Reassessing the Role of Labor Market Institutions for the Business Cycle

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Abstract

This paper investigates empirically the effect of labor market institutions (LMIs) on business cycle fluctuations. Most studies, using a cross-country panel approach, have found a weak effect of LMIs on unemployment and, especially, inflation dynamics. In this paper, we estimate an Interacted Panel VAR for OECD countries, where we allow the dynamics of inflation, unemployment and the interest rate to vary with the characteristics of the labor market. We find that LMIs have a large and significant effect on both unemployment and inflation dynamics. Stricter employment protection legislation and higher union density mute the reaction of unemployment, but increase the response of inflation to external shocks. The opposite effects are found for the generosity of the unemployment benefit system and the extent of the tax wedge. Countries with decentralized wage bargaining manage to absorb shocks through lower variations in unemployment. Our results imply that countries with very rigid or very flexible labor markets can have similar inflation and unemployment dynamics.

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1 Introduction

This paper contributes to a recent body of literature that investigates the scope and importance of labor market institutions (LMIs) for business cycle fluctuations. The empirical literature on the connection between labor market institutions and the level of unemployment is rather vast[1] but only few studies have systematically addressed the role of labor market institutions for the business cycle properties of macroeconomic variables. Little consensus emerges from this literature. For instance, in the case of stricter employment protection legislation some studies find no effect on inflation volatility (Rumler and Scharler, 2011; Merkl and Schmitz, 2011) or output volatility (Rumler and Scharler, 2011), while others find a negative effect on unemployment or output volatility (Faccini and Rosazza Bondibene, 2012; Merkl and Schmitz, 2011) or an inverted U-shaped effect on the relative unemployment to output volatility (Lochner, 2014). The available evidence is similarly inconclusive in the case of benefit replacement rates or for the impact of unions on business cycle dynamics.[2]

Most of these papers use a cross-country panel approach based on the regression of business cycle volatilities on selected LMIs and controls. There are several reasons why this approach may not fully capture the relationship between LMIs and macroeconomic outcomes. First, there is the risk that the association of LMIs with fluctuations at higher frequency washes out when working with 5-year averages or volatilities. Second, it may be important to control for the magnitude and types of shocks that hit different economies. Third, typically this framework does not allow to control for systematic differences in the monetary policy response to inflation and unemployment dynamics in a satisfactory way. Therefore, studies that rely on this approach likely face more difficulties in identifying robust relationships between various dimensions of the labor market and business cycle fluctuations.

We try to overcome these hurdles by estimating an Interacted Panel VAR (Towbin and Weber, 2013; Sa et al., 2014) for a panel of 20 OECD countries for the period from 1970 to 2013. The approach allows the response coefficients in the VAR to change deterministically with the characteristics of the labor market. Moreover, this technique allows us to fully exploit the time

[1] See for instance Elmeskov et al. (1998), Blanchard and Wolfers (2000), Bertola et al. (2002), or Nickell et al. (2005) to name but a few.

[2] See Table 1 for a summary of this literature.

dimension of the data and to control for different shocks and policy responses. We focus on two external shocks, an oil price shock and a world demand shock, and analyze how the responses of the unemployment and the inflation rates to these shocks vary under different types and degrees of labor market rigidities.

Labor market institutions are found to have a strong and significant effect on business cycle dynamics. We find that stricter employment protection legislations (EPL) by making it more costly to fire workers, induce firms to absorb shocks through price changes. Therefore, higher EPL reduces unemployment volatility, but increases inflation volatility, as suggested by the models of Zanetti (2011) and Thomas and Zanetti (2009). More generous unemployment benefits have the opposite effect. Higher benefits improve workers' outside option, reduce the responsiveness of wages and inflation to aggregate fluctuations and increase unemployment volatility (see, e.g., Campolmi and Faia, 2011, and Thomas and Zanetti, 2009). Similarly, a higher tax wedge, by increasing the workers' reservation wage, reduces inflation volatility and increases unemployment volatility.

Interestingly, the effects of trade unions partially depend on the shocks hitting the economy. We consider two indicators capturing the effects of trade unions: union density and the degree of wage bargaining centralization. High union density amplifies the response of inflation to external shocks and slightly reduce the unemployment response, though the latter effect is significant only in the case of external demand shocks. These results support the claim that in countries with high unionization rates, workers may be able to extract greater compensation following a cost or demand shock, and thus cause a wage-price spiral. On the contrary, the effects of the degree of centralization in the wage bargaining process crucially depend on the nature of the shock. Following an oil price shock, high centralization amplifies inflation volatility while it has no significant effect on unemployment fluctuations. Following a demand shock, instead, centralization increases unemployment fluctuations but reduces inflation adjustment. This confirms the importance of controlling for the magnitude and type of shocks hitting the economy, because the strategy of trade unions, and the interaction between unions, governments and central banks, may change depending on the nature of the shocks.

Our results suggest that it can be misleading to focus the attention on a unidimensional characterization of the labor market.[3] We show that the inflation and unemployment responses to shocks in countries with overall rather rigid labor markets (e.g. Belgium) is not significantly different from the response in economies with relatively flexible labor markets (e.g. Switzerland or the USA). Finding no difference between "rigid" and "flexible" economies does not imply that LMIs are irrelevant for business cycle dynamics, but is simply a consequence of the offsetting effects of different institutions. The starkest contrast in the responses of inflation and unemployment to shocks can be found in those countries with institutions that limit price adjustments (e.g. the Netherlands) compared to those countries with institutions that limit quantity adjustments (e.g. Portugal). Quantity adjustments are found to be limited in countries with high EPL, high union density, low unemployment benefits and low tax wedge. Price adjustments are found to be limited in countries with the opposite constellation of LMIs.

The findings of our study support a related and growing theoretical literature that incorporates the search and matching model of the labor market into the state of the art New Keynesian model.[4] While most of these models imply a strong effect of labor market institutions on unemployment fluctuations, there is less agreement regarding the effect of LMIs on inflation dynamics. For example, Campolmi and Faia (2011) claim that differences in the generosity of unemployment benefits can partly explain inflation volatility differentials among euro area countries. Thomas and Zanetti (2009) find instead that the effect of labor market reforms (lower benefits and/or firing costs) on inflation dynamics is likely to be small. Christoffel, Kuester and Linzert (2009) argue that only institutions like nominal wage stickyness that affect directly wage dynamics have a non-negligible effect on inflation; the importance of other labor market rigidities (hiring costs, unemployment benefits, workers' bargaining power) is rather limited. Our results are qualitatively consistent with these contributions but, importantly, suggest that LMIs have a significant impact not only on unemployment fluctuations, but also on inflation dynamics.

The remainder of this paper is structured as follows. Section 2 outlines the estimation strategy. Section 3 presents the main results and section 4 concludes. Further details on the data and additional results are available in an external appendix.

[3]See e.g. Bertola and Rogerson (1997) for a similar argument

[4]See, e.g., Trigari (2009), Walsh (2005), Krause and Lubik (2007), Blanchard and Galí (2010), Thomas (2008), Thomas and Zanetti (2009), Gertler and Trigari (2009), Christoffel and Linzert (2005).

2 Estimation approach

The following sections present the IPVAR approach in its general form, its application in the context of this analysis, and a description of the data.

2.1 An interacted panel VAR approach

Our estimation strategy is motivated by the structural representation of a standard log-linearized solution of a rational expectation DSGE model:[5]

$$\mathbf{A}_0 (\Lambda) \mathbf{y}_t = \mathbf{A}_1 (\Lambda) \mathbf{y}_{t-1} + \mathbf{B}_0 (\Lambda) \mathbf{z}_t \tag{1}$$

$$\mathbf{C}_0 \mathbf{z}_t = \mathbf{C}_1 \mathbf{z}_{t-1} + \varepsilon_t \tag{2}$$

where the vector $\mathbf{y}_t$ denotes the endogenous variables, $\mathbf{z}_t$ a vector of AR(1) shock processes and Λ is a vector of policy parameters with elements λ_j that correspond to the individual LMIs of the economy.[6] Matrices labeled $\mathbf{A}$ govern the dynamics among dependent variables, matrices labeled $\mathbf{B}$ govern the impact of shocks on endogenous variables and matrices labeled $\mathbf{C}$ determine the dynamics of shocks. Subscripts refer to the relevant lag order of the corresponding variables.

Because there is often limited variation in Λ for an individual country, most studies analyzing the effect of different labor market structures on business cycle dynamics adopt a cross-country panel approach and estimate a model of the form:

$$\ln \sigma_{i,t} = \beta \Lambda_{i,t} + \gamma X_{i,t} + e_{i,t} \tag{3}$$

where $\ln \sigma_{i,t}$ stands for the log variance of the dependent variable of interest for country i and period t, $X_{i,t}$ is a vector of controls potentially including time and country fixed effects and $e_{i,t}$ stands for an error term. Table 1 provides a summary of the recent empirical literature, which is mostly based on this approach. Several of these studies find a rather weak effect of most LMIs on business cycle volatilities. In the appendix we use a similar approach to estimate

[5] We would like to thank an anonymos referee for suggesting this analogy.

[6] Notice that we assume that the LMIs do not respond endogenously to the state of the economy. We also assume shock processes to be independent of the policy parameters, i.e. the latter affect only the transmission of shocks to the endogenous variables.

directly the effects of LMIs on inflation and unemployment volatilities with our dataset. Our results confirm the relatively weak and unstable link between macroeconomic volatilities and LMIs: while several indicators are significant at times, coefficients change sign, are insignificant, or are not robust to the inclusion of country fixed effects.

The failure to find a robust relationship does not necessarily prove the irrelevance of LMIs for business cycle dynamics. First, several studies work with 5-year periods to compute the volatility of the dependent variable. This may mask an effect of LMIs on macroeconomic fluctuations at higher frequency. Second, this approach makes it difficult to control for the fact that different countries are likely to be exposed to different types or magnitudes of shocks. Third, a linear regression of volatility on LMIs could mask a more nuanced relationship between LMIs and macroeconomic outcomes as the variance of the system (1) and (2) implies a possibly strong non-linear relationship between LMIs and the volatility of the dependent variable.[7]

In this paper we propose an alternative approach - the Interacted Panel VAR (Towbin and Weber 2013, Sa et al. 2014).[8] The IPVAR approach pools estimates across a sample of countries and estimates directly how the matrices $\mathbf{A}_0$, $\mathbf{A}_1$ and $\mathbf{B}_0$ of the system (1) and (2) depend on the policy parameters (Λ). Intuitively, the IPVAR estimates a first order approximation of these matrix functions around the sample average of Λ, $\bar{\Lambda}$. That is, the IPVAR approximates:

$$\mathbf{A}_l\left(\Lambda\right) \approx \mathbf{A}_l\left(\bar{\Lambda}\right) + \sum_{j=1}^{h} \frac{\partial \mathbf{A}_l}{\partial \lambda_j}\left(\bar{\Lambda}\right)\left(\lambda_j - \bar{\lambda}_j\right) \quad for \quad l \in (0,1) \tag{4}$$

and similarly for $\mathbf{B}_0$. h refers to the dimension of the vector of policy parameters.

In practice, the main difference of the IPVAR to a panel VAR is that the regressand is not only regressed on the regressors at various lags, but also on the regressors interacted with the respective labor market institutions. Thus, the response coefficients are allowed to change deterministically with the characteristics of the economy. This permits controlling for different shocks and monetary policy responses, and allows analyzing the impulse responses and volatilities of macroeconomic variables for varying constellations of LMIs. It is a more encompassing estimation of the effect of LMIs on business cycle dynamics, because interactions among the

[7] The general solution for the volatility of the dependent variable of the system (1) and (2) is given by: $\mathbf{vec}(\mathbf{\Sigma_y}) = \left[\mathbf{I} - \widetilde{\mathbf{A_1}}\left(\mathbf{\Lambda}\right) \otimes \widetilde{\mathbf{A_1}}\left(\mathbf{\Lambda}\right)\right]^{-\mathbf{1}} \left[\widetilde{\mathbf{B_0}}\left(\mathbf{\Lambda}\right) \otimes \widetilde{\mathbf{B_0}}\left(\mathbf{\Lambda}\right)\right] \mathbf{vec}(\mathbf{\Sigma_z})$ where $\widetilde{\mathbf{A}_1} = \mathbf{A}_0^{-1}\mathbf{A}_1$ and $\widetilde{\mathbf{B}_0} = \mathbf{A}_0^{-1}\mathbf{B}_0$.

[8] For a related approach see also Loayza and Raddatz (2007), Nickel and Tudyka (2014) and Georgiadis (2014).

LMIs affect the impulse response functions and the variances of the dependent variables in the IPVAR. However, there are also some potential limitations of the approach. The most important one is that LMIs may be endogenous to the shocks hitting the economy: a potential limitation we share with almost all the empirical literature on the effects of LMIs on business cycle fluctuations. In the main specification, we try to partially control for this by using lagged policy variables in the estimation, but we acknowledge that our strategy is based on the assumption that business cycle fluctuations have a negligible effect on the choice of LMIs. A second potential limitation is the linearity assumption embedded in our IPVAR as reflected by the approximation equation (4).[9] This assumption could be relaxed by considering various non-linear combinations of the different LMIs.[10] However, it is very difficult to determine a priori the correct non-linear relationship and relevant interaction terms. Moreover, depending on the number of observations and of policy parameters in the estimation, overfitting of the model is a concern.[11] We therefore leave the analysis of the importance of non-linearities and of the assessment of the endogeneity of LMIs to future research.

2.2 Estimation and identification

The IPVAR representation of the estimated model considered here is given by:[12]

$$\begin{pmatrix} C_0 & 0 \\ B_{0,t} & A_{0,t} \end{pmatrix} \begin{pmatrix} \mathbf{s}_{i,t} \\ \mathbf{y}_{i,t} \end{pmatrix} = \mu_i + \sum_{l=1}^{L} \begin{pmatrix} C_l & 0 \\ B_{l,t} & A_{l,t} \end{pmatrix} \begin{pmatrix} \mathbf{s}_{i,t-l} \\ \mathbf{y}_{i,t-l} \end{pmatrix} + \begin{pmatrix} \varepsilon_{i,t}^{S} \\ \varepsilon_{i,t}^{Y} \end{pmatrix} \tag{5}$$

where $\mathbf{y}_{i,t}$ is the vector of endogenous variables for country i, $\mathbf{s}_{i,t}$ a vector of external variables, $\varepsilon_{i,t}^{S}$ and $\varepsilon_{i,t}^{Y}$ are the structural shocks and μ_i are a set of country fixed effects. The vector of dependent variables $\mathbf{y}_{i,t}$ includes with the (annualized) inflation rate and the unemployment rate

[9] If the relationship between the propagation matrices and the policy variables is not linear, the approximation (4) might lead the residuals to be correlated with right hand side variables. In a recent study, Lochner (2014) explores the role of non-linearity for the case of EPL and finds that more stringent EPL has an inverted U-shaped effect on the ratio of unemployment to output volatility.

[10] Towbin and Weber (2013) consider only two policy parameters, but allow for their interaction. Georgiadis (2014) allows for polynomials of the relevant policy parameters.

[11] It should also be noted that the dimensionality increases more than one-for-one depending on the number of dependent variables in $\mathbf{y}_t$ and the number of lags considered in the VAR.

[12] The representation corresponding to (1) and (2) is given by: $\mathbf{z}_t = \begin{pmatrix} s_t & s_{t-1} & \varepsilon_t^{Y} \end{pmatrix}'$, $\mathbf{A}_0(\Lambda) = A_{0,t}$, $\mathbf{A}_1(\Lambda) = A_{1,t}$, $\mathbf{B}_0(\Lambda) = \begin{pmatrix} B_{0,t} & B_{1,t} & I \end{pmatrix}$, $\mathbf{C}_0 = \begin{pmatrix} C_0 & 0 & 0 \\ 0 & I & 0 \\ 0 & 0 & I \end{pmatrix}$, $\mathbf{C}_1 = \begin{pmatrix} C_1 & 0 & 0 \\ I & 0 & 0 \\ 0 & 0 & 0 \end{pmatrix}$.

the two main variables considered in studies on the effect of LMIs on business cycle dynamics and with the 3-month short-term T-bill rate a third factor, which controls for varying monetary policy responses. The vector of external variables, $\mathbf{s}_{i,t}$, includes the log-difference of the oil price and a measure of world demand growth, which we proxy by the log-difference of the sum of real GDP in the *other* countries ($\Delta \ln M_{i,t} = \Delta \ln \sum_{j \neq i}^{I} GDP_{j,t}$).[13]

We analyze the role of LMIs for the adjustment dynamics by allowing the coefficients of the A-matrices and B-matrices to vary with the labor market indicators:[14]

$$A_{l,t} = \bar{A}_l + \alpha_l \cdot \Lambda_{i,t} \tag{6}$$

$$B_{l,t} = \bar{B}_l + \beta_l \cdot \Lambda_{i,t} \tag{7}$$

where $l = 0, 1, .., L$ refers to the lag order. The estimated $\bar{A}$, $\bar{B}$, α and β-coefficients, can be used to evaluate the A and B-coefficients for any possible combination of LMIs, reflecting the dynamic responses of an economy with a particular labor market structure. We characterize the labor market ($\Lambda_{i,t}$) using five indicators: (i) the strictness of employment protection legislation (EPL); (ii) the generosity of the unemployment benefit system, as measured by the benefit replacement rates (BRR); (iii) the tax wedge, which is a measure of the difference between labor costs to the employer and the net take-home pay of the employee (TW); (iv) the degree of unionization as measured by the percentage of workers affiliated to a union (UDENS); and (v) the centralization of wage bargaining in the economy (CEW). Even though this is not an exhaustive list of indicators to describe the overall design of the labor market, these five dimensions cover the most widely used aspects in studies on the effect of labor market institutions on macroeconomic developments.[15]

We focus on two external shocks, an oil price shock and a world demand shock. This partial identification strategy is motivated by three main reasons: First, using external shocks allows

[13] For instance, the external demand shock for Germany is the growth rate of the sum of all countries' real GDP excluding Germany.

[14] The representation corresponding to equation (4) is given by: $\mathbf{A}_l(\Lambda) = A_{l,t}$, $\bar{\mathbf{A}}_l(\Lambda) = \bar{A}_l$ and $\sum_{j=1}^{h} \frac{\partial \mathbf{A}_l}{\partial \lambda_j} \left(\bar{\Lambda}\right) \left(\lambda_j - \bar{\lambda}_j\right) = \alpha_l \cdot \Lambda_{i,t}$; similarly for $\mathbf{B}$.

[15] In our choice of labor market institutions we are constrained by two main factors: data availability, in the sense that we need a sufficiently long series of LMIs for a sufficiently large number of countries, and a sort of dimensionality curse. Adding more LMIs, in fact, would multiply the number of coefficients to estimate and would reduce the sample size due to more limited data availability of other LMI measures, which taken together would significantly reduce the degrees of freedom of our analysis.

us to focus on the role of LMIs for the adjustment process avoiding a discussion of the appropriateness of one over the other identification scheme in individual countries. Second, we focus on an oil price and a world demand shocks, because they can be interpreted as supply and demand shocks. Third, the focus on external shocks implies that the heterogeneity that is observed in the response variables is unrelated to the shock itself.[16] To identify the oil price shock, we follow Blanchard and Gali (2007) and assume the oil price to be contemporaneously unaffected by the remaining variables in the system. All other variables (including world demand) are contemporaneously affected by the oil price. We allow the lagged values of the world demand to impact the oil price to control for demand driven price increases. The other variables have no impact on world demand and oil prices.[17] Our identifying assumptions for equation (5) are thus given by constraining the matrix C_0 to be lower triangular. While the literature has proposed alternative identification schemes (see, for instance, Kilian, 2008) we find our results to be robust to a change in the ordering of the two external shocks.

Under the described assumptions and identifying restrictions, we can consistently estimate (5), (6) and (7) using OLS. Due to the non-linearity of the impulse responses in the coefficient 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.[18] All estimations are performed using quarterly data and a lag length of four as suggested by the Schwarz criteria. Unlike the other variables, labor market indicators are available on an annual or bi-annual basis. This makes an assumption about the timing of the influence of a change in the LMI on business cycle dynamics necessary. We choose the timing such that a change in a LMI is always effective as of the first quarter of

[16]For instance, using country-by-country estimates and comparing the dynamic responses of inflation and unemployment to an identified (country specific) shock, say a domestic demand shock, potentially blurs the role of LMIs and different shock dynamics across countries.

[17]The underlying exogeneity assumption implies that each single country is too small to affect world demand and prices. Relaxing this assumption by allowing countries to affect world variables with a lag of one quarter has again no implications for the findings in this study.

[18]The procedure may be described in the following way. 1) Estimate (5,6,7) 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 $\hat{A}_l$, $\hat{B}_l$ and $\hat{C}_l$ 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 (5,6,7) 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.

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. Finally, to control for the potential endogeneity of LMIs, we use four quarter lags for LMIs. Using contemporaneous LMIs indicators, results are close to identical.

2.3 Data

Data come from various sources. The unemployment rate, the annual inflation rate, the short-term interest rate and the Brent oil price in US dollar are from the OECD Economic Outlook quarterly statistics. The seasonally adjusted real GDP constant PPP US dollar series, used to construct the world demand shock, are taken from the OECD Quarterly National Accounts database. Labor market indicators are taken from Nickell (2006) CEP-OECD institutions database. The original dataset contains annual observations until 2004. We extend the data until 2013 using information from the OECD, the ICTWSS Database on Institutional Characteristics of Trade Unions, Wage setting, State Intervention and Social Pacts (Visser 2009), and own calculations as described in the Appendix.

The sample includes 20 countries, corresponding to the 20 countries in the original CEP-OECD database. Data on labor market indicators are close to complete with 846 annual observations out of 860 ($= 43 \cdot 20$) possible observations. Our sample covers the period from 1970:1 to 2013:4 unless otherwise indicated, and includes the following countries:[19] Austria, Australia, Belgium, Canada, Denmark (1979:2-2013:4), Finland, France, Germany, Ireland (1984:1-2013:4), Italy (1971:1-2013:4), Japan, New Zealand (1974:1-2013:4), the Netherlands, Norway, Portugal (1978:1-2013:4), Spain (1980:1-2013:4), Sweden (1982:1-2013:4), Switzerland (1974:1-2013:4), the UK, and the US.

Table 2 summarizes statistics for the labor market structures of all the countries in our sample. We divide OECD countries in five groups: Anglo-Saxon, Continental Europe, Mediterranean, Scandinavia and Japan. Anglo-Saxon countries are characterized by flexible labor markets along all five dimensions we consider. For the US, in particular, the LMIs are always below the 20^{th} percentile of the distribution of LMIs across all countries in the sample. At the

[19] The individual countries' starting points are affected by missing labor market and interest rate data.

other extreme, Scandinavian countries are characterized by high levels of almost all LMIs, in particular of the unemployment benefits, the tax wedge and union density. The only exception is EPL, which takes a value close to the median. Continental European labor markets are in between the Scandinavian and the Anglosaxon models and characterized, on average, by values very close to the median LMIs. There are, however, many differences across countries, with Belgium having one of the most rigid labor markets and Switzerland one of the most flexible ones. Finally, Mediterranean countries are characterized by very high levels of EPL and centralized wage setting, and relatively low generosity of unemployment benefits.

3 Results

Based on the IPVAR estimation results for the sample of 20 OECD countries, we analyze the role of LMIs for macroeconomic fluctuations, conducting three exercises: First, we analyze to which extent the responses of unemployment and inflation to a given shock vary with specific aspects of the labor market. Second, we assess the impact of individual LMIs on the aggregate volatility of inflation and unemployment. This allows us to compare our results to the results of studies that estimate directly the effects of LMIs on macroeconomic volatilities. Third, we ask how important is the interplay of different labor market institutions and study how business cycle dynamics change when we vary multiple LMIs at the same time, approximating relevant country examples.

3.1 Impulse response function for different LMIs

To assess the role of LMIs, we compare the impulse response functions (IRFs) of the endogenous variables to the two external shocks for different degrees of labor market rigidities. In practice this implies that we compute the IRFs using the estimates in (5), (6) and (7) evaluating all LMIs at their median value, with the exception of the specific LMI of interest, which we vary from taking on the value corresponding to the 20^{th}-percentile (low) and 80^{th}-percentile (high) of the sample distribution. Figures 1 and 2 present the impulse responses of inflation, unemployment, and interest rates to oil price and world demand shocks for varying degrees of EPL and unemployment benefits. They show three columns: the first depicts IRFs and corresponding

90 percent confidence bands when the relevant LMI has a low level; the second column the corresponding IRFs when the LMI has a high level and the third column shows the difference of the two IRFs. This allows us to assess whether the specific LMI has a significant impact on the dynamic adjustment to the external shocks. The one standard deviation shocks roughly correspond to an increase in the oil price by about 15 percent and an increase in world demand by about 0.5 percent on impact.

In line with standard responses to supply and demand shocks, an oil price shock leads to a persistent increase of unemployment, inflation and interest rates, while an increase in world demand leads to a reduction in unemployment and a (delayed) increase in inflation and interest rates. The size and persistence of the responses, however, differ markedly across different labor market constellations.

Consider first the effects of the *employment protection legislation index* (EPL), which is generally interpreted as a proxy for firing costs. In theory, firing costs reduce job destruction at given wages during downturns, and also reduce hirings during cyclical upswings, because additional employees increase the expected future firing costs. Therefore, when hiring and firing costs are higher, firms find it easier and cheaper to absorb shocks by changing prices than by changing employment. Such an interpretation is in line with Thomas and Zanetti (2009) and Zanetti (2011) who find in a search and matching model that higher firing costs dampen the employment adjustment.[20] Our empirical results are in line with these models: following the two shocks higher EPL values lead to a more muted response of the unemployment rate, and an amplified response of inflation to the world demand and the oil price shock (Figure 1a and 2a). The different dynamics of inflation and unemployment translate into different interest rate responses. Monetary policy largely appears to react proportionally to inflation and unemployment.

A generous *benefit replacement ratio* affects business cycle dynamics through two channels with potentially opposing effects. On the one side, when the unemployment benefit system is very generous workers face a better outside option and are not willing to accept a big reduction in wages in order to keep their jobs. This implies that wages are less sensitive to aggregate

[20]The predictions of search and matching models can change depending on the assumption of the productivity level of newly hired workers. Assuming newly hired workers to be less productive than old workers implies that for some calibration values higher firing costs lead to more employment adjustment (Silva and Toledo, 2009).

fluctuations while firms' hiring efforts and unemployment are more sensitive (see, e.g., Hagedorn and Manovskii (2008), Zanetti (2011) and Campolmi and Faia (2011)). On the other side, unemployment benefits are likely to affect the workers' search effort. In a search model where unemployed workers search with variable intensity or effort, high unemployment benefits may discourage workers from searching. The lower search effort of the unemployed translates into a relatively low job finding probability and a smaller response of the unemployment rate to shocks. Results from the impulse responses are consistent with the first channel. Higher unemployment benefits reduce the response of the inflation rate and amplify the response of the unemployment rate, although the latter effect is only marginally significant for the world demand shock (Figure 1b and 2b). These findings are consistent with the view that unemployment benefits induce wage rigidity and amplify unemployment volatilities (see e.g. Campolmi and Faia (2011), Thomas and Zanetti (2009) and Zanetti (2011)).

Table 3 summarizes the results of the impulse response analysis also for the remaining LMIs. It reports the response and significance levels for the inflation and unemployment rates after 4, 8, and 12 quarters following the two external shocks. Additionally, it reports the quarter in which the difference between the responses of unemployment (inflation) under low and high LMI is at its maximum (last column), the value of unemployment (inflation) in this quarter for low and high LMI (VaPD = Value at Peak Difference), and the associated difference of the unemployment (inflation) response (Peak Dif.).

An institution that has received a lot of attention, especially in Europe, is the *tax wedge*, which is a measure of the difference between labor costs to the employer and the net take-home pay of the employee. Following a supply shock, a higher tax wedge significantly reduces the inflation response, but has no significant impact on unemployment dynamics. Similarly, following a demand shock, higher labor taxes are found to significantly reduce inflation volatility, but additionally amplify unemployment volatility. These results are consistent with a view of a high tax wedge creating real wage rigidities. A higher tax wedge requires a higher compensation for a given level of consumption, which makes the wage rate less responsive to unemployment changes.

The impact of *unions* on business cycle fluctuations is, in theory, ambiguous. Trade unions are often considered as one of the potential sources of real wage rigidities. For instance, Zanetti

(2007) introduces union bargaining into a New Keynesian model and finds that unionization lowers inflation volatility, but amplifies output volatilities. However, how unions respond to shocks depends primarily on the unions preferences for tolerating variations in the real wage over variations in the labor force. It is hence perfectly plausible that a powerful trade union may opt for a strategy which allows for higher variations in the wage adjustment as opposed to variations in the labor force. Impulse responses suggest that a higher degree of union density is associated with a stronger response of inflation to shocks, and a somewhat milder variation of the unemployment rate in case of a world demand shock. Thus, our sample is not supportive of the view that trade unions create real wage rigidities and reduce inflation volatility. Instead, results support the claim that higher union density may cause a wage-price spiral in response to an external shock and are consistent with earlier univariate results by Bowdler and Nunziata (2007).[21]

The degree of *centralization* of the wage bargaining process is often used as a proxy for the degree to which trade unions internalize the macroeconomic consequences of their wage claims. Proponents of the corporatist view argue that real wages are more responsive under centralized wage bargaining, since unions internalize possible adverse effects of wage changes on unemployment. Calmfors and Driffill (1988) argue instead that 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. Most studies in the literature find stronger support for the corporatist argument,[22] which suggests that the centralization of wage settlement leads to a reduction of real wage rigidities. The results of our estimation following a supply shock are broadly consistent with the corporatist argument. The response of inflation in countries with high centralization is significantly stronger and more persistent than in countries with decentralized wage bargaining. The response of unemployment, instead, is not significantly different in the two cases. However, the effects of the degree of bargaining centralization following a demand shock differ: following a positive world demand shock countries with centralized wage bargaining are associated with a large, persistent and

[21]This interpretation would not apply necessarily to shocks that would trigger a fall in inflation. As this would go well beyond the scope of this paper, we leave an analysis of possible asymmetric effects of LMIs in response to positive and negative shocks to future research.

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

significant reduction of the response of inflation but an increase in the unemployment response. One possible explanation for these differences may be related to the fact that while supply shocks imply a trade-off between inflation and unemployment stabilization for governments and trade unions, such a trade-off is absent following demand shocks. The optimal strategy of trade unions, and the interactions between unions, governments and central banks, can thus depend on the type of shocks hitting the economy, and this may explain why it is sometimes difficult to identify the effect of trade unions and of the relevant level of bargaining on business cycle fluctuations.

3.2 Inflation and unemployment volatility for different LMIs

To assess the impact of LMIs on macroeconomic volatilities, we use the estimation results to simulate artificial data for different constellations of the labor market and compute the implied variance of the simulated unemployment and inflation series. The exercise is performed considering both external shocks. We vary one of the LMIs at a time, evaluating it respectively at the 20^{th}, 50^{th}, and 80^{th} percentile. All other LMIs are set at their median value. For each of these simulated economies, we use the bootstrapped coefficient estimates from regression equations (5), (6) and (7) to account for the coefficient uncertainty when evaluating whether the volatility of inflation and unemployment for different constellations of the labor market are significantly different from each other.

Figure 3 shows how the volatility of unemployment and inflation vary with the value of LMIs. Each panel displays two Kernel density estimates of the volatilities' distribution based on the underlying bootstrapped coefficient estimates. One distribution reflects the volatilities obtained when the respective LMI is evaluated at a low level (20^{th} percentile); the other one when the LMI is set at a high value (80^{th} percentile). Additionally, we report for each panel the p-value for the null hypothesis that the means for the low and high LMI case are identical. The left column refers to unemployment volatility while the right column to inflation volatility. The x-axis measures the standard deviation of the simulated variable.

Overall, we find that once we take full advantage of the time dimension of the data and control for the shocks hitting the different economies, most of the LMIs have a large and significant effect on both inflation and unemployment volatilities. Moving from low to high EPL, by restricting the adjustment along the quantity side of the labor market, significantly reduces unemployment volatility by about 52 percent; inflation volatility increases by 5 percent, though not significantly so at conventional levels. High unemployment benefits create a form of wage rigidities, and thus increase unemployment volatility by 59 percent and reduce inflation volatility by 25 percent. Both are significant at the 5 percent level. Similarly, moving from a low to a high tax wedge amplifies unemployment volatility by 18 percent and reduces inflation volatility by 20 percent. Strong unions have the opposite effect: inflation volatility is amplified but unemployment volatility is lower. Finally, a decentralized wage setting is associated with lower unemployment volatility, but with no significant impact on inflation volatility. This last result can be explained by noticing that the effect of wage bargaining centralization on inflation volatility following a demand shock is opposite to the effect following an oil price shock. The effects of the two shocks tend to offset each other.

Our results underpin previous findings in the empirical literature. For example, the fact that higher EPL reduces unemployment volatilities corroborates the results of Merkl and Schmitz (2011) and is consistent with the evidence in Gnocchi et al. (2015) and Faccini and Rosazza-Bondibene (2012). Similarly, the positive influence of unemployment benefits on unemployment volatility is consistent with the results of Merkl and Schmitz (2011). Regarding inflation volatility, our evidence is in line with Bowdler and Nunziata (2007), who find that higher unionization of the labor force may lead to an amplification of the inflationary effects of macroeconomic shocks. The main difference with previous studies regards the significance and robustness of these results: most of the LMIs are found to have a significant effect on business cycle volatilities while other studies frequently find support only for a subset of individual LMIs. Moreover, our findings are robust to changes in the sample period and in the countries included in the estimation exercises.[23]

Based on their estimated effects on business cycles, LMIs can be divided into two groups: the institutions that lead to employment rigidities - EPL, union density and a decentralized wage setting - and the ones that tend to reduce the responsiveness of wages and thus create wage rigidities - unemployment benefits and the tax wedge. The first group of institutions limit the

[23]In robustness exercises we estimated the model for two different sample periods (from 1970:1-1999:1 and from 1970:1-2007:1). Moreover, we checked whether results are driven by a single country by excluding one country at a time from the estimation. The main results of the paper are unaffected.

adjustment of labor market quantities and shift the adjustment to labor prices; unemployment volatility is reduced while inflation volatility is increased. The second group of institutions reduce the response of labor prices and shift the burden of the adjustment to employment. They therefore tend to reduce the volatility of inflation, but to increase unemployment volatility. We use this intuition in the following section to study the potential interaction of different LMIs.

3.3 Labor market interactions

So far we have varied one LMI at a time to understand their individual effects on the dynamics of inflation and unemployment. Two main results emerge from the previous sections. First, labor market institutions strongly affect business cycle dynamics following external shocks. Second, different types of labor market rigidities have very different, sometimes opposite, effects on inflation and unemployment.

Another question arises naturally from the analysis: how important is the interplay of different labor market institutions? As argued by Bertola and Rogerson (1997), it can be misleading to focus on a unidimensional characterization of labor markets, especially if labor market institutions have counteracting effects on business cycle dynamics. To address this issue, we compare the dynamics of inflation and unemployment in a completely "rigid" labor market economy, where all LMIs take on high values (80^{th} percentile of the sample distribution), with the ones of an economy with completely "flexible" labor markets, where all LMIs take low values (20^{th} percentile of the sample distribution). In our dataset, the USA and Switzerland have flexible labor markets while Belgium is probably the best example of a rigid labor market. We contrast these cases with two artificial economies where LMIs re-inforce each other such that the adjustment is predominatly borne out by either labor prices or labor quantities, informed by the results from Section 3.2. Specifically, in the first economy EPL and union density are high, while unemployment benefits, the degree of bargaining centralization and the tax wedge are set at a low level. We label this constellation of the labor market as "Quantity rigid", because these LMIs tend to limit the adjustment of labor quantities and to push the adjustment to wages and prices. The order is reversed in the second economy, which we label as "Price rigid" because in a country with high benefits, high tax wedges, low EPL, low union density and centralized wage bargaining it is more costly to change prices and thus shocks tend to be absorbed through changes in employment. In our dataset, the Netherlands is the country that gets closer to the "Price rigid" paradigm and Portugal the one that gets closer to the "Quantity rigid" paradigm.

Figure 4 shows the impulse responses of the four hypothetical economies (labelled "Rigid", "Flex", "Q rigid", and "P rigid", respectively) following an oil price shock. As a benchmark comparison, we also depict the IRFs when all LMIs are evaluated at the median sample value and provide the corresponding 90-percent confidence interval. Moreover, to provide an idea of the impulse responses of specific countries, the light-grey shaded area shows the range that is given by the lowest and highest impulse response based on the average LMI of the individual countries.

Perhaps surprisingly, we find that the dynamics of a completely rigid economy are quite similar to the ones of a completely flexible economy (column 2). In both cases, neither the response of unemployment nor the one of inflation appear to be significantly different from the benchmark economy in which all LMIs take on the median value.

Looking instead at the "extreme" labor market constellations in column 1, one can observe large differences between "Quantity rigid" and "Price rigid" economies. In a "Quantity rigid" economy, the response of unemployment is fully muted but the inflation rate sharply increases to 0.6 percent after one year. The corresponding response of the interest rate is relatively mild with an increase of about 0.4 percent. In a "Price rigid" economy, instead, the unemployment rate increases by 0.5 percentage points after about 2 years, while the inflation rate peaks at less than 0.4. Consequently the interest rate is initially unchanged and turns even accomodative as the unemployment rate reaches its peak after two years. The results for the world demand shocks are comparable and depicted in Figure 5.

These results suggest that it is crucial to take into account the overall structure of the labor market when drawing policy conclusions.

4 Conclusion

The economic consensus view is that "labor market inertia is as crucial as sticky prices in determining macroeconomic shock transmission and adjustment mechanisms" (Bertola, 2014). The existing empirical literature, however, finds a limited role of labor market institutions for business cycle dynamics. In this paper we reassessed the link between labor market institutions and inflation and unemployment dynamics using an Interacted Panel VAR framework that allows coefficient estimates to vary with labor market institutions. Using this approach, we find a significant and sizable effect of several labor market institutions on business cycle fluctuations. Moreover, the results suggest that different labor market rigidities have very different, sometimes opposite, effects on inflation and unemployment. High EPL and high union density, by restricting the adjustment along the quantity side of the labor market, amplify the response of inflation, but smoothen the response of unemployment. High unemployment benefits and high tax wedges, instead, create a form of real wage rigidities, and therefore, reduce inflation volatility, but amplify the unemployment response to shocks. This implies that it can be misleading to draw policy conclusions from unidimensional characterizations of the labor market as rigid or flexible, because the dynamics in countries with overall rigid labor markets are not found to be significantly different from the ones in economies with flexible labor markets. The starkest contrast in the responses of inflation and unemployment to shocks can be found in those countries with institutions that limit price adjustments relative to those countries with institutions that limit quantity adjustments.

The findings of this study have relevant implications, for instance, in the context of a monetary union.[24] When countries within a union exhibit heterogeneous labor markets, the propagation of shocks differs across member states. Symmetric shocks (and thus monetary policy) may have strong asymmetric effects and lead to inefficient inflation and unemployment differentials. Whether this calls for a coordination of labor market reforms, however, depends on the exact configuration of the labor markets of member countries. In particular, the differences in the adjustment mechanisms to shocks may not be as pronounced as expected because labor market institutions can have opposing effects on business cycle dynamics. Considerations about equilibrium unemployment rates and social preferences, not discussed in this paper, but often considered of overriding importance, may in such cases outweigh the benefits for monetary policy coming from a harmonization of labor markets structures.

[24]See, e.g., Faia et al. (2014) and Abbritti and Mueller (2013). Faia et al. (2014) study optimal monetary policy in a model with turnover costs and show that the inefficiencies of the competitive economy increase with the magnitude of firing costs. Abbritti and Mueller (2013) set up a dynamic currency union model and show that asymmetries in labor market structures worsen the adjustment of a currency union to shocks.

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Table 1: Summary of recent empirical studies examining the effect of labor market institutions (LMIs) on business cycles

Study	**Countries**	**Period**	**Estimation Strategy**	**Dependent variables**	**LMIs used**	**Results**
Bowdler and Nunziata (2007)	20 OECD countries.	1961 to 1995.	Panel data analysis	CPI inflation	Coordination of wage bargaining and Union density	High degree of coordination dampens inflation adjustment while union density amplifies inflation responses
Fonseca, Patureau, Sopraseuth (2010)	20 OECD countries.	1964:1 to 2003:4.	Panel data analysis	Business cycle synchronization (i.e. cross-country GDP correlation)	EPL, Union density, Coordination of wage bargaining, unemployment benefits, tax wedge components (employment tax rates, direct and indirect tax rates).	Disparities in employment protection laws and direct taxation tend to lower international comovement while divergence in union density, unemployment benefits, and indirect taxation enhance cross-country correlations.
Rumler and Scharler (2011)	20 OECD countries.	1970:1 to 2006:4	Panel data analysis	Inflation and output volatilities (Standard dev. of 5-year periods)	EPL, Union density, Coordination of wage bargaining	Union density increases output volatility while coordination of wage bargaining lowers inflation volatility. Other LMIs have no significant effect.
Merkl and Schmitz (2011)	11 Euro Area countries.	1999:1 to 2008:2	Cross-country regression	Inflation and output gap volatilities	EPL, Unemployment benefit replacement rates	EPL reduces output volatility, while higher replacement rates increase output volatility. No clear effect on inflation volatility.
Faccini and Rosazza Bondibene (2012)	20 OECD countries.	1975:1 to 2009:4	Panel data analysis	Relative unemployment volatility (i.e. the ratio vol(u)/vol(y))	Temporary / permanent EPL, coordination / centralization of wage bargaining, union coverage / density, tax wedge, unemp. benefit replacement rates and duration	EPL and union density strongly reduce the sensitivity of unemployment to output changes; union coverage increases it. Benefit replacement rates, benefit duration and the tax wedge have a limited impact on the sensitivity of unemployment fluctuations.
Lochner (2014)	20 OECD countries.	1985:1 to 2012:4	Panel data analysis	Relative unemployment volatility (i.e. the ratio vol(u)/vol(y))	Temporary / permanent EPL, union density, coordination / centralization of wage bargaining and net replacement rates	EPL index for permanent contracts has a non-linear, inverted-U-shape effect on relative unemployment volatility. Coordination, union density and replacement rates have also a negative effect. Centralization not significant.
Gnocchi, Lagerborg and Pappa (2015)	19 OECD countries.	1971:1 to 2007:4	1) Spearman rank correlations; 2) Difference-in-difference approach.	1) Decade average business cycle indicators; 2) Macroeconomic performances of reformers and non-reformers	Replacement rates, labor unions (density, coverage, concentration, centralization), wage bargaining process (coordination, government involvement, level at which bargaining takes place, coverage extension of bargained wage) and EPL collapsed in statistical factors based on principal components analysis.	1) Spearman partial rank correlations: more flexible institutions are associated with lower business cycle volatility. 2) Reform episodes: wage bargaining reforms increase the correlation of the real wage with labor productivity and the volatility of unemployment. EPL reforms increase the volatility of employment and decrease the correlation of the real wage with labor productivity. Reforms reducing replacement rates make labor productivity more procyclical.

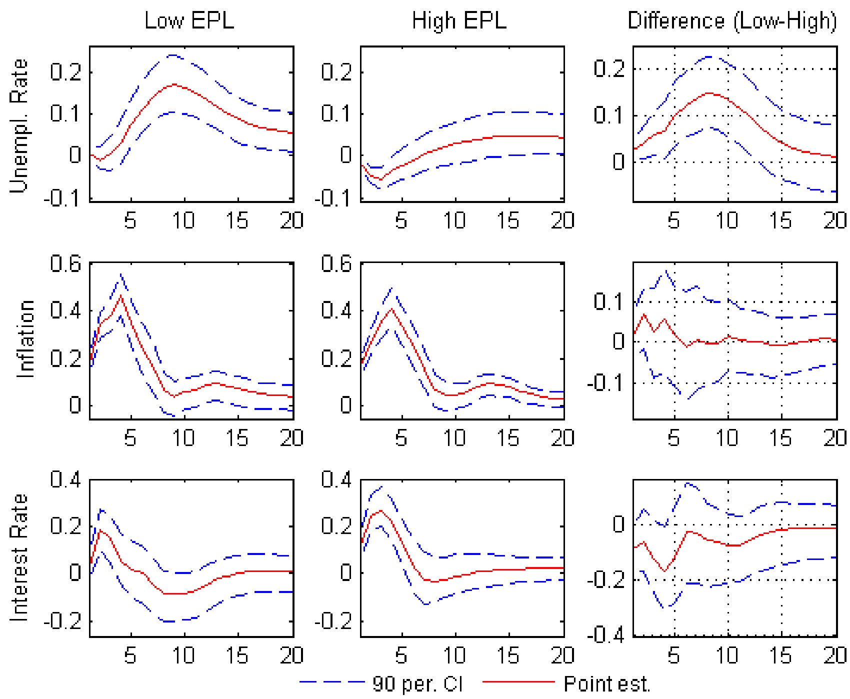
Table 2: Average Labor Market Institution Values over Sample Period, by Country

Country Group	Country	Labor Market Institutions				
		EPL	BRR	TW	UDENS	CEW
Anglo-Saxon	Australia	0.34	22.86	36.39	35.42	1.83
	Canada	0.27	16.92	43.70	31.73	1.00
	Ireland	0.30	30.16	38.32	44.63	2.44
	New Zealand	0.36	28.72	38.04	40.88	1.45
	UK	0.20	18.65	41.90	37.21	1.23
	US	0.07	13.68	32.39	16.98	1.00
	Average	0.26	21.83	38.46	34.48	1.49
Continental	Austria	0.64	28.28	55.19	44.88	2.00
	Belgium	0.94	41.55	55.58	51.28	2.24
	France	0.93	33.65	61.85	12.60	1.85
	Germany	0.97	26.99	51.65	28.84	2.00
	Netherlands	0.83	47.36	52.30	26.89	2.15
	Switzerland	0.34	21.87	36.21	22.67	1.88
	Average	0.77	33.28	52.13	31.19	2.02
Scandinavian	Denmark	0.64	49.69	60.62	72.29	2.23
	Finland	0.73	31.14	59.20	70.48	2.52
	Norway	0.93	34.05	60.69	55.47	2.45
	Sweden	0.87	28.04	71.39	76.81	2.34
	Average	0.79	35.73	62.97	68.76	2.38
Mediterranean	Italy	1.01	15.03	54.47	39.86	2.25
	Portugal	1.24	26.11	42.54	30.90	2.36
	Spain	1.17	29.45	44.39	15.30	2.46
	Average	1.14	23.53	47.13	28.69	2.36
Others	Japan	0.65	11.19	32.17	25.79	1.00
Overall sample	20pct (low)	0.32	17.79	37.21	24.23	1.34
	Median	0.69	28.16	48.02	36.32	2.08
	80pct (high)	0.95	33.85	59.91	53.38	2.40

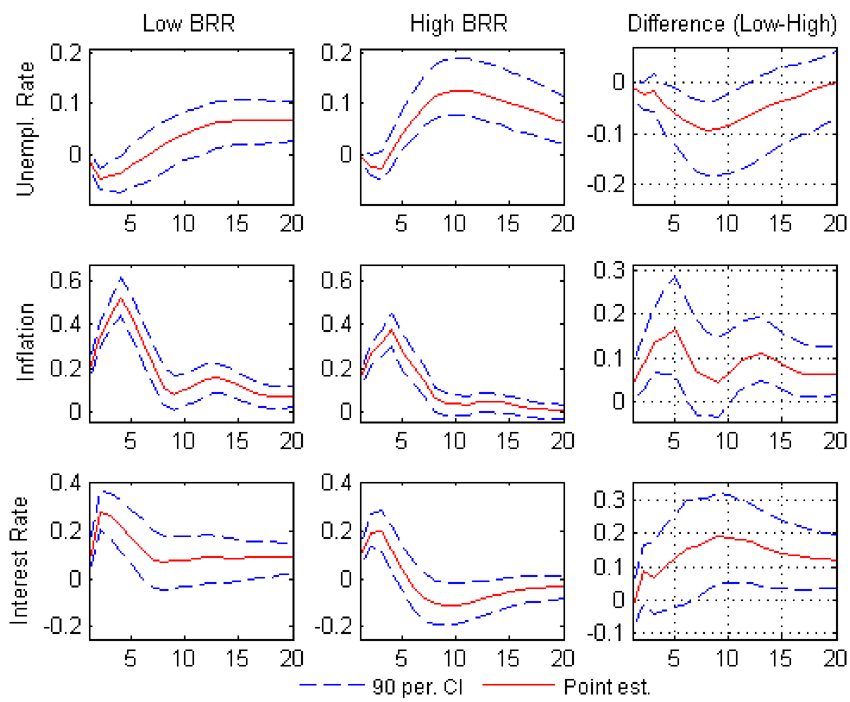
Table 3: Impulse response peak difference first three years for varying LMIs

		Low				High					
LMI	Variable	4q	8q	12q	VaPD	4q	8q	12q	VaPD	Peak Dif.	Quarter
Oil supply shock											
EPL	Unempl. Rate	0.03	0.16***	0.14***	0.16***	−0.04***	0.02	0.04*	0.02	0.15***	8.00
	Inflation	0.47***	0.06*	0.09**	0.34***	0.41***	0.07*	0.08***	0.27***	0.07*	2.00
BRR	Unempl. Rate	−0.04**	0.02	0.06***	0.02	0.01	0.11***	0.12***	0.11***	−0.10***	8.00
	Inflation	0.52***	0.11***	0.15***	0.44***	0.38***	0.06*	0.05*	0.28***	0.17***	5.00
TW	Unempl. Rate	−0.00	0.07***	0.08***	−0.00	−0.02	0.07**	0.09***	−0.02	0.02	4.00
	Inflation	0.45***	0.11*	0.07*	0.29***	0.43***	0.05*	0.10***	0.20***	0.09*	6.00
UDENS	Unempl. Rate	−0.02	0.08***	0.10***	0.08***	−0.01	0.05***	0.08***	0.05***	0.03	8.00
	Inflation	0.43***	0.04*	0.09***	0.19***	0.46***	0.15***	0.07***	0.33***	−0.14***	6.00
CEW	Unempl. Rate	−0.02	0.05*	0.06*	0.06*	−0.01	0.08***	0.11***	0.11***	−0.05	12.00
	Inflation	0.37***	−0.04	0.01	0.11*	0.47***	0.13***	0.11***	0.31***	−0.20**	6.00
World demand shock											
EPL	Unempl. Rate	−0.28***	−0.35***	−0.15***	−0.34***	−0.12***	−0.23***	−0.24***	−0.15***	−0.19***	5.00
	Inflation	−0.03	0.27***	0.19***	−0.03	0.23***	0.26***	0.23***	0.23***	−0.26***	4.00
BRR	Unempl. Rate	−0.17***	−0.25***	−0.22***	−0.25***	−0.19***	−0.30***	−0.25***	−0.30***	0.05*	8.00
	Inflation	0.16***	0.28***	0.27***	0.15***	0.08**	0.23***	0.22***	0.06*	0.09**	3.00
TW	Unempl. Rate	−0.14***	−0.25***	−0.24***	−0.17***	−0.23***	−0.31***	−0.21***	−0.27***	0.11***	5.00
	Inflation	0.17***	0.30***	0.31***	0.33***	0.06*	0.22***	0.20***	0.21***	0.12*	10.00
UDENS	Unempl. Rate	−0.21***	−0.30***	−0.24***	−0.21***	−0.16***	−0.26***	−0.23***	−0.16***	−0.05*	4.00
	Inflation	0.08***	0.23***	0.20***	0.22***	0.16***	0.30***	0.30***	0.32***	−0.10*	10.00
CEW	Unempl. Rate	−0.16***	−0.19***	−0.12***	−0.12***	−0.20***	−0.33***	−0.29***	−0.29***	0.17***	12.00
	Inflation	0.23***	0.36***	0.25***	0.31***	0.05	0.23***	0.24***	0.11**	0.20***	5.00

VaPD = Value at peak difference. *** p<0.01, ** p<0.05, * p<0.1. Significance generally refers to the difference to zero, with the exception of column "Peak Dif.", where significance refers to the difference between the response of the unemployment (inflation) rate for a low compared to a high level of the relevant LMI. Low = 20^{th} percentile and High = 80^{th} percentile of the sample distribution of the relevant LMI.



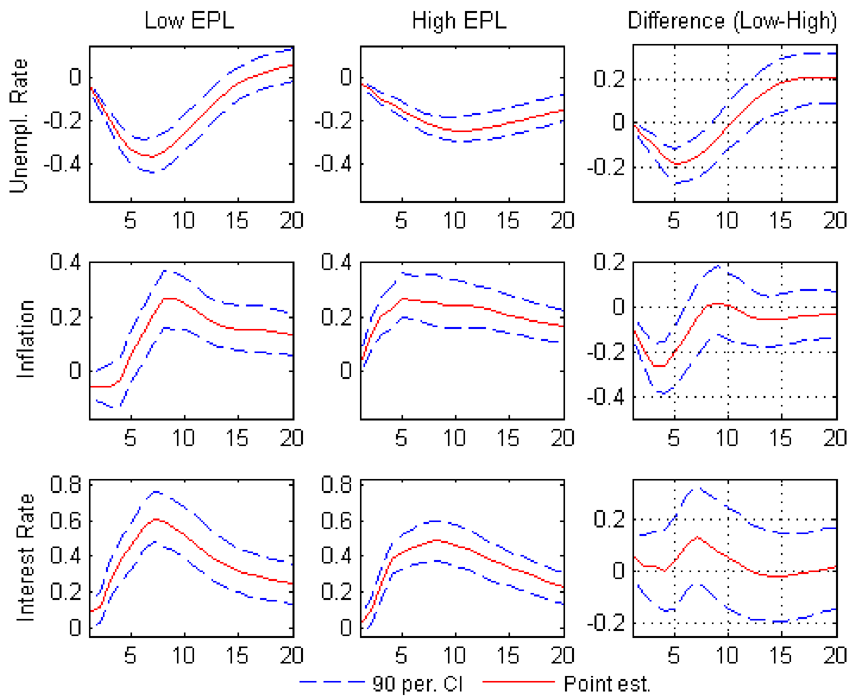
(a) Varying degrees of EPL



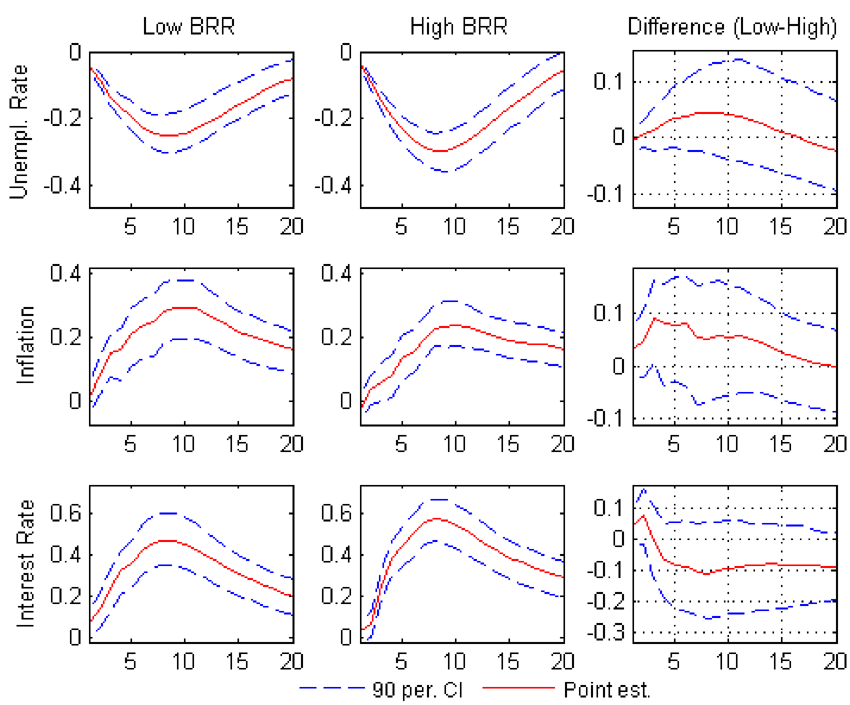
(b) Varying degrees of BRR

Figure 1: Response to a one standard deviation oil price shock

Note: Panels in the first column depicts IRFs and corresponding 90 percent confidence bands when the relevant LMI has a low level (20^{th} percentile). Panels in the second column depict IRFs and corresponding 90 percent confidence bands when the relevant LMI has a high level (80^{th} percentile). The third column shows the difference of the two IRFs and the corresponding 90 percent confidence band.



(a) Varying degrees of EPL



(b) Varying degrees of BRR

Figure 2: Response to a one standard deviation world demand shock

Note: Panels in the first column depicts IRFs and corresponding 90 percent confidence bands when the relevant LMI has a low level (20^{th} percentile). Panels in the second column depict IRFs and corresponding 90 percent confidence bands when the relevant LMI has a high level (80^{th} percentile). The third column shows the difference of the two IRFs and the corresponding 90 percent confidence band.

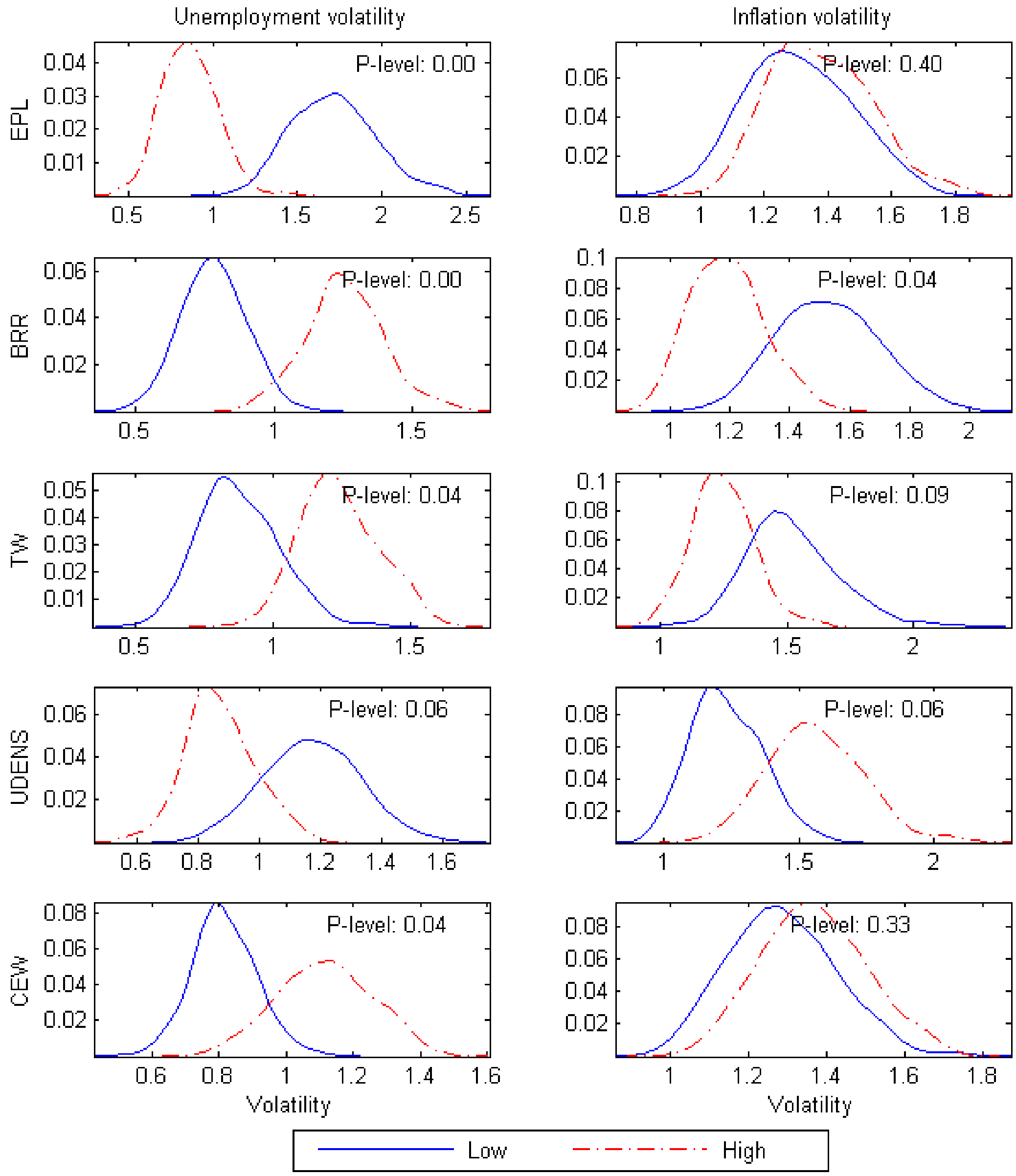


Figure 3: Volatility density

Note: Each panel displays two Kernel density estimates of the volatilities' distribution based on the underlying bootstrapped coefficient estimates varying one LMI while holding all other LMIs at their median value. The blue solid line reflects the Kernel density for the volatilities obtained when the respective LMI is evaluated at a low level (20^{th} percentile); the red dotted line reflects the Kernel density for the volatilities obtained when the relevant LMI is set at a high value (80^{th} percentile). The p-value is provided for the null hypothesis that the means for the low and high LMI cases are identical.

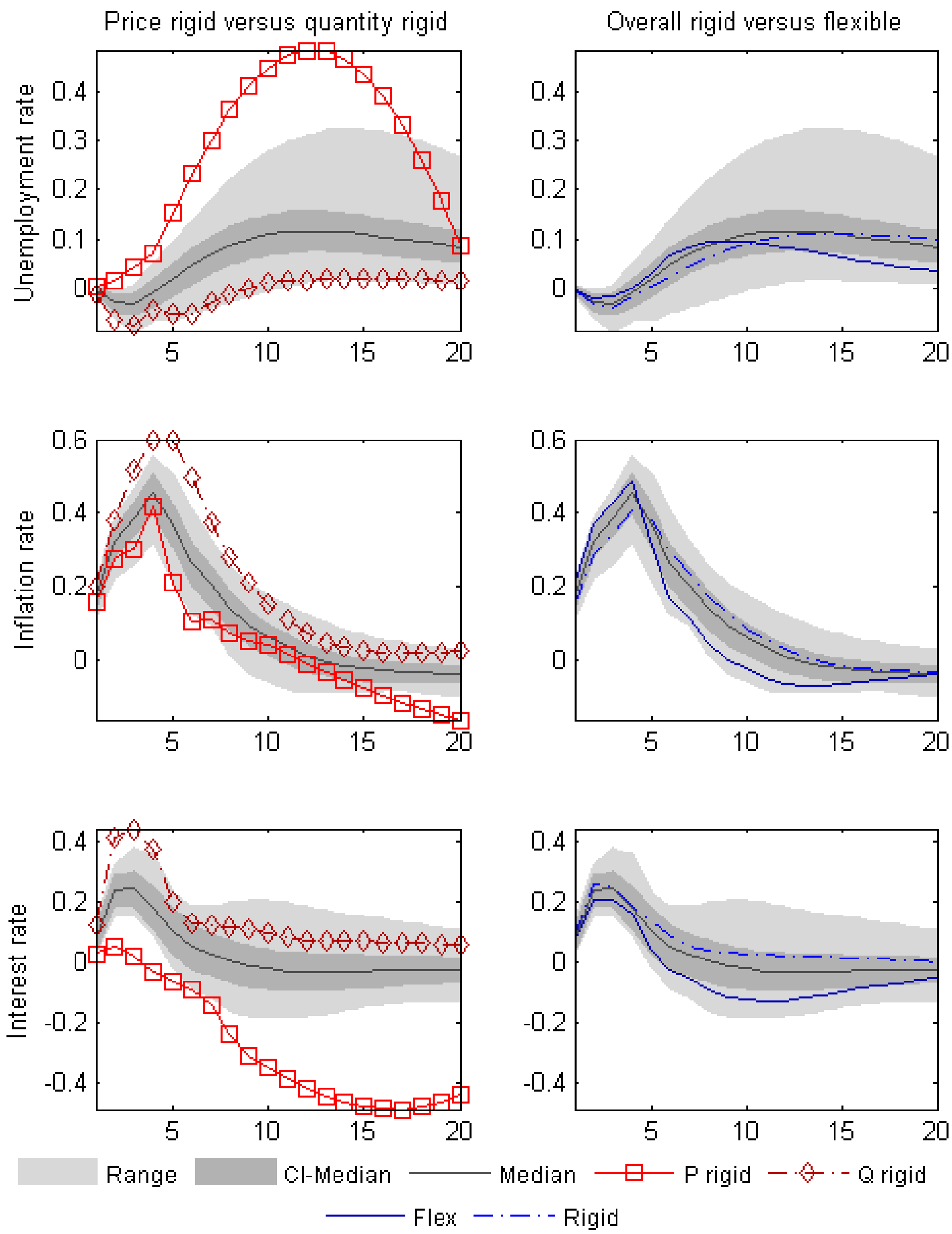


Figure 4: Response to oil price shock and LMIs interactions

Note: "Range" refers to the space spanned by the lowest and highest impulse response based on the average LMIs of the individual countries. "CI-Median" refers to the 90-percent confidence interval for the IRF for a hypothetical economy with all LMIs evaluated at the sample median value. "Median" refers to the corresponding median impulse response. "P rigid" refers to the hypothetical economy characterized by a LMI constellation constraining price adjustments, i.e. EPL and UDENS are evaluated at the 20^{th} percentile of the sample distribution and TW, BRR, and CEW are evaluated at the 80^{th} percentile of the sample distribution. "Q rigid" refers to the hypothetical economy characterized by the opposite LMI constellation. "Flex" and "Rigid" refer to hypothetical economies characterized by LMIs corresponding respectively to the 20^{th} percentile and to the 80^{th} percentile of the sample distribution.

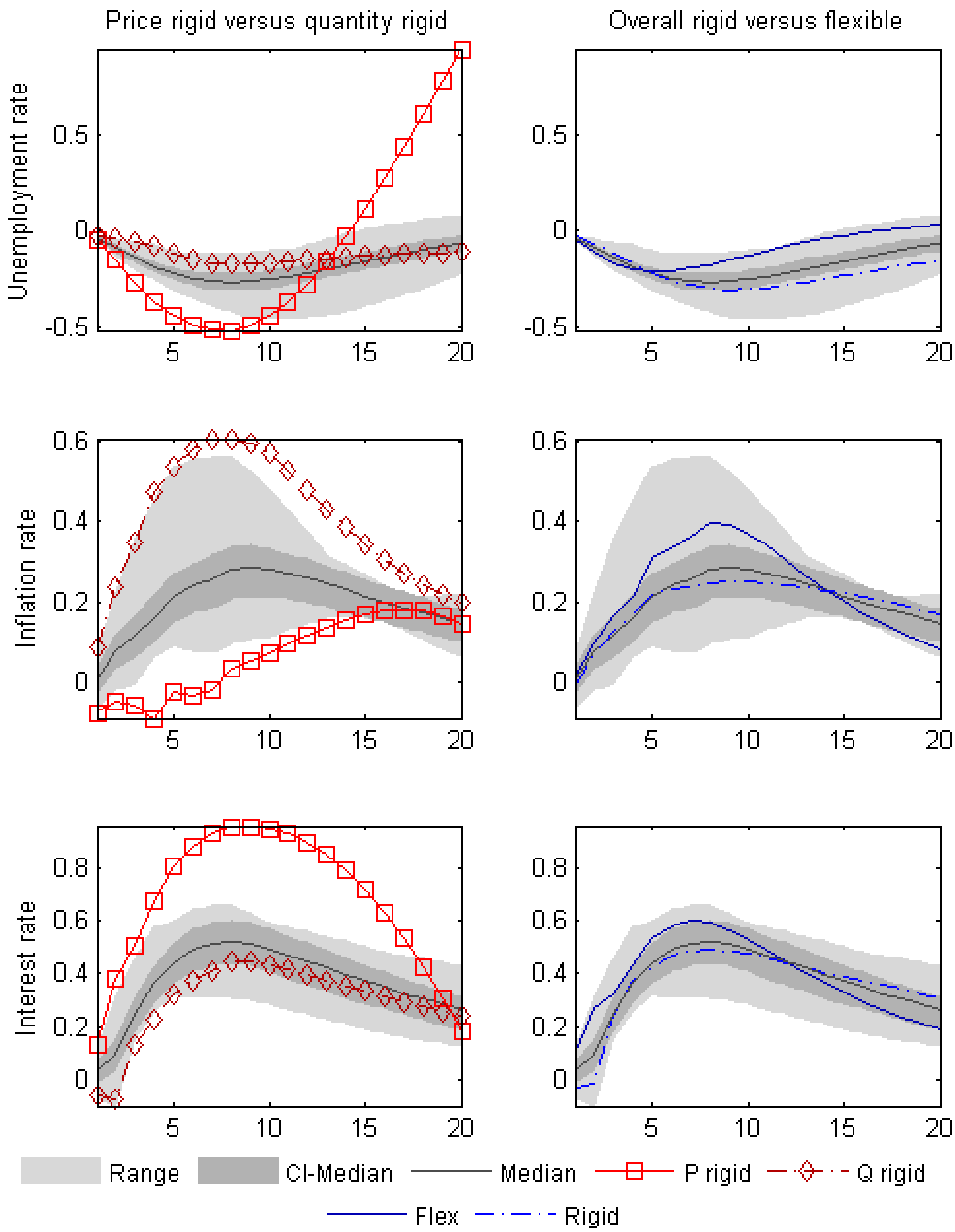


Figure 5: Response to world demand shock and LMIs interactions

Note: "Range" refers to the space spanned by the lowest and highest impulse response based on the average LMIs of the individual countries. "CI-Median" refers to the 90-percent confidence interval for the IRF for a hypothetical economy with all LMIs evaluated at the sample median value. "Median" refers to the corresponding median impulse response. "P rigid" refers to the hypothetical economy characterized by a LMI constellation constraining price adjustments, i.e. EPL and UDENS are evaluated at the 20^{th} percentile of the sample distribution and TW, BRR, and CEW are evaluated at the 80^{th} percentile of the sample distribution. "Q rigid" refers to the hypothetical economy characterized by the opposite LMI constellation. "Flex" and "Rigid" refer to hypothetical economies characterized by LMIs corresponding respectively to the 20^{th} percentile and to the 80^{th} percentile of the sample distribution.