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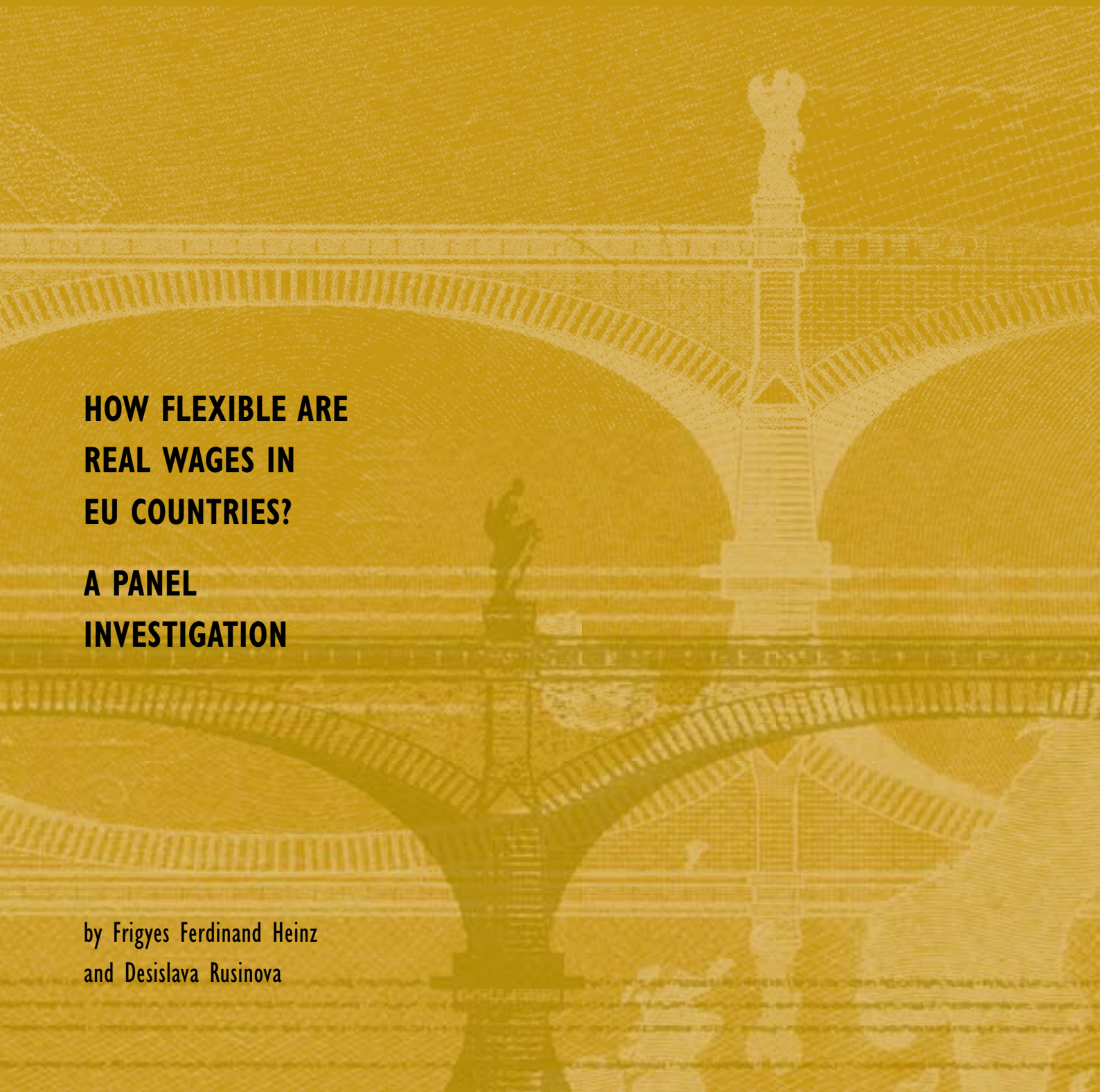

HOW FLEXIBLE ARE REAL WAGES IN EU COUNTRIES?

A PANEL INVESTIGATION

by Frigyes Ferdinand Heinz
and Desislava Rusinova

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1 Both authors: European Central Bank, Kaiserstrasse 29, D-60311 Frankfurt am Main, Germany; e-mails: frigyes-ferdinand.heinz@ecb.europa.eu and desislava.rusinova@ecb.europa.eu

Address
Kaiserstrasse 29
60311 Frankfurt am Main, Germany

Postal address
Postfach 16 03 19
60066 Frankfurt am Main, Germany

Telephone
+49 69 1344 0

Internet
http://www.ecb.europa.eu

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ISSN 1725-2806 (online)

CONTENTS

Abstract

In this paper we estimate the degree of real wage flexibility in 19 EU countries[1] in a wage Phillips curve panel framework. We find evidence for a reaction of wage growth to unemployment and productivity growth. However, due to unemployment persistence, over time the real wage response weakens substantially. Our results suggest that the degree of real wage flexibility tends to be larger in the central and eastern European (CEE) countries than in the euro area; weaker in downturns than during upswings. Moreover, there exists an inflation threshold, below which real wage flexibility seems to decrease. Finally, we find that part of the heterogeneity in real wage flexibility and unemployment might be related to differences in the wage bargaining institutions and more specifically the extent of labour market regulation in different country groups within the EU.

Key Words: real wage flexibility, bargaining institutions, central and eastern Europe, euro area, panel heterogeneity

JEL classification: J31, J38, P5

[1] The countries covered in this paper are the Czech Republic, Bulgaria, Estonia, Hungary, Latvia, Lithuania, Romania, Poland, Slovakia, Slovenia, Germany, France, Spain, Italy, Netherlands, Belgium, Austria, Ireland and Greece.

Non-technical summary

The key objective of our paper is to measure the degree of real wage flexibility in 19 EU countries and to determine how it varies depending on factors such as the cyclical position of an economy labour market institutions or the level of inflation. The economic literature suggests that in a monetary union, where independent monetary and exchange rate policy is not available, real wage flexibility is a crucial adjustment channel to asymmetric shocks, especially if cross-border labour mobility and fiscal flexibility is limited. In addition, sufficient real wage flexibility is also desirable in the CEE countries during their convergence process, in particular to cope with external shocks and structural adjustments that may temporarily cause a decrease in aggregate demand.

Our estimation strategy is conducted in a panel framework, accounting for unobserved country-specific factors. Real wage flexibility is measured in a broad manner, both in terms of the response of real wages to cyclical unemployment as well as to productivity growth. In addition, the models take into consideration not only the immediate, but also the lagged effect of these factors. With respect to unemployment, the baseline specification finds evidence of real wage flexibility on the aggregate EU level, as wage growth responds to contemporaneous cyclical unemployment. However, flexibility is limited by a hysteresis effect as it partially reverses the initial response, which is an often documented phenomenon in EU countries. Real wages are also shown to adjust to past values of productivity growth.

Turning to the factors that might cause heterogeneity in real wage flexibility, our specifications reveal that real wage flexibility tend to be weaker during downturns of the business cycle (when it is most needed) than during upturns (largely in line with the literature). More specifically, when unemployment is below the "equilibrium" (NAIRU) unemployment level (i.e. during an upswing in the business cycle), real wage flexibility is relatively high. In contrast, if unemployment is above the NAIRU level, (i.e. during downturns) there is a clear hysteresis effect, which eliminates in two quarters most of the initial response of real wages to unemployment.

Real wage flexibility appears to be somewhat higher in the CEE countries than in the euro area both with respect to the response to unemployment and to productivity. This difference is likely related to differences in labour market institutions in general and in wage bargaining institutions in particular.

Looking in more detail at the role of institutional differences on real wage flexibility we apply the hierarchical cluster analysis of Du Caju et al. (2008) distinguishing three broad types of countries with respect to labour market institutions: broadly regulated, regulated and deregulated. With respect to unemployment, the least flexible group is the middle one with "broadly regulated" labour markets, since the results point at substantial hysteresis effects. The regulated group also exhibits hysteresis effect, although it does not eliminate all of the wage response. The deregulated

economies seem to exhibit the largest degree of real wage flexibility. The similarity between the regulated and deregulated groups, which are both more flexible than the middle group, is in line with the Calmfors-Driffill hypothesis which postulates a hump-shaped relationship between the level of coordination in the wage negotiations and the degree of real wage moderation. The picture is somewhat different as regards the response of real wages to productivity growth: the response is clearly largest in the deregulated group, where company level bargaining is dominant. The impact in the middle, broadly regulated groupis substantially lower, and the regulated group appears to be the least flexible.

Finally our panel data analysis reveals that an inflation threshold may exist, below which low inflation may decrease real wage flexibility. The differential response of real wage flexibility to inflation seems to confirm the evidence on the presence of nominal downward wage rigidity in the EU countries.

Overall our results suggest that labour market adjustment mechanisms in the EU countries might be impaired in particular in downturns and during low inflation periods. This implies that in the euro area countries and also in those CEE countries outside the euro area that successfully enter a low inflation period in their convergence process have to pay particular attention that their policies do not hamper real wage flexibility. As regards the role of wage bargaining institutions, our results do not suggest that the way to go forward is necessarily to move towards decentralisation. On the contrary, it appears that a high degree of centralisation also has some benefits.

The results of this paper are subject to a number of caveats (e.g. as regards the measurement of unemployment and wages as a result of a relatively large gray economy in some of the countries), however the models appear to be relatively robust over time.

1. Introduction

The objective of the paper is to estimate the degree of real wage flexibility in EU Member states, where real wage flexibility is defined through the responsiveness of real wages to shocks in unemployment and productivity. While the EU countries in our sample are at very different levels of economic development, labour market flexibility is an extremely important structural factor for all of them. In a monetary union, where independent monetary and exchange rate policy is not available, real wage flexibility is a crucial adjustment channel to asymmetric shocks, especially if cross-border labour mobility and fiscal flexibility is limited[2]. In addition, sufficient real wage flexibility is also desirable in the CEE countries during their convergence process, in particular to cope with external shocks and structural adjustments that may temporarily cause a decrease in aggregate demand. Those economies, where a flexible downward adjustment of real wages is possible, tend to have a better chance to withstand adverse economic shocks with lower adjustment costs (e.g. unemployment) than economies that are characterised by rigid real wages.

In our paper we approach the issue of real wage flexibility from a broad perspective looking at a panel of 19 EU countries. In addition to assessing aggregate real wage flexibility, we examine various heterogeneities in the relationship between real wages and real variables. For instance, we evaluate the impact of the economic cycle on real wage flexibility looking at the differences of the impact of real variables on real wage growth in up- and downturns of the cycle (measured by the level of unemployment compared to the NAIRU level.) In addition, we assess the difference between real wage flexibility in the CEE countries (most of which are still outside the euro area) and nine ”old” euro area countries.[3] Moreover, we examine whether real wage flexibility differs depending on the level of inflation. Finally, we obtain estimates on the impact of a broad indicator of the degree of regulation of wage bargaining institutions on real wage flexibility.

An important caveat of our analysis is the fact that besides real wage adjustment, the adjustment in the labour markets can take many other forms (e.g. migration, changes in labour force participation and part time arrangements or other factors). In the presence of these other mechanisms, real wages may react less then they would otherwise. A further complication is the existence of relatively extensive grey economy in some of the countries: it may influence the behaviour of wages, distort the official wage figures and might itself represent an alternative labour market

[2] See for example Chapter 4 in European Commission (2003): European Economy No. 6/2003; The EU Economy: 2003 Review

[3] Germany, France, Spain, Italy, Netherlands, Belgium, Austria, Ireland and Greece.

adjustment channel[4]. In some countries, the share of the grey economy might be substantial: for 2003, among CEE countries, it is estimated at 18% for Hungary and almost 30% for Bulgaria (Tonin, 2004).

The rest of the paper is structured as follows: Section 2 provides a literature review, including an overview of the labour market institutions of the examined EU countries. Section 3 continues with a discussion of the estimation strategy and the data used, and section 4 with the presentation and interpretation of the empirical results. Finally, section 5 concludes.

2. Previous work on real wage flexibility in the EU

2.1. The factors behind real wage heterogeneity

In principle, there are two major approaches measuring real wage flexibility: the wage curve and the Phillips curve approach. While the wage curve approach (e.g. Blanchflower 2001) mainly uses microeconomic data (large datasets of individual data), the Phillips curve approach (e.g. Blanchard and Katz 1999) measures aggregate wage flexibility relying on macroeconomic data (aggregate wages, inflation, unemployment). The conceptual difference between the two approaches is that the wage curve approach relates the level of wages to the unemployment level and therefore represents an equilibrium concept, while the wage Phillips curve relates wage growth to the unemployment level and hence reflects an adjustment process towards equilibrium. Consequently, real wage flexibility is also defined differently: the wage curve approach implies that under higher unemployment, the wage level should be lower, while the Phillips curve approach argues that wages should keep decreasing. Given the availability only of macroeconomic data, we opt for the Phillips curve approach.

We are interested in comparing real wage flexibility across countries and country groups in a broad sense, taking into account its multi-dimensional nature. Hence, we conceptualize real wage flexibility in a broad way, using two indicators. In the first place, similarly to Babetskii (2006), we assume that real wage flexibility is defined through a significant negative link between unemployment and wage growth. Conversely, real wage rigidity implies either an absence of such effect, or a considerably retarded one. As a second indicator of real wage flexibility, we asses the responsiveness of wages to changes in productivity, which has attracted substantially less empirical research than the link with unemployment. For each of these indicators, we compare not only the coefficient sizes, but also the speed and lag structure of the response: as Kittel (2001) argues, it is important to consider not only the differences in the flexibility outcomes, but also in the way these outcomes have been achieved. The timeliness of the wage response to economic developments is

[4] For instance, in the case of an aggregate demand shock employers are more likely to fire first the informal part of the labour force and to cut wages in the part of the labour force not protected by the labour protection regulations of the formal economy.

also relevant, since if it is strongly delayed, then the adjustment might not be optimal any longer in the presence of new shocks.

The empirical literature has found some evidence of real wage flexibility in the EU economies, with substantial heterogeneity across countries (e.g. Arpaia and Pichelmann, 2007, Babetskii 2006, etc.). However, the literature is often inconclusive about the nature of the factors behind country heterogeneity and the magnitude of their impact. Comparison with existing studies is often hindered by differences in model specifications, time periods and different sets of dependent and control variables. In particular, in many cases only contemporaneous variables and not lag structures are considered, hence the estimation does not capture the dynamic nature of the wage response.

In order to determine the country groups, we consider four factors which we expect to have an impact on real wage flexibility: the cyclical position of the economy, proxied by the sign of the gap between cyclical unemployment and NAIRU, the CEE countries vs. euro area division, the labour market institutions and the level of inflation. For each of the factors, there is a body of previous research which provides some expectations about the way they would affect real wage adjustment.

About the dependence of real wage flexibility on the phase of the cycle, the available evidence suggests that it is substantially higher in downturns than in upswings. For instance, Woitek (2004) finds that the phase of the business cycle of the economy matters for the degree of real wage flexibility. Messina et al. (2009) report a positive link between the cyclicality of wages (e.g. the degree to which they react to output) and the level of employment, which would in turn suggest a negative link between their cyclicality and the unemployment level. Arpaia and Pichelmann (2007) also document asymmetric response of wages in upswing and downturn.

As for the comparison between CEE countries and the euro area, there are only a few recent studies which tackle this issue. The results of Babetskii (2006), which are based on macroeconomic data, do not seem to support the argument that the degree of wage adjustment is higher in the three EMU members selected than in the CEE countries. Van Poeck (2007) finds, however, that wages in the four selected CEE countries are more responsive to unemployment than in most EU countries. His finding is associated with differences in labour market institutions, showing that on average institutions are more flexible in the 4 CEE countries in their sample than in the 9 other EU countries (mainly euro area) except for the active labour market policies and taxation of wages.

As regards the impact of labour market institutions, some papers specifically concentrate on the empirical evaluation of the role of institutions on wage dynamics. Much of the empirical literature concentrates on the centralization of wage bargaining, but it is generally inconclusive about its effect on economic outcomes (Du Caju et al., 2008). Some authors find supportive evidence for the Calmfors-Driffill hypothesis, which postulates a hump-shaped relationship between

the level of coordination in the wage negotiations and the degree of real wage moderation. According to the hypothesis, centralized bargaining produces moderate results because of internalizing the negative effects of excessive wage growth on the entire economy, and the company level bargaining – since wage growth is limited by competitive forces (Calmfors 1994). Alesina and Perotti (1997) divide countries into three broad institutional groups, based on the level of wage bargaining, and find support for the hump-shaped relationship between this indicator and wages. Nunziata (2005) also suggests that wage bargaining institutions play a major role in influencing wage dynamics, however he suggests that wage growth moderates with higher level of coordination: while there is no significant effect in countries where coordination remained stable over the period, the increasing level of wage bargaining coordination in the 1990s has been particularly relevant for moderating labour costs in Ireland, France and Italy.

Kittel (2001), considering both level of wage bargaining and type of coordination, finds that countries with uncoordinated labour markets tend to respond less flexibly to shocks than those that rely on some kind of coordination, especially pattern setting and peak-level coordination.

Apart from the level of coordination, another factor identified in the literature is union density and coverage, and a negative relationship has been established between union density and flexibility (e.g. Clar et al. (2007), using a meta-analysis).

The last factor causing heterogeneity in wage flexibility considered is the inflation level. It leads to heterogeneous behaviour of real wages due to the presence of downward nominal wage rigidity (Akerlof et al. 1996, Groschen and Schweitzer 1999). When wages are nominally downward rigid due to a nominal wage floor and inflation is close to zero, real wage flexibility might be limited as firms resort to reducing employment rather than paying real wage above equilibrium (Akerlof et al. 1996). Therefore, moderate inflation levels increase real wage flexibility as they facilitate real wage cuts (e.g. Hyslop, 1997). Empirically, both micro and macro studies have provided supporting evidence. Groshen and Schweitzer (1999) demonstrate on micro data that inflation in a certain low range "adds grease" to the wheels of the labour market, helping to relax real wage rigidities. However, as too high inflation can also be harmful (e.g it can increase the likelihood of the introduction of wage indexation mechanism), the net benefits of inflation seem to peak at a CPI inflation rate around 2.5%. On the macro level, Hyslop et al. (1996) document through a Philips-curve methodology that real wages adjust better in a high-inflation than in a low-inflation regime. Finally, Babetskii (2006) argues that the decrease in real wage flexibility in selected EU countries over the review period, or the absence of such, could be at least partially linked to a decline in inflation. One of the areas where our paper intends to contribute to the empirical literature is conducting a formal search for an inflation threshold causing different real wage flexibility.

2.2. Labour market institutions

Given the central role of labour market institutions in our empirical investigation, we briefly review the labour market institutions of the countries in our sample before proceeding with specification issues.

For classifying countries by institutions, we generally follow Du Caju et al. (2008). However, while their results are based on the questionnaire of the Eurosystem's Wage Dynamics Network sent out in 2006, we also use data from a second round of the questionnaire sent out by the ECB in 2008, that allows us to add institutional data on four further CEE countries (Bulgaria, Latvia, Romania and Slovakia), broadening the geographical scope of the analysis (see Table A2 in the appendix).

The cluster analysis conducted on wage setting institutions in Caju et al. (2008) identifies three groups of countries using a set of twelve indicators of labour market institutions[5]. The first group with a broadly regulated system of wage bargaining includes the majority of euro area countries (Austria, Denmark, France, Germany, Greece, Ireland, Italy, the Netherlands, Norway, Portugal and Sweden). It can be characterised by the existence of extension procedures and a high level of collective agreement coverage, a dominance of sectoral (and to a lesser extent firm level) wage bargaining and the general absence of coordination except through minimum wages (or trend setting sectors).

The second group (Belgium, Cyprus, Finland, Luxembourg, Slovenia and Spain) exhibits the same general wage setting characteristics of the previous group, but with bigger importance of indexation, intersectoral agreements and the role of government.

Finally, the third group includes countries where the wage bargaining system is largely deregulated (Czech Republic, Estonia, Hungary, Japan, Lithuania, Poland, the UK and the US). Most of the other Central and Eastern European EU countries are also in this group (Table A2), including the four countries we add to the sample. They have several characteristics which may support wage flexibility like the limited role played by trade unions, as suggested by measures like trade union density (defined as the percentage of workers who are members of a trade union) and collective bargaining coverage (measured by the share of all workers who are covered by some sort of collective agreement). Moreover, in most of these countries company level bargaining dominate and hence the bargaining process is highly decentralised.

[5] Among these are: trade union density, coverage of collective agreements, level of wage bargaining, type of coordination, government involvement, average duration of wage agreements, minimum wage, presence and type of indexation mechanisms.

3. Empirical analysis on real wage flexibility in the EU

3.1. General economic considerations

The empirical specification is based on the Blanchard and Katz (1999) bargaining adjusted Phillips curve model, where the real wage is set depending on the union's reservation wage, the level of productivity and the prevailing level of unemployment. The model's testable equation relates the change in nominal wages to the unemployment *level,* expected inflation and the change in productivity:

$$w_t - w_{t-1} = c + \beta_1(p^e{}_t - p_{t-1}) - \beta_2(w_{t-1} - p_{t-1} - y_{t-1}) + \beta_3 \Delta y_t + \beta_4 u_t + \beta_5 \Delta w_{t-1} + \varepsilon_t \qquad (1)$$

In the above equation, p_t is the price level (and p^e the expected price level), Δy_t represents the change in productivity level, u_t the unemployment rate and w_t the level of nominal wages (all variables except unemployment are in logs). The term $(w_{t-1} - p_{t-1} - y_{t-1})$ represents an error correction term (ECT), which is derived from a long-run relationship between wages, prices and trend productivity.

We adopt a distributed lag structure similarly to Wulfsberg (1997) and Kittel (2001), where the independent variables influence wage growth through their current and lagged values. There are two important reasons for this choice. First, as we are dealing with relatively high-frequency (e.g. quarterly) data, we are likely to observe slow adjustment of the variables to shocks in the labour market, taking longer than one quarter. Second, the lag structure reflects the speed of adjustment of real wages to changes in the exogenous factors and hence contains important information on the timing and structure of the wage response. The results of the empirical analysis (Section 4) reveal that the lag structure does indeed provide important information and that we observe significant lagged values of all external factors, which is evidence of deterred adjustment. In particular, investigating the significance and the signs of the lagged unemployment terms allows for detecting potential hysteresis or persistence effects.

After including the lag structure, the Phillips curve takes the following form:

$$\Delta w_t = c + \alpha(L)\Delta p_t + \beta(L)\Delta y_t + \gamma(L)u_i + \theta ECT_{t-1} + \delta \Delta w_{t-1} + \varepsilon_t \qquad (3)$$

In equation (3), L is the lag operator and $\alpha(L)$, $\beta(L)$ and $\gamma(L)$ are polynomials. The maximum lag length used in the regressions is determined empirically, starting from a maximum of four lags for all variables.

The dependent variable is the change in *nominal wages*, which is calculated as logarithmic quarter-on-quarter difference of the seasonally adjusted nominal average wage for the total economy. A number of studies based on the wage bargaining model (Blanchard and Katz 1999, Wulfsberg 1997, Kittel 2001) consider routinely nominal wages as dependent variable since

nominal wages are the object of the wage bargaining. Coe (1995) argues that the alternative of real (deflated) wages on the left hand side would be equivalent to imposing a unitary coefficient of current inflation on wages, or full indexation of wages to prices. This is unlikely to be the case in general, and also not in our case, as wage indexation only plays a significant role in a handful of countries.

The key independent variable in our analysis is the *cyclical unemployment rate,* which is a measure of the labour market conditions (e.g. Layard et al. 2006). It is calculated as a difference between the unemployment rate and NAIRU, where NAIRU is approximated by applying Hodrick-Prescott filter to the unemployment rate series. The first dimension of real wage flexibility is represented by the coefficients and the lag structure of the structural unemployment variable γ_i (e.g. Hyclak and Johnes 1995), given that inflation is controlled for through the inflation variable.

Inflation captures the degree of adjustment of wages to inflation, or nominal wage flexibility. Our inflation variable refers to CPI inflation since sufficiently long series of other inflation measures (GDP deflator, PPI) are not available for all countries in the sample. CPI inflation is relevant for employees, who aim at preserving their purchasing power in the wage bargaining process and seek indexation for their wages according to the CPI, while employers are guided by the producer prices that reflect better changes in production costs. Since in a number of countries (see Du Caju et al. 2008) expected inflation is taken into account in the process of wage bargaining, a measure of *inflationary expectations*, based on Eurostat consumer price expectations survey, is added for those countries where this data is available (See Appendix A).

The coefficient of *productivity* is the second measure of real wage flexibility we consider since it represents an additional path of real wage adjustment to macroeconomic shocks. The productivity measure we employ is value-added based: it is obtained by dividing whole economy real value added by total employment. For employers, productivity growth can be considered as the upper limit to acceptable wage increases. It is likely to play an especially important role in the CEE countries, since they have experienced substantial productivity improvements in the period considered.

In order to capture the external influences on the economy, we include the *trade-weighted nominal effective exchange rate*. The sign of the expected effect on real wages is ambiguous. The depreciation of the domestic currency would lead to upward pressure on nominal wages in the wage negotiations as the cost of living increases due to the rising import prices (Radziwill and Walewski 2006). However, as the CPI inflation term corrects for the increase in cost of living, the remaining effect depends on how fast and fully nominal wages can adjust to match this increase. Some works report negative response of real wage growth to the exchange rate (e.g. deceleration of wage growth under depreciation) - e.g. Goldberg and Tracy, 2003 for the USA.

With all variables included, taking into account the panel setup and with lag structure rewritten in an extensive form, equation (3) transforms into the following estimable equation[6]:

$$\Delta w_{ct} = c + \sum_{i=0}^{4} \alpha_i \Delta p_{c,t-i} + \sum_{i=1}^{4} \beta_i \Delta y_{c,t-i} + \sum_{i=0}^{4} \gamma_i u_{c,t-i} + \sum_{i=1}^{4} \delta_i \Delta w_{c,t-i} +$$
$$+ \theta ECT_{t-1} + \phi \sum_{i=1}^{4} neer_{c,t-i} + \varphi \Delta p_c^e + \mu_c + \varepsilon_{ct} \qquad (4)$$

where Δp^e is expected inflation, $\Delta neer_{t-i}$ is the trade-weighted nominal effective exchange rate, and μ_c denotes the country fixed effects. The c subscript refers to "country," while the t subscript to "time" in the equation.

3.2. Econometric considerations and data

We opt for pooling together the observations for all countries using panel estimation. Within the panel, we implement different country or country-time groupings in order to identify systematic differences in wage flexibility caused by factors like the phase of the business cycle, labour market institutions, the level of inflation, etc. As a general strategy for investigating heterogeneities, we allow for differential slopes by including interaction terms of unemployment and productivity with sets of group dummies. This method partly relaxes the restrictions imposed by a completely homogenous model and allows for an individual pattern of adjustment in each group. Hence, if there are reasons for expecting heterogeneous behaviour, this technique could substantially reduce the potential bias introduced by the homogeneity restriction (Nunziata 2005 refers to this technique as a "semi-pooled regression"). It has been extensively used in the literature for testing differences across regimes, including the effect of labour market institutions on wages and other macroeconomic variables (Alesina and Perotti 1997, Kittel 2001, Nunziata 2005).

Our preferred estimation method is feasible generalized least squares (FGLS), which corrects for heteroskedasticity, as heteroskedasticity has been reported in previous works estimating Phillips curves in EU cross-country setting (e.g. Arpaia and Pichelmann, 2007). The regressions include country fixed effects to capture unobserved cross-country heterogeneity.[7]

Our panel is dynamic (includes a lagged dependent variable on the right-hand side), which in principle causes a bias in the coefficients estimated by OLS. However, it has been demonstrated that the size of the bias is of order O(1/T), and hence the bias is less relevant for longer panels (Nunziata 2005). Judson and Owen (2005) demonstrate that even with sample size T = 30, the bias is relatively small and the fixed effects estimator performs better than alternative estimators. As our

[6] All changes are expressed in logarithmic differences. Trend productivity for the long-term relationship is obtained through applying a Hodrick-Prescott filter on the productivity series.
[7] Period fixed effects are not included as these are jointly insignificant.

panel has a maximum time length of T = 82, we can expect the bias from estimating the panel with GLS to be relatively limited.

Another issue regarding the econometric estimation is that the estimated regressions including unemployment or inflation might suffer from simultaneity bias, since wage growth is also likely to have an impact on the unemployment level and inflation. The problem is addressed by considering only lagged and not contemporaneous variables. As an exception, we allow for contemporaneous cyclical unemployment, which can theoretically be regarded as a lagged indicator of labour market conditions (see Coe, 1985)[8]. Finally a further important issue in the multi-country setup is the poolability across countries. We address this issue in subsection 4.6.

The data used is quarterly data stemming mostly from Eurostat. The sample is unbalanced, with data starting in 1995 or 1996, and ending in Q2 2010. For some of the countries the data starts later (2000 for Bulgaria and Greece) whereas for Germany, France and Italy we can use longer series going back to 1990 (see Table A.1 in Appendix A). All details regarding the data used and transformations applied are available in Appendix A.

4. Results

Before turning to the estimation results, we investigate the stationarity of the variables through panel unit root tests. As shown in Table 1, the variables in levels, which form the cointegrating relationship, have unit roots, whereas the log-differenced variables are stationary.

Table 1. Results of panel unit root tests for the variables used

Variables	Series tested	Levin, Lin & Chu t*	Im, Pesaran and Shin W-stat	ADF-Fisher
HICP	level	-0.977	-0.107	33.472
	log-dfference	7.31***	-8.45***	151.07***
Wage	level	-2.12	-0.78	45.21
	log-dfference	-2.82***	-8.90***	164.52***
URXC	level	-1.70**	-7.37***	133.92***
PVA	level	2.54	1.28	29.53
NEER	log-dfference	-7.21***	-15.23***	302.69***
	level	-6.19***	-3.35***	79.13***

Notes: HICP refers to the HICP index, Wage to the nominal wage level, URXC to the cyclical component of unemployment, PVA to the productivity level, while NEER to the nominal effective exchange rate. The Levin, Lin and Chu t-test assumes common unit root process, whereas the remaining tests assume individual unit root processes. All tests in levels (with the exception of cyclical unemployment) include individual intercepts and trends. For unemployment, the test only includes intercept.

[8] This also necessitates allowing contemporaneous inflation on the right-hand side in order to preserve the assumption of real wages.

4.1. Baseline specification

First, the baseline specification of the panel regression is presented in two versions: with and without the expected inflation variable (Specifications 3.1 and 3.1a in Table 3).

In the pooled sample, the results suggest some evidence of real wage flexibility, based on the value of the unemployment coefficients γ_0 to $\gamma_{2,}$ however part of the initial wage response is reversed in the long run due to hysteresis effects, as explained below. Economically, the magnitude of the estimated contemporaneous semi-elasticity would suggest that a 1 p.p. bigger gap between unemployment rate level and NAIRU is associated with approximately 1p.p.lower wage growth.

The significant second unemployment lag with positive coefficient suggests the presence of unemployment persistence effects: after the initial effect of unemployment on wages there is a second, opposite effect, which (partly or in the case of hysteresis fully) reverses the initial reaction. This leads to lower longer-term real wage flexibility or a complete lack of response of wages in the case of hysteresis (see Gordon 1989, Moghadam and van Rijckeghem 1994).[9] Although persistence effects are usually diagnosed by a unit root in the unemployment rate (Leon-Ledesma and McAdam, 2004), alternatively a positive coefficient on lagged unemployment in the Phillips curve may also reflect a persistence effect (Layard et al. 2006, Feve et al., 2003). Unemployment persistence or hysteresis has been documented for many EU countries (e.g. Moghadam and Rijckeghem 1994 for Belgium, and Camarero et al. 2003 for Central and Eastern Europe) and insider effects have been identified as an important reason. After an adverse shock, the number of participants in the wage bargaining is reduced (e.g. laid off) and since insiders have a higher chance of keeping their jobs at any given wage, they generate an upward pressure on wages (Layard et al. 2006; Blanchard and Summers, 1987). This in turn prolongs the effect of the unemployment shock.

Turning to productivity growth as a second indicator of real wage flexibility, we observe certain evidence of wage flexibility as the first and second lag of the productivity variable have significant positive coefficients. This result refers to the short-run adjustment process, while the longer-run adjustment of real wages towards trend productivity captured by the long-run relationship.

The coefficient of inflation implies that around 48% of growth in prices gets passed on to wage growth. In the specification with expected inflation (3.1a), the latter is significant and has a positive sign, indicating that it is a factor which matters in the wage determination process. Its inclusion increases the explanatory power of the regression and weakens somewhat the estimated relationship between wages and actual inflation.

[9] Under full hysteresis, the coefficients of the contemporaneous and lagged unemployment are equal in absolute value, hence in the longer run no relationship exists between the unemployment level and wages, but only between unemployment and wage growth. In this case, wages are considered rigid.

Real wages exhibit inertia, measured by a significant and positive coefficient of lagged wage growth up to the second lag. In total, about 34% of real wage growth is determined by its past values.

Concerning the impact of the nominal effective exchange rate on wage growth, the coefficient of exchange rate depreciation is significant, but with a negative sign. A possible explanation of the negative coefficient might be the combination of long wage inertia and nominal wage rigidity that hampers the adjustment of nominal wages in the short run to exchange rate-related price level changes. This in turn causes a decrease of real wages in the short run as a result of exchange rate depreciation. Indeed, the negative NEER coefficient appears in the first lag, i.e. concerns the real wage response within one quarter. A comparison across specifications reveals that the negative NEER coefficient is a quite robust result.

Finally, the highly significant negative coefficient of the error correction term suggests that in the aggregate sample, wages have a strong tendency to return to their values determined by trend productivity and the price level. The long-term relationship between these three variables is presented in Table 2, imposing the restriction that the coefficient of the log price level is equal to one.

Table 2. Cointegrating relationship between wages, prices and trend productivity

Variables	Test staistics
Constant	-5.297***
	(0.147)
log(HICP)	1.00***
log(PVA trend)	1.226***
	(0.019)
Country fixed effects	yes
Adj. R-squared	0.80
Panel unit root test (resid.)	55.59**
No. observations	1155

Note: The dependent variable is the logarithm of the wage level. The other variables are the logarithm of the price level (log(HICP)) and that of the productivity level ((log(PVA trend)). The test reported is the ADF-Fisher Chi-square panel unit root test for individual unit root processes; the PP-Fisher unit root test gives very similar results.

Table 3. Panel estimations of real wage flexibility

Variables	3.1	3.1a	3.2		3.3		3.4		3.5		
Constant	0.006***	0.008***	0.006***		0.006***		0.006***		0.006***		
	(0.001)	(0.001)	(0.001)		(0.001)		(0.001)		(0.001)		
HIC	0.256***	0.271***	0.217***		0.261***		0.247***		0.363***		
	(0.083)	(0.089)	(0.083)		(0.083)		(0.084)		(0.078)		
HIC(-1)	0.228**	0.156*	0.226***		0.228***		0.226**		0.161		
	(0.087)	(0.094)	(0.088)		(0.088)		(0.089)		(0.083)		
HIC(-2)	-0.112	-0.219**	-0.099		-0.103		-0.121		-0.037		
	(0.082)	(0.088)	(0.082)		(0.082)		(0.083)		(0.076)		
NEER (-1)	-0.095	-1.12***	-0.085***		-0.095***		-0.099***		-0.057**		
	(0.025)	(0.027)	(0.025)		(0.025)		(0.025)		(0.028)		
NEER (-2)	0.065**	0.071**	0.058**		0.063**		0.068**		0.009		
	(0.025)	(0.028)	(0.025)		(0.026)		(0.025)		0.03		
WAGE (-1)	0.158***	0.116***	0.181***		0.150***		0.154***		0.091**		
	(0.031)	(0.033)	(0.032)		(0.031)		(0.031)		(0.037)		
WAGE (-2)	0.184***	0.144***	0.179***		0.180***		0.183***		0.178***		
	(0.031)	(0.033)	(0.031)		(0.034)		(0.031)		(0.039)		
ECT (-1)	-0.022***	-0.017***	-0.023***		-0.023***		-0.024***		-0.044***		
	(0.004)	(0.004)	(0.004)		(0.004)		(0.004)		(0.006)		
Unemployment			*U above NAIRU*	*U below NAIRU*	*CEE*	*non-CEE*	*high infl.*	*low infl.*	*broadly reg.*	*deregulated*	*regulated*
URXC	-0.004***	-0.005***	-0.004***	-0.004***	-0.005***	-0.004***	-0.005***	-0.002***	-0.005***	-0.006***	-0.007***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)	(0.001)
URXC(-1)	0.002	0.002	0.002	0.003	0	0.004**	0	0.001	0.005***	0.003	0.004***
	(0.001)	(0.001)	(0.002)	(0.002)	(0.002)	(0.002)	(0.003)	(0.001)	(0.001)	(0.001)	(0.002)
URXC(-2)	0.002**	0.002**	0.003**	0.001	0.003**	0	0.002**	0.002***	0	0.003	0.001
	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)	(0.001)	(0.001)	(0.001)	(0.002)	(0.002)	(0.001)
Productivity											
PVA (-1)	0.083***	0.043	0.135***	0.045	0.180***	0.039	0.111***	0.089***	0.089**	0.376***	0.016
	(0.033)	(0.038)	(0.052)	(0.043)	(0.068)	(0.039)	(0.064)	(0.038)	(0.042)	(0.089)	(0.075)
PVA (-2)	0.072**	0.125***	0.086	0.068*	0.133**	0.045	0.128**	0.067*	0.051	0.254***	-0.072
	(0.033)	(0.037)	(0.053)	(0.041)	(0.064)	(0.039)	(0.064)	(0.038)	(0.042)	(0.09)	(0.074)
Expected inflation		0.0008***									
		(0.0003)									
Countryf ixed effects	yes	yes	yes		yes		yes		yes		
R-squared	0.33		0.34		0.34		0.34		0.46		
Adj. R-squared	0.32	0.34	0.32		0.32		0.32		0.43		
RZB test statistic	3.99		3.70		*3.62*		*3.72*		2.62		
No. observations	1060	884	1060		1060		1060		791		

4.2. Asymmetric response of wages with respect to the unemployment gap

The differential response of wages to unemployment across the cycle is tested by allowing for different response depending on whether unemployment is below or above NAIRU (i.e. cyclical unemployment is positive or negative). The results (specification 3.2) suggest that a difference exists, and it mostly concerns the presence and size of persistence effects, as the contemporaneous coefficients in the two regimes are almost identical. When unemployment is below NAIRU, (i.e. during an upswing), the persistence term is not statistically significant and the coefficient (-0.004) is relatively large. In contrast, if unemployment is above NAIRU, (i.e. during a downturn) there is a clear hysteresis effect, which eliminates in two quarters most of the initial response of real wages to unemployment. This is in line with the findings of the literature (see Section 2.1.)

Downward real wage rigidity is an explanation for this asymmetric behaviour: During downturns downward real wage rigidity becomes binding, whereas during upswings, even if present due to the institutional setup, it is not binding. Indeed, microeconomic studies on the EU countries present ample evidence on downward real wage rigidity (DRWR) in EU. It is usually related to the presence of institutional factors (e.g. indexation mechanisms), which do not allow real wages to adjust downwards (Babetskii at al, 2009). The microeconomic DRWR phenomenon is related to the cyclical response of wages. Messina et al. (2009) report a significant negative link between the extent of DRWR and the cyclicality of wages, defined as the response of wages to macroeconomic shocks. Arpaia and Pichelmann (2007) investigate the wage response in individual countries and find evidence not only that their wage measure adjusts more when output is above potential, but also that cross-country heterogeneity is substantially higher in the down phase of the cycle.

The size of the productivity coefficients also reveal differences in the productivity-wage relationship across the regimes, however statistical tests do not reject the coefficients' equality. There is indication that the response to productivity is the opposite compared to the response to unemployment: during downturns real wages adjust better to productivity changes than during upswings, when the link is much less clear. This could mean that adjustment to productivity works as an alternative adjustment channel when adjustment of real wages downward is prevented by rigidities.

4.3. Differences between CEE countries and the euro area

Another division criterion is between CEE countries, which joined the EU as a result of enlargement in 2004 and 2007 and the rest of the sample, called for brevity euro area[10]. In principle, this division overlaps to a large extent with the grouping determined by labour market institutions: as shown in Section 2.2., the CEE EU members stand out along several institutional dimensions like dominant level of coordination and union density. However, the CEE-euro area division might also capture factors beyond labour market institutions, like the fact that the CEE countries are characterized by faster productivity growth during the sample period.

Specification 3.3 reveals different patterns across regimes both with respect to unemployment and to productivity, suggesting somewhat higher real wage flexibility in the CEE countries than in the euro area group. Regarding unemployment, like in the previous section, the difference is not in the contemporaneous term, but the first and second lags. In the case of the euro area group there is a fast reversal of the initial effect, which decreases substantially the cumulative degree of real wage flexibility in the longer run to a fraction of the initial value. For the CEE countries, the reversal is smaller in magnitude, and also takes more time to materialize. The F-test rejects equality of coefficients of the first lag of unemployment at the 10%, and for the second lag - at the 5% level.

The more substantial difference between the two regimes is the one concerning the effects of productivity: the cumulative short-run coefficient in CEE countries is about 0.3 and very significant, whereas in the euro area there is no significant response. In fact, van Poeck (2007) also reports significantly bigger effect of productivity on wages in his CEE sample as compared to the euro area, which necessitates allowing for different slopes in the pooled data. The weaker link between productivity and real wage growth in this group might be also related to institutions and the degree to which they allow for adjustment of the real wage to productivity developments.

4.4. The role of labour market institutions

The basis for outlining the labour market institutions regimes is the hierarchical cluster analysis of Du Caju et al. (2008), which distinguishes three broad types of countries with respect to labour market institutions: broadly regulated, regulated and deregulated (See section 2.2). It should be noted that this specification uses a shorter sample than the previous ones (it starts in 2000), as the cluster grouping in Du Caju et al. (2008) is based on the institutional

[10] We include some current euro area countries in the CEE group (Estonia, Slovakia and Slovenia), since these countries have only joined the euro area towards the end of the sample period of our panel.

indicator values in 2008, and it is uncertain whether the clustering would be the same for the 1990s, when many EU countries have undergone substantial reforms of their labour market institutions (e.g. Anspal and Vork, 2007).

The results of specification 3.5 suggest that with respect to the response to unemployment, the least flexible group is the middle one with "broadly regulated" labour markets, since the immediate reversal of the initial response with equal coefficient points at substantial persistence effects. The regulated group also exhibits a hysteresis effect, but it does not eliminate all of the wage response. The deregulated economies seem to exhibit the largest degree of real wage flexibility – they have a large coefficient and no persistence term. The F test does not reject the equality of coefficients between the regulated and deregulated group, but rejects the equality of coefficients of each of these two with the middle group. Merging the regulated and de-regulated group and comparing it with the "broadly regulated" group gives a significant test statistic, suggesting that the middle group is indeed the one that stands out with the weakest degree of real wage flexibility.

Explaining these differences requires investigating the components of the institutional clusters. (Du Caju et al. 2008). One dimension in which the three groups differ is the dominant level of bargaining. In the "broadly regulated" group, the sectoral level of bargaining is dominant in all but one of the countries, whereas in the deregulated group negotiations take place mostly on a company level. In the regulated group, with the exception of Belgium, negotiations take place mostly at the national or regional level[11]. In this sense, the similarity between the regulated and deregulated groups, which are both more flexible than the middle group, is in line with the Calmfors-Driffill hypothesis, which postulates a hump-shaped relationship between the level of coordination in the wage negotiations and the degree of real wage moderation.

Turning to another institutional dimension – union density and coverage, it is notable that in the broadly regulated and regulated groups, all countries have high union coverage (only Germany has a middle level), whereas in the deregulated group union coverage is low to very low (with the exception of the Czech Republic, which has moved from a low to medium level). This might be a factor which explains partly the observed heterogeneity in wage flexibility, at least in the deregulated vs the middle group. High union coverage might also explain the high degree of unemployment persistence in the regulated and broadly regulated groups: higher coverage could give the union bigger bargaining power and hence cause a larger insider-caused persistence effect (see the persistence discussion in Section 4.1).

[11] In Belgium, although the national level is also present, it is not dominant.

The response of real wages to productivity developments shows a very different picture as compared to unemployment. Here unambiguously the largest response is in the deregulated countries (a cumulative coefficient of 0.6), followed by the middle group with a substantially lower coefficient – 0.09. In the regulated group no significant short-run response of wages to productivity can be identified. Hence, the response to productivity is the largest in those countries where the company level bargaining is dominant and the union coverage is low. The intuition could be that real wages are better aligned with productivity in the company setting, where company-level productivity is directly observable to both bargaining parties and wages are not bound by a union benchmark. In contrast, on a sectoral or national level the link might be less clear, as uniformly set wages would have to be aligned with the productivity growth in a heterogeneous group of industries.

4.5. The role of the inflation level

The last issue considered is whether an inflation threshold exists, above which inflation can act as a factor that enhances real wage flexibility. We implement a search over a broad range of inflation values, allowing for different intercepts below and above the threshold. As optimal specification we choose the one, which maximizes the adjusted R-square and at the same time shows significant difference in the slope coefficients below and above the threshold. The inflation value that corresponds to this specification is equal to 0.014 in logarithmic terms, or around 5.6% in terms of annual inflation.

The contemporaneous coefficient of unemployment above the threshold is significantly larger (in absolute value) than the one below (see specification 3.4 in Table 3). The cumulative wage response is also stronger, as the size of the lagged coefficient below the threshold hints at full hysteresis. Our result is in line with the findings reported in section 2.1, explaining the differential response to inflation through the presence of nominal downward wage rigidity. In turn, the degree of nominal downward wage rigidity is related to the existing labour market institutions: Holden and Wulfsberg (2007) find that downward nominal wage rigidity is larger in countries with higher union density and better labour protection, as workers whose wage is set by unions have better protection against a nominal wage cut. Employment protection legislation is key to protecting non-unionized workers from wage cuts (Holden and Wulfsberg 2007).

Concerning the response to productivity, the results do not reveal significant differences between the two regimes.

4.6. Poolability

Poolability is an important consideration in any panel strategy. In our paper poolability is tested by applying the Roy-Zellner-Baltagi (RZB) test (Baltagi, 2008), in combination with the modified critical values reported by Bun (2004)[12]. All tests are performed with respect to several groups of variables similarly to Arpaia and Pichelmann (2007): for unemployment only, productivity only; unemployment and productivity jointly and then jointly for all exogenous slopes, without the intercepts (see Table 4). In the baseline specification (Specification 3.1 in Table 3), although poolability is not rejected by the less restrictive threshold value for dynamic panels with non-spherical disturbances, it is rejected by the stricter version which also takes into account serial correlation.

Table 4. Poolability results

Poolability - null hypothesis	Test statistic
H0: All exog. slopes are poolable	3.99
H0: URX and PVA slopes are poolable	3.58
H0: URX is poolable	3.44
H0: PVA is poolable	3.42
5% critical values by Bun	
Dynamic panel, non-spheric disturbances	2.6
Dynamic panel, non-spheric disturbances, serial correlation	5.4

Note: The unrestricted model used for calculation of test statistics is with varying slopes of the unemployment (URX), productivity (PVA), inflation (HICP) and NEER variables.

An issue to which we return after having considered all specifications is how the poolability test results change after controlling for heterogeneity across different groups. In most specifications, except the one including labour market institutions, the poolability test statistics point at modest improvements and the results are rather similar to the baseline specification. The specification with labour market institutions however marks a very substantial improvement: the test statistics is very close to the stringent threshold value, which takes into account the dynamic panel, heteroskedasticity and serial correlation. The poolability test statistic provides a value of 2.62, comparable with Bun's threshold value of 2.60 in Table 1. We can conclude that for this specific sample, labour market institutions capture a substantial part of individual country heterogeneity.

[12] Bun (2004) has demonstrated that the asymptotic RZB test statistics are biased for finite samples of macroeconomic panels with relatively large T as compared to N and the non-corrected asymptotic test would tend to always reject the null, especially in dynamic panels and with serial correlation.

4.7. Robustness across time

Our robustness check suggests that the patterns of adjustment of wage growth to unemployment and productivity remain very similar if we consider a shorter sample. In order to investigate the degree of homogeneity of the estimated coefficients over time, all regressions from Table 3 (with exception of the institutional specification), are re-estimated with a shorter sample starting in q1 2000 (Table 5). In general, the results are similar (i.e. with respect to the sign, significance and size of coefficients), however there are several slight differences between the two samples.

Table 5. Panel estimations with sample starting 2000

Variables	5.1	5.1a	5.2		5.3		5.4	
Constant	0.007***	0.007***	0.006***		0.006***		0.007***	
	(0.001)	(0.001)	(0.001)		(0.001)		(0.001)	
HIC	0.364***	0.380***	0.347***		0.346***		0.348***	
	(0.083)	(0.092)	(0.086)		(0.083)		(0.091)	
HIC(-1)	0.11	0.051	0.093		0.132*		0.111	
	(0.087)	(0.098)	(0.092)		(0.084)		(0.091)	
HIC(-2)	-0.061	-0.148**	-0.003		-0.061		-0.009	
	(0.080)	(0.089)	(0.083)		(0.076)		(0.082)	
NEER (-1)	-0.065**	-0.078**	-0.066**		-0.064**		-0.048***	
	(0.029)	(0.034)	(0.031)		(0.028)		(0.032)	
NEER (-2)	0.017**	0.034	0.017		0.014**		0.022	
	(0.032)	(0.036)	(0.033)		(0.030)		(0.033)	
WAGE (-1)	0.123***	0.133***	0.127***		0.115***		0.159***	
	(0.036)	(0.040)	(0.036)		(0.037)		(0.039)	
WAGE (-2)	0.217***	0.196***	0.220***		0.195***		0.203***	
	(0.037)	(0.039)	(0.037)		(0.038)		(0.038)	
ECT (-1)	-0.043***	-0.040***	-0.045***		-0.045***		-0.048***	
	(0.001)	(0.006)	(0.006)		(0.004)		(0.006)	
Unemployment			*U above NAIRU*	*U below NAIRU*	*CEE*	*non-CEE*	*high infl.*	*low infl.*
URXC	-0.005***	-0.006***	-0.006***	-0.004***	-0.004**	-0.006***	-0.006***	-0.003***
	(0.001)	(0.001)	(0.002)	(0.001)	(0.002)	(0.002)	(0.001)	(0.001)
URXC(-1)	0.003**	0.004**	0.003**	0.003	0	0.004***	0	0.001
	(0.001)	(0.002)	(0.001)	(0.002)	(0.002)	(0.001)	(0.001)	(0.001)
URXC(-2)	0.001	0.001	0.001	0.001	0	0.001	0.003**	0.002***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)	(0.001)	(0.001)	(0.001)
Productivity								
PVA (-1)	0.111***	0.087**	0.169***	0.076	0.222***	0.081**	0.156**	0.115***
	(0.036)	(0.042)	(0.056)	(0.048)	(0.075)	(0.039)	(0.073)	(0.042)
PVA (-2)	0.016	0	-0.005	0.083	0.168**	-0.086	-0.054	-0.005
	(0.036)	(0.042)	(0.045)	(0.063)	(0.064)	(0.049)	(0.075)	(0.042)
Expected inflation		0.001***						
		(0.000)						
Countryf ixed effects	yes	yes	yes		yes		yes	
R-squared	0.43	0.42	0.44		0.45		0.44	
Adj. R-squared	0.41	0.40	0.41		0.42		0.41	
No. observations	791	686	791		791		773	

One, two and three asterisks denote significance correspondingly at the 10%, 5% and 1% levels. Standard errors are in parentheses.
The estimation method is fixed effect panel FGLS.

The major difference is that with the shorter sample, the determinants considered explain a larger part of the variation in wage growth (the R-squared is higher). Second, the adjustment appears to happen faster: the effect which was earlier spread over two quarters now is captured within one quarter and the second lags are rarely significant – this applies to unemployment, productivity, exchange rate and inflation. The higher coefficient of the error correction term (which almost doubled in most cases) also indicates a faster adjustment towards long-term equilibrium. Finally, in the specification with business cycle heterogeneity, the response of wages to unemployment appears to be more equal across regimes – the differences in the unemployment coefficients are no longer significant.

5. Conclusions

The key objective of our paper was to measure the degree of real wage flexibility in EU countries and to determine how it varies depending on country characteristics such as labour market institution.

Our baseline specification finds evidence of a negative and significant response of wage growth to contemporary cyclical unemployment. However, we also find that part of the initial wage response is reversed in a few quarters due to hysteresis effects. Turning to an alternative indicator of real wage flexibility, some evidence of flexibility has also been detected with respect to productivity growth.

One of our alternative specifications reveals a differential response of wages to unemployment across the cycle, which is a result largely in line with the literature. When unemployment is below NAIRU (i.e. during an upswing in the business cycle), the persistence term is not significant and real wage flexibility is relatively high. In contrast, if unemployment is above NAIRU (i.e. during a downturn when real wage flexibility is the most needed) there is a clear hysteresis effect, which eliminates in two quarters most of the initial response of real wages to unemployment.

Real wage flexibility appears to be somewhat higher in the CEE countries than in the euro area both with respect to unemployment and to productivity. This difference is likely related to differences in labour market institutions.

Looking in more detail at the role of institutional differences on real wage flexibility we apply the hierarchical cluster analysis of Du Caju et al. (2008) distinguishing three broad types of countries with respect to labour market institutions: broadly regulated, regulated and deregulated. With respect to unemployment, the least flexible group is the middle one with "broadly regulated" labour markets, since the immediate reversal of the initial response with equal coefficient points at substantial hysteresis effects. The regulated group also exhibits a hysteresis

effect, although it does not eliminate all of the wage response. The deregulated economies seem to exhibit the largest degree of real wage flexibility. The similarity between the regulated and deregulated groups, which are both more flexible than the middle group, is in line with the Calmfors-Driffill hypothesis which postulates a hump-shaped relationship between the level of coordination in the wage negotiations and the degree of real wage moderation. The picture is somewhat different as regards the response of real wages to productivity growth. The response to productivity is clearly largest in the deregulated group, where company level bargaining is dominant. The second largest impact is in the middle, broadly regulated group with a substantially lower coefficient.

Finally our panel data analysis reveals that an inflation threshold may exist, below which low inflation may decrease real wage flexibility. The differential response of real wage flexibility to inflation seems to confirm the evidence on the presence of nominal downward wage rigidity in the EU countries.

Overall our results suggest that labour market adjustment mechanisms in the EU countries might be impaired in particular in downturns and during low inflation periods. This implies that in the euro area countries and also in those CEE countries outside the euro area that successfully enter a low inflation period in their convergence process have to pay particular attention that their policies do not hamper real wage flexibility (e.g. by avoiding excessive minimum wage or public sector pay increases). As regards the role of wage bargaining institutions, our results do not suggest that the way to go forward is necessarily to move towards decentralisation.

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Appendix A: Data definitions and sources

Wage growth (dl_WAGE) is calculated as logarithmic quarter-on-quarter difference of the seasonally adjusted nominal average wage for the total economy. The raw data for this indicator is taken from ESA. Wages in national currency are converted to euro using the monthly average of the bilateral exchange rate.

Inflation (dl_HIC) is the logarithmic quarter-on-quarter difference of the level of the seasonally adjusted HICP index, reported by ESA.

Productivity (PVAE) is expressed as the real value added in constant 2000 prices, divided by total employment, where both series stem from ESA. Only in Greece, the nominal value added is divided by the HICP index in order to obtain a real figure, due to a lack of a suitable real value added series. Productivity is seasonally adjusted and converted into euro using the value of the exchange rate in January 2000. **Productivity growth** (dl_PVAE) is obtained as the quarter-on-quarter logarithmic change of the productivity series. **Trend productivity**, which is used in the cointegrating relationship, is obtained by applying Hodrick-Prescott filter to the productivity series.

For **cyclical unemployment (URXC)**, we use as a basis the unemployment rate, but from slightly different sources for CEE countries and the euro area. For CEE countries we follow the LFS definition and obtain the unemployment rate through dividing the LFS number of unemployed persons aged 15 and above by the LFS economically active population in the same age range. For some countries (Czech Republic, Poland, Slovakia, Lithuania) the series are extended backwards with earlier data from the ILO Laborsta database, which also follows the LFS definition. For the euro area, we use the standardized unemployment rate from the ESA short-run statistics database, as for these countries the LFS unemployment rate is rarely available at quarterly frequency before 2000. Unemployment is seasonally adjusted and used in levels. For cyclical unemployment, an estimate for NAIRU is constructed through applying a Hodrick – Prescott filter to the original unemployment series, which is then subtracted from the unemployment series.

Expected inflation (exp_infl) is calculated using a quantification of the EC surveys on inflation perceptions and expectations. The theoretical basis for this quantification is the methodology developed by Forsells and Kenny (2002) for the euro area. As input data, it uses the series of responses to the questions regarding perceived inflation the last 12 months and

expected price developments over the next 12 months. The survey data is available for all countries except Germany and Bulgaria, but for some countries the series is rather short (for Lithuania, Poland and Romania, the data only starts in 2001).

Nominal effective exchange rate (NEER) is taken from Haver Analytics and the national banks of the countries.

Table A1. Data availability: Start dates of the main time series for EU countries

Country	URX	PVA	HICP	WAGE	Exp. Infl
Bulgaria	q1 2000	q1 2000	q4 1996	q3 1999	-
Czech republic	q1 1994	q1 1995	q1 1995	q1 1995	q1 1995
Estonia	q1 1997	q1 1993	q1 1995	q3 1993	q2 1993
Latvia	q2 1996	q1 1993	q1 1995	q1 1995	q1 1993
Lithuania	q1 1998	q1 1995	q1 1995	q1 1995	q2 2001
Hungary	q1 1995	q1 1995	q1 1996	q1 1993	q1 1993
Poland	q1 1994	q1 1995	q1 1996	q1 1995	q2 2001
Romania	q1 1996	q1 1998	q1 1995	q1 1993	q2 2001
Slovenia	q1 1996	q1 1995	q1 1995	q1 1993	q1 1996
Slovakia	q1 1994	q1 1994	q1 1995	q1 1995	q2 1999
Germany	q1 1990	q1 1991	q1 1990	q1 1991	-
Spain	q1 1990	q1 1990	q1 1992	q1 1990	q1 1990
France	q1 1990	q1 1990	q1 1990	q1 1990	q1 1990
Italy	q1 1998	q1 1990	q1 1990	q1 1990	q1 1990
Austria	q1 1993	q1 1995	q1 1990	q1 1990	q4 1995
Greece	q2 1998	q1 2000	q1 1990	q1 2000	q1 1990
Ireland	q2 1990	q1 1998	q1 1990	q1 1998	q1 1990
Belgium	q1 1990	q1 1995	q1 1991	q1 1995	q1 1990
Netherlands	q1 1990	q1 1990	q1 1990	q1 1995	q1 1990

Table A2. Level of collective bargaining, collective bargaining coverage and union density in the CEE countries

Country	Main level of Bargaining	Collective Bargaining coverage	Union Density
Bulgaria	Company	Very low	Very low
Czech R.	Sectoral	Low	Low
Estonia	Company	Low	Very low
Hungary	Company	Low	Very low
Latvia	Company	Very low	Very low
Lithuania	Company	Very low	
Poland	Company	Low	Very low
Romania	Company/National	-	-
Slovakia	Sectoral	Low	Very low
Slovenia	National/Sectoral	High	High

Source: Eurosystem's Wage Dynamics Network Questionnaire (2006), ECB Ocassional Paper 61. "Determinants Of Growth in the Central and Eastern European EU Member States - A Production Function approach"
Notes: The values in the dark cells refer to the year 2003, while the rest of the information refers to 2006.

Very Low: 0-25%; Low: 26-50%; Medium: 51-75%; High:76%-100%