Labor Market Institutions and Macroeconomic Volatility in a Panel of OECD Countries *

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Abstract

In this paper we analyze empirically how labor market institutions influence the cyclical volatility of output and inflation in a sample of 20 OECD countries. Our results suggest that highly coordinated wage bargaining systems have a dampening impact on inflation volatility, whereas countries characterized by high union density tend to experience more volatile movements in output.

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1 Introduction

Conventional wisdom holds that the flexibility of wages is an important element of the macroeconomic adjustment process in the face of shocks (see e.g. Pichelmann, 2007). If wages are sufficiently flexible, then most of the necessary adjustment will come from wages without large reactions in employment and aggregate output. In other words, business cycles should be less volatile in economies characterized by a high degree of wage flexibility.

In this paper, we investigate empirically how institutional characteristics of the labor market, in particular the organization of the wage bargaining process, influence output and inflation volatility in a panel of OECD countries. Our analysis is motivated by the idea that the institutional framework in which wages are negotiated determines to some extent the degree of wage flexibility and therefore also the propagation of shocks.[1] In a seminal paper, Calmfors and Driffill (1988) argue that the degree to which unions internalize the macroeconomic consequences of their actions has implications for macroeconomic outcomes and specifically for the unemployment rate. In this paper, we take this argument one step further and ask how the characteristics of the wage bargaining process influence the adjustment of macroeconomic variables such as inflation and output to disturbances. The novel aspect of our analysis is that we focus explicitly on the volatility of macroeconomic variables.

Although the role of labor market institutions for macroeconomic performance, and in particular long-run unemployment, has been investigated extensively in the literature (see e.g. Blanchard and Wolfers, 2000), only few papers explore the implications for the business cycle. Nunziata (2003) study the cyclical adjustment of employment and hours worked. Campolmi and Faia (2006) analyze to what extent differences in labor market institutions can explain cyclical inflation differentials across countries in a dynamic stochastic general equilibrium model. Nunziata and Bowdler (2005) and Nunziata (2003) study the implications of labor market institutions for inflation dynamics but without taking volatility into account. Fonseca et al. (2007) also explore how labor market institutions are related to the business cycle, but their analysis is concerned with international

[1] Several studies document that wage flexibility is closely related to the institutional environment in which wage negotiations take place (see e.g. Clar et al., 2007, and the references therein).

co-movement and not volatility.

In terms of the empirical strategy we pursue in this paper, our analysis is closely related to the literature that studies the determinants of business cycle volatility in a cross-section framework. Karras and Song (1996) investigate potential sources of business cycle volatility in a sample of OECD countries and find that volatility is related to monetary as well as real factors. Ferreira da Silva (2002), Buch and Pierdzioch (2005) and Beck et al. (2006) find that financially more developed economies experience smoother business cycles. Kose et al. (2003a) and Kose et al. (2003b) analyze the impact of globalization. Fatás and Mihov (2003) study the role of fiscal policy for output volatility. They conclude that discretionary government spending increases output volatility. In contrast to these papers, we exploit not only the cross-section variation, but also the variation along the time dimension by using a panel data set.

We find that labor market institutions and in particular the characteristics of unions determine to some extent the cyclical behavior of output and inflation. In line with the view that in highly coordinated wage bargaining systems, unions internalize the macroeconomic consequences of their actions, we find that inflation volatility is lower in economies where coordination is high. However, we find only a small impact of coordination on output volatility. Nevertheless, stronger unionization has a significantly positive impact on output volatility, which may indicate that the bargaining power of unions has an impact on business cycle volatility. Overall, we find only limited evidence in favor of the hypothesis that unions act as shock absorbers.

The paper is organized as follows: Section 2 discusses the role of real wage rigidity for the business cycle in the context of a sticky price model. Section 3 describes our empirical strategy and the data, while Section 4 presents the estimation results and Section 5 concludes the paper.

2 Theoretical Motivation

Calmfors and Driffill (1988) were among the first to argue that the organization of the wage bargaining process may have implications for macroeconomic outcomes. However, their analysis is primarily concerned with the level of the unemployment rate, therefore the question remains, how a union that internalizes the consequences of its actions responds to shocks that call for an adjustment of real wages. In this section we use a standard sticky price model to explore how the wage setting process may influence fluctuations in output and inflation. To illustrate the main points, we proceed in two steps: First, we augment the standard sticky price model to allow for real wage rigidity, since our hypothesis is that unions and labor market institutions more generally influence macroeconomic volatility via the rigidity of wages. Second, we discuss how real wage rigidity may be related to the organization of the wage bargaining process.

Note that despite our focus is on labor market institutions, the theoretical model does not explicitly cover the role of institutions. Nevertheless, this class of models is the workhorse model for the analysis of business cycle dynamics. And since we are mainly interested in cyclical fluctuations we choose this model as a basis for our analysis. Although a detailed, theoretical analysis is beyond the scope of this paper, we can gain still gain some insights based on the standard sticky price model.

As this type of model is widely used, the description will be brief (see e.g. Woodford, 2003; Clarida et al., 1999, for more detailed discussions). Consider the following framework:

$$y_t = -\frac{1}{\sigma}(r_t - E_t\pi_{t+1})) + E_t(y_{t+1}) + u_{1t}, \tag{1}$$

$$\pi_t = \delta_0 mc_t + \delta_1 E_t\pi_{t+1} + \delta_2\pi_{t-1} + u_{2t}. \tag{2}$$

$$r_t = \rho r_{t-1} + (1-\rho)(\chi_0\pi_t + \chi_1 y_t), \tag{3}$$

where y_t, π_t, mc_t and r_t denote aggregate output, the inflation rate, real marginal cost and the nominal interest rate as percentage deviations from the steady state and E_t is the expectation operator conditional on information available at time t. Equation (1) is the forward-looking IS curve which relates output to the real interest rate and expected future output. The New Keynesian Phillips Curve in (2) states that inflation is determined by real marginal cost, mc_t, expected inflation and lagged inflation. As in Clarida et al. (1999) we interpret u_{1t} and u_{2t} as demand and supply shocks with $E(u_{1t}) = E(u_{2t}) = 0$, $E(u_{1t}u_{2t}) = 0$. Equation (3) is the interest rate rule which describes how the monetary authority sets the nominal interest rate, r_t.

To study the business cycle implications of rigid real wages we follow Blanchard and Galí (2005) among others and assume that real wages evolve according to

$$w_t = \lambda w_{t-1} + (1 - \lambda) mrs_t, \tag{4}$$

where mrs_t denotes the marginal rate of substitution between labor and consumption and $\lambda \in [0, 1]$ measures the sluggishness of real wages. For $\lambda = 0$, (4) states that the real wage is equated to the marginal rate of substitution between consumption and labor, which is the wage that would prevail if there were no frictions on the labor market. For $\lambda > 0$, the real wage becomes dependent on its own past value. Thus, a high value of λ corresponds to substantial real wage rigidity.

To see how different degrees of real wage rigidity, as indexed by λ, influence business cycle dynamics, we calibrate and simulate the model.[2] Figures 1 and 2 display the impulse response functions generated by the model for a relatively low degree of real wage rigidity ($\lambda = 0.1$) and a high degree of real wage rigidity ($\lambda = 0.9$). We choose these extreme values for λ to highlight the role of wage rigidity.

Figure 1 shows the responses to a supply shock, that is a one unit shock to u_{2t}, and Figure 2 displays the responses to a unit shock to u_{1t}, which we interpret as a demand shock. Consider first the supply shock. The top graph of Figure 1 shows that high wage rigidity dampens the response of the real wage, as one would expect. Moreover, the responses of inflation (middle graph) and output are both amplified under a relatively high degree of real wage rigidity, that is a high value of λ. In the case of a demand shock Figure 2 shows a somewhat different picture. If real wages are highly rigid, the reaction of the real wage is muted as in the case of a supply shock. However, the inflation response turns out to be less pronounced, although somewhat more persistent, for high values of λ. The output response, in contrast, is slightly stronger if real wages are rigid.

In this paper, we are primarily interested in the influence of labor market institutions on macroeconomic stability. Although the model does not explicitly cover the wage bargaining process, we can still gain some insights by asking how real wage rigidity, as indexed by λ, should be expected to be related to labor market institutions.

[2] Details on the calibration can be found in the Appendix. The model is solved using the Blanchard and Kahn (1980) method.

Consider for instance an adverse supply shock that leads to an increase in the inflation rate and a slow-down in real economic activity. Unions may react with higher nominal wage claims to compensate the loss in purchasing power resulting from the increased inflation. Such a behavior would give rise to rigid real wages, that is a relatively high λ. As we see from the simulations described above, a high degree of real wage rigidity leads to an amplification of the initial supply shock as firms face higher production costs. Consequently, production slows down even further and production costs increase due to higher wages, resulting in additional inflationary pressure.

However, if unions internalize the macroeconomic implications of their high wage claims leading to real wage rigidity, they may prefer to let the real wage adjust. In this case, the initial shock is dampened and the impact on employment, output and inflation is less pronounced.

A similar reasoning applies in the case of demand disturbances. However, as we have seen, real wage flexibility may even amplify inflation volatility in this case. Consider a shock to aggregate demand that gives rise to an increase in economic activity. Intuitively, an increase in aggregate demand will lead to higher marginal cost which translates into higher inflation via the Phillips Curve. However, if real wages are rigid, then the increase in marginal cost, and thus in inflation, should be less pronounced. Again, if unions internalize the macroeconomic implications of the wage bargaining process they may react by aiming at relatively stable real wages despite the occurrence of the shock and thereby stabilize inflation. Note that the output response is only marginally amplified when real wages are rigid in this case.

To sum up, in the case of a supply shock, macroeconomic volatility is dampened if unions allow real wages to adjust. In the case of a demand shock rigid real wages may dampen inflation volatility. Overall, we see that unions that internalize the macroeconomic consequences of their wage claims can indeed reduce the impact of disturbances on the economy. By responding appropriately, they may act as a shock absorber.

Since, unions are more likely to take macroeconomic consequences into account when wage bargaining is coordinated Calmfors and Driffill (1988) we therefore expect output and inflation volatility to be lower in countries characterized by highly coordinated systems of wage bargaining. Moreover, it appears conceivable that the bargaining power of unions may be related to macroeconomic volatility. These are the main hypotheses that we test empirically in the next section.

3 Empirical Model and Data

In this section we describe our empirical strategy. The simulations presented in the previous section show how real wage rigidity, which should at least be partly determined by labor market institutions, may influence output and inflation fluctuations in a standard business cycle model. In particular, by responding appropriately to supply and demand side disturbances, unions may act as a shock absorber.

Note that the empirical analysis is complicated by the result that the effect of real wage rigidity depends on the type of shocks. Therefore, a detailed empirical analysis of the link between the wage bargaining process and business cycle volatility via real wage rigidity would require to identify supply and demand shocks. Although several studies attempt to identify the structural shocks which are the driving forces behind the business cycle (see e.g. Smets and Wouters, 2003, 2004; Ireland, 2004) such an exercise is not feasible for our purposes, since we are analysing a large sample of countries. Therefore, we limit our analysis to the estimation of a reduced-form relationship between labor market institutions and the volatilities of output and inflation. This approach allows us to focus on business cycle volatility without explicitly taking the real wage into account.

To investigate the relationship between labor market institutions and macroeconomic volatility, we regress the standard deviations of the cyclical component of per capita real GDP and the inflation rate on proxies for the institutional characteristics of the labor market and a set of control variables. Specifically, our empirical analysis is based on the following system of equations:

$$\sigma(y_{it}) = \alpha_1 + \beta_1 \sigma(\pi_{it}) + \gamma_1' LMI_{it} + \delta_1' X_{1,it} + \mu_i + \lambda_t + \epsilon_{1,it}, \quad (5)$$

$$\sigma(\pi_{it}) = \alpha_2 + \beta_2 \sigma(y_{it}) + \gamma_2' LMI_{it} + \delta_2' X_{2,it} + \mu_i + \epsilon_{2,it}, \quad (6)$$

where y_{it} is the quarterly growth rate of per capita real GDP and π_{it} denotes quarterly inflation rate. $\sigma(\cdot)$ denotes the logged standard deviation.[3] The vector LMI_{it} contains variables related to the structure of the wage-bargaining process and $X_{1,it}$ and $X_{2,it}$ are vectors of control variables. Note that in order to identify the system, the elements in $X_{1,it}$ and $X_{2,it}$ have to be chosen appropriately.

We allow for two-way fixed effects in equation (5) by including country fixed effects, μ_i, and time fixed effects, λ_t, whereas (6) includes only country fixed effects.[4] Thus, any developments which are not explicitly modeled and are common to all countries in our sample, impact directly on output volatility and only indirectly on inflation volatility. $\epsilon_{1,it}$ and $\epsilon_{2,it}$ are disturbances which we allow to be correlated across equations.

We specify and estimate (5) and (6) as a system of simultaneous equations with $\sigma(y_{it})$ and $\sigma(\pi_{it})$ as endogenous variables, and therefore depart from the existing empirical literature which mostly estimates equations similar to (5) in a single equation framework.[5] Our approach is more general and also more in line with modern business cycle models which treat output and inflation as endogenous variables. Since we allow $\epsilon_{1,it}$ and $\epsilon_{2,it}$ to be correlated, we estimate the system (5) and (6) by three-stage least squares.

Depending on the specification, LMI_{it} contains a proxy for the coordination of the wage bargaining process, CO_{it}, union density, UD_{it}, and an index capturing the strictness of employment protection legislation, EP_{it}. CO_{it} is a summary measure reflecting whether wage negotiations take place at the firm, industry or national level and also the role of government and employers federations in the wage bargaining process. CO_{it} ranges from 1 to 3 where higher values indicate a higher level of coordination. As it is standard in the literature, we use the coordination of the wage bargaining process as our main proxy for the degree to which unions internalize the macroeconomic consequences of wage claims. In highly coordinated systems, we would expect unions to internalize the macroeconomic effects of their behavior to a greater extent. Hence, we expect that output and inflation

[3]We follow Fatás and Mihov (2003) and use the log of the standard deviations which allows us to interpret the coefficient estimates as elasticities or semi-elasticities. Qualitatively, our results are not affected by this transformation.

[4]We include time fixed effects only in the output equation, since they are jointly not significant in the inflation equation.

[5]Several authors instrument inflation by variables such the money supply. However, these approaches do not take the interrelationship between output and inflation into account.

evolve in a smoother fashion in economies characterized by more coordinated bargaining systems. In one specification we also include an alternative proxy for the coordination of wage bargaining, COW_{it}. The difference to the former is that COW_{it} contains more short-term variation in coordination (see Nickell et al., 2001).

Union density, UD_{it}, refers to the net union membership rate of employees (gross minus retired and unemployed members) and is interpreted as a proxy for the bargaining power of unions. Nunziata and Bowdler (2005) interpret high unionization rates as an indication for a strong bargaining position of unions and therefore the response to shocks may be more pronounced, as wage moderation may be rather limited in this case. Thus, we expect that business cycle volatility is larger in countries characterized by higher values of UD_{it}.

The strictness of employment protection legislation is proxied by EP_{it} which is again a summary measure that broadly summarizes constraints on the dismissal of workers (e.g. period of notice before dismissal and severance pay). Higher values of the EP_{it} index, which is defined between 0 and 2, correspond to stronger labor market frictions.

Note that although labor market institutions are usually assumed to be exogenous, this need not be the case. One could argue for instance that union density and employment protection are relatively high in economies which face volatile business cycles and not the other way around. To guard against this possibility of reverse causality we use the initial values of the interval over which standard deviations are calculated.[6]

The vector of control variables $X_{1,it}$ in (5) contains the log of the standard deviation of government consumption as a percentage of GDP, $\sigma(GOV)$, the logged standard deviation of the terms of trade, $\sigma(TOT)$, - where GOV and TOT are deviations from their HP trend - and per capita GDP in the initial period of the 5-year interval, Y_0. The choice of these control variables is motivated by the existing literature. We include $\sigma(GOV)$ to control for unsystematic fiscal policy as suggested by Fatás and Mihov (2003). Beck et al. (2006) find that output volatility is influenced by fluctuations in the terms of trade and that countries with higher per capita GDP experience smoother cycles.[7]

[6] Including averages taken over the 5-year intervals instead of initial values leaves our results largely unaltered.

[7] We initially also included the log of the sum of imports and exports over GDP as a proxy for trade

We specify $X_{2,it}$ to include an index for central bank independence, CBI, and the logged standard deviation of import price inflation, $\sigma(IMP)$, in addition to $\sigma(GOV)$ and Y_0. The CBI index is obtained from Van Lelyveld (2000) which is an update of the Cukierman (1992) index of the legal independence of central banks. Its values range from 0 to 1, where 1 indicates the maximum possible independence of central banks. Since independent central banks are more likely to put a larger weight on price stability, we expect CBI to dampen inflation volatility. In open economies, inflation may be affected by import prices (see e.g. Rumler, 2007; Leith and Malley, 2007). Galí and Monacelli (2005) derive an open economy version of the New Keynesian Phillips Curve which includes the terms of trade as an additional driving variable of inflation. Accordingly, we also estimated variants of (6) with $\sigma(TOT)$ instead of $\sigma(IMP)$. However, these specifications performed relatively worse.[8]

4 Data Description and Results

4.1 Data

Our sample includes 20 OECD countries (Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Ireland, Italy, Japan, Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, UK and the US). The quarterly series cover 1970:1 to 2006:4. Macroeconomic variables are obtained from the OECD Economic Outlook (ECO) database. To calculate real GDP per capita we divide real GDP by the total working age population. We calculate y_{it} as the cyclical component of GDP defined as the deviation of real per capita GDP from its Hodrick-Prescott (HP) trend and π_{it} is the quarterly change in the consumer price index.[9] Standard deviations are calculated over 5-year non-overlapping intervals.

openness, as it is frequently done in the literature. In the estimations reported here, we do not include this variable as it never turned out to be significant.

[8] In an economically integrated, import and export prices may also be endogenous like inflation. While this is a convincing arguments for the U.S. or the euro area as a whole, it is probably not so compelling in our sample which consists to a large extent of small open economies.

[9] Results are similar when the growth rate of per capita GDP is used instead of the output gap.

Data for Labor Market Institutions are taken from Nickell et al. (2001), where the ultimate data source for most variables are various OECD employment outlooks, e.g. OECD (1999). The Nickell and Nunziata database contains yearly data on various labor market institutions indicators for all OECD countries from 1960 to 1995. Since our macro data start in 1970 and the labor market institutions variables end in 1995, this gives us a panel dataset with 6 (five-year interval) observations in the time dimension and 20 observations in the cross-sectional dimension.

4.2 Estimation Results

Tables 1 and 2 show the estimation results for the system in (5) and (6) based on estimation by three stage least squares. The tables include three different specifications. The second column presents our baseline specification. In the third column we test for a non-linear effect of the coordination variable in the spirit of Calmfors and Driffill (1988). The last column shows the results when we use an alternative proxy for coordination.

Consider first the equation for output volatility. We see from the second column of Table 1 that inflation volatility does not appear to exert a significant effect on $\sigma(y)$. In contrast, the volatility of the cyclical component of government spending, $\sigma(GOV)$, has a positive and strongly significant impact on the volatility of the output gap. This result is in line with Fatás and Mihov (2003) who find that discretionary fiscal policy makes business cycle more volatile. The remaining control variables, $\sigma(TOT)$ and Y_0, turn out to be insignificant at standard levels. The insignificance of Y_0 is somewhat at odds with the findings reported in the literature, where wealthier countries are found to experience smoother cycles. However, these studies typically analyze samples that also include less developed countries, whereas our sample consists entirely of developed countries. Similarly, less developed countries are also likely to be more exposed to fluctuations of terms of trade. The remaining columns of the table show that the results are robust with respect to different specifications.

In this paper we are mainly interested in the influence of labor market institutions related to the coordination of the wage bargaining system and the bargaining power of unions. As expected, Table 1 shows that countries characterized by higher union density tend to experience more volatile fluctuations in the output gap. The point estimate of 1.15 implies that a change in union density by one standard deviation increases the volatility of the output gap by 21 percent.[10]

This result is robust across specifications and consistent with the interpretation that higher unionization as measured by UD indicates that unions have higher bargaining power and which may result in less wage moderation and thus in higher macroeconomic volatility.

We also see that the proxy for coordination, CO, enters with a positive, although insignificant, coefficient. Thus, so far we find no evidence in favor of the hypothesis that more coordinated wage bargaining systems are characterized by lower output volatility. In the third column we add the square of CO to allow for a non-linear relationship between wage coordination and output volatility. Neither CO nor CO^2 turns out to be significantly different from zero in this specification. In the last column, we replace CO by COW which is an alternative proxy for coordination. Here we see that the coefficient on COW remains positive and turns out to be significant at the 10 percent level. Hence, it appears that coordination may even give rise to more volatile business cycles. In addition, employment protection, EP, does not appear to exert a significant influence on the volatility of the output gap.

Table 2 shows the results for $\sigma(\pi)$ as the dependent variable. Output volatility has a positive and significant impact on inflation volatility. To the extent that output movements are associated with fluctuations in marginal cost this result is consistent with the New Keynesian Phillips Curve. We also see that the volatility of import price inflation significantly impacts upon the standard deviation of inflation. In addition, countries with higher initial levels of per capita real GDP tend to have less volatile inflation rates. This result is similar to Nunziata and Bowdler (2005) who find a negative impact of per capita GDP on the level of inflation. $\sigma(GOV)$ and CBI, in contrast, turn out to be insignificant.

Turning to the labor market variables, a high level of coordination dampens inflation volatility. CO has the expected negative sign and is highly significant. Interestingly, we find that inflation volatility tends to be lower in countries characterized by highly

[10]In our sample the variable UD has a mean of 0.43 and a standard deviation of 0.19.

coordinated systems. Although a higher degree of coordination may not stabilize output, our results suggest that it contributes to stable inflation rates.

The third column shows that we do not find any evidence in favor of a non-linear effect of CO on $\sigma(\pi)$. In the last column where we replace CO by the alternative measure COW, coordination is no longer significant. Hence, we find only weak evidence in favor of the hypothesis that unions affect inflation dynamics differently in coordinated systems. The remaining two institutional variables, employment protection and union density, do not significantly influence the volatility of the inflation rate.

To summarize, our results indicate that labor market institutions influence macroeconomic volatility to some extent. However, we find only limited support for the hypothesis that countries characterized by highly coordinated wage bargaining systems experience greater macroeconomic stability. Although we find some indications that inflation dynamics are damped in coordinated systems, output volatility may even be amplified in coordinated systems. Nevertheless, a rather robust result is that high union density is associated with higher output volatility. Hence, our results presented so far cast some doubt on the role of unions as a shock absorber.

4.3 Robustness Analysis

To see if our results are robust with respect to different estimation methods, we re-estimate the two equations of our system separately as single equations, using the fixed effects (FE) and the random effects (RE) estimators. In addition, we estimate the system by two-stage least squares (2SLS).

Table 3 shows that with the exception of the random effects estimator, UD enters positively and significantly into the output equation, which confirms our previous results. The fixed effects estimator also indicates that higher levels of coordination may lead to higher output volatility.

For inflation volatility, the results reported in Table 4 show that CO has a dampening impact which is in line with our previous results. Using 2SLS, we find that CO enters negatively and significantly. The fixed effects estimator also indicates that CO enters marginally significantly, at the 11 percent level.

Thus, qualitatively, these additional estimators largely confirm the results obtained by 3SLS in our standard specification for both, inflation and output volatility.

4.4 Adding Interaction Effects

To study more closely how labor market institutions propagate disturbances we extend our baseline system to include interaction terms. In particular, we interact $\sigma(TOT)$ with EP, UD and CO in (5) to capture fluctuations in the terms or trade. Similarly, we extent (6) by interacting $\sigma(IMP)$ with our three institutional variables.[11]

Note that one could interpret $\sigma(TOT)$ and $\sigma(IMP)$ in terms of structural shocks and thereby obtain a closer correspondence to the model outlined in Section 2.[12] However, we prefer a more general interpretation and do not view terms of trade fluctuations as a proxy for a specific, underlying structural shocks.

Table 5 shows the results. We see from the second column that employment protection legislation and union density tend to amplify the effect of terms of trade fluctuations on output volatility, whereas in this specification, coordination significantly dampens output volatility. Turning to the results for inflation volatility, the table shows that coordination has a negative and strongly significant impact on the propagation of import price fluctuations.

Hence, we find some indications that, on the one hand, coordination dampens the transmission of volatility in the terms of trade and import price inflation to output and inflation volatility. Relatively strict employment protection legislation and high union density, on the other hand, appear to amplify the impact of terms of trade fluctuations on output volatility.

Overall, we see that adding interaction terms largely confirms our earlier findings. Union density and to some extent also employment protection tend to amplify output volatility. In contrast to our previous results, we now find that coordination dampens inflation as well as output volatility. Thus, we now find some more evidence in favor

[11] We also estimated the system with $\sigma(GOV)$ interacted with EP, UD and CO. However, since none of the interaction terms were significantly different from zero, we do not report the results.

[12] Beck et al. (2006) argue that terms of trade disturbances give rise to variation in input prices and can therefore be interpreted as productivity shocks.

of the role of unions as a shock absorber at least in highly coordinated wage bargaining systems.

5 Concluding Remarks

In this paper we analyze if institutional aspects of the wage bargaining process play a role in shaping the adjustment of output and inflation over the business cycle. Our results indicate that a higher degree of coordination of the wage bargaining process dampens inflation volatility. This result is consistent with the hypothesis that in coordinated wage bargaining systems, unions take the consequences of their actions into account and thereby stabilize fluctuations in the inflation rate. However, concerning the effect of labor market institutions for output volatility, we find only little evidence in favor of any effects of coordination. In contrast, countries characterized by a high union density tend to experience larger fluctuations in output.

Overall, our results suggest that unions act only to a limited extent as shock absorbers. This might be due to limited information about the shocks that hit the economy. Our simulations indicate that the appropriate response depends on the type of shock that hits the economy. Hence, even if unions take the consequence of their actions into account and try to dampen shocks, this objective is complicated by the fact that the appropriate response depends on the type of shock. Since unions, just like policy makers, may only observe fluctuations in aggregate variables without being aware of the type of underlying shock, they may simply not have enough information to act appropriately.

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A Calibration

The calibration of the model closely follows the literature. We assume that preferences are described by the utility function: $E_0 \sum_{t=0}^{\infty} \beta^t \left(\frac{C_t^{1-\sigma}}{1-\sigma} - \frac{L_t^{1+\eta}}{1+\eta} \right)$, where β is a discount factor, C_t is consumption of a composite good in period t, L_t denotes labor supply in period t. The composite consumption good, C_t, is a CES aggregate of the quantities of differentiated goods, $C_t(i)$, where $i \in (0,1)$: $C_t = \left(\int_0^1 C_t(i)^{\frac{\epsilon-1}{\epsilon}} di \right)^{\frac{\epsilon}{\epsilon-1}}$. The time discount factor β is set to 0.99. The coefficients in the utility function, σ and η, are both set equal to 2, which is standard in the literature. The elasticity of substitution between differentiated goods, ϵ, is set to 11 which implies a mark-up of 10 percent in the steady state. Each firm i hires labor, H_{it}, and produces output according to: $Y_{it} = H_{it}^{1-\alpha}$, were α is set to 0.33. The reduced-form parameters in (2) are functions the structural parameters. In particular, $\delta_0 = \frac{(1-\theta)(1-\theta\beta)(1-\alpha)(1-\omega)}{(1+\alpha(\epsilon-1))(\theta+\omega(1-\theta(1-\beta)))}$, $\delta_1 = \beta\theta(\theta + \omega(1-\theta(1-\beta)))^{-1}$, and $\delta_2 = \omega(\theta + \omega(1-\theta(1-\beta)))^{-1}$. We set $\omega = 0.3$, which means that 30 percent of the firms follow a backward looking pricing rule. Prices are assumed to be fixed on average for 4 quarters, therefore $\theta = 0.75$. This calibration of the price setting behavior is in line with recent empirical evidence (see e.g. Leith and Malley, 2005). The interest rate rule parameters are chosen according to the estimates presented in Gerdesmeier and Roffia (2004) for the euro area. We set $\chi_0 = 2$, $\chi_1 = 0.5$ and $\rho = 0.8$. The shocks are modeled as $u_{1t} = 0.95u_{1t-1} + \tilde{u}_{1t}$ and $u_{2t} = 0.95u_{2t-1} + \tilde{u}_{2t}$, where $\tilde{u}_{1t}$ and $\tilde{u}_{2t}$ are i.i.d. random variables.

Figure 1: Impulse Responses to a Supply Shock

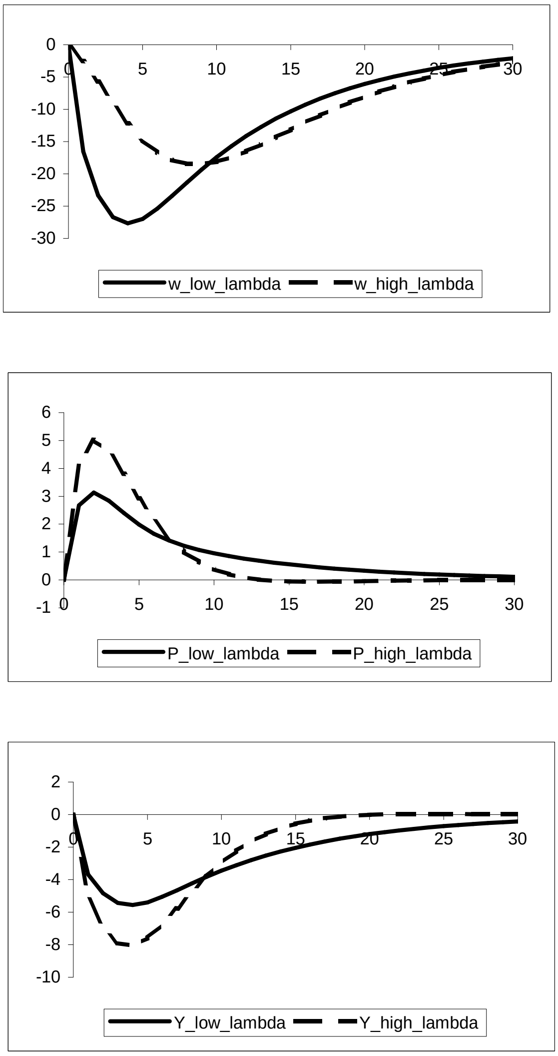

Figure 2: Impulse Responses to a Demand Shock

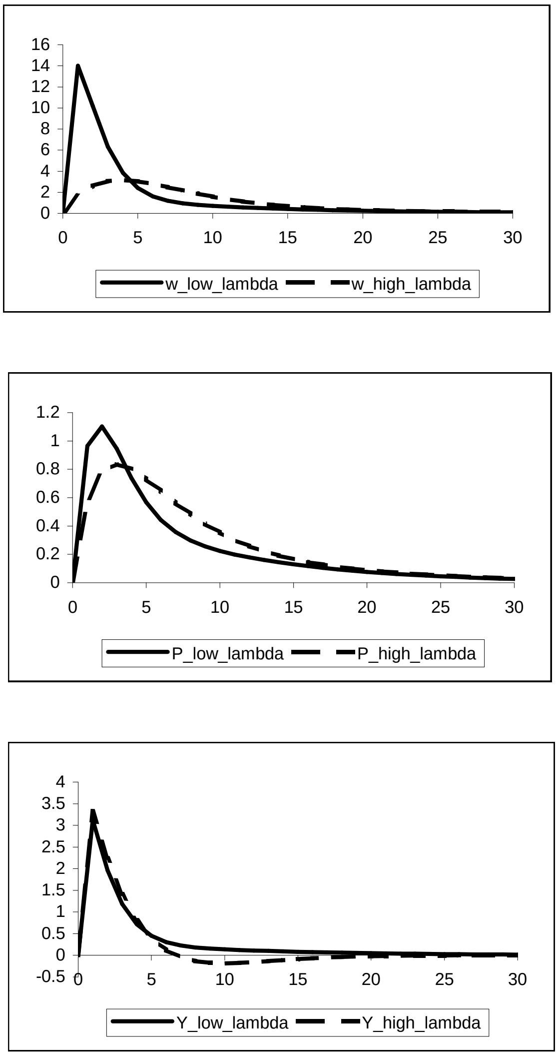

Table 1: System Estimation (3SLS): Output Volatility ($\sigma(y)$)

$\sigma(\pi)$	-0.38		-0.34		-0.26	
	(-0.64)		(-0.61)		(-0.45)	
$\sigma(GOV)$	0.56	***	0.56	***	0.58	***
	(5.23)		(5.44)		(5.64)	
$\sigma(TOT)$	-0.06		-0.06		-0.08	
	(-0.73)		(-0.79)		(-1.02)	
Y_0	0.59		0.62		0.81	
	(0.95)		(1.04)		(1.16)	
EP	0.14		0.12		0.14	
	(0.54)		(0.52)		(0.54)	
UD	1.15	**	1.09	**	1.13	**
	(2.23)		(2.15)		(2.29)	
CO	0.30		0.79			
	(1.39)		(0.96)			
CO^2			-0.12			
			(-0.56)			
COW					0.17	*
					(1.67)	
Obs	119		119		119	
R^2	0.64		0.66		0.68	

Notes: Coefficient estimates with t-values in parenthesis. * denotes significance at the 10%, ** at the 5% and *** at the 1% level. Endogenous variables: $\sigma(y)$ and $\sigma(\pi)$. In addition to the variables displayed, the equation contains dummy variables for each country and time period to account for country- and time-fixed effects.

Table 2: System Estimation (3SLS): Inflation Volatility ($\sigma(\pi)$)

$\sigma(y)$	0.71	***	0.68	**	0.49	**
	(2.59)		(2.48)		(2.01)	
$\sigma(GOV)$	-0.27		-0.25		-0.15	
	(-1.40)		(-1.31)		(-0.83)	
$\sigma(IMP)$	0.16	***	0.16	***	0.15	***
	(2.73)		(2.84)		(2.72)	
CBI	0.47		0.42		0.16	
	(1.22)		(1.09)		(0.48)	
Y_0	-1.47	***	-1.43	***	-1.57	***
	(-6.55)		(-6.40)		(-7.65)	
EP	0.25		0.24		0.25	
	(1.33)		(1.29)		(1.33)	
UD	-0.77		-0.84		-0.33	
	(-1.24)		(-1.37)		(-0.60)	
CO	-0.48	**	0.34			
	(-2.03)		(0.38)			
CO^2			-0.19			
			(-0.95)			
COW					0.04	
					(0.36)	
Obs	119		119		119	
R^2	0.69		0.69		0.71	

Notes: Coefficient estimates with t-values in parenthesis. * denotes significance at the 10%, ** at the 5% and *** at the 1% level. Endogenous variables: $\sigma(y)$ and $\sigma(\pi)$. In addition to the variables displayed, the equation contains dummy variables for each country to account for country-fixed effects (time-fixed effects are assumed to be present only in the output equation).

Table 3: Robustness Analysis: Output Volatility ($\sigma(y)$)

	FE		RE		2SLS	
$\sigma(\pi)$	0.17	*	0.17	*	-0.36	
	(1.93)		(1.88)		(-0.51)	
$\sigma(GOV)$	0.49	***	0.57	***	0.55	***
	(6.14)		(5.82)		(4.43)	
$\sigma(TOT)$	-0.05		0.00		-0.06	
	(-0.59)		(0.05)		(-0.63)	
Y_0	0.92	**	0.01		0.59	
	(2.05)		(0.06)		(0.80)	
EP	-0.01		0.00		0.13	
	(-0.10)		(0.03)		(0.44)	
UD	1.15	**	0.18		1.16	*
	(2.10)		(0.81)		(1.93)	
CO	0.43	*	0.06		0.31	
	(1.87)		(0.77)		(1.22)	
Obs	119		119		119	
R^2	0.65		0.58		0.65	

Notes: Coefficient estimates with t-values in parenthesis. The second and third columns show results based on the fixed effects and random effects estimators, where $\sigma(\pi)$ is assumed to be exogenous. Results based on on two-stage least squares are shown in the last column. T-values in single equations are computed with White standard errors. * denotes significance at the 10%, ** at the 5% and *** at the 1% level. In addition to the variables displayed, the equation contains dummy variables for each time period to additionally account for time-fixed effects.

Table 4: Robustness analysis, inflation volatility ($\sigma(\pi)$)

	FE		RE		2SLS	
$\sigma(y)$	0.23	**	0.20	*	0.71	**
	(2.04)		(1.81)		(2.27)	
$\sigma(GOV)$	0.01		-0.03		-0.27	
	(0.07)		(-0.27)		(-1.22)	
$\sigma(IMP)$	0.10		0.11		0.16	**
	(1.35)		(1.51)		(2.38)	
CBI	0.36		0.16		0.47	
	(1.18)		(0.67)		(1.07)	
Y_0	-0.75		-0.76	***	-1.47	***
	(-1.46)		(-3.11)		(-5.73)	
EP	0.28		0.07		0.25	
	(1.45)		(0.69)		(1.16)	
UD	-0.38		0.63	***	-0.77	
	(-0.81)		(2.66)		(-1.09)	
CO	-0.36		-0.13		-0.48	*
	(-1.61)		(-1.37)		(-1.78)	
Obs	119		119		119	
R^2	0.67		0.59		0.69	

Notes: Coefficient estimates with t-values in parenthesis. The second and third columns show results based on the fixed effects and random effects estimators, where $\sigma(y)$ is assumed to be exogenous. Results based on on two-stage least squares are shown in the last column. T-values in single equations are computed with White standard errors. * denotes significance at the 10%, ** at the 5% and *** at the 1% level. In addition to the variables displayed, the equation contains dummy variables for each time period to additionally account for time-fixed effects.

Table 5: System Estimation (3SLS): Adding interaction effects

	dependent variable: $\sigma(y^*)$		dependent variable: $\sigma(\pi)$	
$\sigma(\pi)$	-0.24			
	(-0.89)			
$\sigma(y)$			0.49	**
			(2.41)	
$\sigma(GOV)$	0.56	***	-0.13	
	(7.00)		(-0.87)	
$\sigma(TOT)$	-0.21			
	(-0.92)			
$\sigma(IMP)$			0.62	***
			(3.06)	
Y_0	0.63		-1.68	***
	(1.26)		(-8.36)	
CBI			0.41	
			(1.02)	
EP	0.86	*	0.21	
	(1.72)		(0.90)	
UD	6.06	***	-0.80	
	(4.00)		(-1.43)	
CO	-0.75		-0.02	
	(-1.38)		(-0.10)	
$EP * \sigma(TOT)$	0.20	*		
	(1.69)			
$UD * \sigma(TOT)$	1.15	***		
	(3.41)			
$CO * \sigma(TOT)$	-0.26	**		
	(-2.15)			
$EP * \sigma(IMP)$			0.03	
			(0.25)	
$UD * \sigma(IMP)$			0.18	
			(0.64)	
$CO * \sigma(IMP)$			-0.27	***
			(-2.83)	
Obs	119		119	
R^2	0.73		0.74	

Notes: Coefficient estimates with t-values in parenthesis. * denotes significance at the 10%, ** at the 5% and *** at the 1% level. Endogenous variables: $\sigma(y)$ and $\sigma(\pi)$. In addition to the variables displayed, the output equation contains dummy variables for each country and time period and the inflation equation only dummy variables for each country, as above.