.

We find that multipliers are nearly zero for cuts in the consumption tax, small but positive for government spending and large for hiring subsidies and cuts in the income tax (for the latter only in the long-run) . Income tax cuts are beneficial as they reduce bargained wages (before taxes) and stimulate labour demand in a model with inefficient unemployment. Hiring subsidies help to reduce labour market distortions, hence they boost output. On the contrary, the extension of short-time work delivers negative output multipliers in the short run, as this measure increases the number of employed workers but endogenously reduces their productivity. However, short-time work can be used to stabilise the number of employed workers. Interestingly, our model highlights a novel dimension through which multipliers operate, namely the labour demand stimulus which occurs in a model with non-walrasian labour markets. Specifically, any measure that smoothes wages or reduces distortionary hiring costs, stabilizes inefficient unemployment fluctuations and amplifies both short run and long run output responses. In this respect our multipliers are largely driven by a supply-side mechanism rather than by a traditional demand-side mechanism.

A widespread concern is that large fiscal stimuli might induce potential free-riding from neighbouring countries due to the positive demand spillovers. We find small spillover effects. Finally, in order to add realism to the model, we test and confirm our results under two alternative assumptions: a) announced versus unannounced policies, b) fiscal intervention versus no intervention

[1] This seems realistic as in the aftermath of the crisis most fiscal packages included temporary interventions.

when starting from a recession scenario.

The rest of the paper is structured as follows. Section 2 describes the alternative fiscal packages undertaken by various countries. Section 3 describes the model economy. Section 4 shows quantitative results on the fiscal multipliers. Section 5 concludes.

2 Fiscal Packages Across Countries

In this section we provide an overview of the different packages undertaken by various countries following the current financial crisis. We refer to the four main Euro area countries, to the US and the UK. We describe both, the size of the fiscal stimuli and the target chosen for directing government expenditures. Sources for the information provided in this section are in Appendix 1.

For the year 2008-2009 Germany has passed the so-called “Konjunkturpaket I & II”. The total size of the package is €80 billions. An amount of €14 billions has been directed toward the labour market in the form of an extension of short-time work and support to qualification programmes. An amount of €20 billions has taken the form of traditional public spending. At last the stimulus has included various tax cuts.

For the year 2009-2010 France has passed the “Plan de relance”. The total size of the package is €65 billions, of which €33 billions has been allocated to total expenditures, while the remaining part has been allocated to tax cuts. Out of the total expenditures an amount of €0.5 billions has been devoted to labour market measures, namely support of short-time work and increases in unemployment benefits.

For the years 2009-2012 Italy has approved the “Pacchetto fiscale” which consists of €80 billions over the next three years. The amount devoted to public spending is €16.6 billions in 2010, mainly spent in infrastructure. An amount of € 4 billions will be spent in labour market programmes, specifically a limited extension of unemployment benefit coverage and measures to stabilize the demand side of the labour market (short-time work). A limited amount of resources has been devoted to temporary tax cuts in the form of family bonuses and financial support for low-income households.

For the year 2009-2010 Spain has passed “El Plan E”. Total package: €37.8 billions. Measures in the labour market have mainly taken the form of increases in unemployment benefits coverage.

Furthermore, some resources have been devoted to financial support for self-employed people. Public spending by an amount of €21 billions has been allocated to local investments and traditional government spending. Finally, an amount of €6 billions has been allocated to tax savings.

In the Pre-Budget Report 2008 the United Kingdom has approved a fiscal plan for an amount of £20 billions. Part of it has been spent in the labour market in the form of increased capacity within job centers, provision of a guaranteed job training or work placement for all 18-24-year old who reach 12 months of unemployment. Public spending by an amount of £3 billions has been allocated to capital expenditures. Finally, there have been tax cuts for £12.4 billions in the form of a temporary cut in VAT from 17.5 % to 15 %.

The American Recovery and Reinvestment Act of 2009 passed in the United States covers an amount of US$787 billions. Measures directed to support the labour market take up to US$40 billions. This amount has been mainly devoted to an extension of unemployment benefits coverage. Traditional public spending takes up US$94.7 billions of the resources. Finally, US$288 billions have been allocated to a tax relief plan in the form of federal tax cuts and incentives.

3 An Open Economy Model with Labour Turnover Costs

Our reference model for the labour market is Lechthaler et el. [11] and Faia et al. [8]. Each economy is populated by households who consume different varieties of domestically produced and imported goods, save and work. Households save in both, domestic and internationally traded bonds. Each agent can be either employed or unemployed. The labour market in each country features labour turnover costs, while wages are determined according to a right to manage bargaining process. We endogenize hiring and firing decisions by assuming that the profitability of each worker is subject to an i.i.d. shock each period. Firms in each country can change their price in any period but price-changes are subject to quadratic adjustment costs.

The tax system is articulated as follows: distortionary taxes are levied on consumption, wage income and firms' profits. The government can finance expenditure or tax cuts with a mixture of current government bonds and future lump sum taxes. Fiscal stimuli can be directed toward aggregate demand, taxes or toward labour market measures.

3.1 Households in the Domestic Economy

In the following, we derive the maximization problems for the domestic economy. The ones for the foreign economy are symmetric.

There is a continuum of agents who maximize their expected lifetime utility.

$$E_t \left\{ \sum_{t=0}^{\infty} \beta^t \frac{c_t^{1-\sigma}}{1-\sigma} \right\}, \tag{1}$$

where c denotes aggregate consumption in final goods. Total real labour income is given by w_t and is specified below. Unemployed households members, u_t, receive an unemployment benefit, ub. The contract signed between the worker and the firm specifies the wage and is obtained through a Nash bargaining process. In order to finance consumption at time t each agent also invests in foreign non-state contingent nominal bonds, b_t^*, which are internationally traded and which pay a gross nominal interest rate $(1+i_t^f)$ one period later. As in Andolfatto 1996 and Merz 1995 it is assumed that workers can insure themselves against earning uncertainty and unemployment. For this reason, the wage earnings have to be interpreted as net of insurance costs. Finally, agents receive profits from the firms which they own, $\tilde{\Pi}_{a,t}$, pay lump sum taxes, τ_t, a consumption tax, τ_t^c, a wage income tax, τ_t^n, and a tax on profits, τ_t^p. The sequence of budget constraints in terms of domestic CPI consumption goods reads as follows:

$$(1+\tau_t^c)c_t + \frac{b_t^*}{p_t} \leq (1-\tau_t^n)w_t(1-u_t) + ubu_t + (1-\tau_t^p)\frac{\tilde{\Pi}_{a,t}}{p_t} - \frac{\tau_t}{p_t} + (1+i_{t-1}^*)\frac{b_{t-1}^*}{p_t}. \tag{2}$$

Households choose the set of processes $\{c_t, b_t^*\}_{t=0}^{\infty}$ taking as given the set of processes $\{p_t, w_t, i_t^f\}_{t=0}^{\infty}$ and the initial wealth b_0^* so as to maximize (1) subject to (2). The following optimality conditions must hold:

$$\lambda_t = \beta(1+i_t^f)E_t \left\{ \lambda_{t+1} \frac{p_t}{p_{t+1}} \right\}, \tag{3}$$

$$\frac{1}{1+\tau_t^c} c_t^{-\sigma} = \lambda_t. \tag{4}$$

Equation (3) is the optimality condition with respect to internationally traded bonds. Equation (4) is the marginal utility of consumption. Optimality requires that a No-Ponzi condition on wealth is also satisfied.

Arbitrage condition and accumulation of assets. Due to imperfect capital mobility and/or in order to capture the existence of intermediation costs in foreign asset markets, workers pay a spread between the interest rate on the foreign currency portfolio and the interest rate of the currency area. This spread is proportional to the (real) value of the country's net foreign asset position:[2]

$$\frac{1+i_t^f}{1+i_t} = \zeta\left(\frac{b_t^*}{p_t}\right), \tag{5}$$

where $\zeta > 0$, $\zeta' > 0$. In addition we assume that the initial distribution of wealth between the two countries is symmetric.

Workers in the Foreign Region. We assume throughout that all goods are traded, that both countries face the same composition of consumption bundles and that the *law of one price* holds. This implies that $p_{h,t} = p_{h,t}^*$ and $p_{f,t} = p_{f,t}^*$. Under the currency union assumption the nominal exchange rate is equal one. Foreign workers face an allocation of expenditure and wealth similar to the one of workers in the domestic region except for the fact that they do not pay an additional spread for investing in the international portfolio. The efficiency condition for bond holdings reads as follows:

$$\lambda_t^* = \beta(1+i_t^f)E_t\left\{\lambda_{t+1}^*\frac{p_t^*}{p_{t+1}^*}\right\}. \tag{6}$$

All other optimality conditions are like in the home region. After substituting equation (5) into equation (3) and after merging with (3), we obtain the following relation:

$$E_t\left\{\frac{\lambda_{t+1}^*}{\lambda_t^*}\right\} = E_t\left\{\frac{\lambda_{t+1}}{\lambda_t}\frac{e_{t+1}^r}{e_t^r}\zeta\left(e_t^r\frac{b_t^*}{p_t^*}\right)\right\}, \tag{7}$$

which states that marginal utilities across countries are equalized up to the spread for the country risk.

3.2 Demand Aggregation and Open Economy Relations

The final good c in the domestic country is obtained by assembling domestic and imported intermediate goods via the Armington aggregate production function:

[2] See Schmitt-Grohe and Uribe [16].

$$c_t = \left((1-\alpha)^{\frac{1}{\eta}} c_{h,t}^{\frac{\eta-1}{\eta}} + \alpha^{\frac{1}{\eta}} c_{f,t}^{\frac{\eta-1}{\eta}} \right)^{\frac{\eta}{\eta-1}}, \tag{8}$$

with $p_t \equiv [(1-\alpha)p_{h,t}^{1-\eta} + \alpha p_{f,t}^{1-\eta}]^{\frac{1}{1-\eta}}$ being the corresponding price index and where η represents the elasticity between domestic and foreign goods while $\alpha < 0.5$ measures the degree of home-bias.

We define $c_{h,t} \equiv \left(\int_0^1 c_{h,t}(i)^{\frac{\varepsilon-1}{\varepsilon}} di \right)^{\frac{\varepsilon}{\varepsilon-1}}$ and $c_{f,t} \equiv \left(\int_0^1 c_{f,t}(i)^{\frac{\varepsilon-1}{\varepsilon}} di \right)^{\frac{\varepsilon}{\varepsilon-1}}$ as the composite aggregates of domestic and imported intermediate goods respectively, with ε being the elasticity across different varieties and $p_{h_t t} \equiv \left(\int_0^1 p_{h,t}(i)^{1-\varepsilon} di \right)^{\frac{1}{\varepsilon-1}}$, $p_{f,t} \equiv \left(\int_0^1 p_{f,t}(i)^{1-\varepsilon} di \right)^{\frac{1}{\varepsilon-1}}$ being the respective price indices.

Optimal demand for domestic and foreign goods is given by:

$$c_{h,t} = (1-\alpha) \left(\frac{p_t}{p_{h,t}} \right)^{\eta} c_t \ ; \quad c_{f,t} = \alpha \left(\frac{p_t}{p_{f,t}} \right)^{\eta} c_t. \tag{9}$$

All the relations hold symmetrically for the foreign country.

For expositional convenience we now express all aggregators as functions of inflation and the terms of trade. Lets' define the terms of trade as the relative price of imported goods:

$$s_t \equiv \frac{p_{f,t}}{p_{h,t}}. \tag{10}$$

The terms of trade can be related to the CPI-PPI ratio as follows

$$\frac{p_t}{p_{h,t}} = [(1-\alpha) + \alpha s_t^{1-\eta}]^{\frac{1}{1-\eta}} \equiv g(s_t), \tag{11}$$

with $g^{'}(s_t) > 0$. A equivalent relation holds for the ratio $d(s_t) \equiv \frac{p_t}{p_{f,t}}$. We can therefore express the demand functions for domestic and foreign goods as follows:

$$c_{h,t} = (1-\alpha) \left(g(s_t) \right)^{\eta} \ c_t \ , \tag{12}$$

$$c_{f,t} = \alpha \left(d(s_t) \right)^{\eta} \ c_t. \tag{13}$$

Finally, we need to obtain the relation between terms of trade and nominal exchange rates which reads as follows:

$$\frac{s_t}{s_{t-1}} = \frac{\pi^*_{f,t}}{\pi_{h,t}}, \tag{14}$$

where $\pi_{h,t} = \frac{p_{h,t}}{p_{h,t-1}}, \pi^*_{f,t} = \frac{p^*_{f,t}}{p^*_{f,t-1}}$ are respectively the domestic and the foreign PPI inflation rate. Finally, we can relate the CPI inflation rate to the PPI:

$$\pi_t = \pi_{h,t} \frac{g(s_t)}{g(s_{t-1})}, \tag{15}$$

$$\pi^*_t = \pi^*_{f,t} \frac{d(s_t)}{d(s_{t-1})}. \tag{16}$$

3.3 Production and the Labour Market in the Domestic Economy

In each country there are three types of firms. (i) Firms that produce intermediate goods employ labour, exhibit linear labour adjustment costs (i.e. hiring and firing costs) and sell their homogenous products on a perfectly competitive market to the wholesale sector. (ii) Firms in the wholesale sector transform the intermediate goods into consumption goods and sell them under monopolistic competition to the retailers. They can change their price at any time but price adjustments are subject to a quadratic adjustment cost à la Rotemberg [14]. (iii) The retailers, in turn, aggregate the consumption goods and sell them under perfect competition to the households. We characterise the optimization problems of households in the domestic economy. The foreign residents act symmetrically.

3.3.1 Intermediate Goods Producers and Employment Dynamic

Intermediate goods firms hire labour to produce the intermediate good z. Their production function is:

$$z_t = a_t N_t, \tag{17}$$

where a is technology and N the number of employed workers. They sell the product at a relative price $mc_t = p_{z,t}/p_{h,t}$ which they take as given in a perfectly competitive environment, where p_z is the absolute price of the intermediate good evaluated in domestic goods and p_h is the domestic price index. The variable mc_t in this economy plays the role of marginal costs as it represents the lagrange multiplier on the production function.

We assume that every worker (employed or unemployed) is subject to a random operating cost ε, which follows a *logistic* probability distribution $g(\varepsilon_t)$ over the support $-\infty$ to $+\infty$.[3] The operating costs can be interpreted as an idiosyncratic shock to a worker's productivity or as a match-specific idiosyncratic cost-shock. The firms learn the value of the operating costs of every worker at the beginning of a period and base their employment decisions on it, i.e. an unemployed worker with a favorable shock will be employed while an employed worker with a bad shock will be fired. Hiring and firing is not costless, firms have to pay linear hiring costs, h, and linear firing costs, f, both measured in terms of the final consumption good. Wages are determined through Nash bargaining between insiders and the firm. The bargaining process takes the form of a *right to manage.* This assumption leads to the following timing of events. First, the operating cost shock takes place and median insiders and the intermediate goods firm bargain over the wage. Given the wage schedule, firms make their hiring and firing decisions. Thus, firms will only hire those workers who face low operating costs and fire those workers who face high operating costs.

The hiring and firing costs induce two types of distortions (a gap and a wedge). The presence of hiring and firing costs reduces labour turnover at any given period, compared to a walrasian labour market, thereby inducing a gap between the perfectly competitive economy and our non-walrasian labour market. Second, our model features an inter-temporal wedge that distorts hiring and firing decisions between two sub-sequent periods. Indeed once workers are inside the firm they are fired only if the discounted stream of future profits is smaller than the firing costs, on the other side firms will hire only if the discounted value of future profits is bigger than the hiring costs. Because of those two wedges the retention rate, defined as the mass of workers who keep their jobs, is always bigger than the firing rate.

The operating costs, ε, are measured in terms of the final consumption good and are assumed to grow at the same rate as productivity.[4] It turns out that this ensures that technological progress does not affect the unemployment rate.

Let's now consider the real profit generated by a firm-worker relation whose operating cost is ε_t. At this point it is important to notice that while workers value their labour income, w_t, in

[3] The logistic distribution was chosen because it is very similar to the normal distribution, but in contrast to the latter there is a neat expression for the cumulative density function.

[4] For permanent technology shocks it can be assumed the the operating, hiring and firing costs grow at the same rate as the technological progress. This ensures that the hiring and firing rates are independent of long-run technological growth. As we only consider mean-reverting technology shocks in this paper, we skip this assumption for analytical simplicity.

terms of CPI goods, firms value their revenues in terms of domestic goods. This implies that in the firms' profit function we need to normalize wages by multiplying with $g(s_t)$:

$$\begin{aligned}\tilde{\Pi}_{I,t}(\varepsilon_t) &= (1-\tau_t^p)(a_t mc_t - g(s_t)w_t - \varepsilon_t) + \\ &+E_t\left\{\sum_{j=t+1}^{\infty}\Delta_{t,j}\left[\begin{array}{c}(1-\phi_j)^{j-t}(1-\tau_{t+j}^p)\left(a_j mc_j - g(s_j)w_j - \left(\frac{1}{1-\phi_j}\int_{-\infty}^{\upsilon_{f,j}}\varepsilon_j g(\varepsilon_j)d\varepsilon_j\right)\right)\\ -\phi_j f_j(1-\tau_t^p)(1-\phi_j)^{j-t-1}\end{array}\right]\right\},\end{aligned}$$

where w is the real wage, ϕ is the separation probability, $\Delta_{t,j}$ is the stochastic discount factor from period t to j. To simplify the profit function, we rewrite it in recursive manner:

$$\tilde{\Pi}_{I,t}(\varepsilon_t) = (1-\tau_t^p)(a_t mc_t - w_t g(s_t) - \varepsilon_t) + E_t(\Delta_{t,t+1}\tilde{\Pi}_{I,t+1}(\varepsilon_{t+1})), \tag{18}$$

where $\tilde{\Pi}_{I,t+1}(\varepsilon_{t+1})$ are future profits.

We now solve for the dynamics of employment and wages. Because of the abovementioned timing of events we solve the model backward and derive the hiring and firing decisions for a *given wage schedule*. Let's define the hiring and the firing rate threshold respectively as $\upsilon_{h,t}$ and $\upsilon_{f,t}$. Hiring decisions are carried as follows. Unemployed workers are hired whenever their operating cost does not exceed a certain threshold such that the profitability of this worker is higher than the hiring cost. Thus, the hiring threshold $\upsilon_{h,t}$ is obtained by solving the following zero profit condition:

$$(1-\tau_t^p)h_t = (1-\tau_t^p)(a_t mc_t - w_t g(s_t) - \upsilon_{h,t}) + E_t(\Delta_{t,t+1}\tilde{\Pi}_{I,t+1}(\varepsilon_{t+1})). \tag{19}$$

Unemployed workers whose operating cost is lower than this value get a job, while those whose operating cost is higher remain unemployed. The resulting hiring probability is given by:

$$\eta_t = \int_{\infty}^{\upsilon_{h,t}} \varepsilon_t g(\varepsilon_t) d\varepsilon_t. \tag{20}$$

Similarly, the firm will fire a worker if current losses are higher than the firing cost. Again, a zero profit condition defines the firing threshold as follows:

$$-f_t(1-\tau_t^p) = (1-\tau_t^p)(a_t mc_t - g(s_t)w_t - \upsilon_{f,t}) + E_t(\Delta_{t,t+1}\tilde{\Pi}_{I,t+1}(\varepsilon_{t+1})), \tag{21}$$

and the separation rate is defined as:

$$\phi_t = \int_{\upsilon_{f,t}}^{\infty} \varepsilon_t g(\varepsilon_t) d\varepsilon_t. \tag{22}$$

We are now in the position to obtain the aggregate employment evolution. The change in employment $(N_t - N_{t-1})$ is the difference between the hiring from the unemployment pool (ηU_{t-1}) and the firing from the employment pool (ϕN_{t-1}), where U_{t-1} and N_{t-1} are the aggregate unemployment and employment levels: $N_t - N_{t-1} = \eta U_{t-1} - \phi N_{t-1}$. Letting $(n_t = N_t/L_t)$ be the employment rate, we assume a constant workforce, L_t, and normalize it to one. Therefore, we obtain the following employment dynamics curve.

$$n_t = n_{t-1}(1 - \phi_t - \eta_t) + \eta_t. \tag{23}$$

The unemployment rate is simply $u_t = 1 - n_t$.

3.3.2 Wage Bargaining

For simplicity, let the real wage $g(s_t)w_t$ be the outcome of a Nash bargain between the median worker[5] with operating cost ε^I and her firm. The median worker faces no risk of dismissal at the negotiated wage. The wage is renegotiated in each period t. Under bargaining agreement, the median worker receives the real wage $g(s_t)w_t$ and the firm receives the expected profit $(1-\tau_t^p)(a_t mc_t - g(s_t)w_t)$ in each period t. Under disagreement, the worker's fallback income is $g(s_t)ub_t$, assumed for simplicity to be equal to the real unemployment benefit. The firm's fallback position is $-s$, where s is the cost for the firm in case of disagreement. This may be a fixed cost of non-production or a cost that is imposed due to a strike. Assuming that disagreement in the current period does not affect future surpluses, workers' surplus is $(1-\tau_t^n) g(s_t)w_t - g(s_t)ub_t$ while the firm's surplus is $(1-\tau_t^p)\left(a_t^I mc_t - g(s_t)w_t - \varepsilon^I\right) + s$, where ε^I are the operating costs of the median worker. Consequently, the Nash-product is:

$$\Theta = \left(g(s_t)w_t\left(1-\tau_t^n\right) - g(s_t)ub\right)^{\gamma}\left(\left(1-\tau_t^p\right)\left(a_t^I mc_t - g(s_t)w_t - \varepsilon^I\right) + s\right)^{1-\gamma}, \tag{24}$$

[5] For simplicity, we allow the median worker to bargain over wages. Alternative settings, such as individual bargaining process with marginal workers, would not change the main implications of the model.

where γ represents the bargaining strength of the worker relative to the firm. Maximizing the Nash-product with respect to the real wage, yields the following equation:

$$
\begin{aligned}
& (1-\tau_t^n)\,\gamma\left(\left(a_t^I mc_t - g(s_t)w_t - \varepsilon^I\right)(1-\tau_t^p) + S\right) + (1-\gamma)\,g(s_t)ub\,(1-\tau_t^p) && (25)\\
= \;& (1-\gamma)\,g(s_t)w_t\,(1-\tau_t^n)\,(1-\tau_t^p)\,, && (26)
\end{aligned}
$$

which implicitly defines the negotiated wage. Rearranging yields the following simple formula:

$$
w_t = \frac{\gamma}{g(s_t)}\left(a_t mc_t - \varepsilon_t^I + \frac{s}{1-\tau_t^p}\right) + (1-\gamma)\,\frac{ub}{1-\tau_t^n}. \tag{27}
$$

Two considerations on the wage equation are in order.

First, due to the right to manage structures wages lose part of their allocative role compared to wages negotiated within efficient Nash bargaining arrangements. In the efficient Nash bargaining individual firms would have to choose wages alongside with hiring and firing decisions. This would allow wages to be contingent on employment decisions and to adjust faster to shocks. Instead, in this context wages are negotiated at an aggregate level and firms make hiring and firing decisions only ex-post.[6] This implies, for instance, that negative shocks can affect worker flows more strongly than wages. We believe that such a bargaining arrangement can capture well the reality of Euro area labour markets in which wages are usually bargained ex-ante at an aggregate level (collectively), while individual firms make ex-post hiring and firing decision.

Second, equation 27 highlights the effects of cross-country spillovers through the interaction between the CPI/PPI ratio and the wage. In standard New Keynesian models, changes in terms of trade (hence in the CPI/PPI ratio) produce spillovers across countries as they lead to relative changes in export demand. A country that increases government expenditure experiences a terms of trade appreciation which reduces its net exports compared to the rest of the currency area, hence neighborhood countries benefit from an increase in demand of foreign produced goods. In our model, changes in the terms of trade have additional effects on the labour markets. Indeed, the appreciation in the CPI/PPI ratio, due to the increase in government spending, has the additional

[6] This is a particular case of a sequential bargaining framework proposed by Manning 1987, as firms and workers fail to internalize the consequences of today´s wage decisions on future hiring and firing decisions. The scope for pre-commitment is barred as neither workers nor firms can credibly commit to a sequence of future wages and employment.

effect of increasing domestic wages while reducing wages in neighborhood countries. Such a labour market spillover brings about an increase in labour demand and a reduction in unemployment for neighborhood countries.

3.3.3 Marginal costs

Marginal costs in this model summarize the set of wedges that characterize the labour market. To obtain a measure of the marginal cost we should first characterize the equilibrium conditions for labour market flows. By merging equations 19 and 21 we obtain the following equilibrium condition:

$$\upsilon_{h,t} + h_t = \upsilon_{f,t} - f_t. \tag{28}$$

This condition implies that marginal costs can be equally derived from 19 or from 21. The expression for marginal costs will then read as follows:

$$mc_t = \left(g(s_t)w_t + \upsilon_{h,t} + h_t - \frac{1}{1-\tau_t^p} E_t(\Delta_{t,t+1}\tilde{\Pi}_{I,t+1}(\varepsilon_{t+1})) \right) / a_t. \tag{29}$$

In this context wages lose part of their allocative role as marginal costs depend also on two additional components. The first component which is given by $\upsilon_{h,t} + h_t$ is an intra-temporal wedge which makes hiring (and firing) deviate from the ones that would arise in a walrasian labour market at any time t. The second component, represented by $E_t(\Delta_{t,t+1}\tilde{\Pi}_{I,t+1}(\varepsilon_{t+1}))$, is an inter-temporal wedge which distorts hiring (and firing) decisions between two sub-sequent dates. This second wedge represents the long run value of a worker, as by retaining the marginal worker the firm can earn extra profits in the future. Because of this positive externality attached to the marginal worker, retention rates tend to be higher than job finding rates.

3.3.4 Wholesale Sector and Retail Sector

Firms in the wholesale-sector can change their prices every period, facing quadratic price adjustment costs a la Rotemberg. They maximize the following profit function:

$$\tilde{\Pi}_{W,t} = E_t \sum_{t=0}^{\infty} \Delta_{t,t+j}(1-\tau_t^p) \left[\frac{p_{h,t}(i)}{p_{h,t}} y_t(i) - mc_t y_t(i) - \frac{\Psi}{2} \left(\frac{P_{h,t}(i)}{P_{h,t-1}(i)} - 1 \right)^2 \left(c_{h,t} + c_{h,t}^* \right) \right], \tag{30}$$

where Ψ is a parameter measuring the extent of price adjustment costs and $\bar{\pi}$ is the steady state inflation rate. Taking the derivative with respect to the price yields after some manipulations a price-setting rule under Rotemberg adjustment costs:

$$\begin{aligned} 0 &= (1-\varepsilon) + \varepsilon mc_t - \Psi\left(\pi_{h,t} - 1\right)\pi_{h,t} \\ &\quad + E_t\{\Delta_{t,t+1}\Psi\left(\pi_{h,t+1} - 1\right)\frac{c_{h,t+1} + c^*_{h,t+1}}{c_{h,t} + c^*_{h,t}}\pi_{h,t+1}\}. \end{aligned} \tag{31}$$

3.4 Workers' Heterogeneity and Aggregation

We start by deriving aggregate real profits of intermediate firms which are given by revenues minus wage payments, operating costs and labour turnover costs:

$$\begin{aligned} \tilde{\Pi}_I &= mc_t a_t n_t - g(s_t) w_t n_t - n_t(1-\phi_t)\Xi^i_t - \\ &\quad (1-n_t)\eta_t \Xi^e_t - n_{t-1}\phi_t f_t - (1-n_{t-1})\eta_t h_t, \end{aligned} \tag{32}$$

where Ξ^i_t is the expected value of operating costs for insiders, conditional on not being fired and Ξ^e_t is the expected value of operating costs for entrants, conditional on being hired, defined by:

$$\begin{aligned} \Xi^e_t &= \frac{\int_{-\infty}^{\upsilon_h} \epsilon_t g(\epsilon_t) d\epsilon_t}{\eta_t}, \\ \Xi^i_t &= \frac{\int_{-\infty}^{\upsilon_f} \epsilon_t g(\epsilon_t) d\epsilon_t}{1-\phi_t}. \end{aligned}$$

The real profits ($\tilde{\Pi}_W$) of the wholesale sector are given by:

$$\tilde{\Pi}_W = y_t - mc_t a_t n_t - \frac{\Psi}{2}\left(\pi_{h,t} - 1\right)^2\left(c_{h,t} + c^*_{h,t}\right).$$

Retailers make zero-profits. Aggregate real profits in this economy therefore are given by:

$$\begin{aligned} \tilde{\Pi}_{a,t} = y_t - g(s_t) w_t n_t - n_{t-1}\phi_t f_t - (1-n_{t-1})\eta_t h_t - n_t(1-\phi_t)\Xi^i_t \\ -(1-n_t)\eta_t \Xi^e_t - \tfrac{\Psi}{2}\left(\pi_{h,t} - 1\right)^2\left(c_{h,t} + c^*_{h,t}\right). \end{aligned} \tag{33}$$

We can substitute this into the budget constraint, (2), and after imposing equilibrium in the bond market we obtain the following resource constraint:

$$(1+\tau_t^c)c_t = g(s_t)w_t n_t(1-\tau_t^n) + ubu_t - \tau_t \tag{34}$$
$$+(1-\tau_t^p)\left[y_t - n_{t-1}\phi_t f_t - (1-n_{t-1})\eta_t h_t - n_t(1-\phi_t)\Xi_t^i - (1-n_t)\eta_t \Xi_t^e - \tfrac{\Psi}{2}\left(\pi_{h,t}-1\right)^2\left(c_{h,t}+c_{h,t}^*\right)\right].$$

Equations 34 identifies the net income for the domestic economy, which is given by the right hand side minus the left hand side. In the world economy the domestic net income must be equalized to net exports, $c_{h,t}+c_{h,t}^*$. After imposing market clearing, aggregating and recalling that $p_{h,t}=p_{h,t}^*$, we can express the resource constraint as:

$$c_{h,t}+c_{h,t}^* = y_t - n_{t-1}\phi_t f_t a_t - (1-n_t)\eta_{t-1}h_t - n_t(1-\phi_t)\Xi_t^i - (1-n_t)\eta_t\Xi_t^e - \frac{\Psi}{2}\left(\pi_{h,t}-1\right)^2\left(c_{h,t}+c_{h,t}^*\right) - g_t. \tag{35}$$

We assume zero total net supply of bonds.

3.5 Model Calibration

The calibration is summarized in table 1 below.

Preferences. The discount rate, β, is set to 0.99, consistently with an annual interest rate of 4 percent. The intertemporal elasticity of substitution, σ is set to 2. The elasticity of substitution between different product types, ε, is set to 10 (see, e.g., Galí [9]). The elasticity of substitution between home and foreign goods, η, is set to 2, consistently with most empirical studies, while the degree of home bias in consumption, α, i set to 0.2, consistently with data for net exports in the euro area.

Pricing. The parameter of price adjustments, Ψ, is calibrated in line with microeconometric evidence for Europe (see Alvarez et al. [1]).

Labour markets. The bargaining power of workers, γ, is set to a benchmark value of 0.5. Taking continental Europe as reference point, the firing costs are set to 60 percent ($f=0.6$) of the annual productivity which amounts to approximately 66 percent of the annual wage[7] and the

[7] For the period from 1975 to 1986 Bentolila and Bertola [2] calculate firing costs of 92 percent, 75 percent and 108 percent of the respective annual wage in France, Germany and Italy respectively. The OECD 2004 reports that many European countries have reduced their job security legislation somewhat from the late 1980 to 2003 (in terms of the overall employment protection legislation strictness). Therefore, we consider $f=0.6$ to be a realistic number for continental European countries.

hiring costs are set to 10 percent ($h = 0.1$) of annual productivity (see Chen and Funke [3]). The unemployment benefits is set to 65 percent of the level of productivity ($ub = 0.6$). This implies, that in steady state the wage replacement rate is roughly 65 percent, which is in line with evidence for continental European countries (see OECD [12]). Operating costs are assumed to follow a logistic distribution with zero mean. The scaling parameter of the distribution and the payments under disagreement, s, are chosen in such a way that the resulting labour market flow rates match the empirical hiring and firing rates described further below. This yields a scale parameter of 0.53 and payments under disagreement to -0.06. We calibrate our flow rates using evidence for West Germany, as there are only Kaplan-Meier functions for individual countries.[8] Wilke's [20] Kaplan-Meier functions indicate that about 20 percent of the unemployed leave their status after one quarter. For a steady state unemployment rate of 9 percent, a quarterly job finding rate of 2 percent is necessary. This is roughly in line with Wilke's estimated yearly risk of unemployment. The used flow numbers are in line with the OECD [13] numbers for other continental European countries.[9] Hence a quarterly job hiring rate of $\eta = 0.20$ and a firing rate of $\phi = 0.02$ are reasonable averages for continental European countries.

Fiscal policy parameters. We follow Trabandt and Uhlig [18], so taxes are calibrated as follows (average of EU-14): $\tau^c = 17\%$, $\tau^n = 41\%$, $\tau^p = 33\%$ and the share of government spending is $g/y = 0.23$.

3.6 Monetary Policy

An active monetary policy sets the short term nominal interest rate by reacting to an average of the inflation levels in the area. This rule rationalizes the behavior of the stability pact signed by euro area countries:

$$i_t = \exp\left(\frac{1-\chi}{\beta}\right)(V_H \pi_t + V_F \pi_t^*)^{b_\pi}\,, \tag{36}$$

where V_H and V_F are the weights used to build up an aggregate measure of inflation for the currency area. As it is customary in the new Keynesian literature we assume $b_\pi = 1.5$, as this value guarantees determinacy of the equilibrium and avoids explosive paths for inflation. In terms

[8] We choose the Kaplan-Meier functions for Germany, as it is the largest continental European country.

[9] Although the numbers of the OECD outlook are not directly applicable to our model, since they are built on a monthly basis, it is possible to adjust them using a method described in Shimer [15].

Table 1: Parameters of the Numerical Model

Parameter	Description	Value	Source
β	Subjective discount factor	0.99	Standard value
σ	Consumption utility	2	Intertemp. elasticity of subst.
ε	Elasticity of subst.	10	Galí [9]
Ψ	Price adjustment cost	104.85	Equivalent to $\theta = 0.75$
a	Productivity	1	Normalization
γ	Workers' bargaining power	0.5	Standard value
f	Firing cost	0.6	Bentolila and Bertola [2]
h	Hiring cost	0.1	Chen and Funke [3]
b	Unemployment benefits	0.65	OECD [12]
$E(\varepsilon)$	Expected value of op. costs	0	Normalization
sd	Distr. scaling parameter	0.53	To match the flow rates
s	Payments under disagreement	0.06	To match the flow rates
τ^n	Income tax	0.41	Trabandt and Uhlig [18]
τ^c	Consumption tax	0.17	Trabandt and Uhlig [18]
τ^p	Profit tax	0.33	Trabandt and Uhlig [18]
g/y	Governments spending	0.23	Trabandt and Uhlig [18]

of monetary policy setting this can be considered as a conservative scenario. Indeed, in some countries (particularly the US) large fiscal packages have been implemented over the last year in face of nearly zero nominal interest rate. For this reason other authors have considered passive monetary policy (interest rate pegs) or accommodative monetary policy (reaction to inflation lower than one). Those alternative assumptions tend to amplify fiscal multipliers as monetary policy relinquishes its stabilization role.

3.7 Fiscal policy regimes

Fiscal policy is conducted independently by each country. The single national governments face the following budget constraint:

$$g_t + ubu_t - \tau_t + (1 + r^n_{t-1})b_{t-1} - \tau^c_t\,(c_{h,t} + c_{f,t}) - \tilde{\Pi}_{a,t}\tau^p_t = \tau^n_t w_t n_t + b_t. \tag{37}$$

Since government expenditure is financed partly with taxes and partly with government bonds we need some rules to pin down the evolution of government bonds. In the baseline scenario, we assume that $\tau^c_t = \tau^c$, $\tau^p_t = \tau^p$and $\tau^n_t = \tau^n$ and that government expenditure follows an exogenous process. We assume that the higher expenditures are finance by lump-sum taxes.

We analyze five different fiscal packages. We assume that only one of the two countries undertakes the fiscal stimulus.

1. *A pure demand stimulus.* We consider a temporary shock to government expenditure given by:

$$\frac{g_t}{g} = \left(\frac{g_{t-1}}{g}\right)^{\rho_g} + \varepsilon_t^g, \tag{38}$$

where ε_t^g is a surprise increase and ρ_g is the autocorrelation of the shock.

2. A *temporary consumption tax cut* (VAT). We consider temporary cuts in the consumption tax with the following shock representation:

$$\frac{\tau_t^c}{\tau^c} = \left(\frac{\tau_{t-1}^c}{\tau^c}\right)^{\rho_{\tau^c}} + \varepsilon_t^{\tau^c}, \tag{39}$$

where $\varepsilon_t^{\tau^c}$ is the surprise increase and ρ_{τ^c} is the autocorrelation of the shock. Such a measure affects mainly the marginal utility of consumption as shown in equation 4. More specifically a temporary cut in consumption taxes can increase current private consumption. The quantitative impact of such a measure depends on the propensity to consume in face of temporary income shocks.

3. A *temporary income tax cut.* We consider temporary cuts in the income tax with the following shock representation:

$$\frac{\tau_t^n}{\tau^n} = \left(\frac{\tau_{t-1}^n}{\tau^n}\right)^{\rho_{\tau^n}} + \varepsilon_t^{\tau^n}, \tag{40}$$

where $\varepsilon_t^{\tau^n}$ is the surprise increase and ρ_{τ^n} is the autocorrelation of the shock. Such a measure has a direct and immediate impact on the wage function:

$$w_t = \frac{\gamma}{g(s_t)}\left(a_t mc_t - \varepsilon_t^I + \frac{s}{1-\tau_t^p}\right) + (1-\gamma)\frac{ub}{1-\tau_t^n}. \tag{41}$$

A reduction in τ_t^n reduces wages (before taxes), hence it increases labour demand. This is particularly beneficial in a model with inefficient equilibrium unemployment.

4. *Hiring subsidies.* In this case the increase in government spending finances a reduction in hiring costs hence it enters the equation determining the hiring threshold:

$$(1-\tau_t^p)(h_t - hs_t) = (1-\tau_t^p)(a_t mc_t - w_t g(s_t) - \upsilon_{h,t}) + E_t(\Delta_{t,t+1}\tilde{\Pi}_{I,t+1}(\varepsilon_{t+1})) \tag{42}$$

where hs_t represents the hiring subsidy. From the above expression it is clear that a reduction in hiring costs increases the mass of hired workers. Such a measure can be potentially very beneficial in sclerotic labour markets.

5. *Short-time work* ("Kurzarbeit" in Germany). To implement the last measure we reason as follows. Whenever an employee does not generate a contemporaneous profit, the firm is allowed to reduce the working time of this worker by a share $(1 - \Upsilon)$, which is set by the government. This will affect the firm's endogenous firing cut-off. The government will pay unemployment benefits for the respective share. We assume that Υ (1 in the steady state, i.e. no short-time work possibilities) follows an autoregressive process of order one:

$$\frac{\Upsilon_t}{\Upsilon} = \left(\frac{\Upsilon_{t-1}}{\Upsilon}\right)^{\rho_\Upsilon} + \varepsilon_t^{\Upsilon}. \tag{43}$$

For further technical details see the Appendix.

Following the literature (see Perotti 2004), the coefficient of autocorrelation of government spending is calibrated to $\rho_g = 0.9$. For comparability reasons we use the same number for all fiscal measures.

4 Fiscal Multipliers and Open Economy Spillovers

4.1 Baseline Scenarios

For the five fiscal packages described above, we compute short run and long run multipliers [10] and open economy spillovers. In all cases we assume that only the domestic economy undertakes the fiscal measure. Results are summarized in table 2.

Pure demand stimulus. In this case, both the short run and the long run multipliers are very small. An increase in government spending has three detrimental effects. First, as already highlighted by the previous literature (see for instance Cogan, Cwik, Taylor and Wieland [5], Cwik and Wieland [7], Uhlig [19]), forward looking agents expect that current increases in government spending will be financed by future taxes. This induces a crowding out effect on current private

[10] Short-run multipliers are calculated as output effects during the impact period divided by costs during the impact period. Long-run multipliers are the discounted output effects divided by the discounted costs. All graphs are normalized such that they represent a 0.5 percent of GDP spending package during the implementation period. To make government spending and tax multipliers comparable, we calculate the multipliers based on the steady state values for all endogeneous variables.

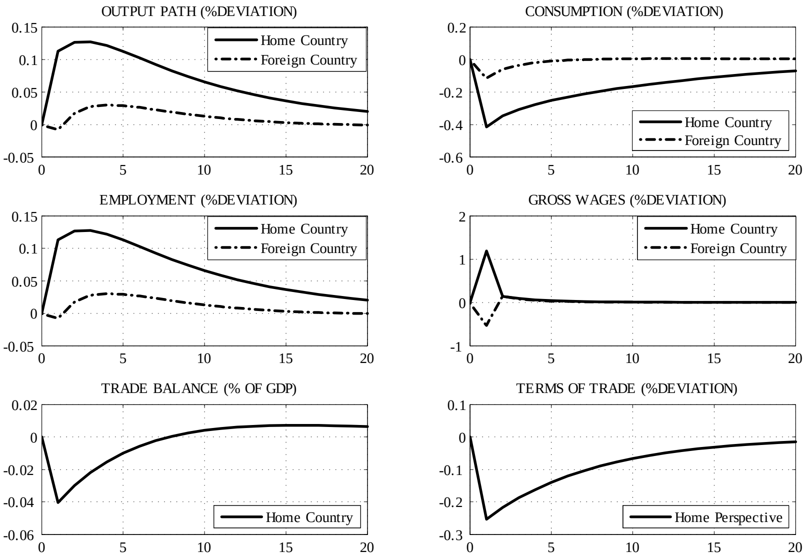

Figure 1: Impulse responses to temporary increase in government spending (normalised to 0.5% of GDP).

consumption demand as shown in figure 1, illustrating the impulse response to a temporary increase in government spending. Second, in an open economy context an increase in aggregate demand leads to an increase in domestic prices relative to foreign prices. This reduces export demand for the country which implements the fiscal stimulus and improves the trade balance for the foreign country (see figure 1). Finally, a fall in terms of trade, triggered by an increase in government spending, leads to a fall in the CPI/PPI ratio, which in turn leads to an increase in domestic wages as highlighted by equation 27. The ensuing fall in labour demand triggers a reduction in output. Hence the initial increase in government spending is counteracted by three detrimental effects. This explains the nearly zero output multiplier.

In principle the foreign country should benefit from the terms of trade appreciation. Due to the increase in fiscal spending, prices in the domestic economy rise relative to foreign prices, hence demand switches from domestic to foreign goods. Such *switching expenditure effects* are governed mainly by two parameters: the elasticity of substitution between home and foreign goods, η, and the degree of home bias in consumption of the domestic economy, α. The higher the values for

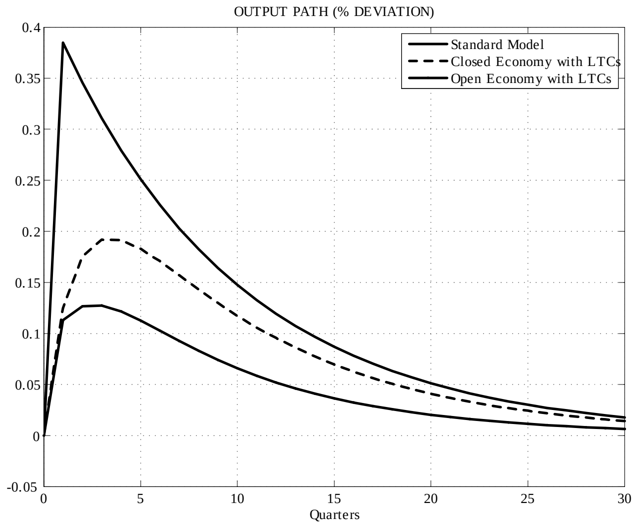

Figure 2: Model comparison

those parameters the higher is the switch in demand toward foreign goods. Moreover, as explained earlier, an increase in the CPI/PPI ratio induces an increase in domestic wages and conversely a fall in foreign wages. This labour market spillover can potentially boost labour demand in the foreign economy. Despite the fact that those two effects should operate in favor of boosting output in the foreign economy, the spillover effects (increase in foreign output and aggregate demand) are nearly zero. Indeed, a temporary fiscal stimulus in the foreign country combined with low values for η and α, make such demand spillovers rather small, the more so in a currency area.

To highlight the role of labour market frictions and the open economy, we perform the same government spending exercise in a frictionless closed economy[11] and in a closed economy with labour market frictions. It can be seen in figure (2) that a traditional demand stimulus generates a substantially larger effect in a frictionless closed economy model than in a model with labour turnover costs. The reason is straightforward. Labour turnover costs make employment adjustment more costly. As a consequence, the price for intermediate goods increases and this dampens the expansionary effects. As expected, the open economy dimension reduces the effects of government spending due to spillover effects.

[11] We use a separable utility function with the same specification for consumption as in our model and with a quadratic disutility of labor.

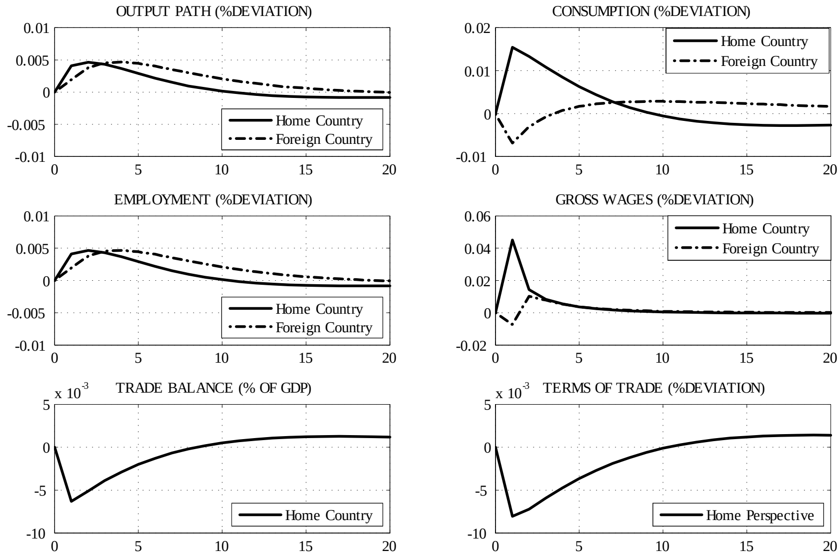

Figure 3: Impulse responses to temporary cut to consumption (VAT) taxes (normalised to 0.5% of GDP).

Consumption (VAT) tax cuts. In this case multipliers are nearly zero. The reason, already highlighted in the previous literature (see for instance Cogan, Cwik, Taylor and Wieland [5]) is twofold. First, as for the case of a pure demand stimulus, expectations of future tax increases tend to crowd out current private consumption (see the second panel of figure 3). Second, to the extent that consumption tax cuts are temporary, permanent income theory suggests that the impact on private consumption is very small (previous empirical studies have highlighted a propensity to consume in this case around 0.3). Hence the positive effect coming from the tax cut is not big enough to compensate the negative effect associated with future expectations of tax increases.

Spillovers to the foreign country are nearly zero, too. Figure 3 shows that the improvement in foreign trade balance is negligible. The reason is similar to the one outlined for the case of a pure demand stimulus.

Income tax cuts. For this experiment, and contrary to the case with consumption tax cuts, the multipliers are pretty large. Most importantly, long run multipliers are larger than short run multipliers. This result is very much in line with the ones highlighted in Uhlig [19], who shows

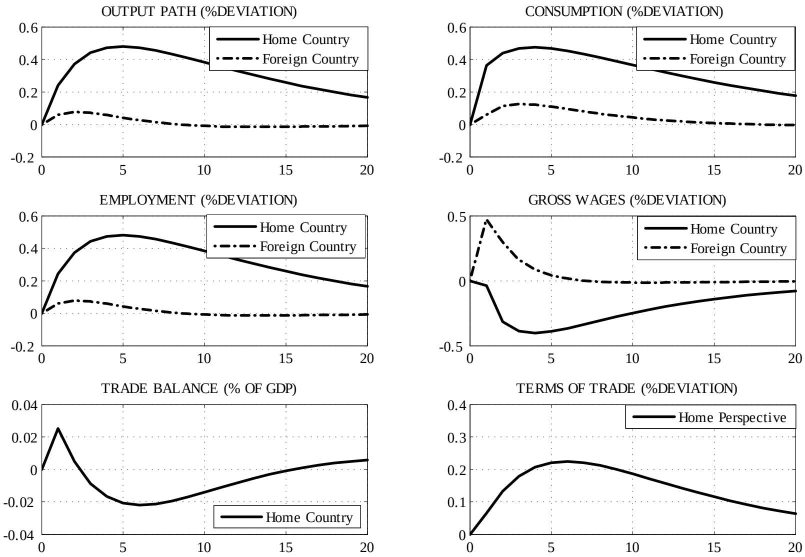

Figure 4: Impulse responses to temporary cut of income taxes (normalised to 0.5% of GDP).

that tax cuts tend to produce positive effects mainly in the long run. In our case this result is even stronger as the long run multiplier is larger than one. The reason being that this measure has a direct and strong impact on labour market outcomes.

Given the wage equation:

$$w_t = \frac{\gamma}{g(s_t)} \left(a_t mc_t - \varepsilon_t^I + \frac{s}{1-\tau_t^p} \right) + (1-\gamma) \frac{ub}{1-\tau_t^n}, \tag{44}$$

it is immediate to see that a cut in τ_t^n reduces wages (before taxes), hence leads to an increase in labour demand (see also figure 4 which shows the impulse responses to a 1% cut in income taxes). In this respect, our model highlights a novel dimension through which fiscal stimuli might lead to large multipliers. In this case, however, fiscal multipliers operate through supply side effects rather than through traditional demand side effects.

Two additional considerations are in order. First, we have parameterised workers' bargaining power to 0.5. Lower values for this parameter would induce a greater elasticity of labour demand, hence they would amplify the fiscal multipliers. Second, in our model labour demand changes take place only at the extensive margin (number of workers); if we were to include an intensive margin

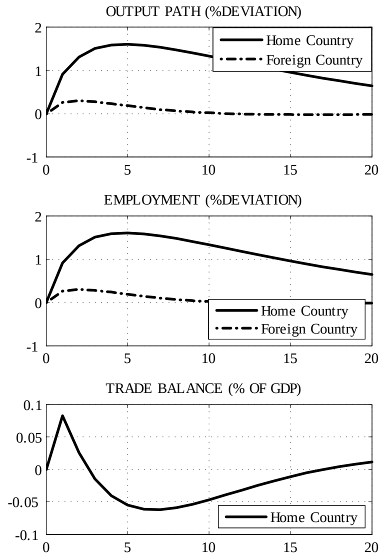

Figure 5: Impulse responses to temporary increase in government spending to finance hiring subsidies (normalised to 0.5% of GDP).

(endogenous choice of labour hours) the fiscal multiplier would likely be even larger.

Again positive spillovers to the other countries are rather small. In this case they operate mainly through a reduction in foreign wages as the foreign trade balance even turns negative.

Hiring subsidies. Multipliers are very large for this case. This is even more so for long run multipliers. Hiring costs are strongly distortionary in our model as they lead to inefficient unemployment fluctuations. A reduction in hiring costs increases the hiring threshold as shown in equation 42 and reduces firms' marginal costs, as shown by equation 29. The ensuing increase in employment (see figure 5 which shows impulse responses in this case) pushes output toward the pareto efficient level. In this case the increase in government spending does not produce any crowding out of private demand; on the contrary, it helps to boost private consumption.

The effects of hiring subsidies probably have to be considered as a upper bound. We assume that the wage is bargained between incumbent workers and the firm. This is a very realistic assumption for central European countries. Collective bargaining coverage in countries such as Austria, Belgium, France, Germany or the Netherlands lies within the range of 68% to 97.5 % (see

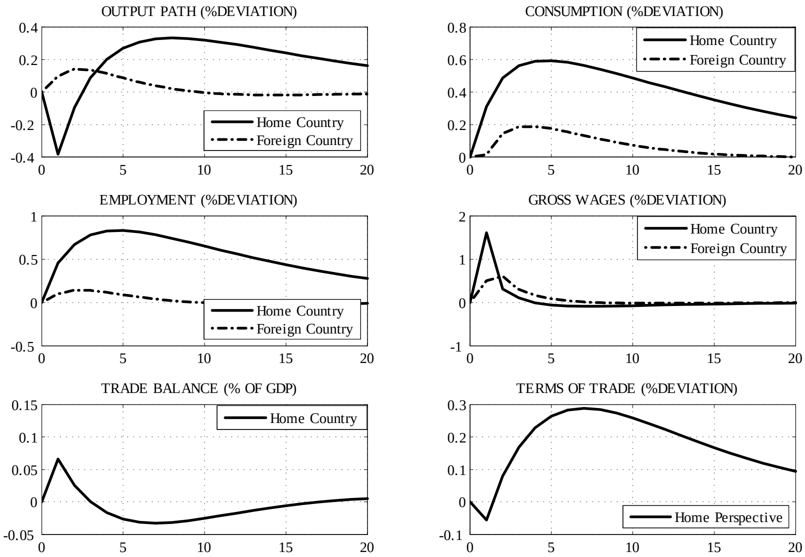

Figure 6: Impulse responses to a temporary increase in government spending dedicated to short-time work (normalised to 0.5% of GDP).

OECD [13]). However, in countries where part of the contracts are bargained by individualistic bargaining, this would reduce the multipliers somewhat. A hiring subsidy increases the value of unemployment, which leads to a higher wage. As a consequence, displacement effects would reduce the effect of hiring subsidies somewhat.

Again spillover effects are positive but small and as for the income tax cut they operate mainly through the labour market.

Short-time work (Kurzarbeit). In this case firms can reduce the the working time of workers with low productivity. The domestic government then reimburses a part of these workers lost wage income. Overall, output multipliers are negative in the short-run. While firms retain more workers, they only use a smaller share of their working time, thereby reducing the labour input and the output in the short-run. However, short-time work has non-negligible positive long-run multipliers. To understand the transmission of fiscal shocks in this case we also computed employment multipliers, which are equal to about one in the short run. Those results can be rationalized as follows. On the one side, financing part of the wage bill lowers the firing threshold,

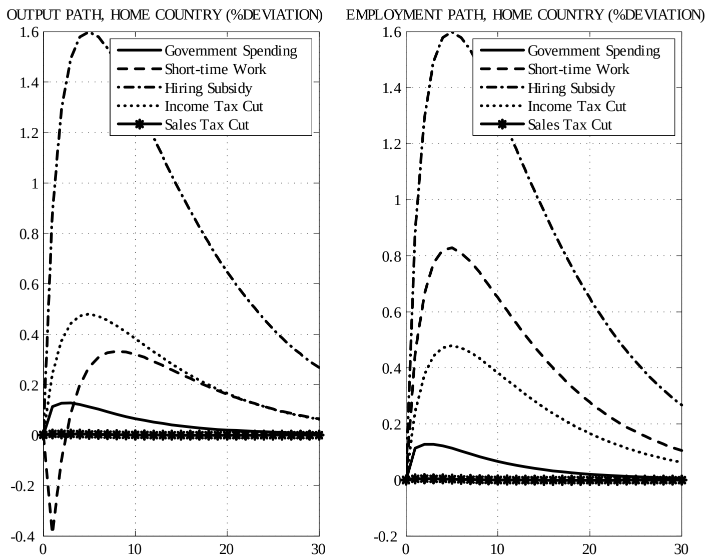

Figure 7: Employment and output effects for different programmes (all normalised to 0.5% of GDP)

hence increases the number of employed workers. This explains the large employment multipliers. On the other side, short-time work endogenously reduces average worker productivity, since workers with very low productivity are kept instead of being fired.

Spillovers are again very small. The increase in the number of employed people, accompanied by the fall in productivity, increases firms' marginal costs. The ensuing increase in the CPI level abates demand growth in the whole area.

Table 2: Summary of fiscal multipliers and spillovers across countries for different fiscal packages.

	Demand stim.	VAT cut	Inc. tax cut	Hiring subs.	STW
Home, short-run	0.23	0.01	0.50	1.85	-0.76
Home, long-run	0.31	0.00	1.62	4.83	1.04
Foreign, short-run	-0.01	0.00	0.13	0.53	0.20
Foreign, long-run	0.04	0.01	0.06	0.27	0.12

Summary. Table 2 summarises the output multipliers in the home country (i.e., the country that performs the fiscal stimulus) and the foreign country (denoted as spillover). Figure 7 provides an overview of the impulse response functions for output and employment for all five measures, where the initial fiscal stimulus is normalised to 0.5% of GDP.

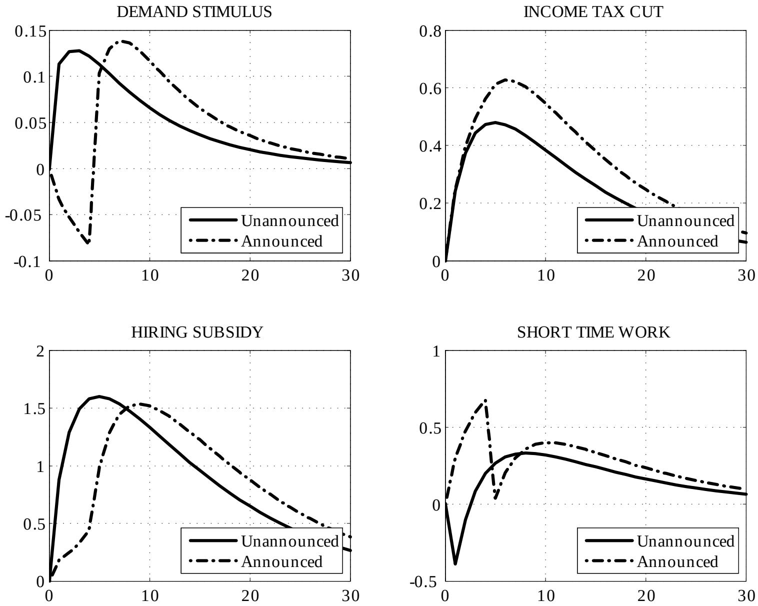

Figure 8: Response of output under four fiscal packages (pure demand stimulus, income tax cut, hiring subsidy and short time work). Announced (dashed line)versus announced (solid line) policy.

4.2 Announcement Effect

In most cases fiscal measures suffer of implementation delays. The political process and other factors prevent governments from making fiscal intervention immediately effective at the time of the announcement. Such delays can abate the benefits of expansionary fiscal policies. For this reason it is realistic to compare multipliers for the case of no implementation delays, which we call unannounced policy, and for the case of five quarters implementation delays (a realistic time span), which we call announced policy. Figure 8 shows the response of output under the announced (dashed line) and the unannounced policy (solid line). We exclude the case of consumption tax cuts, since as before multipliers are nearly zero. Under a pure demand stimulus short run multipliers are negative for the first five quarters. This is so since the detrimental effect of anticipating future tax increases is not compensated by any increase in government spending in the first five quarters. In contrast, announcements tend to amplify fiscal multipliers for income tax cuts due to the beneficial effect on private consumption of anticipating higher future disposable income. Under the hiring subsidy policies, the announcement simply delays the effects of the fiscal stimulus, which remains

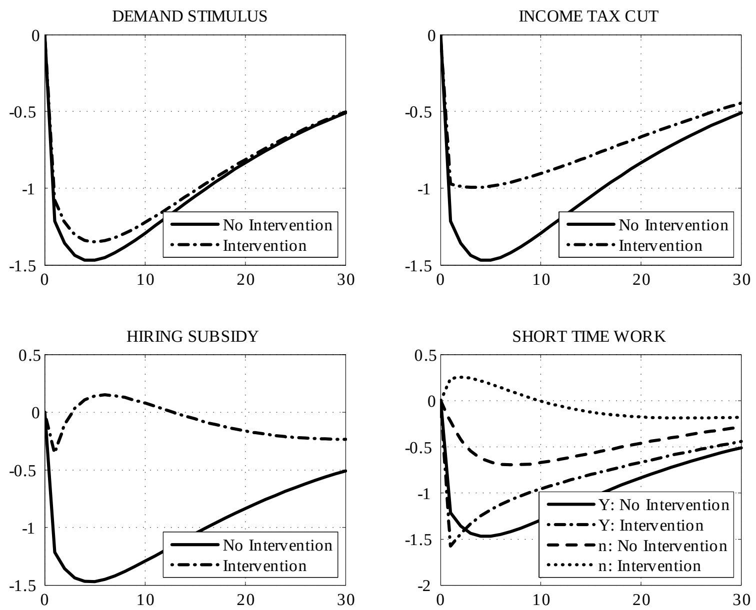

Figure 9: Response of output under four fiscal packages (pure demand stimulus, income tax cut, hiring subsidy and short time work) and starting from a recession scenario. Case with fiscal intervention (dashed line) versus case with not fiscal intervention (solid line).

unaltered in terms of size. Most interesting is the case of short-time work. Immediately after announcing the policy, output goes up. Firms increase their workforce, knowing that unproductive workers can be sent on short-time work in the future. Thus, the anticipation of short-time work reduces the risk of employing workers and employment goes up. Once the policy is implemented, output drops considerably. This is the case since some workers are sent on short-time work and this reduces average productivity.

4.3 Starting from Recession Scenario

Recently, unprecedented fiscal measures have been undertaken, largely to counteract the recessionary impact of the financial crisis. For this reason it seems realistic to reassess the size of the multipliers starting from a recession scenario, which we implement through a productivity slowdown.[12] Although we are aware that the recent crisis was not generated solely by a productivity slowdown. Figure 9 shows the response of output for the case in which the initial recession is not

[12] We assume a one percent productivity shock with autocorrelation coefficient 0.95.

followed by any policy intervention (solid line) and for the case in which a policy intervention is in place (dashed line). As before we do not show results for the consumption tax cuts as multipliers are nearly zero. For the remaining four fiscal measures previous results are largely confirmed. Pure demand stimulus has negligible effects compared to the situation in which the economy recovers from the recession in absence of policy intervention. Income tax cuts and hiring subsidies help to recover fast from the recession. As for short-time work, it helps to abate the reduction in employment, nonetheless it does not allow output to recover fast.

5 Conclusions

We have used an open economy model with labour market frictions in the form of labour turnover costs to measure fiscal multipliers. We have done so for different types of fiscal packages. Income tax cuts and hiring subsidies deliver large output stimuli, both in the short run and in the long run. Overall, measures directed toward reducing labour market distortions are associated with large multipliers. Mixed results emerge under an extension of short-time work; although this measure increases the number of employed workers, there is a significant drop in their productivity. Overall our model highlights a novel dimension through which fiscal stimuli can operate, namely a supply side channel that boosts labour demand. We test and confirm our results under alternative realistic assumptions such as announced policies and recessionary scenarios.

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6 Appendix 1 - Sources for Fiscal Stimulus Packages

Germany - Source:

1. German Government: http://www.konjunkturpaket.de.
2. http://www.faz.net/s/RubEC1ACFE1EE274C81BCD3621EF555C83C/Doc~EA3A5D8CEFD6A4E4C

France - Source: French Government: http://www.relance.gouv.fr/index.php.

Italy - Sources:

1. http://www.studiocataldi.it/news_giuridiche_asp/news_giuridica_6304.asp
2. http://www.lavoro.gov.it/Lavoro/md/AreeTematiche/AmmortizzatoriSociali/CIGS/ (short-time work)

Spain - Sources:

1. Programa estabilidad 2008–2011: http://serviciosweb.meh.es/apps/dgpe/TEXTOS/progest/progest.pd
2. http://www.spiegel.de/politik/deutschland/0,1518,594618,00.html
3. http://www.scribd.com/doc/16477252/El-Banco-de-Espana-desglosa-el-coste-de-las-medidas-anticrisis

UK: Source:

Treasury of the United Kingdom:

http://www.hm-treasury.gov.uk/prebud_pbr08_repindex.htm

US: Source:

American Government:

http://frwebgate.access.gpo.gov/cgi-bin/getdoc.cgi?dbname=111_cong_bills&docid=f:h1enr.pdf

7 Appendix 2: Technical Details on Short-Time Work

A a retained worker has the following profit function.

$$
\begin{aligned}
\tilde{\Pi}_{I,t}(\varepsilon_t) &= (1-\tau_t^p)(a_t mc_t - g(s_t)w_t - \varepsilon_t) + \\
&+E_t\left\{\sum_{j=t+1}^{\infty}\Delta_{t,j}\left[\begin{array}{c}(1-\phi_j)^{j-t}(1-\tau_{t+j}^p)\left(a_j mc_j - g(s_j)w_j - \left(\frac{1}{1-\phi_j}\int_{-\infty}^{\upsilon_{f,j}}\varepsilon_j g(\varepsilon_j)d\varepsilon_j\right)\right) \\ -\phi_j f_j(1-\phi_j)^{j-t-1}\end{array}\right]\right\},
\end{aligned}
$$

$$\tilde{\Pi}_{I,t}(\varepsilon_t) = (1-\tau_t^p)(a_t mc_t - w_t g(s_t) - \varepsilon_t) + E_t(\Delta_{t,t+1}\tilde{\Pi}_{I,t+1}(\varepsilon_{t+1})). \tag{45}$$

A firm is eligible for short-time work whenever the following condition holds (i.e., the worker generates no profit in the current period):

$$(1-\tau_t^p)(a_t mc_t - w_t g(s_t) - \varepsilon_t) < 0. \tag{46}$$

The cut-off for short-time work is:

$$\upsilon_{s,j} = a_t mc_t - w_t g(s_t), \tag{47}$$

$$\varrho_t = \int_{\upsilon_{s,j}}^{\upsilon_{f,t}} \varepsilon_t g(\varepsilon_t) d\varepsilon_t. \tag{48}$$

When a worker is eligible, the firm does not have to pay for a certain share of his wage and the operating costs. In return, the input of the worker is reduced proportionally. Let's assume that this share is equal to Υ, which follows an autoregressive process. Thus, the firms profits are:

$$\tilde{\Pi}_{s,t}(\varepsilon_t) = \Upsilon(1-\tau_t^p)(a_t mc_t - w_t g(s_t) - \varepsilon_t) + E_t(\Delta_{t,t+1}\tilde{\Pi}_{I,t+1}(\varepsilon_{t+1})), \tag{49}$$

with

$$\begin{aligned} \tilde{\Pi}_{I,t+1}(\varepsilon_{t+1}) \; = \; & \left(1-\varrho_{t+1}-\phi_{t+1}\right)(1-\tau_{t+1}^p)(a_{t+1}mc_{t+1} - w_{t+1}g(s_{t+1}) \\ & -\frac{1}{1-\varrho_{t+1}-\phi_{t+1}} \int_{-\infty}^{\upsilon_{s,j}} \varepsilon_j g(\varepsilon_j) d\varepsilon_j + E_t(\Delta_{t,t+2}\tilde{\Pi}_{I,t+2}(\varepsilon_{t+2}))) \\ & +\varrho_{t+1}\left(\Upsilon(1-\tau_t^p)(a_t mc_t - w_t g(s_t) - \frac{1}{\varrho_{t+1}} \int_{\upsilon_{s,j}}^{\upsilon_{f,t}} \varepsilon_j g(\varepsilon_j) d\varepsilon_j) + E_t(\Delta_{t,t+2}\tilde{\Pi}_{I,t+2}(\varepsilon_{t+2}))\right) \\ & +\phi_{t+1} f. \end{aligned} \tag{50}$$

Hiring and firing thresholds are endogenously determined as follows:

$$h_t(1-\tau_t^p) = (1-\tau_t^p)(a_t mc_t - w_t g(s_t) - \upsilon_{h,t}) + E_t(\Delta_{t,t+1}\tilde{\Pi}_{I,t+1}(\varepsilon_{t+1})), \tag{51}$$

$$-f_t(1-\tau_t^p) = \Upsilon(1-\tau_t^p)(a_t mc_t - w_t g(s_t) - \varepsilon_t) + E_t(\Delta_{t,t+1}\tilde{\Pi}_{I,t+1}(\varepsilon_{t+1})). \tag{52}$$

Equation 52 shows that Υ reduces the firing threshold, which, however, implies a reduction in the workers' productivity.