Inflation Volatility and Labor Market Institutions in a panel of OECD countries

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Abstract

We examine theoretically and empirically the role of the institutional settings of the labor market in explaining inflation volatility over time and across countries. Allowing for time variation in the wage indexation, we establish a direct relationship between inflation volatility and three labor market institutions factors: the bargaining power of unions, the number and independence of negotiations. Using the system-GMM estimator for linear dynamic panel data models on a sample covering 15 OECD countries, analysed in the period from 1960 to 2011, this paper finds that the bargaining power of unions increases the volatility of inflation whereas the number and independence of negotiations decrease inflation volatility. Furthermore, policy recommendations point towards a relatively more restrictive government intervention in the bargaining processes to reduce inflation volatility .

JEL Classification Codes: E31, E40, E52

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1 Introduction

High and volatile inflation is generally harmful to an economy. A number of theoretical and empirical studies attempted to fully understand the inflationary process in order to achieve price stability. While studies on the determinants of inflation levels are abundant in the literature, few economists have extensively investigated the causes of inflation volatility. In this paper, we examine inflation volatility differentials across countries and study their link with labor market institutions specifically, the bargaining power of unions, the number and independence of negotiations.

By labor market institutions, we refer to the characteristics of the unions involved in the wage indexation bargaining process as well as the environment within which wage bargaining is conducted. We believe such factors are country specific and deeply embedded in national preferences. Labor market institutions not only define the framework within which wages are negotiated but they also influence the dynamics of real wages, which are a main driver of inflation. Therefore, it seems interesting to evaluate the quantitative relevance of such institutions in determining inflation volatility behavior. We do so in two steps.

First, we establish a theoretical relation between inflation volatility and labor market institutions. Using the wage indexation bargaining process whereby wages are indexed to inflation, we derive a testable hypothesis between inflation volatility and the structure of the labor market. The crucial assumptions we make are: (i) wage indexation is a random bargaining outcome between the unions [1] and (ii) wage indexation is time varying [2]. Then, we build a partial equilibrium neoclassical model with a representative firm, characterized by wage indexation bargaining. We use this simple economy to document the effects of the institutional settings on inflation volatility. Secondly, we investigate empirically how these institutional characteristics influence the dynamic of inflation volatility in a panel of OECD countries.

Using a panel data covering 15 OECD countries from 1960 to 2011, we show that stronger bargaining power of the unions involved in the wage indexation process lead to higher inflation volatility. We also show that a higher number of negotiations and a more independent negotiation system have a negative impact on inflation volatility. These results reveal the essential role played by the structure of the labor market in explaining inflation volatility. This paper contributes to the

[1] see Du caju, Gautier, Momferatou and Ward-Warmedinger

[2] see Holland (1986)

literature in two ways. First we propose a new theoretical framework establishing the labor market institutions as a reason for inflation volatility differences across countries. Second, we extend the empirical literature by considering three aspects of the labor market institutions.

Our paper is related to a large literature studying the effect of the wage bargaining process on inflation. On one hand, Calmford and Drifill (1988) ; Daniels, Nourzad and Vanhoose (2006) ; Rumler and Schaler (2004) and Barbier-Gauchard, De palma and Diana (2014) describe an inverse U shape relationship between the centralization of wage bargaining and inflation. They believe a highly centralized bargaining process in the labor market will recognize broader range of issues and will therefore be prone to less volatile wage increases. This implies that there is a negative relationship between the degree of centralization and inflation volatility. On the other hand, as shown by Campolmi and Faia (2011), the democratization of the wage bargaining process leads to more restricted increases in wages. This implies a different result where the volatility of inflation rather increases when the wage bargaining process becomes more centralized. Our paper suggests a way to reconcile these two contradictory results. We account for the bargaining power of the unions involved in the bargaining process and control for government intervention. The advantage of our analysis is that a fully-fledged model with both aspects of the labor market institutions provides an unbiased and more precise effect of the degree of centralization of the bargaining process on inflation volatility.

Our approach is also linked to the fairly large literature dealing with bargaining power and macroeconomic volatility. Rumler and Scharler (2011) ; Barbier-Gauchard, De palma and Diana (2014) analysis is tailored to the strength of the labor unions. In contrast to this stand of work we account for the bargaining power of both the workers unions and the employers unions. Without the government intervention, employers with strong bargaining power drive down wages which in turn increase inflation volatility. So it is natural to include not only labor unions but also employers unions.

The rest of this study is organized as follows. Section 2 presents the theoretical model that derives the hypothesis on the relationship between labor market institutional variables and inflation volatility. Section 3 describes the data and estimation techniques used. Section 4 discusses the results as well as robustness checks conducted. Finally, section 5 conludes.

2 Theoretical Framework

The macroeconomic model considered in this research project is based on the methodology in Attey and de Vries (2011). Their key result established a relationship between the variance of wage indexation and the variance of inflation. However, the degree of wage indexation depends on the structure of a country's labor market in particular the characteristics of unions. In this paper, we therefore exploit the result in Attey and de Vries and link the labor market institutions to inflation volatility.

2.1 Wage Indexation and Inflation Volatility

Wage indexation links wages to the evolution of some underlying variables which are not observed when the base contracts are negotiated. Indexation to inflation is widespread in the US and among Europe. In this subsection, we will describe the wage indexation bargaining process and show how it is related to inflation volatility.

Wage Indexation Bargaining Process

Consider a setting under which there are several simultaneous negotiations with regards to wage indexation associated with each negotiating unit i (x_{it}) between workers' unions and employers' unions. Assuming that there are m negotiations conducted independently and that the aggregate wage indexation outcome is a simple average of all independent outcomes, the aggregate x_t is given by the relation as follows:

$$x_t = \frac{1}{m}\sum_{i=1}^{m} x_{it} \tag{1}$$

The individual wage indexation outcome x_{it} is independently and identically distributed. The formulation of wage indexation in this work allows aggregate wage indexation to be time varying which will be instrumental in the subsequent section to establish the relationship between the variance of inflation and the variance of wage indexation. We also assume that individual and aggregate wage indexation to be random bargaining outcomes as in Attey and de Vries (2011).

The variance of the aggregate wage indexation given the number of independent negotiating unit

m can then be expressed as follows:

$$var(x_t) = \frac{var(x_{it})}{m} \tag{2}$$

This variance is decreasing in the number of independent negotiations units that engage in the wage indexation bargaining. Thus, whenever m varies, the variance of wage indexation also varies as well. Making the substitution $var(x_t) = \sigma_x^2$, the following expression is implied to hold when the number of independent negotiations m is allowed to vary:

$$\sigma_x^2 = f(m, \xi) \qquad \frac{\partial f}{\partial m} < 0 \tag{3}$$

where ξ contains a set of variables specific to the individual unions involved in the bargaining processes that affect the distribution of the individual bargaining outcome. For example, a higher bargaining power of one of the negotiating parties would result in a higher variance of the individual negotiation outcome. Furthermore, higher levels of inflation following periods of lower inflation will most likely reinforce the bargaining power of unions when negotiating for the degree of wage indexation thus resulting in relatively higher variance in aggregate wage indexation.

Next we show how the aggregate wage indexation influences the volatility of inflation.

Wage Indexation and Inflation Volatility

The economy is characterized by a representative firm producing output using a fixed coefficient Ricardian technology with labor as a sole input :

$$Y_t = Z_t N_t^a$$

where $a < 1$ so that the production function exhibits diminishing marginal returns. N_t is the amount of labor demand employed in producing output and Z_t represents technological shocks which follow an iid normal distribution.

The representative firm maximize profits with respect to labor, thus marginal productivity of labor should be equal to real wages. The solution to the firm's maximization problem in given in the appendix.

Labor supply is exogeneously given :

$$n_t^s = \beta_0 + \beta_1(w_t - p_t)$$

where w_t and p_t are the log of nominal wages and prices prevailing in the economy.

The level of aggregate wage indexation x_t is the outcome of a bargaining process between the unions and the employers and it is an iid random process. In particular, we consider the following adaptive indexation rule :

$$w_t = E_{t-1}w_t^* + x_t(p_t - p_t^e) \tag{4}$$

where π_t is the log of nominal inflation.

Indexed wage contracts allow wages to be automatically adjusted in the event actual inflation differs from the expected. We assume that wage indexation is the only source of nominal rigidity in the economy. The objective of the monetary authority is to minimize the expected squared deviation of inflation from its target. In order to achieve it, the policy maker uses interest rate as an instrument in the conduct of optimal monetary policy under the assumption of rational expectations.

The objective function of the policy maker is therefore given as follows:

$$\min_i E_{t-1}[\hat{\pi}_t^2] \tag{5}$$

subject to the following constraints:

$$g_t = \lambda_t(\hat{\pi}_t - \hat{\pi}_t^e) + u_t \tag{6}$$

$$g_t = -\phi\lambda_t(i_t - \hat{\pi}_t^e - r - \pi^*) + v_t \tag{7}$$

$$w_t = E_{t-1}w_t^* + x_t(p_t - p_t^e) \tag{8}$$

where g_t is the output gap, λ_t is the slope of the AS curve which captures the response of output gap to changes in the deviation of inflation from target [3]. $\hat{\pi}_t$ denotes the deviation of inflation from a target [4] . $u_t = \log(Z_t)$ and $u_t \sim N(0, \sigma_u^2)$. i_t is the interest rate and r is the natural interest rate. The random variable v_t captures the demand shock which is assumed to be iid distributed as follows $v_t \sim N(0, \sigma_v^2)$.

Equation 6 is the aggregate supply curve showing the relationship between output gap and inflation. This differs from the conventional aggregate supply curves because it allows for time varying. It is derived from the expressions for output, labor supply and wage indexation. The detailed derivation of aggregate supply curve is given in the appendix.

The use of the interest rate as an instrument in the conduct of monetary policy necessitates the introduction of an aggregate demand curve. Equation 7 shows the relationship between output gap and inflation when interest rate is the instrument used to stabilize inflation.

The detailed optimal solution to this monetary problem is contained in the Appendix . The equilibrium inflation under optimal monetary policy in the presence of random degree of wage indexation scheme considered in (4) is as follows:

$$\hat{\pi}_t = \frac{v_t - u_t}{\lambda_t} \tag{9}$$

The expression (9) above indicates that equilibrium inflation also depends on the random degree of wage indexation variable: λ_t [5] which is also the slope of the aggregate supply curve.

[3] λ_t is the time varying parameter which depends on the degree of wage indexation in the economy

[4] It is assumed to be constant : $\hat{\pi}_t = \pi_t - \pi^*$

[5] Equilibrium inflation rate explodes when one approaches full indexation $x_t = 1$.

$$\lambda_t = \frac{\frac{a}{(1-a)}}{(1-x_t)}$$

As detailed in the appendix, λ_t comes from the wage indexation rule. It follows that the volatility of the equilibrium inflation process would also depend on the variance of the random wage indexation process (σ_x^2). Using equation 9 we compute for the volatility of inflation. We proxied it by the conditional variance of inflation and we derive an approximation of the conditional variance of inflation as follows:

$$\sigma_\pi^2 = \left(\frac{\alpha}{1-\alpha}\right)^2 \left(\frac{1}{\bar{x}^2} + 3\frac{\sigma_x^2}{\bar{x}^4} + \frac{\sigma_x^4}{\bar{x}^6}\right)(\sigma_v^2 + \sigma_u^2) \tag{10}$$

The detailed derivation of this conditional volatility of inflation is provided in the appendix. The volatility of inflation in equilibrium increases in the variance of demand and supply shocks. This is a result which is readily obtainable in conventional monetary models. From equation (10) above, another variable that influences the volatility of inflation is the variance of the degree of wage indexation. The apparent neglect of this variable in models explaining inflation volatility stems from the absence of time varying degree of wage indexation. However, as we just shown, the variance of wage indexation does play a significant role in explaining inflation volatility. Next, we establish the link between inflation volatility and labor market institutions.

2.2 Labor market institutions and Inflation Volatility

In this subsection, we motivate the hypothesis that labor market institutions influence the dynamics of inflation volatility. We showed in the previous section how the variance of wage indexation influences the variance of inflation volatility.

From equation (10), we summarize the volatility of inflation as follows:

$$\sigma_\pi^2 = F(\sigma_v^2, \sigma_u^2, \sigma_x^2)$$

where

$$\frac{\partial \sigma_\pi^2}{\partial \sigma_v^2} \geq 0$$

$$\frac{\partial \sigma_\pi^2}{\partial \sigma_u^2} \geq 0$$

$$\frac{\partial \sigma_\pi^2}{\partial \sigma_x^2} \geq 0$$

Given that $\sigma_v, \ \sigma_u \ \sigma_\pi \ \in \mathcal{R}^+$

The volatility of inflation not only depends on the variance of demand and supply shocks but also on the variance of the wage indexaton. A higher variance in the wage indexation increases the volatility of inflation. As we showed earlier, the variance of the wage indexation depends on the structure of the labor market as seen from equation (2). We simply substitute the expression for the variance of wage indexation into the volatitlity of inflation and we obtain our inflation volatility - labor market institutions relationship:

$$\sigma_\pi^2 = F(\sigma_v^2, \sigma_u^2, m, \zeta) \tag{11}$$

The volatility of inflation is decreasing in the number of independent negotiations m. This stems from the fact that the volatility of inflation is increasing in the variance of the degree of wage indexation which is decreasing in the number of independent wage indexation negotiations conducted. An intuitive reason as to why the decline in the number of independent negotiations should lower the variance of equilibrium inflation is due to the fact that the variance of wage indexation is more volatile if it is only as a bargaining outcome of one negotiation. However, if it is the average over several independently conducted negotiations, the variance of wage indexation decreases.

As mentionned earlier, ζ contains country specific labor market characteristics such as the bargaining power of the unions involved in the wage indexation bargaining process. Intuitively, wage moderation are limited when unions have a strong bargaining position. Thus inflation volatility is likely to be larger in countries characterized by higher unionization rates. Therefore, $\frac{\partial \sigma_\pi^2}{\partial \zeta} \geq 0$.

We then log linearize the function for the variance of inflation and derive the following expression :

$$\sigma(\pi_{i,t}) = \theta + \varphi' X_{i,t} + \gamma' Z_{i,t} + \nu_i + \varepsilon_{i,t} \tag{12}$$

where $X_{i,t} = [m, \zeta]'$ is the vector that contains the variables that pertain to the structure of the labor market in country i at time t ; $Z_{i,t}$ refers to a set of control variables that drive inflation volatility; $\varepsilon_{i,t}$ is the approximation error which is iid and normally distributed with mean and variance $(0, \sigma_\varepsilon^2)$; the parameter θ summarizes the effects of the variance of productivity and demand shocks[6].

Next, we break down m into two conceptual dimensions which are the independence of negotiations (m_1) and and the number of negotiations (m_2) with regards to wage indexation bargaining.

Finally, we have three labor market institutions variables that influence inflation : the bargaining power ζ of the unions involved in the wage indexation negotiation process, the independence of the negotiations conducted and the number of the negotiations. All these are examined over time and across countries. We expect the following specific relationships:

$$\frac{\partial \sigma \pi_{i,t}}{\partial m_1} < 0$$

$$\frac{\partial \sigma \pi_{i,t}}{\partial m_2} < 0$$

$$\frac{\partial \sigma \pi_{i,t}}{\partial \zeta} > 0$$

These stem from the fact that the volatility of inflation is increasing in the variance of the wage indexation while the latter is decreasing in m. The hypotheses that inflation volatility is decreasing in the number and independence of negotiations and increasing in bargaining power is tested by the use of a panel data estimation methodology. The next section gives details on the estimation method and the type of data used for the analysis of this work.

3 Data and Empirical Analysis

Our sample includes 15 OECD countries with data spanning the period from 1960 to 2011. The list of the countries whose data are analyzed in this study are Austria, Belgium, Canada, Denmark, Finland, France, Germany, Ireland, Italy, Japan, The Netherlands, Norway, Sweden, UK and USA.

[6] We asumed that they are constant in order to estimate the effect of the labor market institutions variables on the volatility of inflation.

The countries were chosen on the basis of availability of data relevant for the purposes of this study. For instance, data for post-Soviet countries begin from 1990 while variables in the cases of some countries do not vary over the 50 year period which the data spans. Data for the countries with regards to which the above situations are applicable are omitted from the panel.

The analysis in this study employs the use of three datasets namely: inflation, productivity and labor market institution datasets. The monthly inflation data used for the analysis is obtained from the statistical database of the Organization for Economic Cooperation and Development. In the case of all countries except for Germany, the Purchasing Power Parity Converted GDP Laspeyres per hour worked by employees is employed as a proxy for productivity. The proxy employed in Germany's case is the manufacturing output per hour. The two measures of productivity are taken from the Federal Bank of Saint Louis Database. Finally, the Amsterdam Institute for Advanced Labour Studies AIAS compiles data on industrial relations spanning 1960 to 2011 in OECD member countries under the ICTWSS database and this serves as the source of data on industrial relation variables.

3.1 Data

We use the average monthly inflation volatility as the dependent variable. The main explanatory variables used in the analysis are labor market institutional variables. We grouped these variables into three categories. The first category includes variables that indicate the bargaining power of both employers and labor unions. The second category includes variables that indicate the independence of unions engaged in the bargaining process[7]. The final category comprises of variables that indicate the absolute number of pair of employer and labor unions engaged in negotiation[8].

Inflation volatility

We employ two measures of inflation volatility. The first measure is the standard deviation of monthly inflation figures averaged over a calendar year. The second measure is the annual average of monthly volatility values obtained from GARCH(1,1) estimations with the mean equations modeled as AR(1) processes. Rother (2004) in a closely related study also employs the use of volatility figures

[7]Both wage and wage indexation barganing are considered.

[8]We depart from the theoretical framework and use number and independence of unions. The intuition is that the number of negotiations is zero if they are no unions and the negotiations are independent only if the unions are independent.

derived from GARCH(1,1) estimates on annual inflation. However, this measure does not adequately capture the effects labor institutional variables have on inflation volatility. For instance, information on extreme volatility caused by strong bargaining power of both labor and employers' unions are likely be more apparent from higher frequency inflation figures than lower ones.

Bargaining power

We consider two variables for bargaining power: union density and the strenght of sectorial institutions representing employment relations. The first variable is a measure of the strenght of the labor unions only. Union density (*ud*) is defined as net union membership as a proportion of wage and salary earners in employment and ranges from 0 to 100%. We interpret high unionization rates as an indication of strong bargaining power of the unions.

The second variable measure both the strenght of the labor and employers unions. The strength of sectoral institutions representing employment relations (*sect*) takes the value 0 when there are weak or no institutions, 1 when there is a strong institution on one side and 2 when there are strong institutions on both sides. In order to give an interpretation of this variable which is more consistent with increasing bargaining power, we reorder the values as follows: 0 when there are weak or no institutions, 1 when there are strong institutions on both sides and 2 when there is strong institutions on only one side. We find this ordering more plausible since weak institutions on both sides are likely to maintain the status quo while a dominant institution on only one side is more likely to drive bargaining outcome into the extremes.

Number of negotiations

We identify two variables that provide information on the relative number of negotiations. These are laws constraining wage and indexation bargaining. The first variable is: articulations with regards to sectoral bargaining (*bart*) and it indicates the presence of laws governing bargaining. It ranges from 1 (when there are no constraints on bargaining) to 5 (when there are severe limitations on additional bargaining on wages). A value of 0 denotes the absence or near absence of sectoral bargaining of any form. In order to render interpretation of this variable more consistent with increasing number of negotiations, we reverse the values when they are between 1 and 5, while 0 still denotes the absence of any form of sectoral bargaining. Intuitively, if there are no constraints on bargaining, there will be a high number of negotiations.

The second variable is: wages (*wage*) which indicates the presence of a social pact concerning wages in a particular year. It takes the value of 1 when there is a social pact and 0 when there is none [9].

We interpret no constraints on sectorial bargaining (higher values of *bart*) and the presence of a social pact on wages as increasing number of negotiations.

Independence of negotiations

Coordination of wage setting (*crd*) is the first variable considered under this category. It is a summary measure reflecting whether wage negotiations take place at the firm, industry or national level. Its values range from 1 when there is fragmented wage bargaining at plant level to 5 when there is a centralized nationwide bargaining. We reverse order the values to permit an interpretation more consistent with increasing independence of negotiations.

The second variable is the autonomous negotiation of wages (*auw*). It is a binary variable taking on the value 1 when there is autonomous wage negotiations and 0 when there is none.

Control variables

The labor market institutional variables could have an indirect effect on inflation volatility through inflation and variance of productivity shocks . In order to more isolate the direct effects, we introduce inflation (π_t) and variance of productivity shocks ($\sigma_{u,t}$)[10] as control variables.

We also control for government intervention in wage bargaining (*gvint*). The assigned values of this variable reflect an increasing severity of intervention. The values range from 1 when there is no intervention to 5 when the government imposes wage settlements in the private sector.

Finally, we introduce a set of dummies to control for the effects of crises (d_{cr}) and Eurozone accession of the member countries considered in this study (d_{eu}) on the volatility of inflation. The following years are considered as crises years: 1973, 1974, 2008 and 2009. The former two years are included to reflect the first oil crises while the latter two years are included to reflect the global

[9]There are other variables such as number of independent unions and total number of unions that could be interpreted as falling under this category. We abstracted from the use of these variables due the substantial amount of missing observations.

[10]The variance of the productivity shocks is estimated by use of GARCH(1,1) on the productivity data.

financial crises. The second oil crises is excluded due the fact that its impact was to a large extent limited to the US economy. We further include an interaction of the dummies with the volatility of productivity shocks since it is likely that the correlation between volatility of inflation and variance of productivity shocks might be different under the events indicated by the dummies.

3.2 Empirical model

To investigate the relationship between labor market institutions and inflation volatility, we start by regressing the log linearize equation[11] obtained in section 2. Specifically, our empirical analysis is based on :

$$log(\sigma_\pi)_{it} = \phi_1 log(\sigma_\pi)_{i,t-1} + \phi_2 \Delta ud_{it} + \phi_2 sect_{it} + \phi_4 bart_{it} + \phi_5 wage_{it} + \phi_6 crd_{it} + \phi_7 auw_{it} + \gamma' C_{it} + \nu_i + \varepsilon_{it} \quad (13)$$

where $log(\sigma_\pi)_{it}$ stands for the logarithm of the average standard deviation of monthly inflation of country i at time t ; ud_{it}[12] and $sect_{it}$ represent bargaining power of unions in country i at time t; $bart_{it}$ and $wage_{it}$ indicates the number of negotiations conducted in country i at time t; crd_{it} and auw_{it} denote the independence of negotiations done in country i at time t; C_{it} are the control variables; $\phi_1, ...\phi_7$ and γ are the parameters to be estimated; ν are country specific fixed effects and ε[13] is the error term. Descriptive statistics of the variables included in the regression model are shown in table 4.

One problem of estimating this model using Ordinary Least Squares (OLS) is that the lagged of log volatility of inflation $[log(\sigma_\pi)_{i,t-1}]$ is endogenous to the fixed effects (ν), which gives rise to dynamic panel bias. Thus, OLS estimates of this baseline model will be inconsistent, even in the fixed or random effects settings, because $log(\sigma_\pi)_{i,t-1}$ would be correlated with the error term, ε_{it}, even if the latter is not serially correlated[14]. First-differencing (13) removes the individual effects (ν) and thus eliminates a potential source of bias:

[11] We follow Fatas and Milhov (2003) and use log of the standard deviations which allows us give the coefficients an elasticity or semi elasticity interpretation. Qualitatively, our results are not affected by this transformation.

[12] We first difference union density because of its persistence fall in most countries in our sample.

[13] $\varepsilon \sim N(0, \sigma_\varepsilon^2)$.

[14] See Arellano and Bond (1991) and Baltagi (2001).

$$\Delta log(\sigma_\pi)_{it} = \phi_1 \Delta log(\sigma_\pi)_{i,t-1} + \phi_2 \Delta^2 ud_{it} + \phi_2 \Delta sect_t + \phi_4 \Delta bart_{it} + \phi_5 \Delta wage_{it} + \phi_6 \Delta crd_{it} + \phi_7 \Delta auw_{it} + \gamma' \Delta C_{it} + \Delta \varepsilon_{it} \quad (14)$$

However, when variables that are not strictly exogenous are first-differenced, they become endogenous, since the first difference will be correlated with the error term. Arellano and Bond (1991) developed a Generalized Method of Moments (GMM) estimator for linear dynamic panel data models that solves this problem by instrumenting the differenced predetermined and endogenous variables with their available lags in levels: levels of the dependent and endogenous variables, lagged two or more periods; levels of the pre-determined variables, lagged one or more periods. The exogenous variables can be used as their own instruments.

A problem of this difference-GMM estimator is that lagged levels are weak instruments for first-differences if the series are very persistent (see Blundell and Bond 1998). According to Arellano and Bover (1995), efficiency can be increased by adding the original equation in levels to the system. If the first-differences of an explanatory variable are not correlated with the individual effects, lagged values of the first-differences can be used as instruments in the equation in levels. Lagged differences of the dependent variable may also be valid instruments for the levels equations.

4 Results and Robustness checks

4.1 Results

Our main results are the estimations performed using the Arellano$_{B}ondsystemGMMfoundincolumn5and6oftab$

We hypothesized a positive effect of bargaining power of parties involved in bilateral negotiations on inflation volatility. The results obtained in column 5 and 6 supports this hypothesis. Both bargaining power proxies have a statistically and significant positive effect on inflation volatility. Interestingly, the strenght of sectoral institutions (*sect*) magnitude (0.24) is higher than the union density (Δud) magitude (0.02) which is the most used measure of bargaining power. This is not a surprising result since *sect* gives a measure of bargaining power of both the labor and employers unions. In contrast, unions density *ud* only gives a measure of the labor unions bargaining power.

One would therefore expect variations in the general measure of bargaining power (*sect*) to better explain variations in inflation volatility than variations in the specific measure (*ud*). However, our results stand in contrast to that of Barbier-Gauchard, De Palma and Diana (2014) who argue that strengthening unions improves the efficiency of the monetary authority in stabilizing inflation. The analysis conducted in that study fails to control for government intervention as well as the coordination among unions. Therefore, the bargaining power of both employers and labor unions would destabilize inflation since it increases inflation volatility.

The next labor market institutional variable is the number of negotiations. Our results from GMM estimations show that there is partial evidence for a statistically and significant negative effect of the number of negotiations on inflation volatility. The presence of articulations on bargaining (*bart*) decreases inflation volatility by 0.07. Though the social pact on wage (*wage*) do not have a significant effect on inflation volatility, the sign of the coefficient is negative as expected.

Our last labor market institutional variable is the independence of negotiations. The coefficients of the coordination of wage setting (*crd*) and the autonomous wage negotiation (*auw*) are both negative which support our hypothesis on the impact of the independence of negotiations. Yet, the effect of *auw* is statistically significant and decrease inflation volatility by 0.27. Moreover, of all 3 labor market institutional variables, the independence of negotiations seems to be the most important because the magnitude of the estimated coefficients are the highest. Previous estimations performed in Daniels, Nourzad and VanHoose (2006) seem to confirm our results on the impact of independence of negotiations. According to their study, increasing centralization of negotiations (decreasing independence) would increase inflation volatility. But, Rumler and Scharler (2004) found a contradictory result. Their analysis showed that highly coordinated wage bargaining systems do have a positive impact on inflation volatility. This apparent contradiction can be resolved when one notes that it is highly possible that bargaining of highly coordinated bargaining systems might be subject more to government intervention. Any policy maker will not be oblivious to the potentially destabilizing consequences of a coordinated bargaining system and may be forced to intervene. Thus, any analysis on the impact of coordination on inflation volatility should control for government intervention. This is done in our paper. Therefore the destabilizing effects of interdependence in negotiation systems shown in this study better portrays empirical reality.

Though our main explanatory variables are the labor market institutions, we also present results for the control variables as follows.

From column 1 to 6, inflation ($log(\pi)$) and productivity ($log(\sigma_\mu)$) do have a positive statistically significant effect on inflation volatility. This result still holds after correcting for possible endogeneity. Also, table 2 indicates a significant autocorrelation in inflation volatility as shown by the coefficient on the lagged inflation volatility ($log((\sigma_\pi)_{t-1})$). Inflation volatility increased during the crisis periods 1973, 1974, 2008 and 2009. Our results however suggest Eurozone member countries experience higher inflation volatility when using Arellano-Bond system GMM. At first, this may appear counter-intuitive as one would expect a better stability in inflation levels as is the goal of the Maastricht treaty. However, the fact that maintaining stability in annual inflation might imply relatively higher volatility in monthly inflation can explain this result.

Our results also suggest that the correlation between the variance of productivity and the volatility of inflation significantly reduced during the periods of crises and Eurozone accession. An explanation for this result stems from the fact that the the structural dependence between productivity and inflation might have been attenuated during crises periods. Moreover, accession to the Eurozone requires member countries to place more emphasis on inflation stabilization. This places limitations on the use of inflationary policy to stabilize output hence the decreased correlation between productivity volatility and inflation volatility.

In this section, we use Arellano-Bond system GMM to test the hypothesis on labor market institutions given in section 2. We expected a positive relationship between the bargaining power of unions and inflation volatility and a negative relationship between both the number and the independence of negotiations and inflation volatility. The results obtained generally confirm the direction of impact as hypothesized. Among the three categories of labor market variables considered, bargaining power have the most unequivocal effect in terms of significance and magnitude. There is some evidence to support the negative impact of the independence and the number of negotiations. Next, we investigate how robust our findings are to another measure of inflation volatility. This measure is defined as annual average of log monthly volatility derived from GARCH estimations.

4.2 Robustness

We perform a number of sensitivity analysis. Table 3 reports the robustness of the results when the annual average of monthly GARCH volatility is used as the measure of inflation volatility. In general, the results are similar to those of the estimations using the annual average of the standard deviation of monthly inflation as the dependent variable.

The coefficients for bargaining power change very little and remains highly as seen in column 6. The relationship between the independence of negotiations and inflation volatility is still negative and significant. Moreover, the effects of the lag of logarithm inflation volatility, the inflation rate and the variance of productivity are not altered when the annual average of monthly GARCH volatility is used. There is a decreased in the magnitude of the impact of the variance of productivity on inflation during crisis and the period of being a Eurozone member.

However, few differences exist between the two estimations. First, the lag of logarithm inflation volatility plays a bigger role in explaining inflation volatility when the dependent variable is derived from GARCH estimations. The fact that GARCH variances are modeled to be persistent does explain this result. Also, none of the measures used for number of negotiations are statistically significant in explaining variations in inflation volatility under the Arellano-Bond System GMM estimations. The variable *bart* does retain some significant explanatory power as hypothesized under the panel fixed effects estimation and one of the pooled OLS estimation. Also, *crd* becomes the significant variable explaining inflation volatility (under the system GMM estimation) when one switches to using GARCH volatility as the measure of inflation volatility. These differences do not change our results meaningfully. The same conclusion holds from the results in Table 2 that there is some evidence supporting the hypothesis that inflation volatility varies positively with bargaining power and negatively with number and independence of negotiations.

5 Conclusion

This paper investigates the role of the labor market institutions in explaining inflation volatility differentials across countries and over time. First, we derive a theoretical structure in which the bargaining power, the number and independence of negotiations influence the volatility of inflation. Then, using the system-GMM estimator for linear dynamic panel data models on a sample covering 15 OECD countries, analyzed in the period from 1960 to 2011, this paper finds that higher bargaining power of the unions, less independence, and lower number of negotiations, lead to more volatile inflation rates. We clearly show that those variables are important determinants of inflation volatility and have sizeable direct effects.

Our results concerning the strong positive relationship between the bargaining power of unions and inflation volatility are also consistent with previous findings (see, among others, Rumler and Schaler (2011)). The contribution of our paper to the literature is the identification of a proxy that captures the bargaining power of both the labor unions and the employers unions. However, our study contradicts the results in Rumler and Scharler (2011). Less independence increase inflation volatility once you control for government intervention. Another contribution of our paper is that, a study of the coordination of negotiations on inflation volatility should correct for government intervention.

The analysis and findings of this article are a valuable contribution to the academic and policy circles. By understanding the labor market institutions, OECD countries can create viable mechanisms conducive to long-run price stability. A restrictive government intervention in the bargaining process, limiting the effects of coordination among the unions would reduce inflation volatility.

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Table 1: Categories and Expected Signs of Coefficients

Variable	Category	Sign
ud	bargaining power	$+$
sect	bargaining power	$+$
bart	number of bilateral bargaining/ negotiations	$-$
wage	number of bilateral bargaining/negotiations	$-$
auw	independence of bilateral bargaining/negotiations	$-$
crd	independence of bilateral bargaining/negotiations	$-$
gvint	control variable	$+/-$
$\ln(\sigma_{\pi,t-1})$	control variable	$+$
$\ln(\sigma_u)$	control variable	$+$
$\ln(\pi)$	control variable	$+$
$d_{cr}\ln(\sigma_u)$	control variable	$-$
$d_{eu}\ln(\sigma_u)$	control variable	$-$
d_{cr}	control variable	$+$
d_{eu}	control variable	$+/-$

[1] Expected signs of the various explanatory variables. d_cr denotes dummy for crisis period while d_eu denotes the dummy for Eurozone accession.

A The Phillips Curve and Monetary Policy

A.1 Deriving the Phillips Curve

Given the output technology described in the main text, the labor demand can be derived from otpimizing behaviour of the representative firm. Under this behaviour, the first order conditions dictate that wages be equal to the marginal product of labour, as indicated in the equation below:

$$\frac{W_t}{P_t} = aZ_t N_t^{a-1}. \tag{A.1}$$

Let the smaller case letters represent the natural log values of the upper case letters. The expression for labour demand is derived by taken log of A.1 and expressing the resulting equation in terms of $n_t = \log N_t$. Let $\delta_0 = (log(a)) / (1-a)$ and $\delta_1 = 1/(1-a)$. The expression below gives the labour demand:

$$n_t^d = \delta_0 - \delta_1(w_t - p_t) + \delta_1 z_t \tag{A.2}$$

Given the labor supply relation as $n_t^s = \beta_0 + \beta_1(w_t - p_t)$. as well as bearing in mind that the production technology can be rendered as $y_t = an_t + z_t$, one derives the following respective expressions for equilibrium wage rate, equilibrium employment (labour) and equilibrium output :

$$w_t^* = \frac{\delta_0 - \beta_0}{\delta_1 + \beta_1} + p_t + \frac{\delta_1}{\delta_1 + \beta_1} z_t \tag{A.3}$$

$$n_t^* = \frac{\beta_1 \delta_0 - \beta_0 \delta_1}{\delta_1 + \beta_1} + \frac{\delta_1^2}{\delta_1 + \beta_1} z_t \tag{A.4}$$

$$y_t^* = a\frac{\beta_1 \delta_0 - \beta_0 \delta_1}{\delta_1 + \beta_1} + \left(\frac{a\delta_1^2}{\delta_1 + \beta_1} + 1 \right) z_t \tag{A.5}$$

Since z_t is an iid process distributed as follows $z_t \sim N(0, \sigma_z^2)$. Taking expectations of equation (A.3) derives the expected prevailing equilibrium wage rate as follows $E_{t-1} w_t^* = (\delta_0 - \beta_0)/(\delta_1 + \beta_1) + E_{t-1} p_t$. Making the substitution of expected equilibrium wages into the wage indexation rule given in (4) and subtracting p_t from both sides of the equation gives the following expression for real wages:

$$w_t - p_t = (x_t - 1)(p_t - E_{t-1} p_t) + \frac{\delta_0 - \beta_0}{\delta_1 + \beta_1} \tag{A.6}$$

The wage indexation given in (4) is the source of nominal rigidity in the model employed in this study. The presence of such rigidities prevents the labor market from clearing. The level of employment and output is therefore determined by labor demand. Noting this, one derives labor demand in the presence of wage indexation is derived by substituting equation(A.6) into (A.2) to obtain the following expression:

$$n_t^d = \frac{\beta_1\delta_0 - \beta_0\delta_1}{\delta_1 + \beta_1} - \delta_1(x_t - 1)(p_t - E_{t-1}p_t) + \delta_1 z_t. \tag{A.7}$$

Recalling the expression $y_t = an_t + z_t$ permits one to derive the output prevailing in the presence of wage indexation. This expression is given below as follows:

$$y = a\frac{\beta_1\delta_0 - \beta_0\delta_1}{\delta_1 + \beta_1} - a\delta_1(x_t - 1)(p_t - E_{t-1}p_t) + a\delta_1 z_t + z_t \tag{A.8}$$

Finally, subtracting the equilibrium output as expressed in (A.5) from the output prevailing under wage indexation as given in (A.8), together with making the substitutions $g_t = y_t - y_t^*$, $\lambda_t = \frac{a/1-a}{(1-x_t)}$ and $u_t = a\delta_1\beta_1/\left(\delta_1 + \beta_1\right) z_t$ derives the aggregate supply curve as follows:

$$g_t = \lambda_t(\pi_t - E_{t-1})\pi_t + u_t \tag{A.9}$$

The last expression is apparent when one considers that $p_t - E_{t-1}p_t = p_t - p_{t-1} - E_{t-1}(p_t - p_{t-1})$

A.2 Optimal Monetary Policy

The optimal monetary policy problem requires one to solve for inflation in terms of interest rates. Thus, equating the equation 6 (aggregate supply) to 7 (aggregate demand) yields the following expression for inflation.

$$(\hat{\pi}_t - \hat{\pi}_t^e) = \frac{v_t - u_t}{\lambda_t} - \phi\lambda_t(i_t - \hat{\pi}_t^e - r - \pi^*) \tag{A.10}$$

Noting that the interest rate i_t is an instrument set by the monetary policy authority and taking expectation of the equation above gives the following rule for the interest rate : $i_t = \hat{\pi}_t^e + r - +pi^*$. The first order condition associated with the problem given by equation (5) in the main part of the study implies that the following must hold : $E_{t-1}(\hat{\pi}_t) = \hat{\pi}_t^e = 0$. This in turn implies that the interest rate rule that should be followed is

$$i_t = r + \pi^* \tag{A.11}$$

Finally substituting the first order condition and the interest rate rule in (A.11) into (A.10) derives the equilibrium inflation rate under optimal monetary policy as follows:

$$\hat{\pi}_t = \frac{v_t - u_t}{\lambda_t} \tag{A.12}$$

A.3 Volatility of Inflation

Wages are indexed to current inflation (as similarly considered in Gray (1978) and Attey and de Vries (2011)). Under this arrangement nominal wages are automatically adjusted when current inflation differs from inflation according to expectations formed by agents in the previous period. Under an indexation to current inflation scheme the equilibrium inflation is given by the expression:

$$\tilde{\pi}_t = \frac{v_t - u_t}{\lambda_t} \qquad \lambda_t = \alpha\delta_1(1 - x_t) \tag{A.13}$$

The distribution of the random aggregate wage indexation outcome is symmetric around the mean $\bar{x}$ in the case of bargaining under arbitration. The probability of realizations of the random aggregate wage indexation at the extreme ends of the distribution can be approximated by a power function. The distribution of λ_t which is linear in x_t is $P[\lambda \leq x] = c_0 x^m$ where c_0 is a constant. The derivation of the distribution for the inverse of λ_t

$$\begin{aligned}
\Pr\left\{\frac{1}{\lambda_t} \leq q\right\} &= \Pr\left\{A_t \geq \frac{1}{q}\right\} \\
&= 1 - \Pr\left\{\lambda_t \leq \frac{1}{q}\right\} \\
&= 1 - \frac{1}{c_0 q^m}.
\end{aligned}$$

The final expression indicates that $1/\lambda_t$ has a fat tail distribution. Since inflation under optimal monetary policy is simply a product of $1/\lambda_t$ and a function which is linear in the supply and demand shocks u_t and v_t, the distribution of inflation also exhibits fat tail characteristics.

Noting that $1 - \bar{x} = \bar{x}$, $1/\lambda_t$ can be approximated by a Taylor expansion around its mean as as follows.

$$\frac{1}{\lambda_t} = \frac{1}{\alpha\delta_1}\left(\frac{1}{1-x_t}\right) \approx \frac{1}{\alpha\delta_1}\left(\frac{1}{\bar{x}} + \frac{1}{\bar{x}^2}(x_t - \bar{x}) + \frac{1}{\bar{x}^3}(x_t - \bar{x})^2 + ...\right)$$

With the above expression, one can derive an approximation to the mean and the standard deviation of the random variable $1/\lambda_t$. Ignoring terms above the second order, the approximation for the mean is given below.

$$E\left[\frac{1}{\lambda_t}\right] \approx \frac{1}{\alpha\delta_1}\left(\frac{1}{\bar{x}} + \frac{\sigma_x^2}{\bar{x}^3}\right) \tag{A.14}$$

Similarly ignoring the terms above the fist order in the approximation, we derive the variance of the inverse of the aggregate wage indexation outcome as follows.

$$\sigma^2_{1/\lambda_t} \approx \frac{1}{\alpha^2\delta_1^2}\left(\frac{\sigma_x^2}{\bar{x}^4}\right) \tag{A.15}$$

An approximation of the variance of equilibrium inflation given in (A.13) can then be derived as the following:

$$\sigma_\pi^2 = (\sigma_v^2 + \sigma_u^2)(\sigma^2_{1/\lambda_t} + E[1/\lambda_t]^2) \tag{A.16}$$

A substitution of these values into (A.16) derives the following expression for the variance of inflation under optimal monetary policy:

$$\sigma_\pi^2 = \frac{1}{\alpha^2\delta_1^2}\left[\frac{1}{\bar{x}^2} + 3\frac{\sigma_x^2}{\bar{x}^4} + \frac{\sigma_x^4}{\bar{x}^6}\right] \tag{A.17}$$

From the above expression, the variance of inflation is determined by the mean and the variance of the wage indexation. The variance of equilibrium inflation is therefore decreasing in the number of independent bargaining units m.

B Tables

Table 2: $\ln(\sigma_{\pi t})$: standard deviation of monthly inflation

	Pooled OLS		*Panel (Fixed Effects)*		*Arellano-Bond GMM*	
	(1)	(2)	(3)	(4)	(5)	(6)
$log(\sigma_{\pi,t-1})$					0.227***	0.226***
					(0.036)	(0.036)
Δud_t	0.0367***	0.034***	0.038***	0.036***	0.024**	0.02*
	(0.014)	(0.014)	(0.012)	(0.054)	(0.012)	(0.01)
$sect_t$	-0.114***	-112***	0.377***	0.382***	0.186*	0.237**
	(0.031)	(0.031)	(0.053)	(0.054)	(0.097)	(0.097)
$bart_t$	-0.018	-0.011	-0.08***	-0.078***	-0.067***	-0.067***
	(0.013)	(0.013)	(0.018)	(0.018)	(0.024)	(0.023)
$wage_t$	0.021	0.003	-0.048	-0.059	-0.05	-0.056
	(0.065)	(0.065)	(0.057)	(0.057)	(0.051)	(0.05)
crd_t	-0.041***	-0.041***	0.022	0.023	-0.032	-0.031
	(0.014)	(0.014)	(0.022)	(0.022)	(0.022)	(0.022)
auw_t	0.208***	-0.19***	-0.06	-0.055	-0.252***	-0.266***
	(0.071)	(0.071)	(0.074)	(0.073)	(0.081)	(0.08)
$gvint_t$	-0.019	-0.012	-0.017	-0.019	-0.003	-0.01
	(0.016)	(0.016)	(0.019)	(0.019)	(0.021)	(0.021)
$log(\pi_t)$	0.246***	0.226***	0.209***	0.211***	0.18***	0.194***
	(0.02)	(0.022)	(0.018)	(0.019)	(0.019)	(0.019)
$log(\sigma_{u,t})$	0.179***	0.2***	0.232***	0.254***	0.163**	0.211***
	(0.041)	(0.046)	(0.042)	(0.046)	(0.045)	(0.049)
$d_{eu} \cdot log(\sigma_{u,t})$		0.003		-0.046		-0.145*
		(0.102)		(0.089)		(0.084)
$d_{cr} \cdot log(\sigma_{u,t})$		-0.189		-0.251		-0.209**
		(0.148)		(0.125)		(0.105)
d_{eu}		-0.158*		0.025		0.238***
		(0.082)		(0.074)		(0.074)
d_{cr}		0.214**		0.249***		0.205***
		(0.108)		(0.092)		(0.078)
$const$	-0.881***	-0.9***	-1.425***	-1.455***		
	(0.087)	0.087)	(0.101)	0.104		

[1] Sysytem GMM estimates for dynamic panels in columns (5) and (6) . Sample period 1960-2011

[2] All labour market institutional variables are treated as exogenous. $ln(\pi)$, $\ln(\sigma_u)$, $d_{eu} \cdot \ln(\sigma_u)$ and $d_{cr} \cdot \ln(\sigma_{u,t})$ are treated as endogenous.variables. Two to five periods lagged values of the differences of the endogenous variables were used as instruments.

[3] * $p > 0.10$, **$p > 0.05$ and ***> 0.01

[4] Figures in parenthesis indicate the standard errors of the coefficients

Table 3: $\ln(\sigma_{\pi t})$: annual average of monthly GARCH volatility

	Pooled OLS		*Panel (Fixed Effects)*		*Arellano-Bond GMM*	
	(1)	(2)	(3)	(4)	(5)	(6)
$log(\sigma_{\pi,t-1})$					0.807***	0.811***
					(0.017)	(0.017)
Δud_t	0.0368***	0.036***	0.033***	0.033***	0.008**	0.006* *
	(0.011)	(0.011)	(0.008)	(0.008)	(0.003)	(0.003)
$sect_t$	-0.057**	-0.057**	0.411***	0.398***	0.058**	0.071**
	(0.025)	(0.024)	(0.038)	(0.039)	(0.029)	(0.029)
$bart_t$	-0.018*	-0.01	-0.085***	-0.078***	-0.003	-0.002
	(0.013)	(0.01)	(0.012)	(0.013)	(0.007)	(0.008)
$wage_t$	0.038	0.025	-0.038	-0.048	0.014	0.01
	(0.053)	(0.052)	(0.041)	(0.041)	(0.015)	(0.01)
crd_t	-0.022*	-0.023**	0.024	0.022	-0.021***	-0.019***
	(0.011)	(0.011)	(0.016)	(0.016)	(0.006)	(0.006)
auw_t	0.255***	-0.232***	-0.063	-0.055	-0.024	-0.024
	(0.057)	(0.056)	(0.053)	(0.053)	(0.024)	(0.023)
$gvint_t$	-0.018	-0.009	-0.014	-0.013	-0.013**	-0.014***
	(0.013)	(0.013)	(0.014)	(0.014)	(0.006)	(0.006)
$log(\pi_t)$	0.24 ***	0.213***	0.21***	0.188***	0.045***	0.047***
	(0.016)	(0.017)	(0.013)	(0.013)	(0.005)	(0.006)
$log(\sigma_{u,t})$	0.129***	0.155***	0.211***	0.233***	0.048***	0.07***
	(0.033)	(0.037)	(0.03)	(0.033)	(0.013)	(0.014)
$d_{eu} \cdot log(\sigma_{u,t})$		0.027		-0.042		-0.068***
		(0.081)		(0.064)		(0.024
$d_{cr} \cdot log(\sigma_{u,t})$		-0.098		-0.156*		-0.09***
		(0.118)		(0.09)		(0.03)
d_{eu}		-0.19***		0.071		0.076***
		(0.065)		(0.053)		(0.021)
d_{cr}		0.032		0.066***		0.086***
		(0.087)		(0.066)		(0.02)
const	-0.695***	-0.704***	-1.241***	-1.231***		
	(0.069)	0.07)	(0.074)	(0.075)		

[1] Sysytem GMM estimates for dynamic panels in columns (5) and (6) . Sample period 1960-2011

[2] All labour market institutional variables are treated as exogenous. $ln(\pi)$, $\ln(\sigma_u)$, $d_{eu} \cdot \ln(\sigma_u)$ and $d_{cr} \cdot \ln(\sigma_{u,t})$ are treated as endogenous.variables. Two to five periods lagged values of the differences of the endogenous variables were used as instruments.

[3] * $p > 0.10$, **$p > 0.05$ and ***> 0.01

[4] Figures in parenthesis indicate the standard errors of the coefficients

Table 4: Descriptive Statistics

Variable	Description	Obs	Mean	Std Dev	Min	Max
auw	autonomous negotiations and implementation of agreements	779	0.929	0.256	0	1
bart	articulation of sectoral bargaining	778	1.812	1.475	0	5
crd	coordination of wage setting	780	0 .823	0.841	0	2
gvint	government intervention is wage bargaining	780	2.419	2.581	0	4
sect	strength of sectoral institutions representing employment relations	780	0.837	0.645	0	2
typ	type of coordination	780	3.109	1.653	0	5
ud	union density	744	44.151	18.744	7.576	87.442
wage	pact or agreement about wage issues negotiated	779	0.0706	0.256	0	1
$\ln(\sigma_\pi)$ (GARCH)	log average monthly volatility from GARCH estimations	752	-0.957	0.505	-2.343	0 .993
$\ln(\sigma_\pi)$(Std)	log standard deviation of monthly inflation	755	-0.763	0 .426	-1.75	1.335
\$ $\ln(\sigma_u)$	log volatility of productivity from GARCH estimations	751	0 .519	0.451	-2.261	2.48
$\ln(\pi)$	log annual inflation	736	1.211	0.853	-2.303	3.186

[1] Each of the variables above have been placed under one of the following categories: bargaining power, number of negotiations and independence of negotiations.Appropriate transformations are applied to some variables to facilitate their interpretation. with regards to the categories under which those variables fall.

[3] A value of 2 has been observed for *negp* in the case of the Netherlands. This has been corrected as 1 given that *negp* is a binary variable.