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Employment protection in dual labor markets

Any amplification of macroeconomic shocks?*

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Abstract

Although labor market duality is a widespread phenomenon in many OECD countries, there is yet no research consent on the effects of duality on labor market dynamics and performance. Against this background, using a New Keynesian model with unemployment, this paper theoretically investigates the importance of labor market duality on labor market volatilities. The new insight is that duality leads to a non-linear reaction of unemployment volatility for both supply and demand shocks. A subsequent empirical panel data analysis confirms the model predictions. Uncovering the non-linearity in unemployment volatility helps reconciling previous divergent research results.

Keywords: Dual Labor Market, Employment Protection, Firing Costs, Unemployment
JEL Classification: E24, E32, E52, J23, J41, J63

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1 Introduction

Recently, many OECD labor markets have developed a dual structure with highly protected permanent and weakly protected fixed-term labor contracts. Related Employment Protection Legislation (EPL) reforms which affected the relative strictness of the protection of temporary and permanent work are a complex and a controversial policy issue because these reforms create a trade-off between labor market flexibility and economic security of employees.

Remarkably enough, even though EPL reforms have become so widespread, there is no consent, neither in theory nor in empirics, about how EPL reforms affect labor market dynamics and performance. In addition, evidence from theoretical research also seems to be highly dependent on the evaluated country (see for example Zanetti (2011) for the UK, Silva and Toledo (2009) for US, Bentolila et al. (2012) and Costain et al. (2010) for Spain).

Against this background, this paper deepens the line of research by analyzing how duality induced by a distinction between EPL for fixed-term and permanent workers affects labor market volatilities. More precisely, it focuses on the interaction of duality and macroeconomic shocks. This analysis is performed in two different perspectives:

First, the theoretical perspective provides a New Keynesian model with a search and matching labor market characterized by endogenous job separations and the division of fixed-term and permanent labor contracts. This framework explicitly allows to explore the effects of labor market segmentation in terms of EPL on the reaction of unemployment to monetary, productivity as well as joint shocks. To simulate duality, I increase the gap in layoff costs between the two job types. In addition, I compare the simulation results for increasing duality with those of an unified labor market. Second, a subsequent empirical analysis based on a large panel data-set on unemployment fluctuations, EPL indices and other institutional variables for 20 OECD countries from 1985 - 2012 directly tests the theoretical predictions.

The new insight of this analysis is that the results of both perspectives claim that relative unemployment volatility is a concave, non-linear function in the firing costs gap between fixed-term and permanent workers. More precisely, unemployment volatility follows an inverted U-shaped pattern as duality increases. The results suggest that there exists a threshold in duality that makes the effects on unemployment ambiguous. For low duality, firms shift their labor turnover to the fixed-term job segment because they become more reluctant to layoff permanent workers. At the same time, they become less selective contracting fixed-term workers which encourages job creation but also actuates job destruction in the temporary segment. Permanent work becomes more sclerotic while flows into and out of fixed-term work inflate, leading to increased unemployment volatility. However, as the EPL gap further increases, less and less fixed-term jobs are transformed into permanent jobs and firms secure more and more unproductive permanent workers. Due to the large restraining in the separation of permanent workers unemployment volatility at some point decreases because the large fall in the overall separation volatility outweighs the rise in volatility of the job finding rate in the fixed-term worker segment. This finding helps understanding the sources of unemployment volatility and uncovers why previous theoretical literature has produced divergent results in explaining the effects of EPL on unemployment volatility.

The remainder of the article is as follows. The next section presents the New Keynesian model, describes duality in the labor market and derives the equilibrium conditions. Section 3 discusses the calibration and the simulated institutional regularities. Section 4 shows the steady state analysis for the different simulation exercises. Section 5 analyzes the dynamics of the model. Section 6 gives a literature review. Section 7 presents several empirical tests of the model predictions. The final section concludes.

2 The model

The model is a basic New Keynesian sticky price model in discrete time. A representative household chooses consumption and asset holding to maximize its lifetime utility. A representative intermediate goods-producing firm carries out the production and sells intermediate goods to the retail sector. Retailers act under monopolistic competition and are subject to price-setting frictions of Calvo (1983). They transform each intermediate good into a unit of retail goods which they resell to the household. A central bank follows a Taylor rule with interest rate smoothing. The model embeds a search-and-matching labor market with both exogenous and endogenous separations as in Krause and Lubik (2007). Unemployed workers search for jobs and contact the firm. Due to labor market frictions, every period only a fraction of job-seekers finds a vacant position and only a fraction of vacancies is filled.

Most important, the labor market is characterized by two types of workers that coexist in the model economy: Fixed-term workers (indexed by FC) have a limited contract duration and permanent workers (indexed by PC) are employed by open-ended contracts. Duality in the labor market arises by the assumption that for every job type, there exist contract-specific EPL in the form of exogenous layoff taxes which are collected and redistributed by the government. For simplicity, it is assumed that every job-seeker who enters the labor market is first employed on a non-renewable temporary basis. On first sight, this assumption might seem restrictive because firms are not supposed to hire under a permanent contract instantaneously. However, Guell and Petrongolo (2007, p. 154) report that in Spain in the early 1990s about 90% of jobs start as temporary contracts. Goux et al. (2001, p. 534) state that in France in 1992 80% of all entries into employment were made by fixed-term contracts. Therefore, taking fixed-term contracts as the common method of hiring seems to be a valid approximation in order to study dual labor markets. The transition between fixed-term and permanent work is thought to happen with an exogenous probability reflecting legal restriction on the duration of fixed-term contracts. Figure (1) illustrates

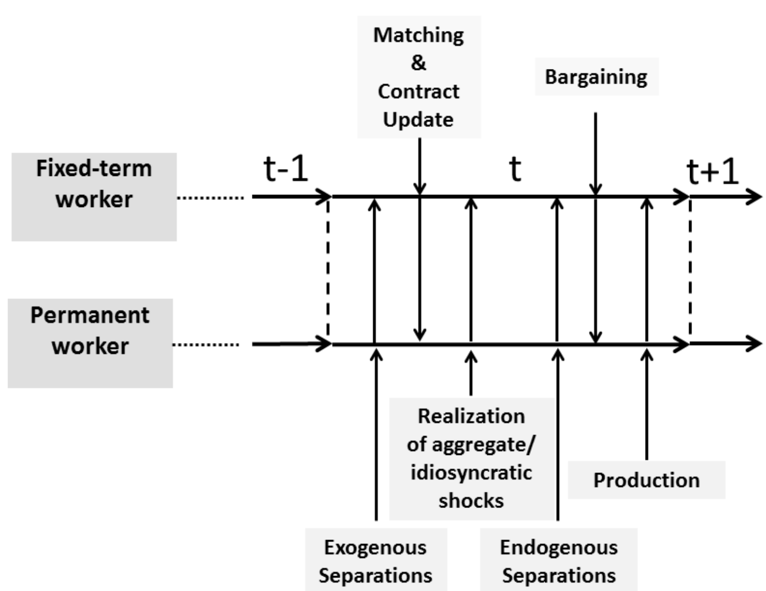

Figure 1: Timing of events in the labor market

the labor market structure as well as the timing of events within each period: A stock of fixed-term and permanent workers as well as unemployed job seekers leave period $t-1$ entering period t. In period t, first, exogenous separations take place which as in den Haan (2000) are assumed to be worker-initiated. There is no immediate rehiring. After this, with a certain probability fixed-term contracts are updated to permanent contracts. At the same time, unemployed job seekers from $t-1$ meet with vacant jobs from $t-1$. Then, the realization of idiosyncratic and aggregate shocks happens. Depending on the outcome of the shocks which is described below, endogenous separations take place and firms may decide to post vacancies. Then, all surviving matches bargain about the wages. Afterwards, production takes place.

2.1 Household

The representative household is thought of as a very large family with a continuum of members with names on the unit interval. Each member can either work or be unemployed. Individual labor supply is inelastic and each individual shares all income with all other household members.[1] During each period $t = 0, 1, 2, ...$, the household maximizes its expected lifetime utility which takes the form

$$E_t \sum_{t=0}^{\infty} \beta^t \left[(C_t^{1-\psi} - 1)/(1-\psi) \right]. \tag{1}$$

C_t is a composite consumption good, E_t is the expectation operator under rational expectations and ψ is the coefficient of relative risk aversion.[2] The household discounts future returns by the intertemporal discount factor $\beta \epsilon (0,1)$. The household chooses $\{C_t, B_t\}_{t=0}^{\infty}$ subject to the following budget constraint:

$$P_t C_t + B_t/R_t = B_{t-1} + P_t W_t^{'} + P_t b u_t + D_t + T_t^f - T_t^b \tag{2}$$

The household takes bonds B_{t-1} from the previous period into period t. It receives labor income $W_t^{'} = n_t^{FC} w_t^{FC} + n_t^{PC} w_t^{PC}$, aggregate profits D_t from the intermediate goods-producing firm and the value of home production b which also represents unemployment benefits. The government levies a lump-sum tax T_t^b for financing unemployment insurance and redistributes the firing tax income collected from the intermediate goods-producing firm by a lump sum transfer T_t^f. The household's optimal consumption path is expressed by the Euler equations

$$C_t^{-\psi} = \lambda_t, \tag{3}$$

$$E_t \beta_{t+1} = E_t \frac{\pi_{t+1}}{R_t}, \tag{4}$$

where $\pi_t = P_t/P_{t-1}$ is the gross inflation rate, λ_t denotes the non-negative Lagrange multiplier of the budget constraint and $\beta_{t+1} = \beta u'(C_{t+1})/u'(C_t) = \beta \frac{\lambda_{t+1}}{\lambda_t}$ is the stochastic discount factor.

[1] This assumption follows Merz (1995) and Andolfatto (1996). It avoids heterogeneity problems because the household's consumption decision does not depend on a worker's employment status and thus applies for all household individuals.

[2] I exclude money from the utility function because under an interest rate rule, as I assume below, the money demand equation can be ignored to compute the equilibrium.

2.2 Dual labor market

2.2.1 Matching function

The process of matching is assumed to be time-consuming and costly. The number of matches m_t is determined by a constant returns to scale Cobb-Douglas matching function of the form $m_t(u_t, v_t) = \chi u_t^{\alpha} v_t^{1-\alpha}$, where u_t is the stock of unemployed workers, v_t is the stock of vacancies and α is the matching elasticity with respect to unemployment. The parameter $0 \leq \chi \leq 1$ determines the matching efficiency. Vacancies meet workers with probability $m_t(u_t, v_t)/v_t = \chi\theta^{-\alpha} \equiv q(\theta_t)$, where $\theta_t = v_t/u_t$ denotes the labor market-tightness. The worker-finding rate is the ratio of the number of matches and the number of posted vacancies in period t. Its inverse, $1/q(\theta_t)$, defines the mean duration of vacancies. The probability for a job-seeker to meet a job is $m_t(u_t, v_t)/u_t = \chi\theta^{1-\alpha} \equiv p(\theta_t)$. The job-finding rate is the ratio of the number of matches and the number of unemployed workers. Its inverse, $1/p(\theta_t)$, is the mean unemployment spell duration.

2.2.2 Match specific idiosyncratic productivity and endogenous separation

As in den Haan et al. (2000), I assume that the idiosyncratic shock arrival rate is equal to one. In addition, I assume that idiosyncratic shocks affect the productivity of all matches such that the separation decision applies for both sorts of workers.[3] This explicitly allows to create a dual contract environment. In the model, each of the two jobs has a different, match-specific productivity, a_t, which is assumed to be independent and identically distributed across firms and time, with a cumulative distribution function $F(a)$ and probability density function $f(a)$ on the positive support. In response to idiosyncratic shocks, a_t turns to a new value which is independent from former values but with the same distribution probability. As in den Haan et al. (2000), I assume a lognormal distribution.

A match can be separated exogenously with a rate ρ^x, independently of the realized shocks. In addition, a matched worker-firm pair can decide to endogenously separate with a rate $F(\widetilde{a}_t^i)$, $i = PC, FC$. Every period, there exists a match-specific threshold productivity $\widetilde{a}_t^i$, such that all matches with a productivity below these critical thresholds create a negative surplus and are destroyed. The total separation probabilities conditioned on being a certain worker type at the beginning of period t are:

$$\rho_t^{PC} = \rho^x + (1 - \rho^x)F(\widetilde{a}_t^{PC}) \tag{5}$$

and

$$\rho_t^{FC} = \rho^x + (1 - \rho^x)[\phi F(\widetilde{a}_t^{PC}) + (1 - \phi)F(\widetilde{a}_t^{FC})]. \tag{6}$$

Within ρ_t^{FC}, there is a fragmentation which is due to the assumption that a fixed-term worker converges to a permanent worker with probability ϕ. In the model, ϕ also represents the average duration of an employment relationship between a firm and a fixed-term worker. ϕ is thought to represent legal restrictions on the use of fixed-term work. For simplicity. I assume this probability to be exogenous. This assumption is motivated by statutory maximum contract durations for fixed-term contracts in most of the OECD countries after which firms must either update the contract to permanency or dissolve it.

[3] Mortensen and Pissarides (1994) and Zanetti (2011) contrarily assume that new matches have an idiosyncratic productivity which is always above a critical productivity threshold such that new matches never separate.

2.2.3 Fixed-term and permanent workers

The value of being permanently appointed is given by

$$W_t^{PC}(a_t) = w_t^{PC}(a_t) + E_t\beta_{t+1}\left\{(1-\rho^x)\left[\int_{\widetilde{a}_{t+1}^{PC}}^{\infty} W_{t+1}^{PC}(a)dF(a) + F(\widetilde{a}_{t+1}^{PC})U_{t+1}\right] + \rho^x U_{t+1}\right\}. \quad (7)$$

A permanent worker collects the wage $w_t^{PC}(a_t)$ in period t. If she does not separate exogenously and if her productivity is above the critical threshold $\widetilde{a}_{t+1}^{PC}$, then she gets the value of holding a job in the next period. However, if the match is dissolved endogenously or exogenously, she gets the value of being unemployed U_{t+1} in the following period.

Similarly, for a fixed-term worker, the value from holding a job is given by

$$W_t^{FC}(a_t) = w_t^{FC}(a_t) + E_t\beta_{t+1}(1-\rho^x)\left\{\begin{array}{c}\phi\left[\int_{\widetilde{a}_{t+1}^{PC}}^{\infty} W_{t+1}^{PC}(a)dF(a) + F(\widetilde{a}_{t+1}^{PC})U_{t+1}\right] \\ +(1-\phi)\left[\int_{\widetilde{a}_{t+1}^{FC}}^{\infty} W_{t+1}^{FC}(a)dF(a) + F(\widetilde{a}_{t+1}^{FC})U_{t+1}\right]\end{array}\right\} + E_t\beta_{t+1}\rho^x U_{t+1}. \quad (8)$$

With probability ϕ, the fixed-term contract converges to an permanent appointive and generates the value W_{t+1}^{PC} in the following period. With probability $1-\phi$, in period $t+1$, the worker is still employed as a fixed-term worker and consequently earns the value, W_{t+1}^{FC}.

Finally, the present discounted value of being unemployed is given by

$$U_t = b + E_t\beta_{t+1}\left\{\begin{array}{c} p(\theta_t)\int_{\widetilde{a}_{t+1}^{FC}}^{\infty} W_{t+1}^{FC}(a)dF(a) \\ +\left[1 - p(\theta_t)(1 - F(\widetilde{a}_{t+1}^{FC}))\right]U_{t+1}\end{array}\right\}. \quad (9)$$

Each unemployed worker receives b which represents unemployment benefits, the value of leisure and home production. b is time-invariant and financed through non-distortionary taxes. A job-seeker meets a job with probability $p(\theta_t)$ and stays unemployed with probability $1-p(\theta_t)$. If the productivity is above the critical threshold $\widetilde{a}_{t+1}^{FC}$, an unemployed worker will earn the value of holding a fixed-term position, W_{t+1}^{FC}. Otherwise, if she does not meet a job in period t, she stays unemployed and will receive the value of being unemployed in the next period.

2.3 Firms

2.3.1 Intermediate goods firm

The following Bellman equations describe the problem of the firm. The firm's value of a job of a permanent worker, for a given realization of a_t, is given by:

$$
\begin{aligned}
J_t^{PC}(a_t) &= A_t\varepsilon_t a_t - w_t^{PC}(a_t) \\
&+E_t\beta_{t+1}(1-\rho^x)\left\{\int_{\widetilde{a}_{t+1}^{PC}}^{\infty} J_{t+1}^{PC}(a)dF(a) + F(\widetilde{a}_{t+1}^{PC})(V_{t+1}-f^{PC})\right\} \\
&+E_t\beta_{t+1}\rho^x V_{t+1}.
\end{aligned} \tag{10}
$$

The value of a permanent worker yields the contemporaneous net return $A_t\varepsilon_t a_t - w_t^{PC}(a_t)$. I assume a competitive goods producing sector with ε_t being the real price requested by the intermediate goods-producing firm for its output, which is equivalent to the real marginal cost for the retail firms. $w_t^{PC}(a_t)$ represents the wage which the firm must pay for a permanent worker. The future expected present value of the job can be interpreted as follows: If the permanent worker does not separate exogenously, a new observation from the productivity distribution is drawn in the next period. If the productivity falls below the specific threshold, then the job is endogenously destroyed and the firm must pay the firing tax for permanent workers, f^{PC}, and gets the present-discounted value of expected profits from a vacant job, V_t. Similarly, the value of a fixed-term worker is given by:

$$
\begin{aligned}
J_t^{FC}(a_t) &= A_t\varepsilon_t a_t - w_t^{FC}(a_t) \\
&+E_t\beta_{t+1}(1-\rho^x)\left\{\begin{array}{c} \phi\left[\int_{\widetilde{a}_{t+1}^{PC}}^{\infty} J_{t+1}^{PC}(a)dF(a) + F(\widetilde{a}_{t+1}^{PC})(V_{t+1}-f^{PC})\right] \\ +(1-\phi)\left[\int_{\widetilde{a}_{t+1}^{FC}}^{\infty} J_{t+1}^{FC}(a)dF(a) + F(\widetilde{a}_{t+1}^{FC})(V_{t+1}-f^{FC})\right] \end{array}\right\}. \\
&+E_t\beta_{t+1}\rho^x V_{t+1}
\end{aligned} \tag{11}
$$

The present value of an open vacancy for a firm is

$$
V_t = -c + E_t\beta_{t+1}\left\{\begin{array}{c} q(\theta_t)[\int_{\widetilde{a}_{t+1}^{FC}}^{\infty} J_{t+1}^{FC}(a)dF(a) - F(\widetilde{a}_{t+1}^{FC})f^{FC}] \\ +\left[1-q(\theta_t)(1-F(\widetilde{a}_{t+1}^{FC}))\right]V_{t+1} \end{array}\right\}. \tag{12}
$$

With probability $q(\theta_t)$ the firm finds a fixed-term worker and then gets the return J_{t+1}^{FC}, if next period's productivity is above the productivity threshold. If the productivity falls below this threshold the firm must pay the firing tax for fixed-term workers. Higher firing costs for fixed-term workers c. p. discourage vacancy postings and hence reduce labor market tightness. With complementary probability, $1-q(\theta_t)$, the firm does not find a suitable worker and then receives the value of an open vacancy. In equilibrium firms post vacancies as long as the value of doing so equals zero, i.e. in equilibrium I assume the usual free entry of firms, so that $V_t = 0$.

Note that due to free entry, (12) becomes:

$$
\frac{c}{q(\theta_t)} = E_t\beta_{t+1}\left\{\int_{\widetilde{a}_{t+1}^{FC}}^{\infty} J_{t+1}^{FC}(a)dF(a) - F(\widetilde{a}_{t+1}^{FC})f^{FC}\right\}. \tag{13}
$$

2.3.2 Retailers and price setting

There is a continuum of retail firms in the retail sector. Retailers buy intermediate goods at price ε_t from the intermediate goods-producing firms and use constant-return-to-scale technology, transforming each unit of the intermediate good into the differentiated retail good. Each retailer sells $Y_t(i)$ units at the nominal price $P_t(i)$ to the household. The Dixit-Stiglitz type final output is given by,

$$Y_t = \int_0^1 \left[Y_t(i)^{\frac{\gamma-1}{\gamma}} di\right]^{\frac{\gamma}{\gamma-1}}, \tag{14}$$

where $\gamma > 1$ is the elasticity of demand for each intermediate good and $Y_t(i)$ is the quantity of output by retailer i. Retailers maximize their nominal profit function according to

$$\max_{Y_t(i)} P_t Y_t - \int_0^1 P_t(i) Y_t(i) di, \tag{15}$$

where the total revenue is the final goods price times the final output minus total costs. The individual retailer demand curve is a function of relative price:

$$Y_t(i) = [P_t(i)/P_t]^{-\gamma} Y_t. \tag{16}$$

$P_t(i)$ is the retail goods price and P_t is the aggregate price. Under the assumption of perfect competition the price of the retail good equals its marginal cost of production:

$$P_t = \left[\int_0^1 P_t(i)^{1-\gamma} di\right]^{\frac{1}{1-\gamma}}. \tag{17}$$

As in Calvo (1983), prices are assumed to be sticky: Independently of the time since the last price adjustment, each retailer is allowed to reset its price with a probability $(1-\nu)$, where $\nu \in (0,1)$. Each period there is only a fraction $(1-\nu)$ of retailers who can reset their prices, while a fraction ν must keep the previous period's price. Retailers reset their price maximizing their real profits, described by:

$$\max_{P_t(i)} E_t \sum_{j=0}^{\infty} (\beta\nu)^j \beta_{t+j} \left\{ [P_t(i)/P_{t+j}]^{-\gamma} Y_{t+j} \left[P_t(i)/P_{t+j} - \varepsilon_{t+j}\right] \right\}, \tag{18}$$

where ε_{t+j} is the real marginal cost and β_{t+j} is the stochastic discount factor in period $t+j$. Note that in this price setting framework, firms discount future profits by the stochastic discount factor β_{t+j} and, in addition, they discount future profit flows with the probability to be stuck with the price they choose today. The first order condition for this problem is:

$$P_t(i) = \frac{\gamma E_t \sum_{j=o}^{\infty} (\beta\nu)^j \beta_{t+j} \left[P_{t+j}^{\gamma} \varepsilon_{t+j} Y_{t+j}\right]}{(\gamma-1) E_t \sum_{j=o}^{\infty} (\beta\nu)^j \beta_{t+j} \left[P_{t+j}^{\gamma-1} Y_{t+j}\right]}. \tag{19}$$

This equation defines the optimal reset price. The current price which price-changing retailers choose is a present discount value of marginal costs. Due to symmetry this first order condition is the same for all retailers because they face the same marginal costs and take aggregate variables as given.[4]

2.4 Wage bargaining

Wages are bargained, yielding quasi-rents for any matched pair of firm and worker. On the firm's side, the surplus of a match consists of the value of the specific job subtracted by the firm's outside option. Note that under the free entry assumption the firm's outside option is specific to the contract type, i.e. either $-f^{FC}$ or $-f^{PC}$, reflecting that the firm must pay the firing tax if the match is separated. On the worker's side, it consists of the value of holding a certain position subtracted by the worker's outside option which is becoming unemployed. The wage bargaining rules are

$$(1-\eta)(W_t^{FC}(a_t)-U_t)=\eta(J_t^{FC}(a_t)-(V_t-f^{FC}) \tag{20}$$

and

$$(1-\eta)(W_t^{PC}(a_t)-U_t)=\eta(J_t^{PC}(a_t)-(V_t-f^{PC}), \tag{21}$$

where $\eta \: \epsilon \: [0,1]$ denotes workers' bargaining power relative to the one of firms'.
The wage for a permanent, respectively a fixed-term worker is the Nash solution that maximizes the weighted product of the worker's and firm's net return from the job match and is obtained by combining (7), (8), (9), (10) and (11) and rearranging:

$$\begin{aligned} w_t^{FC}(a_t) \;\; = \;\; & \eta[A_t\varepsilon_t a_t + c\theta_t - \phi E_t\beta_{t+1}(1-\rho^x)f^{PC} \\ & -(1-\phi)E_t\beta_{t+1}(1-\rho^x)f^{FC} + f^{FC} + p(\theta_t)E_t\beta_{t+1}f^{FC}] + (1-\eta)b \end{aligned} \tag{22}$$

and

$$w_t^{PC}(a_t)=\eta[A_t\varepsilon_t a_t + c\theta_t - E_t\beta_{t+1}(1-\rho^x)f^{PC} + f^{PC} + p(\theta_t)E_t\beta_{t+1}f^{FC}] + (1-\eta)b. \tag{23}$$

Aggregate wages are the average wages among all workers - conditioned on the idiosyncratic productivity shock being above the job-specific thresholds:

$$E[w_t^{FC}(a_t)|a_t \geq \widetilde{a}_t^{FC}] = \eta \left[\begin{array}{c} A_t\varepsilon_t H(\widetilde{a}_t^{FC}) + c\theta_t \\ -\phi E_t\beta_{t+1}(1-\rho^x)f^{PC} \\ -(1-\phi)E_t\beta_{t+1}(1-\rho^x)f^{FC} + f^{FC} + p(\theta_t)E_t\beta_{t+1}f^{FC} \end{array} \right] + (1-\eta)b \tag{24}$$

and

$$E[w_t^{PC}(a_t)|a_t \geq \widetilde{a}_t^{PC}] = \eta \left[\begin{array}{c} A_t\varepsilon_t H(\widetilde{a}_t^{PC}) + c\theta_t - E_t\beta_{t+1}(1-\rho^x)f^{PC} \\ +f^{PC} + p(\theta_t)E_t\beta_{t+1}f^{FC} \end{array} \right] + (1-\eta)b \tag{25}$$

[4] After rearranging and log-linearizing, the usual New Keynesian Phillips curve can be derived as log-deviations from steady state: $\widehat{\pi}_t = \frac{(1-\nu)(1-\nu\beta)}{\nu}\widehat{\varepsilon}_t + \beta E_t\widehat{\pi}_{t+1}$.

$$\text{with } H(\widetilde{a}_t^i) = \int_{\widetilde{a}_t^i}^{\infty} a \frac{f(a)}{1-F(\widetilde{a}_t^i)} da \qquad i = PC, FC.$$

Note that the aggregate wages contain some compensation for firing costs which is granted by the firm. This compensation consists of the specific firing cost f^{FC}, respectively $f^{PC}$and the term $p(\theta_t)E_t\beta_{t+1}f^{FC}$ in both cases. The latter compensation part is weighted with the probability for a worker to leave unemployment.

2.5 Employment dynamics

I follow Silva and Toledo (2009) to define the (un)employment dynamics. The evolution of unemployment is determined by

$$u_t = u_{t-1} + \rho_t^{PC} n_{t-1}^{PC} + \rho_t^{FC} n_{t-1}^{FC} - p(\theta_{t-1})(1 - F(\tilde{a}_t^{FC}))u_{t-1}. \tag{26}$$

The number of job-seekers in period t consists of the mass of unemployed workers in the previous period and all workers from the previous period who are exogenously or endogenously separated. $p(\theta_{t-1})(1-F(\tilde{a}_t^{FC}))$ determines the probability for a worker to find a job and both the firm and the worker come to a mutual agreement about creating a new job. The stock of fixed-term employees is defined as

$$n_t^{FC} = (1 - \rho_t^{FC})n_{t-1}^{FC} + p(\theta_{t-1})(1 - F(\tilde{a}_t^{FC}))u_{t-1} - \phi(1 - \rho_t^{PC})n_{t-1}^{FC}, \tag{27}$$

where the first term defines all fixed-term workers from the previous period who are not separated, the second term represents the flow from unemployment into employment and the third term represents the flow of fixed-term employees who are transferred to the stock of permanent employees. Consequently, the number of permanent workers is given by

$$n_t^{PC} = (1 - \rho_t^{PC})n_{t-1}^{PC} + \phi(1 - \rho_t^{PC})n_{t-1}^{FC}, \tag{28}$$

simply adding up all permanent employees from the previous period who are not separated plus the number of fixed-term workers who are updated to permanency in period t.

The normalized labor force is

$$1 = u_t + n_t^{PC} + n_t^{FC}. \tag{29}$$

Finally, job creation and job destruction is defined as the total number of new matches respectively the sum of all separated matches scaled by the total labor force:

$$jc_t = \frac{p(\theta_{t-1})(1 - F(\tilde{a}_t^{FC}))u_{t-1}}{(1 - u_{t-1})} \tag{30}$$

and

$$jd_t = \frac{\rho_t^{FC} n_{t-1}^{FC} + \rho_t^{PC} n_{t-1}^{PC}}{(1 - u_{t-1})}. \tag{31}$$

2.6 Job destruction and creation conditions

By combining (7), (8), (10), (11) and (9) and rearranging, the total match surpluses can be written as[5]

$$
\begin{aligned}
S_t^{FC}(a_t) \;&=\; A_t\varepsilon_t a_t - b + f^{FC} + \phi E_t\beta_{t+1}(1-\rho^x)\left[\int_{\widetilde{a}_{t+1}^{PC}}^{\infty} S_{t+1}^{PC}(a)dF(a)\right] \\
&\quad -\phi E_t\beta_{t+1}(1-\rho^x)f^{PC} + (1-\phi)E_t\beta_{t+1}(1-\rho^x)\left[\int_{\widetilde{a}_{t+1}^{FC}}^{\infty} S_{t+1}^{FC}(a)dF(a)\right] \\
&\quad -(1-\phi)E_t\beta_{t+1}(1-\rho^x)f^{FC} - \eta p(\theta_t)E_t\beta_{t+1}\left[\int_{\widetilde{a}_{t+1}^{FC}}^{\infty} S_{t+1}^{FC}(a)dF(a)\right]
\end{aligned}
\tag{32}
$$

and

$$
\begin{aligned}
S_t^{PC}(a_t) \;&=\; A_t\varepsilon_t a_t - b + f^{PC} + E_t\beta_{t+1}(1-\rho^x)\left[\int_{\widetilde{a}_{t+1}^{PC}}^{\infty} S_{t+1}^{PC}(a)dF(a)\right] \\
&\quad -E_t\beta_{t+1}(1-\rho^x)f^{PC} - \eta p(\theta_t)E_t\beta_{t+1}\left[\int_{\widetilde{a}_{t+1}^{FC}}^{\infty} S_{t+1}^{FC}(a)dF(a)\right],
\end{aligned}
\tag{33}
$$

where

$$S_t^{FC}(a_t) = J_t^{FC}(a_t) - V_t + f^{FC} + W_t^{FC}(a_t) - U_t \tag{34}$$

and

$$S_t^{PC}(a_t) = J_t^{PC}(a_t) - V_t + f^{PC} + W_t^{PC}(a_t) - U_t. \tag{35}$$

The threshold productivities $\widetilde{a}_t^{PC}$ and $\widetilde{a}_t^{FC}$ define the zero surplus conditions. In equilibrium, $J_t^{PC}(\widetilde{a}_t^{PC}) + f^{PC} = 0$, respectively $J_t^{FC}(\widetilde{a}_t^{FC}) + f^{FC} = 0$ holds, if and only if $S_t^{PC}(\widetilde{a}_t^{PC}) = W_t^{PC}(\widetilde{a}_t^{PC}) - U_t = 0$, respectively $S_t^{FC}(\widetilde{a}_t^{FC}) = W_t^{FC}(\widetilde{a}_t^{FC}) - U_t = 0$. Intuitively, these conditions state that if job destruction takes place, breaking up the match is always an optimal strategy for both the firm and the worker because otherwise both sides would suffer from a negative surplus. Given that all terms in the surplus equations except the revenue products are common to all specific matches, I can subtract $S_t^{FC}(\tilde{a}_t^{FC}) = 0$ from $S_t^{FC}(a_t^{FC})$ and $S_t^{PC}(\tilde{a}_t^{PC}) = 0$ from $S_t^{PC}(a_t^{PC})$ and get $S_t^{FC}(a_t^{FC}) = A_t\varepsilon_t(a_t - \tilde{a}_t^{FC})$ and $S_t^{PC}(a_t^{PC}) = A_t\varepsilon_t(a_t - \tilde{a}_t^{PC})$. By inserting this in (33), respectively in (32) and equating it to zero, I get the final job destruction condition for permanent workers,

[5] All derivations (e.g. wage equations, surpluses etc.) are available upon request from the author.

$$0 = A_t\varepsilon_t\tilde{a}_t^{PC} - b + E_t\beta_{t+1}(1-\rho^x)A_{t+1}\varepsilon_{t+1}\left[\int_{\tilde{a}_{t+1}^{PC}}^{\infty}(a_{t+1}-\tilde{a}_t^{PC})dF(a)\right] \tag{36}$$
$$-E_t\beta_{t+1}(1-\rho^x)f^{PC} + f^{PC} - \eta p(\theta_t)E_t\beta_{t+1}A_{t+1}\varepsilon_{t+1}\left[\int_{\tilde{a}_{t+1}^{FC}}^{\infty}(a_{t+1}-\tilde{a}_{t+1}^{FC})dF(a)\right].$$

The first term on the right hand side is the lowest return that is acceptable for firms in order to not destroy a match, i.e. the production at the threshold productivity $\widetilde{a}_t^{PC}$. The second term represents the opportunity costs of employment, i.e. unemployment benefits, b. The third term is the expected return from holding a job in the next period. The fourth term describes future expected firing costs in the case that the worker does not separate exogenously. The fifth term represents the saving on firing costs in the current period. The last term represents the expected yield from job search. The job destruction condition for fixed-term workers again yields the fragmentation of permanent and fixed-term workers represented by the probability ϕ and is

$$0 = A_t\varepsilon_t\tilde{a}_t^{FC} - b + \phi E_t\beta_{t+1}(1-\rho^x)A_{t+1}\varepsilon_{t+1}\left[\int_{\tilde{a}_{t+1}^{PC}}^{\infty}(a_{t+1}-\tilde{a}_{t+1}^{PC})dF(a)\right] \tag{37}$$
$$-\phi E_t\beta_{t+1}(1-\rho^x)f^{PC} + (1-\phi)E_t\beta_{t+1}(1-\rho^x)A_{t+1}\varepsilon_{t+1}\left[\int_{\tilde{a}_{t+1}^{FC}}^{\infty}(a_{t+1}-\tilde{a}_{t+1}^{FC})dF(a)\right]$$
$$-E_t(1-\phi)\beta_{t+1}(1-\rho^x)f^{FC} + f^{FC} - \eta p(\theta_t)E_t\beta_{t+1}A_{t+1}\varepsilon_{t+1}\left[\int_{\tilde{a}_{t+1}^{FC}}^{\infty}(a_{t+1}-\tilde{a}_{t+1}^{FC})dF(a)\right].$$

By combining (13) and (20), the job creation condition can be derived as:

$$\frac{c}{q(\theta_t)} = (1-\eta)E_t\beta_{t+1}A_{t+1}\varepsilon_{t+1}\int_{\tilde{a}_{t+1}^{FC}}^{\infty}(a_{t+1}-\tilde{a}_{t+1}^{FC})dF(a) - E_t\beta_{t+1}f^{FC}. \tag{38}$$

The final job creation condition states that, in equilibrium, the expected cost of a vacancy is equal to the expected benefit received from filling that vacancy. The job creation condition directly determines the value of θ_t and $q(\theta_t)$.

2.7 Monetary authority and government

Following empirical evidence from Rudebusch (2002), the central bank conducts monetary policy using a modified Taylor (1993) rule which can be defined in log-linear form:

$$\widehat{R}_t = \rho_r\widehat{R}_{t-1} + (1-\rho_r)(\rho_\pi\widehat{\pi}_t + \rho_y\widehat{y}_t) + e_{M,t}. \tag{39}$$

$\widehat{R}_t$, $\widehat{\pi}_t$ and $\widehat{y}_t$ are log-deviations from steady state of the interest rate, inflation and output. ρ_r indicates the interest rate smoothing coefficient. e_M is the policy shock which is zero-mean serially uncorrelated and normally distributed with a standard deviation σ_M^2. With this interest rate rule, the monetary authority gradually adjusts the nominal interest rate in response to output and inflation fluctuations.

The government collects the firing taxes and a lump-sum tax from the households respectively from the intermediate goods producing firms to finance the unemployment benefit payments as well as the redistribution of the firing costs. The balanced budget restriction is

$$0 = \tilde{f} - T_t^f + T_t^b - bu_t, \text{ where} \tag{40}$$

$$\begin{aligned} \tilde{f} \;=\;& (1-\rho^x)[(1-\phi)F(\tilde{a}_t^{FC})n_{t-1}^{FC}f^{FC} + F(\tilde{a}_t^{PC})n_{t-1}^{PC}f^{PC} + \phi F(\tilde{a}_t^{PC})n_{t-1}^{FC}f^{PC}] \\ & + p_{t-1}u_{t-1}F(\tilde{a}_t^{FC})f^{FC} \end{aligned} \tag{41}$$

sums up all firing costs due to endogenous separations.

2.8 Aggregation

In equilibrium the aggregate income is

$$Y_t = A_t[H(\tilde{a}_t^{FC})n_t^{FC} + H(\tilde{a}_t^{PC})n_t^{PC}] - cv_t \tag{42}$$

which represents the weighted average of production of fixed-term, respectively permanent workers subtracted by the searching costs. I assume that vacancy posting costs are not redistributed and are pure resource losses. The aggregate productivity shock follows an AR(1) process:

$$\ln A_t = \rho_A \ln A_{t-1} + e_{A,t} \text{ with } 0 < \rho_A < 1 \text{ and } e_{A,t} \sim i.i.d.(0, \sigma_A^2). \tag{43}$$

The model is approximated by log-linearizing its equations around the steady-state. The symmetric equilibrium system describes how the endogenous variables change in response to exogenous shocks.

3 Quantitative analysis

For the quantitative analysis, I pursue a two-step strategy: First, I calibrate the benchmark economy at quarterly frequency to the U.S. economy (see Table 1) which is a proxy for a deregulated labor market, i.e. weak respectively no duality.[6] Next, I asymmetrically change the layoff-taxes which changes the gap in EPL between fixed-term and permanent workers and therefore the degree of duality. When simulating the labor market's response to aggregate shocks under different constellations of EPL and contract structure, there are basically two simulation strategy. One possibility is to hold the steady state values constant while changing the parameters for EPL, implicating that labor market variables like unemployment and job flows are policy-invariant in the steady state. Another possibility is to let the steady state values adjust endogenously whenever there is a policy change. I choose the second approach for two reasons: First, there is evidence that EPL is significantly correlated with steady state job flows (for empirical evidence see Boeri and Garibaldi (2009, p. 435), for theoretical evidence see Bentolila and Bertola (1990)). Second, the

[6] Figure (13) and (14) show that the U.S. displays the lowest EPL indices among a sample of 20 OECD countries.

steady state analysis below shows that labor turnover costs crucially affect the paths of the steady state labor market variables.

I consider the following two simulation scenarios:

3.0.1 Scenario A: Single contract labor market

This scenario simulates increased firing costs in a unified, e.g. single contract labor market. This simulation exercise is motivated by several policy initiatives in favor for eliminating the EPL gap (see for example Andrés et al. (2009)). More precisely, I set $f^{FC} = f^{PC} = f > 0$. In this case, as long as $f^{FC} = f^{PC}$, the conversion rate, ϕ , is irrelevant. Hence, ϕ can take any value in $[0, 1]$ because $J_t^{FC}(a_t)$ tend to approach $J_t^{PC}(a_t)$ and therefore the wages, $w_t^{FC}(a_t)$ and $w_t^{PC}(a_t)$ are equal. Consequently, the separation probabilities for both worker types are the same, so that $\rho_t^{FC} = \rho_t^{PC}$ and there is only one job destruction condition.

3.0.2 Scenario B: Dual contract labor market

This scenario simulates a rise in labor market duality. Holding firing costs for fixed-term contracts constant while increasing firing costs for permanent contracts increases the gap in separation costs and dualism in the model. Formally expressed, I set $f^{FC} = 0$ and $0 \leq f^{PC}$. I increase the firing tax from zero to 0.32 which approximately gives a firing cost steady state wage ratio of $f/\overline{w} = 0.35$ as an upper bond of firing costs.[7] According to the OECD (2002, table 3.11) on average about 60 percent of fixed-term contracts last less than one year. Consequently, I set $\phi = 0.33$ and assume that fixed-term contracts on average last about three quarters. The appendix presents the simulation results for $\phi = 0.25$ and $\phi = 0.5$, e.g. an average duration of fixed-term contracts of two respectively four quarters.

3.1 Benchmark calibration

Calibrated Parameters for Benchmark Economy

Parameter	Value	Source
Calvo frequency of price adjustment ν	0.6	Dennis (2006)
Interest rate smoothing ρ_r	0.73	Rudebusch (2002)
Interest rate response to output ρ_y	0.2	Orphanides (2004)
Interest rate response to inflation ρ_π	1.53	Rudebusch (2002)
Parameter for risk aversion ψ	2.0	Krause and Lubik (2007)
Discount rate β	0.99	Krause and Lubik (2007)
Workers' bargaining power η	0.5	Standard value
Elasticity w.r.t. unemployment α	0.5	Petrongolo and Pissarides (2001)
Exogenous separation probability ρ^x	0.065	Krause and Lubik (2007)
Separation cost for fixed-term workers f^{FC}	0.0	Benchmark Calibration
Separation cost for permanent workers f^{PC}	0.0	Benchmark Calibration
Conversion probability ϕ	0.33	OECD (2002)

Table 1: Calibration of the benchmark economy

[7] According to the World Bank (2013) the average of total redundancy costs for the sample of OECD countries I study in the empirical part of this article is equal to about 26 weeks of salary. Absence any further microevidence, I assume that the ratio of layoff costs and total redundancy costs is about 15%.

Preferences: As in Krause and Lubik (2007, p. 717), the value of the quarterly discount factor is 0.99 and the coefficient of relative risk aversion is set to 2. The substitution elasticity for retail goods is set to 11 which implies a steady state mark-up of prices over marginal costs of 10%.

Policy and Price Rigidity: The interest rate response to inflation, ρ_π, is set equal to 1.53 and the interest rate response to output, ρ_y, equals 0.2. The interest smoothing parameter, ρ_r, is equal to 0.73. These parameter values are near to those in Rudebusch (2002, p. 1164) and Orphanides (2004, Table 1., 2nd row, p. 161). For the Calvo adjustment parameter, I follow Dennis (2006) who assumes a value of 0.6.[8] In the benchmark economy, 40% of the firms change prices each quarter and the duration between price changes is about 3 quarters on average.

Matching Labor Market: The matching elasticity with respect to unemployment, α, equals 0.5.[9] As it is standard in the related literature, the workers' bargaining power equals 0.5. The worker finding rate, $q(\theta)$, is set to 0.7, following den Haan et al. (2000). I calibrate the quarterly job finding rate, $p(\theta)$, to 0.83 which is consistent with Shimer's (2005) monthly rate of 0.45. The scale parameter in front of the matching function, χ, is set to 0.657. The total separation rate is 10 % as in Krause and Lubik (2007).[10] I assume that about one third of separations is endogenous whereas two thirds are exogenously determined. The steady-state unemployment rate is about 11%. As in Fujita (2004), I assume that the implied unemployment rate includes those who are looking for a job, being out of the labor force.[11] For the given job flows, the computation of b yields a value of $b = 0.75$.[12]

Shocks: Without loss of generality, the steady-state average aggregate labor productivity, $\overline{A}$, is normalized to one. The idiosyncratic productivity, a_t, is i.i.d. log-normally distributed. The mean of the c.d.f., μ_a, is equal to zero and the standard deviation, σ_a, is equal to 0.25. The standard deviation is in the middle of the one calibrated by Silva and Toledo (2009) and Zanetti (2011) who choose 0.17, respectively 0.29. In the appendix, I provide a robustness check with respect to σ_a. As common in the literature, the aggregate shock processes are calibrated to match the standard deviation of U.S. GDP. My aim is not to exactly replicate the data in every dimension but rather to study the amplification mechanism behind labor market duality in terms of an EPL gap. In the empirical section of this article, I calculate a standard deviation of U.S. GDP of 1.34% for the years 1985-2012. I set the standard error of the uncorrelated interest rate shock to 0.0014.[13] The productivity shock consequently has an autocorrelation of 0.96 and a standard error of 0.007.

Firing Costs: There is no EPL in the benchmark economy, i.e. the benchmark calibration represents a pure deregulated labor market without duality.

[8] Consequently, the elasticity of inflation with respect to marginal costs is $\kappa = (1-\beta\nu)(1-\nu)/\nu = 0.169$.

[9] There is a contentious debate about the scaling of the matching elasticity with respect to unemployment. For a more detailed discussion see for example Broersma and van Ours (1999).

[10] This is an intermediate value of the one adopted by Merz (1995) (0.07) and Andolfatto (1996) (0.15).

[11] This assumption is made by a large body of literature (e.g. Thomas (2006), Silva and Toledo (2009), Fujita (2004)). Den Haan et al. (2000, p. 491) draw upon evidence from Blanchard and Diamond (1990) and point out the intuition behind this assumption: "[...]we interpret unmatched workers in our model as including both workers classified as unemployed and those not in the labor force but stating that they "want a job," [...]".

[12] The related literature has shown that the calibration of b crucially affects the outcomes of the model. Hagedorn and Manovskii (2008) is an example of a calibration with a high value of $b = 0.955$, so the difference between the present value of market activity and non-market activity is rather small. It has been argued that high values of b imply a unrealistic sensitivity of the unemployment rate to changes in b. Shimer (2005) however uses $b = 0.4$, a low value implying large surpluses and low variability of labor market variables.

[13] The standard error for the interest shock is broadly in line with Smets and Wouters (2007).

4 Steady state analysis

4.1 Scenario A - Single contract labor market

Figure (2) shows the steady state values for increasing firing costs in the single contract labor market. In order to keep the marginal revenue of the job constant, firms will reduce the reservation productivity which is defined as the productivity which makes a match profitable. Consequently, as firing costs make it more expensive for a firm to lay off a worker, firms reduce their endogenous separation rates and therefore job destruction decreases. Note that up to about $f = 0.075$ the decline of the separation probability is very large and diminishes then. The reason for this is that I assume a lognormal c.d.f. which is monotonically increasing in the reservation productivity. To be precise, when the reservation productivity decreases to a certain degree, it reaches the tail of the distribution implying a value near zero, so that the endogenous separation probability barely changes when the reservation productivity further decreases. Vacancies fall when firing costs increase representing a decline in the incentive for firms to create new jobs. The average wage is increased because firms pay a compensation for saving firing costs in case of not separating the match. The effect on unemployment is ambiguous: unemployment declines with lower firing costs because of the great fall of the separation probability. Lower vacancies imply a slacker labor market tightness and an increase in the unemployment duration. Intuitively, higher firing costs make it harder for firms to adjust employment along the job destruction margin. They cut hirings which induces unemployment to increase.

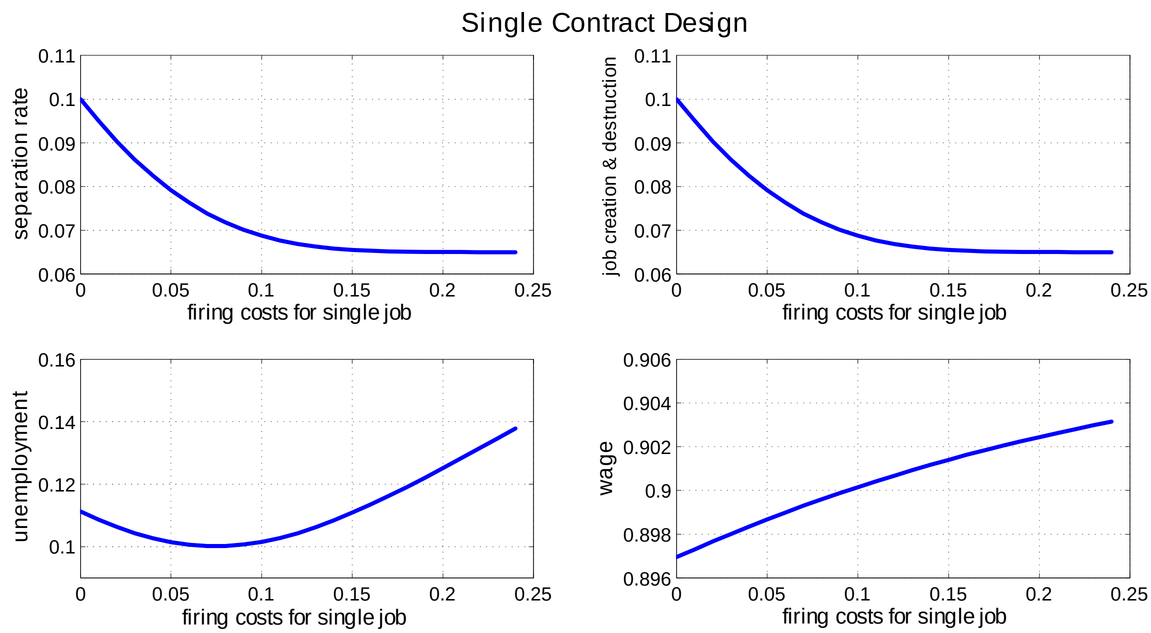

Figure 2: Steady-state effects of increasing firing costs for single job ($f^{FC} = f^{PC} = f$)

4.2 Scenario B - Dual contract labor market

Figure (3) presents the calculated steady-state values for scenario B. The intuition is straightforward: higher firing costs for permanent workers induce firms to lay off less because shedding those workers becomes more expensive. Firms will decrease the reservation productivity in order to countervail the additional costs. Consequently, the separation probability for permanent workers decreases. Firms know that with a certain probability a temporary worker is updated to a permanent worker and firing is then subject to firing costs. Accordingly, firms will rather lay off temporary workers before the converting process which causes the separation probability for temporary workers to increase. A higher productivity threshold implies a lower surplus value for new jobs, hence lower vacancy postings and consequently a slacker labor market. Job destruction diminishes because the fall in the separation rate of permanent workers overbalances the rise in that of fixed-term workers. The lower market tightness reduces the bargaining power of workers which induces the averages wages to decrease. The effect on unemployment is ambiguous: First, unemployment declines when the average separation probability decreases. Second, a slacker labor market decreases the job finding rate and increase unemployment duration. Therefore, when the decrease in the separation probability shrinks, the second effect dominates causing unemployment to increase.

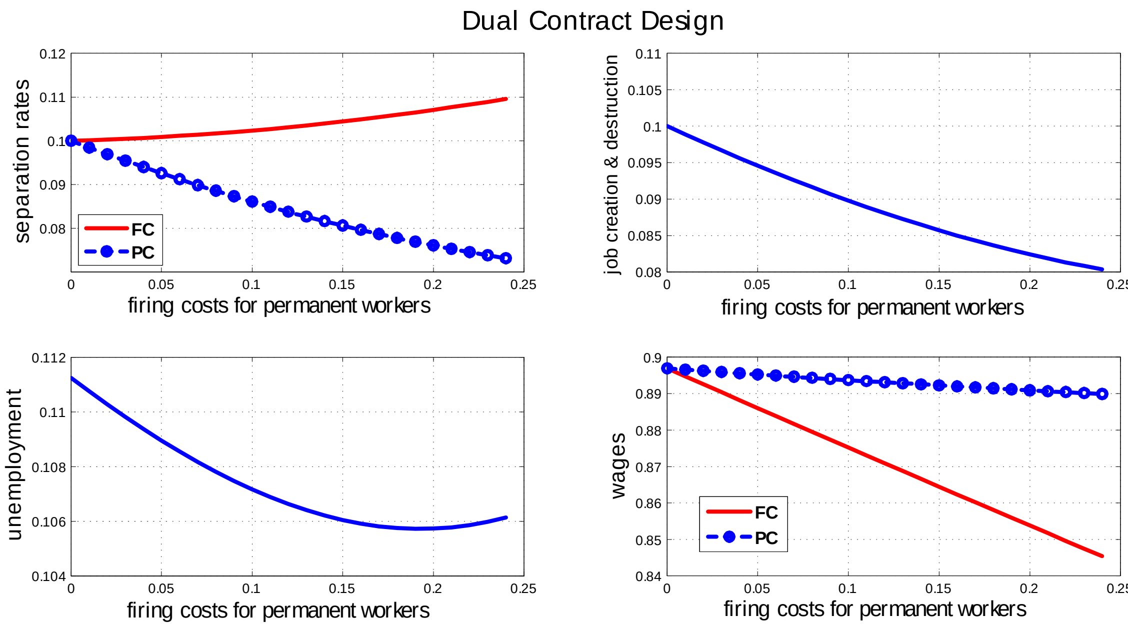

Figure 3: Steady-state effects of increasing firing costs for permanent workers ($f^{PC} \mid f^{FC} = 0$)

5 Model dynamics

5.1 The benchmark model

5.1.1 Interest rate shock

Figure (4) shows the impulse response functions to an one standard deviation interest rate shock in the benchmark economy. Due to nominal rigidities, the real interest rate shifts down on impact. Aggregate demand and the level of output increase. Real wages and consequently real marginal costs initially increase which creates pressure on the price level. Inflation increases on impact before quickly returning to its steady state. Firms react on the higher demand by shifting down the threshold productivity and consequently dampen their separation rates. Job destruction shrinks and employment is enhanced. Accordingly, unemployment drops on impact before reverting to its steady state value. As the serially uncorrelated interest rate shock dies out, output, marginal costs and inflation recover driving separations to increase again which causes unemployment to rise again.

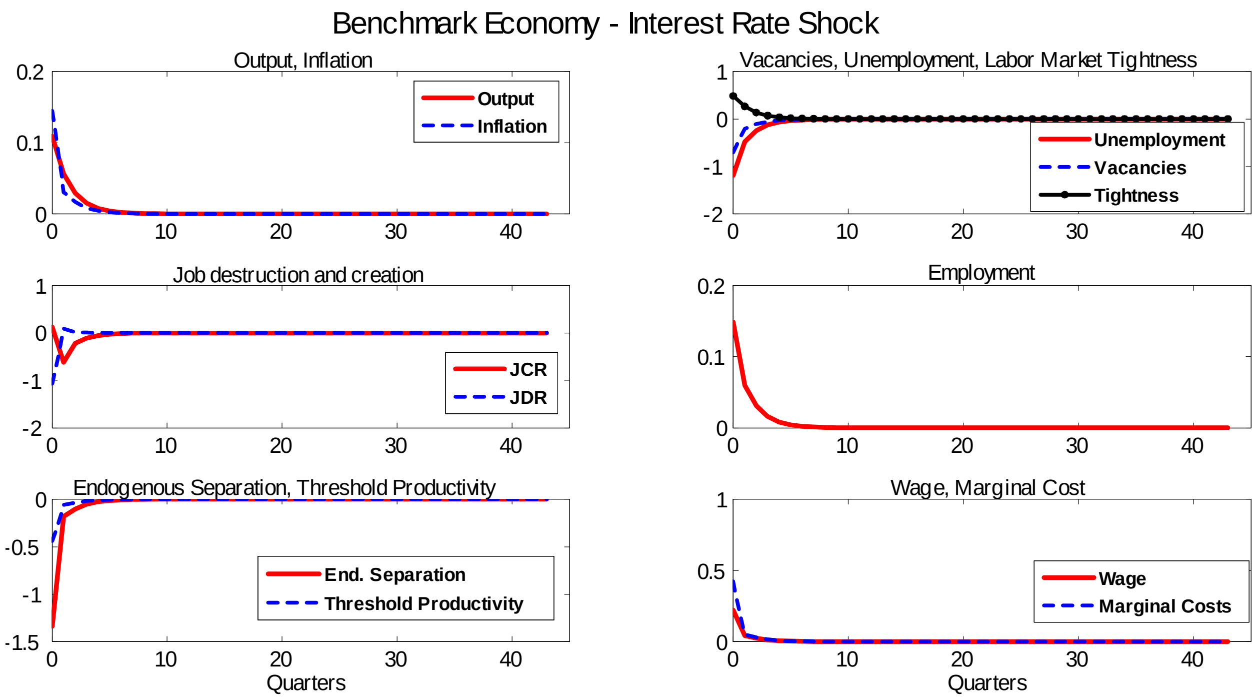

Figure 4: Impulse response function (%-deviation) to an one standard deviation interest rate shock

5.1.2 Productivity shock

Figure (5) shows the impulse response functions to a positive productivity shock in the benchmark calibration. On impact, the initial rise in aggregate productivity carries over to an output increase. The higher productivity leads to a decrease in marginal costs although real wages rises. Inflation declines on impact. In addition, the rise in aggregate productivity decreases the job destruction threshold which leads to a decrease in the separation rate and consequently job destruction decreases. Intuitively, when productivity rises, firms reduce firings by decreasing the productivity cut-off point. Thereby, even less productive workers are protected. Since the separation rate drops, unemployment falls initially before returning to its steady state. By the job creation condition, it is readily observable that a fall in the productivity cut-off will also cause firms to post more vacancies. The rise in vacancies and the decrease in the stock of job-seekers tighten the labor market causing the job finding rate to increase. Consequently, since the increase in the job finding rate outweighs the fall in unemployment, the job creation rate rises. After the shock, when productivity and output decline, firms post fewer vacancies. Since unemployment further decreases driven by the prolonged decline of the endogenous separation rates, the number of new matches shrinks because it gets more difficult for firms to find a worker. As a result, the job creation rate drops. The productivity thresholds finally increase again and this carries over to an increase of the endogenous separation rates. Unemployment rises causing a decline in the labor market tightness. The interplay of the increase in unemployment and the slacker labor market causes an increase in job creation. Consequently, job destruction finally dominates job creation.

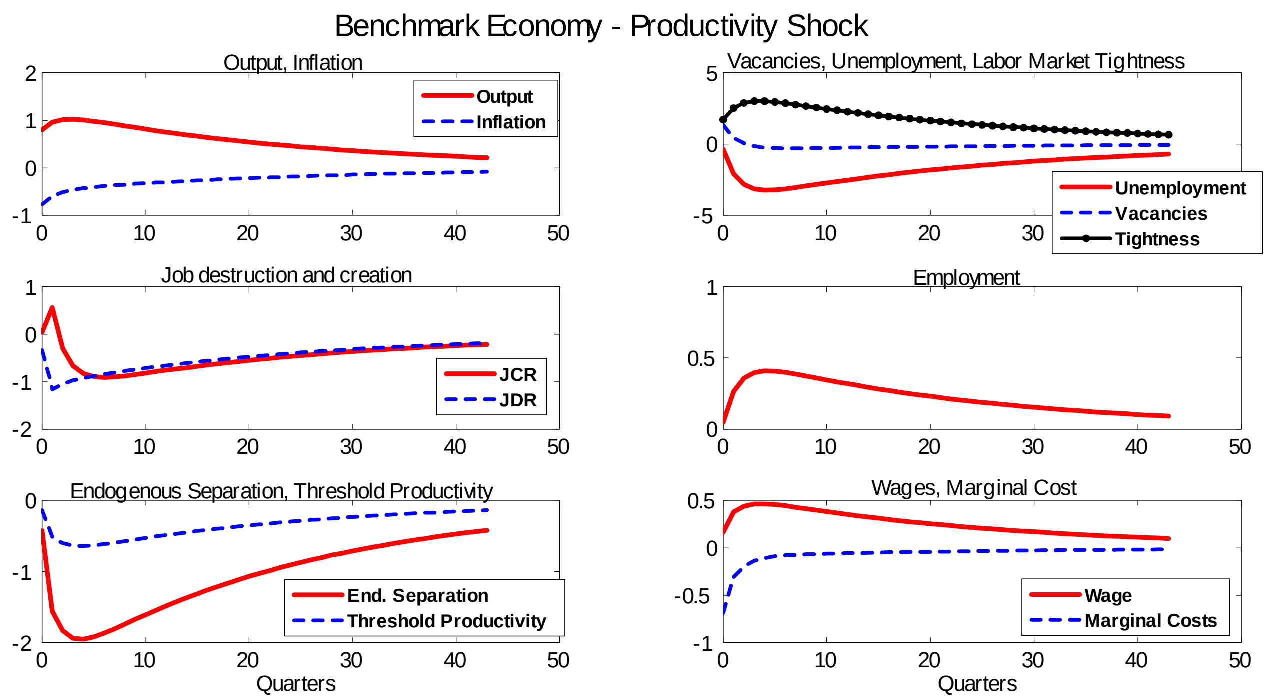

Figure 5: Impulse response function (%-deviation) to an one standard deviation productivity shock

5.2 Effects of firing costs in the single and dual contract labor market

This section presents c.p. analyses for firing costs under both supply and demand shocks. Therefore, I vary the size of firing costs, keeping all other parameters constant. Then I analyze how this changes the theoretical HP-filtered ($\lambda = 1600$) second moments. Table (2) and (3) in 5.2.1 and 5.2.2 report the absolute theoretical standard deviations of a subset of variables. Section 6 presents the relative standard deviations graphically.

5.2.1 Scenario A - Single contract labor market

Under the demand shock, firms increase production to meet aggregate demand. Firms decrease separations, unemployment and vacancies fall. The labor market tightens which increases real wages and real marginal costs. How do firing costs in a single labor contract environment change this reaction? In the single job labor market, firms internalize future dismissal costs and smooth job destruction by making their endogenous separation rates less responsive to the shock. On the one hand, higher firing costs create an incentive for firms to retain less productive workers. On the other hand, firing costs directly increase the reaction of marginal costs and inflation which dampens the volatility of job vacancies and job creation. Consequently, the reaction of unemployment is strongly restrained. This result is in line with Merkl and Schmitz (2011) who argue that firing costs generate an endogenous cost push shock that leads to a more severe inflation reaction. All in all, since the results show that the single job labor market reacts more sclerotic, the output path is strongly dampened. Under the supply shock, there are two main effects: First, as productivity rises,

Absolute volatilities in the single job design

Firing costs single job	0	0.08	0.16	0.24	0.32
Joint Shock					
Job Creation	1.54	1.45	1.54	1.68	1.70
Job Destruction	1.72	1.03	0.42	0.52	0.52
Unemployment	4.18	3.17	2.30	2.13	2.13
Inflation	0.86	0.84	0.86	0.85	0.85
Output	1.34	1.21	1.19	1.22	1.22
Productivity Shock					
Job Creation	1.40	1.38	1.54	1.68	1.70
Job Destruction	1.37	0.67	0.42	0.52	0.52
Unemployment	4.01	3.10	2.30	2.13	2.13
Inflation	0.85	0.80	0.80	0.79	0.78
Output	1.34	1.21	1.19	1.22	1.22
Interest Rate Shock					
Job Creation	0.64	0.44	0.04	$8 \text{x} 10^{-5}$	$2 \text{x} 10^{-5}$
Job Destruction	1.04	0.79	0.07	$2 \text{x} 10^{-5}$	$3 \text{x} 10^{-6}$
Unemployment	1.19	0.66	0.05	$9 \text{x} 10^{-5}$	$1 \text{x} 10^{-5}$
Inflation	0.14	0.25	0.32	0.33	0.33
Output	0.11	0.05	$3 \text{x} 10^{-4}$	$7 \text{x} 10^{-6}$	$5 \text{x} 10^{-6}$

Table 2: Absolute volatilities in the single job design

marginal costs decrease because each worker is able to generate more output. This counteracts the endogenous cost push shock induced by firing costs. Hence, inflation becomes less volatile. Second, in line with Thomas (2006, p. 16), when the same shock hits one economy with EPL, the fraction of jobs affected by job destruction is smaller compared to an economy without EPL. In other words, when firms reduce the productivity threshold, even unproductive workers are secured and not being dismissed. Firms make separations less responsive to the shock and the volatility of the job destruction rate decreases which directly maps into a diminished reaction of unemployment and an increased reaction of labor market tightness. This mechanism works until firms cannot further decrease their endogenous separation rates. After that threshold, all firings are exogenous in the model. Firms keep posting vacancies because the rise in aggregate productivity increases the surplus of a match. This leads to an increase in the reaction of the job finding probability which turns into an augmented reaction of job creation and employment and hence output. From a more technical view, this is exactly why the calibration for the lognormal productivity distribution is so crucial in this kind of models. By assuming larger values of σ_a, the distribution takes a course which displays a larger slope and a higher peak. Consequently, the same amount of firing costs induces a larger fall of endogenous separations and reinforces the explained mechanism.

Under the joint shock, the model predicts that the oscillation of unemployment is dampened. Admittedly, for inflation volatility the relative magnitude of the shock matters. However, the simulation exercise for the joint shock indicates that higher firing costs lead to strengthened price adjustment and hence more inflation volatility.

5.2.2 Scenario B - Dual contract labor market

In this simulation scenario, the labor market is characterized by duality, i.e. an EPL gap between fixed-term and permanent workers. By increasing this gap, firms adjust their hiring and firing decisions by altering the threshold productivities which are now specific to the contract type.

On the one hand, firms become more and more reluctant to layoff permanent workers. They reduce their separation rates for permanent workers to avoid the increasing firing costs, i.e. firms make their permanent worker separation rate less sensitive to shocks. More unproductive workers are secured. In addition, they narrow down the transition rates between fixed-term and permanent jobs because they anticipate that this implies the increased layoff costs in the future. On the other

Absolute volatilities in the dual labor market design

Firing costs PC	0	0.08	0.16	0.24	0.32
Joint Shock					
Job Creation	1.54	1.62	1.64	1.61	1.61
Job Destruction	1.72	1.64	1.45	1.21	0.98
Unemployment	4.18	4.41	4.55	4.59	4.56
Inflation	0.86	0.87	0.88	0.88	0.89
Output	1.34	1.35	1.36	1.37	1.39
Productivity Shock					
Job Creation	1.40	1.48	1.50	1.47	1.48
Job Destruction	1.37	1.31	1.17	0.97	0.79
Unemployment	4.01	4.25	4.42	4.48	4.47
Inflation	0.86	0.87	0.88	0.88	0.89
Output	1.34	1.35	1.36	1.37	1.38
Interest Rate Shock					
Job Creation	0.64	0.66	0.67	0.65	0.63
Job Destruction	1.04	0.98	0.87	0.72	0.58
Unemployment	1.19	1.16	1.10	1.00	0.89
Inflation	0.14	0.15	0.17	0.18	0.19
Output	0.11	0.11	0.10	0.09	0.08

Table 3: Absolute volatilities in the dual labor market design

hand, firms use fixed-term contracts as a "side-track" for the more and more sclerotic permanent contract segment. Since there are less firing costs for fixed-term worker, firms shift their labor turnover in this segment by increasing both job creation and job destruction. They become less selective contracting fixed-term workers. At the same time, they have an incentive to interrupt the convergence process by terminating fixed-term contracts before being updated to permanency. Technically, firing costs for permanent workers increase the surplus for a permanent job, S^{PC}, while they decrease the surplus for a fixed-term job, S^{FC}. Consequently, in equilibrium the threshold productivity $\tilde{a}^{PC}$ must diminish while $\tilde{a}^{FC}$ must rise.

This "side-track" mechanism works until firms cannot further decrease their separation rates for permanent contracts because the reservation productivity reaches the tail of the lognormal productivity distribution. The permanent worker segment collapses to an exogenous separation model invariant to shocks which dramatically reduces the volatility of the overall separation rate. From this point on, the reaction of job creation is reduced because firms cannot further bypass the stricter regulation in the permanent worker segment, i.e. they cannot further secure permanent work by lowering the permanent productivity threshold. Intuitively, firms are at some point reliant on a minimum requirement of productive permanent staff to sustain production.

Under the interest rate shock marginal costs and consequently inflation become more volatile with higher duality. This partly wipes out the effect on the job creation margin. As a result the job finding rate reacts less volatile and so does labor market tightness. The diminished reaction of the job finding rate is enough to decrease the volatility of unemployment and output.

Under the productivity shock, the steady-state surplus of fixed-term workers is smaller than the surplus for permanent worker for every aggregate productivity level.[14] Hence, when the shock hits and moves productivity from its steady state level, the impact on the surplus for fixed-term workers is larger. Given the job creation condition, this goes along with a more sensible reaction of labor market tightness and the job finding rate becomes more volatile. The reaction of unemployment depends on the interplay between job creation and job destruction, respectively the job finding and separation rates. As explained above, when the "side-track" mechanism is active, the rise in the variability of job creation is larger than the fall in the overall separation rate. As a consequence unemployment volatility is enhanced. However, at the edge of the "side-track" mechanism, this interplay inverts because of the large fall in the separation rate in the permanent segment, leading to an decreased unemployment volatility. Unemployment volatility thus displays an inverted U-shape.

Under both shocks, the reaction of job destruction is clearly dampened indicating that the fall in the volatility of permanent separations exceeds the increased volatility of fixed-term separations. As explained above, the reaction of job creation is first increased. Given the close relation between employment and output, the volatility of output slightly increase which results from the increased job turnover in the segment of fixed-term workers. All in all, under the joint shock the model predicts that the sensibility of output and inflation slightly increase while unemployment follows an inverted U-shaped pattern.

6 Relative unemployment volatility and literature comparison

The model predictions for unemployment also hold in relative terms. Figure (6) graphs the relative unemployment volatility as a function of firing costs for permanent workers hence duality. Figure (7) plots the relative unemployment volatility as a function of firing costs for the single job in the single job labor market design.[15] Relative volatility is defined as the theoretical HP-filtered standard deviation of unemployment divided by the theoretical HP-filtered standard deviation of total income. i.e. σ_U/σ_Y.

It is obvious that relative unemployment volatility in the single job design is in any case lower than in the dual labor market. Irrespective of the shock type, the inverted U-shape is visible in the simulations for duality. How do these results match up with previous theoretical work?

Theoretical literature has produced so far very divergent results in terms of the effects of institutions on the amplification of macroeconomic shocks. Veracierto (2008) shows that, in a Real Business Cycle Model, the volatility of employment and output tends to be lower in countries with higher levels of EPL. Thomas (2006) uses a matching model and concludes that firing costs reduce the magnitude of business cycle fluctuations. Zanetti (2011) studies the impact of unemployment benefits and firing taxes in a New Keynesian model for the UK. He finds that firing costs decrease the volatility of output, employment, unemployment and of flows out of and into unemployment while the volatility of vacancies, inflation and real wages increase (see Zanetti (2011), Table 2, p.

[14] This was also found by Hornstein (2005) and Silva and Toledo (2009).

[15] I do not plot the interest rate shock for the single job design because the volatility of total income virtually vanishes at high amounts of firing costs.

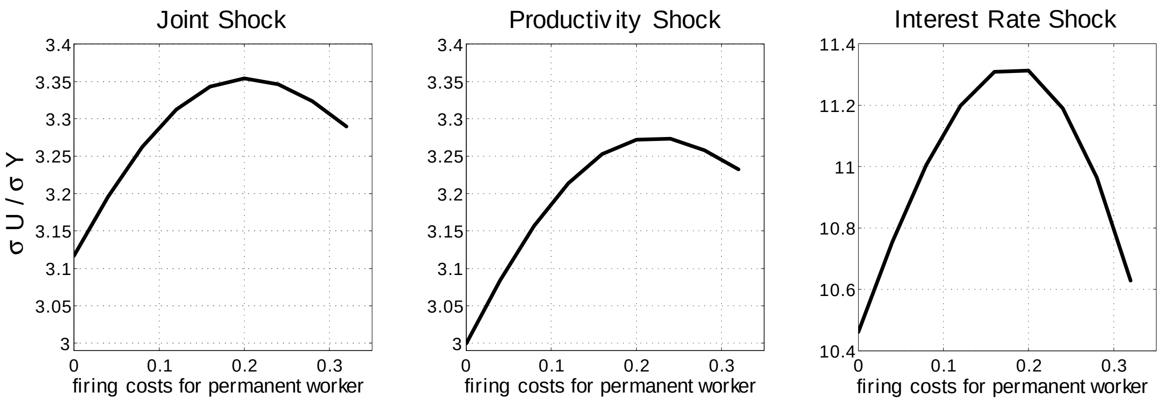

Figure 6: Relative unemployment volatility in the dual labor market

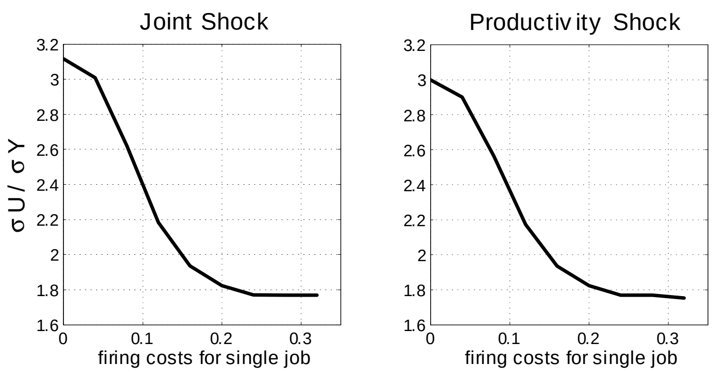

Figure 7: Relative unemployment volatility in the single job labor market

654). For the U.S., Silva and Toledo (2009) extent the standard matching model not only by introducing firing costs but make these costs specific to both new hires and incumbent workers and find that the volatility of unemployment and job creation is higher than without hiring and firing costs. Contrary, Sala et al. (2012) find that an increase in firing costs, for either fixed-term or permanent jobs reduce the volatility of unemployment in their model with a representative European labor market. Bentolila et al. (2012) study the different response of Spanish and French unemployment to productivity shocks. In a counterfactual simulation, they argue that the larger EPL gap in Spain can explain Spain's higher steady state unemployment as well as higher unemployment volatility during the Great Recession. Costain et al. (2010) is probably the most related article to this one. They study the dynamics of the dual Spanish labor market over a longer period represented by a sequence of productivity shocks. In a simulation exercise, amongst other things, they find that unifying, e.g. equalizing firing costs for fixed-term and permanent, would decrease unemployment volatility.

My theoretical model is complementary to the mentioned work but is able to uncover the source of the divergent results. Zanetti (2011) assumes that new matches always have maximum productivity, so that they are never separated. This assumption shuts down the "side-track" mechanism. Therefore, unemployment volatility decreases unambiguously. Technically, this is equivalent to the single job design of my model. Contrary, as in Silva and Toledo (2009) and Costain et al. (2010) I relax the maximum productivity assumption for new workers and therefore the "side-track" mechanism is operative which leads to unemployment volatility to increase. However, this can explain unemployment fluctuations only up to a certain threshold. After the threshold, the unemployment response to macroeconomic shocks is dampened because it gets more difficult for firms to substitute permanent with temporary layoffs. This insight makes clear that non-linearities play an important role and the effects of firing costs depend on the benchmark level of duality.

7 Empirics

7.1 Related literature

There is also empirical cross-country literature on the role of labor market institutions on labor market volatilities. In a purely empiric paper, Faccini and Rosazza-Bondibene (2011) study how different labor market institutions affect unemployment fluctuations. Amongst other things, they find that EPL for permanent workers reduces unemployment volatility. Sala et al. (2012) use a bivariate OLS regression to analyse the relationship of EPL on unemployment volatilities. They regress absolute unemployment volatilities of different OECD countries on the corresponding average EPL index and find an alternating relationship. From 1970 to 1990 they find a negative relationship and from 1990 to 2006 a positive relationship for permanent contracts. Rumler and Scharler (2011) focus on the effects of labor market institutions on output and inflation volatilities by estimating a two-way fixed effects model. These authors find that the strictness of EPL appears to play only a limited role for output and inflation volatility. Abbritti and Weber (2010) employ a panel vectorautoregression to analyze the dynamics of inflation and unemployment. They study the response of the labor market to macroeconomic shocks under different institutional regimes. In particular, they find that the response of unemployment to different macroeconomic shocks is smaller in a regime with low unemployment benefits and high EPL compared to a vice versa regime.

7.2 Empirical approach

Amongst methodology and data selection, the main difference between the mentioned previous empirical work and mine is that my hypothesis are directly engendered from the theoretical model. To a certain extent, it is thus straightforward to inspect the predictions from the dynamic model above by studying the correlation between labor turnover costs and the response of unemployment to GDP fluctuations. However, there are at least two major challenges for the empirical analysis:

First, model simulations are comparisons of different responses of the labor market to macroeconomic shocks while only changing one institutional characteristic, e.g. EPL. Analysis based solely on cross-country variation are not directly comparable to dynamic models, e.g. bivariate regressions of averages of labor market variables on averages of institutional characteristics clearly miss the variation along the time dimension. Second, when two countries are hit by macroeconomic shocks of different magnitude, labor market volatilities could be different, even though EPL would be of comparable size in both countries.

To cope with the challenges mentioned above, I use a panel data-set for 20 OECD countries from 1985 to 2012 controlling for both time and country fixed-effects. Furthermore, I take a relative measure of unemployment as a dependent variables, e.g. I focus on the ratio of the volatility of unemployment to the volatility of GDP to measure the amplification effects of changes in EPL. I focus on unemployment volatility because it is a proxy for the entire labor market and comparable data is available for many countries.

7.3 Estimation strategy for volatility

The theoretical model predicts a concave non-monotone relationship between unemployment volatility and EPL. Therefore I conduct a two-step estimation strategy: First I try to uncover the true nature of the non-linearity by estimating the relationship as a restricted cubic spline function.[16] The aim is to find a transformation of the EPL variable that is close to the semi-parametric fit of the spline smoother. Second, I include a transformation of the EPL index on permanent contracts and run panel estimations. Figure (8) shows the spline smoother and an inverse transformation that seems to be a reasonable approximation.[17]

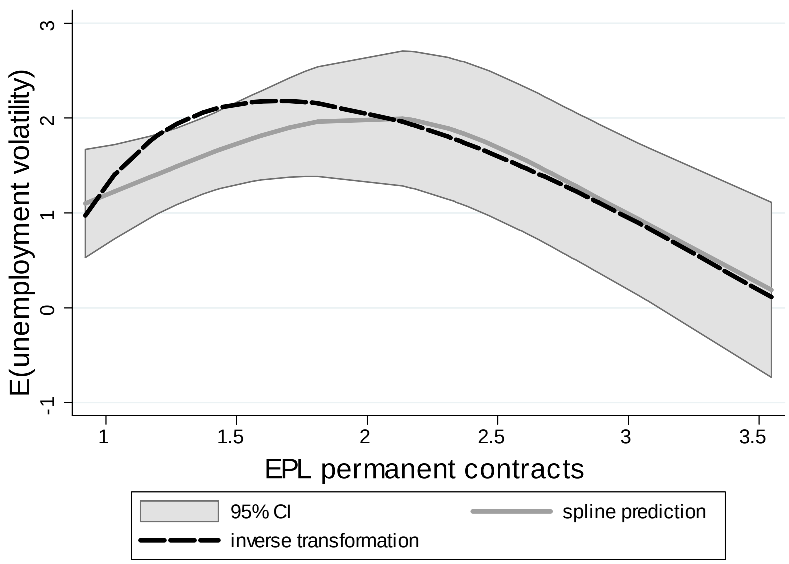

Figure 8: The solid gray line plots the restricted cubic spline. The gray space represents 95% confidence intervals and the dashed black line plots the inverse fit using panel regression (v) below. I excluded obvious outliers with an EPL below 0.8 and above 4.

Specifically, the baseline empirical model has the form:

$$\ln\left(\frac{\sigma(u)_{it}}{\sigma(y)_{it}}\right) = \alpha + EPL_{it}^{PC}\beta_1 + \frac{1}{EPL_{it}^{PC}}\beta_2 + INST_{it}\gamma + CONT_{it}\delta + \eta_i + \rho_t + \epsilon_{it}, \tag{44}$$

where $i = [1, ..., 20]$ indexes a country, $t = [1, ..., 7]$ indexes a non-overlapping four-year time span and $\ln(.)$ stands for the log of the unemployment-GDP-ratio. I use the log of the ratio in order to interpret the results as semi-elasticities. EPL_{it}^{PC} terms the OECD EPL index for permanent contracts. $INST_{it}$ denotes a vector of other labor market institutions including the EPL index for fixed-term contracts and $CONT_{it}$ a vector of structural control variables. As I allow for two-way

[16] I estimate $\ln\left(\frac{\sigma(u)_{it}}{\sigma(y)_{it}}\right) = \alpha + f(EPL_{it}^{PC}) + INST_{it}\gamma + CONT_{it}\delta + \eta_i + \rho_t + \epsilon_{it}$,
where $f(EPL_{it}^{PC})$ approximates the functional space with a restricted cubic spline smoother. I use Stata's mkspline command which uses a restricted cubic spline to obtain a continuous smooth function that contains linear as well as piecewise cubic polynomials.

[17] The inclusion of an inverse transformation has been suggested by Lind and Mehlum (2007) and is further justified by the results of a simple Ramsey (1969) regression specification-error test.

fixed effects, η_i denotes a country fixed-effect and ρ_t a time-window fixed-effect. ϵ_{it} is an error term.[18] Given the model predicts an inverted U-shape relationship between the outcome variable and EPL_{it}^{PC}, I would expect a threshold value of EPL^{PC} at which the overall marginal effect $\frac{\partial y}{\partial EPL^{PC}} = \beta_1 - \frac{\beta_2}{EPL^{PC2}}$ changes the sign from positive to negative.

7.4 Descriptive statistics

7.4.1 Macroeconomic variables

Both unemployment and GDP time series are taken from Eurostat and the OECD and reach from Q1/1985 to Q4/2012. Unemployment is defined as the harmonized, seasonally adjusted, quarterly unemployment rate. GDP is measured by the expenditure approach and is expressed in quarterly millions of national currency. I choose national currency because it is most suitable for the comparison with the outcomes of my simulated model. For example, when the macroeconomy is hit by a positive productivity shock, this means that the average worker in a country produces more in terms of the country's currency. In contrast to other studies (e.g. Rumler and Scharler (2011), Faccini and Rosazza-Bondibene (2011)), I do not to measure output by GDP per capita because standard search and matching models ignore part-time issues or labor force participation. In line with the simulations above, the volatility is measured by the standard deviation of the HP-filtered ($\lambda = 1,600$) cyclical component from its trend. The HP-filter is applied to the full length of the time series. In order to obtain a panel structure, I split the time span into seven non-overlapping four-year periods. Then I set up ratios between the volatility of unemployment and GDP.[19]

7.4.2 Employment protection

I proxy layoff costs by the OECD EPL indices. Figures (14) and (13) in the appendix show the averages of the EPL indices for permanent respectively temporary contracts from 1985 to 2012. The Anglo-Saxon countries display the lowest employment protection among the given OECD countries whereas the central-European states are distributed at the upper tail of the ranking. In addition, Figure (**??**) shows the evolution of both indices from 1985 to 2012 for every country. These indicators measure the procedures and costs involved in dismissing workers and the procedures involved in hiring workers on fixed-term contracts. These indices range in a scale from 0 to 6 and are increasing with stricter EPL.[20] For my analysis, I use version 1 of the index for individual dismissals (regular/ indefinite contracts) and for fixed-term contracts which are weighted summary indicators of dismissal protection.[21]

[18] Note that the concave, non-linear relationship is not purely identified by within variation. McIntosh and Schlenker (2006) show that if the depend variable is a global nonlinear function of an explanatory variable, both the variation within and between groups are responsible for the identification of the estimation coefficients. Deviation from the mean of the explanatory variable results in different impacts on the dependent variable which depend on the absolute value of the explanatory variable.

[19] Table (10) in the appendix shows the unemployment respectively GDP volatilities and their corresponding ratios across the entire time span for the 20 OECD countries that are in my sample. The importance of the relative unemployment measure becomes apparent. Countries like Finland and Norway with a high absolute values of unemployment volatility are ranked in the middle field of OECD because GDP volatility is also high in absolute values. There is neither a particular pattern for Anglo-Saxon nor for European countries in the raw data. However, the ratio for the US is about twice as high as in the biggest European economies, e.g. Germany and France.

[20] Note that it is not possible to compare the absolute magnitude of the index for contracts with the absolute magnitude of the index for fixed-term contracts.

[21] The index incorporates three aspects: (i) procedural inconveniences such as notification and consultation requirements, (ii) notice periods and severance pay for no-fault individual dismissal and (iii) difficulty of dismissal which includes the definition of unfair dismissal, length of trial period, compensation (not ordinary severance pay) following

The OECD indices have some advantages over other available measures when analyzing dual labor markets. First, unlike the World's Bank index for firing costs, the OECD distinguishes between temporary and permanent contracts. Second, many studies use the EPL index calculated by Nickell (2006). However, Nickell's (2006) index is not available after 2006. To cover a large time span (1985-2012), I use the latest OECD indices.

In many studies, institutional variables like EPL are treated as exogenous without any further discussions. Imagine a situation in which labor market regulation policies become stricter when economies face relative volatile unemployment. If this is the case, the correlation between the EPL variables and the error term would introduce bias into the estimates. To guard against this best possible, I use the initial values of the EPL indices rather than just taking the averages over the four-year time windows.[22] Of course this does not entirely ensure the possible endogeneity problem. However, the potential influence of the volatility ratio on the EPL indices is reduced to a minimum. In addition, the exogeneity argument comes straight from the model simulations which show the c.p. connection between EPL and changes in the volatility ratio.

7.4.3 Other institutions and control variables

To cover other channels that might influence relative unemployment dynamics, I include four additional institutional variables into the panel analysis taken from various sources: union density, coordination of wage-setting, centraliziation of wage bargaining and net benefit replacement rates. I further control for monetary policy stance by including the real interest rate. In addition, the government final consumption expenditures as a percentage of GDP denotes a proxy variable for the fiscal policy stance.[23]

7.5 Results

Table (4) displays the results of five GLS regressions of relative unemployment on EPL and controls.[24] Column (i) shows the estimates of a regression solely including the EPL index for permanent workers plus its inverse transformation controlling for both time and country-fixed effects. In (ii) I include the EPL index for fixed-term contracts. In (iii) and (iv), I randomly add the other institutional and control variables to the regression. In the regression displayed in (v), I successively exclude any variable that does not have significant parameter estimates, starting with the least significant one. In any of the five regression, the coefficients for the EPL index and its reciprocal transformation have a negative sign and are both individually and jointly significant at the .01, respectively at the .05 level. The EPL index for temporary contracts shows a negative coefficient which seems to be in line with the simulation results of scenario A but is not statistical significant. Higher union density, coordination of wage-setting and net benefit replacement rates seem to have

unfair dismissal and possibility of reinstatement. Version 1 of the index for temporary contracts is a weighted indicator of two aspects: (i) fixed-term contracts and (ii) temporary work agency employment which denotes the definition of validity for the use of fixed-term contracts, the maximum number and cumulated duration of successive contracts.

I exclude aspect (ii) because temporary agency employment is not exclusively formulized in the model. Thus, I calculate an index only for fixed-term contracts.

[22] This method is also used in Rumler and Scharler (2011). Note that the results do not change qualitatively when using averages instead of the initial values.

[23] The appendix provides more detailed information on all data definitions and sources.

[24] I first did a simple LSDV estimation approach. A modified Wald test could not reject the null hypothesis of homoscedasticity indicating that there is groupwise heteroscedasticity. A Wooldridge test for autocorrelation for panel data indicated that there is also autocorrelation. To deal with this issues, I use panel corrected standard errors like in Beck and Katz (1995) which allow the disturbances to be heteroscedastic and that within panels, there is first-order autocorrelation and that the coefficient of the AR(1) process is specific to each panel.

Dependent variable: Relative unemployment volatility $[\sigma(u)_{it}/\sigma(y)_{it}]$

	(i)	(ii)	(iii)	(iv)	(v)
EPL PC	-1.473***	-1.488***	-1.493***	-1.769***	-1.607***
	[0.382]	[0.400]	[0.398]	[0.382]	[0.325]
1/EPL PC	-4.073**	-4.116**	-3.163**	-4.111***	-3.714***
	[1.795]	[1.838]	[1.423]	[1.297]	[1.232]
EPL FC		-0.00891	-0.0705	-0.108	
		[0.0994]	[0.108]	[0.0996]	
Coordination			-0.235***	-0.249***	-0.209***
			[0.0698]	[0.0722]	[0.0646]
Centralization			1.073	0.917	
			[0.668]	[0.631]	
Union density			-0.0208*	-0.0232**	-0.0163*
			[0.0116]	[0.0111]	[0.00921]
Replacement			-1.500***	-1.254**	-1.234**
			[0.503]	[0.518]	[0.513]
Interest rate				-0.0925*	-0.0904*
				[0.0536]	[0.0543]
Government size				-0.0252*	-0.0223*
				[0.0132]	[0.0133]
Constant	18.41***	18.58**	16.27***	20.70***	18.96***
	[7.103]	[7.283]	[5.656]	[5.191]	[4.779]
N	136	136	136	132	132
R-sq	0.754	0.753	0.788	0.753	0.76

Panel corrected standard error in brackets. * p<0.10, **p<0.05, *** p<0.01;

Table 4: GLS estimation results

negative effects on relative unemployment volatility. Higher interest rates and a larger government size also seem to have dampening effects on the volatility ratio.

7.6 Robustness and sensitivity

To further check the non-monotone relationship between EPL and relative unemployment volatility, I test for the presence of an inverted U-shaped pattern using the Sasabuchi (1980) test.[25] Given the empirical model has the form $y_{i,t} = \alpha + X_{i,t}\beta + X_{i,t}^{-1}\gamma + Z_{i,t}\delta + \varepsilon_{i,t}$, the test checks for an inverted U-shape by testing the following joint hypothesis:

$$H_0 : (\beta - \frac{\gamma}{X_{\min}^2} \leq 0) \cup (\beta - \frac{\gamma}{X_{\max}^2} \geq 0) vs. H_1 : (\beta - \frac{\gamma}{X_{\min}^2} > 0) \cup (\beta - \frac{\gamma}{X_{\max}^2} < 0). \quad (45)$$

Table (5) shows the corresponding test results for regression (v). It turns out that the extreme value of the EPL index for permanents for the main regression (v) is about 1.5. The slope on the left hand side of this extreme point is always positive and significant at the .01 level. Beyond the extreme value the slope is negative and significant at the .01 level. All in all, the test rejects a monotone or U-shape in favour of an inverted U-shape.

[25] I use the Stata ado-file by Lind and Mehlum (2010). They adopted the general framework of Sasabuchi (1980) to test for the presence of a U-shaped or inverted U-shaped pattern.

Sasabuchi test for (v)

	Lower bound	Upper bound
Interval	0.257	5
Slope	48.72	-1.33
t-value	2.74	-4.58
P>|t|	0.0036	0.00001
Overall test of inverse U-shape		
Extreme point: 1.50597		
t-value = 2.74		
P>|t| = .00357		

Table 5: Sasabuchi test results

However, it might be the case, that there are some outliers in the data. In order to check whether some particular time periods or countries drive the results , I evaluate the time sensitivity as well as the cross-sectional stability. Given the theoretical model predicts that dualism of the labor market entails an inverted U-shaped pattern of relative unemployment volatility when the labor market regulations becomes stricter for permanent contracts, this should be observable when countries with very distinctive dual labor markets are excluded from the sample. Hence, I first gradually drop time windows from the sample and then re-estimate (iv). Next, I use the same technique for deleting particular countries.[26]

Table (6) and (7) report the absolute minima and maxima of the estimates, the results of the Sasabuchi test and the corresponding time windows respectively countries which were dropped.

Dropping time periods

	Max	Min
EPL PC	-2.143***	-1.438***
	[0.472]	[0.455]
Dropped period	(1997-2000)	(2001-2004)
1/EPL PC	-6.457***	-3.408**
	[1.678]	[1.680]
Dropped period	(1997-2000)	(2001-2004)
Extreme point	1.735754	1.539256
Inverse U shape	P>|t|= 0.0001	P>|t| = 0.0239

Table 6: Robustness check - dropping time periods

Overall, the results for the EPL index for permanent contracts and its transformation are unaffected by excluding any particular time window. In any of the seven sub-regressions the inverted U-shaped pattern is at least significant at the .05 level. I interpret this as the results are not driven by any particular time period. When dropping countries the significance of the coefficients on the EPL for permanent contracts is affected by the exclusion of countries. In particular, the significance of the inverted U-shaped pattern is increasing in the exclusion of Anglo-Saxon countries and decreasing in the exclusion of European countries. More specifically, in 19 of 20 regressions the coefficients of the EPL variables display negative signs and are significant at least at the .05 level indicating that

[26] I do not exclude insignificant variables here because missing variables might be significant in a regression in which I dropped time windows or countries and this would bias the results for the EPL coefficients. Hence, I estimate (iv) - the regression with the full set of controls.

Dropping countries

	Max	Min
EPL PC	-1.996***	-0.0784
	[0.4224]	[0.864]
Dropped country	Ireland	Spain
1/EPL PC	-5.263***	-0.927
	[1.6767]	[0.460]
Dropped country	Ireland	Spain
Extreme point	1.62395	3.437208
Inverse U shape	P>|t|= 0.0012	P>|t| = 0.467

Table 7: Robustness check - dropping countries

there is an inverted U-shape in the data. In 1 of 20 regressions however, when Spain is excluded, both EPL coefficients drop and turn insignificant. Both from a technical and an economic view, this is not surprising. First, Spain displays the largest within variation in the EPL index in the entire sample.[27] By excluding Spain, the model loses a large part of variation which is required for statistical significance of the inverted U-shape of relative unemployment volatility. Second, with an average share of fixed-term contracts (number of workers on fixed-term contracts divided by total employment) of about 30% in the considered time period of 1985 to 2012, Spain's labor market displays the most distinctive example of a dual contract environment among all countries in the sample.[28] To further investigate the role of Spain, I drop the non-linear reciprocal transformation of the EPL index for permanent contracts and run a linear regression in which I regress the volatility ratio on solely the linear EPL index and control variables excluding Spain from the sample. In this linear regression, the coefficient for the EPL index has a negative sign and is significant at the .05 level. I conclude that the inclusion of distinctive dual labor markets generates the described inverted U-shape, while removing very dual labor markets from the sample goes along with an negative relationship between unemployment volatility and EPL for permanent workers which is comparable to the theoretical simulation results of the single contract labor market scenario.

8 Conclusion

In this paper I provide a New Keynesian model to analyze whether labor market duality either amplifies or dampens the labor market's reaction to macroeconomic shocks.

I find that labor market duality has noticeable effects on the cyclicality of unemployment, inflation and output and that the degree of duality determines the strength and directions of the effects. In particular, I find that low duality amplifies wheras high duality dampens unemployment volatility. On the one hand, duality provides an additional channel for employment adjustment for employers. Firms have the possibility to bypass stricter regulations in the permanent worker segment by shifting their labor turnover in the fixed-term worker segment. Even less productive permanent workers are secured whereas firms more frequently hire fixed-term workers but terminating their contracts before being updated to permanent agreements. The increased labor turnover in

[27] Spain's EPL index for permanent contracts has a variation of 1.191 units over the time period from 1985 to 2012. The average within standard deviation of the entire sample is 0.1726.

[28] Sala and Silva (2009, p. 152) place emphasis on the distinctiveness of the duality in Spain's labor market. They say that temporary contracts with no separation costs represent about 90% of all new hires and that this inflated the labor turnover in the segment of temporary workers since the first stark labor market reform in 1984.

the temporary worker segment leads to an amplification of unemployment volatility. On the other hand, for high degrees of duality, the endogenous separation rate for permanent workers becomes inelastic and the model converges to an exogenous separation model. This rigidity dampens the reaction of unemployment. The overall result is that duality leads to an inverted U-shaped response of unemployment to macroeconomic shocks.

A comparative simulation exercise for a single contract labor market predicts that higher EPL leads to vanishing unemployment volatility that is in any case lower than in the segmented labor market. Full regulation precludes labor market segmentation and hence firms do not have the possibility to adjust employment by the job creation margin.

In the empirical part of the paper, I construct a panel data-set and test the theoretical model predictions. I find that EPL for permanent workers is significantly correlated with unemployment volatility. In particular, the panel estimation infers that unemployment volatility is a global non-linear function in EPL for permanent workers. An inverted U-shape is identified which confirms the theoretical predictions. The non-linear relationship is particularly identifiable for countries with very segmented labor markets which I take as further evidence for the model's predictive power.

The theoretical predictions as well as the empirical tests show that labor market duality plays an important role in explaining labor market dynamics. By uncovering non-linearities in unemployment volatility, this paper helps reconciling the divergent previous research results.

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10 Appendix

10.1 Robustness analysis

10.1.1 Variation in the contract update probability (ϕ)

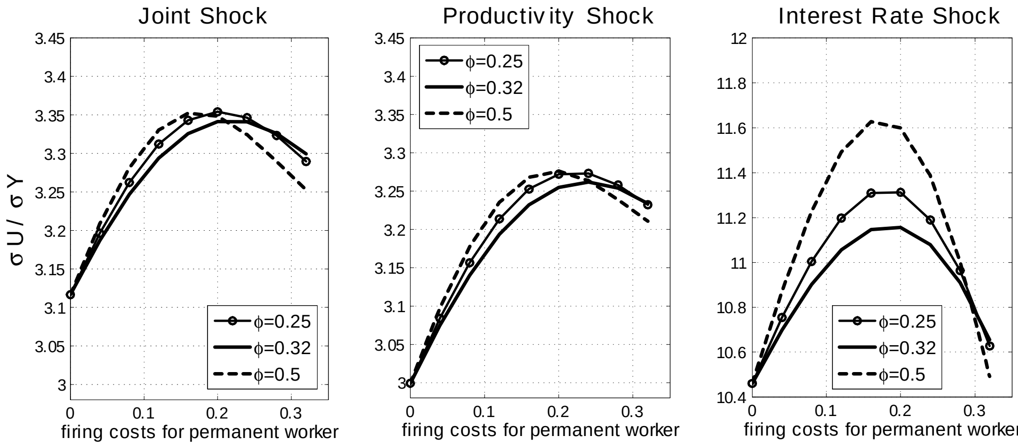

Figure 9: Relative unemployment volatility for different values of ϕ.

10.1.2 Variation in the variance of the distribution of idiosyncratic productivity (σ_a)

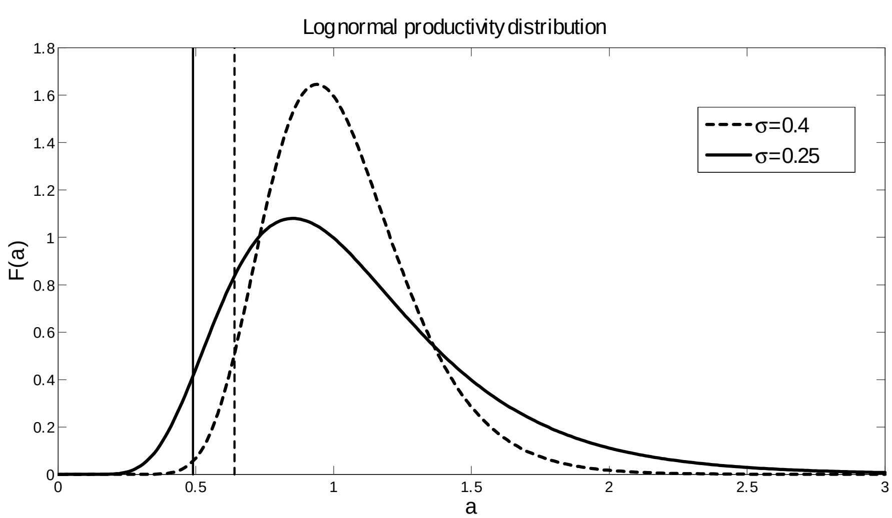

Figure 10: Lognormal productivity distribution for different values of σ_a.

To explore the robustness of the results I experiment with the variance of the distribution of idiosyncratic productivity. In the benchmark model above I use $\sigma_a = 0.25$. Now, I increase the variance to $\sigma_a = 0.4$ as in Trigari (2009). Hence, the positive skew of the lognormal-distribution increases and the distribution moves “farer away” from a normal distribution. Figure (10) plots the distributions. The vertical lines represent the equilibrium thresholds. Figure (11) and (12) show the results of the same simulation exercises as above. A higher variance of the productivity distribution scales down the amplitude of relative unemployment volatility. In addition, the effects of increasing firing costs decrease: With $\sigma_a = 0.25$, the relative volatility of unemployment increases by about 8% before decreasing again. With $\sigma_a = 0.25$, the relative volatility of unemployment only increases by about 5% before falling. The reason for this is that higher values of σ_a decrease the equilibrium threshold productivity per se, so the slope in the neighborhood of the threshold productivity is greater for lower values of σ_a. Thus, the same amount of firing costs moves more mass under the distribution which produces greater volatilities. Overall, the qualitative differences are minor and show that the inverted U-shaped reaction is robust with respect to changes in σ_a.

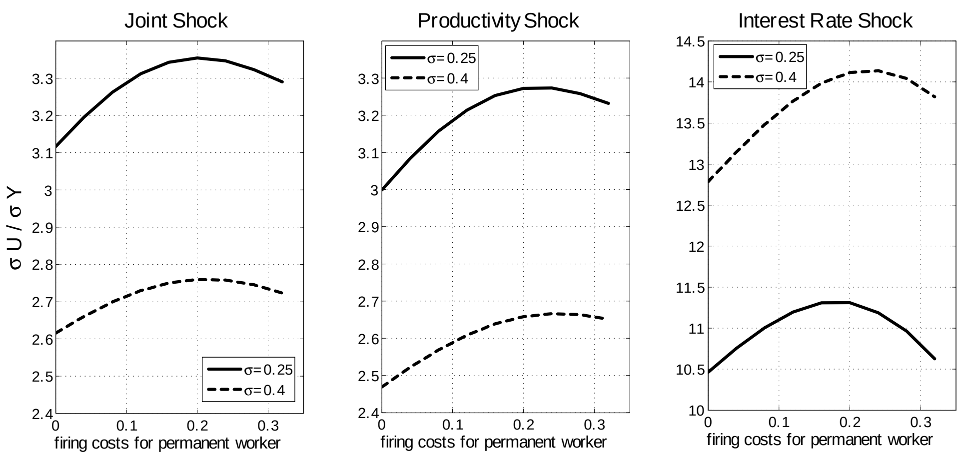

Figure 11: Relative unemployment volatility in the dual labor market for different variances of idiosyncratic productivity.

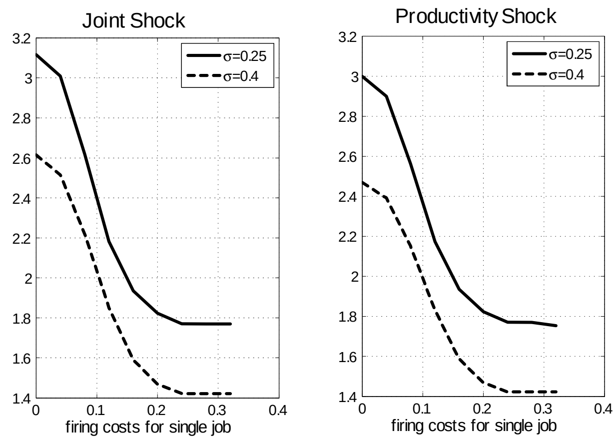

Figure 12: Relative unemployment volatility in the single labor market for different variances of idiosyncratic productivity.

10.2 Data description

Variable	Mean	Std. Dev.	Min	Max
Ln Ratio	1.648	0.619	-0.329	3.472
EPL permanent workers	2.096	0.957	0.257	5.000
EPL fixed-term workers	1.704	1.419	0.000	6.000
Coordination	3.050	1.321	1.000	5.000
Centralisation	0.395	0.186	0.089	0.978
Union density	37.114	20.648	7.663	83.863
Net replacement rate	0.669	0.116	0.140	0.910
Interest rate	1.989	1.375	-3.636	8.539
Government size	19.960	3.788	10.525	29.167

Table 8: Descriptive data details

Variable	Computation/ Description	Source
Unemployment Volatiltiy	Standard deviation of HP-filtered (lambda=1,600) harmonised, seasonally adjusted, quarterly unemployment rate	OECD (2013), Eurostat (2013)
GDP Volatility	Standard deviation of HP-filtered (lambda=1,600) GDP. Measured by expenditure approach in millions of national cur.	OECD (2013), Eurostat (2013)
EPL permanent	Version 1 of OECD EPL index for regular workers from 1985-2012	OECD (2013)
EPL fixed-term	Version 1 of OECD EPL index for fixed-term workers from 1985-2012 without temporary agency employment (TWA)	OECD (2013)
Coordination	ICTWSS index ranging from 1 to 5 reflecting at which level wage bargaining takes place	Visser (2013)
Centralisation	Summary measure taking into account both , union authority and union concentration at multiple levels	Visser (2013)
Union density	Ratio of wage and salary earners that are in trade unions, divided by the total number of wage and salary earners	OECD (2013)
Net replacement rate	Ratio between the net income while being out of work and while in work	Van Vliet and Caminada (2012)
Interest rate	Ratio of four-year average nominal short-term interest rate and inflation (%, all items)	OECD (2013)
Government size	Government final consumption expenditures as a percentage of GDP	Obben (2012)

Table 9: Data description and sources

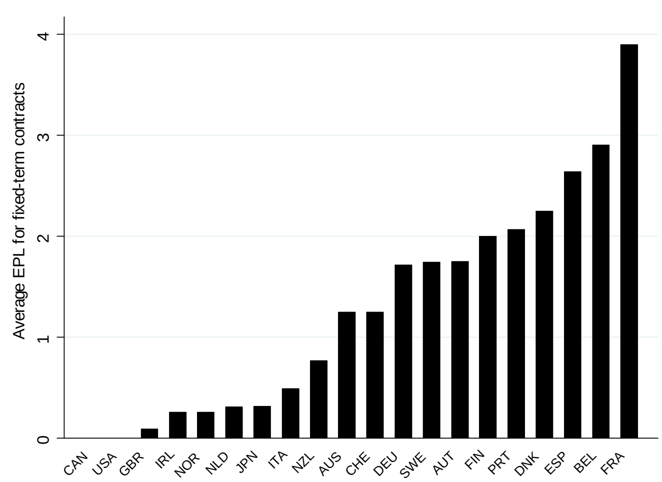

Figure 13: Average EPL for fixed-term contracts among OECD countries from 1985 - 2012. Source: OECD (2013)

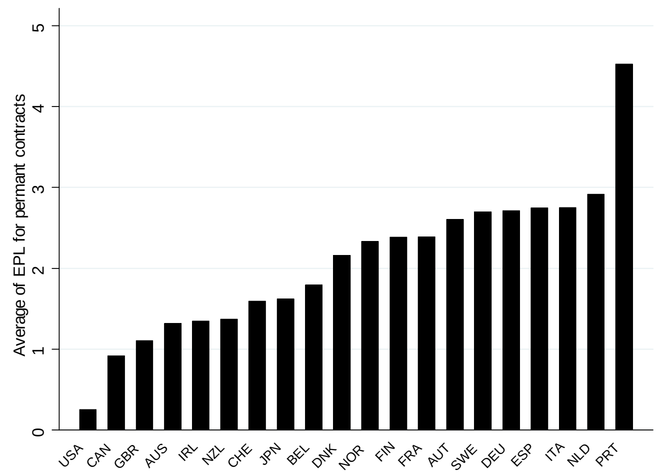

Figure 14: Average EPL for permanent contracts among OECD countries 1985 - 2012. Source: OECD (2013)

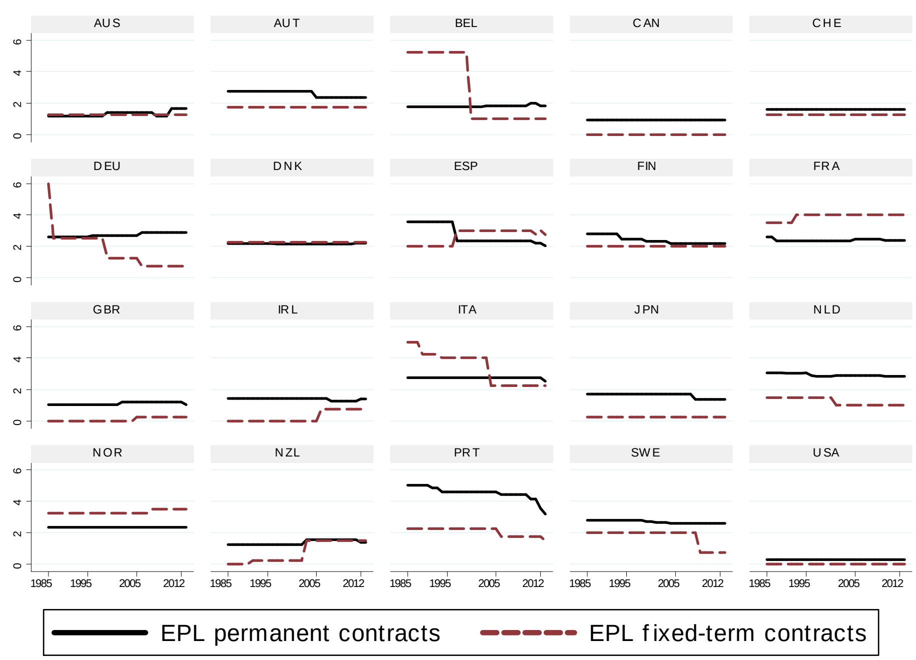

Figure 15: EPL indices over time among OECD countries. Source: OECD (2013)

Country	Average Ratio	Unemployment vol.	GDP vol.	Time period
Italy	3.76	5.05	1.34	1985-2012
Ireland	3.88	11.12	2.86	1985-2012
Canada	3.91	7.58	1.94	1985-2012
New Zealand	4.02	10.08	2.51	1985-2012
Norway	4.07	13.93	3.43	1985-2012
Germany	4.26	6.35	1.49	1993-2012
Japan	4.29	6.67	1.56	1985-2012
France	4.79	5.36	1.12	1985-2012
Australia	4.80	8.53	1.78	1985-2012
Finland	5.17	16.14	3.12	1985-2012
Austria	5.46	7.81	1.43	1994-2012
UK	5.49	7.61	1.39	1985-2012
Portugal	5.75	9.60	1.67	1985-2012
Belgien	6.10	7.32	1.20	1985-2012
Spain	6.51	9.72	1.49	1985-2012
Denmark	7.41	12.13	1.64	1985-2012
Sweden	7.71	15.13	1.96	1985-2012
Netherlands	8.36	12.31	1.47	1985-2012
US	8.48	11.37	1.34	1985-2012
Swiss	13.74	21.12	1.54	1985-2012

Table 10: GDP/ Unemployment volatilities among OECD countries

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