

# Fiscal Multipliers and the Labour Market in the Open Economy\*

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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 to the European Monetary Union) 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 cuts* 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.

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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 [35] 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 [13], Cwik and Wieland [15], Uhlig [40]).<sup>1</sup> 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 reference 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 [14]).

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. As explained later on, the model we employ also features unused capacity, hence it is particularly suitable for a traditional analysis of the fiscal multipliers. Indeed, the reference model is essential to judge the quantitative impact of a fiscal package. Interestingly we find that labour turnover costs reduce the multiplier on traditional government spending, while they increase the multiplier on income tax cuts. 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 across countries and worker flows.

For this analysis, we use a two country model (more specifically, a currency area calibrated

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<sup>1</sup>Christiano, Eichenbaum and Rebelo [12] point out that government spending multipliers may be large when the zero bound on nominal interest rates is binding.

to the European Monetary Union, EMU) with labour market frictions in the form of firing and hiring costs. We extend the labour market model by Lechthaler, Merkl and Snower [24] to a monetary union setting. This model has several advantages in the context of our analysis. First, it contains European type labour market institutions, such as firing costs and bargaining between incumbent worker and firms. Thus, it is a particularly realistic representation for our exercise, which we targeted to the EMU. In our analysis, we also show, using some statistics, that the model is able to reproduce the correlations and the volatilities of the main macro variables in the euro area. Second, the model does not suffer from the Shimer [37] puzzle, i.e., it generates strong labour market amplification effects in response to macroeconomic shocks. This may be particularly important when we analyze measures that are targeted to the labour market (to generate realistic quantitative responses). Further, the model can replicate several other important features of the data, such as strong persistence and appropriate correlations of labour market variables. Third, since the model contains a productivity distribution, this enables us to analyse measures such as short-time work, which were recently implemented by several European governments. We are the first to analyse this type of measure from a microfounded dynamic model perspective.

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, hiring subsidies and short-time work).

We simulate temporary expansionary fiscal policy<sup>2</sup> financed with future lump sum taxes<sup>3</sup> 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*

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<sup>2</sup>This seems realistic, as in the aftermath of the crisis most fiscal packages included temporary interventions.

<sup>3</sup>Lump-sum taxes allow us to isolate the effects of the respective stimulus measures. We are aware that lump-sum taxes are not readily available to policy makers. However, the main focus of our analysis is in comparing the effects of the five different measures and for this exercise. The precise financing is not important, since all measures are financed in the same way. Furthermore, it remains unclear how governments will consolidate their budget in the medium run. A consolidation by raising VAT taxes would only have minor output effects in our model, a consolidation by raising income taxes would reduce output substantially, while a consolidation by medium-run government spending cuts would have positive short-run effects (see Corsetti, Meier and Müller [14] for the latter).

work (German "*Kurzarbeit*"). Of particular interest are the last two as they induce a shift in the endogenous determination of hiring and firing thresholds and thereby affect average productivity. Although our focus is on the euro area, we compare simulations for fiscal policy in the closed versus the open economy model; this allows us to assess the role of the labour market frictions versus the open economy assumptions in driving the results.

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). In our model wages are bargained collectively between incumbent workers and the firm: the resulting wage schedule produces inefficient unemployment. Income tax cuts are beneficial as they reduce bargained wages (before taxes) and stimulate labour demand, bringing output closer to the pareto efficient level. Hiring subsidies, by increasing the hiring threshold and reducing firms' marginal costs, help to increase labour demand and to reduce labour market distortions; overall 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 and delivers substantial multipliers in the long-run. 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 abates the adjustment of wages or that 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 neighborhood 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 when starting from a recession scenario, c) a monetary policy setting a constant interest rate close to zero, d) imperfect international risk sharing versus perfect risk sharing.

Our analysis contains the main ingredients featuring the classical Mundell-Fleming study of the

fiscal multipliers. We focus on a currency area featuring unused capacity and non-walrasian labour markets. We put this question into a modern perspective by using a fully-fledged micro-founded model. Interestingly our results tend to deviate from the ones in the traditional Mundell-Fleming analysis. Indeed, our model shows that subsidies targeted toward the supply side are more effective than those focused on the demand side and that income tax cuts are more effective than traditional government spending.

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 puts our work in the perspective of the relevant empirical work. Section 6 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 al. [24] and Faia et al. [17].<sup>4</sup> 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 endogenise hiring and firing decisions, by assuming that the profitability of each

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<sup>4</sup>The mentioned papers analyse labour turnover costs in a closed economy model and do not touch fiscal policy issues.

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.

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

where  $c$  denotes aggregate consumption in final goods. Total real labour income is given by  $w_t$  and is specified below. Unemployed household members,  $u_t$ ,<sup>5</sup> 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 [2] and Merz [29], 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 real profits  $\tilde{\Pi}_{a,t}$  from the firms which they own, pay lump sum taxes,  $\tau_t$ , a consumption tax,  $\tau_t^c$ , a wage income tax,  $\tau_t^n$ , and a tax on profits,  $\tau_t^p$ . The sequence of budget constraints in terms of domestic CPI consumption goods reads as follows:

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

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

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<sup>5</sup> $u_t$  denotes the unemployment rate. But as the labor force,  $L$ , is normalised to 1,  $u_t$  is equal to the number of unemployed workers.

conditions must hold:

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

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

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.** Financial integration in the European Monetary Union is far from full, hence we assume that capital markets are imperfect in our model. In section 4.5 we will compare fiscal multipliers under the two alternative scenarios of perfect versus imperfect financial integration in order to assess the consequences of imperfect capital mobility. We capture imperfect capital mobility by postulating 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:<sup>6</sup>

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

where  $i_t$  is the interest rate of the currency union. 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:

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

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<sup>6</sup>See Schmitt-Grohe and Uribe [36].

All other optimality conditions are like in the home region. After substituting equation (5) into equation (3) and after merging with (6), we obtain the following relation:

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

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:

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

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  $\eta$  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  $\varepsilon$  being the elasticity across different varieties and  $p_{h,t} \equiv \left( \int_0^1 p_{h,t}(i)^{1-\varepsilon} di \right)^{\frac{1}{1-\varepsilon}}$ ,  $p_{f,t} \equiv \left( \int_0^1 p_{f,t}(i)^{1-\varepsilon} di \right)^{\frac{1}{1-\varepsilon}}$  being the respective price indices.

Optimal demand for domestic and foreign goods is given by:

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

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:

$$s_t \equiv \frac{p_{f,t}}{p_{h,t}}. \quad (10)$$

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

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

with  $\iota'(s_t) > 0$ . 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:

$$c_{h,t} = (1 - \alpha) (\iota(s_t))^\eta c_t, \quad (12)$$

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

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

$$\frac{s_t}{s_{t-1}} = \frac{\pi_{f,t}^*}{\pi_{h,t}}, \quad (14)$$

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:

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

$$\pi_t^* = \pi_{f,t}^* \frac{d(s_t)}{d(s_{t-1})}. \quad (16)$$

### 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 homogeneous 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 quadratic Rotemberg [34] adjustment cost. (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 Dynamics

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  $\varepsilon$ , which follows a *logistic* probability distribution  $q(\varepsilon_t)$  over the support  $-\infty$  to  $+\infty$ .<sup>7</sup> 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 incumbent workers 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 incumbent workers and the intermediate goods firm bargain over the wage<sup>8</sup>. 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

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<sup>7</sup>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.

<sup>8</sup>We assume that the bargaining takes place between the median insider and the firm. This allows us to keep analytical tractability and to present the reduced form of the model in a more elegant appearance. Notice however that the main implications of the model would not change under the assumption of individual bargaining with each marginal worker.

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-subsequent 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 these two wedges the retention rate, defined as the mass of workers who keep their jobs, is always bigger than the firing rate. Importantly this observation is in line with Hobijn and Sahin [22] who show that separation rates in the OECD are between 0.7 and 2 percent (i.e., retention rates are larger than 98%) and job-finding rates are at most 56 percent. The operating costs,  $\varepsilon$ , are measured in terms of the final consumption good.<sup>9</sup>

Let's now consider the real profit generated by a firm-worker relation whose operating cost is  $\varepsilon_t$ . At this point, it is important to note that while workers value their labour income,  $w_t$ , in 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  $\iota(s_t)$ :

$$\begin{aligned} \Pi_{I,t}(\varepsilon_t) = & (1 - \tau_t^p)(a_t m c_t - \iota(s_t)w_t - \varepsilon_t) + \\ & + E_t \left\{ \sum_{j=t+1}^{\infty} \Delta_{t,j} \left[ (1 - \phi_j)^{j-t} (1 - \tau_{t+j}^p) \left( a_j m c_j - \iota(s_j)w_j - \left( \frac{1}{1-\phi_j} \int_{-\infty}^{v_{f,j}} \varepsilon_j q(\varepsilon_j) d\varepsilon_j \right) \right) \right. \right. \\ & \left. \left. - \phi_j f_j (1 - \tau_t^p) (1 - \phi_j)^{j-t-1} \right] \right\}, \end{aligned}$$

where  $\Pi_{I,t}$  are the expected profits of an incumbent worker (after taxes),  $w$  is the real wage,  $\phi$  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:

$$\tilde{\Pi}_{I,t}(\varepsilon_t) = (1 - \tau_t^p)(a_t m c_t - w_t \iota(s_t) - \varepsilon_t) + E_t(\Delta_{t,t+1} \tilde{\Pi}_{I,t+1}(\varepsilon_{t+1})), \quad (18)$$

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

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<sup>9</sup>For permanent technology shocks, it can be assumed that 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.

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  $v_{h,t}$  and  $v_{f,t}$ . 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  $v_{h,t}$  is obtained by solving the following zero profit condition:

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

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:

$$\eta_t = \int_{-\infty}^{v_{h,t}} \varepsilon_t q(\varepsilon_t) d\varepsilon_t. \quad (20)$$

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:

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

and the separation rate is defined as:

$$\phi_t = \int_{v_{f,t}}^{\infty} \varepsilon_t q(\varepsilon_t) d\varepsilon_t. \quad (22)$$

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 ( $\eta U_{t-1}$ ) and the firing from the employment pool ( $\phi N_{t-1}$ ), 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.

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

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

The evolution of unemployment in this model clearly depends on the fluctuations of the firing and the hiring threshold. Higher firing rates and lower hiring rates increase unemployment. Unemployment in this model is both, inefficient and involuntary, as workers searching for a job would be willing to work even at wages which are lower than the ones bargained by incumbent workers (see Lindbeck and Snower [25] Blanchard and Summers [8]).

### 3.3.2 Wage Bargaining

For simplicity, let the real wage  $\iota(s_t)w_t$  be the outcome of a Nash bargain between the median worker<sup>10</sup> with operating cost  $\varepsilon^I$  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  $\iota(s_t)w_t$  and the firm receives the expected profit  $(1 - \tau_t^p)(a_t^I m c_t - \iota(s_t)w_t)$  in each period  $t$ . Under disagreement, the worker's fallback income is  $\iota(s_t)ub_t$ , 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  $(1 - \tau_t^n)\iota(s_t)w_t - \iota(s_t)ub$ , while the firm's surplus is  $(1 - \tau_t^p)(a_t^I m c_t - \iota(s_t)w_t - \varepsilon^I) + s$ , where  $\varepsilon^I$  are the operating costs of the median worker. Consequently, the Nash-product is:

$$\Theta = (\iota(s_t)w_t(1 - \tau_t^n) - \iota(s_t)ub)^\gamma \left( (1 - \tau_t^p)(a_t^I m c_t - \iota(s_t)w_t - \varepsilon^I) + s \right)^{1-\gamma}, \quad (24)$$

where  $\gamma$  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:

$$(1 - \tau_t^n) \gamma \left( (a_t^I m c_t - \iota(s_t)w_t - \varepsilon^I) (1 - \tau_t^p) + s \right) + (1 - \gamma) \iota(s_t)ub (1 - \tau_t^p) \quad (25)$$

$$= (1 - \gamma) \iota(s_t)w_t (1 - \tau_t^n) (1 - \tau_t^p), \quad (26)$$

---

<sup>10</sup>For simplicity, we allow the median worker to bargain over wages. Alternative settings, such as individual bargaining process with marginal workers, would not affect the model dynamics. Empirical evidence for the relevance of union contracts is provided below.

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

$$w_t = \frac{\gamma}{\iota(s_t)} \left( a_t m c_t - \varepsilon_t^I + \frac{s}{1 - \tau_t^p} \right) + (1 - \gamma) \frac{ub}{1 - \tau_t^n}. \quad (27)$$

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.<sup>11</sup> 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 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.

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<sup>11</sup>This is a particular case of a sequential bargaining framework proposed by Manning [26], 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.

### 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:

$$v_{h,t} + h = v_{f,t} - f. \quad (28)$$

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:

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

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  $v_{h,t} + h$  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 Rotemberg price adjustment costs. They maximize the following profit function:

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

where  $\Psi$  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:

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

The latter equation is a traditional non-linear Phillips curve in which current inflation depends on future inflation and marginal costs. Crucially marginal costs are also affected by the terms of trade, as firms' revenues are measured in CPI while costs are measured in PPI.

### 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:

$$\begin{aligned}
\tilde{\Pi}_I &= mc_t a_t n_t - \iota(s_t) w_t n_t - n_t (1 - \phi_t) \Xi_t^i - \\
&\quad (1 - n_t) \eta_t \Xi_t^e - n_{t-1} \phi_t f - (1 - n_{t-1}) \eta_t h,
\end{aligned} \tag{32}$$

where  $\Xi_t^i$  is the expected value of operating costs for incumbent workers, conditional on not being fired and  $\Xi_t^e$  is the expected value of operating costs for entrants, conditional on being hired, defined by:

$$\Xi_t^e = \frac{\int_{-\infty}^{v_h} \epsilon_t q(\epsilon_t) d\epsilon_t}{\eta_t}, \tag{33}$$

$$\Xi_t^i = \frac{\int_{-\infty}^{v_f} \epsilon_t q(\epsilon_t) d\epsilon_t}{1 - \phi_t}. \tag{34}$$

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

$$\tilde{\Pi}_W = y_t - mc_t a_t n_t - \frac{\Psi}{2} (\pi_{h,t} - 1)^2 (c_{h,t} + c_{h,t}^*). \tag{35}$$

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

$$\begin{aligned}
\tilde{\Pi}_{a,t} &= y_t - \iota(s_t) w_t n_t - n_{t-1} \phi_t f - (1 - n_{t-1}) \eta_t h - n_t (1 - \phi_t) \Xi_t^i \\
&\quad - (1 - n_t) \eta_t \Xi_t^e - \frac{\Psi}{2} (\pi_{h,t} - 1)^2 (c_{h,t} + c_{h,t}^*).
\end{aligned} \tag{36}$$

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

$$(1 + \tau_t^c)c_t = \iota(s_t)w_t n_t(1 - \tau_t^n) + ubu_t - \tau_t \quad (37)$$

$$+(1 - \tau_t^p) \left[ \begin{array}{c} y_t - n_{t-1}\phi_t f - (1 - n_{t-1})\eta_t h - n_t(1 - \phi_t)\Xi_t^i - \\ (1 - n_t)\eta_t \Xi_t^e - \frac{\Psi}{2} (\pi_{h,t} - 1)^2 (c_{h,t} + c_{h,t}^*) \end{array} \right]. \quad (38)$$

Equations 37 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, balanced budget, aggregating and recalling that  $p_{h,t} = p_{h,t}^*$ , we can express the resource constraint as:

$$c_{h,t} + c_{h,t}^* = y_t - n_{t-1}\phi_t f a_t - (1 - n_t)\eta_{t-1} h - n_t(1 - \phi_t)\Xi_t^i - (1 - n_t)\eta_t \Xi_t^e - \frac{\Psi}{2} (\pi_{h,t} - 1)^2 (c_{h,t} + c_{h,t}^*) - g_t. \quad (39)$$

### 3.5 Model Calibration

The calibration is summarized in table 1 below.

*Preferences.* The discount rate,  $\beta$ , is set to 0.99, consistently with an annual interest rate of 4 percent. The intertemporal elasticity of substitution,  $\sigma$  is set to 2. The elasticity of substitution between different product types,  $\varepsilon$ , is set to 10 (see, e.g., Galí [20]). The elasticity of substitution between home and foreign goods,  $\eta$ , is set to 2, consistently with most empirical studies, while the degree of home bias in consumption,  $\alpha$ , is set to 0.2, consistently with data for net exports in the euro area. The elasticity of the spread on foreign bonds to the net asset position,  $\zeta$ , is set to very different values in the literature (see, e.g., Benigno [5], Kollmann [23], Rabanal and Tuesta [33] and Schmitt-Grohe and Uribe [36]). In line with these papers, we set the parameter to 0.01.<sup>12</sup>

*Firms and the labour market.* The parameter of price adjustments,  $\Psi$ , is calibrated in line with microeconomic evidence for Europe (see Alvarez et al. [1]).

The annual average productivity is normalised to 1 (i.e., 0.25 per quarter). The bargaining power of workers,  $\gamma$ , is set to a benchmark value of 0.5. Taking continental Europe as reference

<sup>12</sup>Note that the size of the multipliers is almost unaffected by the choice of this parameter. The choice matters most for the comparison with perfect capital markets (Section 4.5).

Table 1: Parameters of the Numerical Model

Parameter	Description	Value	Source
$\beta$	Subjective discount factor	0.99	Standard value
$\sigma$	Consumption utility	2	Intertemp. elasticity of subst.
$\varepsilon$	Elasticity of subst.	10	Galí [20]
$\Psi$	Price adjustment cost	104.85	Equivalent to $\theta = 0.75$
$a$	Annual Productivity	1	Normalization
$\gamma$	Workers' bargaining power	0.5	Standard value
$f$	Firing cost	0.6	Bentolila and Bertola [6]
$h$	Hiring cost	0.1	Chen and Funke [10]
$b$	Unemployment benefits	0.0875	OECD [30]
$E(\varepsilon)$	Expected value of op. costs	0	Normalisation
$sd$	Distr. scaling parameter	0.1325	To match the flow rates
$s$	Payments under disagreement	0.0561	To match the flow rates
$\alpha$	Home bias parameter	0.2	To match typical net exports
$b_\pi$	Weight on inflation	1.5	Galí [20]
$\zeta$	Intermediation cost	0.01	Within range in the literature
$\tau^n$	Income tax	0.41	Trabandt and Uhlig [39]
$\tau^c$	Consumption tax	0.17	Trabandt and Uhlig [39]
$\tau^p$	Profit tax	0.33	Trabandt and Uhlig [39]
$g/y$	Governments spending	0.23	Trabandt and Uhlig [39]

point, the firing costs are set to 60 percent ( $f = 0.6$ )<sup>13</sup> of the annual productivity which amounts to approximately 66 percent of the annual wage<sup>14</sup> and the hiring costs are set to 10 percent ( $h = 0.1$ ) of annual productivity (see Chen and Funke [10]). The unemployment benefits are set to 8.75 percent of the level of annual productivity ( $ub = 0.0875$ ). 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 [30]). 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 0.1325 and payments under disagreement to 0.0561. We calibrate our flow rates using evidence for West Germany, as there are only Kaplan-Meier functions for individual countries.<sup>15</sup> Wilke's [41] 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 firing 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 [31] numbers for other continental European countries.<sup>16</sup> Hence a quarterly job finding 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 [39], 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

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<sup>13</sup>For an empirically admissible range of values of firing costs our main numerical results are unchanged.

<sup>14</sup>For the period from 1975 to 1986 Bentolila and Bertola [6] 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.

<sup>15</sup>We choose the Kaplan-Meier functions for Germany, as it is the largest continental European country.

<sup>16</sup>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 [38].

euro area countries:

$$\frac{1 + i_t}{1 + \bar{i}} = \left( \frac{1}{2} \pi_t + \frac{1}{2} \pi_t^* \right)^{b_\pi} \quad (40)$$

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 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 Quantitative Properties of the Model

Before using our model for policy analysis, it is appropriate to verify that it is able to reproduce the salient features of the European labour market and to reproduce the path of the main macro variables across countries. To this purpose we compute a number of selected statistics both in the model and in the data. Table 2 reports the statistics for the four largest euro area countries, namely France, Germany, Italy and Spain, and for the EMU period, namely Q1 1997-Q1 2010. We have included some years for the pre-EMU period, as several empirical studies have shown that convergence had taken place starting from 1997. Quarterly data for consumption and GDP are taken from Eurostat and data for employment are taken from OECD. All series in logs have been Hodrick-Prescott de-trended. Consistently with most literature in open macro (see for instance Backus, Kehoe and Kydland [3]), our calculations show that correlations of output, consumption and employment are positive across countries. Consistently with the literature in labour markets (see for instance Shimer [37]), we find that the volatility of unemployment is significantly higher than the volatility of output in all countries considered

Table 3 shows the model equivalent statistics, which have also been computed using Hodrick Prescott filtered series with the same smoothing parameter used in the data. Second moments have been calculated using productivity and government spending shocks. Productivity shocks are calibrated consistently with data for industrialized countries and following Backus, Kehoe and

Table 2: Selected statistics for main euro area countries.

	Correlation GDP			Corr Consumption					
	France	Germany	Italy	France	Germany	Italy			
France									
Germany	0.87			0.07					
Italy	0.87	0.90		0.73	0.05				
Spain	0.92	0.86	0.90	0.80	0.03	0.76			
	Corr Employment			Standard Deviations					
	France	Germany	Italy	$y$	$c$	$u$	$\eta$	$\phi$	
France				1.00*	0.52	6.45	6.89	7.11	
Germany	0.45			1.56	0.81	7.06	10.73	13.08	
Italy	0.47	0.21		1.36	0.86	5.02	12.91	8.91	
Spain	0.13	0.36	0.46	1.32	1.66	12.02	12.15	13.20	

\*Numbers for standard deviations are in percentage terms

Kydland [3], hence their standard deviation is set to  $\sigma_a = 0.007$ , their persistence parameter is set to  $\rho_a = 0.95$  and their correlation across countries is set to 0.25. To calibrate government expenditure shocks we follow Perotti [32] and set  $\sigma_g = 0.008$  and  $\rho_g = 0.9$ . Since we focus on euro area countries, we further assume that government expenditure shocks have a positive correlation of 0.2; this is consistent with several studies showing that demand shocks are positively correlated across EMU countries (see Funke [19] among others) and with studies showing that fiscal policy shocks are positively coordinated within the main euro area countries (see for instance Marcellino [27] and Bénassy-Quéré and Cimadomo [4]).

Table 3: Selected statistics from the model.

	Productivity Shocks	Gov. Sp. Shocks	Both Shocks
Corr output	0.48	0.56	0.48
Corr consumption	0.83	0.82	0.83
Corr employment	0.54	0.56	0.54
St. dev. $y$	1.44	0.07	1.45
St. dev. $c$	1.60	0.15	1.61
St. dev. $u$	6.39	0.69	6.43
St. dev. $\eta$	6.25	0.83	6.30
St. dev. $\phi$	7.65	1.02	7.72

The model can reproduce positive co-movements across countries (see table 3). Standard new open economy models are unable to reproduce positive correlations of output and employment

(see Backus, Kehoe and Kydland [3]) due to the predominance of the switching expenditure effect, which in response to productivity shocks tends to move consumption demand across countries in opposite directions. In the presence of non-walrasian labour markets and government expenditure shocks the wealth effect becomes predominant. Indeed, the increase in prices experienced by both countries raises the firms' profits, which in turn raises labour demand and output in both countries. The model is also able to reproduce a large standard deviation of the unemployment rate, the job-finding rate and the separation rate compared to the standard deviation of output (see table 3). Further, the model generates a large persistence of unemployment and output (not shown in the table, for details and an intuition on the volatility and persistence issues see Lechthaler, Merkl and Snower [24]).

### 3.8 Fiscal policy regimes

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

$$g_t + ubu_t - \tau_t - \tau_t^c (c_{h,t} + c_{f,t}) - \tilde{\Pi}_{a,t} \tau_t^p = \tau_t^n w_t n_t. \quad (41)$$

In the baseline scenario, we assume that  $\tau_t^c = \tau^c$ ,  $\tau_t^p = \tau^p$  and  $\tau_t^n = \tau^n$  and that government expenditure follows an exogenous process. We assume that the higher expenditures are financed 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:

$$\frac{g_t}{g} = \left( \frac{g_{t-1}}{g} \right)^{\rho_g} e^{\varepsilon_t^g}, \quad (42)$$

where  $\varepsilon_t^g$  is a surprise increase and  $\rho_g$  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:

$$\frac{\tau_t^c}{\tau^c} = \left( \frac{\tau_{t-1}^c}{\tau^c} \right)^{\rho_{\tau^c}} e^{\varepsilon_t^{\tau^c}}, \quad (43)$$

where  $\varepsilon_t^{\tau^c}$  is the surprise increase and  $\rho_{\tau^c}$  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:

$$\frac{\tau_t^n}{\tau^n} = \left( \frac{\tau_{t-1}^n}{\tau^n} \right)^{\rho_{\tau^n}} e^{\varepsilon_t^{\tau^n}}, \quad (44)$$

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

$$w_t = \frac{\gamma}{\iota(s_t)} \left( a_t mc_t - \varepsilon_t^I + \frac{s}{1 - \tau_t^p} \right) + (1 - \gamma) \frac{ub}{1 - \tau_t^n}. \quad (45)$$

A reduction in  $\tau_t^n$  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:

$$(1 - \tau_t^p)(h - hs_t) = (1 - \tau_t^p)(a_t mc_t - w_t \iota(s_t) - v_{h,t}) + E_t(\Delta_{t,t+1} \tilde{\Pi}_{I,t+1}(\varepsilon_{t+1})) \quad (46)$$

where  $hs_t$  represents the hiring subsidy:

$$hs_t = hs_{t-1}^{\rho_{hs}} e^{\varepsilon_t^{hs}}, \quad (47)$$

where  $\varepsilon_t^{hs}$  is the surprise increase and  $\rho_{hs}$  is the autocorrelation of the shock.

>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  $\Upsilon$  (1 in the steady state, i.e. no short-time work possibilities) follows an autoregressive process of order one (for further technical details see the Appendix):

$$\frac{\Upsilon_t}{\Upsilon} = \left( \frac{\Upsilon_{t-1}}{\Upsilon} \right)^{\rho_\Upsilon} e^{\varepsilon_t^\Upsilon}. \quad (48)$$

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<sup>17</sup> and open economy spillovers. In all cases we assume that only the domestic economy undertakes the fiscal measure. Results are summarized in table 4.

**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 [13], Cwik and Wieland [15], Uhlig [40]), government expenditures have to be financed via taxes (in our case lump-sum taxes). This reduces available income and thereby consumption, as shown in figure 1, illustrating the impulse response to a temporary increase in government spending. Note that our assumption about balanced budgets is irrelevant for this result. Due to Ricardian equivalence, a shift of the tax burden to future periods would be anticipated and reduce consumption in the exact same way. 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

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<sup>17</sup>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 normalised 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 endogenous variables.

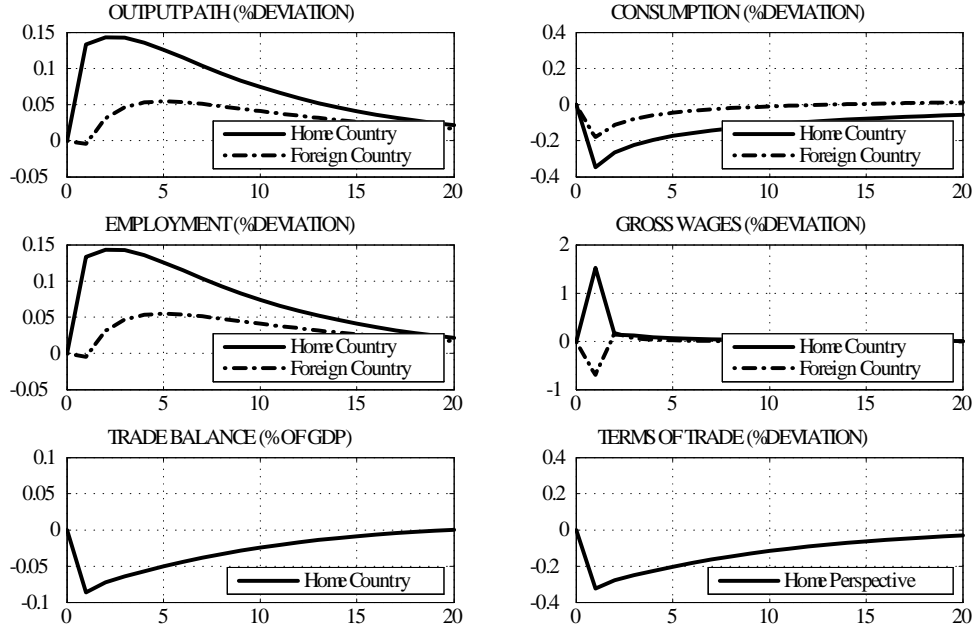


Figure 1: Impulse responses to temporary increase in government spending (normalised to 0.5% of GDP).

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,  $\eta$ , and the degree of home bias in consumption of the domestic economy,  $\alpha$ . The higher the values for those parameters the higher is the switch in demand toward foreign goods.<sup>18</sup> 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. Overall, changes in relative wages induce changes in relative marginal costs, which, in

<sup>18</sup>The baseline calibration for  $\eta$  and  $\alpha$  follows the ones mostly used in the open economy literature and the one which received the largest empirical support. Notice that robustness checks along this dimension show that open economy spillovers remain almost unchanged when using other empirically valid calibrations.

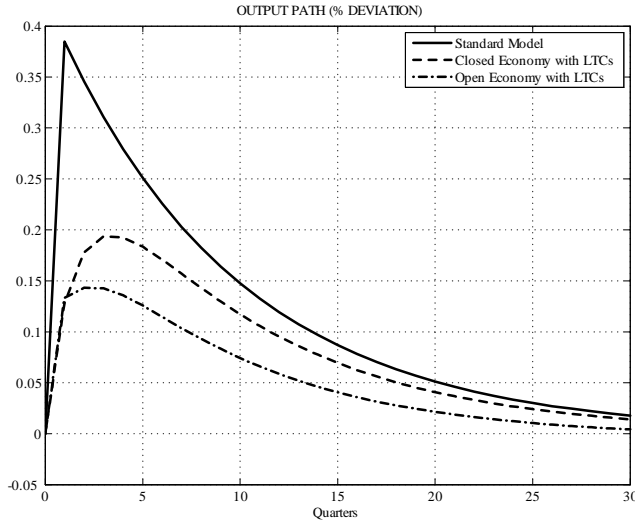


Figure 2: Model comparison for government spending shocks

turn, bring about changes in employment and job flows across countries. 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  $\eta$  and  $\alpha$ , makes such demand spillovers rather small, the more so in a currency area. The reason for this is mostly related to the fact that we consider a currency area model: shutting off the exchange rate channel abates movements in terms of trade and net exports, hence both the spillover through aggregate demand and the spillover through relative wages are small.

To highlight the role of labour market frictions and the open economy, we perform the same government spending exercise in a frictionless closed economy<sup>19</sup> 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

<sup>19</sup>We use a separable utility function with the same specification for consumption as in our model and with a quadratic disutility of labor.

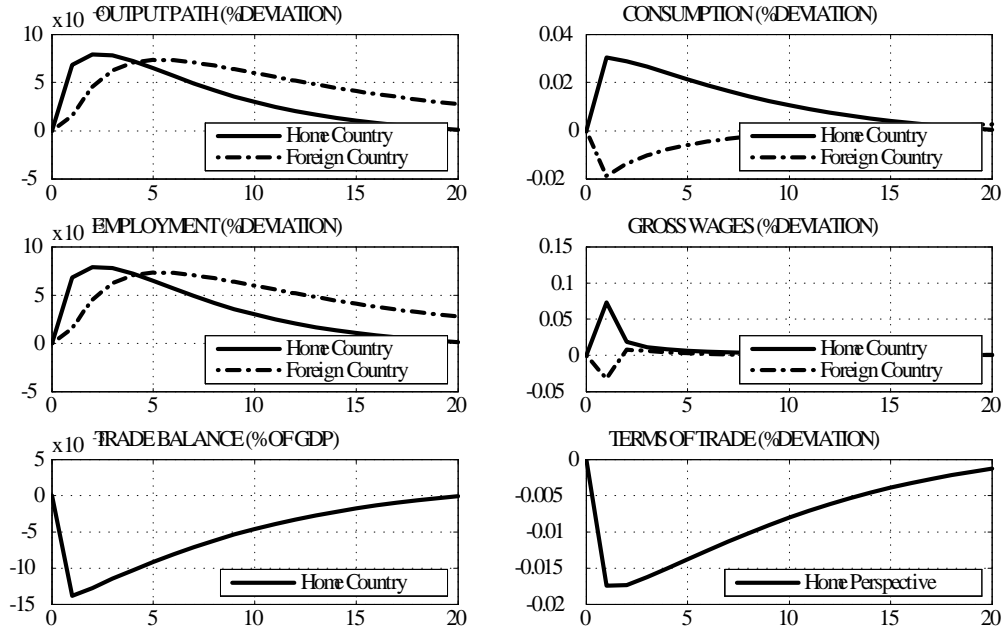


Figure 3: Impulse responses to temporary cut to consumption (VAT) taxes (normalised to 0.5% of GDP).

spending due to spillover effects: the appreciation of the terms of trade, following the increase in government spending, reduces net exports, hence aggregate demand is below the one prevailing in the closed economy model.

**Consumption (VAT) tax cuts.** In this case multipliers are nearly zero. The reason, already discussed in the previous literature (see for instance Cogan, Cwik, Taylor and Wieland [13]) is twofold. First, as for the case of a pure demand stimulus, cuts in consumption tax are financed by increases in the lump-sum tax. 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.

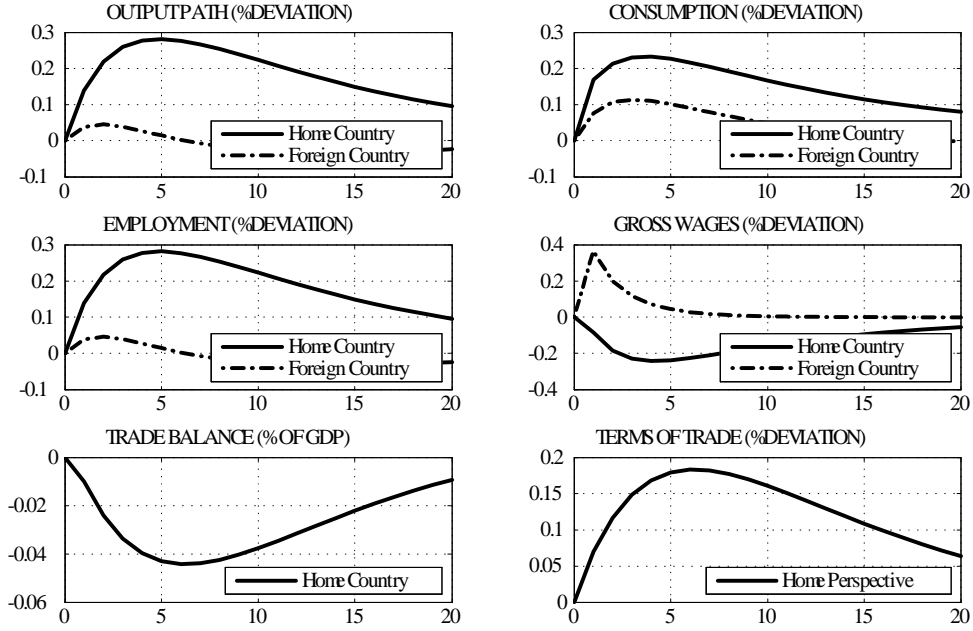


Figure 4: Impulse responses to temporary cut of income taxes (normalised to 0.5% of GDP).

**Income tax cuts.** For this experiment, and contrary to the case with consumption tax cuts, the multipliers are pretty large in the long-run. Most importantly, long run multipliers are larger than short run multipliers. This result is very much in line with the ones highlighted in Uhlig [40], who shows 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 around one. The reason being that this measure has a direct and strong impact on labour market outcomes.

Given the wage equation:

$$w_t = \frac{\gamma}{\iota(s_t)} \left( a_t m c_t - \varepsilon_t^I + \frac{s}{1 - \tau_t^p} \right) + (1 - \gamma) \frac{ub}{1 - \tau_t^n}, \quad (49)$$

it is immediate to see that a cut in  $\tau_t^n$  reduces wages (before taxes), hence leads to an increase in labour demand (see also figure 4 which shows the impulse responses to a cut in income taxes, normalised to 0.5% of GDP). 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. This is further highlighted by figure 5, comparing the effects of income tax cuts in a frictionless economy and a closed economy

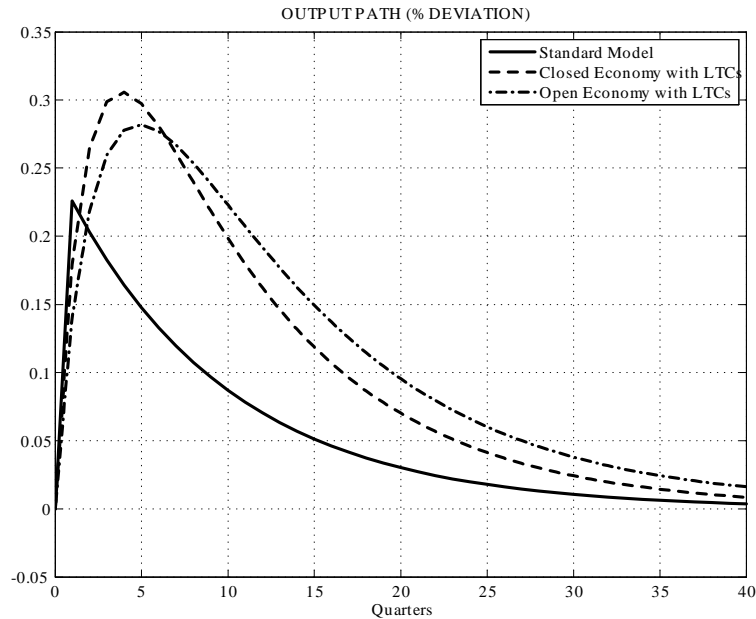


Figure 5: Model comparison for income tax cuts

with labor market frictions. In contrast to the case of traditional government spending, the effects of income tax cuts are more beneficial in the presence of labor turnover costs.

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 (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 increase the steady state unemployment rate. A reduction in hiring costs increases the hiring threshold as shown in equation 46 and reduces firms' marginal costs, as shown by equation 29. The ensuing increase in employment (see figure 6 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

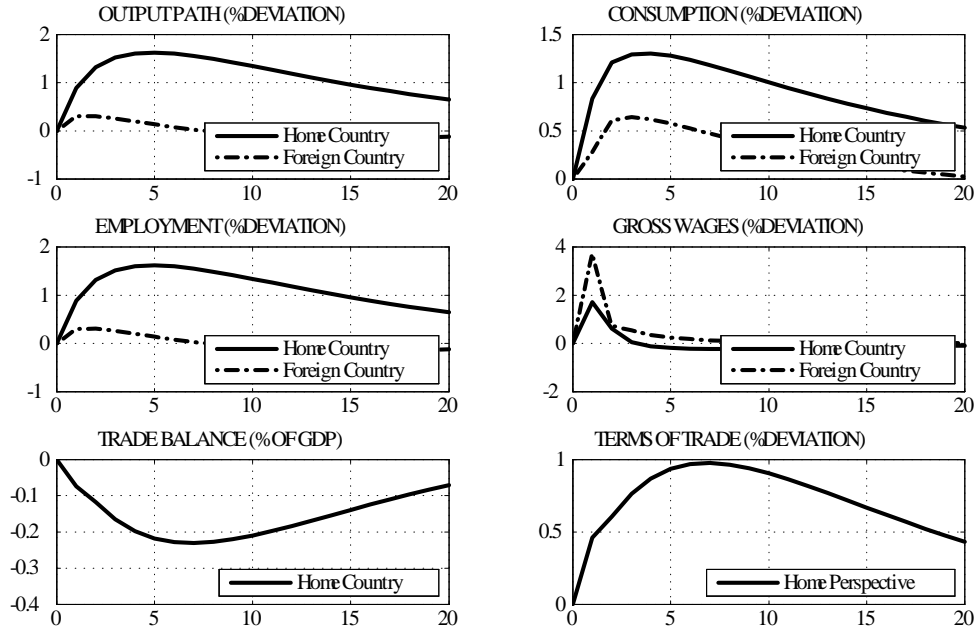


Figure 6: Impulse responses to temporary increase in government spending to finance hiring subsidies (normalised to 0.5% of GDP).

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 an 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 OECD [31]). 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 under individualistic bargaining. As a consequence, displacement effects would reduce the effect of hiring subsidies somewhat.

Again spillover effects are positive but small and as the income tax cut affects relative wages across countries they operate mainly through the labour market.

**Short-time work (Kurzarbeit).** In this case firms can reduce 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 (see figure 7) While firms retain

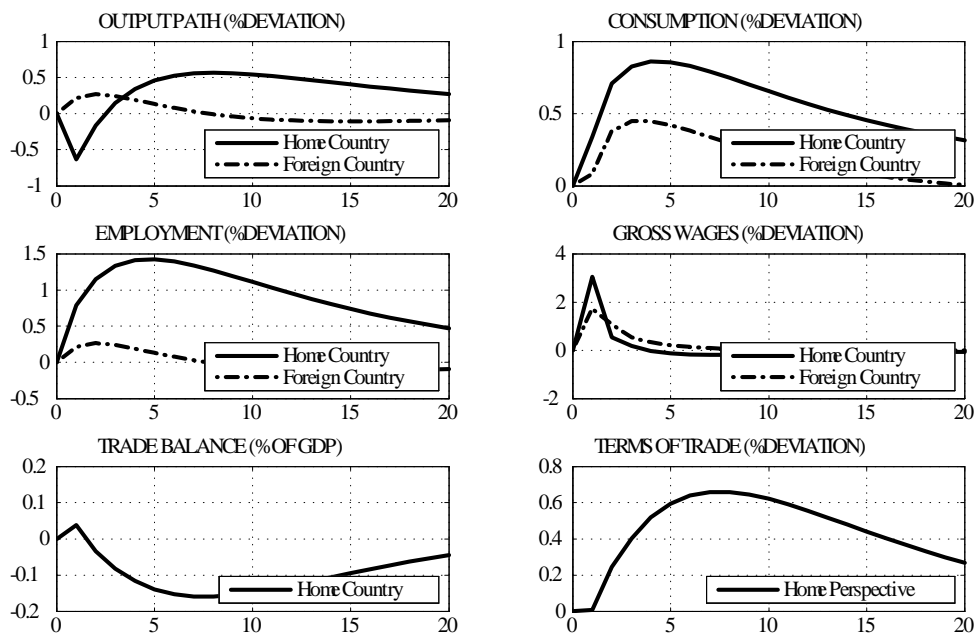


Figure 7: Impulse responses to a temporary increase in government spending dedicated to short-time work (normalised to 0.5% of GDP).

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 1.5 in the short run.<sup>20</sup> Those results can be rationalised as follows. On the one side, financing part of the wage bill lowers the firing threshold, 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.

**Summary.** Table 4 summarises the output multipliers in the home country (i.e., the country that performs the fiscal stimulus) and the foreign country (i.e., the country that remains passive,

<sup>20</sup>When 0.5 percent of GDP are devoted to short-time work, this increases employment by roughly 0.75 percentage points.

Table 4: 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	0.26	0.01	0.28	1.80	-1.28
Home, long-run	0.32	0.01	0.96	4.93	1.82
Foreign, short-run	-0.01	0.00	0.08	0.61	0.43
Foreign, long-run	0.17	0.03	-0.07	-0.22	-0.13

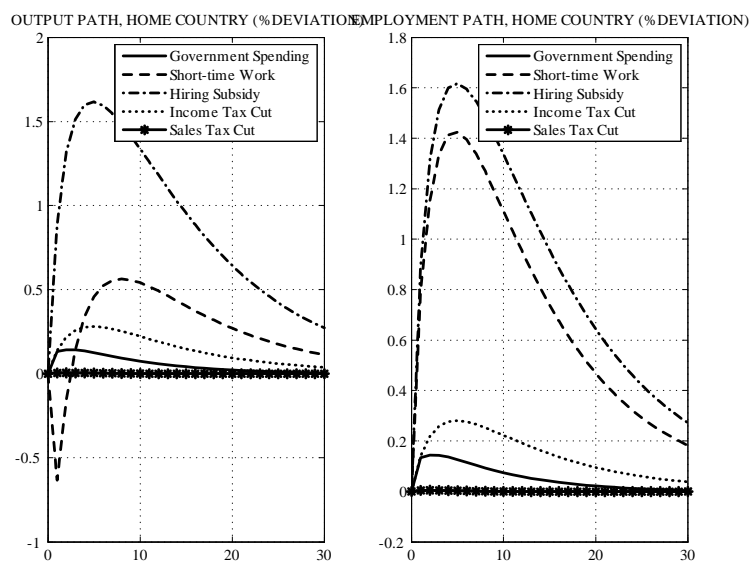


Figure 8: Employment and output effects for different programmes (all normalised to 0.5% of GDP)

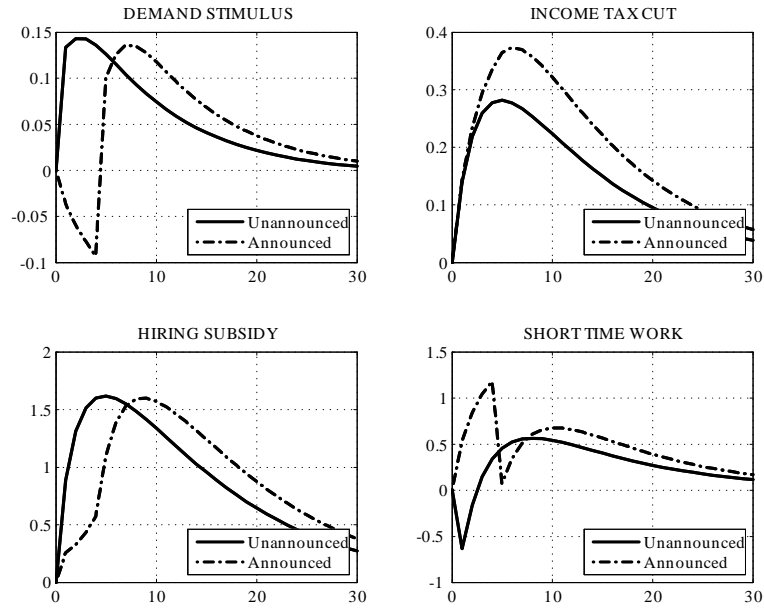


Figure 9: Response of output under four fiscal packages (pure demand stimulus, income tax cut, hiring subsidy and short time work). Announced (dashed line) versus unannounced (solid line) policy.

denoted as spillover). Figure 8 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.

#### 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 9 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

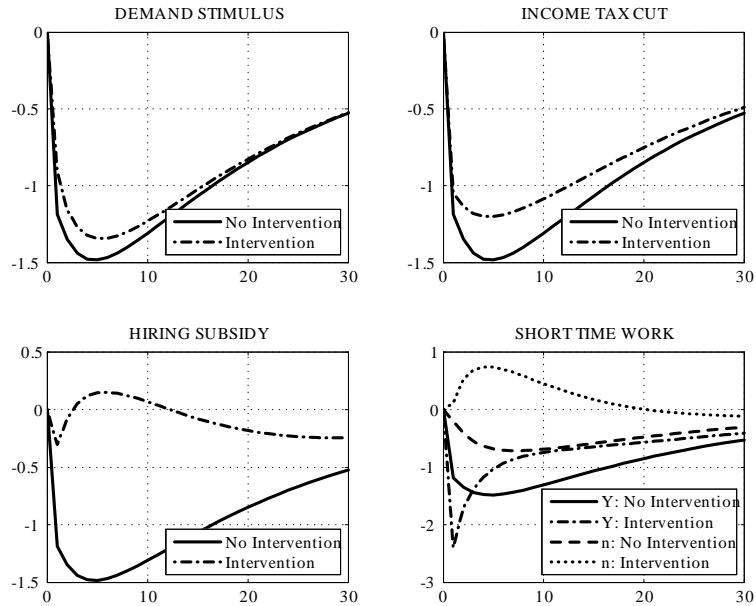


Figure 10: Response of output under four fiscal packages (pure demand stimulus, income tax cut, hiring subsidy and short time work) and starting from a recession scenario. Case with fiscal intervention (dashed line) versus case with not fiscal intervention (solid line).

contrast, announcements tend to amplify fiscal multipliers for income tax cuts due to the beneficial effect on labor demand due to anticipated lower future labor costs. Under the hiring subsidy policies, the announcement simply delays the effects of the fiscal stimulus, which remains almost 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 slow-

down,<sup>21</sup> although we are aware that the recent crisis was not generated solely by a productivity slowdown. Figure 10 shows the response of output for the case in which the initial recession is not 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, it aggravates the recession in the short run<sup>22</sup> and it strengthens the recovery in the medium run.

#### 4.4 Constant Interest Rates

Romer and Bernstein [35] assume that monetary policy maintains a constant nominal interest rate. The exercise served the purpose of modeling the idea that monetary policy could accommodate the fiscal stimuli for some time to make it more effective. The resulting fiscal multipliers might be larger in this case (see also Christiano, Eichenbaum and Rebelo [12]).

In the aftermath of the crisis the ECB has also followed an accommodative policy, hence it is essential to reconsider once more our results in the case in which the monetary authority follows an accommodative policy. To perform this check, we follow Cwik and Wieland [15] and assume that the monetary authority keeps the interest rate constant for four quarters.<sup>23</sup> Afterwards, central bank policy is assumed to return to a policy rule that ensures a greater than one-for-one response to rising inflation. Such a rule avoids explosive and self-fulfilling increases in inflation.

Figure 11 shows the results for the output multipliers when we keep the interest rate constant for four quarters. Once again, our main results are unaltered as the order of the magnitude for the fiscal multipliers remains the same across the different fiscal packages considered. However, in this case the multiplier for the demand stimulus is larger and the multipliers for the other fiscal packages

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<sup>21</sup>We assume a one percent productivity shock with autocorrelation coefficient 0.95.

<sup>22</sup>The first two observations would be in line with the experience in Germany, where short-time work composed an important part of the business cycle package (€ 14 billion in 2009). Compared to other European countries, Germany had one of the most severe output drops in 2009, but relatively stable unemployment.

<sup>23</sup>For this exercise we had to reduce the shock-size to a quarter. To assure the comparability with the other graphs, the resulting impulse response functions were multiplied by four.

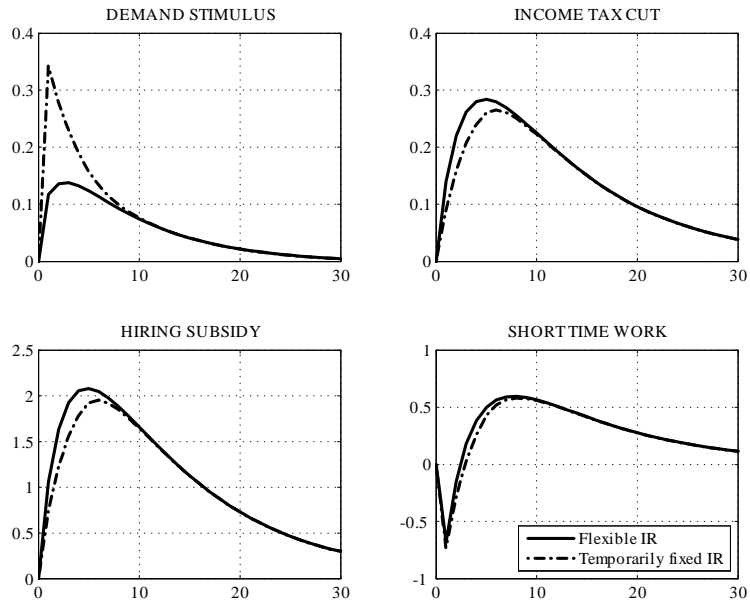


Figure 11: Response of output under four fiscal packages (pure demand stimulus, income tax cut, hiring subsidy and short time work). Case with flexible interest rate (solid line) versus case with temporarily constant interest rate (dashed line).

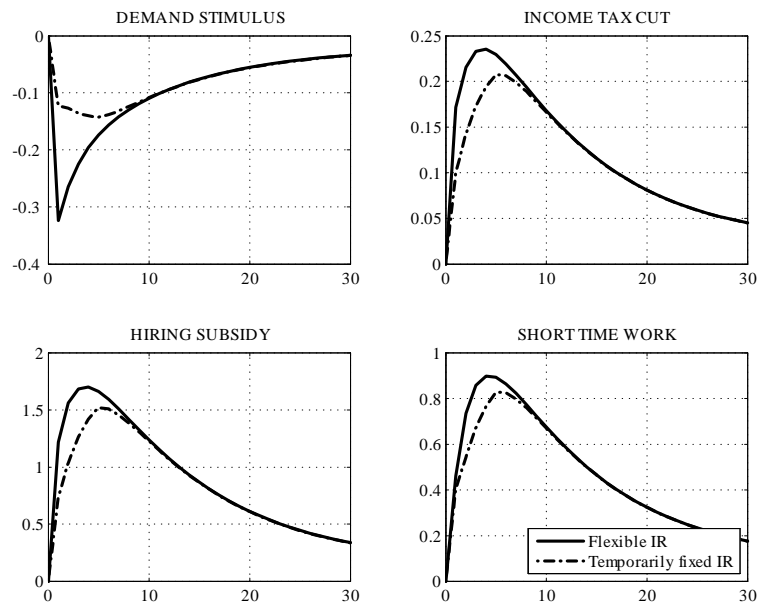


Figure 12: Response of consumption under four fiscal packages (pure demand stimulus, income tax cut, hiring subsidy and short time work). Case with flexible interest rate (solid line) versus case with temporarily constant interest rate (dashed line).

are smaller than in absence of accommodative monetary policy. Demand side stimuli are now more effective since monetary accommodation is anticipated by forward-looking households and firms. Hence crowding-out effects, arising from an increase in interest rates following the announcement of fiscal stimulus, are reduced. On the other side, crowding out effects are not induced by the other fiscal packages. Hence for those, fiscal policy does not benefit from accommodative monetary policies. This argument can be well understood by inspecting figure 12 which shows the effects of the four fiscal packages on consumption: under the pure demand stimuli the fall in consumption, namely the crowding out of private expenditure, is more muted under temporarily fixed interest rates. The opposite is true for the other fiscal packages.

#### 4.5 The Role of International Risk Sharing

In the traditional Mundell-Fleming analysis, which also features non-walrasian labour markets, fiscal multipliers are larger under fixed exchange rates and under imperfect financial integration. Indeed, under floating exchange rates and perfect capital mobility the adjustments in the exchange rates and the interest rate tend to offset the beneficial effects of an increase in government spending. In this paper, we consider a currency area which is an extreme form of fixed exchange rates. We have also assumed that capital markets are imperfectly integrated. As the process of financial integration in the euro area is under development, it is natural to ask whether alternative assumptions about capital mobility can affect fiscal multipliers.

Figure 13 compares the output response in the benchmark model with intermediation costs as formalized by equation 5 with the one in the model with perfect capital mobility and shows that our results are robust to changes in intermediation costs. Perfect capital mobility is formalized by assuming that households can do perfect risk sharing across regions. This implies the following relation between consumption profiles in the two countries (see Chari, Kehoe and McGrattan [11]):

$$\left(\frac{c_t^*}{c_t}\right)^{-\sigma} = s_t \frac{\iota^*(s_t)}{\iota(s_t)} \quad (50)$$

Although the differences are not large, results show that the output multiplier is higher under perfect risk-sharing for the pure demand stimulus package and lower for all other fiscal measures. The reason for this result lies in the insurance against asymmetric shocks, implied by perfect capital

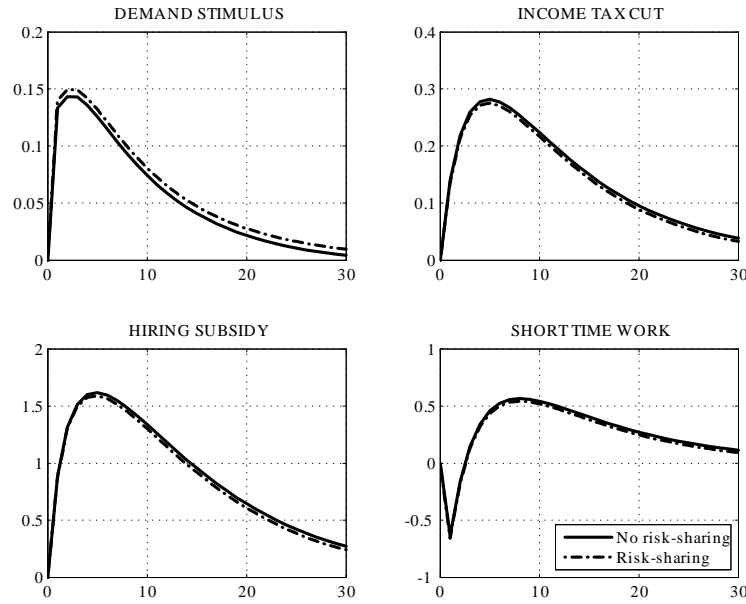


Figure 13: Response of output under four fiscal packages (pure demand stimulus, income tax cut, hiring subsidy and short time work). Case with imperfect risk sharing (solid line) versus case with perfect risk sharing (dashed line).

markets. If asymmetric shocks lead to large decreases or increases of consumption in one country, then perfect capital markets will imply that these changes are more equally distributed among the countries.

As already discussed above, traditional government spending crowds out private consumption – and much more so in country one, the country initiating the fiscal impulse. The insurance implied by perfect capital markets will reduce these differences, increasing consumption in country one (see figure 14). This can be accomplished in two ways: by increasing output (see Figure 13) and by decreasing net-exports (relative to imperfect capital markets).

For the other fiscal measures its exactly the other way around. They tend to increase private consumption and much more so in country one. Therefore, perfect capital markets will decrease consumption and the multiplier will be lower (relative to imperfect capital markets). This is very well illustrated in Figure 14, where the differences between the paths of consumption in both countries is considerably narrowed by perfect capital markets.

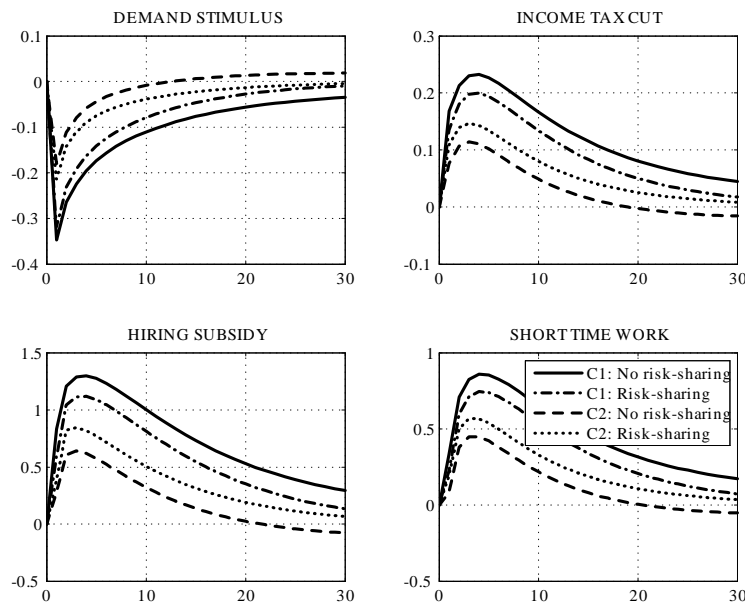


Figure 14: Response of consumption under four fiscal packages (pure demand stimulus, income tax cut, hiring subsidy and short time work). Case with imperfect risk sharing versus case with perfect risk sharing.

## 5 Putting our Work in the Empirical Perspective

While there is much agreement on the stylized facts of monetary policy, the effects of fiscal policy are a lot more debated. The empirical studies agree that an increase in government spending implies a positive short-run output reaction (see, e.g., Blanchard and Perotti [7], Fatás and Mihov [18] or Mountford and Uhlig [28], where this holds only in the short-run), which is in line with the results of this paper. However, there is much less agreement about the actual size of government multipliers, depending on the employed methodology and the country. Perotti [32] concludes, for example, that government spending multipliers for most countries (except for the United States in the pre-1980 period) are small (i.e., smaller than 1). While traditional government stimuli generate very small output multipliers in our dynamic model, spending measures that are targeted at the labour market can generate quite large multipliers. Therefore, our theoretical analysis calls for a closer empirical look at the effects of different spending components; particularly those which are targeted at the labour market.

The empirical literature also predicts positive multipliers for deficit-financed tax cuts (see Blanchard and Perotti [7] and Mountford and Uhlig [28]). While there is no agreement about the exact size of the multipliers, Mountford and Uhlig [28] (p. 983) identify the following common feature: “the effect on output of a change in tax revenues is persistent and large.” Our labor market model rationalizes why the effects of income spending cuts may be large. Further, the labor market generates a very persistent output reaction for income tax cuts (see figure 4).

There is probably least agreement about the reaction of consumption to positive government spending shocks. Blanchard and Perotti [7] find a positive reaction, while Mountford and Uhlig [28] find almost no reaction at all. In contrast, Edelberg, Eichenbaum and Fisher [16] conclude that consumption falls in response to an increase government spending. While our theoretical model predicts a behavior for traditional government stimuli, which is in line with the second view, it is not necessarily at odds with the first view. Government spending that is targeted at the labour market may generate substantial increases in consumption (see figures 6 and 7). Thus, our model is able to rationalize a positive consumption reaction to government spending, without resorting to the assumption of rule of thumb consumers, as put forward by Galí, López-Salido and Vallés [21].<sup>24</sup>

Overall, our simulation results are well in line with the empirical evidence on the effects of government spending and tax cuts. Our model offers a potential new explanation for the positive consumption effects of government spending.

## 6 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, particularly 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

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<sup>24</sup>Rule of thumb consumers have the disadvantage that they are very ad-hoc and difficult to reconcile with the spirit of rational expectations models. It has to be noted that rule of thumb consumers do not really represent credit-constrained consumers, as those would at least be able to save, which rule of thumb consumers do not by assumption.

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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## 7 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](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:

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[http://www.hm-treasury.gov.uk/prebud\\_pbr08\\_repindex.htm](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](http://frwebgate.access.gpo.gov/cgi-bin/getdoc.cgi?dbname=111_cong_bills&docid=f:h1enr.pdf)

## 8 Appendix 2: Technical Details on Short-Time Work

A retained worker has the following profit function.

$$\begin{aligned} \tilde{\Pi}_{I,t}(\varepsilon_t) = & (1 - \tau_t^p)(a_t m c_t - \iota(s_t)w_t - \varepsilon_t) + \\ & + E_t \left\{ \sum_{j=t+1}^{\infty} \Delta_{t,j} \left[ \begin{aligned} & (1 - \phi_j)^{j-t} (1 - \tau_{t+j}^p) \left( a_j m c_j - \iota(s_j)w_j - \left( \frac{1}{1-\phi_j} \int_{-\infty}^{v_{f,j}} \varepsilon_j q(\varepsilon_j) d\varepsilon_j \right) \right) \right. \\ & \left. - \phi_j f_j (1 - \phi_j)^{j-t-1} \right] \right\}, \end{aligned}$$

$$\tilde{\Pi}_{I,t}(\varepsilon_t) = (1 - \tau_t^p)(a_t m c_t - w_t \iota(s_t) - \varepsilon_t) + E_t(\Delta_{t,t+1} \tilde{\Pi}_{I,t+1}(\varepsilon_{t+1})). \quad (51)$$

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

$$(1 - \tau_t^p)(a_t m c_t - w_t \iota(s_t) - \varepsilon_t) < 0. \quad (52)$$

The cut-off for short-time work is:

$$v_{s,j} = a_t m c_t - w_t \iota(s_t), \quad (53)$$

$$\varrho_t = \int_{v_{s,j}}^{v_{f,t}} \varepsilon_t q(\varepsilon_t) d\varepsilon_t. \quad (54)$$

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  $\Upsilon$ , which follows an autoregressive process. Thus, the firms profits are:

$$\tilde{\Pi}_{s,t}(\varepsilon_t) = \Upsilon(1 - \tau_t^p)(a_t m c_t - w_t \iota(s_t) - \varepsilon_t) + E_t(\Delta_{t,t+1} \tilde{\Pi}_{I,t+1}(\varepsilon_{t+1})), \quad (55)$$

with

$$\begin{aligned} \tilde{\Pi}_{I,t+1}(\varepsilon_{t+1}) &= (1 - \varrho_{t+1} - \phi_{t+1})(1 - \tau_{t+1}^p)(a_{t+1} m c_{t+1} - w_{t+1} \iota(s_{t+1})) \\ &\quad - \frac{1}{1 - \varrho_{t+1} - \phi_{t+1}} \int_{-\infty}^{v_{s,j}} \varepsilon_j q(\varepsilon_j) d\varepsilon_j + E_t(\Delta_{t,t+2} \tilde{\Pi}_{I,t+2}(\varepsilon_{t+2})) \\ &\quad + \varrho_{t+1} \left( \Upsilon(1 - \tau_t^p)(a_t m c_t - w_t \iota(s_t) - \frac{1}{\varrho_{t+1}} \int_{v_{s,j}}^{v_{f,t}} \varepsilon_j q(\varepsilon_j) d\varepsilon_j) + E_t(\Delta_{t,t+2} \tilde{\Pi}_{I,t+2}(\varepsilon_{t+2})) \right) \\ &\quad + \phi_{t+1} f. \end{aligned} \quad (56)$$

Hiring and firing thresholds are endogenously determined as follows:

$$h(1 - \tau_t^p) = (1 - \tau_t^p)(a_t m c_t - w_t \iota(s_t) - v_{h,t}) + E_t(\Delta_{t,t+1} \tilde{\Pi}_{I,t+1}(\varepsilon_{t+1})), \quad (57)$$

$$-f(1 - \tau_t^p) = \Upsilon(1 - \tau_t^p)(a_t m c_t - w_t \iota(s_t) - \varepsilon_t) + E_t(\Delta_{t,t+1} \tilde{\Pi}_{I,t+1}(\varepsilon_{t+1})). \quad (58)$$

Equation 58 shows that  $\Upsilon$  reduces the firing threshold, which, however, implies a reduction in the workers' productivity.