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WAGE DYNAMICS NETWORK

WORKING PAPER SERIES

NO 1183 / APRIL 2010

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LABOR MARKET INSTITUTIONS AND THE BUSINESS CYCLE

UNEMPLOYMENT RIGIDITIES VS. REAL WAGE RIGIDITIES

by Mirko Abbritti
and Sebastian Weber

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UNEMPLOYMENT RIGIDITIES VS. REAL WAGE RIGIDITIES [1]

by Mirko Abbritti [2] and Sebastian Weber [3]

In 2010 all ECB publications feature a motif taken from the €500 banknote.

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Wage Dynamics Network

This paper contains research conducted within the Wage Dynamics Network (WDN). The WDN is a research network consisting of economists from the European Central Bank (ECB) and the national central banks (NCBs) of the EU countries. The WDN aims at studying in depth the features and sources of wage and labour cost dynamics and their implications for monetary policy. The specific objectives of the network are: i) identifying the sources and features of wage and labour cost dynamics that are most relevant for monetary policy and ii) clarifying the relationship between wages, labour costs and prices both at the firm and macro-economic level.

The WDN is chaired by Frank Smets (ECB). Giuseppe Bertola (Università di Torino) and Julián Messina (World Bank and University of Girona) act as external consultants and Ana Lamo (ECB) as Secretary.

The refereeing process of this paper has been co-ordinated by a team composed of Gabriel Fagan (ECB, chairperson), Philip Vermeulen (ECB), Giuseppe Bertola, Julián Messina, Jan Babecký (CNB), Hervé Le Bihan (Banque de France) and Thomas Mathä (Banque centrale du Luxembourg).

The paper is released in order to make the results of WDN research generally available, in preliminary form, to encourage comments and suggestions prior to final publication. The views expressed in the paper are the author's own and do not necessarily reflect those of the ESCB.

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Abstract

This paper investigates the importance of labor market institutions for inflation and unemployment dynamics. Using the New Keynesian framework we argue that labor market institutions should be divided into those institutions that cause Unemployment Rigidities (UR) and those that cause Real Wage Rigidities (RWR). The two types of institutions have opposite effects and their interaction is crucial for the dynamics of inflation and unemployment. We estimate a panel VAR with deterministically varying coefficients and find that there is a profound difference in the responses of unemployment and inflation to shocks under different constellations of the labor market.

Keywords: Labor Market Search, Real Wage Rigidity, Unemployment, Business Cycle, Monetary Policy

JEL Classification: E32, E24, E52

Non Technical Summary

Understanding the working of labor markets is crucial to understand inflation and unemployment dynamics. Over recent years, many voices have risen to advocate reforms to make labor markets more flexible. The conventional view among policy makers is that more flexible labor markets are needed to improve the effectiveness of monetary policy. Moreover, flexible labor markets are believed to be important to facilitate the efficient adjustment of the economy to sectoral shifts and economic changes. However, most of these voices do not specify what labor market flexibility actually means. The aim of this paper is to shed some light, both theoretically and empirically, on three related issues: (1) Are labor market institutions really important for inflation and unemployment dynamics and, if yes, how? (2) What does labor market flexibility mean? (3) How important are interactions among different labor market institutions?

Recent theoretical articles have started to incorporate labor markets in the DSGE framework. The findings from these models have enhanced our understanding of unemployment and inflation dynamics and improved in various aspects the fit with the data. But studies on the empirical link are still scarce and most authors calibrate the labor market to assess the fit of their proposed model. With this paper we provide a first attempt to use data on actual labor institutions to analyze their role for dynamic adjustments of inflation and unemployment in a cross country comparison. We analyze the response to external shocks and evaluate to which extent monetary policy effectiveness is affected by the constellation of the labor market. To conduct the analysis we first derive a simple DSGE model to describe the theoretical predictions of the different labor market rigidities in the model. What truly matters for the adjustment is whether the institutions constrain the adjustment of prices or the flows in and out of employment. While the former aspect is introduced via real wage rigidities the latter comes from search and matching for labor, where it is costly to hire new workers. The findings from the model imply that the starkest contrast in the response of inflation and unemployment to shocks is observed when the two types of labor market institutions are substitutes, while the responses are more alike if both institutions are either rigid or flexible.

The insights from the model are taken directly to the data and are tested on a sample of OECD countries. We estimate a panel VAR which includes, next to unemployment and inflation, the interest rate as a measure of monetary policy and two global shocks: the oil price and an external demand shifter. To incorporate the role of the labor market the coefficients are allowed to vary deterministically with indicators of the two dimensions of the labor market by using interaction terms. In line with the model there is a significantly different response of inflation and unemployment to the two external shocks. In the economy with rigid labor and flexible wages inflation increases by twice the amount in response to an oil shock compared to the economy with flexible labor and rigid wages. On the other hand unemployment hardly reacts in the latter case while it increases significantly in the case with flexible labor and rigid wages. For a drop in external demand a similar picture emerges.

1 Introduction

Understanding the working of labor markets is crucial to understand inflation and unemployment dynamics. Over recent years, many voices have risen to advocate reforms to make labor markets more flexible. The conventional view among policy makers is that more flexible labor markets are needed in order to "improve the effectiveness of monetary policy by facilitating price stability" (Trichet, 2007)[1]. Moreover, flexible labor markets are believed to be important to facilitate the efficient adjustment of the economy to sectoral shifts and economic changes. Indeed, the perceived wisdom in European policy circles is that there is a “need for more flexible labour markets in the context of the EU, particularly at the national and regional levels”.[2] However, most of these voices do not specify what labor market flexibility actually means.

The aim of this paper is to shed some light, both theoretically and empirically, on three related issues: (1) Are labor market institutions really important for inflation and unemployment dynamics and, if yes, how? (2) What does labor market flexibility mean? (3) How important are interactions among different labor market institutions?

Our paper is related to a rapidly growing body of literature that has started to investigate, in the context of New Keynesian models, the scope and importance of labor market rigidities for unemployment and inflation dynamics.[3] While most of the authors find a strong effect of labor market institutions (LMI) on unemployment fluctuations, there is less agreement regarding the effect of LMI on inflation dynamics. On the one side, Campolmi and Faia (2008) claim that labor market institutions matter, and in particular that differences in the generosity of unemployment benefits can partly explain inflation volatility differentials among euro area countries. On the other side, Thomas and Zanetti (2009) argue that the effect of labor market reforms (lower benefits and/or firing costs) on inflation dynamics is likely to be small. In the middle, Christoffel, Kuester and Linzert (2009) argue that only institutions that affect directly wage dynamics have a non-negligible effect on inflation. More specifically, they find that while a reduction in the degree of nominal wage stickiness would make monetary policy more effective, the importance of other labor market rigidities (hiring costs, unemployment benefits, workers’ bargaining power) is rather

[1] "The implementation of the reforms of the Lisbon agenda, by easing labour and product rigidities [...] will also improve the effectiveness of monetary policy by facilitating price stability." (Jean Monnet Lecture to the Lisbon Agenda, 4 June 2007)

[2] ECB Monthly Bullettin, May 2005, p. 71.

[3] See, e.g., Trigari (2009), Walsh (2005), Krause and Lubik (2007), Blanchard and Galí (2009) and Thomas and Zanetti (2009).

limited.[4]

A discrepancy thus appears between the policy-makers perception that LMI are important for inflation dynamics and most recent academic research, who find the effect of LMI on inflation dynamics to be rather limited. The claim of our paper is threefold:

First, we claim that labor market institutions can be divided into *two groups*: *Unemployment Rigidities (UR)* which capture the institutions - like employment protection legislation, hiring costs and the matching technology - that limit the flows in and out of unemployment; and *Real Wage Rigidities (RWR)*, intended to capture all the institutions - including wage indexation and the wage bargaining mechanism and legislation - which influence the responsiveness of real wages to economic activity. Distinguishing the two types of rigidities is crucial since we show they have *opposite* dynamic effects. When the degree of unemployment rigidities is higher inflation volatility increases and the responses of the real economy to shocks is dampened. A higher degree of real wage rigidity amplifies the response of the real economy to shocks and reduces the volatility of inflation. This is a very intuitive result, since (loosely speaking) in the first case, the rigidity is in "labor quantities", while in the second case it is "labor prices" that cannot adjust.

Second, we show that what really matters for the dynamics of inflation and unemployment is the *interaction* among the two types of institutions.[5] Since UR and RWR have opposite dynamic effects, it is crucial to determine whether different labor market institutions are *complements* or *substitutes*. If UR and RWR are *complements*, in the sense that countries with rigid wages are the ones with rigid labor and countries that have flexible wages also have flexible labor, their effects tend to offset each other. If UR and RWR are *substitutes*, in the sense that countries with rigid wages have flexible labor or vice versa, the effects of different types of rigidities reinforce and magnify each other. This implies that the slope of the Phillips curve in a country with both flexible wages and flexible labor (like the US) can be very similar to the one of countries with both rigid wages and rigid labor (like Spain or Belgium). In other words, looking separately at one institution can be highly misleading.

Third, we argue that these effects are quantitatively relevant not only for unemployment but also for inflation dynamics. To support this claim, in the second part

[4] The empirical strategy of this paper differs from Thomas and Zanetti (2009) and Christoffell et al. (2009) because we adopt a cross-country perspective. Both Thomas and Zanetti (2009) and Christoffell et al. (2009) results are based on models that are partially calibrated and partially estimated. Importantly, in both cases most labor market parameters are calibrated.

[5] A similar point, in a different context, has been put forward by Bertola and Rogerson (1997).

of the paper we associate labor market institutions with the two channels at work in the model and we provide support to our claims using two different econometric strategies. First, we estimate a panel model with time-varying volatility measures for six sub-periods. Then we estimate a panel VAR using a technique that allows to control for the impact of different labor market institutions. We find that the model's predictions are confirmed quite well by the data, which covers a sample of OECD countries from 1970-1999, and that once the interaction among different labor market institutions is taken into account, the structure of labor markets matter not only for unemployment but also for inflation dynamics.

We believe that our findings carry strong policy implications, both with respect to the conduct of monetary policy and with respect to the effects of labor market reforms. Using two examples, we first show that it is not necessarily true that more flexible labor markets improve the effectiveness of monetary policy: monetary policy actually becomes less effective in lowering inflation if the degree of unemployment rigidities gets lower. In the second example we show that labor market reforms may have very different effects depending on whether they reduce hiring and firing costs or wage frictions: while lower RWR make macroeconomic stabilization easier, lower UR make it more difficult.

The remainder of the paper is structured as follows: Section 2 outlines the model, which consists in a relatively simple New Keynesian model with search and matching in the labor market. As a modelling strategy, we explicitly build the simplest possible model that can convey the intuition behind our results, which we consider to be more general and to hold in a wider class of models. The baseline calibration is described in Section 3. Section 4 presents the moments of the simulated model under different calibrations of the labor market. In Section 5 we draw some policy implications for the design of monetary policy under varying labor market constellations. Section 6 confronts these results to the data of a range of OECD countries. Finally, Section 7 concludes.

2 The model economy

In order to show the basic intuition behind our results, we build a simple new Keynesian model which combines nominal rigidities with search and matching in the labor market and allows for the presence of real wage rigidities. Additionally, we introduce oil in the model as a channel for an external supply shock. The model consists of four building blocks: the households, the intermediate goods firms, the retail firms and a monetary authority. We briefly discuss each sector below.

2.1 Households

Each household is thought of as a very large extended family with names on the unit interval. The representative household maximizes a standard lifetime utility, which depends on the household's consumption and disutility of work:[6]

$$E_t \sum_{s=0}^{\infty} \beta^s \left[\log(C_{t+s}) - \varkappa N_{t+s}\right] \tag{1}$$

The households consume two types of goods: a domestically produced good and oil[7]

$$C_t = \Theta C_{m,t}^{\alpha_c} C_{x,t}^{1-\alpha_c} \tag{2}$$

where $C_{m,t}$ denotes consumption of imported oil, $C_{x,t}$ is a CES index of domestic goods with elasticity of substitution ε and $\Theta \equiv \alpha_c^{-\alpha_c}(1-\alpha_c)^{-(1-\alpha_c)}$. N_t denotes employment.

Households own all firms in the economy and face, in each period, the following budget constraint:

$$\frac{P_{x,t}C_{x,t}}{P_{c,t}} + \frac{P_{m,t}C_{m,t}}{P_{c,t}} + Q_t^B \frac{B_t}{P_{c,t}} = \frac{W_t}{P_{c,t}} N_t + \frac{B_{t-1}}{P_{c,t}} + \frac{D_t}{P_{c,t}} \tag{3}$$

where $P_{x,t} \equiv \left(\int_0^1 P_{x,t}(i)^{1-\varepsilon} di\right)^{\frac{1}{1-\varepsilon}}$ is the price index of domestic goods, $P_{m,t}$ is the price of oil in domestic currency and $P_{c,t}$ the CPI. W_t is the nominal wage; Q_t^B is the price of a one period domestic bond, paying one unit of domestic currency and B_t is the quantity of the bond purchased in period t. D_t denotes the family share of aggregate profits from retailers and matched firms, net of government lump-sum taxes. For simplicity, we assume no access to international financial markets.

The optimal allocation of consumption between domestic and imported goods implies a constant expenditure share, with α_c reflecting the share of oil in consumption. If we denote by S_t the real price of oil in term of domestic goods, $S_t = \frac{P_{m,t}}{P_{x,t}}$, we can express the CPI as $P_{c,t} = P_{x,t} S_t^{\alpha_c}$.

Conditional on an optimal allocation between the two goods, consumption maximization leads to the standard Euler condition:

[6] To avoid distributional issues we assume that consumption is pooled inside the family.
[7] The introduction of oil in the model follows Blanchard and Galí (2008).

$$Q_t^B \equiv \frac{1}{R_t} = \beta \mathbb{E}_t \left\{ \frac{C_t}{C_{t+1}} \frac{P_{c,t}}{P_{c,t+1}} \right\}$$

2.2 Supply side

There are two sectors of production in the economy. Competitive firms in the wholesale sector produce the intermediate homogeneous good using labor and oil as inputs. The output is sold to retailers who are monopolistic competitive. Retailers transform the homogeneous goods one for one into differentiated goods at no cost. Price rigidities, in the form of Calvo (1983) price staggering, arise in the retail sector, while search and matching frictions arise in the wholesale sector.

2.2.1 The wholesale sector

The number of newly formed firm–worker matches in the labor market, m_t, depends on the measure of vacancies v_t and job seekers s_t according to a constant return to scale matching technology:

$$m_t = \bar{m} s_t^{\sigma} v_t^{1-\sigma}$$

where $\bar{m}$ is a scalar reflecting the efficiency of the matching process. The fraction of searching workers is given by:

$$s_t = 1 - (1 - \delta) N_{t-1} \tag{4}$$

where the labor force is normalized to unity. The separation rate δ represents the fraction of the employed that each period lose their jobs and join the unemployment pool.

The probability for the firm to fill an open vacancy is

$$q_t = \frac{m_t}{v_t} = \bar{m} \theta_t^{-\sigma}$$

where $\theta_t = \frac{v_t}{s_t}$ denotes the labor market tightness. The probability that a worker looking for a job is matched with an open vacancy is

$$p_t = \frac{m_t}{s_t} = \theta_t q_t.$$

Each firm in the intermediate good sector produces the domestic good according to the CRS production function:[8]

$$X_t = A_t N_t^{1-\alpha_p} O_t^{\alpha_p}$$

where A_t is an exogenous productivity process and O_t is the quantity of imported oil used in production. The intermediate good is sold to retailers at the relative price $\varphi_t = \frac{P_t^{Int.}}{P_{x,t}}$ in terms of the domestic good.

The cost of posting a vacancy is $\kappa_t = \frac{\kappa}{\lambda_t}$, where κ is the utility cost from search services and $\frac{\kappa}{\lambda_t}$ the corresponding cost in terms of the consumption good. Employment evolves according to the law of motion:

$$N_t = (1-\delta)N_{t-1} + q_t v_t \tag{5}$$

For future reference, we also define *(after-hiring) unemployment* as the fraction of searching workers that remain unemployed after hiring takes place, $u_t = 1 - N_t$.

Firm maximization leads to the following first order conditions:

$$\frac{\kappa_t}{q_t} = \varphi_t \frac{mpl_t}{S_t^{\alpha_c}} - w_t^R + (1-\delta)\mathbb{E}_t \left[\beta_{t,t+1} \frac{\kappa_{t+1}}{q_{t+1}} \right] \tag{6}$$

$$O_t = \alpha_p \varphi_t \frac{X_t}{S_t} \tag{7}$$

where $\beta_{t,t+1} = \beta \frac{C_t}{C_{t+1}}$ is the stochastic discount factor, $mpl_t = (1-\alpha_p)\frac{X_t}{N_t}$ is the marginal product of labor and $w_t^R \equiv \frac{W_t}{P_{c,t}}$ is the real wage in terms of the consumption goods. Eq. (6) is the job creation condition, which equates the costs of posting a vacancy to the expected payoffs from an employment relationship. The latter depends on real revenue minus the real wage, and includes the continuation value represented by the saving in next period's expected hiring costs. Eq. (7) is the firm's demand for imported oil.

2.2.2 Wage determination

Wages are determined in a framework of decentralized Nash bargaining. Let $V_t^E - V_t^U$ be the value of an employment relationship for the household in period t. The net value of employment (V_t^E) as opposed to unemployment (V_t^U) is the real wage net of the disutility of work, plus the discounted continuation value:

[8] Since all wholesale firms are equal in equilibrium we avoid firm specific's subscripts.

$$V_t^E - V_t^U = \frac{W_t}{P_{c,t}} - \frac{\varkappa}{\lambda_t} + (1-\delta)\mathbb{E}_t\left[\beta_{t,t+1}\left(1-p_{t+1}\right)\left(V_{t+1}^E - V_{t+1}^U\right)\right] \qquad (8)$$

On the other side, the value of an employment relationship for a firm is, in units of consumption goods, $J_t = \frac{\kappa_t}{q_t}$.

A realized job match yields a rent equal to the sum of the expected search costs of the firm and the worker. We assume that the Nash real wage $w_t^{Nash} = \frac{W_t^{Nash}}{P_{c,t}}$ is determined according to the maximization of the following Nash criterion:

$$\arg\max_{\left\{w_t^{Nash}\right\}}\left[\left(J_t\right)^{1-\eta}\left(V_t^E - V_t^U\right)^{\eta}\right]$$

where η is the bargaining power of workers. The solution to this problem gives:

$$\begin{aligned} w_t^{Nash} &= \frac{\varkappa}{\lambda_t} + \frac{\eta}{1-\eta}\left\{\frac{\kappa_t}{q_t} - (1-\delta)\,\mathbb{E}_t\left[\beta_{t,t+1}\left(1-p_{t+1}\right)\frac{\kappa_{t+1}}{q_{t+1}}\right]\right\} \qquad (9) \\ &= RES_t + \frac{\eta}{1-\eta}PRE_t \end{aligned}$$

Intuitively, the Nash wage depends on two parts: a relatively stable one, the reservation wage RES_t (here given by the marginal rate of substitution between leisure and consumption, $\frac{\varkappa}{\lambda_t}$), and a more volatile one, the "wage premium" PRE_t, which depends on the size of the rents for existing employment relationships and on the workers' relative bargaining power (the last two terms).

2.2.3 Introducing real wage rigidities

Following much of the literature, we formalize real wage rigidity by employing a version of Hall's (2005) notion of a wage norm.[9] A wage norm may arise as a result of social conventions that constrain wage adjustment for existing and newly hired workers. One way to model this is to assume that the real wage w_t^R is a weighted average of the desired wage (the Nash bargained wage w_t^{Nash}) and a wage norm $\bar{w}$, which is simply assumed to be the wage prevailing in steady state. Specifically, the

[9] As first noted by Hall (2005) and Shimer (2005), the introduction of real wage rigidities considerably improves the performance of search and matching models in terms of the dynamics of the labor market. This issue is especially important for the euro area, which is characterized by a considerable degree of wage rigidity. See e.g. Dickens et al. (2007) and Du Caju et al. (2008) for some evidence on nominal and real wage rigidity in the euro area.

real wage is determined as follows:[10]

$$w_t^R = \left(w_t^{Nash}\right)^{1-\gamma}(\bar{w})^{\gamma} \tag{10}$$

where γ is an index of the real wage rigidities present in the economy, with $0 \leq \gamma \leq 1$. As shown by Hall (2005), this rule falls inside the bargaining set and thus remains robust to the Barro (1977) critique.

2.2.4 Final good sector

There is a measure one of monopolistic retailers indexed by z on the unit interval, each of them producing one differentiated consumption good. Due to imperfect substitutability across goods, each retailer faces a Dixit Stiglitz demand function for its product:

$$Y_t(z) = \left(\frac{P_{x,t}(z)}{P_{x,t}}\right)^{-\varepsilon} Y_t$$

Firms in the retail sector purchase intermediate goods from wholesale producers at price φ_t and convert it into a differentiated final good sold to households and to the government authority. Retailers share the same technology which transform one unit of wholesale good into one unit of retail good, $X_t(z) = Y_t(z)$. The relative price of the intermediate good φ_t represents the marginal cost for the final good producer, which can be rewritten as:

$$\varphi_t = mc_t = \frac{S_t^{\alpha_c}}{mpl_t}\left\{w_t^R + \frac{\kappa_t}{q_t} - (1-\delta)\,\mathbb{E}_t\beta_{t,t+1}\frac{\kappa_{t+1}}{q_{t+1}}\right\}$$

Notice that labor market institutions affect the evolution of marginal costs both directly, through their effect on marginal hiring costs $\left(\frac{\kappa_t}{q_t} - (1-\delta)\,\mathbb{E}_t\beta_{t,t+1}\frac{\kappa_{t+1}}{q_{t+1}}\right)$, and indirectly, through the evolution of real wages w_t^R.

We introduce nominal price rigidity using the formalism à la Calvo (1983). Each period, firms may reset their prices with a probability $1-\varsigma$. Log-linearizing around a zero inflation steady state we obtain a standard New Keynesian Phillips Curve:

$$\hat{\pi}_{x,t} = \beta E_t\hat{\pi}_{x,t+1} + \lambda_p\hat{\varphi}_t \tag{11}$$

[10] In a previous version of this paper we have considered a real wage rule where the wage norm is last period's wage:

$$w_t^R = \left(w_t^{Nash}\right)^{1-\gamma}(w_{t-1})^{\gamma}$$

Even though the latter rule gives richer dynamics, similar results and the same intuition apply.

where $\hat{\pi}_{x,t}$ is domestic (i.e. producer price) inflation, $\lambda_p = (1-\beta\varsigma)(1-\varsigma)/\varsigma$ and $\hat{\varphi}_t$ represents the log deviation of real marginal costs from the steady state value, which can be expressed as

$$\hat{\varphi}_t = h_0 \hat{w}_t^R + (1-h_0)\,\hat{c}_t - \widehat{mpl}_t + \alpha_c \hat{S}_t + h_1 \left[\hat{\theta}_t - \beta\,(1-\delta)\,\hat{\theta}_{t+1}\right]$$

where $h_0 = \frac{w^R S^{\alpha_c}}{\varphi mpl}$ and $h_1 = \frac{\kappa}{\lambda q}\frac{S^{\alpha_c}}{\varphi mpl}\sigma$

2.3 Market clearing

In an equilibrium with balanced trade (and hence $B_t = 0$) we must have that

$$\begin{aligned} P_{c,t}C_t + P_{c,t}G_t &= P_{x,t}Y_t - P_{m,t}O_t \\ &= P_{x,t}Y_t - P_{m,t}\left(\alpha_p \varphi_t \frac{Y_t}{S_t}\right) \\ &= \left[1-\alpha_p\varphi_t\right] P_{x,t}Y_t \end{aligned}$$

where we make use of the demand for oil in production $O_t = \alpha_p \varphi_t \frac{Y_t}{S_t}$. G_t denotes government spending, which by assumption is homogenous with the consumption good. Dividing both sides by $P_{c,t}$, we get the aggregate resource constraint

$$C_t + G_t = \left[1-\alpha_p\varphi_t\right] Y_t S_t^{-\alpha_c}$$

where, as in Krause and Lubik (2007), the costs of vacancy posting are assumed to be distributed across households.

2.4 Fiscal and monetary policy

The fiscal authority is assumed to adjust lump-sum taxes, T_t, to balance its budget in every period. The law of motion for government spending follows an autoregressive process of order one:

$$\log G_t = \left(1-\rho_g\right)\log \bar{G} + \rho_g \log G_{t-1} + \varepsilon_t^g$$

where $\rho_g < 1$ and ε_t^g is an i.i.d. government spending shock.

The central bank sets the short term nominal interest rate by reacting to a measure of core CPI inflation, according to the following monetary policy rule (here in log-linear form):

$$\hat{\imath}_t = \rho_m \hat{\imath}_{t-1} + \phi_\pi (1 - \rho_m) \hat{\pi}_{x,t} + \varepsilon_t^m$$

where ρ_m captures the degree of interest rate smoothing, $\phi_\pi > 1$ is the response coefficient of inflation and ε_t^m is an $i.i.d$ monetary policy shock.

3 Calibration

Before proceeding, some details on the calibration strategy are needed. We want to distinguish between two key dimensions of the labor market: *Unemployment Rigidities (UR)*, which capture the institutions - such as employment protection legislation, hiring costs and the matching technology - that limit the flows in and out of unemployment; and *Real Wage Rigidities (RWR)*, intended to capture all the institutions - including wage indexation and the wage bargaining mechanism and legislation - which influence the responsiveness of real wages to economic activity.

To study the role of different degrees of RWR is straightforward. We simulate the model varying the index of RWR (γ) from 0 to 0.9. Calibrating the degree of UR is a more challenging task, as the overall degree of "rigidity" in the labor market does not depend only on one parameter but on the entire configuration of the labor market. Following Blanchard and Galí (2009), we define labor as "flexible" when the job-finding rate and the separation rate are high; the opposite holds if labor is rigid. Figure 1 displays the evolution of the parameters implied by this calibration strategy. As our UR index increases from 0 to 1 the job-finding rate decreases from 0.7 to 0.25 and the separation rate decreases from 0.12 to 0.04. The implied unemployment rate increases from 0.05 to 0.10.[11] Notice that this way of capturing the degree of URs is consistent with the findings of Elsby et al. (2008) that outflow and inflow rates from unemployment are much higher in Anglo-Saxon and Nordic countries than in Continental Europe.

The calibration of the remaining parameters is fairly standard. Time is taken as quarters. The discount factor β is set equal to 0.992. The elasticity of substitution between differentiated goods ε is set equal to 6, corresponding to a markup $\mu = 1.2$. The steady state level of productivity A and the relative price of oil S are normalized to 1. For the elasticity of the matching function, we adopt the standard value of

[11] Notice that the two extremes of our UR index correspond to the "EU calibration" and to the "US calibration" in Blanchard and Galí (2009). Notice also that total hiring costs in steady state are kept constant to 1 percent of steady state GDP. This implies that marginal hiring costs are higher in economies with low hiring rates (i.e. high UR), which is consistent with a view of "sclerotic" economies characterized by institutional constraints on the hiring process.

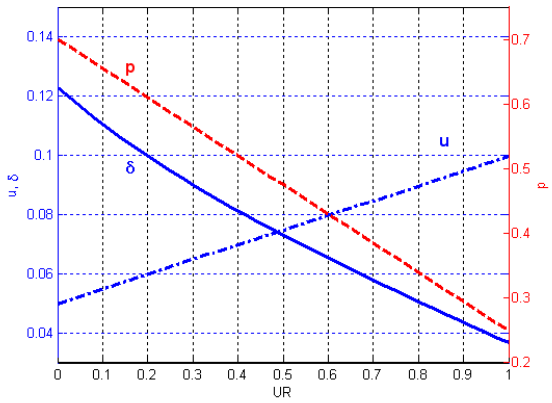

Figure 1: *The Unemployment Rigidity (UR) Index*

$\sigma = 0.5$. As in Blanchard and Galí (2008), we set the share of oil in consumption and in production respectively to $\alpha_c = 0.012$ and $\alpha_p = 0.017$. The share of government consumption is assumed to be 20 percent of GDP, as in Thomas and Zanetti (2009).

In the baseline calibration, designed to capture the euro area in 2005, we set unemployment to be $u = 0.08$. The job-finding rate p is set to 0.4, which corresponds approximately to a monthly rate of 0.15. Given u and p, it is possible to determine the separation rate using the relation $\delta = up/\left((1-u)(1-p)\right)$. We obtain a value $\delta = 0.058$. The vacancy filling rate q is set to 0.8. The workers' relative bargaining power η is set to 0.5, as standard in the literature. The vacancy cost parameter κ is chosen such that hiring costs represent a 1 percent fraction of steady state output. The parameter $\varkappa$ on disutility of labor is determined using steady state relations.

The degree of price rigidity ζ is set equal to 0.75, implying an average duration of price contracts of one year. In the baseline calibration, we set the degree of real wage rigidity to $\gamma = 0.5$, as in Blanchard and Galí (2009).

Regarding monetary policy, we assume the central bank reacts to inflation with an elasticity $\phi_\pi = 1.5$ and a persistence in interest rates $\rho_m = 0.9$.[12]

There are four shocks in the model: the productivity shock, the oil shock, the demand/government shock and the monetary policy shock. The standard deviation of the monetary shock is set to $\sigma_\varepsilon = 0.0015$. The persistence of the oil price shock is set to $\rho_o = 0.95$ while its standard deviation is calibrated to $\sigma_o = 0.16$, as in Blanchard and Galí (2008). Following Christoffel et al. (2009), we set the persistence and the standard deviation of government shocks to $\rho_g = 0.8$ and $\sigma_g = 0.005$.

[12] See, e.g, Clarida et al. (2000).

Finally, the persistence and the standard deviation of productivity shocks are set to the standard values $\rho_a = 0.9$ and $\sigma_a = 0.006$.

4 Labor market institutions and the cycle

Business cycle characteristics depend primarily on three elements: the *structure* of the economy, the *shocks* experienced by the economy and the *policy* followed by the central bank (see, e.g., Stock and Watson, 2003, for a discussion). Recent research has mainly focused on the last two elements and on their role in contributing to decreased macroeconomic volatility.[13] Here we focus instead on the structure of the economies and analyze how different labor market institutions affect business cycle characteristics. To this aim, we simulate the model keeping the shock processes and the monetary policy rule fixed, and vary only the labor market structure, as captured by the RWR and the UR indices. We first look at the effect of one type of rigidity in isolation, and then we study the interactions between the two types of labor market rigidities.

4.1 The separate role of UR and RWR for macroeconomic stability

Fig. 2 shows how different degrees of UR (left column) and RWR (right column) affect the volatility of key macroeconomic variables. We simulate the model for different calibrations of the labor market and show the standard deviation of the hp-filtered time series of the macroeconomic variables. The volatility of inflation refers to the quarterly volatility of the cpi inflation rate (non annualized). In order to interpret the volatility of unemployment and vacancies, notice that $\hat{u}_t$ and $\hat{v}_t$ are defined as the deviations of unemployment and vacancies from steady state, i.e. as $\hat{u}_t \equiv u_t - \bar{u}$ and $\hat{v}_t = v_t - \bar{v}$ (and thus the results are not influenced by the fact that the steady state levels of unemployment and vacancies differ across calibrations).[14]

A higher degree of UR reduces the volatility of unemployment and vacancies but increases the volatility of marginal costs, real wages and inflation. When job-finding and separation rates are lower employment adjusts less easily to changing labor mar-

[13]See, among others, Stock and Watson (2003) and Galì and Gambetti (2009) for two competing views.

[14]Notice that when we compute the volatility of vacancies in terms of log deviations from steady state, we get a value that ranges between 11.95 and 24.56. These numbers are roughly consistent with Shimer's (2005) results.

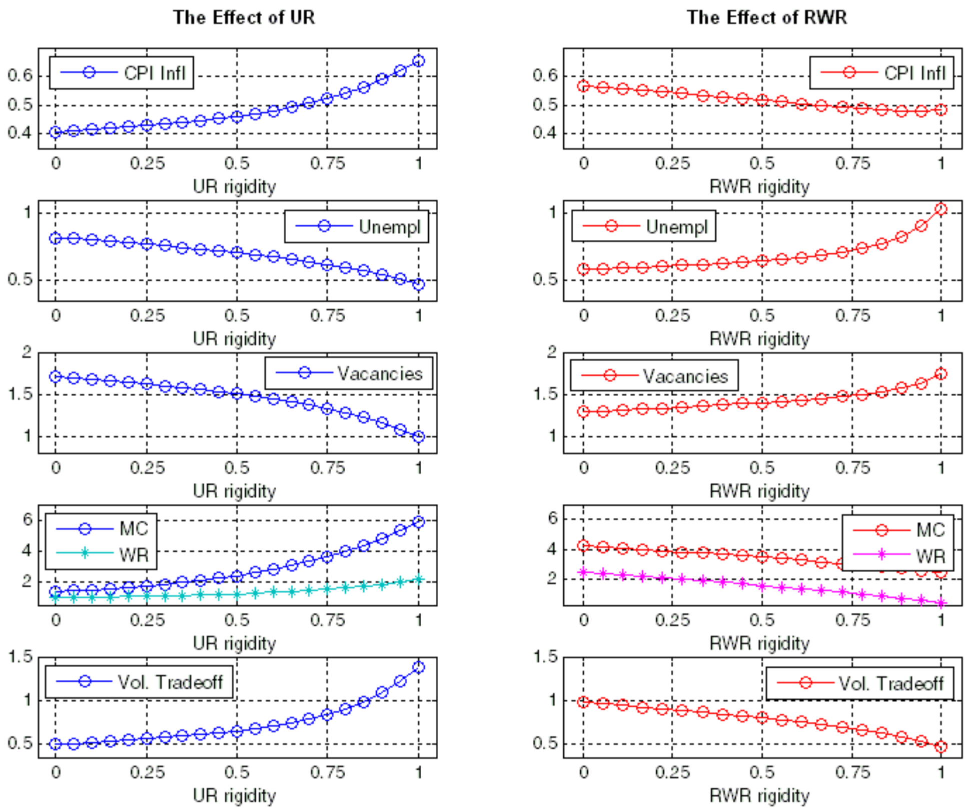

Figure 2: *Labor Market Institutions and Macroeconomic Volatilities*

ket conditions. This in turn implies that marginal costs and hence inflation become more sensitive to unemployment changes.[15] As a consequence, the volatility trade-off, which we define as the ratio between the inflation volatility and unemployment volatility $\left(\frac{vol(\hat{\pi}_{c,t})}{vol(\hat{u}_t)}\right)$, is strongly increasing in the degree of unemployment rigidities.

A higher degree of RWR, on the contrary, limits wage adjustments and creates incentives for firms to absorb shocks using the hiring margin: as in Hall (2005), when real wages are rigid, the firms' share of the match surplus change strongly with shocks and hence hiring and unemployment react strongly to changing economic conditions. This lowers the sensitivity of marginal costs and inflation to unemployment changes and tends to amplify the response of the real economy to shocks. RWR thus reduce the volatility of marginal costs and inflation and increase the volatility of unemployment and real variables. As a consequence, the volatility trade-off is decreasing in the degree of RWR.

The preceding analysis establishes from a theoretical point of view our first claim.

[15]See Ravenna and Walsh (2008) for a similar argument.

Real wage rigidities and unemployment rigidities, while often associated in policy discussions (and often labeled under the same category of labor market rigidities) are likely to have *opposite* effects on business cycle fluctuations. It does make a difference whether the rigidity lies in the wage determination mechanism or in the flows in and out of unemployment. This is a very intuitive result, since (loosely speaking) in the first case the rigidity is in "labor prices", while in the second it is "labor quantities" that cannot adjust.

4.2 The importance of labor market interactions

Another important question arises naturally from the analysis: how do different labor market rigidities interact? Are interaction effects likely to be important or negligible?

Fig. 3 shows how the volatility trade-off, i.e. the ratio between the volatility of inflation and the volatility of unemployment, change for different combinations of real wage rigidities and unemployment rigidities. Notice that the trade-off has a nice economic interpretation, as it is related to the slope of the Phillips Curve and represents how much inflation volatility needs to be afforded in order to reduce the volatility of unemployment by one percent. The shape of the trade-off conveys that though looking at the effect of one type of rigidity while maintaining the other constant is informative, it can be misleading, as it ignores the existence of important interactions between the institutions.

If UR and RWR are *complements*, in the sense that countries with rigid wages are the ones with rigid labor and countries that have flexible wages also have flexible labor, the effects of RWR and UR tend to offset each other. This has very important implications, since it implies that countries like the US that have relatively flexible wages and labor may have the same slope of the Phillips curve than countries like Belgium or Spain that have both rigid wages and sclerotic labor.[16]

If UR and RWR are *substitutes*, in the sense that countries with rigid wages have flexible labor or vice versa, the effects of different types of rigidities on the trade-off tend to reinforce and magnify each other. The volatility trade-off is at its maximum in a country with very rigid labor and flexible wages (the north corner) as both elements induce firms to prefer changes in prices rather than changes in quantities.

[16] See Bertola and Rogerson (1997) for a similar argument. Notice that the Blanchard and Galí (2009) definition of a "sclerotic" labor market refers to turnover flows, and the Bertola and Rogerson (1997) mechanism and results were indeed based on the complementarity between flows restrictions and wage setting institutions leading to wage compression.

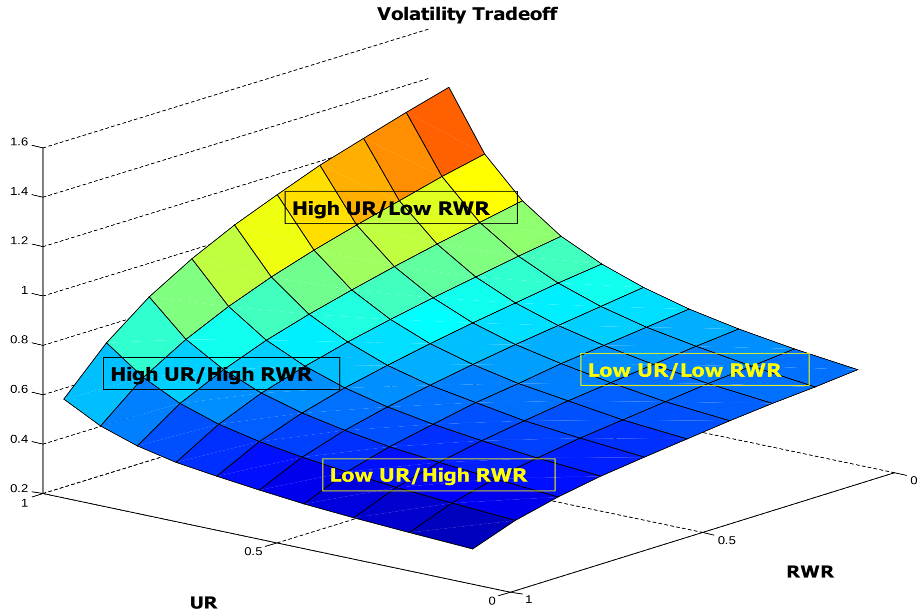

Figure 3: *The Importance of Labor Market Interactions*

It is at its minimum in countries where real wages are rigid and unemployment rigidities are low (the south corner). Notice that even for a reasonable calibration, the effects are strong and non-linear.

Are UR and RWR likely to be complements or substitutes? A priori, there is no clear-cut answer, as good theoretical arguments can be found that go in both directions.[17] The final answer is empirical, and we defer to the second part of the paper for a discussion of the available evidence.

5 Policy implications

Our analysis has shown that there is a pronounced difference between labor market institutions and the way they affect macroeconomic dynamics. Naturally these dif-

[17]For instance, a strict employment protection legislation (a source of UR) and a generous unemployment benefit system (a source of RWR) can arguably be considered as substitutes: anectodical evidence suggests that countries with weak public finance may find it difficult to put in place an efficient unemployment benefit system and may therefore opt for firing costs as a way to defend the workers from transitory shocks. On the other side, the presence of hiring/firing costs may be considered as complement of the insider/outsider problem: hiring and firing costs, in fact, increase the rents linked to an employment relationship and thus the insiders' power. If wages are set by the insiders, this may lead to a decrease of the responsiveness of real wages to economic activity and unemployment.

ferences in dynamics carry over to much more nuanced policy implications, beyond the "flexible is good, rigid is bad" dichotomy. In the following we present two examples, studying first the impact of oil price and monetary policy shocks and then the effects of labor market reforms.

5.1 Does labor market flexibility make monetary policy more effective?

Policy makers often advocate labor market reforms on the ground that a more flexible labor market improves the effectiveness of monetary policy and facilitates price stability. Is this necessarily true? To investigate this point we consider three different types of labor market constellations and compare the effect on inflation and unemployment of an increase in the nominal interest rate by one standard deviation. The values of the parameters for the labor market which we use in this exercise are summarized in the following table:

	Baseline	High	Low
RWR	$\gamma = 0.5$	$\gamma = 0.65$	$\gamma = 0.35$
UR	$p = 0.4, \delta = 0.06$	$p = 0.25, \delta = 0.04$	$p = 0.7, \delta = 0.12$

Consider the two panels on the left of Figure 4, which show the response of inflation and unemployment when we vary the degree of RWR or UR while keeping the other fixed. Suppose first the government is able to pass a reform that reduces the degree of RWR. Following a monetary policy shock, inflation would react slightly more and unemployment less. Monetary policy would indeed be more effective in lowering inflation, but the effect, under our calibration, would be very small.

Suppose instead the government is able to pass a reform that facilitates the flows in and out of unemployment. Inflation reacts less and unemployment more when UR are low. Monetary policy, contrary to the conventional wisdom, would become less effective in lowering inflation and the central bank should become more aggressive to reach the target.

The two panels on the right demonstrate the effect of labor market interactions, by showing what happens when labor markets are substitutes (that is, when low RWR are combined with high UR or viceversa). The impact of the same shock is magnified when labor market institutions are substitutes. On impact, inflation reacts almost three times more when RWR are low and UR are high than when UR are low and RWR are high; the opposite holds for unemployment. On the contrary, it can be

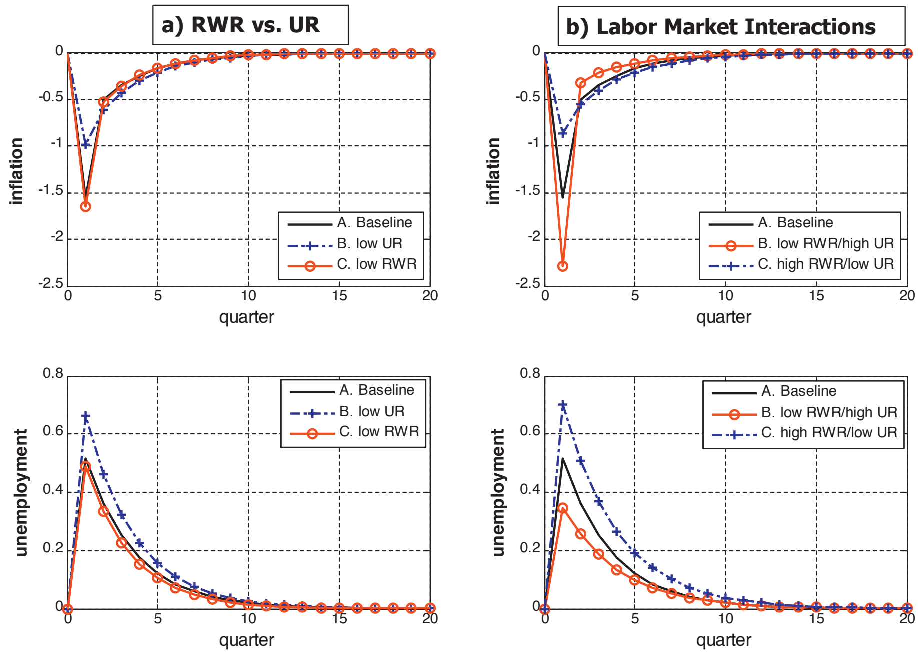

Figure 4: *Response to a negative monetary policy shock*

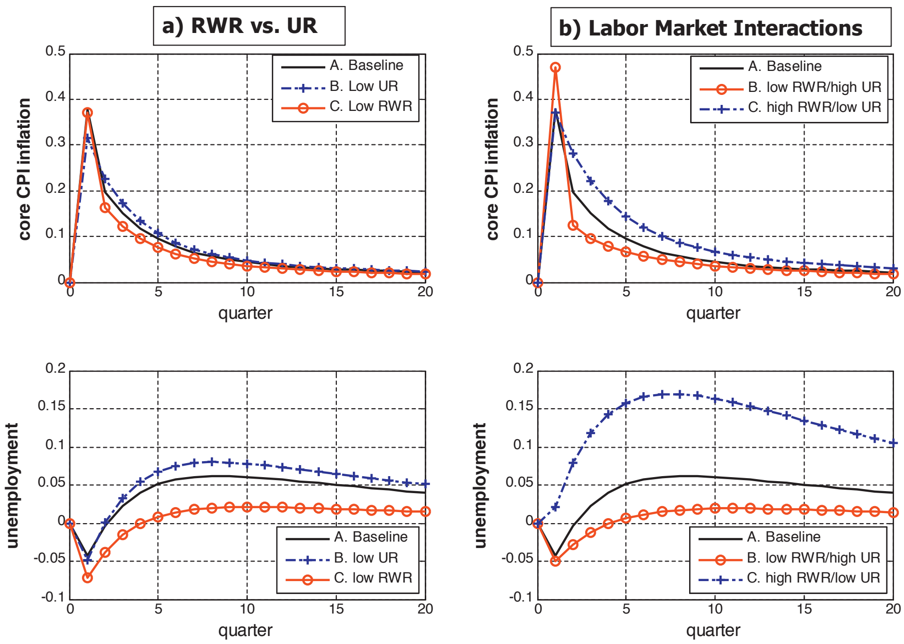

Figure 5: *Response to an oil price shock*

shown that when institutions on the two side of the labor market are complements, the differences in the impulse responses get small. Hence, a move from an overall rigid labor market to an overall flexible market may have little impact on the effectiveness of monetary policy.

This intuition is confirmed when we analyze the effect of other shocks. Consider the effect of an oil price increase (Fig. 5). Again, only once we consider the interaction between the two types of institutions the difference in responses becomes large and significant (in particular for inflation). This may explain why many studies find no or little role of labor market institutions for inflation dynamics, when looking at one dimension in isolation.

To determine the effect of shocks on inflation and unemployment dynamics it is thus crucial to determine whether institutions are substitutes or complements. This becomes particularly evident in the context of a monetary union. When countries within a union exhibit heterogeneous labor markets, the propagation mechanisms of shocks are likely to differ across member countries. Only when labor market institutions are substitutes, symmetric shocks (and thus monetary policy) will have strong asymmetric effects and thus lead to large, inefficient, inflation and unemployment differentials. The common central bank will find it optimal to react differently to shocks originating in different regions, as the effect of shocks depends crucially on the labor market structure of the region where the shock takes place.[18]

5.2 Does labor market flexibility make macro stabilization easier?

Flexible labor markets are believed to be important to facilitate the efficient adjustment of an economy to sectoral shifts and economic changes. In order to understand to what extent this is true, Figure 6 shows the policy frontier, i.e. the best combination of inflation volatility and unemployment volatility that the CB can achieve.[19]

A reduction in UR changes the slope of the policy frontier, which shifts outside. Intuitively, when labor is flexible, inflation becomes less sensitive to labor market conditions and the Phillips curve becomes flatter. For monetary policy this implies

[18] See, e.g., Campolmi and Faia (2008) and Abbritti and Mueller (2009).

[19] The Pareto policy frontier is found minimizing the following loss function:

$$\min_{\{\hat{\pi}_{c,t},\hat{u}_t,\}} L1 \equiv E_0 \sum_{t=0}^{\infty} \beta^t \left[\omega \left(\hat{\pi}_{c,t}\right)^2 + (1-\omega)\left(\hat{u}_t\right)^2 \right]$$

for $\omega \epsilon [0,1]$ under the constraints given by the supply side of our economy.

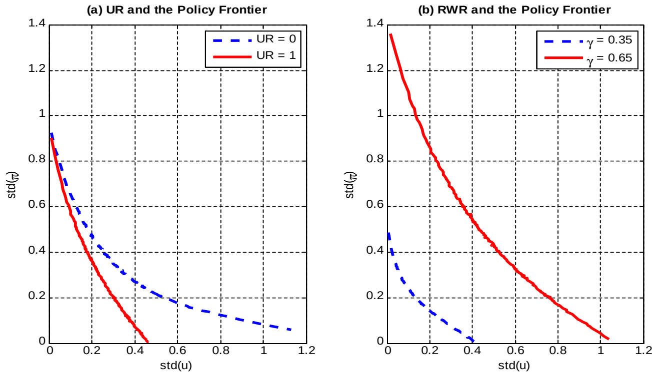

Figure 6: *Labor Market Rigidities and the Policy Frontier*

that the central bank can only reduce inflation volatility at the cost of a larger increase in unemployment volatility. To put it in simple words, macroeconomic stabilization is more difficult in an economy with lower UR. A reduction in RWR, on the contrary, shifts the policy frontier inside (as it reduces the trade-off of monetary policy in face of productivity and oil shocks)[20] and steepens its slope (as the Phillips curve gets steeper). Both effects tend to reduce the costs in terms of inflation and unemployment volatilities: more flexible wages make macroeconomic stabilization much easier.[21]

This analysis suggests that reforms that reduce the hiring and firing costs in the labor market (which are likely to have beneficial effects on the natural level of unemployment) may decrease the responsiveness of inflation to unemployment, render macroeconomic stabilization more difficult and lower the effectiveness of monetary policy on the nominal side of the economy. The opposite would hold if, by reducing the degree of wage indexation or the generosity of the unemployment benefit system, real wages become more flexible. Taking into consideration these effects is likely to be important in order to give monetary policy a role in accommodating labor market reforms in an optimal way.

6 Empirical analysis

Our simple model provides several predictions regarding the dynamic behavior of inflation and unemployment under different labor market structures. The approach we choose in testing these hypothesis is twofold. In a first step, we test to which

[20] See Blanchard and Galì (2008).

[21] See Abbritti and Mueller (2009) for a similar analysis in the context of a currency union model.

extent labor market institutions impact the volatility of unemployment, inflation and the trade-off, respectively. Doing so allows us to establish whether it is useful to divide between institutions that can be considered as RWR and those which can be considered as UR, and to comment on the interaction of the two. In a second step we estimate a panel VAR with interaction terms and analyze how the impulse responses of unemployment and inflation vary with the two types of labor market institutions as a response to external oil and demand shocks. This provides a more stringent test of the first two claims and allows us to comment on the quantitative relevance of the two types of institutions in shaping the response of unemployment and inflation to shocks.

6.1 Associating labor market institutions

The labor market literature identifies an abundant amount of LMIs. In our model this complex set of institutions is subdivided into two main groups: institutions which cause unemployment rigidities and those which lead to real wage rigidities. To map the theoretical predictions of the model into empirics, it is essential to subdivide LMIs into those groups. To do so, we resort to the findings of the labor market literature and sketch how different institutions could be accommodated in the context of our framework.

Institutions constraining the quantity adjustment in the labor market are *hiring costs* (κ), *firing costs* (δ) and the *(in)efficiency of the matching technology* ($\bar{m}$). When hiring costs and firing costs are higher, or when the matching between the workers and the firms in the labor market is less efficient, firms find it easier and cheaper to absorb shocks by changing prices than by changing quantities. In terms of observable institutions, we have a reliable indicator of firing costs in the employment protection legislation index (EPL), while, unfortunately, good indicators of hiring and firing costs are missing. In the following, we will therefore refer to the EPL as our main indicator of unemployment rigidities.

Institutions that potentially affect the degree of real wage rigidities are the generosity of the unemployment benefit system, the tax wedge, the union density/coverage and the extent of coordination/centralization of the wage bargaining.[22]

A high *benefit duration* or generous *benefit replacement ratios* may increase the degree of wage rigidities by raising the reservation wage (RES). When the unemployment benefit system is very generous workers face a better outside option and

[22] Another institution creating real wage rigidities, which we do not consider due to lack of data, is the degree of wage indexation (γ) and the contract length.

are not willing to accept a big reduction in wages in order to keep their jobs. This argument has been formalized by Zanetti (2007) and Campolmi and Faia (2008). However, higher generosity in the benefit system may also affect the search effort, which in turn has quantity implications. It is therefore to some extent an empirical question whether the benefit system is a good measures of RWRs.

The *tax wedge* would enter in our setup the wage equation via the reservation wage (RES), since a higher tax wedge requires a higher compensation for a given level of consumption. Hence, a higher tax wedge increases the fraction of the wage that is less responsive to the labor market conditions, making the wage rate less responsive to unemployment changes, causing real wage rigidities.

The effects of the *centralization* of the wage bargaining process are not clear-cut. On the one side, proponents of the corporatist argument argue that real wages are more responsive under centralized wage bargaining. This argument is based on the notion that in a centralized system, unions internalize possible adverse effects of wage increases on unemployment. On the other side, according to Calmfors and Driffill (1988) wage setting tends to be less aggressive at the decentralized and at the centralized level, while at intermediate levels wage settlements tend to be higher. This gives rise to the hump-shaped hypothesis. Since most studies in the literature find stronger support for the corporatist argument,[23] we start from the assumption that a higher decentralization of wage settlement leads to more rigid wages.[24]

The impact of *unions* is not incorporated easily in our framework. Associating union density with a higher or a lower degree of RWR depends primarily on the unions preferences over tolerating rather variations in the real wage or variations in the labor force. It is hence perfectly plausible that a union with high coverage may opt for a strategy which allows for higher variations in the wage adjustment as opposed to variations in the labor force. Given this theoretical ambiguity and the absence of an indicator reflecting union preferences, as opposed to simple coverage, we do not include union density in our analysis.

Table 1 shows the correlations between the different indicators and their evolution across time. Our sample extends over 19 OECD countries for the period from 1970 to 1999. Higher levels of EPL seem to be associated with shorter benefit duration (BD) and negatively correlated with more decentralized wage setting (DEC), but there is

[23] See for example Bertola et al. (2002), Blanchard and Wolfers (2000) and Nickell et al. (2001).

[24] To the extent that the centralization index is a proxy of the workers' bargaining power, a higher degree of centralization is associated with a higher η in the model and thus associated with more volatile wages - as the share of the surplus captured by workers is higher. This is in line with our proposed ordering.

a positive correlation with the tax wedge (TAX) and the benefit replacement rate (BRR). It is worth noting that the benefit replacement ratio and to some extent the overall benefit measure (BEN) show an increasingly positive correlation with EPL throughout time, reflecting the trend in an increase in the respective benefit measures across time, while EPL has been more stable.

	EPL					
	70-74	75-79	80-84	85-89	90-94	95-99
BEN	0.10	0.00	0.03	0.19	0.24	0.28
BRR	0.12	0.07	0.14	0.27	0.36	0.40
BD	-0.21	-0.25	-0.25	-0.22	-0.21	-0.23
TAX	0.13	0.23	0.28	0.42	0.34	0.19
DEC	-0.30	-0.36	-0.68	-0.54	-0.57	-0.56

Table 1: Correlation across LMIs

6.2 Regression approach for volatility

As a first test we estimate directly the relationship between labor market institutions and the volatilities of inflation, the unemployment rate and the trade-off, respectively.[25] In line with the simulations, the volatility is measured by the standard deviation of the HP filtered cyclical component from its trend using quarterly data. The volatility measure is computed for 6 non-overlapping 5-year periods, roughly equivalent to the average length of the business cycle. This procedure results in a panel with potentially 112 observations.[26] Our baseline regression is given by:

$$\ln \sigma_{i,t} = \beta_1 UR_{i,t} + \beta_2 RWR_{i,t} + \gamma X_{i,t} + \varepsilon_{i,t} \tag{12}$$

where $\ln \sigma_{i,t}$ stands for the log of the standard deviation of the respective dependent variable, $UR_{i,t}$ for the measure of unemployment rigidities (EPL) and $RWR_{i,t}$ for the respective potential measures of real wage rigidity. $X_{i,t}$ is a vector of controls

[25] Three studies have addressed the role of labor market institutions for the dynamics of macroeconomic variables. Bowdler and Nunziata (2007) find that countries with higher centralization tend to exhibit a dampened response of inflation to certain macroeconomic shocks. Rumler and Scharler (2009) find that inflation and output volatility tend to be lower in countries with more centralized wage bargaining. Merkl and Schmitz (2009) study the effect of labor turnover costs and benefit replacement rates on inflation and output volatilities during the Eurozone period (1999-2008) in 11 Euro area countries. They argue that labor market institutions matter for output volatility but not for inflation volatilities.

[26] We exclude Germany and Finland during the early 90s due to the extraordinary size of the shock that was associated with reunification and the collapse of the Soviet Union. However, results differ only marginally.

including a constant, time fixed effects, the (log) volatility of output ($\sigma(Y)$) and the monetary policy stance proxied by the average real interest rate level (R). Taking the standard deviation of the unemployment rate as dependent variable, we expect $\beta_1 < 0$ and $\beta_2 > 0$. For the standard deviation of the inflation rate and the trade-off (the ratio of the std. dev. of inflation over the std. dev. of unemployment) we expect the signs to be exactly opposite. Labor market variables are scaled such that coefficient estimates are interpretable as the percentage change in the standard deviation of the respective dependent variable as a response to a one unit change in the independent variable.[27] The coefficient on the monetary policy stance is the semi-elasticity of the standard deviation with respect to a 10bp increase in the real interest rate.

The regression estimates A1-A5 in Table 2 show the results when regressing the volatility of unemployment on the LMIs. EPL has always the right sign and it is significantly negative when using all measures of real wage rigidity but the benefit duration measure. The point estimates are in all but one of the significant cases very similar and imply that an increase in EPL by one standard deviation results in a reduction in unemployment volatility by roughly 10%. All potential RWR measures have the right sign and are significant. The coefficients imply that an increase in their value by one standard deviation increases the volatility of unemployment by 12-16%. The real interest rate appears to have no consistently significant impact on the volatility of the unemployment rate while an increase in the volatility of GDP by 1% tends to be associated with an average increase in the volatility of unemployment by 0.3-0.45%.

The estimates for inflation (B1-B5) yield in four out of five cases a significantly positive impact of EPL on the volatility of inflation, in line with the predictions of our model. The magnitude implies that an increase by one standard deviation increases inflation volatility by a moderate 5-6%. The potential RWR measures appear to be correctly signed and significant only when we use the overall benefit measure and the tax wedge. The coefficients which have the expected sign imply a reduction in the volatility of inflation by close to 8%. The volatility of output is always significant and implies a positive link between the two. The real interest rate appears now also in most regressions highly significant, implying that an increase by 100bp reduces the volatility of inflation by 6-8%.

[27] Rumler and Scharler (2009) employ a similar approach although they focus on output rather than unemployment volatility.

	σ(u)					σ(INFL)					σ(INFL.)/σ(u)				
	A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	C1	C2	C3	C4	C5
EPL	-1.81**	$-1.98^{\dagger}$	-0.99	-1.84**	$-1.82^{\dagger}$	0.95**	0.95*	0.77**	1.19**	-0.45	$2.77^{\dagger}$	$2.94^{\dagger}$	1.76**	$3.03^{\dagger}$	$1.38^{\dagger}$
	(0.77)	(0.76)	(0.99)	(0.76)	(0.71)	(0.43)	(0.51)	(0.31)	(0.52)	(0.32)	(0.73)	(0.55)	(0.70)	(0.85)	(0.42)
BEN	$1.11^{\dagger}$					$-0.58^{\dagger}$					$-1.69^{\dagger}$				
	(0.34)					(0.14)					(0.35)				
BRR		$0.86^{\dagger}$					-0.33*					$-1.19^{\dagger}$			
		(0.16)					(0.17)					(0.34)			
BD			$3.59^{\dagger}$					0.55					$-3.04^{\dagger}$		
			(0.88)					(0.69)					(1.03)		
TAX				0.78*					-0.56*					$-1.34^{\dagger}$	
				(0.44)					(0.29)					(0.50)	
DEC					10.09**					0.16					-9.93**
					(5.14)					(2.94)					(4.23)
R	0.57	0.70*	0.54	0.53	$1.26^{\dagger}$	$-0.63^{\dagger}$	$-0.71^{\dagger}$	$-0.77^{\dagger}$	-0.61*	-0.27	$-1.19^{\dagger}$	$-1.40^{\dagger}$	$-1.31^{\dagger}$	$-1.15^{\dagger}$	$-1.53^{\dagger}$
	(0.38)	(0.41)	(0.38)	(0.50)	(0.33)	(0.21)	(0.23)	(0.27)	(0.32)	(0.23)	(0.27)	(0.29)	(0.23)	(0.38)	(0.27)
$\sigma(Y)$	0.39**	$0.45^{\dagger}$	0.34**	$0.46^{\dagger}$	$0.47^{\dagger}$	0.27**	0.25*	$0.27^{\dagger}$	0.31**	$0.27^{\dagger}$	-0.12	-0.20	-0.07	-0.15**	-0.20
	(0.16)	(0.11)	(0.14)	(0.09)	(0.15)	(0.11)	(0.13)	(0.09)	(0.13)	(0.08)	(0.12)	(0.17)	(0.16)	(0.07)	(0.13)
Obs.	103	103	103	98	93	103	103	103	98	93	103	103	103	98	93
R^2	0.23	0.25	0.21	0.20	0.31	0.42	0.40	0.38	0.42	0.34	0.43	0.41	0.35	0.35	20.31

Table 2: Estimation Results, bootstrap std.errors in parenthesis based on 200 draws, † $p<0.01$, ** $p<0.05$, * $p<0.1$

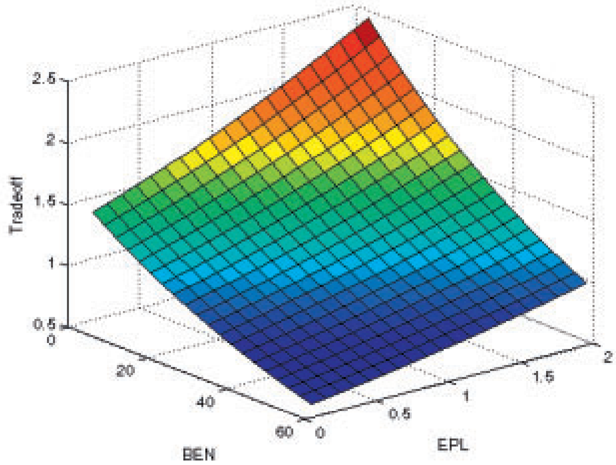

Figure 7: *Predicted Volatility Tradeoff: Volatility Model*

For the volatility trade-off (C1-C5), our measure of UR enters all regressions significantly and correctly signed.[28] The estimated impact of an increase in EPL by one standard deviation ranges between 8-16%. All potential RWR measures have the expected negative sign and are significant. The coefficients on BRR and BEN imply that an increase in one standard deviation by the respective measure leads to a fall in the trade-off by 22%, while an increase in the benefit duration yields a lower estimate (10%).

Thus it appears that in particular the generosity of the unemployment benefit system and the tax wedge are reasonable measures of RWR, since they constrain the adjustment of prices. To get a better idea about this link in terms of quantitative implications, we represent graphically the predicted values for the volatility trade-off using the composite benefit measure (BEN) as proxy for RWR, i.e. regression C1. The shape gets very close to the one predicted by our simple model in terms of ordering and magnitude.

The overall R^2s for these three regression groups indicate that the estimation equation explains about 25% of the variation in the volatility of the unemployment rate and 40% for both the inflation rate and the volatility trade-off. We perform a series of robustness checks, dropping the controls, considering pooled estimators,

[28] Regressing the ratio on the LMIs is not only conceptually an appealing concept but avoids also the problem of endogeneity that may exist when we think of inflation and unemployment volatility being influenced by each other. While Rumler and Scharler (2009) estimate a system of inflation and output volatility, we prefer our approach since we find it difficult to argue for a valid instrument in this context.

introducing country fixed effects and allowing for direct interaction terms between RWR and UR by replacing $\beta_2 RWR_{i,t}$ with $\beta_2 UR_{i,t} \cdot RWR_{i,t}$ (Results are available on request and are not reported to save space). The major findings may be summarized by the following three points: First, labor market institutions account for about half of the share in the R^2 in the unemployment equation and the volatility trade-off equation but only for about a fourth in the inflation equation. Second, on a cross country basis, labor market institutions are more relevant for unemployment dynamics, while on a within basis, they appear to be more relevant for inflation dynamics. In the inflation regressions with country fixed effects, the coefficients on the LMIs are in four out of five regressions significant and correctly signed, explaining up to 20% in the variation across time of inflation volatility. Third, employing interaction terms increases the level of significance of most coefficients but leaves the explanatory power of the model unchanged.

6.3 Regression approach for dynamic responses

The preceding analysis - while being supportive to our model's predictions - leaves one aspect unaddressed: it neglects potential differences in the underlying shocks that countries face. Our second test goes one step further. We analyze the dynamics of inflation and unemployment using a panel VAR approach and allow the coefficient estimates to vary with the characteristics of the labor market.[29] This allows us not only to control for the magnitude of the shocks within an economy but also to analyze the differential response to shocks under different degrees of labor market rigidities and evaluate their quantitative implications for the transmission to inflation and unemployment dynamics. We estimate the following panel VAR:

$$A_0 Y_{i,t} = \mu_i + \sum_{l=1}^{L} A_l Y_{i,t-l} + \varepsilon_{i,t} \tag{13}$$

where $Y_{i,t} = \begin{pmatrix} S_{it}, & U_{it}, & INFL_{it}, & INT_{it} \end{pmatrix}'$, $\varepsilon_{i,t}$ are the structural shocks and μ_i are a set of country fixed effects. S_{it} stands for a set of exogenous shocks, U_{it} for the unemployment rate, $INFL_{it}$ for the inflation rate and INT_{it} for the nominal interest rate. We consider two exogenous external shocks, an oil price shock and an external demand shock (which we proxy by the real growth rate of imports in the

[29] For a similar approach in different contexts see Loyaza and Raddatz (2007) or Towbin and Weber (2009).

other OECD countries).[30] While the inclusion of the latter is primarily motivated by the need to control for potential demand driven price increases in the oil price, it provides simultaneously an additional metric to test the economy's response to an external demand shock. To contrast the role of RWR and UR for the adjustment dynamics of unemployment and inflation, we allow the coefficients a_l^{ij} of the matrices A_0 and A_l to vary with the labor market:

$$a_l^{ij} = \beta_{1,l}^{ij} + \beta_{2,l}^{ij} \cdot UR_{i,t} + \beta_{3,l}^{ij} \cdot RWR_{i,t} \tag{14}$$

for $l = 0, 1, .., L$ and $i = U_{it}$, $INFL_{it}$ and $j = S_{it}$, U_{it}, $INFL_{it}$, INT_{it} where i is the regressand and j the regressor. Notice that once we have estimated all the β-coefficients, we can evaluate the a-coefficients for any possible combination of UR and RWR. The resulting a-coefficients can then be understood as reflecting the dynamic responses of a model economy with a particular labor market structure. Hence, different to a usual panel VAR the regressand is not only regressed on the regressors at various lags but also on the regressors interacted with the respective labor market institutions.[31]

To identify the oil price shock we follow Blanchard and Gali (2008) by considering the oil price as being contemporaneously unaffected by the remaining variables in the system. All other variables (including the external demand shifter) are contemporaneously affected by the oil price. Notice however that we allow the lagged values of the external demand shifter to impact the oil price to control for demand driven price increases. The other variables have no contemporaneous impact on the demand shifter. While the literature has proposed alternative identification schemes (see for instance Kilian 2007) we find our result to be robust to a change in the ordering of the two external shocks. For the response to the exogenous shocks, we require only a partial identification, as the response of unemployment and inflation is unaffected by the consecutive ordering.[32] Additionally, we are interested in the response to a monetary policy shock. To identify the shock we impose a Choleski decomposition, ordering the unemployment rate first, followed by inflation and the interest rate. Finally, we restrict the nominal interest rate to react to all variables

[30] For instance, the external demand shock for Germany, is the growth rate of the sum of all countries' imports excluding Germany. Hence, shocks are country specific.

[31] The overall dynamics may thus also be described by a panel VAR of the form $(B_{1,0} + B_{2,0}X_{it})\, Y_{i,t} = \sum_{l=1}^{L} (B_{1,l} + B_{2,l}X_{i,t})\, Y_{i,t-l} + \varepsilon_{i,t}$ where the coefficients are a function of a time invariant constant term ($B_{1,0}$ and $B_{1,l}$) and a component which varies deterministically over time with the structure of the labor market in time t ($B_{2,0}X_{i,t}$ and $B_{2,l}X_{i,t}$).

[32] For a formal proof see Christiano, Eichenbaum and Evans (1999).

in the system contemporaneously and at all lags and to its own lags, but we restrict the response to be homogenous across labor market structures. Under the described assumptions, we can estimate (13) equation by equation using OLS. Due to the non-linearity of the impulse responses in the OLS estimates, analytical standard errors may be inaccurate. To address this issue we use bootstrapped standard errors as proposed by Runkle (1987) adjusted for the fact that we are dealing with a panel and make use of interaction terms.[33]

The estimation is performed using quarterly data. The interest rate, the (annualized) inflation rate and the unemployment rate enter the regression untransformed, while the oil price is the growth rate of the oil price (in US dollars)[34] and the external demand shifter is the growth rate of the real value of the other OECD countries' imports measured in 2000 US dollars. As in our simple volatility analysis, we employ EPL as an indicator of quantity constraining institutions ($UR_{i,t}$) and we use our favorite measure, the overall benefit measure BEN, as a proxy for price constraining institutions ($RWR_{i,t}$). Unlike the other variables, labor market indicators are only available on a (bi-)annual basis. This makes the timing of the influence of a change in the LMI on the dynamics necessary. The timing with which we let the LMIs influence the dynamics is chosen such that a change in a LMI is always effective as of the first quarter of the respective year in which a change in the indicator occurred. This date may not coincide exactly with the respective change in the legislation and different timings may be chosen (e.g. the last quarter of the respective year). However, the exact timing appears to have no influence on our findings.[35] As before we exclude Germany and Finland during the 90s from the sample, although not doing so has no impact on the results. In our main specification, we also exclude Spain and Portugal since both countries experienced a drastic regime shift and had a declining inflation rate from over 20% to 3%, which potentially creates stationarity problems. We consider a lag length of four lags.

[33] The procedure may be described in the following way. 1) Estimate (13) by (restricted) OLS, 2) draw randomly from the matrix of (structural) errors $\hat{\varepsilon}_{i,t}$ a vector of errors $\hat{\varepsilon}_{i,\tilde{t}}$ 3) use $\hat{\varepsilon}_{i,\tilde{t}}$ and the initial observations of the sample and the estimates of $\hat{A}_l$ to simulate recursively $\hat{Y}_{i,1}$. 4) After the first period is simulated for all variables in the system interact the variables with the interaction terms and now repeat 2 and 3 as many times as there are errors. 5) The artificial sample is then used to re-estimate the coefficients of (13) with which the IRFs are constructed. 6) This exercise (step 2 to 5) is repeated 500 times and confidence intervals are the p^{th} and $1 - p^{th}$ value of the 500 constructed IRFs. In the following we use $p = 5\%$ such that responses are drawn with a 90% confidence interval.

[34] We prefer to use the US dollar price of oil rather than the real price of oil or the price in domestic currency to avoid a transformation involving an endogenous variable.

[35] When we reestimate the entire model using only annual data results remain unaltered.

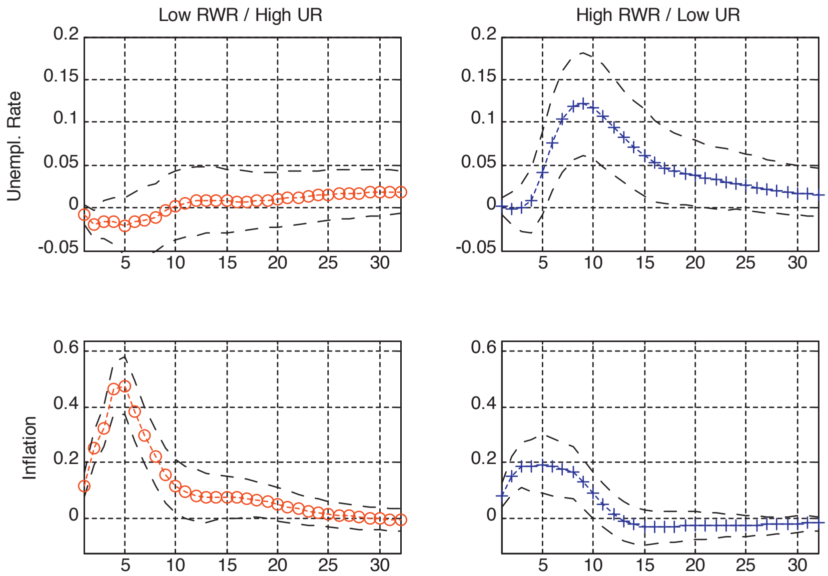

Figure 8: *Response to an oil price shock*

Consider first the response to an oil price shock, where we normalize the shock to equal a 10% increase in the price of oil on impact. Drawing from the predictions of the model, we focus on the case in which labor market rigidities are substitutes. To this end we draw two impulse responses, one given by evaluating UR at the 80^{th} and RWR at the 20^{th} percentile, and the other by evaluating UR at the 20^{th} and RWR at 80^{th} percentile (see Fig. 8). We find that the increase in inflation as a response to the shock is much more pronounced if a country has a high degree of UR and a low RWR value. The inflation rate peaks after one year at around 0.5 percentage points compared to 0.2 percentage points in the low UR - high RWR case. On the other hand, the increase in the unemployment rate is much higher when labor is flexible and wages are rigid. Unemployment starts to rise after one year and peaks after 2 years at an extra 0.1 percentage point, recovering only slowly afterwards. For high UR and low RWR the unemployment rate remains essentially unaffected. The hump-shaped response of inflation and the lagged response of unemployment is in line with the results of Blanchard and Gali (2008), who run separate VARs for 6 of the countries in our sample. More strikingly, the empirical results match very closely the patterns of the impulse response functions implied by the model for both unemployment and inflation.

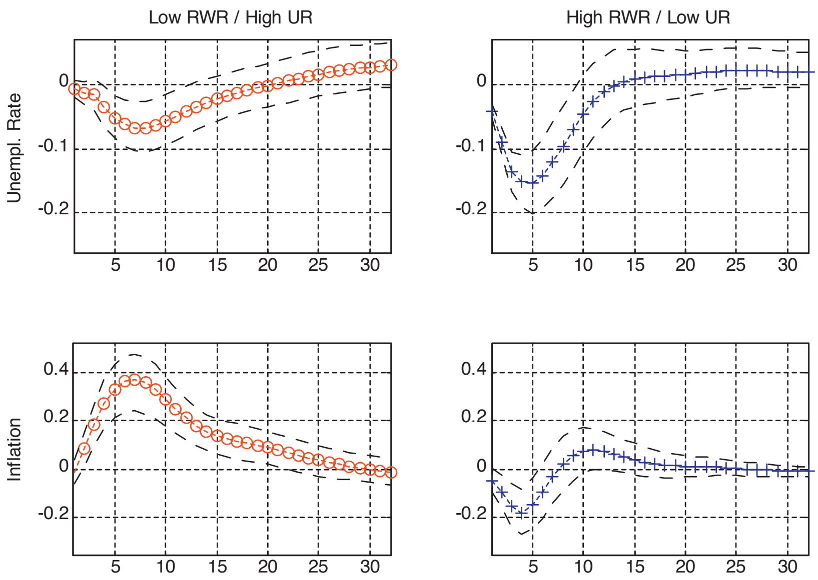

Figure 9: *Response to an external demand shock*

When we consider the external demand shock results are confirmed (see Fig. 9). A one percent increase in the level of external demand leads to a much more pronounced reduction in the unemployment rate in countries with low UR and high RWR. The response of unemployment in the high UR - low RWR case is much smaller but more persistent, as it peaks only after more than 6 quarters. The response of inflation is in turn more pronounced for the case of high UR and low RWR, peaking after one year at somewhat above 0.3 percentage points. For the low UR - high RWR case the initial response appears even negative and turns quickly insignificant.[36]

Finally, we consider the monetary policy shock (see Fig. 10). In response to a 100 basis point increase, unemployment rises significantly more if RWR is high and UR is low in line with theory. The response is highly persistent and hump-shaped. The response of inflation in the case of high RWR and low UR is muted and not

[36]The slight negative response is driven by an outlier in the growth rate of real imports. In the first half of 1975 imports contracted extremely by more than 5% and at the same time inflation peaked in most countries following the first oil price shock in the end of 1973. Although our identification allows the oil price to affect the imports, in this particular case the demand shock is not perfectly isolated. If we exclude this outlier from the sample, the inflation response is close to zero and insignificant for the demand shock under low UR and high RWR, while all other results are unchanged.

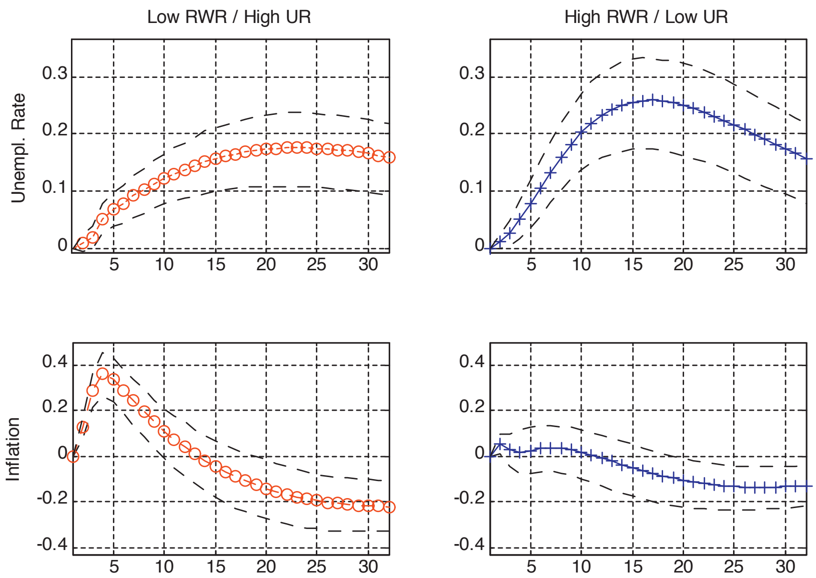

Figure 10: *Response to an interest rate shock*

significantly different from zero at most lags exerting only very late a slight negative impact on inflation. This response stands in striking contrast to the response under low RWR and high UR. Initially, inflation increases in response to a monetary policy shock but turns in subsequent quarters negative for a prolonged period. The initial positive response is well documented in the literature as the price puzzle (Bernanke and Blinder, 1992; Sims 1992). Several resolutions have been proposed ranging from the inclusion of further information in the VAR to different identification schemes. This indicates that the identification of the monetary policy shock deserves further investigation, which is beyond the scope of this article. For the focus of this paper it is sufficient to note that with respect to all three shocks considered in the analysis unemployment responds more if RWR is high and UR low, while inflation responds consistently stronger to shocks if RWR is low and UR high.

While we tested the significance in the difference of the responses across the two labor market constellations also formally, visual inspection makes already clear that in all cases, the high UR - low RWR response is significantly different from the low UR - high RWR response in the short to medium run. The exception is the response of unemployment to an oil shock, which is only significantly different starting after the 7th quarter. Since all responses return to the initial equilibrium there is no difference in the long run.

Additionally, we want to see whether we are able to recover from the data a picture similar to Fig. 3. To this aim, we evaluate the institutional framework for various constellations of the UR-RWR grid (spanning the entire combinations of UR and RWR in the 20^{th}-80^{th} percentile plane) and simulate the system drawing errors randomly from the sample residuals.[37] Hence, we create bootstrapped samples after evaluating the coefficients. Finally, we compute the standard deviation of unemployment and inflation on the simulated series. Notice that this procedure is completely analogous to the exercise in the theoretical model that produced Fig. 3.

The results are very similar to those of the theoretical model (See the appendix for a graphical illustration). In particular, inflation volatility is strongly decreasing in the degree of real wage rigidity as measured by the benefit measure. An increase in EPL tends to lead to an increase in the volatility of inflation. For unemployment the reaction appears also in line with the model. The unemployment volatility decreases with a fall in RWR and with an increase in EPL, in particular for lower levels of RWR. The above implies that the trade-off takes again the highest value when UR is high and RWR is low while it takes the lowest value when RWR is high and UR is low, in line with the model´s predictions (Fig. 11).

We performed various robustness checks. We first checked whether results are driven by a single country by excluding one country at a time from the regression. Results remained unchanged. Only excluding Japan, caused the response of inflation to an external demand shock to half in both labor market cases, leaving the other results and the conclusions unaffected. We then reestimated the model excluding the interest rate without notable changes in the results, implying that much of the variation is driven by shocks other than monetary policy shocks. In another robustness check we included real GDP as an additional variable. Results turned out to be even more pronounced. In a further check, we re-introduced Spain and Portugal in the regression with little effect for the results. In a further check we proxied the external demand shock by the growth of real GDP in the other countries. This led to a postponement of the response to an external GDP growth shock, suggesting that the spillover to demand for increased imports is lagged. We also estimated the model using yearly rather than quarterly data. Again results remained supportive to all our initial findings although responses to shocks appeared generally more

[37] Using a parametric approach gives the same results. What is important is that we draw for each constellation of the labor market from the same distribution of errors, such that the difference in the standard deviation of inflation and unemployent that is afterwards computed, is entirely driven by the different $a-$coefficients resulting from the different labor markets.

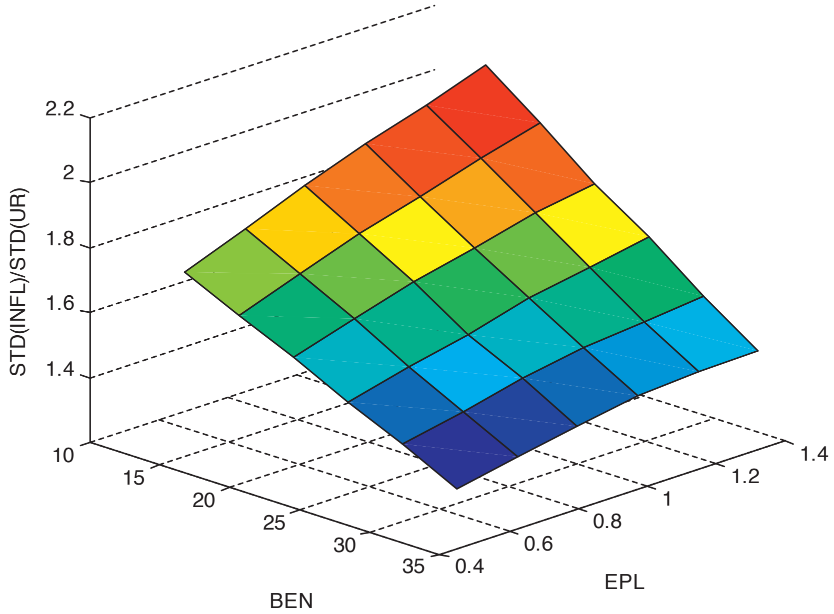

Figure 11: *Predicted Volatility Trade-off*

persistent. Finally, we repeated the estimation using the tax wedge, the benefit duration and the benefit replacement rate as RWR measures, respectively. While the particular shape of the impulse responses as well as the level of significance varied, results remained very robust. In particular all estimates for the response and the unconditional variance of inflation were confirmed implying always that an increase in the RWR measure leads to a reduction in inflation volatility while an increase in the UR measure increases the volatility of inflation. Results for the unemployment rate were confirmed when using the tax wedge as a measure of RWR, implying a fall in the unemployment volatility as EPL increases and an increase in the volatility of inflation as the tax wedge increases. Similarly, we found the volatility of the unemployment rate to be increasing in the benefit duration and the benefit replacement rate. We only did not find the volatility of the unemployment rate to be a decreasing function of EPL, when using the benefit replacement rate and the benefit duration as a RWR measure, although the impulse responses of unemployment remained in line with the predictions of our model.

7 Conclusion

Conventional wisdom holds that more flexibility in the labor market implies necessarily more efficient adjustment and thus is always preferable. The present paper argues that such a view starts from the misperception that the labor market may be reduced to a single dimension. We show, both theoretically and empirically, that labor market institutions should at least be divided in two categories: the institutions that constrain the flows in and out of unemployment (which we have referred to as unemployment rigidities, UR) and the institutions that restrain the responsiveness of wages to shocks (real wage rigidities, RWR). This distinction is important, because the two types of labor market institutions are found to have opposite effects on the business cycle: while a higher degree of UR increase inflation volatility and reduce unemployment volatility, more rigid wages reduce the volatility of nominal variables and increase the response of the real economy. In the empirical part, we have proposed a classification of the labor market institutions into these two groups and we have shown that this simple intuition works well.

Second, we argue that analyzing one institution in isolation of the other may be misleading due to important interactions among the different labor market institutions. In particular, it is crucial to determine whether institutions are *complements* or *substitutes*: the effects of RWR and UR on the slope of the Phillips curve tend to offset each other when the two types of rigidities are *complements* (in the sense that high RWR are associated with high UR, or vice versa) while they tend to reinforce and magnify each other when they are *substitutes* (in the sense that countries with rigid labor have flexible real wages or vice versa). The distinction is crucial since it implies that the dynamics of a country that has rigid labor and rigid wages may be very similar to the dynamics of a country that has relatively flexible wages and unemployment flows. Indeed, we believe that the success of our empirical part in detecting the effect of different institutions on inflation and unemployment dynamics follows from the fact that we have explicitly taken the existence of these interaction effects into account.

Third, estimating a panel VAR with interaction terms, we have shown that the response of inflation and unemployment to oil price, monetary policy and external demand shocks is significantly different across countries with different labor market institutions. Labor market institutions thus appear to be important not only for unemployment dynamics, but also for inflation dynamics.

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A Data appendix

Data come from various sources. Macroeconomic data comes from the OECD's Economic Outlook.[38] Most labor market indicators are taken from Nickel et al. (2001). In particular the benefit replacement rate, the benefit duration, the tax wedge and the union density measures are from Nickel. The measure for the coordination of wage setting is taken from Kenworthy (2001).[39] The qualitative implication of using the coordination measures by Nickel et al. (2001) are unchanged. In both cases,

[38] Since no real imports in GDP PPP values are available for Germany before 1990, we used the growth rate of real imports to write the values backwards. The measure does not include Austria's imports since no quarterly data is available.

[39] The variable is not available for Portugal and Spain.

centralized wage setting systems attribute a more prominent role to reducing unemployment volatility as opposed to inflation volatility for which coefficients were mostly insignificant. The benefit measures (BEN) is a composite benefit measure provided by the OECD and is reported on a biannual basis. Our sample includes the following 19 countries: Australia, Belgium, Canada, Denmark, Finland, France, Germany, Ireland, Italy, Japan, New Zealand, the Netherlands, Norway, Portugal, Spain, Switzerland, Sweden the UK and the US. The following tables report descriptive statistics for the entire sample and some selected countries across the entire sample period (1970-1999).[40]

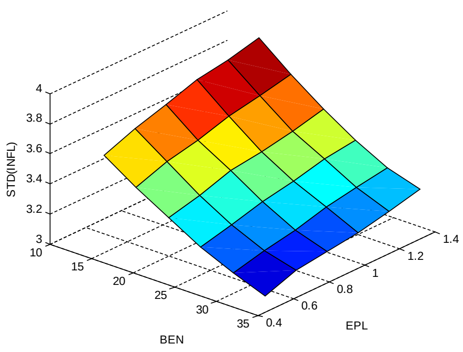
Variable	Mean	SDev.	Low	High	Source and description
- EPL	10.6	5.5	1	20	Nickel et. al. (2001), original variable which ranges from 0.1 to 2 was multiplied by ten.
- BEN	27.0	13.2	0	64.9	OECD
- BRR	42.4	18.7	1	88	Nickel et. al. (2001)
- BD	4.5	3.3	0	10.4	Nickel et. al. (2001), original variable, which ranges from 0 to 1.04 was multiplied by ten.
- TW	48.5	12.6	24.2	83.1	Nickel et. al. (2001)
- UNION	42.9	18.6	9	91.1	Nickel et. al. (2001)
- DEC	2.7	1.4	1	5	Kenworth (2001), the original scaling (ken) was adj. to Dec=max(ken)+min(ken)-ken
- R	2.78	3.03	-9.07	8.05	OECD Eco. Outl., ratio of the 5-year av. nom. sh. term ineterst rate and the inflation (%)
- σ(GDP)	0.55	0.37	0.08	2.4	OECD Eco. Outl., real GDP nat. acc. basis, s. dev., output gap (HP filter over the real GDP)
- UR	6.09	3.9	0.01	19.3	OECD Eco. Outl.
- INFL	6.16	4.8	-1.21	39.6	OECD Eco. Outl.
- INT	8.92	4.4	0.09	25.8	OECD Eco. Outl., short term interest rate
- S_1: OIL	2.17	15.7	-49.2	89.4	IFS, q-to-q growth (%) Brent, US dollar/barrel
- S_2: IMP	1.34	1.6	-6.76	6.3	OECD Eco. Outl. q-to-q growth (%) real, USD
- S_2^*: GDP	0.73	0.6	-1.69	2.9	OECD Eco. Outl., q-to-q growth (%) real, PPP

[40] The volatility is measured by the standard deviation of the HP filtered cyclical component from its trend over the entire sample period.

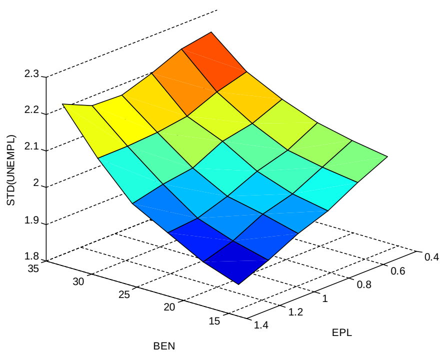
	Standard Deviation			Labour Market Indicators						
	UR	INFL	T.off	EPL	BEN	BRR	BD	TAX	DEC	UND
Anglo										
Austral.	0.81	0.76	0.94	5.0	23.2	23.0	10.2	36.3	3.00	46.6
UK	0.71	1.15	1.63	3.4	21.0	28.1	6.5	47.5	4.30	49.7
USA	0.77	0.52	0.67	1.0	12.6	27.7	1.8	43.3	4.73	20.8
Skand.										
Denmk.	0.66	0.75	1.12	10.0	50.0	59.8	7.5	57.1	2.00	73.8
Norway	0.46	0.68	1.50	15.0	28.2	45.4	4.6	61.9	1.23	54.0
Sweden	0.59	0.87	1.48	14.3	23.7	60.8	4.0	72.8	1.83	79.6
Cont. Eur.										
France	0.41	0.44	1.07	12.8	31.7	57.6	3.6	63.2	4.00	16.2
Italy	0.43	0.79	1.85	19.1	6.32	10.1	0.6	58.8	3.23	43.6
Spain	1.02	0.82	0.80	18.3	28.2	64.8	1.7	37.1	na	11.9

B Empirical Volatility of Inflation and Unemployment

The following two graphs report the inflation and unemployment volatility as a function of the two types of labor market institutions. Values are computed simulating the economies under different types of labor market constellations holding the distribution of shocks constant analogous to the theoretical model.



Inflation



Unemployment