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Abstract:

Several contributions have recently assessed the size of fiscal multipliers both in RBC models and New Keynesian models. This paper uses a labor selection model with labor turnover costs and Nash bargained wages to compute fiscal multipliers. The emergence of involuntary unemployment in the model enlarges the scope of the analysis. Short- and long-run multipliers are computed for five types of fiscal packages: pure demand stimuli and consumption tax cuts return very small multipliers; income tax cuts, hiring subsidies and short-time work (German "Kurzarbeit") deliver large multipliers, as they increase employment.

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 2009 estimates of the impact of an increase in government spending on GDP and employment in the United States, several other authors have provided less favorable scenarios and much smaller fiscal multipliers (see for instance Cogan, Cwik, Taylor and Wieland 2010, Uhlig 2009).[1] All of those studies have been conducted using 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 labor market.

The purpose of this paper is twofold. First, we aim at reconsidering measures of the fiscal multiplier in a standard New Keynesian model with involuntary unemployment[2] and with labor market frictions in the form of labor turnover costs, which allow for an endogenous determination of hiring and firing decisions.[3] Wages in the model are determined through Nash bargaining between the firm and the median insider. Our reference model is the one in Lechthaler et al. 2010 and Faia at al. 2009. Among other things, this model features inefficient and involuntary unemployment, hence it is apt to an analysis of fiscal multipliers, as it features real rigidities alongside nominal rigidities. The model is used to compare the impact of fiscal stimuli with alternative targets, ranging from traditional government spending, to hiring or wage subsidies to short-time work. The latter measures can be analyzed only within a model which features a rich characterization of the labor market. The previous literature has largely omitted the labor market dimension. We are the first paper to analyze important measures such as German short-time work.[4]

The labor market of the model economy features workers which are heterogenous in terms of

[1]Christiano et al. 2009 point out that government spending multipliers may be large when the zero bound on nominal interest rates is binding.

[2]One classical definition of involuntary unemployment is "A worker is involuntarily unemployed (...) if he does not have a job during that period, even though he would wish to work at an efficiency wage that is less than the efficiency wage of a current employee (...)" (Lindbeck and Snower, 1988, p. 105).

[3]Recently, Monacelli et al. 2010, Campolmi et al. 2010 and Brückner and Pappa 2010 have also studied fiscal multipliers in models with unemployment. All of these papers use the search and matching model. None of the models above considers a labor selection process, labor turnover costs and involuntary unemployment as we do here. Further, we analyze a broader set of measures, including short-time work.

[4]Short-time work is often mentioned as one of the main reasons why unemployment has remained stable in Germany during the Great Recession in 2009.

operating costs. Labor flows are determined based on a *labor selection process*: at each point in time workers file an application to the firm, which then selects according to the realization of the operating cost. Hiring and firing decisions are determined endogenously: the marginal worker is hired when the discounted stream of profits exceeds hiring costs and he is fired when the stream of profits is lower than firing costs. Lechthaler et al. 2010 and Faia at al. 2009 show that the above mentioned features render the model able to replicate the high volatility and persistence of both employment and job market flows. Wages are formed through a Nash bargaining which takes place, before the hiring and firing process, between the incumbent workers and the firm.

With this model in hand, we model temporary expansionary fiscal policy,[5] financed with future lump sum taxes[6] and compute short-run and long-run multipliers for five types of fiscal packages: *pure demand stimulus, consumption tax cut, income tax cut, hiring subsidies, short-time work (German "Kurzarbeit").* The latter measure is designed as follows: whenever an employee does not generate a contemporaneous profit, the firm is allowed to reduce his working time. This will affect the firm's endogenous firing cut-off.[7] The last two measures considered are of particular interest, as they both induce a 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, cuts in the income tax (mainly in the long-run) and short-time work. In our model the presence of hiring and firing costs induces both, static and dynamic wedges.[8] At any point in time turnover costs introduce a wedge between the retention rate and the firing rate. The same costs introduce an inter-temporal wedge which affects the value of the marginal worker between two different periods. Additionally, the assumption of collective bargaining between incumbent workers and firms, coupled with turnover costs, induces involuntary unemployment. The latter calls the policy maker for active policies, while the presence of time-varying wedges calls for the use of state contingent subsidies. Income tax cuts are beneficial as they reduce bargained wages (before taxes) and stimulate labor demand, bringing output closer to

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

[6] Lump sum taxes allow us to isolate the effects of the respective stimulus measures. Although such an assumption might be restrictive, it serves our purpose.

[7] The assumption of workers heterogeneity is crucial in order to implement such a measure.

[8] See Faia et al. 2010 for a detailed analysis of this issue.

the pareto efficient level. Hiring subsidies, by increasing the hiring threshold and reducing firms' marginal costs, help to increase labor demand and labor market distortions. Overall they boost output. Short-time work increases employment since firms are more reluctant to fire workers. The effects on productivity are ambiguous. On the one hand, workers with low productivity are retained; this decreases average productivity. On the other hand, the working time of unproductive workers is reduced; this increases average productivity. Interestingly, our model highlights a novel dimension through which multipliers operate, namely the labor demand stimulus which occurs in a model with non-walrasian labor markets. Our results show that any measure that reduces distortions decreases unemployment and thereby creates substantial short-run and long-run output multipliers. In this respect, our multipliers are largely driven by a supply-side mechanism rather than by a traditional demand-side mechanism.

To add realism to the model, we test and confirm our results under the assumption that monetary policy is set at the zero lower bound for a number of periods. In this case, and consistently with the results in Christiano et al. 2009, multipliers become larger. Since a widespread concern in the euro area is that large fiscal stimuli might induce potential free-riding from neighborhood countries (due for instance to the positive demand spillovers), we extend our analysis to an open economy context (specifically to a currency area) and by considering both, perfect and imperfect financial integration. In the open version of our model we have both demand and labor market spillovers, as the terms of trade affect both, net exports and Nash bargained wages. We find that both those effects tend to dampen fiscal multipliers in the open economy. Furthermore, we find that spillover effects are negligible.

The rest of the paper is structured as follows. Section 2 describes the model economy. Section 3 shows quantitative results for the fiscal multipliers. Section 4 shows the effects of the zero lower bound on nominal interest rates and discusses open economy aspects. Section 5 puts our work in the perspective of the relevant empirical work. Section 6 concludes.

## 2 The Model

Our reference model for the labor market is Lechthaler et el. 2010 and Faia et al. 2009.[9] Each agent can be either employed or unemployed. The labor market features workers' heterogeneity in terms of productivity and labor turnover costs, while wages are determined according to Nash bargaining. Hiring and firing decisions are endogenized by assuming that the profitability of each worker is subject to an i.i.d. shock each period. Firms 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. Note, however, that in our model Ricardian equivalence holds so that the exact timing of increases in the lump sum tax does not matter. Fiscal stimuli can be directed toward aggregate demand, taxes or toward labor market measures.

### 2.1 Households

There is a continuum of households 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 labor income is given by $w_t$ and is specified below. Unemployed household members, $u_t$,[10] 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 non-state contingent nominal bonds, $b_t$, which pay a gross nominal interest rate $(1 + i_t)$ one period later. As in Merz 1995 and Andolfatto 1996, 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 reads as follows:

[9] The mentioned papers do not touch fiscal policy issues.

[10] $u_t$ denotes the unemployment rate. But as the labor force, $L$, is normalized to 1, $u_t$ is equal to the number of unemployed workers.

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

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

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

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

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

## 2.2 Production and the Labor Market

There are three types of firms. (i) Firms that produce intermediate goods employ labor, exhibit linear labor 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 quadratic Rotemberg 1982 adjustment cost. (iii) The retailers, in turn, aggregate the consumption goods and sell them under perfect competition to the households.

### 2.2.1 Intermediate Goods Producers and Employment Dynamics

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

$$z_t = a_t N_t, \quad (5)$$

where $a$ is technology and $N$ the number of employed workers. They sell the product at a relative price $mc_t = p_{z,t}/p_t$ which they take as given in a perfectly competitive environment, where $p_z$ is the absolute price of the intermediate good and $p$ is the 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 $\varepsilon$,[11] which follows a *logistic* probability distribution $q(\varepsilon_t)$ over the support $-\infty$ to $+\infty$.[12] 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 without costs, 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.[13] Second, 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 presence of hiring and firing costs induces both a static and an inter-temporal wedge. The static wedge is linked to the fact that the retention rate, defined as the mass of workers who keep their jobs, is always bigger than the firing rate.[14] Under these circumstances current employees and firms extract time-varying rents. Public finance principles suggest that rents should be taxed via state contingent instruments. The inter-temporal wedge arises since turnover costs affect the hiring and firing decisions between two subsequent dates. Those two wedges lead to a time-varying dynamic gap between the efficient allocation and the flexible price equilibrium, which results in inefficient and involuntary unemployment fluctuations.[15] The policy maker can use state

[11] The operating costs, $\varepsilon$, are measured in terms of the final consumption good. 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.

[12] 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.

[13] 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.

[14] This feature is in line with Hobijn and Sahin 2009 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.

[15] See Faia et al. 2009 for details.

contingent inflation to smooth such inefficiencies. The real frictions outlined above coupled with the nominal rigidities produce non-trivial policy trade-offs, hence they extend the scope for fiscal stimuli. The real profit generated by a firm-worker relation, whose operating cost is $\varepsilon_t$, is given by:

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

where $\Pi_{I,t}$ 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 $j$ to $t$. To simplify the profit function, we rewrite it in recursive manner:

$$\tilde{\Pi}_{I,t}(\varepsilon_t) = (1-\tau_t^p)(a_t mc_t - w_t - \varepsilon_t) + E_t(\Delta_{t,t+1}\tilde{\Pi}_{I,t+1}(\varepsilon_{t+1})), \tag{6}$$

where $\tilde{\Pi}_{I,t+1}(\varepsilon_{t+1})$ are future profits. Given our timing of events, the model is solved backward. Hiring and firing decisions are obtained for a *given wage schedule*. Let's define the hiring and the firing rate threshold respectively as $\upsilon_{h,t}$ and $\upsilon_{f,t}$. 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 therefore obtained by solving the following zero profit condition:

$$(1-\tau_t^p)h = (1-\tau_t^p)(a_t mc_t - w_t - \upsilon_{h,t}) + E_t(\Delta_{t,t+1}\tilde{\Pi}_{I,t+1}(\varepsilon_{t+1})). \tag{7}$$

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:

$$\eta_t = \int\limits_{-\infty}^{\upsilon_{h,t}} \varepsilon_t q(\varepsilon_t)d\varepsilon_t. \tag{8}$$

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:

$$-f(1-\tau_t^p) = (1-\tau_t^p)(a_t mc_t - w_t - \upsilon_{f,t}) + E_t(\Delta_{t,t+1}\tilde{\Pi}_{I,t+1}(\varepsilon_{t+1})), \tag{9}$$

and the separation rate is defined as:

$$\phi_t = \int_{v_{f,t}}^{\infty} \varepsilon_t q(\varepsilon_t) d\varepsilon_t. \tag{10}$$

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, with a constant workforce, $L_t = 1$. Employment dynamics read as follows:

$$n_t = n_{t-1}(1 - \phi_t - \eta_t) + \eta_t. \tag{11}$$

The unemployment rate is simply $u_t = 1 - n_t$. The evolution of unemployment in this model clearly depends upon 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 1988 or Blanchard and Summers 1986, 1987).

### 2.2.2 Wage Bargaining

For simplicity, let the real wage $w_t$ be the outcome of a Nash bargain between the median worker[16] 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 such a bargaining agreement, the median worker receives the real wage $w_t$ and the firm receives the expected profit $(1 - \tau_t^p)(a_t mc_t - w_t)$ in each period $t$. Under disagreement, the worker's fallback income is $ub$, 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,

[16] 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.

workers' surplus is $(1-\tau_t^n)\,w_t - ub$, while the firm's surplus is $(1-\tau_t^p)\left(a_t^I mc_t - w_t - \varepsilon^I\right)+s$, where $\varepsilon^I$ are the operating costs of the median worker. Consequently, the Nash-product is:

$$\Theta = \left(w_t\left(1-\tau_t^n\right) - ub\right)^{\gamma}\left(\left(1-\tau_t^p\right)\left(a_t^I mc_t - w_t - \varepsilon^I\right) + s\right)^{1-\gamma}, \tag{12}$$

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:

$$\begin{aligned} & \left(1-\tau_t^n\right)\gamma\left(\left(a_t^I mc_t - w_t - \varepsilon^I\right)\left(1-\tau_t^p\right)+s\right) + \left(1-\gamma\right) ub\left(1-\tau_t^p\right) \\ = \; & \left(1-\gamma\right) w_t\left(1-\tau_t^n\right)\left(1-\tau_t^p\right), \end{aligned} \tag{13}$$

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

$$w_t = \gamma\left(a_t mc_t - \varepsilon_t^I + \frac{s}{1-\tau_t^p}\right) + \left(1-\gamma\right)\frac{ub}{1-\tau_t^n}. \tag{14}$$

Due to the timing of events, wages are negotiated at an aggregate level and firms make hiring and firing decisions only ex-post.[17] This implies, for instance, that negative shocks can affect worker flows more strongly than wages. This bargaining arrangement can capture well the reality of Euro area labor markets in which wages are usually bargained ex-ante at an aggregate level (collectively), while individual firms make ex-post hiring and firing decision.[18]

### 2.2.3 Marginal Costs

Marginal costs are a proxy for the efficiency gaps. Merging equations 7 and 9 we obtain the following equilibrium condition:

$$\upsilon_{h,t} + h = \upsilon_{f,t} - f. \tag{15}$$

[17] 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.

[18] In the euro area the percentage of workers covered by collective bargaining ranges from 90% in Belgium, Germany and France to 95% in Finland and 98% in Austria (see the data collected by the European Union Labour Force Survey of the European Commission).

This condition implies that marginal costs can be equally derived from 7 or from 9. The expression for marginal costs reads as follows:

$$mc_t = \left( w_t + \upsilon_{h,t} + h - \frac{1}{1-\tau_t^p} E_t(\Delta_{t,t+1} \tilde{\Pi}_{I,t+1}(\varepsilon_{t+1})) \right) / a_t. \tag{16}$$

Compared to the walrasian model, marginal costs in this context feature two additional components. The first component which is given by $\upsilon_{h,t} + h$ is an intra-temporal wedge which makes hiring (and firing) deviate from the ones that would arise in a walrasian labor 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. Those two additional components act as an endogenous cost push shock, therefore create non trivial monetary policy trade-offs in response to any shock.

### 2.2.4 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:

$$\Pi_{W,t} = E_t \sum_{t=0}^{\infty} \Delta_{t,t+j} (1-\tau_t^p) \left[ \frac{p_t(i)}{p_t} y_t(i) - mc_t y_t(i) - \frac{\Psi}{2} \left( \frac{P_t(i)}{P_{t-1}(i)} - 1 \right)^2 y_t \right], \tag{17}$$

where $\Psi$ is a parameter measuring the extent of price adjustment costs. Taking the derivative with respect to the price yields after some manipulations a price-setting rule under Rotemberg adjustment costs:

$$\begin{aligned} 0 &= (1-\nu) + \nu mc_t - \Psi (\pi_t - 1) \pi_t \\ &\quad + E_t \{ \Delta_{t,t+1} \Psi (\pi_{t+1} - 1) \frac{y_{t+1}}{y_t} \pi_{t+1} \}. \end{aligned} \tag{18}$$

where $\nu$ is the demand elasticity. The latter equation is a traditional non-linear Phillips curve in which current inflation depends on future inflation and marginal costs.

## 2.3 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 labor turnover costs:

$$\begin{aligned} \tilde{\Pi}_I &= mc_t a_t n_t - w_t n_t - n_{t-1}(1-\phi_t)\Xi_t^i - \\ &\quad (1-n_{t-1})\eta_t \Xi_t^e - n_{t-1}\phi_t f - (1-n_{t-1})\eta_t h, \end{aligned} \tag{19}$$

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:

$$\Xi_t^e = \frac{\int_{-\infty}^{\upsilon_h} \epsilon_t q(\epsilon_t) d\epsilon_t}{\eta_t}, \tag{20}$$

$$\Xi_t^i = \frac{\int_{-\infty}^{\upsilon_f} \epsilon_t q(\epsilon_t) d\epsilon_t}{1-\phi_t}.. \tag{21}$$

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

$$\tilde{\Pi}_W = y_t - mc_t a_t n_t - \frac{\Psi}{2}(\pi_t - 1)^2 y_t. \tag{22}$$

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

$$\begin{gathered} \tilde{\Pi}_{a,t} = y_t - w_t n_t - n_{t-1}\phi_t f - (1-n_{t-1})\eta_t h - n_{t-1}(1-\phi_t)\Xi_t^i \\ -(1-n_{t-1})\eta_t \Xi_t^e - \tfrac{\Psi}{2}(\pi_t - 1)^2 y_t. \end{gathered} \tag{23}$$

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

$$\begin{aligned} (1+\tau_t^c)c_t = &\; w_t n_t (1-\tau_t^n) + b u_t - \tau_t \\ &+ (1-\tau_t^p)\left[\begin{array}{c} y_t - n_{t-1}\phi_t f - (1-n_{t-1})\eta_t h - n_{t-1}(1-\phi_t)\Xi_t^i - \\ (1-n_{t-1})\eta_t \Xi_t^e - \frac{\Psi}{2}(\pi_t-1)^2 y_t \end{array}\right]. \end{aligned} \tag{24}$$

Equations 24 identifies the net income, which is given by the right hand side minus the left hand side. After imposing market clearing, balanced budget and aggregating, we can express the resource constraint as:

$$c_t = y_t - n_{t-1}\phi_t f a_t - (1-n_{t-1})\eta_{t-1}h - n_{t-1}(1-\phi_t)\Xi_t^i - (1-n_{t-1})\eta_t\Xi_t^e - \frac{\Psi}{2}(\pi_t - 1)^2 y_t - g_t. \quad (25)$$

### 2.4 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, $\nu$, is set to 10 (see, e.g., Galí 2008).

*Firms and the labor market.* The parameter of price adjustments, $\Psi$, is calibrated in line with microeconometric evidence for Europe (see Alvarez et al. 2001).

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 [19] |
| $\Psi$ | 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 [4] |
| $h$ | Hiring cost | 0.1 | Chen and Funke [10] |
| $b$ | Unemployment benefits | 0.0875 | OECD [28] |
| $E(\varepsilon)$ | 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 |
| $b_\pi$ | Weight on inflation | 1.5 | Galí [19] |
| $\zeta$ | Intermediation cost | 0.01 | Within range in the literature |
| $\tau^c$ | Consumption tax | 0.17 | Trabandt and Uhlig [35] |
| $\tau^p$ | Profit tax | 0.33 | Trabandt and Uhlig [35] |
| $g/y$ | Governments spending | 0.23 | Trabandt and Uhlig [35] |

The annual average productivity is normalized 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 point, the firing costs are set to 60 percent ($f = 0.6$)[19] of the annual productivity which amounts to

[19] For an empirically admissible range of values of firing costs our main numerical results are unchanged.

approximately 66 percent of the annual wage[20] and the hiring costs are set to 10 percent ($h = 0.1$) of annual productivity (see Chen and Funke 2005). 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 2004). 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 labor 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.[21] Wilke's 2005 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 2004 numbers for other continental European countries.[22] 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.* Following Trabandt and Uhlig 2009, taxes in the steady-state are calibrated as follows (average of EU-14): $\tau^c = 17\%$, $\tau^n = 41\%$, $\tau^p = 33\%$ and the share of government spending is $g/y = 0.23$.

## 2.5 Monetary Policy

An active monetary policy sets the short term nominal interest rate by reacting to inflation.

$$\frac{1 + i_t}{1 + i} = \pi_t^{b_\pi} \tag{26}$$

[20] For the period from 1975 to 1986 Bentolila and Bertola [4] 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.

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

[22] 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 2007.

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 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 results will also be tested under the assumption that the zero lower bound is implemented for a certain number of periods.

### 2.6 Fiscal policy regimes

The government budget constraint reads as follows:

$$g_t + ubu_t - \tau_t - \tau_t^c c_t - \tilde{\Pi}_{a,t}\tau_t^p = \tau_t^n w_t n_t. \tag{27}$$

We assume that the expenditures of the fiscal packages are financed by lump-sum taxes. Five fiscal packages are considered.

1. *A pure demand stimulus.* This measure is implemented through a temporary shock to government expenditure given by:

$$\frac{g_t}{g} = \left(\frac{g_{t-1}}{g}\right)^{\rho_g} e^{\varepsilon_t^g} \tag{28}$$

where $\varepsilon_t^g$ is a surprise increase and $\rho_g$ is the autocorrelation of the shock.

2. A *temporary consumption tax cut* (VAT). Temporary cuts in the consumption tax are implemented according to the following process:

$$\frac{\tau_t^c}{\tau^c} = \left(\frac{\tau_{t-1}^c}{\tau^c}\right)^{\rho_{\tau^c}} e^{\varepsilon_t^{\tau^c}}, \tag{29}$$

where $\varepsilon_t^{\tau^c}$ is the surprise increase and $\rho_{\tau^c}$ is the autocorrelation of the shock. This measure affects mainly the marginal utility of consumption as shown in equation 4. A temporary cut in consumption taxes increases 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.* Temporary cuts in the income tax are implemented according to the following process:

$$\frac{\tau_t^n}{\tau^n} = \left(\frac{\tau_{t-1}^n}{\tau^n}\right)^{\rho_{\tau^n}} e^{\varepsilon_t^{\tau^n}}, \tag{30}$$

where $\varepsilon_t^{\tau^n}$ is the surprise increase and $\rho_{\tau^n}$ is the autocorrelation of the shock. A reduction in $\tau_t^n$ reduces wages (before taxes), hence it increases labor 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:

$$(1-\tau_t^p)(h-hs_t) = (1-\tau_t^p)(a_t mc_t - w_t - \upsilon_{h,t}) + E_t(\Delta_{t,t+1}\tilde{\Pi}_{I,t+1}(\varepsilon_{t+1})) \tag{31}$$

where $hs_t$ represents the hiring subsidy and follows the process below:

$$hs_t = hs_{t-1}^{\rho_{hs}} e^{\varepsilon_t^{hs}}, \tag{32}$$

where $\varepsilon_t^{hs}$ is the surprise increase and $\rho_{hs}$ is the autocorrelation of the shock. Equation 31 shows that a reduction in hiring costs increases the mass of hired workers. Hence, this measure is potentially very beneficial in sclerotic labor markets.

5. *Short-time work* ("Kurzarbeit" in Germany). This last measure is implemented 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 affects the firm's endogenous firing threshold. The government pays unemployment benefits for the respective share. $\Upsilon$ is set to 1 in the steady state, i.e. no short-time work possibilities, and is assumed to follow an autoregressive process of order one (for further technical details see the Appendix):

$$\Upsilon_t = \Upsilon_{t-1}^{\rho_\Upsilon} e^{\varepsilon_t^\Upsilon}. \tag{33}$$

Following the literature (see Perotti 2005), the coefficient of autocorrelation of government spending is calibrated to $\rho_g = 0.9$. The same autoregressive coefficient is used for all other processes.

# 3 Fiscal Multipliers: Baseline Scenarios

Figure 1 and table 2 summarize the output results of the baseline scenarios. Figure 2 shows the impulse response functions for employment and consumption. Short-run and long-run multipliers are computed for the five fiscal packages outlined above. Short-run multipliers are calculated

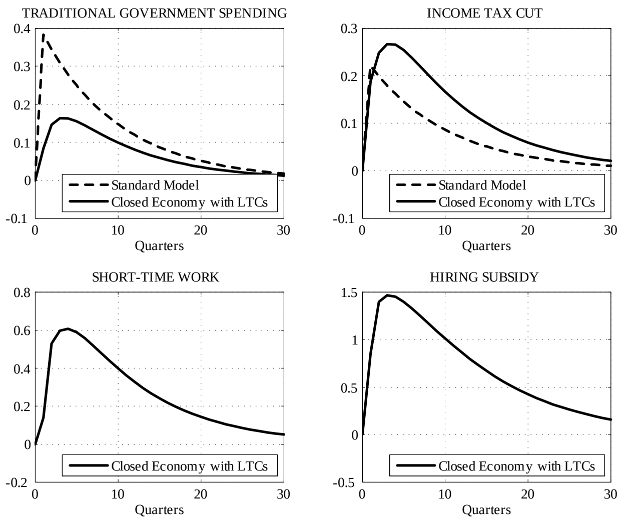


Figure 1: Response of output under four fiscal packages (pure demand stimulus, income tax cut, hiring subsidy and short time work, all normalized to 0.5% of GDP).

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[23] of GDP spending package during the implementation period[24].

**Pure demand stimulus.** In this case, both the short-run and the long-run multipliers are very small (see table 2 and figure 1). This confirms results from the previous literature (see for instance Cogan, Cwik, Taylor and Wieland 2010, Uhlig 2009). An increase in government spending under balanced budget implies an increase in taxes. This depresses agents' income and consumption. Even in absence of a balanced budget, but under Ricardian equivalence, a shift of the tax burden to future periods triggers anticipatory behaviors, hence reduces consumption in the exact same way.[25] This explains the nearly zero output multiplier.

To highlight the role of labor market frictions, we compare the effects of government spending in our model with the effects in the model with a frictionless labor market.[26] Figure 1 shows

[23] This value was chosen for numerical reason as it guarantees determinacy.

[24] To make government spending and tax multipliers comparable, multipliers calculations were based on the steady state values for all endogenous variables.

[25] In fact, under lump sum taxation and Ricardian equivalence, which holds in our framework, the exact timing of the tax increase is irrelevant.

[26] We use a separable utility function with the same specification for consumption as in our model and with a

indeed that a traditional demand stimulus generates a substantially larger effect in the model with frictionless labor markets compared to the model with labor turnover costs. The reason is straightforward. Labor turnover costs make employment adjustment more costly. As a consequence, the price for intermediate goods increases. This dampens the expansionary effects.

**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 rates. A reduction in hiring costs increases the hiring threshold as shown in equation 31 and reduces firms' marginal costs, as shown by equation 16. The ensuing increase in employment 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 production and through this private consumption.

One caveat must be put forward. The effects of hiring subsidies have to be considered as an upper bound. As wages are bargained between incumbent workers and the firm, involuntary unemployment arises since outside unemployed workers would be willing to work at lower wages. Although, as documented earlier, the assumption of collective bargaining is a realistic description of the wage formation process in most euro area countries, it would be nevertheless the case that multipliers are reduced when some of the contracts are bargained individualistically. Indeed, under individualistic bargaining, a hiring subsidy increases a worker's value of unemployment. The ensuing increase in the value of the outside option results in an increase in wages. Hence the displacement effect would partly offset the gains resulting from hiring subsidies.

**Short-time work (Kurzarbeit).** In this case, firms can reduce the working time of workers with low productivity. The government then reimburses a part of workers' lost wage income. As a consequence, the implementation of short-time work reduces the firing threshold of firms (i.e., more workers with high operating costs are retained), since it reduces the losses generated by workers with low productivity. Thus, the firing rate goes down and consequently employment goes up. Two counteracting effects have to be distinguished concerning the average productivity of an employed worker. On the one hand, the fall in the firing thresholds increases the retention rate for low productivity workers, who would have otherwise been fired. On the other hand, workers

quadratic disutility of labor.

with low productivity reduce their working time. This tends to increase average productivity. Thus, the effects of short-time work on average productivity are analytically ambiguous. Overall, short-time work generates larger output effects than traditional government spending (see Figure 1). Furthermore, short-time work can stabilize employment substantially (see Figure 2).

**Income tax cuts.** For this experiment, and contrary to the case with consumption tax cuts, the multipliers are pretty large in the long-run (see table 2). Most importantly, long-run multipliers are larger than short-run multipliers. This result is very much in line with the ones highlighted in Uhlig 2009, 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. In our model such tax cuts have a direct and strong impact on labor market outcomes. Take for instance the wage schedule below:

$$w_t = \gamma \left( a_t mc_t - \varepsilon_t^I + \frac{s}{1-\tau_t^p} \right) + (1-\gamma) \frac{ub}{1-\tau_t^n}, \tag{34}$$

It is immediate to see that a cut in $\tau_t^n$ reduces wages (before taxes), hence leads to an increase in labor demand. In this respect, our model highlights a novel dimension through which fiscal stimuli might lead to large multipliers, namely a supply side effect, which operates through a reduction of real frictions and through an increase in production. Figure 1 highlights this effect. By comparing the effects of income tax cuts in a model with frictionless labor markets and in the economy with turnover costs, the figure shows that the gains from income tax cuts are larger in the second case. The reason is that income taxes are very distortionary in the presence of labor market frictions. Thus, a cut in income taxes becomes very beneficial.

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

**Consumption (VAT) tax cuts.** In this case multipliers are nearly zero (see table 2). The reason, already discussed in the previous literature (see for instance Cogan, Cwik, Taylor and Wieland 2010) is twofold. First, as for the case of a pure demand stimulus, cuts in consumption taxes are financed by increases in the lump sum tax. Second, to the extent that consumption tax

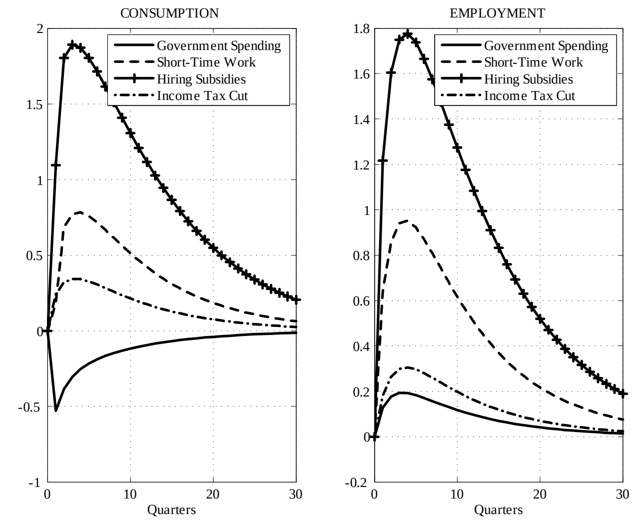


Figure 2: Employment and consumption effects for different programmes (all normalized to 0.5% of GDP).

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. Given the small effects of consumption tax cuts, we decide to ignore them in the preceding of the paper.

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

| | Demand stim. | VAT cut | Inc. tax cut | Hiring subsidy | STW |
|---|---|---|---|---|---|
| Short-run | 0.17 | 0.01 | 0.39 | 1.76 | 0.49 |
| Long-run | 0.44 | 0.01 | 0.76 | 3.81 | 2.90 |

# 4 Robustness Checks

In this section we perform a set of robustness checks to test our results.

## 4.1 Monetary Policy: Constant Interest Rates

Romer and Bernstein 2009 assume that monetary policy maintains a constant nominal interest rate. The exercise served the purpose of modeling the idea that monetary policy could accommodate

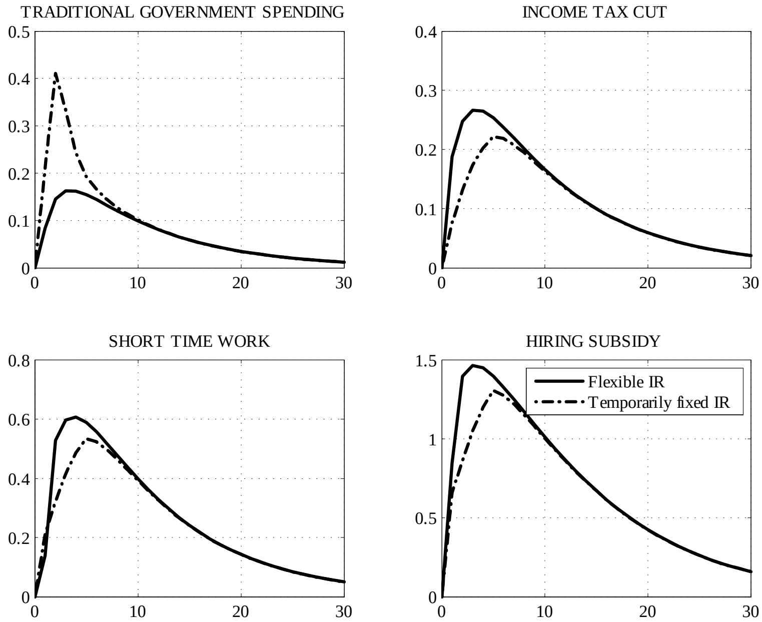


Figure 3: Response of output under four fiscal packages (pure demand stimulus, income tax cut, hiring subsidy and short time work). Case with flexible interest rate (solid line) versus case with temporarily constant interest rate (dashed line).

the fiscal stimuli for some time to make it more effective. The resulting fiscal multipliers might be larger in this case (see also Christiano et al. 2009).

In the aftermath of the crisis both the Fed and the ECB have followed an accommodative policy, hence it is essential to reconsider our results under this assumption. To this end, we assume that the monetary authority keeps the interest rate constant for four quarters.[27] Afterwards, central bank policy returns to a standard Taylor rule to ensure determinacy.

Figure 3 shows the results for the output multipliers in this case. Our main results are unaltered. Broadly speaking, the fiscal multipliers maintain the same ranking and roughly the same order of magnitude that they had in the benchmark case. The multiplier for the demand stimulus becomes now larger and the multipliers for the other fiscal packages become slightly smaller. Demand side stimuli are indeed now more effective since monetary accommodation is anticipated by forward-looking households and firms. Hence, crowding-out effects, arising from an

[27] 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.

increase in interest rates following the announcement of fiscal stimulus, are abated. 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. 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.

### 4.2 Multipliers and Spillovers in Currency Areas

Fiscal policy might be de-amplified in the open economy.[28] An increase in aggregate demand, by increasing domestic prices, tends to depreciate the terms of trade. The country, undertaking the fiscal stimulus looses competitiveness and its current account worsens. To see to what extend such de-amplification is at work, let's consider an extension of our model to an open economy context, more specifically to a currency area. Below we outline the main building blocks required to extent the model. For the rest we assume that countries are symmetric and that each country model economy is constructed according to the benchmark used so far. We follow the new open economy tradition and introduce the following assumptions (described below only for the domestic economy; all the relations hold symmetrically for the foreign country). Final goods, $c$, in the domestic country are obtained by assembling domestic and imported intermediate goods via the Armington aggregate production function:

$$c_t = \left( (1-\alpha)^{\frac{1}{\eta}} c_{h,t}^{\frac{\eta-1}{\eta}} + \alpha^{\frac{1}{\eta}} c_{f,t}^{\frac{\eta-1}{\eta}} \right)^{\frac{\eta}{\eta-1}} \tag{35}$$

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. Optimal demand for domestic and foreign goods is given by:

$$c_{h,t} = (1-\alpha)\left(\frac{p_t}{p_{h,t}}\right)^{\eta} c_t \ ; \quad c_{f,t} = \alpha \left(\frac{p_t}{p_{f,t}}\right)^{\eta} c_t. \tag{36}$$

Terms of trade are defined as the relative price of imported goods (recall that in the currency area the nominal exchange rate is equal to 1):

[28] See Corsetti et al. 2009 for the analysis of fiscal policy in an open economy model.

$$tot_t \equiv E\frac{p_{f,t}}{p_{h,t}}. \tag{37}$$

In the open economy an important role is played by the CPI-PPI, which can be written as a function of the terms of trade:

$$\frac{p_t}{p_{h,t}} = [(1-\alpha) + \alpha tot_t^{1-\eta}]^{\frac{1}{1-\eta}} \equiv \iota(tot_t), \tag{38}$$

with $\iota^{'}(tot_t) > 0$.

As the process of financial integration in the euro area is under development, we assume imperfect financial integration, which is modeled 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:[29]

$$i_t^f = i_t + \zeta\left(e^{\frac{b_t^*}{p_t}} - 1\right), \tag{39}$$

Since firms' surplus is defined in terms of PPI, while workers' surplus is defined in terms of CPI index, the ratio $\iota(tot_t)$ enters the wage equation as follows:

$$w_t = \frac{\gamma}{\iota(tot_t)}\left(a_t mc_t - \varepsilon_t^I + \frac{s}{1-\tau_t^p}\right) + (1-\gamma)\frac{ub}{1-\tau_t^n}. \tag{40}$$

This shows that in our model cross-country spillovers are not solely related to relative shifts in aggregate demand, but that changes in the terms of trade also affect relative wages and relative marginal cost across countries. In standard New Keynesian models, a decrease in terms of trade fueled by an increase in government spending, implies a shift in aggregate demand toward the neighborhood countries. As a result the domestic fiscal multipliers are dampened by the fall in net exports while the foreign country benefits from a positive demand spillover. In our model, a decrease in the terms of trade increases domestic wages, while reducing wages in the neighborhood country. This implies a fall in labor in domestic labor demand and an increase in labor demand for the neighborhood country. Such *labor market spillovers* tend to further dampen domestic fiscal multipliers and to further amplify positive cross-country spillovers.

[29] See Schmitt-Grohe and Uribe 2003.

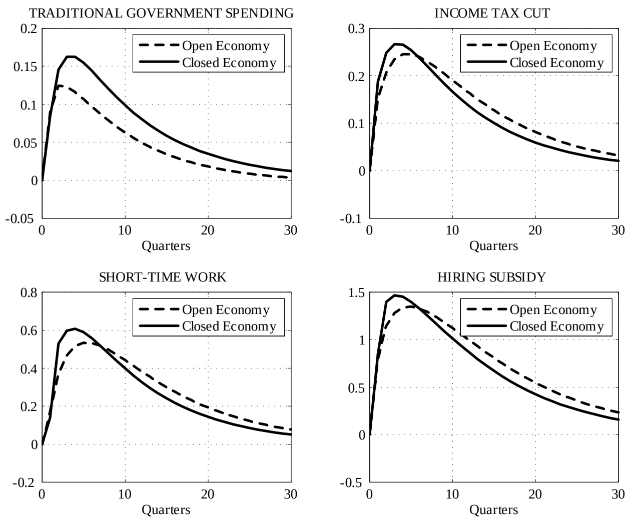


Figure 4: Response of output under four fiscal packages (pure demand stimulus, income tax cut, hiring subsidy and short time work). Closed economy (solid line) versus open economy (dashed line).

The numerical exercises of the fiscal multipliers were based on the following calibration. The elasticity of substitution between home and foreign goods is set to 2, consistently with most empirical studies, while the degree of home bias in consumption 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, , is set to very different values in the literature (see, e.g., Benigno 2009 and Schmitt-Grohe and Uribe 2003). In line with these papers, we set the parameter to 0.01.

To disentangle the effects coming from the open economy dimension figure 4 compares fiscal multipliers in the closed (solid line) and the open economy (dashed line) version of the model. In the open economy context, it is assumed that only the domestic country implements the fiscal stimulus package. As argued above, domestic multipliers are dampened in the open economy model.

## 4.3 The Role of International Risk Sharing

In the traditional Mundell-Fleming analysis, which also features non-walrasian labor 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.

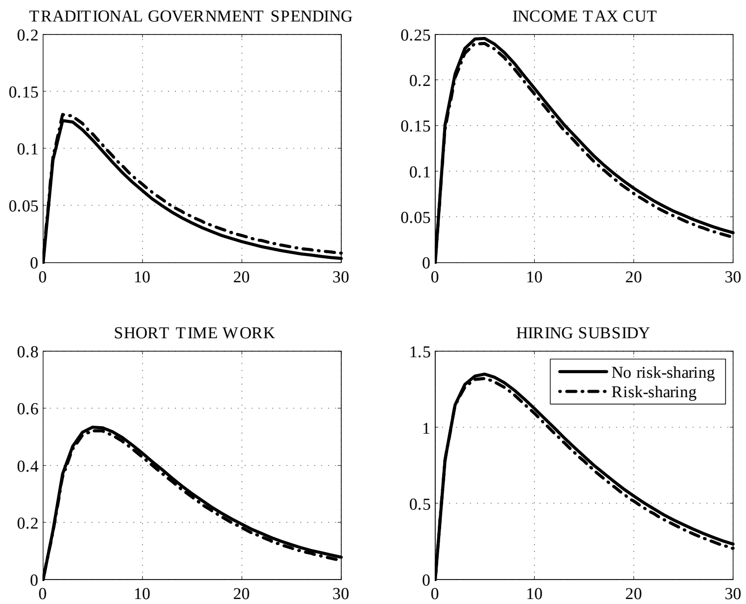


Figure 5: Response of output under four fiscal packages (pure demand stimulus, income tax cut, hiring subsidy and short time work). Case with imperfect risk sharing (solid line) versus case with perfect risk sharing (dashed line).

Above we considered a currency area which is an extreme form of fixed exchange rates. We have also assumed that capital markets are imperfectly integrated. Now we want to compare the results with case of perfect capital mobility, which 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 et al. 2002):

$$\left(\frac{c_t^*}{c_t}\right)^{-\sigma} = tot_t \frac{\iota^*(tot_t)}{\iota(tot_t)} \tag{41}$$

Figure 5 compares the output response in the model with intermediation costs (solid line) with the model featuring perfect risk sharing. 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 insurance against asymmetric shocks, implicit in the perfect capital markets case, can explain this result. Under perfect risk sharing the effects of large shocks are equally shared across countries, hence the current account balances without the need

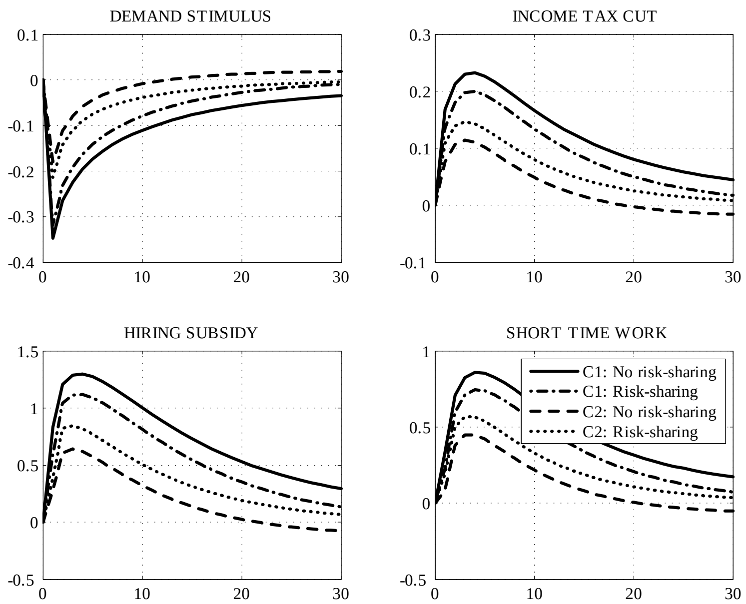


Figure 6: Response of consumption under four fiscal packages (pure demand stimulus, income tax cut, hiring subsidy and short time work). Case with imperfect risk sharing versus case with perfect risk sharing.

of large swings in the terms of trade. By dampening fluctuations in the terms of trade, perfect risk sharing also dampens the fall in domestic net export ensuing from an increase in government spending. Figure 6 helps to clarify this by comparing the effects of the four fiscal packages on the consumption path of both countries. Under the demand stimulus package the fall in consumption demand for the domestic country (labeled as C1) is larger under imperfect risk sharing: as argued above the insurance implicit in the perfect financial integration case, helps to dampen the fall in net exports by abating fluctuations in the terms of trade. For the other fiscal measures things are different. First, consistently with the closed economy case, those alternative fiscal measures do not produce crowding out effects, as private consumption increases: for this reason they are associated with larger multipliers. Second, since perfect capital markets tend to smooth the effects of shocks across countries, the increase in consumption is actually dampened in this case.

## 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 reaction in output (see, e.g., Blanchard and Perotti 2002, Fatás and Mihov 2001 or Mountford and Uhlig 2009, where this holds only in the short-run), which is in line with the results of this paper. There is much less agreement about the actual size of government multipliers, depending on the employed methodology and the country. Perotti 2005 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 labor 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 labor market.

The empirical literature also predicts positive multipliers for deficit-financed tax cuts (see Blanchard and Perotti 2002 and Mountford and Uhlig 2009). While there is no agreement about the exact size of the multipliers, Mountford and Uhlig 2009 (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.

There is probably least agreement about the reaction of consumption to positive government spending shocks. Blanchard and Perotti 2002 find a positive reaction, while Mountford and Uhlig 2009 find almost no reaction at all. In contrast, Edelberg, Eichenbaum and Fisher 1999 conclude that consumption falls in response to an increase in 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 labor market may generate substantial increases in consumption. 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 2007.[30]

[30]Rule of thumb consumers have the disadvantage that they are very ad-hoc and difficult to reconcile with the

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

## 6 Conclusions

This paper uses a model with a labor selection process, labor turnover costs and Nash bargained wages to reassess the size of the fiscal multipliers. Alternative types of fiscal packages have been considered. Income tax cuts and hiring subsidies deliver large output stimuli, particularly in the long run. Overall, measures directed towards reducing labor market distortions are associated with large multipliers. Our model highlights a novel dimension through which fiscal stimuli can operate, namely a supply-side channel that boosts labor demand.

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.

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# 7 Appendix: Technical Details on Short-Time Work

A a retained worker has the following profit function.

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

$$\tilde{\Pi}_{I,t}(\varepsilon_t) = (1-\tau_t^p)(a_t mc_t - w_t - \varepsilon_t) + E_t(\Delta_{t,t+1}\tilde{\Pi}_{I,t+1}(\varepsilon_{t+1})). \tag{42}$$

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

$$(1-\tau_t^p)(a_t mc_t - w_t - \varepsilon_t) < 0. \tag{43}$$

The cut-off for short-time work is:

$$\upsilon_{s,j} = a_t mc_t - w_t, \tag{44}$$

$$\varrho_t = \int_{\upsilon_{s,j}}^{\upsilon_{f,t}} \varepsilon_t q(\varepsilon_t) d\varepsilon_t. \tag{45}$$

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:

$$\tilde{\Pi}_{s,t}(\varepsilon_t) = \Upsilon(1-\tau_t^p)(a_t mc_t - w_t - \varepsilon_t) + E_t(\Delta_{t,t+1}\tilde{\Pi}_{I,t+1}(\varepsilon_{t+1})), \tag{46}$$

with

$$
\begin{aligned}
\tilde{\Pi}_{I,t+1}(\varepsilon_{t+1}) \quad = \quad & \left(1-\varrho_{t+1}-\phi_{t+1}\right)(1-\tau^{p}_{t+1})(a_{t+1}mc_{t+1}-w_{t+1} \\
& -\frac{1}{1-\varrho_{t+1}-\phi_{t+1}}\int\limits_{-\infty}^{\upsilon_{s,j}}\varepsilon_j q(\varepsilon_j)d\varepsilon_j + E_t(\Delta_{t,t+2}\tilde{\Pi}_{I,t+2}(\varepsilon_{t+2}))) \\
& +\varrho_{t+1}\left(\Upsilon(1-\tau^{p}_{t})(a_t mc_t - w_t - \frac{1}{\varrho_{t+1}}\int\limits_{\upsilon_{s,j}}^{\upsilon_{f,t}}\varepsilon_j q(\varepsilon_j)d\varepsilon_j) + E_t(\Delta_{t,t+2}\tilde{\Pi}_{I,t+2}(\varepsilon_{t+2}))\right) \\
& +\phi_{t+1}f.
\end{aligned}
\tag{47}
$$

Hiring and firing thresholds are endogenously determined as follows:

$$
h(1-\tau^{p}_{t}) = (1-\tau^{p}_{t})(a_t mc_t - w_t - \upsilon_{h,t}) + E_t(\Delta_{t,t+1}\tilde{\Pi}_{I,t+1}(\varepsilon_{t+1})), \tag{48}
$$

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

Equation 49 shows that $\Upsilon$ reduces the firing threshold, which, however, implies a reduction in the workers' productivity.