Fiscal Stimulus and Labor Market Policies in Europe

Ester Faia
Goethe Universität Frankfurt

Wolfgang Lechthaler
Kiel Institute for the World Economy

Christian Merkl
University of Erlangen-Nuremberg

(October 2012)
LASER Discussion Papers - Paper No. 68
(edited by A. Abele-Brehm, R.T. Riphahn, K. Moser and C. Schnabel)

Correspondence to:
Christian Merkl, Lange Gasse 20, 90403 Nuernberg, Germany, Email: christian.merkl@wiso.uni-erlangen.de.
Abstract

Several contributions have recently assessed the size of fiscal multipliers both in RBC models and in New Keynesian models. This paper computes fiscal multipliers within a labor selection model with turnover costs and Nash bargained wages. We find that demand stimuli yield small multipliers, as they have little impact on hiring and firing decisions. By contrast, hiring subsidies, and short-time work (German "Kurzarbeit") deliver large multipliers, as they stimulate job creation and employment.

Copyright statement

Please do not quote without permission from the authors. Only the final version that will be accepted for publication should be cited. This document has been posted for the purpose of discussion and rapid dissemination of preliminary research results.

Author note

We thank two anonymous referees, seminar participants at the Bank of Spain conference "Interactions between Monetary and Fiscal Policies," the Annual Meetings of the European Economic Association and the German Economic Association, the MidWest Macro Meeting, the 3rd conference on Economic Policy and the Business Cycle at Milan Bicocca University, and seminars at Boston College, Kiel IfW and the University of Hohenheim. We thank Lorenza Rossi for discussing the paper. Christian Merkl thanks the Fritz Thyssen foundation for support during his visit at the NBER. An earlier version of the paper was circulated as "Fiscal Multipliers and the Labor Market in the Open Economy."
1 Introduction

During the recent global recession large expansionary fiscal packages have been implemented around the globe. The discussion on the evaluation of their effectiveness initiated a vivid debate on the estimates of the fiscal multipliers. 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 with much smaller fiscal multipliers (see the brief literature review below). The previous literature focused on RBC or New Keynesian models and compared broad fiscal measures (increases in government expenditure versus tax cuts), with no reference to specific targets, such as labor market subsidies or short-time work. A close look at the fiscal packages, implemented globally in the aftermath of the crisis, shows that a large percentage of the budget was devoted to labor market measures. The following trend emerges. In the US labor market interventions were mainly targeted at facilitating job creation: an example is given by the American Jobs Act passed recently by the Obama administration. In Europe, instead, most measures were devoted to reduce firms’ reliance on lay-offs and preserve jobs: several countries have implemented short-time work compensations, a policy which allows firms to reduce employees’ working hours, hence their wage bills, while preserving employees’ previous income. Examples of this are the German Kurzarbeit, the Italian Cassa Integrazione and the French chômage partiel (Appendix 1 contains some institutional details on short-time work). In this paper, we measure the effectiveness of fiscal stimuli, with a special focus on measures targeted toward the labor market. To this purpose, the model used features both, a hiring and a firing margin, hence allows us to implement a variety of measures. We devote special attention to one measure, the German Kurzarbeit: the latter may indeed have been successful in guaranteeing stable employment during the Great Recession and a non jobless recovery.

The model used features a labor selection process with Nash bargained wages and labor turnover costs. In the model workers have heterogenous operating costs and participate in a labor selection process: at each point in time unemployed workers file an application to one firm, which then selects them according to their suitability, determined by the realization of the random

---

1Our model is closely related to the one in Faia et al. (2009) and Lechthaler et al. (2010), but with a richer specification of the fiscal sector. See Brown et al. (2010) for details on the labor selection process.
operating cost. Hiring and firing decisions are determined endogenously: a worker is hired when the discounted stream of profits she generates exceeds the costs of hiring. An incumbent worker is fired when the stream of profits she generates is lower than the firing cost. In this environment, labor market measures have a direct impact on hiring and firing decisions, hence on job creation and destruction. The assumption of heterogeneity in workers’ operating costs, coupled with endogenous hiring and firing margins, renders the dynamics of employment and worker flows highly volatile. This feature, which is in line with the empirical evidence, contributes to amplify the effectiveness of policies aimed at encouraging hiring and dampening firing. Wages in the model are determined through Nash bargaining between the firm and the median incumbent worker. This assumption represents well the collective bargaining agreement characterizing several euro area countries. The assumption of price rigidity is introduced in the model to make our measures of the multipliers comparable to the recent literature using New Keynesian models. Short-run and long-run multipliers are computed for the following interventions: increases in government spending, income tax cuts, hiring subsidies and short-time work (German "Kurzarbeit"). Note that the assumption of workers’ heterogeneity in our model is essential for modeling short-time work compensation. The presence of such schemes implies that the threshold for the marginal retained worker is shifted toward larger operating costs and thus fewer workers are fired.

We find that multipliers are small but positive for government spending and large for hiring subsidies and short-time work. The size of the long-run multiplier for income tax cuts depends on the persistence of the measure. If tax cuts are very persistent, they can generate larger long-run multipliers than government spending. Hiring subsidies reduce firms’ marginal cost and increase the hiring threshold. Income tax cuts reduce bargained wages. Both measures increase the value of a match, therefore increasing job creation and employment. The assumption of collective bargaining between incumbent workers and firms, coupled with turnover costs, induces involuntary unemployment.\(^2\) Hiring subsidies and income tax cuts, by reducing firms’ costs of new entrants, bring job creation closer to Pareto efficiency. Short-time work schemes increase employment, since firms are more reluctant to fire workers. The effects on productivity are ambiguous. On the one

\(^2\)This model also features involuntary unemployment (see Lindbeck and Snower (1988)), as many unemployed workers would be willing to work at the prevailing wages set by the median incumbent worker. Policy corrections on wages can then reduce the region of inefficient unemployment.
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.

To add realism to the model, we test the robustness of our results with a lower persistence of the fiscal and labor market measures. We also relax the assumption of a balanced government budget and introduce fiscal rules: the results remain robust in this alternative set-up. At last, we explore the extent of the widespread concern that large fiscal stimuli induce potential free-riding from neighborhood countries due to a shift in competitiveness associated with both, demand spillovers and changes in relative wages. For this reason, we extend the model to an open economy context (specifically to a currency area with a specific focus on the euro area) and consider both, perfect and imperfect financial integration. In the model, terms of trade affect both, net exports and relative wages across countries, therefore creating both, demand and labor market spillovers. Both spillovers dampen the multipliers for government spending, albeit mildly.

Our model is related to the recent literature which measures fiscal multipliers in RBC (Uhlig (2009)) and New Keynesian models (see e.g. Cogan et al. (2010), Christiano et al. (2011)). A comprehensive overview of the literature on fiscal multipliers can be found in Coenen et al. (2010, 2012) and Hebous (2011). Some authors have also computed fiscal multipliers in models featuring unemployment (see e.g. Bosca et al. (2010), Brückner and Pappa (2010), Mayer et al. (2010), Monacelli et al. (2010), and Campolmi et al. (2011)), though using different modeling frameworks. There are several novel features in our analysis. The above mentioned papers have measured fiscal multipliers either in standard New Keynesian models or in models with search and matching frictions: We use a labor selection model in which worker flows are determined through match-specific heterogenous productivities. This model structure allows us to replicate a number of empirically appealing features. Faia et al. (2009) and Lechthaler et al. (2010) show, for example, that selection models can generate strong labor market amplification effects in response to aggregate shocks, i.e. there is no Shimer (2005) puzzle. In addition, they can generate substantial employment and output persistence. Our model is particularly suitable to analyze policy interventions such as hiring subsidies. Contrary to the past literature, we interpret fiscal interventions in a broader sense, by including labor market policies on top of traditional government spending.

---

3 A similar approach is taken in Garibaldi and Violante (2005) who assume that job creation (or job destruction) takes place if the productivity draw upon meeting is sufficiently large (or low).
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 some robustness checks. Section 5 puts our work in the perspective of the relevant empirical work. Section 6 concludes.

2 The Model

The model we use follows the one in Faia et al. (2009) and Lechthaler et al. (2010), but with a richer specification of the fiscal sector. Each agent can be either employed or unemployed. Workers are heterogeneous in terms of their operating costs. Wages are determined according to Nash bargaining. Hiring and firing decisions are subject to turnover costs: this, coupled with workers’ heterogeneity, renders hiring and firing decisions endogenous. Finally, firms face quadratic adjustment costs when changing prices.

The tax system is articulated as follows: distortionary taxes are levied on consumption, wage income and firms’ profits. Fiscal stimuli are assumed to be financed by lump sum taxes. The budget is balanced at any time. 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.

\[ E_0 \left\{ \sum_{t=0}^{\infty} \beta^t \frac{c^{1-\sigma}}{1-\sigma} \right\}, \]  

where \( c \) denotes aggregate consumption of final goods. Real wages are \( w_t \) and are set according to Nash bargaining. Unemployed household members, \( u_t \), receive an unemployment benefit, \( ub \). 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. Notice that the tilde sign indicates profits gross of taxes. Households also pay lump sum taxes, \( \tau_t \), a consumption tax,
\( \tau_i^c \), a wage income tax, \( \tau_i^n \), and a tax on profits, \( \tau_i^p \). The sequence of budget constraints reads as follows:

\[
(1 + \tau_i^c)c_t + \frac{b_t}{p_t} \leq (1 - \tau_i^n)w_t(1 - u_t) + ubu_t + (1 - \tau_i^p)\bar{\Pi}_{o,t} - \frac{\tau_i}{p_t} + (1 + i_{t-1})\frac{b_{t-1}}{p_t},
\]

where \( p_t \) is the price index. 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:

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

\[
\frac{1}{1 + \tau_i^c}c_t^\sigma = \lambda_t.
\]

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 turnover 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 face quadratic adjustment costs in changing prices. (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:

\[
\begin{align*}
z_t &= a_t N_t, \\
n &= \text{number of employees}.
\end{align*}
\]

where \( a_t \) is technology and \( N_t \) the number of employed workers. They sell the product at a relative price \( mc_t = \frac{p_{z,t}}{p_t} \) which they take as given in a perfectly competitive environment, where \( p_z \) is
the absolute price of the intermediate good. 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 $\varepsilon_t$, which follows a logistic probability distribution $q(\varepsilon_t)$ over the support $-\infty$ to $+\infty$. The operating costs can be interpreted as an idiosyncratic shock to a worker’s productivity or as a match-specific idiosyncratic cost-shock. All unemployed workers get in contact with a firm at the beginning of the period. Firms learn the value of the individual operating costs upon contact at the beginning of each period and base their employment decisions on it, so that an unemployed worker with a favorable shock will be employed, while an employed worker with a bad shock will be fired. Hiring and firing features 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 and after the realization of the operating cost, the median incumbent worker and the firm bargain over the wage. 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.

Let’s define the hiring and the firing rate threshold respectively as $v_{h,t}$ and $v_{f,t}$. Unemployed workers are hired whenever their operating cost does not exceed a certain threshold, such that the expected intertemporal value of this worker is higher than the hiring cost. The hiring threshold, $v_{h,t}$, is obtained by using firms’ profit function in recursive form and by solving the following zero profit condition:

---

4 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. We skip this assumption for analytical simplicity.

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

6 This can be considered as a degenerate matching/contact function, where the number of contacts is equal to the number of unemployed workers. The realization of the random operating costs is decisive for finding a job or not. Based on the operating costs, the firm makes a selection decision among a set of heterogeneous applicants.

7 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. See Faia et al. (2009) for details.
\[(1 - \tau_t^p)h = (1 - \tau_t^p)(a_tmc_t - w_t - v_{h,t}) + E_t(\Delta_{t,t+1}\Pi_{t+1}), \tag{6}\]

where \(\Pi_{t+1}\) are the future profits, defined as:

\[
\Pi_{t+1} = (1 - \phi_{t+1}) \left( (1 - \tau_{t+1}^p) \left( a_{t+1}mc_{t+1} - w_{t+1} - \frac{1}{1 - \phi_{t+1}} \int_{-\infty}^{v_{f,t+1}} \varepsilon_{t+1}q(\varepsilon_{t+1})d\varepsilon_{t+1} \right) \right) + E_{t+1} \left( (1 - \phi_{t+1}) \Delta_{t+1,t+2}\Pi_{t+2} - \phi_{t+1}f(1 - \tau_{t+1}^p) \right), \tag{7}\]

where \(\phi\) is the separation probability, \(\Delta_{t,t+1}\) is the stochastic discount factor from period \(t+1\) to \(t\).

Given our timing of events, the model is solved backwards. Hiring and firing decisions are obtained for a given wage schedule.

Unemployed workers whose operating cost is lower than the threshold value \(v_{h,t}\) defined in equation 6, while those workers whose operating cost is higher remain unemployed. The resulting hiring probability is given by:

\[
\eta_t = \int_{-\infty}^{v_{h,t}} q(\varepsilon_t)d\varepsilon_t. \tag{8}\]

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 \(v_{f,t}\) as follows:

\[
-f(1 - \tau_t^p) = (1 - \tau_t^p)(a_tmc_t - w_t - v_{f,t}) + E_t(\Delta_{t,t+1}\Pi_{t+1}), \tag{9}\]

and the separation rate is defined as:

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

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. Hence \(N_t - N_{t-1} = \eta U_{t-1} - \phi N_{t-1}\). Letting \((n_t = N_t/L_t)\) be the employment rate, with a constant workforce, \(L_t = 1\), employment dynamics read as follows:
\begin{equation}
n_t = n_{t-1}(1 - \phi_t - \eta_t) + \eta_t. \tag{11}
\end{equation}

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.

The presence of hiring and firing costs induces both a static and an intertemporal wedge. For this reason some interventions in the labor market also help in reducing the resource costs associated with the labor market frictions. The static wedge emerges since, with hiring and firing costs, the retention rate, defined as the mass of workers who keep their jobs, is always bigger than the firing rate.\footnote{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.} Under these circumstances, current employees and firms extract time-varying rents. The operating cost of a retained worker, who should be fired otherwise, represents a resource cost. Similarly, the reduction in the operating cost of a new entrant, who would be hired in absence of hiring cost, represents a resource cost. The intertemporal wedge arises since turnover costs affect the hiring and firing decisions between two subsequent dates. This time varying wedge renders the equilibrium value of a worker different than her social value. Subsidies to the hiring costs reduce the extent of turnover costs, hence wedges. Labor income tax cuts, by reducing bargained wages, increase the value of new entrants and bring employment closer to Pareto efficiency.

\subsection*{2.2.2 Wage Bargaining}

Let the real wage \( w_t \) be the outcome of a Nash bargaining process between the median worker\footnote{For simplicity, we allow the median worker to bargain over wages. Alternative settings, such as individual bargaining, would not affect the model dynamics. Empirical evidence for the relevance of union contracts is provided below.} 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 \( (1 - \tau_t^I) \left( a_tmc_t - w_t - \varepsilon^I \right) \) in each period \( t \). Under disagreement, the worker’s fallback income is \( ub \), the real value of the 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 the cost linked to a strike.
Assuming that disagreement in the current period does not affect future surpluses, workers’ surplus is \((1 - \tau_i^n) w_t - ub\), while the firm’s surplus is \((1 - \tau_i^p) \left(a_t mc_t - w_t - \varepsilon_t^I\right) + s\). Consequently, the Nash-product is:

\[
\Theta = (w_t (1 - \tau_i^n) - ub) (1 - \tau_i^p) \left(a_t mc_t - w_t - \varepsilon_t^I\right) + s \right)^{1-\gamma}
\]

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:

\[
(1 - \tau_i^n) \gamma \left((a_t mc_t - w_t - \varepsilon_t^I) (1 - \tau_i^p) + s\right) + (1 - \gamma) ub (1 - \tau_i^p)
= (1 - \gamma) w_t (1 - \tau_i^n) (1 - \tau_i^p),
\]

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

\[
w_t = \gamma \left(a_t mc_t - \varepsilon_t^I + \frac{s}{1 - \tau_i^p}\right) + (1 - \gamma) \frac{ub}{1 - \tau_i^p}.
\]

Due to the timing of events, wages are negotiated at an aggregate level and firms make hiring and firing decisions only ex-post.\(^{10}\) This bargaining arrangement captures 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.\(^{11}\)

### 2.2.3 Marginal Costs

Marginal costs are a proxy for the efficiency gaps. Merging equations 6 and 9 delivers:

\[
v_{h,t} + h = v_{f,t} - f.
\]

This condition implies that marginal costs can be equally derived from 6 or from 9. The expression for marginal costs reads as follows:

\[
mc_t = \left(w_t + v_{h,t} + h - \frac{1}{1 - \tau_i^p} E_t(\Delta_{t,t+1} + \tilde{\Pi}_{t,t+1})(\varepsilon_{t+1})\right) / a_t.
\]

\(^{10}\)This is a particular case of a sequential bargaining framework proposed by Manning (1987).

\(^{11}\)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).
Compared to the Walrasian model, marginal costs in this context feature two additional components. The first component which is given by $v_{h,t} + h$ is an intratemporal 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, $E_t(\Delta_{t,t+1} \Pi_{t,t+1}(\varepsilon_{t+1}))$, represents the long-run value of a worker.

### 2.2.4 Wholesale Sector and Retail Sector

Firms in the wholesale-sector can change their prices every period, facing quadratic Rotemberg (1982) price adjustment costs. They maximize the following profit function:

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

where $y_t = a_t n_t$, $\Psi$ is a parameter measuring the extent of price adjustment costs and $i$ is a firm-index. Taking the derivative with respect to the price yields after some manipulations a price-setting rule under Rotemberg adjustment costs:

$$
0 = (1 - \nu) + \nu mc_t - \Psi (\pi_t - 1) \pi_t + E_t \{ \Delta_{t,t+1} \Psi (\pi_{t+1} - 1) \frac{y_{t+1}}{y_t} \pi_{t+1} \},
$$

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, but note that marginal costs in our model are more complex than in the standard model.

### 2.3 Aggregation with Workers’ Heterogeneity and Resource Constraint

Due to workers’ heterogeneity, aggregation in this model requires a number of steps. Real profits for intermediate firms are given by revenues minus wage payments, operating costs and labor turnover costs

$$
\Pi_I = mc_t a_t n_t - w_t n_t - n_{t-1} (1 - \phi_t) \Xi_t -
(1 - n_{t-1}) \eta_{f} \Xi_t - n_{t-1} \phi_t f - (1 - n_{t-1}) \eta h,
$$

where $\Xi_t = \int_{-\infty}^{\infty} \varepsilon_t q(\varepsilon) d\varepsilon_t$ is the expected value of operating costs for incumbent workers, conditional on not being fired, and $\Xi_t^e = \int_{-\infty}^{\infty} q(\varepsilon) d\varepsilon_t$ is the expected value of operating costs for entrants, conditional on being hired. The real profits ($\Pi_{W}$) of the wholesale sector are given by:
\[ \Pi_W = y_t - mc_t a_t n_t - \frac{\Psi}{2} (\pi_t - 1)^2 y_t. \]  

(19)

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

\[ \tilde{\Pi}_{a,t} = y_t - wt n_t - n_{t-1} \phi_t f - (1 - n_{t-1}) \eta h - n_{t-1} (1 - \phi_t) \Xi^t_k 
- (1 - n_{t-1}) \eta \Xi^t - \frac{\Psi}{2} (\pi_t - 1)^2 y_t. \]

(20)

After substituting this into the budget constraint, 2, and after imposing equilibrium in the bond market, the following resource constraint arises:

\[
(1 + \tau^c_t) c_t = w_t n_t (1 - \tau^p_t) + ubu_t - \tau_t \\
+ (1 - \tau^p_t) \left[ \frac{y_t - n_{t-1} \phi_t f - (1 - n_{t-1}) \eta h - n_{t-1} (1 - \phi_t) \Xi^t_k}{(1 - n_{t-1}) \eta \Xi^t - \frac{\Psi}{2} (\pi_t - 1)^2 y_t} \right].
\]

(21)

Equations 21 identifies the net income. After imposing market clearing, fiscal balanced budget and aggregating, the resulting resource constraint reads as:

\[
c_t = y_t - n_{t-1} \phi_t a_t - (1 - n_{t-1}) \eta h - n_{t-1} (1 - \phi_t) \Xi^t_k - (1 - n_{t-1}) \eta \Xi^t - \frac{\Psi}{2} (\pi_t - 1)^2 y_t - g_t. \]

(22)

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 real 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. Since direct estimates of the parameter of price-adjustment costs, \( \Psi \), are not available, we follow much of the literature and perform an indirect calibration. Up to a first order approximation, a model with Rotemberg adjustment costs is observationally equivalent to a model with Calvo staggering. The log-linearized Phillips curve indeed becomes equivalent across the two models if \( \Psi = \frac{\theta \nu}{(1 - \theta)(1 - \beta \theta)} \), where \( (1 - \theta) \) is the probability that a firm can reset its price in the Calvo-model. Hence, for given elasticity of substitution across varieties, we calibrate the parameter \( \Psi \) so as to get an average contract duration in the Calvo model of four quarters:
this value is in line with microeconometric evidence for Europe (see Alvarez et al. (2006)) and it corresponds to the value most widely used in the macro literature.

Table 1: Parameters of the Numerical Model

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
<th>Value</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \beta )</td>
<td>Subjective discount factor</td>
<td>0.99</td>
<td>Standard value</td>
</tr>
<tr>
<td>( \sigma )</td>
<td>Consumption utility</td>
<td>2</td>
<td>Intertemp. elasticity of subst.</td>
</tr>
<tr>
<td>( \nu )</td>
<td>Elasticity of subst.</td>
<td>10</td>
<td>Galí (2008)</td>
</tr>
<tr>
<td>( \Psi )</td>
<td>Price adjustment cost</td>
<td>116.5</td>
<td>Equivalent to ( \theta = 0.75 )</td>
</tr>
<tr>
<td>( a )</td>
<td>Annual Productivity</td>
<td>1</td>
<td>Normalization</td>
</tr>
<tr>
<td>( \gamma )</td>
<td>Workers’ bargaining power</td>
<td>0.5</td>
<td>Standard value</td>
</tr>
<tr>
<td>( f )</td>
<td>Firing cost</td>
<td>0.6</td>
<td>Bentolila and Bertola (1990)</td>
</tr>
<tr>
<td>( h )</td>
<td>Hiring cost</td>
<td>0.1</td>
<td>Chen and Funke (2005)</td>
</tr>
<tr>
<td>( b )</td>
<td>Unemployment benefits</td>
<td>0.0875</td>
<td>OECD (2007)</td>
</tr>
<tr>
<td>( E(\varepsilon) )</td>
<td>Expected value of op. costs</td>
<td>0</td>
<td>Normalisation</td>
</tr>
<tr>
<td>( s_d )</td>
<td>Distr. scaling parameter</td>
<td>0.1326</td>
<td>To match the flow rates</td>
</tr>
<tr>
<td>( s )</td>
<td>Payments under disagreement</td>
<td>0.0561</td>
<td>To match the flow rates</td>
</tr>
<tr>
<td>( b_n )</td>
<td>Weight on inflation</td>
<td>1.5</td>
<td>Galí (2008)</td>
</tr>
<tr>
<td>( \zeta )</td>
<td>Intermediation cost</td>
<td>0.01</td>
<td>Within range in the literature</td>
</tr>
<tr>
<td>( \tau^c )</td>
<td>Consumption tax</td>
<td>0.17</td>
<td>Trabandt and Uhlig (2011)</td>
</tr>
<tr>
<td>( \tau^p )</td>
<td>Profit tax</td>
<td>0.33</td>
<td>Trabandt and Uhlig (2011)</td>
</tr>
<tr>
<td>( g/y )</td>
<td>Governments spending</td>
<td>0.23</td>
<td>Trabandt and Uhlig (2011)</td>
</tr>
</tbody>
</table>

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 \( (f = 0.6) \) of the annual productivity which amounts to approximately 66 percent of the annual wage\(^{12} \) 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, \( s \),

\(^{12}\) For the period from 1975 to 1986 Bentolila and Bertola (1990) 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. For an empirically admissible range of values of firing costs our main numerical results are unchanged.
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 0.1326 and payments under disagreement to 0.0561. We calibrate our flow rates using evidence for West Germany, as there are only Kaplan-Meier survival functions for individual countries.\footnote{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.\footnote{Hence a quarterly job finding rate of $\eta = 0.20$\footnote{For similar numbers see Gartner et al. (2012). Note that our calibration is also consistent with the calibration strategy normally employed in matching models with endogenous dismissal probability. See e.g. Christofoletti et al. (2009) for a calibration for euro zone countries.} and a firing rate of $\phi = 0.02$ are reasonable averages for continental European countries.}}\footnote{We choose the Kaplan-Meier functions for Germany, as it is the largest continental European country.}\footnote{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).} 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.\footnote{In some countries (particularly the US) large fiscal packages have been implemented in face of nearly zero nominal interest rates. For this reason we tested the results under the assumption that the zero lower bound is implemented for a certain number of periods. Since the our main conclusions remain unaffected, the results can be found in the Faia et al. (2009).}

**Fiscal policy parameters.** Following Trabandt and Uhlig (2011), taxes in the steady-state are calibrated as follows (average of EU-14): $\tau^c = 17\%$, $\tau^a = 41\%$, $\tau^p = 33\%$ and the share of government spending is $g/y = 0.23$.

### 2.5 Monetary Policy and Fiscal Policy Regimes

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

\[
\frac{1 + i_t}{1 + i} = \pi_t b_n. \tag{23}
\]

The response to inflation, $b_n$, is set to 1.5.\footnote{In some countries (particularly the US) large fiscal packages have been implemented in face of nearly zero nominal interest rates. For this reason we tested the results under the assumption that the zero lower bound is implemented for a certain number of periods. Since the our main conclusions remain unaffected, the results can be found in the Faia et al. (2009).}

The government budget constraint reads as follows:

\[
g_t + ubu_t + hs_t h_{\eta} u_{t-1} + (1 - \Upsilon_t) g_t n_{t-1} u b = \tau_t + \tau^h_t w_t n_t + \tau^c_t c_t + \Pi_{a,t} \tau^p_t, \tag{24}
\]

where $hs_t h_{\eta} u_{t-1}$ are the costs of subsidizing hiring costs and $(1 - \Upsilon_t) g_t n_{t-1} u b$ are the costs of short-time work. We assume that the expenditures of the fiscal packages are financed by lump sum...
taxes. Four fiscal packages are considered.

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

\[
g_t = \left( \frac{g_{t-1}}{g} \right)^{\rho_g} e^{\varepsilon^g_t},
\]

where \(\varepsilon^g_t\) is a surprise increase and \(\rho_g\) is the autocorrelation of the shock.

2. A *temporary income tax cut*. Temporary cuts in the income tax are implemented according to the following process:

\[
\tau^n_t = \left( \frac{\tau^n_{t-1}}{\tau^n} \right)^{\rho^n} e^{\varepsilon^n_t},
\]

where \(\varepsilon^n_t\) is the surprise increase and \(\rho^n\) is the autocorrelation of the shock. A reduction in \(\tau^n_t\) reduces wages (before taxes), hence it increases labor demand.

3. *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:

\[
(1 - \tau^n_t)h(1 - hs_t) = (1 - \tau^n_t)(a_mc_t - w_t - v_{h,t}) + E_t(\Delta_{h,t+1}\Pi_{I,t+1}(\varepsilon_{t+1})),
\]

where \(hs_t\) represents the hiring subsidy and follows the process below:

\[
1 - hs_t = (1 - hs_{t-1})^{\rho_{hs}} e^{\varepsilon_{hs}^t},
\]

where \(\varepsilon_{hs}^t\) is the surprise increase and \(\rho_{hs}\) is the autocorrelation of the shock. Equation 27 shows that a reduction in hiring costs increases the mass of hired workers.

4. *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 worker flows 2):

\[
\Upsilon_t = \Upsilon_{t-1}^{\rho_{\Upsilon}} e^{\varepsilon_{\Upsilon}^t}.
\]
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. As a robustness check we will also consider a lower level for the autoregressive coefficients.

3 Fiscal Multipliers: Baseline Scenarios

Figure 1 and Table 2 summarize the output effects in the baseline scenarios.\(^\text{17}\) Figure 2 shows the impulse response functions for employment and consumption. Short-run and long-run multipliers are computed for the four fiscal packages outlined above. Short-run multipliers are calculated as output effects during the impact period divided by costs during the impact period (i.e., $\frac{y_t - y}{g_t - g}$ for government spending, where the variables without time subscript denote steady state variables). Long-run multipliers are the discounted output effects divided by the discounted costs (i.e., $\sum_{t=0}^{\infty} \beta^t (y_t - y) / \sum_{t=0}^{\infty} \beta^t (g_t - g)$ for government spending). All graphs are normalized so that they represent a 0.5 percent of GDP spending package during the implementation period.\(^\text{18}\)

**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 et al. (2010) or 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. This explains the small output multiplier.

To highlight the role of labor market frictions, we compare the effects of government spending in our model and in the New Keynesian model with frictionless labor markets.\(^\text{19}\) Figure 1 shows 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. The price for intermediate goods

\(^{17}\)Output is defined as the sum of private and public consumption.

\(^{18}\)To make government spending and tax multipliers comparable, multipliers calculations were based on the steady state values for all endogenous variables.

\(^{19}\)The standard New Keynesian model does not feature any labor market frictions but it does feature an intensive labor margin. We assume indeed that households have a separable utility in consumption and labor hours: the consumption utility is equivalent to the one in our model, while the labor hours disutility is quadratic. See, e.g., Galí (2008, chapter 3).
increases relative to the case with Walrasian labor markets. The price increase dampens the expansionary effects of increases in aggregate demand.

**Hiring subsidies.** Multipliers are very large for this case. This is even more so for long-run multipliers. A reduction in \( h \) increases the hiring threshold, as shown in equation 27, and reduces firms’ marginal costs, as shown in equation 16. The ensuing increase in employment increases production and explains the large multipliers. Contrary to the increase in government spending, there is no crowding out of consumption.

Since wages are bargained between the incumbent workers and the firm, involuntary unemployment arises, i.e. unemployed workers would be willing to work at lower wages. Hiring subsidies, by increasing job creation, help to mitigate this distortion. The type of collective bargaining described is more typical in euro area countries. The size of the multipliers for hiring subsidies would be smaller under individualistic bargaining, which is the prevailing institution in the US.

**Short-time work (Kurzarbeit).** In this case, firms have the possibility of reducing the working time of employees with low productivity. The government then reimburses a part of workers’ lost wage income. The implementation of short-time work increases the firing threshold (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 employment goes up. Two counteracting effects, concerning the average productivity of an employed worker, emerge. On the one hand, the rise in the firing threshold increases the retention rate for low productivity workers, who would have otherwise been fired. This tends to decrease average productivity. On the other hand, workers 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).

Table 2: Summary of fiscal multipliers for different fiscal packages.

<table>
<thead>
<tr>
<th></th>
<th>Demand stim.</th>
<th>Inc. tax cut</th>
<th>Hiring subsidy</th>
<th>STW</th>
</tr>
</thead>
<tbody>
<tr>
<td>Short-run</td>
<td>0.18</td>
<td>0.39</td>
<td>2.11</td>
<td>0.55</td>
</tr>
<tr>
<td>Long-run</td>
<td>0.47</td>
<td>0.74</td>
<td>3.71</td>
<td>2.83</td>
</tr>
</tbody>
</table>

**Income tax cuts.** For this experiment the multipliers are larger than for government spending (see Table 2 and see Section 4.1 for a robustness check). In fact, 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 close to one and almost twice as large as the short run multiplier. A fall in, $\tau^g_t$, reduces wages, as can be seen from the equation below:

$$ w_t = \gamma \left( a_t mc_t - \varepsilon^I_t + \frac{s}{1 - \tau^g_t} \right) + (1 - \gamma) \frac{u^b}{1 - \tau^g_t}, $$

hence it increases job creation and labor demand. Figure 1 highlights this effect, by comparing the effects of an income tax cuts in a model with Walrasian 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.

4 Robustness Checks

To test our results, to add realism to the model and to make our results comparable with part of the literature, we perform a number of robustness checks. First, we check how our results differ when we change the persistence of the government interventions. Second, we test whether our results change under a fiscal rule. Third, we analyze international spillovers in a currency union. And fourth, we analyze the role of risk sharing. In addition, Faia et al. (2009) contains a scenario where monetary policy keeps interest rates constant for four periods and then returns to a regular Taylor rule. Although this exercise makes government spending somewhat more effective and the other measures somewhat less effective, it leaves the ranking of results unaffected.

4.1 Lower Persistence

Government spending time series are fairly persistent in normal times (see, e.g., Corsetti et al., 2012). However, during extreme recessions the government might use fiscal stimulus in a discretionary and episodic fashion. Thus, we also address the effects of fiscal stimuli with shorter time horizons. We do so by reducing the persistence parameter of all our fiscal measures from 0.9 to 0.75.

Table 3 shows two main results. First, traditional government spending now delivers larger long-run multipliers. Since now government spending spans over a shorter time horizon, agents
Table 3: Summary of fiscal multipliers (with autocorrelation coefficients 0.75).

<table>
<thead>
<tr>
<th></th>
<th>Demand stim.</th>
<th>Inc. tax cut</th>
<th>Hiring subsidy</th>
<th>STW</th>
</tr>
</thead>
<tbody>
<tr>
<td>Short-run</td>
<td>0.07</td>
<td>0.14</td>
<td>1.58</td>
<td>0.12</td>
</tr>
<tr>
<td>Long-run</td>
<td>0.66</td>
<td>0.25</td>
<td>2.81</td>
<td>1.18</td>
</tr>
</tbody>
</table>

expect lower increases in future taxes and smaller effects on future interest rates.\(^{20}\) Second, multipliers for income tax cuts, hiring subsidies and short-time work are now smaller, although for the last two they are still significantly larger than those associated with traditional government spending. This is again due to expectational effects. The benefits of those measures arise since they increase the expected present value of worker-firm pairs, hence they increase firms’ profitability and thus boost hiring and dampen firing. When the time-horizon of the fiscal stimulus decreases (i.e. less persistence), the benefits are more muted.

4.2 Fiscal Rules

So far we had assumed that fiscal policy is conducted under balanced budget and in absence of fiscal rules. A more realistic treatment of fiscal policy would suggest that their inclusion might be important in assessing the size of the multipliers (see the recent contributions by Corsetti et al. (2010, 2012) and Uhlig (2009)). We therefore perform a further robustness check by allowing for fiscal rules on government spending and on labor income taxation. In this case, the government budget constraint reads as follows:

$$g_t + ub_t + (1 + i_{t-1}) D_{t-1} = \tau_t + \tau^n_t w_t n_t + \tau^c_t c_t + \bar{\Pi}_{a,t} \tau^p_t + D_t, \quad (31)$$

which includes one-period government debt $D$. In line with Uhlig (2009), we calibrate the steady state level of debt to 65% of output. We model government spending along the lines of Corsetti et al. (2012) and assume spending reversals.

$$g_t = g \left( \frac{g_{t-1}}{g} \right)^{\rho_g} \left( \frac{D_t}{D} \right)^{-\psi_g} e^{x_t g}. \quad (32)$$

\(^{20}\)This is in line with Coenen et al. (2012, p. 25) who write that "the short-run stimulative effects on GDP decrease if the fiscal stimulus becomes ‘too persistent’." However, they also show that the connection between persistence and the size of multipliers is not monotonic.
This rule allows government spending to depend on the level of debt. Whenever the level of debt is above its long-run level, fiscal spending falls. The parameter $\psi_g$, namely the responsiveness of government spending to debt, is set to 0.02, as in Corsetti et al. (2012). In addition, we assume that income taxes are also governed by a fiscal rule. Income taxes increase (decrease) when government debt increase above (below) the steady state value. In line with Corsetti et al. (2012), the parameter governing the response of taxes to government debt, $\psi_r$, is set to 0.02.

Figure 3 shows the impulse response of GDP for the four fiscal packages, comparing the results in the benchmark case (no government spending and no tax rules) to the results under fiscal rules. In response to government spending shocks, the fiscal rule leads to a higher output effect in the initial periods and to a negative output effect in the longer run. In the short run, there are two effects. First, labor taxes increase when the government debt increases. Due to distortionary effects, this reduces the effects of government spending. Second, since there is a government spending reversal according to Corsetti et al. (2012), economic agents anticipate that there will be less government spending in the future. This affects the path of future interest rates and generates a crowding-in effect, which is driven by intertemporal substitution (see Corsetti et al., 2012, for details). Thus, spending reversals generate positive short-run effects on output. With our chosen calibration for the government spending and the tax rule, in the short run the positive effect dominates. In the long run, the inverse is true.

Interestingly, the effects of income tax cuts do not change much due to the fiscal rules. By contrast, the spending and tax rules change the timing of the effects of STW and hiring subsidies. They are somewhat less beneficial in the short run but somewhat more beneficial in the long run.

Most importantly, the comparison shows that the previous ranking of the effectiveness of different policies remains robust. We also experimented with other parametrizations for the government spending and income tax rules. Stronger spending reversals generate a larger immediate effect of government spending, while faster income tax responses do the opposite. Although different parametrizations change the quantitative results somewhat, for a plausible range of parameters, the basic results of the paper remain unaffected.

21We use income taxes instead of lump sum taxes for the tax rule. For the parameters, we rely on the values by Corsetti et al. (2012), which are rationalized based on empirical estimations.
4.3 Multipliers and Spillovers in Currency Areas

Fiscal policy might be de-amplified in an open economy context (see, e.g., Corsetti et al. (2010) for an analysis of fiscal policy in an open economy model). An increase in aggregate demand, by increasing domestic prices, tends to depreciate the terms of trade. The country, undertaking the fiscal stimulus loses competitiveness and its current account worsens. To see how such de-amplification works, let’s consider an extension of our model to an open economy context. We focus on the special case of the currency area, as we have in mind euro area countries in which spillovers might be larger. Below we outline the main building blocks required to extend the model.

We assume that countries are symmetric and modeled according to our benchmark. Standard assumptions characterize the open economy (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:

$$c_t = \left( (1 - \alpha)^{\frac{1}{\eta}} c_{h,t}^{\frac{\eta - 1}{\eta}} + \alpha^{\frac{1}{\eta}} c_{f,t}^{\frac{\eta - 1}{\eta}} \right)^{\frac{\eta}{\eta - 1}},$$  \hspace{1cm} (33)
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:

\[
\begin{align*}
    c_{h,t} &= (1 - \alpha) \left( \frac{p_t}{p_{h,t}} \right)^{\eta} c_t ; \\
    c_{f,t} &= \alpha \left( \frac{p_t}{p_{f,t}} \right)^{\eta} c_t.
\end{align*}
\]

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):

\[
s_t \equiv \frac{p_{f,t}}{p_{h,t}}.
\]

In the open economy, an important role is played by the ratio of the consumer price index (CPI) and the producer price index (PPI), which can be written as a function of the terms of trade:

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

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

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 (see Schmitt-Grohe and Uribe (2003)):

\[
i_t^f = i_t + \zeta \left( \frac{\nu}{\epsilon_i \mu} - 1 \right).
\]

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

\[
w_t = \frac{\gamma}{\iota(s_t)} \left( a_t m c_t - \varepsilon_t^f + \frac{s}{1 - \tau^f_t} \right) + (1 - \gamma) \frac{ub}{1 - \tau^f_t}.
\]

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 the 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 domestic labor demand and an increase in foreign labor demand. Such labor market spillovers reinforce the effects of the traditional demand spillovers in dampening domestic fiscal multipliers and in amplifying positive cross-country spillovers.

Calibration of the additional parameters characterizing the open economy is set as follows. 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 is set to 0.2, consistently with data for net exports in the euro area (and in the US). The calibration for the elasticity of the spread on foreign bonds to the net asset position varies significantly in the literature (see, e.g., Schmitt-Grohe and Uribe (2003) and Benigno (2009)). We take an average value of 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, the multiplier of traditional government spending is reduced in the open economy model. The impact of the other measures does not change much.

4.4 The Role of International Risk Sharing

In the traditional Mundell-Fleming analysis, 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 rate and in the interest rate tend to offset the beneficial effects of an increase in government spending. Above we considered a currency area, which is an extreme form of fixed exchange rates, featuring imperfectly integrated financial markets. To isolate the contribution of financial market imperfection, we now compare the multipliers with the same model featuring perfect risk sharing across countries (see Chari et al. (2002)). The latter assumption is exemplified by the following risk sharing, stating that consumption is equalized across
countries up to the ratio of the terms of trade:

\[
\left( \frac{c_t^*}{c_t} \right)^{-\sigma} = s_t \frac{t^*}{t(s_t)}.
\]  

Figure 5 compares the output response in the model with intermediation costs on international bonds (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 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
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).

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, consistent with the closed economy case, those alternative fiscal measures do not produce crowding out effects, as private consumption increases. For this reason they deliver 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., Fatás and Mihov (2001), Blanchard and Perotti (2002) 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 et al. (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 et al. (2007).

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. However, our model would not rationalize strong asymmetries in output multipliers across booms and recessions (see Auerbach and Gorodichenko (2010, 2012)).

6 Conclusions

This paper computes the fiscal multipliers in a model with a labor selection process, turnover costs and Nash bargained wages. The model is particularly well suited for studying various forms of fiscal stimuli directed toward the labor market, namely income tax cuts, hiring subsidies and short-time work. Results show that hiring subsidies and short-time work schemes are particularly successful in generating large multipliers. Thus, our model suggests that "German Kurzarbeit" has contributed to the stable employment during the Great Recession in Germany.
References


Appendix 1: Institutional Details on Short-Time Work

Short-time work was one of the most important government interventions in continental Europe during the Great Recession in 2008 and 2009. In Belgium 5 percent of the employed workers and in Germany 3 percent of the employed workers went on short-time work (see, e.g., Cahuc and Carcillo (2011), and OECD (2010)).

The precise institutional details for short-time work vary from country to country. Since the German "Kurzarbeit" scheme has been in place for very long time and has had a large coverage, particularly in the last crisis (in 2009 up to 64000 firms and 1.5 million employees used short-time work, with costs of around €5 billion), we focus on its institutional details.

The most important category of German Kurzarbeit is the so called business cycle related ("konjunkturelle") Kurzarbeit. According to the German regulations, whenever there is a "in-escapable lack of work," firms can apply for Kurzarbeit at the Federal Employment Agency. Under Kurzarbeit, firms can reduce the number of working hours of their workforce. Assume that the Federal Employment Agency allows a firm to reduce the working hours by one fifth. In this case, the firm would only have to pay four fifth of the wage bill, but at the same time obtain only four fifth of the usual working time (e.g., workers do not show up one working day of the week). Workers are partly compensated for their wage loss by the government. They obtain a proportional share of unemployment benefits, which are roughly 60 percent of the net wage in Germany. Thus, if a worker is on short-time work with one fifth of his working time, he would obtain 0.8w+0.2b.

Short-time work in Germany has both, a rule based and a discretionary component. This institution is always in place and firms can apply for short-time work without any changes of the rules. However, the government and the Federal Employment Agency make strong use of the discretionary component in severe recessions (e.g., the cost of short-time work is reduced). In our paper, we focus on the discretionary component. As described in the next Section, we assume that the government defines an eligibility criterion for short-time work (namely, workers that are unprofitable in the contemporaneous period are eligible). We assume that the government determines the share of working time reductions: \( Y \) is essentially a proxy for the cost reduction during recessions. Appendix 2 shows that this also affects the hiring and firing thresholds.
8 Appendix 2: Technical Details on Short-Time Work

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

\[(1 - \tau_t^p)(a_t m c_t - w_t - \varepsilon_t) < 0.\] (40)

The cut-off for short-time work is:

\[v_{s,j} = a_t m c_t - w_t,\] (41)

while the mass of workers which are sent on short-time work is given by:

\[q_t = \int_{v_{s,j}}^{v_{f,t}} q(\varepsilon_t) d\varepsilon_t.\] (42)

When a worker is eligible, the firm does not have to pay for a certain share of his wage and for his operating costs. This share is set exogenously by the government. In return, the input of the worker is reduced proportionally. Let’s assume that this share is equal to \(\Upsilon_t\), and that the latter follows an autoregressive process. Thus, the firms profits are:

\[\tilde{\Pi}_{s,t}(\varepsilon_t) = \Upsilon_t(1 - \tau_t^p)(a_t m c_t - w_t - \varepsilon_t) + E_t(\Delta_{t,t+1}\tilde{\Pi}_{f,t+1}(\varepsilon_{t+1})),\] (43)

with

\[\tilde{\Pi}_{f,t+1}(\varepsilon_{t+1}) = (1 - \varrho_{t+1} - \phi_{t+1})(1 - \tau_{t+1}^p)(a_{t+1} m c_{t+1} - w_{t+1} - \varepsilon_{t+1}) - \frac{1}{1 - \varrho_{t+1} - \phi_{t+1}} \int_{-\infty}^{v_{f,t}} \varepsilon_j q(\varepsilon_j) d\varepsilon_j + E_t(\Delta_{t,t+2}\tilde{\Pi}_{f,t+2}(\varepsilon_{t+2})) + \varrho_{t+1}\left(\Upsilon_t(1 - \tau_t^p)(a_t m c_t - w_t - \frac{1}{\varrho_{t+1}} \int_{v_{s,j}}^{v_{f,t}} \varepsilon_j q(\varepsilon_j) d\varepsilon_j) + E_t(\Delta_{t,t+2}\tilde{\Pi}_{f,t+2}(\varepsilon_{t+2}))\right) + \phi_{t+1} f.\] (44)

Hiring and firing thresholds are endogenously determined as follows:
\[ h(1 - \tau_t^p) = (1 - \tau_t^p)(\alpha_t m c_t - w_t - v_{h,t}) + E_t(\Delta_{t,t+1}\tilde{I}_{f,t+1}(\varepsilon_{t+1})), \quad (45) \]

\[ -f(1 - \tau_t^p) = \Upsilon(1 - \tau_t^p)(\alpha_t m c_t - w_t - v_{f,t}) + E_t(\Delta_{t,t+1}\tilde{I}_{f,t+1}(\varepsilon_{t+1})). \quad (46) \]

Equation 46 shows that \( \Upsilon \) reduces the firing threshold.