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Reforming the labor market and improving competitiveness: an analysis for Spain using FiMod

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Abstract:
This paper uses an extended version of "*FiMod – A DSGE Model for Fiscal Policy Simulations*" (Stähler and Thomas, 2011) with endogenous job destruction decisions by private firms to analyze the effects of several currently discussed labor market reforms on the Spanish economy. The main focus is on the firms' hiring and firing decisions, on the implications for fiscal balances and on Spain's international competitiveness. We find that measures aiming at reducing (policy-induced) outside option of workers, such as a decrease in unemployment benefits, public wages or, to a lesser extent, public-sector employment, seem most beneficial to foster output, employment, international competitiveness and fiscal balances. Decreasing the unions' bargaining power also accomplishes this task, however, at a lower level and at the cost of higher job turnover. Our simulation suggests that reforming employment protection legislation does not seem to be a suitable tool from the perspective of improving international competitiveness. All measures imply (income) redistribution between optimizing and liquidity-constrained consumers. Our analysis also suggests that those reforms that are beneficial for Spain generate positive spillovers to the rest of EMU, too.

Keywords: General Equilibrium, Fiscal Policy Simulations, Labor Market Search

JEL codes: E24, E32, E62, H20, H50

Non-technical summary

The current crisis led to a severe increase in the Spanish unemployment rate. But also in "good times", Spain's unemployment rate was well above the EMU average. Structural weaknesses on the labor market – such as generous employment protection or high union power – were identified by some international observers as the key driver of disproportionately high wage claims and, thus, a decline in international competitiveness. Reforming the labor market to make it more flexible and regain competitiveness has recently become a core goal of Spanish politics.

The present work analyzes the effects of several currently discussed labor market reforms on the Spanish economy using *FiMod*, a DSGE model jointly developed by Banco de España and Bundesbank staff for macroeconomic analysis. More precisely, *FiMod* is a two-country monetary union model which includes quite a comprehensive fiscal block as well as the modern theory of unemployment by introducing a frictional labor market. The present paper extends the baseline version of *FiMod* by allowing for endogenous dismissal decisions on the firms' side.

The general findings of the present model analysis can be summarized as follows. In terms of output, employment, international competitiveness and debt, reforming the labor market such that the policy-induced outside option of workers is reduced seems to be most promising. This means that our model suggests decreasing unemployment benefits, public wages and, though at a considerably lower level, public employment to be the most suitable tools to achieve the policy goals. Cutting the unions' bargaining power also achieves these goals, however, at a lower level and at the cost of higher job turnover. As regards employment protection, the situation becomes more complicated and it seems that this may not be a suitable measure to reform the labor market, not least from the perspective of international competitiveness. The model simulation also suggests that an increase in competitiveness of the Spanish economy resulting from the labor market reforms described above has positive spillovers to the rest of EMU.

As in any model analysis, however, the results obtained here should be interpreted with caution. The Spanish labor market is characterized by a segmented dual labor market structure. The present model does not include this feature. Especially with respect to the simulation on employment protection this feature may play an important role, as the literature has shown. By the precise way of modeling the bargaining game between unions and firms in the wage negotiations, effects may be altered, too. Nevertheless, the present work contributes to the literature in an important way by showing that even under some simplifying assumptions reforming the labor market to regain international competitiveness is likely to be much more complicated than sometimes suggested.

Nicht-technische Zusammenfassung

Die gegenwärtige Krise hat Spaniens Arbeitslosenrate drastische ansteigen lassen. Aber auch in "guten Zeiten" lag diese deutlich über der des EU-Durchschnitts. Strukturelle Schwächen auf dem Arbeitsmarkt – darunter insbesondere ein vergleichsweise hoher Kündigungsschutz und große Gewerkschaftsmacht – wurden von einigen internationalen Beobachtern als bremsende Kraft identifiziert, die letztendlich zu überhöhten Lohnforderungen und einem Nachlassen der internationalen Wettbewerbsfähigkeit insbesondere gegenüber anderen EWU-Staaten führten. Eine Reform zur Flexibilisierung des Arbeitsmarktes wird von der spanischen Regierung mittlerweile als eine der Hauptaufgaben für die nächsten Jahre angesehen.

Diese Arbeit untersucht einige der vorgeschlagenen Reformmaßnahmen, darunter insbesondere die Reduktion der Arbeitslosenzahlung, eine Flexibilisierung des Kündigungsschutzes sowie ein Absenken der Gewerkschaftsmacht, im Rahmen von *FiMod*, einem gemeinsam von Mitarbeitern der Banco de España und der Bundesbank entwickelten DSGE Modell für makroökonomische Analysen. Bei *FiMod* handelt es sich um ein Zwei-Länder-Währungsunionsmodell, welches eine vergleichsweise komplexe fiskalpolitische Struktur sowie die moderne Arbeitsmarkttheorie durch die Integration von Suchfriktionen auf dem Arbeitsmarkt beinhaltet. Die vorliegende Arbeit erweitert das Grundmodell durch die endogene Modellierung von Entlassungsentscheidungen auf Firmenseite.

Als Ergebnis der Modellanalyse kann festgehalten werden, dass eine Absenkung des politikinduzierten (direkten) Reservationsnutzens von Arbeitnehmern die größten Effekte auf internationale Wettbewerbsfähigkeit, Output, Arbeitslosigkeit aber auch den Budgetsaldo des Staates hat. Das bedeutet, eine Absenkung der Lohnersatzleistungen, der öffentlichen Gehälter und, allerdings in wesentlich geringerem Maße, auch der öffentlichen Beschäftigung erscheint aus diesem Blickwinkel am vielversprechendsten. Eine Schwächung der Gewerkschaften im privatwirtschaftlichen Lohnverhandlungsprozess kann in Richtung der angestrebten Ziele gehen, jedoch in geringerem Maße und auf Kosten größerer Fluktuationen auf dem Arbeitsmarkt. Eine Flexibilisierung des Kündigungsschutzes erscheint auf Basis der vorliegenden Modellanalyse eher kontraproduktiv zu sein, da sie Output und internationale Wettbewerbsfähigkeit tendenziell senkt und die Arbeitslosigkeit erhöht. Im Ürbigen zeigt sich, dass ein Gewinn an Wettbewerbsfähigkeit der spanischen Wirtschaft durch die beschriebenen Arbeitsmarktreformen einen positiven Effekt auf den Rest von Europa hat.

Wie bei jeder Modellanalyse sollten die hier erzielten Ergebnisse jedoch vorsichtig interpretiert werden. So ist Spanien durch einen sehr segmentierten dualen

Arbeitsmarkt gekennzeichnet. Das vorliegende Modell beinhaltet eine solche Struktur nicht. Gerade bei der Reform des Kündigungsschutzes kann dies, wie die Literatur zeigt, ein wichtiger Gesichtspunkt sein und zu teilweise gegenteiligen Ergebnissen führen. Auch die genaue Modellierung der Verhandlungsspiels zwischen Gewerkschaften und Arbeitgebern hat durchaus Einfluss auf die resultierenden Effekte. Nichtsdestotrotz leistet die vorliegende Arbeit einen wichtigen Beitrag zur Diskussion und zeigt auf, dass eine Reform des Arbeitsmarktes zur Wiederherstellung der internationalen Wettbewerbsfähigkeit selbst unter einigen vereinfachenden Annahmen eine komplexere Analyse erfordert als dies manchmal suggeriert wird.

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Reforming the Labor Market and Improving Competitiveness: An Analysis for Spain Using *FiMod*[1]

1. Introduction

"The global financial crisis triggered an adjustment in the Spanish real estate sector which had serious consequences for the labor market. Since the beginning of the crisis, more than 2 million jobs have been destroyed (...) raising the unemployment rate above 20%" (see National Reform Programme Spain 2011, p. 15).[2] Evidently, the current crisis greatly affected the Spanish labor market. But even in "good times" Spain's unemployment rate was well above the EU average and hardly below around 10%, which hints at some general structural weaknesses. On the labor market, high employment protection and strong unions, among other things, are said by many to have led to disproportionately increasing wage claims, thereby deteriorating Spain's competitiveness vis-à-vis the rest of the monetary union member countries (see, for example, IMF, 2011). In order now to tackle these problems, the Spanish government has – after consultation with the European Commission and the International Monetary Fund (IMF) as well as remarkable demonstrations by primarily young citizens in basically any major city – chosen job creation and the reformation of the labor market to become a core goal of economic policy. In this paper, we analyze the short and long-run impact of making the Spanish labor market "more flexible" on output, unemployment, international competitiveness and fiscal balances using an extended version of "*FiMod – A DSGE **Mod**el for **Fi**scal Policy Simulations*" developed by Banco de España and Deutsche Bundesbank staff for policy simulations. The model has been used in the Working Group on Econometric Modelling (WGEM) of the European System of Central Banks (ESCB) to simulate various fiscal consolidation measures for Spain (see Stähler and Thomas, 2011).

The present paper has two objectives. First, we evaluate proposed measures to reform the Spanish labor market – more precisely, a permanent cut in employment protection, constantly weakening trade unions as well as a permanent cut in unemployment benefits, public wages and public-sector employment – in a medium-scale dynamic, stochastic, general equilibrium (DSGE) model. Second,

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[2]Publicly available at the homepage of the Spanish Ministry of Finance and Economics: http://www.meh.es/Documentacion/National%20Reform%20Programme%202011%20Spain.pdf.

more on the technical side, we propose a way how to simultaneously introduce endogenous dismissal decisions by firms *and* liquidity-constrained consumers in a medium-scale DSGE framework.

DSGE models have recently been more widely used for such analyses as they allow to present arguments in a rather structural way and give some numerical assessment, too. A non-exhaustive overview of papers related to ours are, among others, Zanetti (2011), who finds in a related DSGE model that labor market institutions significantly affect the volatility of output, employment and job flows (negatively for employment protection, positively for unemployment benefits). Thomas and Zanetti (2009) find in a DSGE model with large firms that the effects of such labor market institutions on inflation volatility are rather small. Similarly, Merkl and Schmitz (2011) find that labor market institutions affect inflation volatility to a rather small extent, but they identify significant effects on output volatility. By contrast, Campolmi and Faia (2011) find unemployment benefits to significantly decrease inflation volatility. They, hence, explain inflation differentials in the euro area by differences in the generosity of the unemployment insurance system. Almeida et al. (2008) address the effects of labor and product market reforms on international competitiveness for Portugal in *PESSOA*, the DSGE model used by the Portuguese National Bank. A similar analysis can be found in Kilponen and Ripatti (2005) using the Finnish model, in Deák et al. (2011) using the LSM (the *Luxembourg Structural Model*) and in Krause and Uhlig (2011) analyzing Germany's so-called *Hartz IV* reforms. These analyses find that, in general, labor market reforms improve competitiveness, foster domestic output and play a part in lowering unemployment. They address labor market reforms only as a cut in the "wage markup" (Almeida et al., 2008; and Kilponen and Ripatti, 2005) or as a decrease in unemployment benefits (Deák et al., 2011; and Krause and Uhlig, 2011), however, while we can be somewhat more specific on various measures to be analyzed. Related to this literature, the contribution of the paper at hand is its focus on the effects of specific structural labor market reforms on international competitiveness and fiscal balances.

Our general findings can be summarized as follows. In terms of output, employment, debt and international competitiveness, reforming the labor market such that (policy-induced) workers' outside option is reduced seems to be most promising. Decreasing the unions' bargaining power also achieves these goals, but at lower levels and at the cost of higher job turnover. As regards employment protection, the situation becomes more complicated and it seems that this may not be a suitable measure to reform the labor market – at least when aiming at improving international competitiveness. All measures involve (income) redistribution between optimizing and liquidity-constrained consumers.

FiMod, the model we use to analyze these questions, is a two-country monetary union DSGE model with a comprehensive fiscal block that includes a wide range of taxes and quite some disaggregation in government spending. Furthermore, it includes the modern theory of unemployment by including frictional labor markets. We extend the labor market part of the original model developed by Stähler and Thomas (2011) by endogenous job destruction in order to be able to analyze the firms' hiring and firing decisions in more detail. In doing so, we follow the approach of Zanetti (2011), who basically incorporates the standard Mortensen and Pissarides (1994, 1999, 2003) labor market with endogenous job destruction into a DSGE framework. In more detail, our findings from the model simulations can be summarized as follows.

A decrease in workers' outside option through a decrease in unemployment benefits or public-sector wages unambiguously decreases wage claims and makes it more attractive for firms to create jobs. Because of lower labor costs, firms decide to dismiss fewer people, which decreases unemployment. Furthermore, they lower prices. The latter makes Spanish goods cheaper, which fosters exports and improves the terms of trade. Higher production and less unemployment improve fiscal balances. Additionally, they are directly affected by the fact that a cut in the policy-induced expenditure item (unemployment benefits and the public sector wage bill) immediately decreases expenditures. According to our model simulations, these measures have the highest impact on output, employment, international competitiveness and fiscal balances compared to the other measures. In principle, the argumentation also holds for a cut in public employment. However, given that higher private labor demand cannot compensate for the decrease in public employment, unemployment will increase. This, first, diminishes the magnitude of the positive effects resulting from the other two measures just described and, second, may induce firms to dismiss relatively unproductive workers more frequently and to search for more productive ones in the pool of unemployed workers, even though this is costly. As unemployment has increased, search costs may fall to a sufficient extent for such behavior to pay off from the firms' perspective.

A cut in the unions' bargaining power sets in train some of the mechanisms described above, i.e. a cut in wages fosters job creation and allows firms to reduce prices which, then, increases exports, the terms of trade and output. However, most likely not so intuitive, firms decide to dismiss more frequently, too. This can mainly be attributed to the fact that, regarding the firms' dismissal decision, a cut in the bargaining power has two opposing effects. On the one hand, wages decrease, which makes dismissals less likely. On the other hand, the cut in the unions' bargaining power implies that firms receive a higher share of the surplus of (also newly created) matches. This increases the incentive to dismiss relatively unproductive workers in continuing jobs and to search for new – more productive ones – more frequently. Whenever the matching process is "sufficiently efficient", meaning that average search duration is sufficiently low, this effect dominates until the increase in search costs induced by such a behavior is sufficiently high. In an Appendix, we show, in a simplified model, how this can be related to the condition of Hosios (1990), which addresses the relationship between matching efficiency and bargaining power from the perspective of an "optimal" market outcome in (labor) markets with search frictions.

Our model simulation suggests that a cut in employment protection is not an adequate measure to tackle problems related to international competitiveness. Indeed, job creation increases as the expected cost of getting rid of a worker falls. However, dismissal probability also increases. On average, workers demand higher wages, partly to compensate for the additional dismissal risk, partly because average productivity of employed workers rises due to a rise in the dismissal productivity threshold. Hence, labor costs rise. In order to tackle this, firms increases prices, which deteriorates the terms of trade and causes exports to fall. In our model simulation, unemployment increases as the dismissal effect dominates the job creation effect. The drop in internal and external demand additionally decreases output, contributing to lower labor demand. To put these findings into perspective, some remarks seem in order. First, while reducing average dismissal costs in Spain may – according to our analysis – not contribute to regaining international competitiveness, a reform may still be in order. Spain is characterized by a dual labor market where some benefit greatly from employment protection while others do not have any. Costain et al. (2010) address this issue in a more adequate and very sophisticated model. Also, the comparatively large informal sector may be an issue here. Second, the bargaining game between the union and the firm may have quite an impact on the results. In our model, we follow the standard approach in the matching literature. However, Stähler (2008) has shown that the bargaining game matters. And last but not least, modelling employment protection itself is quite a complicated issue and it probably deserves a more sophisticated modelling than simply implementing firing costs, the approach we followed in the model at hand. For an overview of the different aspects related to employment protection and a discussion, see, among others, Stähler (2007).

The rest of this paper is organized as follows. The model is presented in section 2. Section 3 evaluates the labor market reforms already discussed. We differentiate between short and long-run effects. Section 4 concludes.

2. The model

FiMod is a two-country monetary union DSGE model with frictional labor markets and a comprehensive fiscal block that includes a wide range of taxes and disaggregation of government spending. Households, firms, policymakers and the external sector interact each period by trading final goods, financial assets and production factors. In this section we will briefly present the main characteristics of the model and discuss its calibration to make the paper self-contained. Readers who are familiar with *FiMod* may move on to the labor market section where the endogenous job destruction decision of firms is described. For a complete account of the base model and a more detailed discussion, see Stähler and Thomas (2011).

We start by describing the household sector in section 2.1. Then, we turn to the production sector in section 2.2, while section 2.3 details the labor market. Fiscal authorities are described in section 2.4, followed by a description of international linkages in section 2.5. The calibration strategy is explained in section 2.6.

For what follows, we normalize population size of the monetary union to unity, of which $\omega \in (0,1)$ live in Spain, while the remaining $(1-\omega)$ live in the rest of EMU. Throughout the paper, quantity variables will be expressed in per capita terms, unless otherwise indicated. Both regions are modeled analogously, while we allow structural parameters to differ.

2.1. Households

Following Galí et al. (2007), we assume that each country is populated by a share $(1-\mu)$ of optimizing (or Ricardian) households who have unrestricted access to capital markets and are therefore able to substitute consumption intertemporally. The remaining share $\mu \in [0,1)$ of households is considered to be liquidity-constrained in the sense that they can neither save nor borrow and consume all their labor income in each period. Each household has a continuum of members of size one. The welfare function of each type of representative household at time $t = 0$ is given by

$$E_0 \left\{ \sum_{t=0}^{\infty} \beta^t \cdot u_t \left(c_t^i, c_{t-1}^i, \tilde{g}_t \right) \right\}, \qquad (1)$$

where E_t is the expectations operator conditional on time-t information, c_t^i denotes household consumption of final goods, and the superscripts $i = o, r$ denote optimizing and rule-of-thumb households, respectively. The variable $\tilde{g}_t$ is government services produced by public employees, which is taken as given by private households. The instantaneous utility function is given by

$$u\left(c_t^i, c_{t-1}^i, \tilde{g}_t\right) = \begin{cases} \frac{\left[c_t^i - h \cdot c_{t-1}^i\right]^{1-\sigma_c} - 1}{1-\sigma_c} + \zeta \cdot \frac{\tilde{g}_t^{1-\sigma_c} - 1}{1-\sigma_c}, & \sigma_c > 0, \sigma_c \neq 1 \\ log\left[c_t^i - h \cdot c_{t-1}^i\right] + \zeta \cdot log[\tilde{g}_t], & \sigma_c = 1 \end{cases}. \quad (2)$$

The parameter σ_c is the coefficient of relative risk aversion, h denotes the degree of habit formation in consumption, and $\zeta > 0$ is a parameter capturing the relative valuation of public consumption in the households' utility function.

Inside each household, its members may be employed in the public sector, in the private sector, or unemployed. We assume full consumption insurance within the household, as in Andolfatto (1996) or Merz (1995). This holds both for Ricardian and rule-of-thumb households; see also Boscá et al. (2009, 2010, 2011) and Stähler and Thomas (2011) for a more detailed discussion.

We assume that both countries trade consumption and investment goods as well as international nominal bonds. The consumption and investment baskets, c_t^i and I_t^o, respectively, of a household of type i (only type o for investment) in the home country are given by

$$x_t^i = \left(\frac{x_{At}^i}{\omega + \psi}\right)^{\omega+\psi} \left(\frac{x_{Bt}^i}{1 - \omega - \psi}\right)^{1-\omega-\psi},$$

with $x_t^i = \left\{c_t^i, I_t^o\right\}$, where c_{At}^i, I_{At}^o and c_{Bt}^i, I_{Bt}^o represent consumption/investment demand of goods produced in country A (Spain) and B (rest of EMU), respectively, and ψ is a parameter capturing the degree of home bias in consumption. Cost minimization by the household implies

$$\frac{x_{At}^i}{x_{Bt}^i} = \frac{\omega + \psi}{1 - \omega - \psi} \frac{P_{Bt}}{P_{At}},$$

where P_{At} and P_{Bt} are the *producer price indexes* (PPI) in countries A and B, respectively. From now onwards, let

$$p_{Bt} \equiv \frac{P_{Bt}}{P_{At}}$$

denote the *terms of trade*. The above equations imply that nominal expenditure in consumption and investment goods equal $P_{At}c_{At}^i + P_{Bt}c_{Bt}^i = P_t c_t^i$ and $P_{At}I_{At}^o + P_{Bt}I_{Bt}^o = P_t I_t^o$, respectively, where

$$P_t = (P_{At})^{\omega+\psi} (P_{Bt})^{1-\omega-\psi}$$

is the corresponding *consumer price index* (CPI). Notice that $P_t = P_{At} \cdot p_{Bt}^{1-\omega-\psi}$. Therefore, CPI inflation, $\pi_t \equiv P_t/P_{t-1}$, evolves according to $\pi_t = \pi_{At} \left(\frac{p_{Bt}}{p_{Bt-1}}\right)^{1-\omega-\psi}$, where $\pi_{At} \equiv P_{At}/P_{At-1}$ is PPI inflation in country A.

2.1.1. Optimizing households

The budget constraint of the representative optimizing households in real terms is

$$\begin{aligned}(1+\tau^c)c_t^o + I_t^o + \frac{B_t^o + D_t^o}{P_t} \quad + \quad \frac{T_t}{1-\mu} &= \frac{\Pi_t}{P_t} + \left((1-\tau^k)r_t^k + \tau^k\delta^k\right)k_{t-1}^o \\ &+ \frac{R_{t-1}B_{t-1}^o}{P_t} + \frac{R_{t-1}^{ecb}e^{-\psi_d(d_{t-1}-\bar{d})/Y_{t-1}}D_{t-1}^o}{P_t} \\ &- \tau^b\frac{(R_{t-1}-1)\,B_{t-1}^o}{P_t} + \frac{Sub_t}{1-\mu} \\ &+ (1-\tau^w)\left(w_t^p n_t^{p,o} + w_t^g n_t^{p,g}\right) + (1-n_t^{p,o}-n_t^{g,o})\kappa^B. \end{aligned} \tag{3}$$

Each optimizing household's real labor income (gross of taxes) is given by $w_t^p n_t^{p,o} + w_t^g n_t^{g,o}$, where w_t^p is the average real wage in the private sector (to be derived later), w_t^g is the real wage in the government sector, and $n_t^{p,o}$ and $n_t^{g,o}$ are the number of type-o household members employed in the private and government sector, respectively. The labor income tax rate is denoted by τ^w. Unemployed household members receive unemployment benefits κ^B. τ^c denotes the consumption tax rate. Investments in physical capital k_t^o earn a real rental rate r_t^k, while the capital depreciates at rate δ^k. Returns on physical capital net of depreciation allowances are taxed at rate τ^k. The optimizing household can also purchase nominal government bonds B_t^o, which pay a gross nominal interest rate R_t. Returns on government bonds are taxed at the rate τ^b. Finally, optimizing households can hold international nominal bonds, D_t^o. In order to ensure stationarity of equilibrium, we follow Schmitt-Grohé and Uribe (2003) and assume that home agents pay a risk premium on top of the area-wide nominal policy rate, which we denote by R_t^{ecb}. This implies that the nominal interest rate paid or received by home investors is given by $R_t^{ecb}\exp(-\psi_d(d_t-\bar{d})/Y_t)$, with $\psi_d > 0$, where $d_t \equiv D_t/P_{At}$, D_t is the home country's nominal net foreign asset position and $(-)\,d_t/Y_t$ is the ratio of net foreign debt over output. We assume for simplicity that trading in international bonds is not taxed. Π_t are nominal per capita profits generated by firms. We assume that all firms are owned by the optimizing households and that profits are redistributed in a lump-sum manner. T_t and Sub_t are lump-sum taxes and subsidies, respectively.[3]

The law of motion of private physical capital is given by

$$k_t^o = (1-\delta^k)k_{t-1}^o + \left[1 - S\left(I_t^o/I_{t-1}^o\right)\right]I_t^o, \tag{4}$$

where $S\left(I_t^o/I_{t-1}^o\right) = \frac{\kappa_I}{2}\left(I_t^o/I_{t-1}^o - 1\right)^2$ represents investment adjustment costs (see Christiano et al., 2005, for discussion). Maximizing (1) given (2) subject to equations

[3] As we are not simulating changes in the distortionary tax rates in the following, we treat them as parameters in this paper, which simplifies the labor market calculations significantly. However, it is not a technical problem to endogenize these tax rates, too; see also footnote 6.

(3) and (4) yields the following standard first-order conditions,

$$\text{for } c_t^o: \quad \lambda_t^o = \frac{\left[c_t^o - h \cdot c_{t-1}^o\right]^{-\sigma_c} - \beta \cdot h \cdot E_t\left\{\left[c_{t+1}^o - h \cdot c_t^o\right]^{-\sigma_c}\right\}}{(1+\tau^c)} \ , \tag{5}$$

$$\text{for } B_t^o: \quad \lambda_t^o = \beta \cdot E_t \left\{ \lambda_{t+1}^o \cdot \frac{R_t \cdot (1-\tau^b) + \tau^b}{\pi_{t+1}} \right\} \ , \tag{6}$$

$$\text{for } k_t^o: \quad Q_t = \beta \cdot E_t \left\{ \frac{\lambda_{t+1}^o}{\lambda_t^o} \left[(1-\delta^k) Q_{t+1} + (1-\tau^k) \cdot r_{t+1}^k + \tau^k \cdot \delta^k \right] \right\} \ , \tag{7}$$

$$\begin{aligned} \text{for } I_t^o: \quad 1 = {} & Q_t \left[1 - S\left(I_t^o / I_{t-1}^o\right) - I_t^o \cdot S'\left(I_t^o / I_{t-1}^o\right) \right] \\ & + \beta \cdot E_t \left\{ \frac{\lambda_{t+1}^o}{\lambda_t^o} Q_{t+1} \frac{{I_{t+1}^o}^2}{I_t^o} S'\left(I_{t+1}^o / I_t^o\right) \right\} \end{aligned} \ , \tag{8}$$

$$\text{for } D_t^o: \quad \lambda_t^o = \beta R_t^{ecb} \cdot e^{-\psi_2 (d_t - \bar{d})/Y_t} \cdot E_t \left\{ \frac{\lambda_{t+1}^o}{\pi_{t+1}} \right\}, \tag{9}$$

where λ_t^o is the Lagrange multiplier on equation (3) and $Q_t \cdot \lambda_t^o$ is the Lagrange multiplier on equation (4). Therefore, λ_t^o represents the marginal utility of real income, whereas Q_t represents the shadow real price of a unit of physical capital, i.e. Tobin's Q. We also assume that the No-Ponzi condition on wealth is satisfied.

2.1.2. Non-Ricardian households

As non-Ricardian households can neither save nor borrow, their budget constraint simplifies to

$$(1+\tau^c) c_t^r = (1-\tau^w) \left(w_t^p n_t^{p,r} + w_t^g n_t^{g,r} \right) + (1 - n_t^{p,r} - n_t^{g,r}) \kappa^B, \tag{10}$$

which determines rule-of-thumb consumption, c_t^r. The corresponding marginal utility of consumption for rule-of-thumb households is thus

$$\lambda_t^r = \frac{\left[c_t^r - h \cdot c_{t-1}^r\right]^{-\sigma_c} - \beta \cdot h \cdot E_t\left\{\left[c_{t+1}^r - h \cdot c_t^r\right]^{-\sigma_c}\right\}}{(1+\tau^c)} \ . \tag{11}$$

2.1.3. Aggregation

Given the above description, consumption per capita in the home country equals the weighted average of consumption for each household type, i.e.

$$C_t = (1-\mu) \cdot c_t^o + \mu \cdot c_t^r. \tag{12}$$

For future reference, per capita domestic demand for the home country's and the foreign country's consumption good equals $C_{At} = (1-\mu)\, c_{At}^o + \mu c_{At}^r$ and $C_{Bt} = (1-\mu)\, c_{Bt}^o + \mu c_{Bt}^r$, respectively. For the quantity variables that exclusively concern optimizing households, per capita amounts are given simply by $Z_t = (1-\mu) Z_t^o$, where $Z_t \in \{k_t, B_t/P_t, I_t, D_t, I_{At}, I_{Bt}\}$ and $Z_t^o \in \{k_t^o, B_t^o/P_t, I_t^o, D_t^o, I_{At}^o, I_{Bt}^o\}$. Employment aggregation will be described in the labor market section.

2.2. Production

The retail and intermediate goods sectors of the economy are similar to Smets and Wouters (2003, 2007) or Christiano et al. (2005), with the exception that labor services are not hired directly from the households but from a sector of firms that produce homogenous labor services in the manner of Christoffel at al. (2009) or de Walque et al. (2009). It is the latter firms that hire workers and bargain over wages with them. In this subsection, we focus on the retail and intermediate goods sectors, postponing the description of the labor market to the next subsection.

2.2.1. Retailers

There is a measure-ω continuum of firms in the retail (or final goods) sector. Each retail firm purchases a variety of differentiated intermediate goods, bundles these into a final good and sells the latter under perfect competition. We assume that the law of one price holds within the union, which means that the price of the home country's final good is the same in both countries and equal to P_{At}. The maximization problem of the representative retail firm reads

$$\max_{\{\tilde{y}_t(j):j\in[0,\omega]\}} P_{At}Y_t - \int_0^{\omega} P_{At}(j)\tilde{y}_t(j)dj, \tag{13}$$

where

$$Y_t = \left(\int_0^{\omega}\left(\frac{1}{\omega}\right)^{1/\epsilon}\tilde{y}_t(j)^{(\epsilon-1)/\epsilon}dj\right)^{\epsilon/(\epsilon-1)}, \ \epsilon > 1, \tag{14}$$

is the retailer's production function, $\tilde{y}_t(j)$ is the retailer's demand for each differentiated input $j \in [0,\omega]$, and $P_{At}(j)$ is the nominal price of each input. The first-order condition for each input $j \in [0,\omega]$ reads $\tilde{y}_t(j) = \left(\frac{P_{At}(j)}{P_{At}}\right)^{-\epsilon}\frac{Y_t}{\omega}$. Combining the latter with (13) and the zero profit condition, we obtain that the producer price index in the home country must equal $P_{At} = \left(\int_0^{\omega}\frac{1}{\omega}P_{At}(j)^{1-\epsilon}dj\right)^{1/(1-\epsilon)}$. Notice that, since there are ω retail firms, total demand for each intermediate input equals

$$\omega\tilde{y}_t(j) \equiv y_t(j) = \left(\frac{P_{At}(j)}{P_{At}}\right)^{-\epsilon} Y_t. \tag{15}$$

2.2.2. Intermediate goods

Firms in the intermediate goods sector have mass ω. Each producer $j \in [0,\omega]$ operates the following technology:

$$y_t(j) = \epsilon^a \cdot \left(k_{t-1}^g\right)^{\eta} \cdot \left[\tilde{k}_t(j)\right]^{\alpha} \cdot \left[l_t(j)\right]^{(1-\alpha)}, \tag{16}$$

where $\alpha \in [0,1]$ is the elasticity of output with respect to private capital, $l_t(j)$ denotes the demand for labor services, $\tilde{k}_t(j)$ is the demand for capital services and

ϵ^a is TFP. k^g_{t-1} is the public capital stock available in period t, which is determined by the government and is assumed to be productivity-enhancing; the parameter $\eta \in [0,1)$ measures how influential public capital is on private production (see Leeper et al., 2010, for discussion). Intermediate goods firms acquire labor and capital services in perfectly competitive factor markets at real (CPI-deflated) prices x_t and r^k_t, respectively. In period t, the real profits of firm j are thus given by $\frac{P_{At}(j)}{P_t} y_t(j) - x_t \cdot l_t(j) - r^k_t \cdot \tilde{k}_t(j)$. Cost minimization subject to (16) implies the following factor demand conditions:

$$r^k_t = mc_t \cdot \alpha \cdot \frac{y_t(j)}{\tilde{k}_t(j)}, \tag{17}$$

$$x_t = mc_t \cdot (1-\alpha) \cdot \frac{y_t(j)}{l_t(j)}, \tag{18}$$

where mc_t is the real (CPI-deflated) marginal cost common to all intermediate good producers. Recall that constant returns to scale in private capital and labor, together with perfectly competitive input prices, imply that the ratios $y_t(j)/\tilde{k}_t(j)$ and $y_t(j)/l_t(j)$ are equalized across firms.

We assume that intermediate goods firms set nominal prices à la Calvo (1983). Each period, a randomly chosen fraction $\theta_P \in [0,1)$ of firms cannot re-optimize their price. A firm that has the chance to re-optimize its price in period t chooses the nominal price $P_{At}(j)$ that maximizes

$$E_t \sum_{z=0}^{\infty} (\beta\theta_P)^z \frac{\lambda^o_{t+z}}{\lambda^o_t} \left[\frac{P_{At}(j)}{P_{t+z}} - mc_{t+z} \right] y_{t+z}(j), \tag{19}$$

subject to $y_{t+z}(j) = (P_{At}(j)/P_{At+z})^{-\epsilon} Y_{t+z}$. The first-order condition is given by

$$E_t \sum_{z=0}^{\infty} (\beta\theta_P)^z \frac{\lambda^o_{t+z}}{\lambda^o_t} \left[\frac{\tilde{P}_{At}}{P_{t+z}} - \frac{\epsilon}{\epsilon-1} mc_{t+z} \right] \left(\frac{\tilde{P}_{At}}{P_{At+z}} \right)^{-\epsilon} Y_{t+z} = 0, \tag{20}$$

where $\tilde{P}_{At}$ is the optimal price chosen by all period-t price setters. The law of motion of the price level is then given by

$$1 = \theta_P \left(\frac{1}{\pi_{At}} \right)^{1-\epsilon} + (1-\theta_P) \tilde{p}_t^{1-\epsilon}, \tag{21}$$

where $\tilde{p}_t \equiv \tilde{P}_{At}/P_{At}$ is the relative (PPI-deflated) optimal price.

2.3. The labor market

Labor firms hire and fire workers from the household sector in order to produce homogenous labor services, which they sell to intermediate goods producers at the perfectly competitive price x_t. This modelling strategy follows Christoffel et al. (2009). We follow Zanetti (2011) to endogenize (private-sector) dismissals by including idiosyncratic job-specific productivity shocks. We keep the conventional assumption of the Pissarides (2000) framework that each labor firm can at most hire one worker. The production function of each labor firm is linear in average idiosyncratic productivity by its employees, which is given by $\bar{h}_t$ and will be determined later in section 2.3.2. Letting N_t^p denote both the fraction of the labor force employed in the private sector and the per-capita number of labor firms, the total per-capita supply of labor services is given by

$$L_t = N_t^P \cdot \bar{h}_t. \tag{22}$$

Equilibrium in the market for labor services requires that $\omega L_t = \int_0^\omega l_t(j)dj$. Using equations (15) and (16), together with the fact that the capital-labor ratio is equalized across intermediate goods firms (i.e. $\tilde{k}_t(j)/l_t(j) = k_{t-1}/L_t$ for all j), the above condition can be expressed as $Y_t D_t = \epsilon^a \left(k_{t-1}^g\right)^\eta k_{t-1}^\alpha L_t^{1-\alpha}$, where $D_t \equiv \int_0^\omega \omega^{-1} \left(P_{At}(j)/P_{At}\right)^{-\epsilon} dj$ is a measure of price dispersion. In what follows, we will specify the matching process and flows in the labor market, vacancy creation and job destruction as well as (private) wage determination. Government wages and employment are autonomously chosen by the fiscal authority (see section 2.4).

2.3.1. Matching and dismissal processes and labor market flows

A worker can be in one of three states: (i) unemployed, (ii) employed in the public sector, or (iii) employed in the private sector. Unemployment is the residual state in the sense that a worker whose employment relationship ends flows back into unemployment. Unemployed workers look for job opportunities. They find them either in the public sector (with superscript g for government employment) or in the private sector (with superscript p). Workers do not direct search to either the public or the private sector and are, thus, matched randomly.

Let us denote sector-specific per capita employment in period t by N_t^f, where $f = p, g$ stands for private and public (i.e. government) employment, respectively.[4] The total employment rate is then given by $N_t^{tot} = N_t^p + N_t^g$, while the unemploy-

[4]Note that, as we work with household type-specific (un)employment rates for each sector in the households' budget constraints (see equations (3) and (10)), we basically have to aggregate employment in order to obtain total (per capita) employment levels across public and private employment. This is done in analogy to the aggregation of consumption decisions (see section 2.1.3; again implying that capital letters indicate aggregate levels). Thus, aggregated per capita employment levels in each sector are given by $N_t^f = (1-\mu) \cdot n_t^{f,o} + \mu \cdot n_t^{f,r}$. Noting that dismissal and job-finding probabilities are equal across household types, we have that $N_t^f = n_t^{f,o} = n_t^{f,r}$; see also Moyen and Stähler (2009) for details.

ment rate is given by

$$U_t = 1 - N_t^{tot}. \tag{23}$$

Following Blanchard and Galí (2010), we assume that the hiring round takes place at the beginning of each period, and that new hires start producing immediately. We also assume that workers dismissed at the end of period $t-1$ start searching for a new job at the beginning of period t. Therefore, the pool of searching workers at the beginning of period t is given by

$$\tilde{U}_t = U_{t-1} + s_t^p N_{t-1}^p + s^g N_{t-1}^g,$$

where s^g represents the constant separation rate in the public sector. The separation rate in the private sector, s_t^p, is time-varying as it depends on the dismissal decision of firms. We will describe this in more detail in a moment.

The matching process is governed by a standard Cobb-Douglas aggregate matching function for each sector $f = p, g$,

$$M_t^f = \kappa_e^f \cdot \left(\tilde{U}_t\right)^{\varphi^f} \cdot \left(v_t^f\right)^{(1-\varphi^f)}, \tag{24}$$

where $\kappa_e^f > 0$ is the sector-specific matching efficiency parameter, $\varphi^f \in (0,1)$ the sector-specific matching elasticity and M_t^f the number of new matches formed in period t resulting from the total number of searchers and the number of sector-specific vacancies v_t^f. Note that, by allowing for the possibility that $\varphi^p \neq \varphi^g$, the matching process in the public and private sector may differ. The probability for an unemployed worker to find a job in sector f can thus be stated as $p_t^f = M_t^f / \tilde{U}_t$, while the probability of filling a vacancy is given by $q_t^f = M_t^f / v_t^f$.

During each period t, the flow into unemployment from the private sector results from an exogenous shock, s^x, and from a shock to the idiosyncratic productivity of active jobs, h_t, leading to an endogenous job destruction probability $s_t^n = F(\tilde{h}_t)$ when idiosyncratic productivity of an active job falls below some endogenously determined threshold, $\tilde{h}_t$. The exogenous separation probability s^x – as well as the corresponding probability in the public sector, s^g – can be interpreted as an exogenous retirement rate (see, for example, Costain et al., 2010). As described in Mortensen and Pissarides (1994, 1999, 2003), we assume that new matches are always endowed with a productivity $h^{new} > \tilde{h}_t$ and, thus, that newly created jobs never separate for endogenous reasons in the period they are created. Total private job separations are, hence, given by $s_t^p = s^x + (1 - s^x) s_t^n$. As is standard in the literature, we assume that the idiosyncratic productivity shock will be log-normally distributed with $\log(h_t) \sim N(\mu_h, \sigma_h)$.

The law of motion for sector-specific employment rates is therefore given by

$$N_t^f = \left(1 - \tilde{s}^f\right) \cdot N_{t-1}^f + p_t^f \cdot \tilde{U}_t, \tag{25}$$

with $\tilde{s}^g = s^g$ and $\tilde{s}^p = s_t^p$. Thus, employment in sector f today is given by yesterday's employment that has not been destroyed plus newly created matches in that sector.

2.3.2. Asset value of jobs and wage bargaining

Because of search frictions, formed matches entail economic rents. Firms and workers bargain about their share of the overall match surplus. In order to describe the bargaining process we first have to derive the asset value functions for workers and firms. The present-discounted value of a firm hiring a newly matched worker can be expressed as

$$\begin{aligned} J_t^{new} \quad &= \quad x_t \cdot h^{new} - (1+\tau^{sc}) w_t^{p,new} + \beta(1-s^x) E_t \left\{ \frac{\lambda_{t+1}^o}{\lambda_t^o} \left[\int_{\tilde{h}_{t+1}}^{\infty} J_{t+1}(h_{t+1}) dF(h_{t+1}) \right.\right. \\ &\qquad \left.\left. - F(\tilde{h}_{t+1}) \kappa^F \right] \right\}, \end{aligned} \tag{26}$$

where x_t is the price the labor-goods firm charges for providing the labor service and h^{new} is the (productivity-weighted) "amount" of labor service provided by newly created jobs. The firm has to pay a wage $w_t^{p,new}$ to the worker plus social security contributions to the state at rate τ^{sc}. Whenever the job is not destroyed next period at exogenous probability, s^x, a new idiosyncratic productivity is drawn from the distribution function $F(h_t)$. If this productivity is above the endogenously determined threshold value $\tilde{h}_{t+1}$, the firm earns the present-discounted value of a continuing job with the corresponding productivity, i.e. $J_{t+1}(h_{t+1})$. Whenever the productivity falls below the threshold, which happens at (expected) probability $F(\tilde{h}_{t+1})$, it has to pay a dismissal tax κ^F. Hence, a newly created job yields a net return $x_t h^{new} - (1+\tau^{sc}) w_t^{p,new}$ plus an expected present-discounted net value $J_{t+1}(h_{t+1}) - F(\tilde{h}_{t+1})\kappa^F$ in the following period. For continuing jobs, the presentation and the interpretation of the present-discounted value function is analogous and given by

$$\begin{aligned} J_t(h_t) \quad &= \quad x_t \cdot h_t - (1+\tau^{sc}) w_t(h_t) + \beta(1-s^x) E_t \left\{ \frac{\lambda_{t+1}^o}{\lambda_t^o} \left[\int_{\tilde{h}_{t+1}}^{\infty} J_{t+1}(h_{t+1}) dF(h_{t+1}) \right.\right. \\ &\qquad \left.\left. - F(\tilde{h}_{t+1}) \kappa^F \right] \right\}. \end{aligned} \tag{27}$$

Note that firms use the marginal utility of optimizing households, λ_t^o, to discount future periods as we assume that firms are owned by optimizers.

Opening a vacancy has a real (CPI-deflated) flow cost of κ_v^p. Free entry into the vacancy posting market drives the expected value of a vacancy to zero (see Pissarides, 2000). Under our assumption of instantaneous hiring, real vacancy posting costs, κ_v^p, must equal the time-t vacancy filling probability, q_t^p, times the expected value of a filled job in period t. The latter condition can be expressed as

$$\frac{\kappa_v^p}{q_t^p} = J_t^{new}. \tag{28}$$

We can now derive the asset value functions of workers. In particular, we are interested in the value of the job in excess of the value of being unemployed, i.e. the worker's match *surplus*. Since different household types use different stochastic discount factors, we must distinguish between the surplus for an optimizing and a rule-of-thumb household. For a worker belonging to a type-i household, the surplus value of being employed in a continuing job in the private sector is given by

$$\begin{aligned} H_t^{i,p}(h_t) &= (1-\tau^w)w_t^p(h_t) - \kappa^B + \beta(1-s^x)E_t\left\{\frac{\lambda_{t+1}^i}{\lambda_t^i}\left[\int_{\tilde{h}_{t+1}}^{\infty} H_{t+1}^{i,p}(h_{t+1})dF(h_{t+1})\right.\right. \\ &\quad \left.\left. -p_{t+1}^p H^{i,p,new} - p_{t+1}^g H^{i,g}\right]\right\} \end{aligned} \tag{29}$$

for $i = o, r$. The worker's value of being employed in a newly created job in the private sector is given by

$$\begin{aligned} H_t^{i,p,new} &= (1-\tau^w)w^{p,new} - \kappa^B + \beta(1-s^x)E_t\left\{\frac{\lambda_{t+1}^i}{\lambda_t^i}\left[\int_{\tilde{h}_{t+1}}^{\infty} H_{t+1}^{i,p}(h_{t+1})dF(h_{t+1})\right.\right. \\ &\quad \left.\left. -p_{t+1}^p H^{i,p,new} - p_{t+1}^g H^{i,g}\right]\right\}, \end{aligned} \tag{30}$$

and the value of being employed in the public sector can be stated as

$$H_t^{i,g} = (1-\tau^w)w_t^g - \kappa^B + \beta(1-s^g)E_t\left\{\frac{\lambda_{t+1}^i}{\lambda_t^i}\left[(1-p_{t+1}^g)H_{t+1}^{i,g} - p_{t+1}^p H^{i,p,new}\right]\right\}. \tag{31}$$

An employed worker receives a wage depending on which sector (private or public) he works in, on his idiosyncratic productivity shock h_t and on whether he has been newly hired or is in a continuing job, all net of labor income taxes. Additionally, he receives the option value of the job in case it continues in the next period. The outside option of the worker – i.e. his forgone income of being unemployed – is the sum of unemployment benefits, κ^B, and the expected value of searching for a job in the following period, where p_{t+1}^f is the probability of finding a job in sector $f = g, p$. Conditional on landing on a private-sector job, the surplus of the worker is the surplus of being newly employed in the private sector; when landing on a public-sector job, it is the surplus of working in the public sector.

As in Stähler and Thomas (2011), who follow Boscá et al. (2009, 2010, 2011), private-sector wage bargaining is modelled as a Nash-bargaining game between a union and the firm. The union's utility is the average utility of its members. More precisely, it is the weighted average of the surplus of optimizing and rule-of-thumb workers differentiated for being employed in a continuing job or being newly hired, respectively. Formally, this can be represented by $\Omega_t(h_t) \equiv (1-\mu)H_t^{o,p}(h_t) + \mu H_t^{r,p}(h_t)$ and $\Omega_t^{new} \equiv (1-\mu)H_t^{o,p,new} + \mu H_t^{r,p,new}$. As is explained in more detail in Mortensen and Pissarides (1999, 2003), we will have to take into account that firms in continuing jobs have a different threat point than those firms newly hiring a worker whenever idiosyncratic productivity shocks *and* dismissal costs exist. Firms bargaining to hire a new worker can simply walk away in case of disagreement, while firms in continuing jobs will have to pay the dismissal tax, κ^F. Hence, the resulting wage of newly hired workers and workers in continuing jobs will be different even when the idiosyncratic productivity level is (coincidentally) the same. Given the union's bargaining power parameter $\xi \in [0,1)$, the two-tier joint maximization problem is, therefore,

$$\begin{aligned} \max_{w_t^p(h_t)} \quad & [\Omega_t(h_t)]^{\xi} \left[J_t(h_t) + \kappa^F\right]^{1-\xi}, \\ \max_{w_t^{p,new}} \quad & [\Omega_t^{new}]^{\xi} \left[J_t^{new}\right]^{1-\xi}, \end{aligned} \tag{32}$$

The resulting sharing rules are given by

$$\begin{aligned} \Omega_t(h_t) = \; & \tfrac{\xi}{1-\xi} \cdot \tfrac{1-\tau^w}{1+\tau^{sc}} \cdot \left[J_t(h_t) + \kappa^F\right], \\ \Omega_t^{new} = \; & \tfrac{\xi}{1-\xi} \cdot \tfrac{1-\tau^w}{1+\tau^{sc}} \cdot J_t^{new}. \end{aligned} \tag{33}$$

which states that the (productivity-specific) share of the matching surplus the worker receives depends on the union's bargaining power as well as labor income and consumption taxes. Solving equation (33) for the corresponding wages by using the appropriate firm and worker asset value functions as well as equations (33) and (28) gives

$$\begin{aligned} w_t(h_t) = \; & \xi \cdot \left[\tfrac{x_t \cdot h_t}{1+\tau^{sc}} + \left(1 - \beta(1-s^x)E_t\left\{\tfrac{\lambda_{t+1}^o}{\lambda_t^o}\right\}\right)\tfrac{\kappa^F}{1+\tau^{sc}}\right] + (1-\xi)\tfrac{\kappa^B}{1-\tau^w} + \Xi_t, \\ w_t^{new} = \; & \xi \cdot \left[\tfrac{x_t \cdot h^{new}}{1+\tau^{sc}} - \beta(1-s^x)E_t\left\{\tfrac{\lambda_{t+1}^o}{\lambda_t^o}\right\}\tfrac{\kappa^F}{1+\tau^{sc}}\right] + (1-\xi)\tfrac{\kappa^B}{1-\tau^w} + \Xi_t, \end{aligned} \tag{34}$$

where

$$\Xi_t = \beta(1-s^x)E_t\left\{\frac{\lambda^o_{t+1}}{\lambda^o_t}\left[\xi\cdot\frac{p^p_{t+1}}{(1+\tau^{sc})}\cdot\frac{\kappa^v}{q_{t+1}}+p^g_{t+1}\frac{(1-\xi)}{(1-\tau^w)}\cdot\Omega^g_{t+1}\right]\right.$$
$$\left.+\mu\left(\frac{\lambda^o_{t+1}}{\lambda^o_t}-\frac{\lambda^r_{t+1}}{\lambda^r_t}\right)\left[\int_{\tilde{h}_{t+1}}^{\infty}H^{r,p}_{t+1}(h_{t+1})dF(h_{t+1})-p^p_{t+1}H^{r,p,new}_{t+1}-p^g_{t+1}H^{r,g}_{t+1}\right]\right\}$$

is the expected future option value of the union. It includes the expected value of being matched to a private or public job in the next period for unemployed workers (first row of the equation) and a "union/Rot-smoothing" term (second row of the equation).[5] The latter reminds us that there is risk sharing at the household level, but not between households. Although optimizing and RoT households may have a different reservation wage, they pool together in the labor market via the union structure and bargain with firms to distribute employment according to their share in the population. This implies that all household types receive the same wage and suffer the same unemployment rate. In contrast to Galí et al. (2007), this means that although RoT consumers cannot use wealth for consumption smoothing over time, they take advantage of the fact that a match today is likely to continue in the future, yielding a labor income that will be used to consume tomorrow. Therefore, unionized wage negotiations provide RoT consumers the opportunity to improve their lifetime utility by narrowing the gap in utility with respect to optimizing consumers (see also Boscá et al., 2010, 2011, for more details). Note that this "union/Rot-smoothing" term is zero in steady state.[6]

Wages, given in equation (34), are hence a weighted average between the highest feasible wage (i.e. the marginal productivity of labor, taking into account the future cost of posting a vacancy corrected by the probability that the vacancy will be filled and firing costs) and the lowest acceptable wage (i.e. the reservation

[5] Note that $\Omega^g_t = (1-\mu)H^{o,g}_t + \mu H^{r,g}_t$. While there is no need to calculate the optimizing households' asset value functions explicitly, Ξ_t reveals that the corresponding values for RoT-consumers have to be calculated, as they do affect the union's fall-back position. Technically, we do this by additionally calculating an auxiliary variable (the RoT-dismissal threshold) through "artificial" job creation and job destruction conditions, pretending that RoT-households and firms bargain over wages individually (hence, we also need to derive the corresponding wage equations). The corresponding values for $H^{r,p,new}_t$, $\int_{\tilde{h}_t}^{\infty} H^{r,p}_t(h_t)dF(h_t$ and $H^{r,g}_t$ are then plugged into the corresponding equations of the main text. It is plain to see that, in the steady state, they are irrelevant. However, in out-off steady-state situations, they will have some influence. For the sake of space, and because it is merely pure mathematics, we omit these calculations in the text. Details can, nevertheless, be sent by the authors upon request.

[6] While the term Ξ_t indeed looks quite ugly, it simply results from standard procedure. In the appendix of Moyen and Stähler (2009), the way to derive wages can be retraced in a simpler model. Given that we have to take into account endogenous job destruction and the possibilities of being employed in the private or the public sector in the model at hand, equations just become larger. Were we to include time-varying tax rates, the term would become even bigger. As we are not interested in varying these tax rates in this paper, we decided to present only the shorter and somewhat more intuitive term here. Including time-varying tax rates does not imply any technical problem, however.

wage as given by forgone unemployment benefits plus the probability of finding a job in the public or the private sector when searching next period).

2.3.3. Job creation and job destruction conditions

As we have already noted in equation (28), vacancies are created as long as the value of a newly created job equals average search costs. By substituting the above asset value functions and wages and rearranging, we obtain

$$(1-\xi)\left[x_t \cdot \left(h^{new} - \tilde{h}_t\right) - \kappa^F\right] = \frac{\kappa^v}{q_t} \tag{35}$$

as the job creation condition (JC henceforth). Because, in equilibrium, jobs are destroyed when the surplus the labor firm receives from the job falls below dismissal costs, we note that the job destruction condition (JD henceforth) can be expressed as $J_t(\tilde{h}_t) = -\kappa^F$. Substitution of wages and rearranging yields

$$\begin{aligned} x_t \cdot \tilde{h}_t \quad &- \quad \frac{1+\tau^{sc}}{1-\tau^w}\kappa^B - \frac{1+\tau^{sc}}{1-\xi} \cdot \Xi_t + \left(1 - \beta(1-s^x)E_t\left\{\frac{\lambda^o_{t+1}}{\lambda^o_t}\right\}\right)\kappa^F \\ &+ \quad \beta(1-s^x)E_t\left\{\frac{\lambda^o_{t+1}}{\lambda^o_t}x_{t+1}\int_{\tilde{h}_{t+1}}^{\infty}\left(h_{t+1} - \tilde{h}_{t+1}\right)dF(h_{t+1})\right\} = 0. \end{aligned} \tag{36}$$

As Zanetti (2011) has shown, the average private-sector real wage, w^p_t, is a weighted average of wages of continuing jobs and newly created jobs in equilibrium. The weight for continuing jobs is given by $\omega^c_t = (1-s^p_t)\frac{N^p_{t-1}}{N^p_t}$, while that for newly created jobs is given by $(1-\omega^c_t)$. The average private-sector real wage, therefore, is

$$w^p_t = \xi \cdot \left[\frac{x_t \cdot \bar{h}_t}{1+\tau^{sc}} + \left(\omega^c_t - \beta(1-s^x)E_t\left\{\frac{\lambda^o_{t+1}}{\lambda^o_t}\right\}\right)\frac{\kappa^F}{1+\tau^{sc}}\right] + (1-\xi)\frac{\kappa^B}{1-\tau^w} + \Xi_t, \tag{37}$$

where $\bar{h}_t = \omega^c_t H(\tilde{h}_t) + (1-\omega^c_t)h^{new}$ is the average idiosyncratic productivity per employed worker in the private sector, which we have also used in equation (22), and $H(\tilde{h}_t) = E(h_t|h_t > \tilde{h}_t) = \int_{\tilde{h}_t}^{\infty}\frac{hf(h)}{1-F(\tilde{h}_t)}dh$ is the average productivity of continuing jobs.

2.4. Fiscal authorities

The real (CPI-deflated) per capita value of end-of-period government debt, $b_t \equiv B_t/P_t$, evolves according to a standard debt accumulation equation,

$$b_t = \frac{R_{t-1}}{\pi_t}b_{t-1} + PD_t,$$

where PD_t denotes real (CPI-deflated) per capita primary deficit. The latter is given by per capita fiscal expenditures minus per capita fiscal revenues,

$$\begin{aligned} PD_t &= \left[\frac{G_t}{p_{Bt}^{1-\omega-\psi}} + \kappa^B U_t + Sub_t \right] \\ &\quad - \left[(\tau^w + \tau^{sc}) \left[w_t^p N_t^P + w_t^g N_t^g \right] + \tau^b \frac{R_{t-1} - 1}{\pi_t} b_{t-1} \right. \\ &\quad \left. + \tau^c C_t + \tau^k (r_t^k - \delta^k) k_{t-1} + T_t + (1 - s^x) \cdot s_t^n \cdot N_t^P \cdot \kappa^F \right], \end{aligned} \tag{38}$$

where G_t denotes per capita government spending in goods and services expressed in PPI terms (hence the correction for the CPI-to-PPI ratio, $P_t / P_{At} = p_{Bt}^{1-\omega-\psi}$). Government spending in goods and services is in turn the sum of government demand for privately-produced consumption and investment goods and the public sector wage bill (gross of social security contributions). Following standard practice, we assume full home bias in public purchases and public investment, such that their nominal price is equal to the home country PPI, P_{At}. Letting C_t^g and I_t^g denote real per capita public purchases and public investment, respectively, we have the following nominal relationship: $P_{At} G_t = P_{At} \left(C_t^g + I_t^g \right) + (1 + \tau^{sc}) P_t w_t^g N_t^g$. Dividing by P_{At} and using $P_t / P_{At} = p_{Bt}^{1-\omega-\psi}$, we obtain

$$G_t = C_t^g + I_t^g + \left[(1 + \tau^{sc}) w_t^g N_t^g \right] p_{Bt}^{1-\omega-\psi}. \tag{39}$$

Note furthermore that we assume for simplicity that firing costs revert to the government, which is perfectly standard in the literature (see, for example, Thomas and Zanetti, 2009). Given public investment, the stock of public physical capital evolves as follows:

$$k_t^g = (1 - \delta^g) k_{t-1}^g + I_t^g, \tag{40}$$

where we assume that the public capital stock depreciates at rate δ^g.

Given that we treat tax rates as constant (see also footnote 6), the government has one fiscal instrument on the revenue side: lump-sum taxes, T_t. It has five instruments on the expenditures side: public purchases, C_t^g, public investment, I_t^g, public sector wages, w_t^g, public employment, N_t^g, and lump-sum subsidies, Sub_t. In order to guarantee stability, *at least* one instrument must react to the debt-to-GDP ratio (positively for revenue instruments, negatively for expenditure instruments). As the literature shows, it generally suffices to assume a small and inertial responsiveness of the chosen instrument(s) to deviations in the debt ratio. In principle, the government could use all the instruments to stabilize the debt-to-GDP ratio separately or use any mix of the instruments. As we are primarily interested in the "pure" effects of the labor market reforms in the analysis to follow, we assume that the government uses lump-sum taxes as the fiscal instrument to avoid distortions stemming from the fiscal side.[7] Hence, lump-sum taxes adapt according to the following rule:

$$\log\left(\frac{T_t}{\bar{T}}\right) = \rho_T \cdot \log\left(\frac{T_{t-1}}{\bar{T}}\right) + (1-\rho_T)\,\phi_T \cdot \log\left(\frac{b_{t-1}}{\omega^b Y^{tot}_{t-1}} p^{1-\omega-\psi}_{Bt-1}\right) + \epsilon^T_t, \qquad (41)$$

where ϵ^T_t represents a potential iid shock, ρ_T is a smoothing parameter and ϕ_T the fiscal authority's stance of debt deviations from target. All other fiscal instruments, in principle, follow a similar rule. As detailed above, however, in the analysis to follow, we set the corresponding coefficients $\phi_X = 0$ for the remaining instruments, with $X \in \{C^g, I^g, w^g, N^g, Sub\}$. Remember that this can always be changed at the cost of potentially introducing additional distortions.

2.5. The foreign country block, international linkages and union-wide monetary policy

In this section, we will describe some structural relationships corresponding to the foreign country block, point out the international linkages via trade in goods and foreign assets, and describe the union-wide monetary policy rule.

2.5.1. The foreign country

We use asterisks to denote decisions made by foreign agents as well as structural parameters in the foreign country. The latter is modelled analogously to the home country. For this reason, here we discuss only some structural relationships, while the full set of equations corresponding to the foreign country is analogous to the home country.

The consumption basket of foreign households is given by

$$c^{i*}_t = \left(\frac{c^{i*}_{At}}{\omega-\psi^*}\right)^{\omega-\psi^*} \left(\frac{c^{i*}_{Bt}}{1-\omega+\psi^*}\right)^{1-\omega+\psi^*},$$

for $i = o, r$, where c^{i*}_{At} and c^{i*}_{Bt} denote consumption by foreign type-i households of goods produced in country A (home) and B (foreign), respectively, while ψ^* captures the degree of home bias in foreign households' preferences. The foreign country's investment basket is analogously defined. The corresponding consumer price index in the foreign country (which is used as numeraire by households and

[7] Were we to use, for example, labor income taxes instead, we would introduce additional effects stemming from the fact that those taxes distort the economy. To avoid this, and to focus only on the pure effect of the labor market reform, we chose lump-sum taxes as the instrument. A decrease (increase) in lump-sum taxes can be interpreted as additional fiscal leeway (shortage) induced by the labor market reform.

firms in that country) is given by

$$P_t^* = P_{At}^{\omega-\psi^*} P_{Bt}^{1-\omega+\psi^*} = P_{Bt} \left(\frac{1}{p_{Bt}} \right)^{\omega-\psi^*}.$$

Therefore, the foreign country's consumer price inflation evolves according to

$$\pi_t^* \equiv \frac{P_t^*}{P_{t-1}^*} = \pi_{Bt} \left(\frac{p_{Bt-1}}{p_{Bt}} \right)^{\omega-\psi^*},$$

where $\pi_{Bt} \equiv P_{Bt}/P_{Bt-1}$ is producer price inflation in the foreign country. The PPI itself evolves according to

$$\begin{aligned} P_{Bt} &= \left(\int_0^{1-\omega} \frac{1}{1-\omega} P_{Bt}(j)^{1-\epsilon^*} dj \right)^{1/(1-\epsilon^*)} \\ &= \left[\theta_P^* \left(P_{Bt-1} \right)^{1-\epsilon^*} + (1-\theta_P^*) \left(\tilde{P}_{Bt} \right)^{1-\epsilon^*} \right]^{1/(1-\epsilon^*)}, \end{aligned}$$

where $\tilde{P}_{Bt}$ is the common nominal price chosen by the foreign country's price-setters in period t. Also, the nominal interest rate paid/received by the foreign country's nationals on international bonds equals $R_t^{ecb} \exp\left(-\psi_d \left(d_t^* - \bar{d}^*\right)/Y_t^*\right)$, where $(-)\, d_t^*/Y_t^*$ is the foreign country's ratio of net foreign debt over output.

2.5.2. International linkages

As already mentioned, international linkages between the two countries result from trade in goods and services as well as from trading in international bonds. The home country's net foreign asset position, expressed in terms of PPI, evolves according to

$$d_t = \frac{R_{t-1}^{ecb} \cdot e^{-\psi_d (d_{t-1}-\bar{d})/Y_{t-1}}}{\pi_{At}} \cdot d_{t-1} + \underbrace{\frac{1-\omega}{\omega} \left(C_{At}^* + I_{At}^* \right) - p_{Bt} \left(C_{Bt} + I_{Bt} \right)}_{= \text{Trade balance}}, \tag{42}$$

where $(1-\omega)\left(C_{At}^* + I_{At}^*\right)/\omega$ are real per capita exports and $p_{Bt}\left(C_{Bt} + I_{Bt}\right)$ are real per capita imports. Zero net supply of international bonds implies

$$\omega d_t + (1-\omega)\, p_t^B d_t^* = 0. \tag{43}$$

Finally, terms of trade $p_{Bt} = P_{Bt}/P_{At}$ evolve according to

$$p_{Bt} = \frac{\pi_{Bt}}{\pi_{At}} p_{Bt-1}. \tag{44}$$

2.5.3. Equilibrium in goods markets and GDP

Market clearing implies that private per capita production in the home and foreign country, Y_t and Y_t^* respectively, is used for private and public consumption as well as private and public investment demand,

$$Y_t = C_{At} + I_{At} + C_t^g + I_t^g + \frac{1-\omega}{\omega}\left(C_{At}^* + I_{At}^*\right),$$

$$Y_t^* = C_{Bt}^* + I_{Bt}^* + C_t^{g*} + I_t^{g*} + \frac{\omega}{1-\omega}\left(C_{Bt} + I_{Bt}\right).$$

Consistently with national accounting, each country's GDP is the sum of private-sector production and government production of goods and services. The latter is measured at input costs, that is, by the gross government wage bill. Let Y_t^{tot} and $Y_t^{tot,*}$ denote real (PPI-deflated) per capita GDP in the home and foreign country, respectively. We then have

$$Y_t^{tot} = Y_t + (1+\tau_t^{sc})w_t^g N_t^g p_{Bt}^{1-\omega-\psi}, \tag{45}$$

$$Y_t^{tot,*} = Y_t^* + (1+\tau_t^{sc*})w_t^{g*} N_t^{g*} p_{Bt}^{-(\omega-\psi^*)}, \tag{46}$$

where in (46) we have used $P_t^*/P_{Bt} = p_{Bt}^{-(\omega-\psi^*)}$.

2.5.4. Monetary authority

We assume that the area-wide monetary authority has its nominal interest rate, R_t^{ecb}, respond to deviations of area-wide CPI inflation from its long-run target, $\bar{\pi}$, and to area-wide GDP growth, according to a simple Taylor rule,

$$\frac{R_t^{ecb}}{\bar{R}^{ecb}} = \left(\frac{R_{t-1}^{ecb}}{\bar{R}^{ecb}}\right)^{\rho_R} \left\{ \left[\left(\frac{\pi_t}{\bar{\pi}}\right)^{\omega} \left(\frac{\pi_t^*}{\bar{\pi}^*}\right)^{1-\omega} \right]^{\phi_\pi} \left[\left(\frac{Y_t^{tot}}{Y_{t-1}^{tot}}\right)^{\omega} \left(\frac{Y_t^{tot,*}}{Y_{t-1}^{tot,*}}\right)^{1-\omega} \right]^{\phi_y} \right\}^{(1-\rho_R)},$$

where ρ_R is a smoothing parameter, ϕ_π and ϕ_y are the monetary policy's stance on inflation and output growth, respectively. This completes the model description. We now turn to the model calibration.

2.6. Calibration

In calibrating our model, we strongly rely on Stähler and Thomas (2011). This means that the model is calibrated to Spain (country A) and the rest of EMU (country B) at quarterly frequencies. Spain's country size is set to $\omega = 0.10$, which roughly corresponds to Spain's population share in the EMU, while the remaining parameters are calibrated as follows. Some parameters are chosen such that the model's deterministic steady state replicates a number of long-run targets in the data. These long-run targets for Spain and for the rest of EMU are displayed in Table 1. The data comes from the European Commission (*AMECO* and *Public Finance Report – 2010*), Eurostat (*NEW CRONOS*), Spain's *Encuesta de Población Activa* (EPA) and the OECD (see *www.oecd.org/els/social/workincentives*). From this, we set the steady-state shares of different government spending-to-GDP ratios and calculate implicit tax as well as unemployment rates. For the sake of brevity, readers interested in a precise description and derivation are referred to the calibration section in Stähler and Thomas (2011).

Table 1: Targeted values

Target	Symbol	Value
Home country (Spain)		
PPI inflation	$\bar{\pi}_A$	1.0000
Current account	$\bar{d} = -\bar{d}^*$	0.0000
(Average) Labor income tax rate	$\bar{\tau}^w$	0.1622
Bond tax rate	$\bar{\tau}^b$	0.1622
VAT rate	$\bar{\tau}^c$	0.0762
Social security contribution rate	$\bar{\tau}^{sc}$	0.1555
Capital tax rate	$\bar{\tau}^k$	0.1806
Unemployment rate	$\bar{U}$	0.1113
Fraction of publ. employment	$frac pub = \frac{\bar{N}^g}{1-\bar{U}}$	0.1872
Vacancy filling rate (private)	$\bar{q}^p$	0.7000
Vacancy filling rate (public)	$\bar{q}^g$	0.8000
Gov. SS spending	$\omega^G = \bar{G}/\bar{Y}^{tot}$	0.2131
Gov. SS purchases	$\omega^{Cg} = \bar{C}^g/\bar{Y}^{tot}$	0.0756
Gov. SS investment	$\omega^{Ig} = \bar{I}^g/\bar{Y}^{tot}$	0.0355
SS debt-to-annual-GDP ratio	$\omega^b = \bar{p}_B^{1-\omega-\psi}\bar{b}/(4\bar{Y}^{tot})$	0.4831
SS subsidy-to-GDP ratio	$\omega^s = \bar{p}_B^{1-\omega-\psi}\bar{Sub}/\bar{Y}^{tot}$	0.1543
Foreign country (rest of EMU)		
(Average) Labor income tax rate	$\bar{\tau}^{w*}$	0.2225
Bond tax rate	$\bar{\tau}^{b*}$	0.1267
VAT rate	$\bar{\tau}^{c*}$	0.0995
Social security contribution rate	$\bar{\tau}^{sc*}$	0.1706
Capital tax rate	$\bar{\tau}^{k*}$	0.0704
Unemployment rate	$\bar{U}^*$	0.0844
Fraction of publ. employment	$frac pub^* = \frac{\bar{N}^{g*}}{1-\bar{U}^*}$	0.1814
Vacancy filling rate (private)	$\bar{q}^{p*}$	0.7000
Vacancy filling rate (public)	$\bar{q}^{g*}$	0.8000
Gov. SS spending	$\omega^{G*} = \bar{G}^*/\bar{Y}^{tot*}$	0.2256
Gov. SS purchases	$\omega^{Cg*} = \bar{C}^{g*}/\bar{Y}^{tot*}$	0.0985
Gov. SS investment	$\omega^{Ig*} = \bar{I}^{g*}/\bar{Y}^{tot*}$	0.0238
SS debt-to-GDP ratio (annualized)	$\omega^{b*} = \left(\bar{p}_B^*\right)^{-(\omega-\psi^*)}\bar{b}^*/(4\bar{Y}^{tot*})$	0.6896
SS subsidy-to-GDP ratio	$\omega^{s*} = \left(\bar{p}_B^*\right)^{-(\omega-\psi^*)}\bar{Sub}^*/\bar{Y}^{tot*}$	0.2126

Sources: Original data from European Commission, Eurostat and OECD, own calculations for the ratios and implicit tax rates; normalization as described in Stähler and Thomas (2011).

The rest of the parameters are set according to microeconomic evidence as well as following the literature. A summary of all structural parameters can be found in Table 2. Again, this closely follows Stähler and Thomas (2011) and the reader is referred to there for further details. Unless explicitly stated otherwise, we assume a symmetric calibration between the home and foreign country.

Given the extension of the model, i.e. the inclusion of endogenous job destruction, we have to change calibration partly to still meet the targets we are aiming at. However, this only applies to few parameters that have to be calculated "endogenously" in order to meet the targets. Those parameters set according to microeconomic evidence and literature remain as in Stähler and Thomas (2011). The necessary changes are described in more detail in the following. Regarding the log-normal distribution of idiosyncratic productivity, $\log(h_t) \sim N(\mu_h, \sigma_h)$, we follow Costain et al. (2010) and Thomas and Zanetti (2009), who calibrate their models to Spain and the euro area, respectively. This implies that we set $\mu_h = \mu_h^* = 0$, implying $E_t(h_t) = 1$, and $\sigma_h = \sigma_h^* = 0.25$.[8] We stick to the assumption that total steady-state dismissal probability in the private sector is $\bar{s}^p = 0.06$, while the probability in the public sector is half of that in the private sector, $s^g = 1/2 \cdot \bar{s}^p = 0.03$. In the present setup with endogenous job destruction, we now have to determine the exogenous dismissal probability in the private sector, too. Given the interpretation that this may refer to the retirement decision, we set $s^x = s^g = 0.03$. With this, we are able to calculate the endogenous private-sector dismissal probability as $\bar{s}^n = (\bar{s}^p - s^x)/(1 - s^x) = F(\bar{\bar{h}})$, from which we are able to derive the corresponding productivity threshold for firms, i.e. $\bar{\bar{h}} = F^{-1}(\cdot)$ in the steady state. For the firing costs, we assume that they amount to 30% of the quarterly average real wage in Spain, i.e. $\kappa^F = 0.3 \cdot \bar{w}^p$, and to 20% in the rest of EMU, i.e. $\kappa^{F,*} = 0.2 \cdot \bar{w}^{p,*}$ (see Thomas and Zanetti, 2009, for discussion). As in Stähler and Thomas (2011), the values for private-sector and public-sector matching efficiency κ_e^p and κ_e^g and private-sector vacancy posting costs κ_v^p as well as the corresponding foreign country counterparts, have to be derived "endogenously" to meet the targets. Here, we have to derive unemployment benefits κ^B from the steady-sate JD equation in order to meet the endogenous dismissal rate, too. All these "endogenously derived" parameter values differ somewhat from those in Stähler and Thomas (2011), but not significantly. Despite the changes, we are still able to analytically solve for the model's deterministic steady state.

[8]Given the lack of micro evidence on this latter parameter, we additionally conduct robustness analyses by considering four different values of σ_h: 0.20, 0.30, 0.40 and 0.50. The results we derive are not changed qualitatively.

Table 2: Baseline parameter calibration

Parameter	Symbol	Value
Relative size of home country	ω	0.1
Monetary policy		
Interest rate smoothing	ρ_R	0.9
Stance on inflation	ϕ_π	1.5
Stance on output gap	ϕ_y	0.5
Fiscal policy		
Lump-sum tax smoothing	$\rho_T = \rho_T^*$	0
Stance on debt (lump-sum tax)	$\phi_T = \phi_T^*$	0.9
Price stickiness		
Calvo parameter (prices)	θ_P	0.75
Market power (markup)	ϵ	6
Trade in internat. bonds		
Risk premium parameter	$\psi_2 = \psi_2^*$	0.01
Preferences		
Share of RoT consumers	μ	0.4
Discount rate	β	0.99
Risk aversion	σ_c	2
Habits in consumption	h	0.85
Home bias	$\psi; \psi^*$	0.56; 0.03
Production		
Private-sector capital depreciation	δ^k	0.025
Public-sector capital depreciation	δ^g	0.025
Private-sector capital share in prod.	α	0.4
Public-sector capital influence in prod.	η	0.015
Adjustment cost parameter	κ_I	2.48
TFP scaling parameter	$\epsilon^a; \epsilon^{a*}$	0.42; 0.44
Labor market		
Matching elasticity (private sector)	φ^p	0.5
Matching elasticity (public sector)	φ^g	0.3
Separation rate (public sector)	s^g	0.03
Ex separation rate (private sector)	s^x	0.03
Bargaining power	ξ	0.5
Private-sector matching efficiency	$\kappa_e^p; \kappa_e^{p*}$	0.44; 0.48
Public-sector sector matching efficiency	$\kappa_e^g; \kappa_e^{g*}$	0.30; 0.32
Vacancy posting costs	$\kappa_v; \kappa_v^*$	0.15; 0.12
Unemployment benefits	$\kappa_B; \kappa_B^*$	0.45; 0.28
Dismissal costs	$\kappa^F; \kappa^{F,*}$	0.21; 0.10
Idiosyncratic productivity shock		
Mean	$\mu_h \Rightarrow E\{h_t\} = 1$	0
Standard deviation	σ_h	0.25

Notes: The fiscal instrument used is lump-sum taxes (hence, fiscal policy's stance on debt deviations, ϕ_X, are set to zero for all other fiscal instruments) and home and foreign country parameters are equal (unless indicated otherwise).

3. Analysis

In this section, we first describe the simulation design and then discuss the short and long-run results, respectively. Here, it seems worthwhile noting that our calibration reproduces a downward-sloping Beveridge curve and also a negative correlation between job creation and job destruction to standard shocks.[9] Hence, the results we discuss below do not result from the fact that, sometimes, DSGE models with frictional labor markets and endogenous job destruction fail to reproduce these features (see, for example, Fujita and Ramey, 2005, for a more detailed discussion of this issue).

3.1. Simulation design

As discussed in the introduction, the Spanish government announced or implemented measures to reform the labor market in order, first, to foster wage moderation and, second, to make the labor market more flexible. All the measures are supposed to help regain international competitiveness. More precisely, the Spanish government already decreased public wages and employment, which yields a reduction in the workers' outside option in private wage negotiations. Another – from our model perspective somewhat analogous – measure to achieve this is a cut in unemployment benefits. The government announced it will reform the bargaining system and cut dismissal costs in its recent *Stability Programme 2011* as well as the *National Reform Programme 2011*.

In our model, we implement these measures as follows. In line with Zanetti (2011), we assume a permanent *ex-ante* five-percentage points decrease in firing costs (from 30% of average real wages to 25%) and in the replacement ratio (i.e. unemployment benefits form about 67.9% to 62.9% of average real wages). We also simulate a permanent *ex-ante* five-percentage point reduction in the union's bargaining power (from 50% to 45%). It is important to note that these changes imply changes in many economic variables such that, from the *ex-post* perspective (i.e. in the new steady state), firing costs, for example, may be higher or lower than 25% of average real wages because the latter may have changed. Regarding the cut in public-sector wages, we refer the reader to Stähler and Thomas (2011) for a more detailed discussion of the effects at work to save space and because the effects are perfectly analogous to a model without exogenous job destruction.[10] We also

[9]Including shock processes broadly in line with those estimated by Andrés et al. (2010), we find the correlation between vacancies and unemployment to be $\rho(v_t^p, U_t) = -0.48$ on the aggregate level. For the dismissal threshold and vacancy posting, the correlation is $\rho(p_t^p, \tilde{h}_t) = -0.99$. These values are also similar to those reported in Thomas and Zanetti (2009).

[10]Except some slight variations in the GDP movements resulting from the definition of GDP, which includes the public sector wage bill in our model, the effects are also analogous to a cut in unem-

discuss a 5% decrease in public employment in the present paper.

As structural changes in labor market parameters imply changes in many other economic variables on the transition to the new steady state, and in the new steady state itself, public balances also change. For example, if labor market reforms yield an increase of domestic consumption, consumption tax revenues increase, implying that debt can be decreased. A lower level of debt means lower interest payments on outstanding debt, so the government may have additional leeway to further cut taxes or increase expenditures. Should the labor market reform deteriorate public finances, the opposite is true, of course. In order to guarantee stability of the system without introducing additional distortions, we assume that the government uses lump-sum taxes to take care of these effects. We already discussed the issue in section 2.4. In the next subsection, we analyze the effects of the above mentioned labor market reforms in more detail.

3.2. Simulation results

We start off by analyzing the short-run effects of the measures discussed above. Here, we plot the dynamic responses for the first twenty quarters after the measure has been conducted. At the end of this subsection, we discuss the long-run implications of the labor market reforms and have a look at the spillovers to the rest of EMU.

3.2.1. Dynamic effects

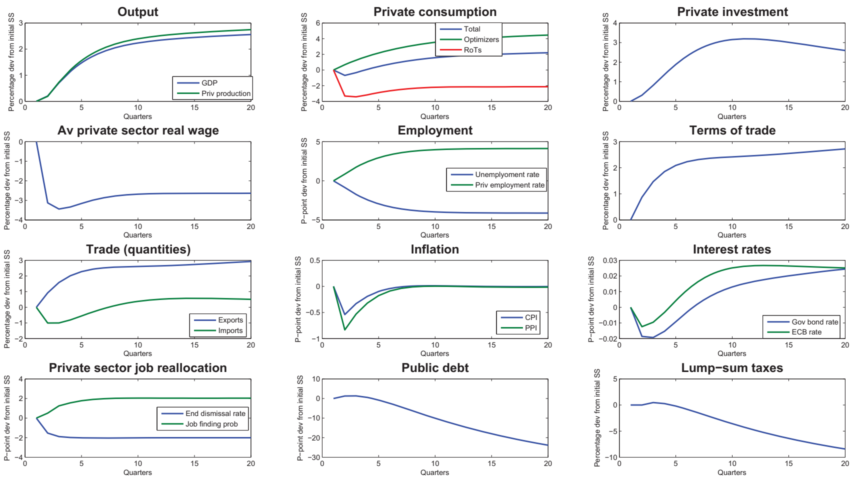
To get started, it seems appropriate to first have a look at the most intuitive reform, the cut in unemployment benefits. Figure 1 plots the dynamic responses for selected variables. A cut in unemployment benefits deteriorates the workers' outside option such that the union is willing to accept lower wages in the bargaining process. Lower wages imply that job destruction – shown as the endogenous dismissal rate in the lowest-left panel of Figure 1 – falls. The reason is that because of lower labor costs, maintaining a worker becomes more attractive for firms such that the dismissal productivity threshold, $\tilde{h}_t$, decreases (see also the JD, equation (36)). This, in turn, means that the expected value of a newly created job increases (see the JC, equation (35)) because the expected duration of keeping the job active and, thus, receiving benefits from it rises. Hence, firms create more vacancies, which is reflected by an increase in the job finding probability for workers. Less job destruction and higher job creation generate more employment and unemployment falls. Lower labor costs allow firms to reduce prices, which improves the terms of trade,

ployment benefits. We show the latter simulation in this paper. To prove our claim, we provide the corresponding graphs of the wage simulation in the Appendix.

fosters demand for Spanish goods in the rest of EMU and, thus, increases exports. We also see that total internal demand increases. The reason for this is that fiscal balances benefit from a cut in unemployment compensation and unemployment levels, which allows the government to reduce debt and, eventually, lump-sum taxes. This positive wealth effect makes optimizing households consume more. RoT-consumers, however, consume less. This is because the drop in wages cannot be compensated for by the increase in the employment level. Nevertheless, optimizers eventually dominate the private consumption pattern. The additional private demand is produced by more employment (as explained above) but also by more capital input, which generates a rise in investment demand, too. Imports initially fall because Spanish goods become relatively cheaper. Higher internal demand, however, eventually pushes real imports up. Because Spain is relatively small, the price changes in Spain lead to only modest reactions of the ECB rate as well as the interest rate on domestic bonds. The higher product demand is satisfied by higher output and GDP.[11] A cut in public wages yields similar effects. The only difference is that, now, the workers' outside option is diminished by the fact that, when finding a public-sector job, its remuneration is lower, yielding to a difference in magnitude (see Stähler and Thomas, 2011, and the Appendix for details).

[11] In a heterogeneous agent model, Krause and Uhlig (2011) present an analysis for Germany's so-called *Hartz IV* reforms which includes a decrease in entitlement duration. In our model, a decrease in entitlement duration is approximated by a decrease in unemployment benefits (as the effects on the workers' fall-back position are similar; see also Moyen and Stähler, 2009). Krause and Uhlig (2011) find that the drop in unemployment is to a large extent driven by the evolution of (more) highly skilled jobs, whereas we cannot differentiate between workers' types in our model. Nevertheless, different effects on different groups within the labor market as well as potential redistributive issues should definitely be taken into account when discussing labor market reforms, too.

Figure 1: Permanent reduction in unemployment benefits



Notes: Transition dynamics of selected home country variables following a permanent reduction in unemployment benefits. The figure shows percentage deviations from initial steady state (percentage point deviations where indicated).

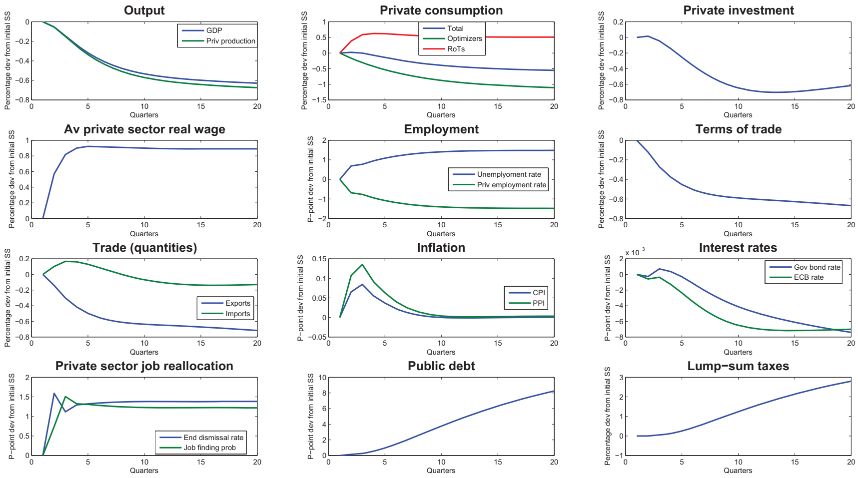
Turning to a decrease in firing costs – another more or less standard issue in labor market analyses (see, for example, Mortensen and Pissarides, 1999, 2003, or Stähler, 2007, chapter 3, for an overview of the literature) – Figure 2 reveals some interesting, and up to a point, surprising effects. From the JD, equation (36), we see that a reduction in firing costs has the opposite effect on job destruction (i.e. the endogenous dismissal probability) to a cut in unemployment benefits. Because dismissals become cheaper, firms are more inclined to lay off a worker and, thus, the reservation threshold $\tilde{h}_t$ increases. A higher reservation threshold implies that the expected benefit a firm receives from employing a new worker falls *ceteris paribus*. Nevertheless, the expected costs of getting rid of this worker also decrease. Because the latter effect always dominates, job creation rises. Formally, this can be seen in the JC, equation (35). Those are standard effects in the literature, leaving the effects on unemployment ambiguous from a purely theoretical perspective. Our simulation suggests that unemployment increases, which is quite robust to alternative parameterizations of the model. The reasons primarily lie in the wage increase as well as in the fall in aggregate production.

Regarding the evolution of wages, we have to differentiate between those wages for newly created jobs and those of continuing workers; see equations (34). Because of lower expected duration of employment (thus, intuitively, lower job security), workers newly hired demand higher wages once firing costs are decreased. In contrast, workers in continuing jobs demand lower wages because they take into account that, were they to demand higher wages, firms would dismiss them even earlier. Because the proportion of new jobs, $(1 - \omega_t^c)$, is fairly small compared to that of continuing jobs (see also Zanetti, 2011), the impact effect of reducing firing costs should lead to a decrease in wages *ceteris paribus*. For the average wage, which we plot in the figures, this is overcompensated for by the increase in the dismissal threshold, $\tilde{h}_t$, which we discussed earlier, and which leads, everything else being equal, to rising average wages due to the fact that average productivity, $\bar{h}_t$, has increased (see also equation (37)). Rising average labor costs induce firms to raise prices, worsening the terms of trade and deteriorating exports. Imports rise on impact because foreign goods become relatively cheaper, but fall along the decline in general private consumption and investment demand. Lower private consumption and higher unemployment deteriorate fiscal balances, implying an increase in debt and lump-sum taxes, which generates a negative wealth effect. Hence, optimizers reduce consumption. RoTs increase their consumption because, on the RoT-family level, higher wages overcompensate the employment loss. Optimizers eventually dominate the consumption demand in the economy, yielding less domestic demand and a drop in output, which also reduces investment demand because of, in the end, less capital input. Interest rates barely move due to Spain's small size within EMU.

Our analysis shows that, with regard to international competitiveness, a decrease in dismissal costs does not seem to be the right choice, as it even harms international competitiveness and fiscal balances due to the effects just described. At first glance, this may seem surprising, as a more flexible labor market is generally assumed to go hand-in-hand with higher production and international competitiveness. Note, however, that this result does fit into the literature as "*on the whole, there is no strong evidence suggesting that reducing EPL* (employment protection legislation) *would lessen or prevent excessive imbalances in the EU*" (see IMF, 2011, p. 87 and the literature discussed therein). Furthermore, two more theoretical remarks also seem in order. First, as has been shown in Stähler (2008), when talking about the effects of employment protection on unemployment in matching labor market frameworks, the bargaining structure itself matters. In the model at hand, we more or less follow the conventional approach. It is not unlikely, however, that altering the bargaining game between unions and firms would alter our findings. For example, in the model by Stähler (2008), employment protection is indeed responsible for higher wage claims and higher unemployment rates. Second, Spain is characterized by a highly dual labor market consisting of (potentially less productive) insiders who enjoy a high degree of employment protection, and outsiders who have barely none. Breaking this dual labor market structure and decreasing the average level of employment protection – but augmenting it for some – may be a way to go. For an analysis in this direction, see Costain et al. (2010).

Summing up, we learn from our analysis that decreasing employment protection to foster international competitiveness may not work – at least not as easily as is often claimed in policy reports which frequently state this to be an option without further detailing the issue. Further research on this topic in general equilibrium models is certainly in order.

Figure 2: Permanent reduction in firing costs

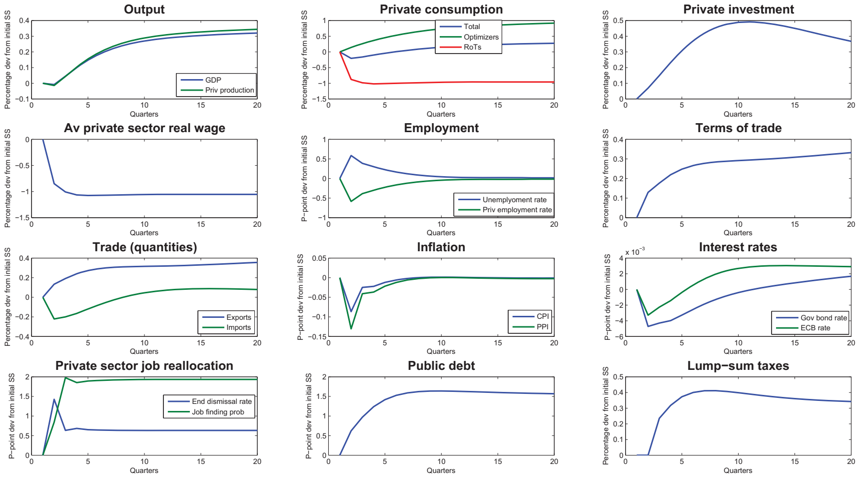


Notes: Transition dynamics of selected home country variables following a permanent reduction in firing costs. The figure shows percentage deviations from initial steady state (percentage point deviations where indicated).

In Figure 3, we plot the evolution of selected variables resulting from a decrease in bargaining power. As one would expect, average real wages decline, setting in train some of the mechanisms already described earlier. More precisely, the wage cut allows firms to reduce prices, which makes Spanish products relatively cheaper, fosters exports and improves the terms of trade. In the long run (see Table 3), this implies an increase in production, which yields higher capital and slightly higher labor input. Thus, unemployment falls. Imports decrease on impact, but start rising with the increase in total private consumption. Again, interest rates barely move.

With regard to the labor market and, especially, at the firms' decisions, we notice that this merits some additional explanation. Job creation increases, which we can attribute to the fact that a decrease in the unions' bargaining power makes hiring a new worker more attractive (as the share of the joint match surplus received by the firm increases; see also equation (35)). Somewhat surprisingly, however, we see that job destruction increases, too. The (fairly strong) increase in the dismissal probability, on impact, implies that unemployment increases because the additional dismissals cannot be overcompensated for by the increase in job cre-

Figure 3: Permanent reduction in union's bargaining power



Notes: Transition dynamics of selected home country variables following a permanent reduction in union's bargaining power. The figure shows percentage deviations from initial steady state (percentage point deviations where indicated).

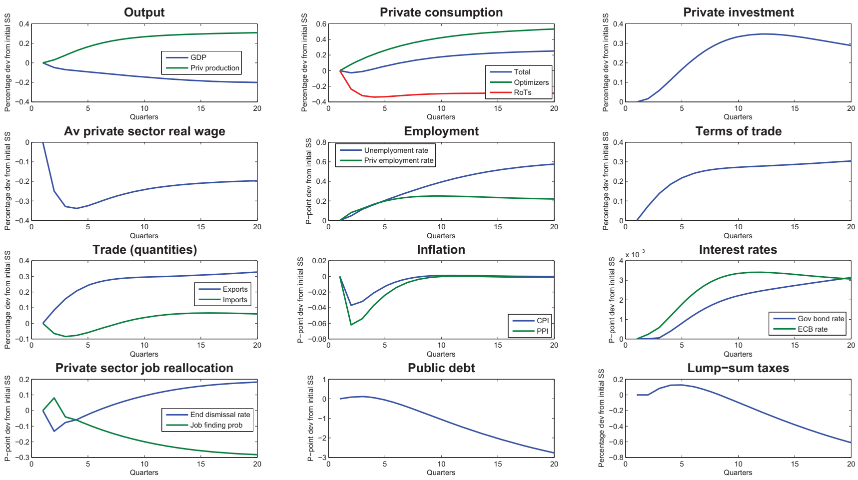
ation. Then, it eventually starts falling as the dismissal probability falls to a lower level. Intuitively, what happens is the following (in the Appendix, we present a simplified model formally clarifying the argument). When the bargaining power of unions is decreased, firms have to decide how to adapt their dismissal decision, i.e. whether to increase or decrease the dismissal productivity threshold $\tilde{h}_t$. Whenever the expected value of dismissing the worker, searching for a new one and bearing the associated search costs is higher than the expected value of keeping the worker, the firm will increase the dismissal threshold. Otherwise, it will prefer to keep the worker longer (on average) and, thus, decrease the threshold. In our model, the former effect dominates, and it is quite robust to alternative parameterizations. In the Appendix, we show that whenever the firms' share of a match surplus is high enough and search costs do not increase too much, firms will always prefer to dismiss the worker and look for a new one. This is because firms can gain from dismissing a relatively unproductive worker and hiring a more productive new one at comparably low cost. The mechanism relates to the condition of Hosios (1990). It states that an efficient labor market outcome can only be achieved when the bargaining power of workers equals the matching elasticity parameter; see also Pissarides (2000). Because of unemployment benefits, taxes and public sector employment in the model at hand (thus, a higher fall-back utility of workers), this condition is tilted towards a lower (or very low) level of bargaining power here. Hence, we find in our model that a decrease in the unions' bargaining power indeed fosters competitiveness, production and employment. It comes, however, at the cost of higher job turnover implied by more dismissals and more job creation.

Figure 4 summarizes the dynamic effects of a cut in public employment. Note that the cut is, in contrast to the other reforms, gradual.[12] However, this does not affect the long-run results at all, and the short-run effects do not change qualitatively (see Stähler and Thomas, 2011, too). We see that, while the effects on private production, private consumption, wages, prices, the terms of trade and fiscal balances are – except in size – analogous to those of a reduction in unemployment benefits or public wages, there are notable differences in the dynamics of GDP, employment and the firms' hiring and firing decisions. This is the case mainly for two reasons. First, the effect on GDP is due to the definition of real GDP itself, namely the sum of private production and government production (measured as the public sector wage bill). The latter falls when dismissing public-sector workers. Nevertheless, this is in fact only a matter of definition because public-sector production is measured by its inputs according to national accounting (see Stähler and Thomas, 2011, for a more detailed discussion). Second, and probably more interesting, are the dynamics of the labor market and the resulting multiplier-diminishing effects. When cutting public-sector employment, the probability of finding a public-sector job decreases, which yields a drop in the workers' average wage claims. On impact, this increases the probability of unemployed workers finding a job in the private sector because lower wages foster the incentive for private job creation. Nevertheless, higher private job creation does not compensate for the lower public-sector labor demand and, thus, the private-sector job finding probability eventually falls. To some extent, the decrease in public-sector employment can be interpreted as an "unemployment shock" increasing the number of unemployed workers in the economy. We see this by the simultaneous increase of the unemployment rate *and* the private-sector employment rate in Figure 4. Furthermore – and in addition to a model with only exogenous (private) job destruction as in Stähler and Thomas (2011) – we see that private-sector job destruction increases (after a short drop on impact). The reason for this is very similar to what happens when the union's bargaining power decreases. Because of the "unemployment shock", it now pays for firms to dismiss a relatively unproductive worker, pay the search costs and hire a new, more productive, one as average search duration (from the firms' perspective) has fallen to a sufficient extent for such a behavior to pay off. Given the differences

[12]Given our assumption of exogenous separations in the public sector, which is arguably the most realistic one in the case of the government sector, it is physically impossible to implement such a reduction immediately. To see this, consider the law of motion of government employment, $N_t^g = (1 - s^g)N_{t-1}^g + p_t^g \tilde{U}_t$. The largest possible percentage reduction in employment, which happens when gross hirings $p_t^g \tilde{U}_t$ drop to zero, is given by s^g, which equals 3% under our calibration. Therefore, even under an extreme policy of complete hiring freeze, the required employment reduction would still have to be implemented gradually.

in the effects on the labor market – especially, the "unemployment shock" –, it is no longer surprising that the effects on the other variables (such as private production, prices, consumptions, and the terms of trade) turn out to be much smaller than when cutting unemployment benefits or public-sector wages.

Figure 4: Permanent reduction in public employment



Notes: Transition dynamics of selected home country variables following a permanent reduction in public employment. The figure shows percentage deviations from initial steady state (percentage point deviations where indicated).

3.2.2. Long-run effects

In Table 3, we present the steady-sate effects of the labor market reforms discussed in the previous subsection on selected home-country variables, while Table 4 shows the long-run spillovers of these reforms to the rest of EMU. The tables present percentage deviations from the initial steady state (percentage point deviations as indicated). The long-run effects are the result of both the permanent labor market reform and the long-run impact on lump-sum taxes. As lump-sum taxes introduce no further distortions in the system, they can be interpreted as the fiscal leeway (if negative) or the fiscal shortage (if positive) resulting from the reform. We discussed this issue above.

Comparing the long-run results in Table 3, we find that measures aiming at reducing the workers' (policy-induced) outside option such as the decrease in unemployment benefits κ^B and public wages $\bar{w}^g$ is most beneficial for improving output, employment and the terms of trade. Aggregate internal and external demand rises. It also generates, by far, the largest leeway for fiscal balances. The reason is that, by reducing the workers' (policy-induced) outside option, wage claims fall and Spanish goods become relatively cheaper. At the same time, fiscal balances

Table 3: Long-run results of different labor market reforms on Spanish economy

Reduction in Effect on	κ^B	κ^F	ξ	$\bar{w}^g$	$\bar{N}^g$
Real GDP	3.28	-0.89	0.41	2.53	-0.11
Real private-sector output	3.53	-0.96	0.44	3.27	0.42
Real priv cons (total)	3.06	-0.84	0.38	2.84	0.36
Real priv cons (optimizers)	5.62	-1.52	1.07	5.01	0.70
Real priv cons (RoTs)	-1.85	0.45	-0.94	-1.33	-0.27
Real private investment	2.40	-0.66	0.30	2.23	0.29
Unemployment	-4.45	1.65	-0.04	-4.12	0.56
End dismissal rate	-2.13	1.46	0.61	-1.98	0.17
Job finding prob	2.43	1.13	1.97	2.14	-0.27
Av private real wage	-2.41	0.87	-1.04	-2.23	-0.18
Terms of trade	3.28	-0.89	0.40	3.04	0.39
Lump-sum taxes	-15.69	5.41	0.06	-15.86	-1.60

Notes: The table shows percentage deviations from initial steady state (percentage point deviations for unemployment rates as well as dismissal and job finding probabilities).

benefit from reducing expenditures, which gives room to additionally reduce taxation because of lower steady-state debt levels further boosting demand. However, it is also evident that RoT-households do not benefit from these measures because the wage drop dominates the rise in employment such that their steady-state consumption possibilities deteriorate while optimizers benefit from the positive wealth effect. The argument also holds for a decrease in public employment, however, to a lesser extent and not for unemployment. This is due, first, to the definition of GDP and, second, to the "unemployment shock"; both are described in the previous section.

Decreasing dismissal costs κ^F does not improve the labor market situation, as the increase in the dismissal probability dominates the rise in job creation. Neither does it increase output nor the terms of trade. The reason is, as we have already described in the previous section, that workers on average demand higher wages, which increases labor costs and makes firms raise prices. Therefore, terms of trade deteriorate. Reforming the employment protection legislation may not be the most suitable measure when planning to improve international competitiveness. However, to draw some important policy conclusions, discussing employment protection legislation reforms most likely deserves a more sophisticated labor market modelling than the one we have offered in the model at hand (see, for example, Stähler, 2007, for an overview of the literature on employment protection and some applications of the matching model).

Reforming the bargaining system by decreasing the unions' bargaining power seems to generate more beneficial results regarding output, employment and the terms of trade. They are, however, much smaller than those of a reduction in the workers' (policy-induced) outside option through a cut in unemployment benefits or public wages and, thus, also generate much less fiscal leeway. It should also be stressed that, even though unemployment slightly decreases through this measure, this comes at the cost of more frequent dismissals and higher labor turnover, which we see by the long-run increase in the endogenous dismissal rate.

Table 4: Long-run spillovers of different labor market reforms on rest of EMU

Reduction in Effect on	κ^B	κ^F	ξ	$\bar{w}^g$	$\bar{N}^g$
Real GDP	0.54	-0.15	0.07	0.50	0.07
Real private-sector output	0.63	-0.17	0.08	0.58	0.08
Real priv cons (total)	0.99	-0.28	0.13	0.92	0.12
Real priv cons (optimizers)	1.17	-0.33	0.15	1.08	0.14
Real priv cons (RoTs)	0.43	-0.11	0.05	0.39	0.05
Real private investment	0.85	-0.24	0.11	0.79	0.11
Unemployment	-0.53	0.15	-0.07	-0.49	-0.07
End dismissal rate	-0.29	0.08	-0.04	-0.27	-0.04
Job finding prob	0.44	-0.12	0.06	0.40	0.05
Av private real wage	0.29	-0.08	0.03	0.27	0.04
Lump-sum taxes	-1.49	0.42	-0.19	-1.39	-0.18

Notes: The table shows percentage deviations from initial steady state (percentage point deviations for unemployment rates as well as dismissal and job finding probabilities).

In Table 4, we report the effects the measures conducted in Spain have on the rest of EMU. There are at least three findings worth pointing out. First, whenever the measure is beneficial for Spain, it is so for the rest of EMU, too. At first sight, this may be surprising because one might guess that an increase in Spain's international competitiveness resulting from these labor market reforms may harm other member countries. However, the resulting additional demand for foreign goods in Spain overcompensates for the loss in competitiveness faced by the rest of EMU countries vis-à-vis Spain, at least on an aggregate level.[13] Second, all measures beneficial for Spain improve the labor market situation in the rest of EMU. The reason is that the additional demand for foreign goods in Spain is produced by more labor input there, too. Given the improvement in the labor market, yielding (slightly) higher wages, too, we note that, third, liquidity-constrained RoT-consumers do not lose from the reforms in Spain – in contrast to the situation in the reforming country itself.

[13]Note that, as we model the rest of EMU as *one* block in the model at hand, it may still be possible that some individual countries lose from the reforms conducted in Spain in practice. Nevertheless, our simulation suggests that, overall, the rest of EMU will benefit.

4. Conclusions

In this paper, we have used an extended version of "*FiMod – A DSGE Model for Fiscal Policy Simulations*" (Stähler and Thomas, 2011) with endogenous job destruction decisions by private firms to analyze the effects of permanent cuts in unemployment benefits, public-sector employment and wages, employment protection and the unions' bargaining power on output, employment, international competitiveness and fiscal balances inspired by the current discussion on labor market reforms in Spain. *FiMod* is a medium-scale two-country monetary union DSGE model with quite a comprehensive fiscal block. Furthermore, it includes the modern theory of unemployment by assuming a frictional labor market.

We find that measures decreasing the policy-induced outside option of workers, such as a cut in unemployment benefits or public wages, seems to be the most effective way to increase output, employment and international competitiveness while, at the same time, improving fiscal balances. The reason is that the effect on the reservation wage feeds through to private-sector wage bargaining almost immediately, while, at the same time, fiscal balances are also directly affected. The same argument holds for cuts in public-sector employment, albeit at a lower level, because the increase in private labor demand cannot compensate for the loss in public-sector employment. Cuts in the unions' bargaining power also achieve the goal of improving competitiveness, output and employment, however, at a lower level and at the cost of higher job turnover. The latter results from the fact that a cut in the unions' bargaining power increases the surplus of a newly created match attributed to the firm. This can increase the incentive for firms to dismiss relatively unproductive workers more frequently and look for more productive ones in the labor market if search duration is sufficiently low. A cut in employment protection does not seem to be an adequate measure to regain international competitiveness. Lower employment protection yields less job security, which may induce workers to demand even higher wages, thereby deteriorating international competitiveness rather than improving it.

Appendix

A. Firms' response to a change in workers' bargaining power

In order to formally assess the argument that, and under which conditions, firms may decide rather to lay off a worker whenever the bargaining power of workers is decreased, let us have a look at a simplified version of the labor market part of the model neglecting public sector employment, firing costs and unemployment benefits for simplicity. Also for simplicity, we restrict our formal analysis to the steady-state. Deriving the job creation and job destruction conditions in perfect analogy to what we did in the main text, we get (see also Zanetti, 2011)

$$(1-\xi)\bar{x}\left(h^{new}-\bar{\tilde{h}}\right)=\frac{\kappa^{v}}{\bar{q}(\bar{\theta})} \tag{47}$$

as the JC, and

$$\bar{x}\bar{\tilde{h}}+\beta(1-s^{x})\bar{x}\int_{\bar{\tilde{h}}}^{\infty}(h-\bar{\tilde{h}})dF(h)=\frac{\xi}{1-\xi}\kappa^{v}\cdot\bar{\theta} \tag{48}$$

as the JD, where we have defined market tightness $\bar{\theta}=\bar{v}^{p}/\bar{\tilde{U}}$ as is common in the literature. Note that $\bar{p}^{p}/\bar{q}^{p}=\frac{\bar{M}^{p}/\bar{\tilde{U}}}{\bar{M}^{p}/\bar{v}^{p}}$ and $\bar{q}(\bar{\theta})=\bar{M}^{p}/\bar{v}^{p}$. Totally differentiating equations (47) and (48) yields

$$-(1-\xi)\bar{x}\cdot d\bar{\tilde{h}}+\frac{\kappa^{v}\cdot\bar{q}'(\bar{\theta})}{\bar{q}(\bar{\theta})^{2}}\cdot d\bar{\theta}=\bar{x}\left(h^{new}-\bar{\tilde{h}}\right)\cdot d\xi,$$

where $\bar{q}'(\bar{\theta})<0$, and

$$\bar{x}\left[1-\beta(1-s^{x})F(\bar{\tilde{h}})\right]\cdot d\bar{\tilde{h}}-\frac{\xi}{1-\xi}\kappa^{v}\cdot d\bar{\theta}=\frac{1}{(1-\xi)^{2}}\kappa^{v}\cdot d\xi.$$

Rearranging and solving for $d\bar{\tilde{h}}/d\xi$ as well as $d\bar{\theta}/d\xi$ yields

$$\frac{d\bar{\tilde{h}}}{d\xi}=\frac{1}{DD}\left\{\frac{(\kappa^{v})^{2}\bar{q}'(\bar{\theta})\bar{\theta}}{\bar{q}(\bar{\theta})^{2}(1-\xi)^{2}}+\frac{\xi\kappa^{v}\bar{x}\left(h^{new}-\bar{\tilde{h}}\right)}{1-\xi}\right\} \tag{49}$$

and

$$\frac{d\bar{\theta}}{d\xi}=\frac{1}{DD}\left\{\bar{x}\frac{\kappa^{v}\bar{\theta}}{(1-\xi)}+\bar{x}^{2}\left[1-\beta(1-s^{x})F(\bar{\tilde{h}})\right]\left(h^{new}-\bar{\tilde{h}}\right)\right\}<0, \tag{50}$$

where

$$DD=\bar{x}\left[1-\beta(1-s^{x})F(\bar{\tilde{h}})\right]\cdot\frac{\kappa^{v}\cdot\bar{q}'(\bar{\theta})}{\bar{q}(\bar{\theta})^{2}}-(1-\xi)\bar{x}\cdot\frac{\xi}{1-\xi}\kappa^{v}<0.$$

From equation (50), we see that market tightness clearly reacts negatively (positively) to an increase (decrease) in workers' bargaining power. As market tightness determines how many vacancies are created, this implies that the incentive for job creation increases (decreases) when the bargaining power falls (rises). Intuitively, this can mainly be attributed to the fact that an increase (decrease) in the union's bargaining power decreases (increases) the share of the surplus firms obtain from a newly created match.

For the dismissal decision, we see in equation (49) that there are two opposing effects at work. Rearranging the term in brackets of equation (49), we see that $\frac{d\bar{\bar{h}}}{d\xi}\begin{pmatrix} > \\ = \\ < \end{pmatrix} 0$ if (remember that $DD < 0$)

$$\xi \cdot \underbrace{(1-\xi)\bar{x}\left(h^{new} - \bar{\bar{h}}\right)}_{=\kappa^v/\bar{q}(\bar{\theta})} \begin{pmatrix} < \\ = \\ > \end{pmatrix} - \frac{\kappa^v}{\bar{q}(\bar{\theta})} \cdot \frac{\bar{q}'(\bar{\theta})\bar{\theta}}{\bar{q}(\bar{\theta})}$$

$$\Leftrightarrow \xi \begin{pmatrix} < \\ = \\ > \end{pmatrix} \varphi^p, \tag{51}$$

where we have made use of the fact that $-\frac{\bar{q}'(\bar{\theta})\bar{\theta}}{\bar{q}(\bar{\theta})} = \varphi^p$ for our (Cobb-Douglas) specification of the matching function. Condition (51) states that whenever the union's bargaining power falls short of the elasticity of the matching function, $\xi < \varphi^p$, an increase in the bargaining power increases the dismissal threshold. The opposite is true for $\xi > \varphi^p$.

To understand this condition, let us step back for a moment and remind ourselves of the condition of Hosios (1990). In a simple matching framework, such as the one we have here in the Appendix, it holds that an "optimal" labor market outcome is achieved whenever $\xi = \varphi^p$. If the bargaining power is too low, $\xi < \varphi^p$, there is too much job creation, too little job destruction and, thus, not enough unemployment in the economy.[14] For $\xi > \varphi^p$, the equilibrium is characterized by too little job creation, too much job destruction and too much unemployment (see also Pissarides, 2000, for further discussion). Hence, the condition of Hosios (1990) states that, in search labor markets, there exists an optimal rate of job turnover (dismissals plus job creation) from which we can then derive an optimal unemployment rate. Given that job creation unambiguously decreases with increasing

[14]Higher employment levels indeed increase production. But low unemployment yields high search costs as the average duration to fill a vacancy increases. Hence, the high incentive to post vacancies whenever $\xi < \varphi^p$ causes an externality, making search disproportionately costly from an efficiency perspective.

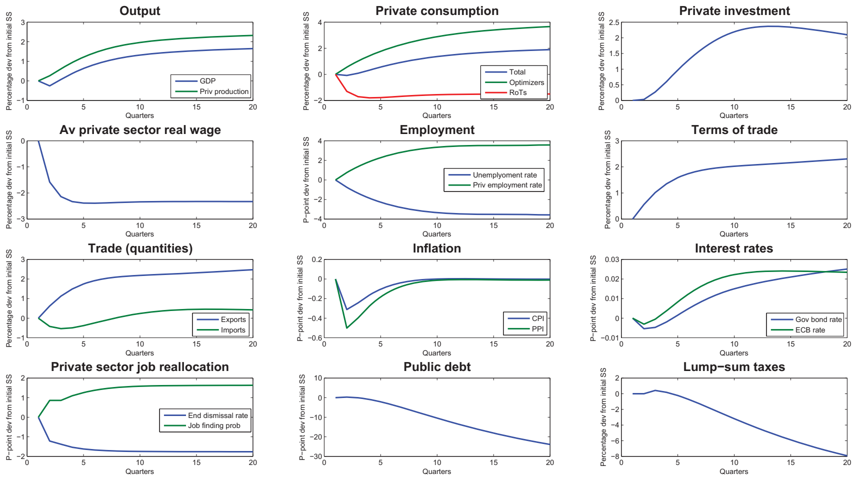
bargaining power of workers (see equation (50)), the dismissal probability has to adapt to reach this optimal job turnover rate. Up to some threshold, formally given at $\xi = \varphi^p$ in this simple framework, dismissals increase with increasing bargaining power, while they decrease beyond this threshold. For any $\xi \neq \varphi^p$, the labor market outcome is suboptimal.

Intuitively, as long as $\xi < \varphi^p$, firms receive a relatively large share of the match surplus because workers' bargaining power is low. Given this large share, it pays off for firms to dismiss a (relatively unproductive) worker, search for a new (more productive) one and bear the induced search costs, even though these increase on the way to the new steady state (remember that newly employed workers always have a higher productivity than those dismissed by assumption). Hence, the dismissal threshold $\bar{\bar{h}}$ increases. For $\xi > \varphi^p$, the share firms receive from the match surplus is too small for such a behavior to pay off, and firms will rather keep the worker longer, so that the dismissal threshold decreases with increasing bargaining power.

Relating these findings to the analysis in the main text, we have to bear in mind that workers have a much higher fall-back utility than the one in the simple model presented here in the Appendix (they receive unemployment benefits and have the chance to work in the public sector; also, taxes distort the sharing rule). This drives the "optimal" bargaining power of workers down because the fall-back utility by itself augments wage claims. Hence, we find ourselves in the situation where it pays off for firms to dismiss a relatively unproductive worker and look for a new more productive one even though search costs increase. This finding is quite robust to alternative parameterizations. We are only able to obtain decreasing dismissal probability as a result of a drop in the bargaining power for unrealistically low values of the union's bargaining power and high values of the matching elasticity (for example, at $\xi = 0.2$ and $\varphi^p = 0.9$). Hence, we conclude that our simulation results are quite robust to alternative labor market parameterizations.

B. Additional graphs

Figure 5: Permanent reduction in public wages



Notes: Transition dynamics of selected home country variables following a permanent reduction in public wages. The figure shows percentage deviations from initial steady state (percentage point deviations where indicated).

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