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PROGRESS REPORT OF THE WAGE DYNAMICS NETWORK (WDN)[1]

Introduction

This progress report summarises the main preliminary findings of the Eurosystem/ESCB Wage Dynamics Network (WDN) since it started operations in July 2006. The WDN studies wage and labour cost dynamics in the euro area and has started to investigate their implications for monetary policy, with the objectives of i) identifying the sources and features of wage and labour cost dynamics that are most relevant for monetary policy and ii) clarifying the relationship between wages, labour costs and prices, both at the firm and macro-economic level. Twenty three NCBs in the European Union are currently actively participating in the research activities of the WDN. In addition, observers from the Federal Reserve Board and the Bank of Japan occasionally participate in the meetings.

Regarding the first objective mentioned above, the WDN attempts to address the following topical research questions:

1. How do wages, labour costs and their various components adjust over the business cycle and in response to various shocks? Are there sectoral and regional differences? Have the dynamics of wages and labour costs been affected by changes in the monetary policy regime (the start of EMU)?
2. How often do wages change? Are wage rigidities nominal or real, symmetric or asymmetric? Do they differ across occupations, sectors, countries or regions?

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3. What are the sources of wage and labour cost rigidity? How do they depend on goods and labour market characteristics, in particular what institutional settings are behind each type of rigidity? Have rigidities of wages and labour costs and their components been affected by structural changes in the macro environment such as the globalisation of production, labour market reforms and changes in the degree of goods market competition?

Regarding the second objective, the following questions are being addressed

4. How do changes in wages and other labour cost components at the worker's level translate into marginal costs and output and pricing decisions at the firm level?
5. How do wage and labour cost rigidities translate into price stickiness and inflation persistence?
6. What factors, such as labour market institutions, the degree of product market competition and globalisation, influence the extent and the speed with which labour costs pass through into output and prices?

To address these questions, the WDN is organised around four research groups: a macro, micro, survey and meta group. The table in Annex 1 provides a detailed list of the participants in each group. While the objectives of each group are aligned with the overall objectives of the WDN, each group follows different lines of research.

1. The macro group explores the empirical characterisation of aggregate, country and sectoral wage and labour cost dynamics in the euro area, as well as the structural analysis of their determinants and their interaction with inflation dynamics. The main focus of the macro group is to address research questions 1, 5 and 6.

2. The micro group uses micro data on wages and focuses its research on determining the nature and magnitude of possible rigidities across countries and sectors in the euro area and on the relationship between wage behaviour, labour cost and price setting at the firm level. The main focus of the micro group is to provide answers to questions 2, 3 and 4.

3. The survey group has launched an ad-hoc survey on wage and price setting behaviour at the firm level. The survey is designed to give answers to questions 2, 3, 4 and 5. This survey has provided a unique piece of information that is particularly valuable given the scarcity of comparable micro data available to researchers. It is described in more detail in Box 1.

4. The meta group has focused on summarising the overall WDN findings with the intention of drawing policy implications for the euro area

Box 1: WDN survey on wage and price setting behaviour at the firm level

A survey on wage and price setting behaviour at the firm level, developed within the WDN, was carried out by 17 national central banks (NCBs) between the end of 2007 and the first half of 2008 on the basis of a harmonised questionnaire. It has led to a unique cross-country dataset on wage and price setting, unprecedented by international standards in terms of both geographical and sector coverage. The total sample size of the dataset is about 17,000 firms. By design, this sample is relatively balanced across firm size categories within each country and its sector distribution closely follows the distribution of employment in the country. The sample size, however, varies across countries both in absolute terms and relative to the population of firms in the country, therefore individual weights have been calculated for each firm to make the sample representative of the population of firms in each country and to account for the amount of workers that the firm represents in the population. This report concentrates on 15 countries for which fully harmonized data is available (Austria, Belgium, Czech Republic, Estonia, France, Greece, Hungary, Italy, Ireland, Lithuania, the Netherlands, Poland, Portugal, Slovenia and Spain). [2] In addition and when comparable, evidence for Germany is included. The sector coverage comprises: manufacturing, trade, market services, non-market services, financial services and construction. The survey widens our understanding of wage-setting practices, the frequency of price and wage changes, and the links between wage and price rigidities. It makes available new evidence on the extent and reasons behind different types of wage rigidities. Moreover, it covers other margins of cost adjustment beyond base wages such as bonuses, flexible forms of employment, etc. Given the large institutional heterogeneity of European labour markets, this unified survey for the euro area countries is designed to widen our understanding of the effects of different labour market institutions on wage-setting practices. The survey addresses differences in firms' wage adjustments to alternative shocks. Finally, the survey contains a set of specific questions linking wage and price rigidities.

Directly surveying firms to analyse wage adjustments has several generic advantages. In particular, it allows to gather information at the firm level that otherwise would be very difficult to collect. Nevertheless, several shortcomings inherent to ad hoc surveys such as low rates of response, potential misunderstanding in interpreting the questions, etc. should be kept in mind. In addition, the survey was conducted at a particular time, which may have an influence on some of the replies.

This progress report is organised as follows. Section 1 presents some stylised facts on the labour markets. It first summarises the findings from an NCB questionnaire on wage setting and bargaining institutions in many countries of the European Union over the last decade. It compares this information with other available sources and with the relevant results from the WDN firm survey. Section 1.2 then recalls some of the stylised business cycle facts of labour markets in

[2] Data for Luxembourg are not ready yet, and unfortunately the survey questionnaire for Germany was not fully harmonised.

Europe, drawing on various macro papers on cyclicality, persistence and responses to shocks that have been written in the context of the WDN macro group. Section 1 ends with a description of (i) changes in the wage structure and wage inequality, and (ii) changes in inter-sectoral wage differentials in 9 European countries. It relates these changes to changes in worker and job characteristics on the one hand, and to macroeconomic and structural trends on the other hand.

Section 2 summarises the micro findings concerning wage changes and wage rigidities. It first discusses the frequency, timing and synchronisation of wage changes drawing on the information collected by the WDN survey and on studies on wage changes based on country-specific micro data. Section 2.2 summarises the evidence regarding downward nominal and real wage rigidity in European countries derived both from micro data following the IWFP methodology and from the WDN Survey. Section 2.3 analyses in detail how wages respond to shocks. Section 2.4 focuses on the dynamics and determinants of wages of new hires versus wages in continuing jobs. Finally, section 2.5 gives an overview of the incidence of different margins of adjustment, other than changes in base wages, used by firms to adjust labour costs.

Section 3 summarises the evidence on the interrelation between prices and wages. Section 3.1 focuses on how wages feed into prices, while section 3.2 presents the evidence on the pass through from prices to wages with a focus on indexation.

The current report contains only limited information on the macroeconomic implications of the findings discussed in sections 1 to 3, as these will be studied in the near future. Section 4 presents some macro models with explicit labour markets that will be used to investigate the macroeconomic implications of some of the micro findings. Section 4.1 introduces the basic new Keynesian model to interpret the different degrees of wage rigidities and illustrates how differences in wage stickiness and indexation affect the response of wages and inflation to certain shocks using this model. Then, section 4.2 first describes the key elements of the basic search and matching labour market model, to highlight the role of various labour market institutions and to frame the discussion of the contributions by the WDN macro group. These contributions include two survey papers (described in subsections 4.2.2 and 4.2.3) that assess the role of labor market frictions and different forms of real wage rigidity for wage and inflation dynamics, as well as a number of dynamic general equilibrium models to assess whether and to what extent the micro-level findings summarized in the previous sections translate into macroeconomic outcomes. These models address the distinction between newly hired and incumbent workers wages (subsection 4.2.4), the role of reference points or norms for wage dynamics (subsection 4.2.5), and the implications of downward nominal wage rigidity for optimal monetary policy (subsection 4.2.6).

The current report does not discuss the monetary policy implications of the findings reported. These will be studied in detail in the near future.

1. Stylized facts on wages in Europe

The WDN has undertaken a number of projects which aim at characterizing the structure and dynamics of wages and prices, providing the background for the study of wage rigidities and the linkages between wage and price setting.

1.1. Wage setting and wage bargaining institutions

Wage bargaining institutions and other wage setting institutions play an important role determining the dynamics of wages and more generally for the operation of labour markets. As we will discuss later in this report, bargaining institutions are correlated with the frequency and timing of wage changes (see Druant et al, 2008a) and the degree of downward wage rigidity (see Messina *et al* , 2008a, Du Caju *et al*., 2008a; Babecky *et al*., 2008 and Dickens *et al,* 2007). They influence the reaction of firms in the aftermath of shocks (see Bertola *et al,* 2008). They play a role in the extent to which firms use different margins of adjustment to reduce their wage bill (see Babecký *et al* 2008 and Dybczak *et al* 2008). Bargaining institutions also affect the evolution of the wage distribution and relative wages across sectors, (see Christopoulou *et al* 2008, Du Caju *et al* 2008c). More generally, there is a vast literature about the role of wage bargaining institutions in shaping labour market outcomes, wage levels, wage dispersion and wage flexibility. For a recent survey, see Freeman (2007).

Although the theoretical literature assigns an important role to wage bargaining institutions and an extensive empirical literature tries to quantify this role, the measurement of institutions remains difficult and comparable information at an international level is still limited. The most comprehensive time series of quantitative information on union density, minimum wages, and indices of union coverage, coordination and corporatism for a number of OECD countries is available from the OECD (see for example Elmeskov, Martin and Scarpetta, 1998). However these indicators provide little information on other aspects of wage setting mechanisms and very little qualitative information on how wage setting institutions are designed or how they operate. Furthermore, information for some EU countries is not available. International organisations such as the European Commission, the European Industrial Relations Observatory (EIRO) and the OECD (e.g. in their Employment Outlook 2004, 2005) provide more detailed qualitative information from ad-hoc studies of particular aspects of wage setting institutions. Often this information is, however, difficult to compare due to its non-standardised nature and the different coverage of countries, periods and institutional features. Furthermore, there is no comparable information on indexation or length of wage agreements.

Two key initiatives taken by the WDN go a long way towards resolving these problems and providing information on wage setting which does not suffer from the problems listed above.

1. WDN NCB questionnaire on national collective wage bargaining institutions

The WDN has collected information on national and sectoral collective wage bargaining institutions using a standardised questionnaire designed within the WDN and answered by national experts from 22(?) NCBs of the European Union, plus the US and Japan. The answers are consistent with and add to previously available information on wage setting institutions and to the information collected by the WDN survey (see below). The resulting dataset provides information for two points in time (1995 and 2006), four sectors of activity (agriculture, industry, market services and non-market services) and the aggregate economy of the 24 countries considered. The information collected includes institutional aspects (e.g. union density, coverage and coordination), as well as other aspects that can be related to the relative flexibility/rigidity of wages across countries, such as the average length of wage agreements and elements considered during wage negotiations. Furthermore, it considers the role of the government in the determination of private sector wages and the incidence of minimum wages and wage indexation. For details, see Du Caju *et al*. (2008b).

2. WDN firm survey on wage and price setting.[3]

This survey provides firm level information on several institutional features affecting wage setting in individual firms: the degree of centralisation and coverage of wage bargaining and indexation mechanisms. This institutional information collected by the WDN survey has the advantages inherent to firm level data (see Box 1), and is consistent with cross country information that is available at more aggregate, country and sector level.

The main WDN findings regarding wage setting institution are described below.

Union density and union coverage. There is a large heterogeneity in the degree of trade union density across countries, ranging from over 70 percent in the Nordic countries to less than 10 percent in most of the Central and Eastern European (CEE) countries, France, Spain and the US. Additionally, trade union density varies across sectors, being highest in the non-market services sector followed by the industrial sector and lowest in market services and agriculture. The level of trade union density has declined over the past decade in practically all European countries, with the

[3] The country sample differs from that of the WDN NCB questionnaire, the survey does not include US, Japan, UK, Sweden, Finland and Denmark, but in addition includes Estonia, Lithuania, and Slovenia.

exception of Ireland and Belgium. Table 1.1.1 gives details on the evidence from the WDN NCB questionnaire and compares it with other available sources of information.

Table 1.1.1. Union Density
(*percentage of employees)*

Source	WDN NCBs Questionnaire	WDN NCBs Questionnaire	OECD 2004	EIRO 2006
Reference year	1995	2006	2000	2000/2004
Austria	46	35	36.5	33
Belgium	52	57	55.6	49
Czech Republic	L	L	27	22
Denmark	89	82	74.4	80
Finland	78	69	76.2	71
France	8.2	VL	9.7	8
Germany	28.7	21.7	25	18
Greece	L	VL	na	20
Hungary	19.7	16.9	19.9	17
Ireland	27.6	45.8	na	38
Italy	L	L	34.9	34
Japan	22.7	18.1	21.5	Na
Luxemburg	51	48.1	33.6	46
Netherlands	28.4	26.8	23.2	25
Poland	33	15	14.7	17
Portugal	L	L	24.3	17
Spain	VL	VL	14.9	16
Sweden	H	H	81.1	77
United Kingdom	29	25.8	32.2	29
United States	14.9	12.5	12.8	Na

Sources: Du Caju *et al* (2008b), OECD Employment Outlook 2004, Chp.3; EIRO report "Industrial relations developments in Europe 2006".Note: 0%<VL=Very Low<25%, 26%<L=Low<50%, 51%<M=Moderate<75%, 76%<H=High<100%.

In spite of the decline of trade union density over the past decade, in Europe a large proportion of workers are still covered by some kind of collective wage agreement. According to the evidence collected by the NCB questionnaire (see Table 1.1.2), the coverage rate is between 80 and 100 percent in Austria, Belgium, France, Greece, Italy, the Netherlands, the Nordic countries, Portugal and Slovenia and has remained stable or has even slightly increased over the last decade. In contrast, coverage is low in Japan and most CEE countries (between 30 and 40 percent) and even lower in the US and Lithuania (less than 20 percent). The evidence collected by the WDN survey, summarised in column 7 of Table 1.1.2, confirms the feature of high coverage in euro area countries and much lower in non-euro-area EU countries. Coverage generally increases with firm size and is more common for high-skilled employees and full-time employees.

Furthermore, extension procedures (which make a collective bargaining agreement binding for all employees and employers within its usual field of application even if they did not sign the agreement) are widespread in Europe.

Table 1.1.2 Union Coverage
(percentage employees)

Source	WDN NCBs Questionnaire	WDN NCBs Questionnaire	W&H 2000	OECD 2004	EIRO 2006	WDN survey
Reference year	1995	2006	1996	2000	2000/2004	2006
Austria	> 95	98	na	95	98	94.5
Belgium	> 90	> 90	na	90	96	86.3
Czech Republic	L	M	na	25	35	50.2
Denmark	79	83	55	80	83	na
Finland	> 90	> 90	95	90	82	na
France	93.3	97.8	90	90	90	na
Germany	72	59	83	68	65	na
Greece	H	H	90	na	65	91
Hungary	45.1	38.5	45	30	42	17
Ireland	na	na	na	na	na	27.1
Italy	H	H	90	80	70	99.7
Japan	20.2	16.1	na	15	na	na
Luxembourg	51	48.1	na	33.6	na	na
Netherlands	81	81	80	80	81	67.6
Poland	M	L	na	40	35	17.9
Portugal	H	H	na	80	87	90.3
Spain	82.5	78.5	82	80	81	96.8
Sweden	H	H	85	90	92	na
United Kingdom	34.5	33.5	48	30	35	na
United States	16.7	13.6	na	14	na	na
Estonia	na	na	na	na	22	8.7
Lithuania	na	na	na	na	15	15.8
Slovenia	na	na	na	na	100	na

Sources: Du Caju *et al* (2008b), Waddington & Hofmann (2000), OECD Employment Outlook 2004, Chapter. 3; EIRO report "Industrial relations developments in Europe 2006", WDN survey. Note: 26%<L=Low<50%, 51%<M=Moderate<75%, 76%<H=High<100%.

Centralization of wage bargaining. The economic literature predicts that the degree of centralization in wage bargaining has an impact on economic performance. While a large empirical literature (see Aidt and Tzannatos, 2005 or Flanagan, 1999) concludes that it is difficult to find a robust relationship between the centralization of wage bargaining and economic outcomes, it has recently been argued that highly centralized wage bargaining leads to less wage dispersion. Empirical results obtained with micro data seem to support this argument (see Card and de la Rica 2006, Cardoso and Portugal 2005, Hartog *et al.* 2002). In general, agreements bargained at the firm and occupational levels are more flexible and are likely to give greater margins of manoeuvre to enable firms to react to economic circumstances.

According to the answers to the WDN NCB questionnaire, there is considerable heterogeneity across countries in the levels at which bargaining takes place. In the euro area countries sectoral level agreements are the most common and tend to dominate (i.e. cover the largest proportion of workers). Firm level agreements are also common, but not dominant. In contrast, wage bargaining systems are highly decentralized and predominantly organised at the firm level in the Czech Republic, Estonia, Hungary, Poland, Lithuania, Luxembourg, the UK and US. Sectoral or national levels of wage agreements existed in some Eastern European countries in the mid 1990s, but no longer play a significant role. WDN survey evidence (see last column of Table 1.1.3) as well as evidence from an EU commission questionnaire confirm these findings. There is no evidence of significant heterogeneity in the wage bargaining level across sectors.

Table 1.1.3: Dominant level of bargaining

Source	WDN Questionnaire	WDN Questionnaire	OECD 2004	EIRO 2006	WDN survey
Reference year	1995	2006	2000	2000-2004	2006
Austria	ind / occ	ind / occ	Ind	ind	higher
Belgium	ind	ind	Ind	firm	higher
Czech Republic	firm	firm	Firm	firm	firm
Denmark	firm / ind	firm / ind	firm / ind	ind	na
Finland	ind	central	central	cross-ind	na
France	firm / ind	firm / ind	firm / ind	firm	higher
Germany	ind / reg	ind / reg	ind	firm / ind	higher
Greece	na	na	na	na	higher
Hungary	firm	firm	firm	firm	firm
Ireland	central	central	ind / central	firm	higher
Italy	ind	ind	firm / ind	ind	higher
Japan	ind	ind	firm	na	na
Netherlands	ind	ind	ind	ind	higher
Poland	firm	firm	firm	na	firm
Portugal	ind	ind	ind / central	firm	higher
Spain	ind / reg	ind / reg	ind	ind	higher
Sweden	ind / occ	Ind / occ	ind	na	na
United Kingdom	firm	firm	firm	na	na
United States	firm	firm	firm	na	na
Estonia	na	na	na	na	firm
Lithuania	na	na	na	firm	firm
Slovenia	na	na	na	na	higher

Sources: Du Caju et al (2008b), OECD 94-97: OECD 2004: OECD Employment Outlook 2004, Chp. 3; EIRO report "Industrial relations developments in Europe 2006", WDN survey data. Ind=industry level, occ=occupation level, higher= higher than firm level.

Indexation and minimum wages. Two very important factors affecting the dynamics and rigidity of nominal wages in many European countries are the existence of indexation to inflation and minimum wages. Formal indexation based on legislative provisions for the economy as a whole is relatively rare in Europe. It,applies only to three European countries: Belgium, Cyprus and

Luxembourg. However, indexation can also be less formal, e.g. when there is no regulation covering the whole economy but the incorporation of price increases in some segments of the labour market is widely accepted. In addition, it is also possible that some types of wages are automatically indexed according to law - often minimum wages - while others are not, or that firms have specific policies that adjust wages to inflation. The information received both via the NCB questionnaire and WDN survey is highly informative in this respect. According to the WDN NCB questionnaire the following 11 countries have some form of indexation of wages to prices: Belgium, Cyprus, Estonia, Finland, France, Hungary, Italy, Slovenia, Luxembourg, Poland, Spain and the US. This information is further complemented by the WDN survey on price and wage setting that directly asked firms whether or not they have a policy that adapts changes in base wages to inflation. If so, they were asked to report whether the adjustment is automatic or not, is subject to a formal rule or not, and whether it refers to past or expected inflation. Overall, about one third of firms seem to have a policy that adapts base wages to inflation (Table 2.3.1 in section 2.3).

Minimum wages exist in most of the countries with the notable exception of Italy. In Germany minimum wages only apply to a few specific sectors. Minimum wages generally cover less than 25 percent of the workforce. The level of the minimum wage differs quite significantly – from less than 30 percent of the average wage of all employees in Spain in 2006 to more than 50 percent in Finland, France and the Netherlands.

All in all, there is still significant heterogeneity in wage setting institutions across Europe**.** Du Caju *et al* (2008b) perform a cluster analysis and identify three groups of countries using the information collected by the WDN NCB questionnaire. The first group (Austria, Denmark, France, Germany, Greece, Ireland, Italy, the Netherlands, Portugal and Sweden) mainly consists of countries with a broadly regulated system of wage bargaining, which is quite typical of Western European countries. This group is characterised by the existence of extension procedures and a high level of collective agreement coverage, a dominance of sectoral wage bargaining and the general absence of coordination. The second group (Belgium, Cyprus, Finland, Luxembourg, Slovenia and Spain) exhibits the same general wage setting characteristics as the previous group, but, in addition, some form of indexation, intersectoral agreements and the role of government are all more important. Finally, the third group (Czech Republic, Estonia, Hungary, Japan, Lithuania, Poland, the UK and the US) gathers the countries where the wage bargaining system is largely deregulated.

1.2 Dynamics of wages over the business cycle

Cyclicality of real wages

The existing empirical evidence is inconclusive regarding the cyclical behaviour of real wages. At the macroeconomic level, the available results differ according to the data and to the methods used for the analysis. In particular, results are very sensitive to the choice of the deflator used to compute real wages (see Abraham and Haltiwanger, 1995).[4] Several empirical studies from the WDN macro group examine the behaviour of real wages across the cycle, investigating robustness with respect to different methods, measures of wages and deflators, and data sources. They take into account the dynamic properties of the macroeconomic data series that are often ignored by the literature, which has mostly looked at the contemporaneous values of real wages and the cycle (see for example Otani, 1980, Sumner and Silver, 1989, Abraham and Haltiwanger, 1995, and Basu and Taylor, 1999).

Messina, Strozzi and Turunen (2008) focus on real wages in the manufacturing sector for a large sample of OECD countries and show that indeed the choice of the deflators matters for the results. They group the countries in three groups: countries with mainly pro-cyclical real wages (Germany, Japan, the UK and the US), countries with mainly counter-cyclical real wages (Ireland, Spain, Canada and New Zealand) and the rest of the OECD countries with either a-cyclical real wages or with very different patterns of cyclicality across deflators. Genre, Lamo and Perez (2008) investigate cyclicality of real wages across six economic sectors and the total economy for the euro area as a whole and five euro area countries (Germany, France, Italy, the Netherlands and Spain) using a large number of methods. They find evidence of lagged pro-cyclicality of real compensation per employee in the euro area aggregate for the whole economy as well as for manufacturing and services. The same results broadly apply to the cases of Germany and Italy. For France the evidence is mixed, depending on the sectors; the overall economy appears to be weakly procyclical. In the cases of Spain and the Netherlands wages per employee are counter-cyclical, particularly in manufacturing, which combined with a pro-cyclical wage bill suggests that cyclical adjustments in these countries occur via employment.

Regarding the behaviour of public sector wages, Lamo, Perez and Schuknecht (2007) provide robust evidence of pro-cyclicality of public wages with a one to two year lag for most of the EU countries and the euro area aggregate. In follow-up work, Lamo, Perez and Schuknecht (2008) and Lamo, Perez and Sanchez (2008), examine the linkages between public and private wages. Results

[4] Contributions of the microeconomic literature tend to favour the hypothesis of pro-cyclicality (e.g. Swanson, 2007). Microeconomic studies on real wage cyclicality succeeded in pinning down a compositional bias present at the aggregate level. See also Carneiro et al. (2008) for Portugal.

support the existence of bi-directional causality between public and private wages for the period 1980-2007 for all countries. While influences from the private sector appear to be stronger, there are direct and indirect feedback effects from public wage setting in a number of countries.

The cross-country heterogeneity in the cyclicality of real wages and inflation can be related to labour market institutions, Messina, Strozzi and Turunen (2008) find that real wages tend to be less pro-cyclical (more counter-cyclical) in countries where unions have strong bargaining power. Lamo, Perez and Schuknecht (2008) also find that institutional features of labour and product markets contain helpful information to explain the heterogeneity across countries regarding public/private wage leadership. The effect of labour market institutions on the cyclical behaviour of output and inflation has also been examined in the WDN. Rumler and Scharler (2007) explore this issue for 20 OECD countries. Highly coordinated wage bargaining systems appear to dampen inflation volatility, even though they do not have a large effect on output volatility. On the other hand, stronger unionization has a significantly positive impact on output volatility, which may be due to the resulting higher real wage rigidity in such countries.

Persistence

Venditti (2006) shows that the levels, dispersion and persistence of unit labor cost growth have fallen in the run up to the European Monetary Union. The fall in cross-country dispersion of unit labour cost growth is mainly due to an alignment of the growth in compensation per employee and by the increased co-movement in labor productivity and compensation per employee. The fall in persistence could be due to structural labor market reforms. Venditti (2006) detects three clusters of countries in the euro area in terms of unit labor cost growth. A low cost growth cluster consists of Germany and Austria, while a high cost growth one includes Spain and the Netherlands. An intermediate club consists of Italy, France, Belgium, and Finland (in spite of substantially lower inflation rates than in Italy). While this pattern is mostly explained by diverging behavior of compensation per employee dynamics, productivity growth differentials in the industrial sector seem to have played a role in the relative gain of competitiveness in Austria and the relative loss in Italy.

Wage responses to shocks

Real wage dynamics is the outcome of the interaction between nominal wage and price dynamics, which in turn are driven by a multitude of shocks hitting the economy. Therefore, to characterise wage and price dynamics, research in the WDN adopted procedures suitable to disentangle the contributions of different shocks. One approach, by Duarte and Marques (2008), uses as a starting point the Layard-Nickell framework of collective wage bargaining and monopolistic price setting to identify the responses to aggregate demand and supply shocks, and price and wage shocks. The study compares euro area dynamics with those in the United States. The main findings are that wage dynamics in both the euro area and the US are mainly driven by shocks to unemployment, i.e.

aggregate demand shocks. In contrast, productivity improvements play a more prominent role in the US, while the euro area is to a much larger extent affected by import price shocks. This reflects the higher openness of the euro area. The same is true for price dynamics. Furthermore, the growth of real and nominal wages as well as price inflation are more persistent in the euro area than in the US following unemployment and technology shocks. Overall, this points to a lower degree of flexibility in European economies. This is also borne out by a comparison of the long-run estimate of the semi-elasticity of wages with respect to unemployment in the euro area (0.15), which is about half that in the United States.

In a related country study, Marques (2008) uses the above mentioned methodology to analyse wage and price dynamics in Portugal. Both real wages and wage inflation are particularly persistent after import price shocks. Most variation in wages is due to unemployment (demand) shocks, while inflation is mainly driven by import price shocks. Productivity improvements play only a minor role. Papageorghiou (2008) sheds light on the role of wage indexation by estimating a wage-price equation for Cyprus, a country where indexation is automatic and occurs twice a year. The main result of the study is the inability to detect in the specific sample period any inflationary spiral (second or higher round effects) between wages and prices despite the automatic price indexation.

Another approach, taken by McCallum and Smets (2008), focuses on the response of labor markets to monetary policy shocks. McCallum and Smets use the FAVAR methodology (see Bernanke et al. 2005) to identify monetary policy shocks and trace their effects on euro area-wide labor market variables. They find that, on average, a monetary policy tightening leads to a significant fall in real wages per employee, as nominal wages fall much more quickly than prices. In contrast, employment falls only gradually, and hours worked per employee do not respond very much. There is considerable heterogeneity across euro-area countries in the response to monetary shocks. In the full sample from 1987 to 2005, Finland, Spain and Italy exhibit strong real wage declines, while real wages weakly rise in Belgium, France, Germany and the Netherlands, after a monetary contraction. Beginning with the early 1990s, real wages fall by more, but the cross-country differences are less pronounced. One possible explanation is that labor market reforms and monetary unification have led to a more similar pattern in wage responses across the euro area. Finally, responses in the industrial sector are strong and significantly negative, while in the other sectors including services and construction, the responses to monetary shocks are muted and gradual.

Babetský (2007) examines the extent to which aggregate wages can accommodate shocks in the new EU member states and provides some macroeconomic indicators of wage flexibility. Overall, this study does not find support for the argument that the degree of wage adjustment is significantly higher for countries which already participate in the ERM-II.

The response of wages to shocks is further analysed in section 2.3, where results from the WDN survey are reported.

1.3. Wage structure

In many OECD countries, particularly in the US and UK, the wage distribution has been widening since the 1980s. This fact has triggered an open debate about the nature, causes and timing of increasing wage inequality. Some authors claim that the widening of the US wage distribution was an one-time event associated with changes in labour market institutions (de-unionisation, changes in the minimum wages) and compositional effects (changes in labour force features), while others claim that it has continued throughout the 1990s and 2000s and was due to skill-biased technological change.[5] Regarding Europe, the conventional wisdom is that changes in the wage structure have been less marked than in the US (with the exception perhaps of the UK), and that the lack of wage flexibility and some labour market institutions have resulted in wage compression, which is in turn responsible of the increase in unemployment among unskilled workers in the 1980s and early 1990s (Krugman, 1994). More recently some empirical studies have documented changes in the wage structure of some European countries that seem similar to those observed in the US but happening a few years later (see for example, Dustmann (2008) on Germany)

Despite the growing empirical literature on wage structure, there is no systematic accounting of cross-country differences in changes in the structure of wages in EU countries over the past decade. The WDN has contributed to filling this gap. Christopoulou, Jimeno and Lamo (2008) systematically examine cross-country differences in changes in the structure of wages in nine EU countries (Austria, Belgium, Germany, Spain, Greece, Hungary, Ireland, Italy and the Netherlands) over the period 1995 to 2002.[6] In addition a number of detailed country-specific projects are ongoing work within the WDN (Pointner and Stiglbauer (2008) for Austria, Dybczak and Galuscak (2008) for the Czech Republic, and Christopoulou and Kosma (2008) for Greece). These studies examine how real wages have changed during the sample period at different points along the wage distribution and disentangle the part of the observed changes in wages that are attributable to changes in the labour force and/or job characteristics (compositional effects) from those due to changes in the returns to these characteristics (the so-called return effects). Then they analyse the relationship between the changes in wages, both observed and cleaned from compositional effects, with institutions and recent macroeconomic and structural trends (such as technological change, globalisation and demographic trends such as immigration and population ageing). The period of

[5] For evidence on the first view see Di Nardo et al. (1996) and Lemieux (2006); for evidence on the second, see Autor, Katz and Kearney (2008), for the UK see for example Machin and van Reenen (1998) and their references.

[6] The sample period slightly varies depending on the country. Annex 1.3.1 contains details on the sample used for each country and a brief description of the Structure of Earning Survey, which is the dataset used in the analyses.

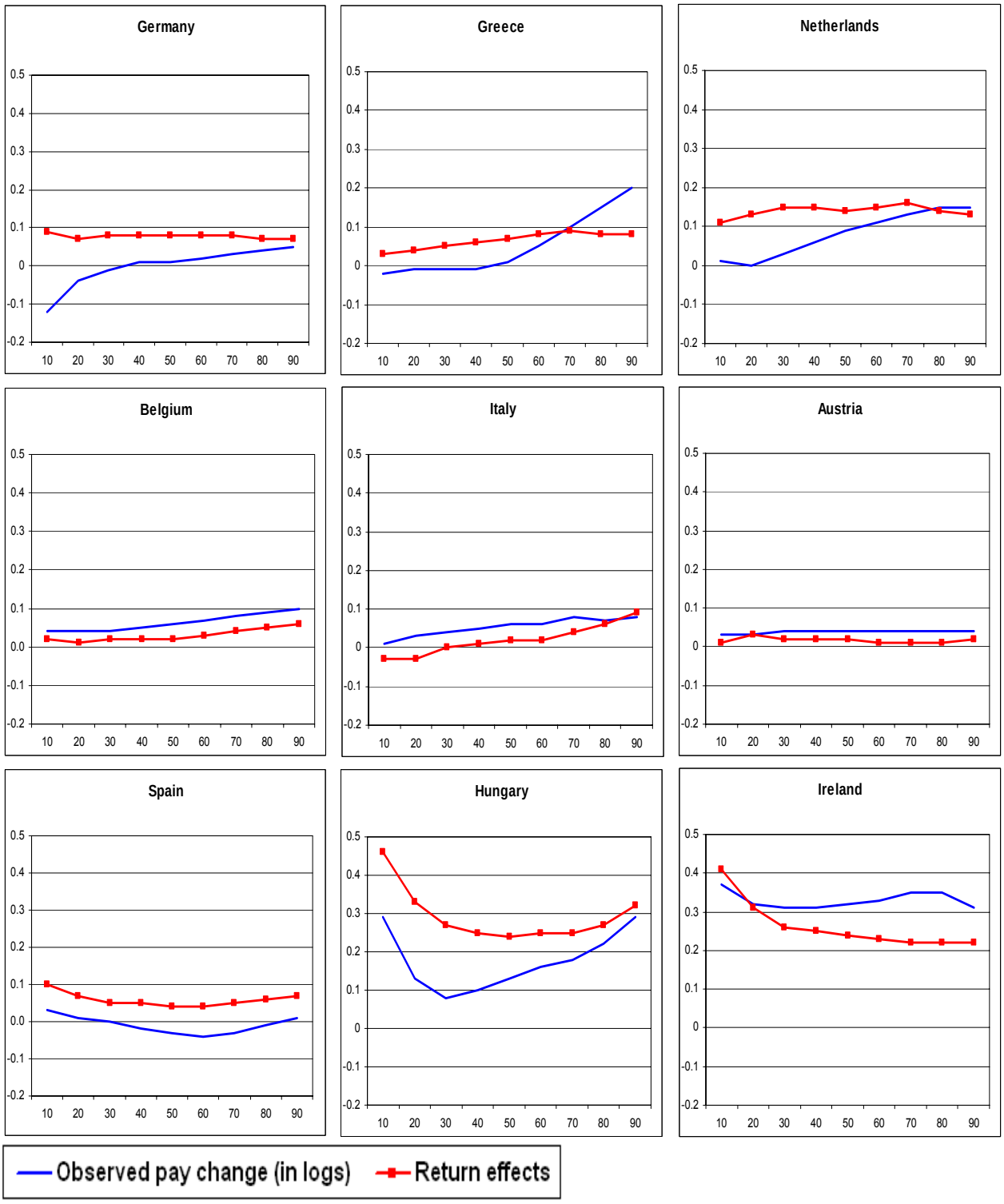
analysis, which is constrained by the availability of data, is precisely a period characterised by technological changes and economic globalization of European markets. This period was also characterised by changes in the environment in which European labour markets operate.

Real wages have increased from 1995 to 2002 along the whole range of wage levels in the nine countries for which the WDN has data available, with the only exceptions of wages of the lowest paid jobs in Germany and wages in the middle part of the wage distribution in Spain. Both the magnitude and shape of the changes observed in real wages differ substantially across countries. Figure 1.3.1 gives an overview of the magnitude and pattern of the changes observed in (log) hourly wage at each decile of the wage distribution for the whole worker population (blue line). Results are quite similar across genders.

Observed wages in the Netherlands, Germany, Greece, Italy and Belgium have increased more the higher the initial wage level, i.e. real wages changes trend upwards along the distribution, with a consequent widening of the wage distribution and an increase in wage inequality. When decomposing the observed wage changes, into the changes due to changes in characteristics of workers and jobs on the one hand (compositional effects), and changes in the returns to those characteristics on the other side (return effects), it turns out that compositional effects have been responsible for the observed widening of the distribution in the Netherlands, Germany and Greece. In fact, once these compositional effects are controlled for, wage increases are roughly constant (red dotted line) along the whole wage distribution, which therefore remains roughly unchanged in terms of dispersion. Return effects even slightly trend downwards in Germany, where composition effects fully account for the negative increase of wages at the lowest end of the distribution (low paid jobs). In Belgium and Italy the widening of the observed wage distribution is less pronounced and holds after controlling for compositional effects. In Austria wage changes from 1995 to 2002 are positive, very small and also constant along the wage distribution.

In contrast, the wage distribution in Hungary, Ireland and Spain has become more compressed, particularly when wages are purged of compositional effects. The observed increase in real wages has been lowest in the middle part of the wage distribution while the largest increases have taken place for low paid jobs. This is even more clear after controlling for composition effects. The "U shape" of the wage changes along the wage distribution has been typically identified as being driven by technological changes that replace routine jobs or jobs that require intermediate skills. This is known as the skill biased technical change hypothesis (see for example Juhn, Murphy and Pierce 1993, Goos and Manning 2003). Returns effects have been positive for all the countries of our sample, except for Italy at the lower end of the wage distribution. This result for Italy is consistent with the opening wage gap between younger new entrants and older workers in Italy as documented in Rosolia and Torrini (2008).

Figure 1.3.1: Distribution of wage changes by country



Source: Christopoulou, Jimeno and Lamo (2008). SES data.

The wage structure of EU countries seems to have responded to some extent to macroeconomic trends and institutional changes according to the regression analysis reported in Christopoulou,

Jimeno and Lamo (2008). There is some evidence in support of the technological bias hypothesis. Variables capturing technological changes, such as the change in the contribution of ICT capital to GDP growth, are positively associated with wage changes, with a larger coefficient at the top and bottom of the distribution (U shape). This holds both for the observed wage changes and for the changes in wages once the compositional effects have been controlled for. Indicators of globalisation and migration are also found to play a role in determining wage changes. Globalisation is associated with wage increases, but less so for the lowest wages. Increases in migration are associated with declines in wages. Finally, regarding the role of institutions, preliminary results suggest that there is a negative relationship between changes in union density and changes in wages and this relation is uniform across the wage distribution. Often the relationships between macro or institutional variables and wage changes differ substantially depending on whether we consider observed wage changes or changes due to returns; this confirms that composition effects may blur the identification of the driving forces of wage changes.

Wage differentials across sectors

The WDN has also examined changes in relative wages across sectors and how these sectoral wge differentials relate to recent macroeconomic trends and institutions. Cross-sectoral differences in wages of workers with identical individual features and identical working conditions is typically interpreted as a sign of non-competitive features in the labour markets, such as efficiency wages (Krueger and Summers, 1988) or rent-sharing. Changes in these differentials are usually read as changes in the degree of competition of the labour market (see, for instance, Saint-Paul, 2005, Koeniger, Leonardi and Nunziata, 2007).

Recent work on wage differentials for European countries includes several papers produced within the Pay Inequality and Economic Performance project (PIEP) which used 1995 SES data. However there is no systematic accounting of cross-country differences in changes in sectoral wage differentials over the past decade. The WDN, using two waves of the SES data (see data Annex 3), has undertaken the task of examining how relative wages across sectors have changed in the EU countries, and to what extent their evolution has been driven by observed stylised facts and macroeconomic trends such as technological changes, globalization, demographic changes, or incipient labour market reforms. Du Caju *et al* (2008c) summarise the WDN evidence on wage differentials across sectors or industries of eight EU countries (Belgium, Germany Greece, Hungary, Ireland, Italy, Netherlands and Spain) and a large number of sectors (from 30 to 48 depending of the country). In addition, a number of country specific papers examine that issue in detail for the respective countries (see for example Du Caju et al 2008d for Belgium, Nicolitsas, 2008 for Greece, and Galuscak and Pertold (in progress) for the Czech Republic).

There is evidence of wage differentials across sectors or industries in a large number of European countries. The ranking of the sectors in terms of observed wage differentials is rather similar across countries and remained broadly unaffected between 1995 and 2002, while their dispersion varies across countries. Dispersion is relatively high in Hungary, Spain and Ireland and relatively low in Belgium and Germany. Sectors paying higher wages to their employees include extraction and mining industries, chemical industries, and the utilities (electricity, gas and hot water supply). In the services sector higher wages are paid in financial and insurance activities, as well as in computer activities and research. Clothing, leather and textiles are among the worst paid industries.

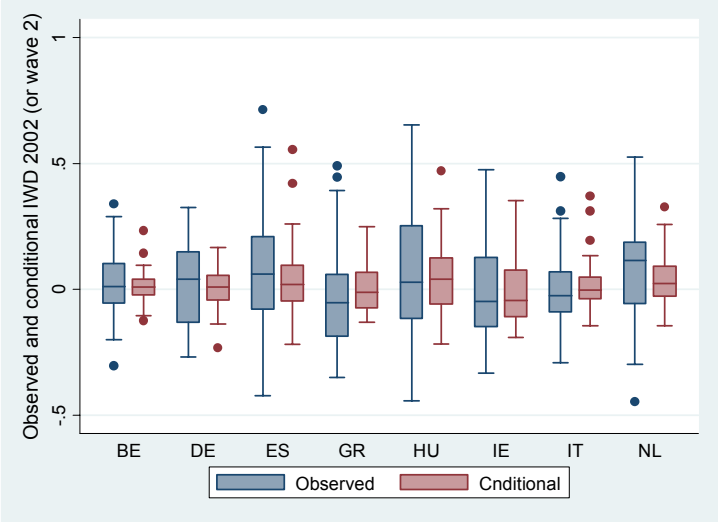
These observed differentials cannot be fully explained by a large set of observed worker, job and firm characteristics. Differentials after controlling for these characteristics are still sizable and very persistent. Furthermore, there is no evidence to support that these could be due to other unobservable worker characteristics. All in all, the evidence confirms the existence and persistence of wage differentials across similar workers, in similar jobs, but different sectors, in the eight EU countries of the sample. This can therefore be understood as evidence of non-market forces at work and leaves room for non-competitive explanations of wage setting. Figure 1.3.2 shows the distribution of the observed sectoral wage differential by country (blue) next to the distribution of the differentials estimated after controlling for observed worker, job and firm characteristics for 2002, similar picture emerges for 1995.

Du Caju *et al* (2008c) find evidence that supports rent sharing theories in the eight EU countries specified above (see Du Caju *et al* (2008d) for a more detailed study focused on Belgium).[7] There is also a negative relationship between sectoral wage differentials and several proxies for the degree of competition in the product markets. Labour market institutions also seem to play a role in explaining these differentials and their change (*on going work*).

Genre, Kohn and Momferatou (2008) also document these differentials using a panel of macro data for the euro area countries for the period 1991-2002. Even if due to the nature of the data, they are unable to control for worker, job and firm characteristics, they find that average workforce characteristics and average firm-related characteristics explain part of the differentials, but country and sector idiosyncratic factors play a major role.

[7] Other theories have not been tested yet.

Figure 1.3.2: Distribution of sectoral wage differential by country



Source: Du Caju *et al.* (2008c). SES data.

2. Nominal and real wage rigidities: the micro evidence

The degree of wage rigidity matters for the transmission of various economic shocks and monetary policy to prices. For example, the higher the degree of nominal wage rigidity, the more protracted the response of inflation and output to various macroeconomic shocks will tend to be.[8] Results from the previous Eurosystem research network, the Inflation Persistence Network (IPN), suggest that the observed price stickiness partly reflects inertial wage behaviour rather than intrinsic barriers to price adjustment (see Altissimo *et al*, 2006). Furthermore, understanding the nature and sources of wage rigidities will also help improving the specification and empirical fit of macro-economic models for policy analysis. Finally, the degree of price and wage flexibility will, among other factors, determine the speed and the cost of adjustment in the presence of emerging macro-economic imbalances. Identifying the features of rigidities will help in designing appropriate structural policies to facilitate this adjustment process.

2.1. The frequency of wage changes

The frequency of wage changes gives a clear indication of the degree of wage stickiness. It is an important parameter for macroeconomic analyses, where estimates of wage and price change frequencies can be used to calibrate price and wage stickiness in standard DSGE models with Calvo mechanisms.

Existing information on the frequency of wage changes is rather scarce and dispersed; the WDN survey provides new and unique information on the frequency of both price and wage changes at

[8] See Christiano, Eichenbaum and Evans (2005) or Smets and Wouters (2003).

the firm level. The relevant evidence from the WDN survey is presented in Druant et al. (2008). In addition, several country studies conducted in the context of the WDN add to this evidence. Heckel, Montornes, Le Bihan (2008) and Lünnemann and Wintr (2008) use micro economic datasets for France and Luxembourg respectively and Knell and Stiglbauer (2008) study collective agreement data for Austria.

A major finding from the WDN survey is that wages change relatively infrequently. The typical frequency of wage change is once per year. On average, over all countries considered, 60 percent of the 17,000 firms surveyed report that they change wages once a year; while 26 percent change wages less frequently (see table 2.1.1). The survey shows that firms change prices more frequently: only 40 percent of firms report that they change prices once a year and 7.4 percent that they change less frequently. As a result, the average duration of wages (about 15 months)[9] is longer than the average duration of prices (about 9.5 months). These estimates are in line with other estimates obtained from consumer and producer price micro data by the IPN (Dhyne et al, 2006, Vermeulen et al. 2005). They are also consist with estimates of average contract length in collective wage agreements (of between one and 1.5 years), although the latter may be an upper bound.

The degree of cross-country heterogeneity is substantial. The percentage of firms responding that they change wages "more frequently than once a year" ranges from 2.6 percent in Hungary and 4.2 percent in Italy to 33.9 percent in Greece and 42.1 percent in Lithuania. In spite of the cross country heterogeneity results do not show significant difference in the frequency of wage changes between firms in euro-area and non-euro area EU countries as a group

Table 2.1.1 Frequency of wage change (WDN survey)

	More frequently than once a year	Yearly	Less frequently than once a year	Never/don't know
Total	**12.1**	**59.3**	**25.8**	**2.8**
Euro area	**11.4**	**59.2**	**26.7**	**2.7**
Austria	6.8	84.2	5.9	3.1
Belgium	22.0	64.8	9.8	3.4
France	19.7	74.1	5.2	1.1
Greece[1]	33.9	56.4	9.7	0.0
Ireland	9.2	71.8	12.9	6.1
Italy	4.2	26.9	64.6	4.3
Netherlands	11.1	69.9	16.9	2.1
Portugal	5.9	82.2	8.4	3.5
Slovenia	27.2	65.6	5.9	1.3
Spain	11.9	84.1	2.5	1.5
Non-Euro area	**14.0**	**59.5**	**23.2**	**3.3**
Czech Republic	11.5	64.1	23.0	1.4
Estonia	19.9	64.4	10.5	5.2

[9] Given the data has been collected in the form of a discrete distribution over several ranges of frequencies some technical assumptions are required to estimate these durations, see Druant *et al* (2008a).

Hungary	2.6	75.0	12.2	10.2
Lithuania	42.1	44.0	7.5	6.4
Poland	13.6	56.3	28.2	1.9

Source: Druant et al. (2008a) Notes: percentage of firms changing wages at each frequency. Figures weighted by employment weight, rescaled excluding non-responses. 1 The split up between frequencies of wage changes has to be interpreted differently for Greece, as the options never/don't know were not allowed in the Greek questionnaire.

The country differences in wage change frequencies are larger than that of price change frequencies, while the degree of cross-sector heterogeneity in the frequency of wage changes is limited, compared to that of price change frequencies. This is consistent with the findings in Druant *et al* (2008) that product market characteristics such as the degree of competition and the labour share are significant determinants of differences in price change frequencies, whereas institutional factors such as wage bargaining institutions and wage indexation influence wage change frequencies. In particular, indexation is found to induce more frequent wage changes. Indeed when asking firms about the frequency of wage changes due to inflation, tenure or other sources, it is remarkable that inflation stands out as the most important factor triggering frequent wage adjustment (on an annual or infra annual basis), while the frequency of wage changes due to tenure is the lowest (see Figure 2.1.1). Regarding the influence of bargaining institutions, an extreme example could be Italy where wage negotiations are conducted mainly at the national level and in that context wages are changed only every 2 years.

Figure 2.1.1: Frequency of wage changes
(*percentages*)

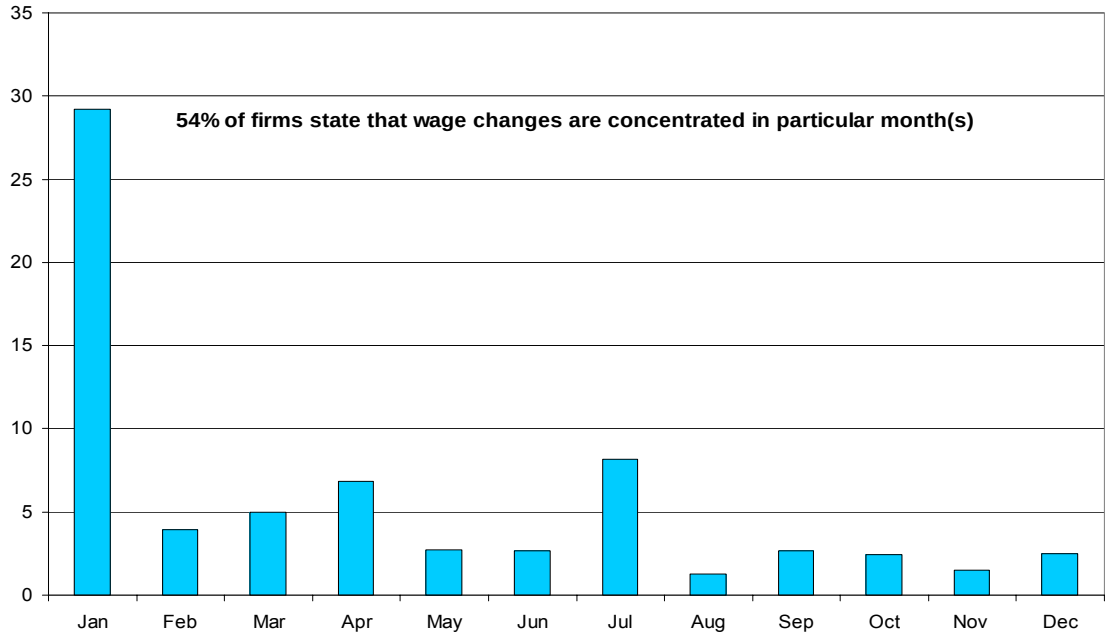
Druant et al. (2008a), Weighted figures (weights based on employment), rescaled excluding non-responses. Germany not included in the calculations.

Finally, larger firms do change wages more often than small firms. This result holds even when the sector is controlled for.

Related to the frequency of wage change is *the timing of wage changes*. Both the WDN survey results and available micro data suggest that there are regular patterns in the timing of wage changes. Indeed, 55 percent of the surveyed firms report that wage changes are concentrated in a specific month. Among the firms that declare such a "time-dependent" wage-setting pattern, wage changes are concentrated mostly in the month of January (see Figure 2.1.2). Overall, about 30 percent of wages are changed in a systematic fashion in January, although in the case of France an important proportion of wage changes concentrates in July. The prominent role of January in wage changes is obtained in every country. However, the percentage of firms reporting using a time-dependent wage-setting rule, as well as the degree of staggering within the year, is subject to substantial cross-country variations. In general, time dependence is much less important in non-euro-area countries, probably due to the much lower incidence of collective bargaining.

Figure 2.1.2: Timing of wage changes

Percentage of firms that change wages in particular month(s)



Source: Druant et al. (2008a). Note: weighted figures, weights based on employment, rescaled excluding non-responses. Germany not included in the calculations.

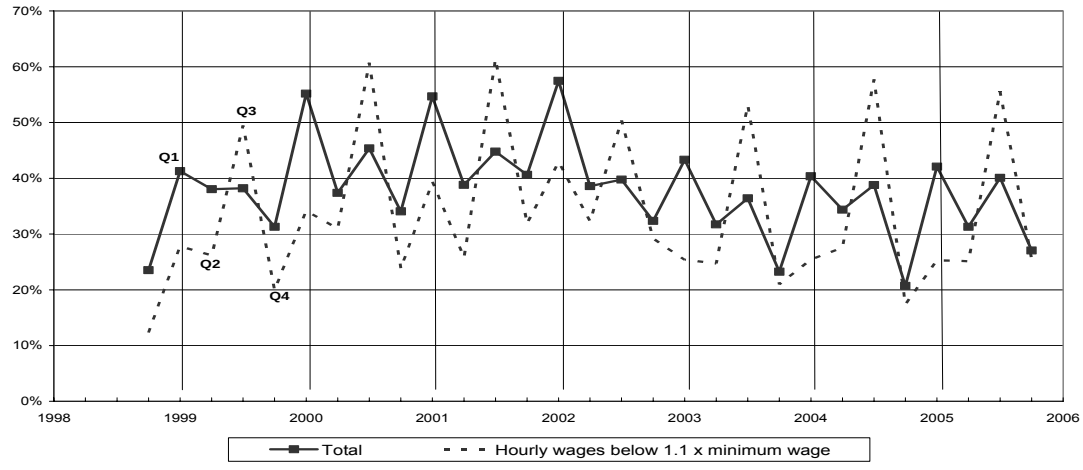
Overall, the timing of wage changes is characterized by a mix of staggering and synchronization. At any given month, there are wage changes observed, but there is a peak in wage adjustment at the beginning of every year.

The broad patterns of the frequency and timing of wage change are confirmed by analysis of micro economic wage data available at an infra-annual level, as well as the analysis of collective agreement data that have been carried out in the context of the WDN for some countries. The

distinctive advantage of these alternative data sources is that they cover a long time period and may overcome some of the limitations implied by the cross-sectional nature of the data of the WDN survey.

The peak in the frequency of wage changes in the beginning of each year consistently emerges from all micro data studies. Using quarterly data from collective agreements in Austria over the period 1980 to 2006, Knell and Stiglbauer (2008) report that on average, 46 percent of wage agreements are signed in the first quarter of the year. Heckel *et al.* (2008) report the quarterly time series of the frequency of wage change in France over the period 1998-2005 (see Figure 2.1.2). There is a peak in the first quarter, all over the sample period. The second peak in the third quarter that is related to the indexation mechanism of the minimum wage, which is updated on the first of July, and is more clearly observed for low-wage workers. These studies all consistently report a mix of wage staggering and synchronisation (in the first quarter) though the extent of staggering varies across countries. Based on an administrative monthly data set, Lünnemann and Wintr (2008) report that, 75 percent of the overall wage changes in a typical year in Luxembourg take place in months with wage indexation and in January. On average, more than 25 percent of all wage changes occur in January, reflecting the predominant share of collective wage agreements entering into force in this month. This suggests that the frequency of wage adjustment in Luxemboug may overstate the true degree of wage flexibility at the discretion of the firms.
The estimate of the frequency of wage change and duration of wage spells with quantitative micro data varies across country studies, but remains in line with the survey evidence.

Figure 2.1.3: Frequency of base wage changes (France)
Percentage of wage earners that change base wages each quarter



Source: Heckel *et al.* (2008). Data from ACEMO survey.

Also confirming survey evidence, Heckel et al. (2008) and Lünnemann and Wintr (2008) report that heterogeneity across firm size is significant: other things being equal: larger firms do change wages more often than small firms. The heterogeneity across firm sizes seems to be more important than heterogeneity across sectors, potentially reflecting more complex wage policies in large firms. For instance, Heckel *et al* (2008) suggest that in large firms, wage increases are split into two or more smaller increases, giving rise to predetermined wage changes. It is also possible that large firms have a separate timing for wage changes due to tenure and for general wage changes.

Evidence from micro studies on the role of inflation in triggering more frequent wage change is mixed. Heckel *et al.* (2008) find a low role for elapsed inflation in explaining the probability of a wage change. The study relates to a period of low and stable inflation. Focussing on Hungary, Katay (2008) reports that the average number of wage changes was 1.2 in 2000 and indicates that "the second wage change has almost entirely disappeared since then". This structural change could be related to the decline in inflation in Hungary in the first part of the decade.

2.2 Downward wage rigidity

The debate about the implications that downward wage rigidity might have for the choice of the optimal rate of inflation has become topical in the current period of moderate levels of inflation in the euro area.[10] This has triggered a growing body of empirical literature looking at whether wages are in fact subject to downward wage rigidity. Recent studies using micro data have focused on the distributions of wage changes across individual workers (Dickens et al, 2007) or sectors (Holden and Wulfsberg (2007)) to estimate downward wage rigidity. Following the pioneering work of Blinder and Choi (1990), another branch of the empirical literature relies on survey evidence to determine the prevalence and sources of downward wage rigidity.

In view of the potential importance of this topic, the WDN devoted considerable efforts to identifying and measuring the extent of downward wage rigidity (DWR) in European countries. In line with the existing literature, two types of downward rigidity were considered. First, downward nominal wage rigidity (DNWR) relates to the inability of firms to implement (and, correspondingly, the reluctance of workers to accept) reductions in nominal wage rates. Second, downward real wage rigidity (DRWR) similarly reflects the inability of firms to increase wages at rates below the prevailing rate of inflation.[11] In measuring DWR, two approaches were followed by the WDN. The first uses micro data on the wage changes of individual workers (either from surveys or

[10] The debate goes back to the old question of whether inflation can "grease" the wheels of economy. Tobin (1972) argued that if central bankers aim at too low inflation rates they might hamper the functioning of labour markets as it will be difficult to cut wages while higher inflation would allow easier wage adjustments and "grease the wheels of the economy".

[11] Obviously, the case of zero inflation – a phenomenon not actually observed in the countries considered during the relevant period – the two concepts become indistinguishable.

administrative data) and estimates rigidities using the methodology pioneered in the International Wage Flexibility Project (IWFP) (see Dickens *et al,* 2007 for a summary). While the original IWFP work provided a comprehensive cross-country study of the incidence of wage rigidities, the coverage of European countries was incomplete and, in the case of some countries, the samples were very outdated,[12] implying that the results may not be representative of the current situation characterised by low and stable inflation. For this reason, it was deemed useful to extend and update the IWFP analysis (see Messina *et al* 2008).[13] The second approach looks at DWR from the point of view of the firms using their responses to the questions in the WDN survey on wage setting (see Babecký *et al* 2008). Going beyond the measurement issue, research within the WDN also explored the factors which explain the incidence of downward rigidities and the reasons for differences across countries.

.

IWFP methodology

The essence of the IWFP methodology is a comparison of the actual wage change distribution with a notional wage change distribution which is assumed to prevail in the absence of DWR. For each country, histograms of wage changes are constructed based on the individual micro data. In order to correct for measurement error, a methodology described at length in Dickens and Goette (2005) is adopted in order to guarantee, to the extent possible, the comparability of results across countries and data sources.

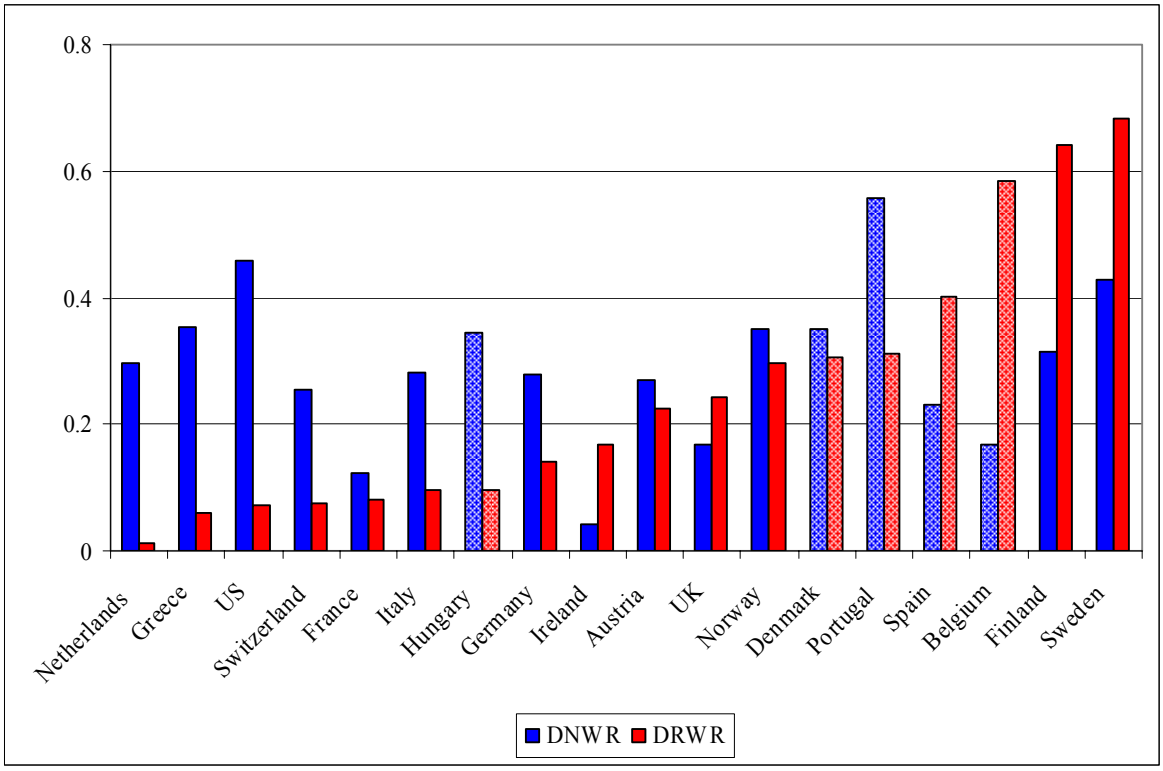
DWR is assumed to distort the wage change distribution. In the case of DNWR, there will be a bunching of wage changes at zero and a relative lack of mass at negative wage changes, both reflecting the absence of cuts in nominal wages. In the case of DRWR, a bunching of wage changes in the vicinity of the inflation rate together with a lack of mass below the inflation rate is expected, reflecting the lack of real wage cuts.

The main results of the IWFP analysis can be summarised by two indicators which measure the fractions of workers who are potentially subject to, respectively, downward nominal and downward real rigidity (see Annex 4 for details of the computation of these measures). These are shown in Figure 2.2 1 for a number of European countries (with the US as a comparator).

[12] In the case of Belgium, for example, the IWFP sample related to the period 1978-1985.

[13] In the context of the WDN, new results using the IWFP methodology were produced for Belgium (Du Caju et al 2007), Hungary (Katay 2008), Spain (Izquierdo 2008, *ongoing work*)

Figure 2.2.1 Downward nominal and real wage rigidity across countries.
IWFP Methodology .(*Fraction of workers*)



Source: the figures for Belgium, Denmark, Portugal and Spain are from (Messina *et al* 2008), figures for Hungary are from Katay (2008b) the rest are IWFP figures from Dickens *et al* (2007). The measures from Dickens *et al* (2007) and the rest are not strictly the same kind of measure. Those from Dickens *et al* (2007) are simple measures from empirical distributions while those from the WDN papers have been corrected for measurement error.

These results show that there are marked differences across countries regarding the incidence of DWR. DNWR appears to be particularly prevalent in the US. For European countries the situation is more mixed. DNWR appears to predominate strongly in Germany, Greece, Italy, the Netherlands and Portugal while being somewhat more important than DRWR in France, Austria, and Norway. Elsewhere real rigidities appear to be more prominent, and are particularly strong in Spain, Belgium and Sweden and Finland. Possible reasons for these cross country differences will be discussed below.

A major original contribution of the WDN to the analysis using the IWFP methodology was to go beyond cross-country comparisons and to examine the extent to which there are differences in DWR along other dimensions, such as across sectors and worker types. Messina et al (2008) computed separate sectoral measures of downward wage rigidity based on the IWFP methodology for four countries (Belgium, Denmark, Portugal and Spain). They find statistically significant differences across sectors in the pattern of DWR but, nonetheless, national factors are found to be the dominant factor. Looking at the specific case of Belgium, Du Caju *et al* (2007 and 2008a) computed DRWR measures by sector and by worker types (blue or white collar, age, sex). They find notable differences across sectors (for example, DWR affects 80 percent of workers in

construction but only 35 percent in transport and storage). They find that white collar workers are more affected by DRWR, in line with efficiency wage theories, while DWR decreases with age but is broadly similar for males and females; and that DRWR decreases in larger firms and in firms experiencing downturns in Belgium.

WDN Survey

Evidence on the incidence of DWR based on the WDN firm survey is presented in Babecký *et al.* (2008). DNWR is measured by the percentage of firms that have frozen base wages over the last 5 years. The WDN survey does not include a measure which directly captures DRWR. However, it is reasonable to expect that this will be closely correlated with the extent to which wages set by the firm are strongly linked to inflation and this is confirmed by empirical evidence comparing the survey and the IWFP measures of DRWR. Thus Babecký *et al*. (2008) use as a proxy for RWR the percentage of firms for which there is an automatic link between wages and past or expected inflation.

A first key finding from the WDN survey is that the prevalence of nominal wage cuts among European firms, with the exception of Germany, is extremely rare. [14] Excluding the German data, only 3.4 percent of firms declared that wages were ever cut during the previous five years. Prima facie, this is strongly suggestive of DWR in Europe.

Turning to the specific measures of DWR, Table 2.2.1 shows that real wage rigidity (as defined above) is much more prevalent among the surveyed firms (16.8 percent of firms are affected) than DNWR (only 9.6 percent of firms are affected), which is consistent with the IWFP evidence cited above. There are sizeable differences between the EU countries and there is a high correlation across countries between the survey based and IWFP measures. Overall, non euro area countries in the sample are twice as likely to experience DNWR compared to euro area countries, and the reverse is true for real wage rigidity. DNWR appears stronger than average in the Czech Republic, Germany, Estonia, Lithuania, the Netherlands and Portugal. It is considerably smaller than average in Spain, France, Italy and Slovenia. Real wage rigidity is especially prevalent in Belgium, Spain and Slovenia, and less so in Italy, Estonia and Poland.

[14] In the case of Germany, Radowski and Bonin (2008) report that 13% and 16% of firms in manufacturing and services, respectively, imposed wage cuts in the previous five years. Similarly, the incidence of wage freezes were is higher than in the other countries. This difference may reflect comparability problems with the survey but also the specific circumstances of the German economy during this period. In this regard, it is notable that aggregate wage and unit labour cost growth in Germany was significantly lower than in other euro area countries during this period. For Luxembourg, for which survey results are not yet available, a similar finding is obtained on the basis of micro wage data. Lünnemann and Wintr (2008) report an overall frequency of wage cut of less than 1 percent per month.

Table 2.2.1: Downward nominal and real wage rigidity across countries

Country	DNWR	RWR
Austria	0.133	0.098
Belgium	0.118	0.982
Czech Republic	0.265	0.117
Estonia	0.217	0.044
Spain	0.024	0.548
France	0.705	0.096
Greece	0.125	0.200
Hungary	0.059	0.112
Ireland	0.071	0.082
Italy	0.039	0.017
Lithuania	0.199	0.108
Netherlands	0.232	.
Poland	0.100	0.069
Portugal	0.150	0.090
Slovenia	0.029	0.235
Total	0.096	0.168
Euro area countries	0.08.1	0.203
Non-euro area countries	0.134	0.085

Source: Babecký *et al*. (2008). Note: Proportion of firms having frozen wages over the past five years and applying an automatic indexation mechanism, employment-weighted averages.

Explaining differences in DWR

The evidence from both micro data on the wage changes of individual workers and the WDN survey point to sizeable differences across countries in the incidence of DWR. In contrast, it appears that, by comparison, the differences across sectors, worker types and firm types are more modest. In view of these two facts, a natural candidate to explain this pattern are differences in national labour market institutions. Indeed, the centralisation of wage setting and the degree of collective bargaining coverage have been related in the recent literature to the extent of downward wage rigidity; Dickens *et al*. (2008) have investigated this relationship at the country level. Using the IWFP measures of DWR, Messina *et al*. (2008) look at sector level data for Belgium, Denmark, Spain and Portugal. They find evidence of higher real wage rigidity for prime-age workers and white collars. Real wage rigidity is found to be less likely if firms apply firm-level wage agreements, whereas nominal wage rigidity is limited by the use of flexible pay instruments. Similarly, focusing on the case of Belgium, Du Caju *et al.* (2008a) report similar findings. They also show that DRWR is lower in more competitive sectors, in labour-intensive sectors, and in sectors with predominant sector-level collective wage agreements. Babecký *et al.* (2008) used the WDN survey information and by means of multivariate regression analysis find that EPL is strongly associated with DNWR. Firms that have firm-level collective bargaining arrangements are more likely to be subject to RWR. The existence of an outside bargaining contract appears to be insignificantly related with wage rigidity.

2.3. How wages respond to shocks

Although adjustment of wages is hampered by rigidity, wages are expected to potentially react to different types of shocks faced by the firm. The WDN survey elicits information on firm's adjustment strategies as reaction to various hypothetical shocks or unanticipated changes in the firms' business environment and allows to examine how the particular response to each shock depends on the characteristics of the firm and of the environment, such as technology and the degree of competition.

The shocks considered are two supply shocks, namely an increase in the cost of an intermediate input (e.g. an oil price increase) and an increase in wages (for example due to contracts bargained at higher levels) and an unanticipated slowdown in demand. All three shocks are common to all firms in the market, and the wage shock was explicitly considered to be permanent.

Reducing non-labour costs is a strategy declared to be relevant or very relevant by 73 percent of firms in response to an increase in the cost of an intermediate input (cost-push shock), with reduction in costs slightly more important than the increase in prices. In the case of a slowdown in demand 80 percent of firms would try to reduce costs; adjusting price, margins or output are relevant strategies for about half of the firms in each case. However, firms generally adopt combinations of these strategies, the combination of reducing other costs and adjusting prices seems the most popular strategy among European firms.

Among the firms that report they attempt to reduce labour costs, only a very small fraction responds it would reduce the base wage (1.2 percent). This is to be expected given the evidence on wage rigidity. Reduction of flexible wage components is the preferred strategy of a larger, although modest, number of firms (about 1 to 11 percent, depending on the kind of shock). Thus at the firm level reducing wages when faced with an adverse shock is a strategy reported by some companies, but not a dominant strategy.

The probability that wages respond to shocks depends on several characteristics of the firm and its institutional environment. Bertola *et al* (2008) investigate the role of firm's characteristics and economic and institutional influences on the mechanism of adjustment used by firms.[15] Wage adjustments whether via base wages or flexible wage components, are more likely in firms with a higher labour share. Collective bargaining coverage does not play a clear role in wage adjustment, while agreements outside of the firm prevent wages from downward adjustment. The more stringent employment protection legislation (EPL), the greater is the likelihood that wages will be

[15] Bertola *et al* (2008) considers the cost and the wage shocks. We do not report on the findings of the wage shock in this section, since we are interested in the endogenous response of wages.

adjusted. In general Bertola *et al* (2008) find that country-level institutional factors are relevant in order to explain the probability of wage adjustment.

Relying on micro-level panel data, Katay (2008) and Fuss and Wintr (2008) have studied the reaction of wages to firm-level total factor productivity in Hungary and Belgium respectively.[16] These studies use annual data so their results are expected not to be affected by short run nominal rigidities resulting from yearly wage contracts. Overall, some reaction of real wages to productivity is found for both countries. The elasticities are however very low, ranging from 0.03 (impact of TFP shocks on average real labour compensation per hour in Belgium) to 0.11 (the impact of permanent TFP shock on real wage in Hungary). Nevertheless, they contrast with the finding that wages are insulated with respect to transient idiosyncratic shocks at the firm level as found by Guiso *et al.* (2005) and Cardoso and Portela (2005) for Italy and Portugal respectively.

Table 2.3.1 summarises, the elasticities obtained for Hungary, Portugal, Italy and Belgium, showing that there is heterogeneity across these countries. Katay (2008) reports that the response of wages to permanent shocks is twice larger than the response to transitory shocks and both are significant. The assumption of full insurance of workers to productivity shocks by firms (predicted by implicit contract theory) can thus be rejected in Hungary. A feature, observed in Belgian data, is that average real labour compensation appears to be substantially more reactive to sectoral level TFP shocks than to firm-level TFP shocks. This reflects the role of sector-level collective wage bargaining that plays a crucial role in transmitting cyclical TFP shocks to labour compensation.

Table 2.3.1: Reaction of wages to firm-level Total Factor Productivity, elasticities.

	wage measure	permanent	transitory	current	lagged
HU: Katay	firm's average net real earnings full-time workers	**0.11**	**0.05**		
PO: Cardoso and Portela	individual gross hourly earnings	**0.09**	(0.00)		
IT: Guiso, Pistaferri and Schivardi	individual earnings full-time stayers	**0.07**	(0.005)		
BE: Fuss and Wintr	firm's real average labour compensation			(0.02)	(0.01)
	hourly compensation			**0.03**	(0.00)

No significant estimates in brackets

Similarly, Kilponen and Santavirta (2008) findings suggest that implicit contracts may not be a prevalent feature of wage determination in Finland.

[16] These studies complement earlier studies on Italy by Guiso, Pistaferri and Schivardi (2005) on Italy and Cardoso and Portela (2005) on Portugal

2.4. Wages of new hires

The distinction between wages of new hires and wages of incumbents has received renewed attention in the context of explaining labor market flows and unemployment volatility. The issue is that firms hiring decisions depend on what the firm will have to pay to its newly hired workers. If these payments are in line with the rather rigid wages of insiders, incentives to hire are not mitigated by rising wages. If, on the other hand, new hires' wages are highly responsive to labor market conditions, firms' incentives to hire are weakened. In this case, the response of the aggregate labor market would be much more muted.

Research in the WDN has contributed to the issue of the rigidity of the wages of new hires by using both direct survey evidence and micro-data. While there is evidence from micro data that wages of new hires are more responsive to changes in the unemployment rate than those in continuing jobs, direct survey evidence suggests that for most firms internal factors are driving wages of newly hired workers.

Using a matched employer/employee data set for Portugal, Carneiro, Guimarães, and Portugal (2008) were able to analyze the heterogeneity of wage responses to aggregate labor market conditions over 20 years in Portugal distinguishing between new hires and existing workers. A one percentage point increase in the unemployment rate correlates with a falling wage for new hires by 2.5 percent. In contrast, wages in continuing jobs just fell by 1.5 percent on average. While this does not mean that wages for new hires are fully flexible, the degree of rigidity is much lower than for ongoing employment relationships.

Evidence from the WDN survey suggests that the margin of adjustment consisting of paying lower wages to new hires is not widely used. In fact almost 80 percent of the firms surveyed report that internal factors such as the collective agreement or the wages of similar employees in the firm are the more important factors driving wages of newly hired workers. External labour market conditions are relatively more important in non-euro area countries (36 percent) than in euro area countries (15 percent). This is analyzed in detail by Galuscak *et al* (2008). Most notably, the more competitive product market conditions are, the more high-skilled workers are employed, and the higher the turnover of employees, the more responsive firms are to external labor market conditions. For firms that appear to face less competition and that employ more intermediate high-skilled workers, the internal labor market matters more. This may be due to a larger role of specific skills accumulated on the job, whereas high-skilled workers may have more general, transferable, skills. Internal factors, such as collective bargaining agreements, appear to matter more for large firms. The dominant reasons for not deviating from the wage of employees already in the firm are related to efficiency wage considerations. Both fairness considerations and the fear that it may have an impact on effort are also perceived to be important.

The results of Rosolia and Torrini (2008) complement these findings. They document an opening wage gap between younger and older workers in Italy. In particular, young workers entering the

labour market since the 1990s earn significantly lower entry wages. As wage profiles have not steepened, these workers are likely to earn less throughout their lifetimes than did workers of older generations. The authors argue that these changes are likely to be the result of partial labour market reforms that protected incumbents and shifted the cost of adjustment on younger new entrants, generating a dual labour market along the age dimension.

2.5 Alternative margins of adjustment

The relevance of downward wage rigidity depends on whether firms have other margins than base wages to adjust labour costs. The WDN firm survey provides unique evidence as it asked whether firms have ever used other adjustment mechanisms to reduce labour cost. These mechanisms include possibilities to reduce or eliminate bonus payments, reduce or eliminate non-pay benefits, change shift assignments or shift premia, slow or freeze the rate at which promotions are filled, recruit new employees at lower wage level than those who left voluntarily, and encourage early retirement to replace high wage employees by entrants with lower wages. About half of the firms have used some of these strategies to adjust labour costs and particularly those firms subject to downward nominal wage rigidity. Table 2.5.1 shows the percentage of firms in each country that reported using the various cost reduction strategies. The prevalence of individual strategies varies quite substantially across countries. The reduction of bonus payments is the most common method used in the non euro area countries, while euro area countries appear less likely to use bonuses to reduce costs, with the exception of Italy where almost a quarter of firms report using this method. Hiring new employees at lower rates than those who left the company or encouraging early retirement are the most commonly used methods in Belgium, France and Italy.

In addition to the variation across countries, strategies also tend to differ across sectors (see Table 2.5.2). The use of cheaper hires to replace workers who leave the firm is the dominant strategy in most sectors. Firms belonging to the energy and financial intermediation sectors are the most likely to target bonuses and benefits when trying to reduce costs. Early retirement is the least likely strategy to be followed, the sector that uses it more often is manufacturing. Changing shift premia and slowing promotions are strategies evenly used by all the sectors.

The various cost reduction strategies are not mutually exclusive and often firms use more than one of them. Reductions in benefits and bonuses appear to be one of the most popular combinations. Cheaper hires to replace workers who left voluntarily and encouragement of early retirement to create vacancies for lower-paid (e.g. more junior) staff is another likely pairing, suggesting that some firms are using turnover to reduce labour costs. Finally, a third strategic combination regards the use of the company's internal wage structure, with changes in shift patterns and slowing of promotions.

When exploring whether firms affected by downward wage rigidity can circumvent this constraint using alternative margins to reduce labour costs, Babecký *et al*. (2008) find that indeed firms that are subject to downward nominal wage rigidity are more likely to use any of these strategies. Moreover, regression analysis also shows that firms operating in a competitive environment are more likely to employ non-base-wage labour cost adjustment strategies. Collective bargaining agreements are associated with a higher probability of using these non-base wage margins to reduce costs; this link is more significant in the case of firm-level bargaining contracts than in the case of higher-level bargaining contracts, reflecting probably that the former type of agreements gives more margin of manoeuvre to companies.

Table 2.5.1: Labor cost adjustment strategies - Country-level statistics

Country	All margins	Reduce bonuses	Reduce benefits	Change shifts	Slow promotions	Cheaper hires	Early retirement
Belgium	46	18.4	7.9	7.2	15	26.4	18.9
Czech Repub	67.9	32.2	7.5	11.1	1.9	8.7	8.9
Estonia	93.6	40.2	20.5	21.1	6.2	16.2	2.6
France	58.6	14.7	6.1	na	15.4	39	30.3
Greece	83.5	20.4	12.4	na	na	na	na
Hungary	67.2	22.7	11.9	38.3	35.1	26.5	10.2
Ireland	88.3	13.3	4.9	9.8	4.7	27.6	4
Italy	71.2	25.6	21.8	26	34	45.6	20.2
Lithuania	100	41	25	19.9	10.6	17.9	2.7
Poland	50.5	23.6	16.3	12.4	12.8	23.7	10.9
Portugal	39.5	13.7	8.4	10.7	14	16.2	0
Slovenia	57.5	13.5	12.8	9.1	18.9	15.8	8.9
Total	62.4	22.8	14.8	19.2	20.9	32.2	16.7
Euro area countries	63.5	20.6	14.8	21.4	25.2	38.8	20.7
Non-euro area countries	60.4	26.7	14.9	16.3	13.4	20.7	9.7

Source: Babecký et al. (2008)] Notes: percentage of firms that use a given strategy, weighted by employment. Data for Austria, Germany, Netherlands and Spain and are not available. In the case of Greece the question was slightly different, in consequence the first column includes the proportion of firms that have reduced bonuses and benefits, as well as overtime hours, number of employees and have engaged in restructuring.

Table 2.5.2: Labor cost adjustment strategies - Proportion of firms by sector

Sector	All margins	Reduce bonuses	Reduce benefits	Change shifts	Slow promotions	Cheaper hires	Early retirement
Manufacturing	61.2	21.1	13.5	18.9	20.5	31.9	17.7
Energy	66.2	30.7	22.1	4.1	13	18.5	25.2
Construction	50.9	20.6	15.2	11	13.1	16.2	5.6
Trade	64	25.4	17.6	22.1	21.9	37.2	10.9
Market services	65.7	23.3	14.8	21.4	22.2	32.9	19.2
Financial interm.	60.1	30.6	15.6	5.2	24.2	36.7	30.8
Non-market serv	25.6	8.9	4	7.6	12.3	8.5	0.7
Total	62.4	22.8	14.8	19.2	20.9	32.2	16.7

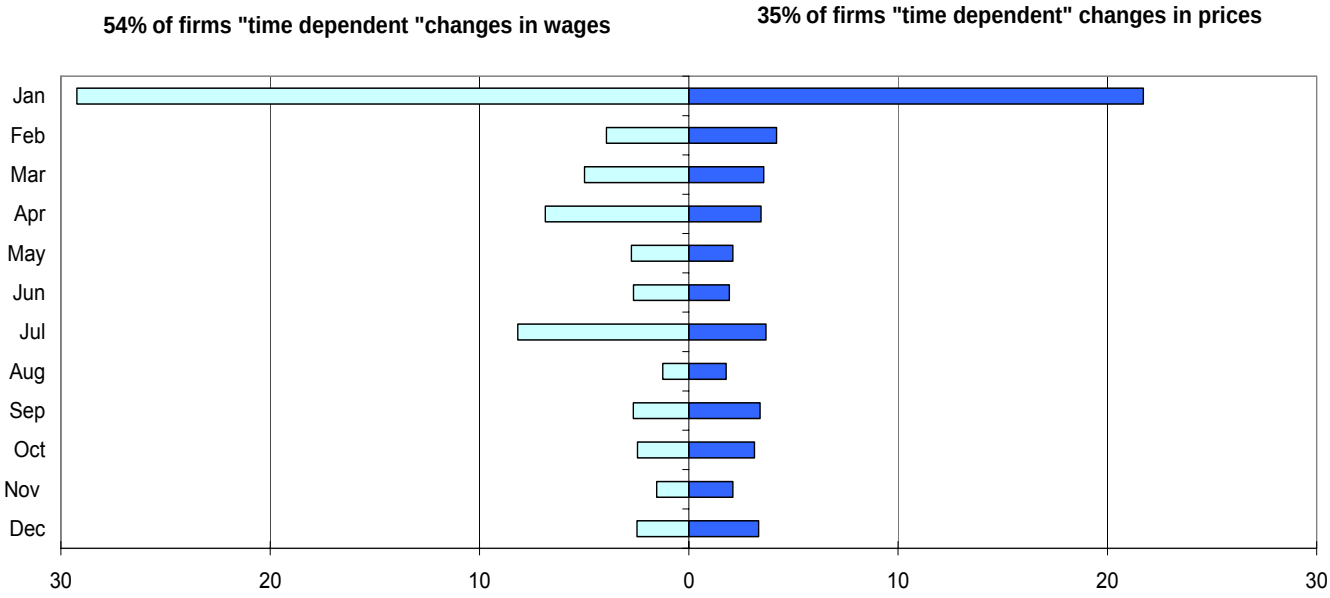
Notes as in table 2.5.1

Analysing firms' wage bill adjustment in Belgium based on individual wage data and firm-level information, Fuss (2008) finds that employment accounts for most of the wage bill adjustment. In particular, on average, wage bill contractions result from employment cuts in spite of wage increases. This is consistent with the survey evidence for Belgium reported by Druant *et al*. (2008b). 60 percent of firms declare that, when reducing costs following an adverse shock, they reduce employment, while only 14 percent of the companies adjust pay (and only do so through the variable components). Fuss (2008) also reports that labour force cuts are achieved through both reduced entries and increased exits. Exits are due to more layoffs, especially in smaller firms, and wider use of early retirement, especially in manufacturing. Lastly, overtime hours, temporary unemployment and interim workers play a role but of limited importance in adapting hours worked to economic circumstances. A very small proportion of enterprises actually reduce working time following adverse shocks.

3. Prices and wage dynamics

One of important facts stemming from the WDN survey is that there is some synchronization between the timing of wage and price changes (see Figure 2.1.3 below). This apparent synchronisation, however, is not particularly strong when looking at individual firms, for example 50 percent of the firms that change prices in January also change wages in that month.

Figure 2.1.3: Timing of wage and price changes
Percentage of firms that change wages and prices in particular month(s)



Source: Druant *et al* (2008a). Weighted figures (weights based on employment), rescaled excluding non-responses. Germany not included in the calculations.

When asked directly 41 percent of firms acknowledge the existence of some relationship between the timing of price and wage revisions within their company. However, 26 percent of the firms report that there is a link between the two decisions, but no pattern in the timing and only 15 percent state that this relationship is quite strong. Within this latter fraction, decisions are taken simultaneously for 4 percent of the firms, prices follow wages in 8 percent of the cases and wages follow prices in the remaining 3 percent. In addition, 59 percent of the firms declare that there is no link between the timing of price and wage changes.

3.1 How wages feed into prices

Evidence from the WDN survey confirms that wages feed into prices at the micro level. About 60 percent of firms surveyed declare that they use a strategy of increasing prices when faced with a permanent unexpected increase in wages (Bertola et al. 2008). For 40 percent of them increasing the price is in fact the dominant strategy when faced with such a shock.[17] Indeed, Bertola *et al* (2008) find that labour share in total costs is a significant determinant of the probability of choosing a price increase as the dominant strategy when the firm is faced with a wage shock. Moreover, confirming previous results from the IPN, the WDN finds that the frequency of price changes varies substantially across sectors and in particular the frequency of price adjustment is lower in firms and sectors with high labour cost share, which suggest that the importance of labour costs and wages has an influence on price adjustments at the firm level see Druant *et al*. (2008). In addition, Druant *et al*. (2008) also find that firms with a high labour cost share report more frequently that there is a strong link between price and wage changes.

This evidence of a substantial, but partial pass-through of wages into prices is more difficult to obtain using micro data. Loupias and Sevestre (2008) have analyzed micro data underlying the Banque de France monthly business survey and found that wage changes have a significant impact on the probability and size of a price change, but this impact is low as compared to that of the price of intermediate goods. The elasticity of (desired) prices to wages is significantly smaller than the elasticity of desired prices to intermediate good prices.[18] Rosolia and Venditti (2008) have analyzed a yearly matched dataset of the Bank of Italy's Survey on Manufacturing Firms and balance sheet data. The elasticity of prices to hourly labour cost is found to be very low, in the order of 0.02-0.03.

[17] These figures are based on a sample that excludes Germany, due to non-comparability in the formulation of questions.

[18] Due to the qualitative nature of the data, the level of the elasticity cannot be identified. Using CPI data for Luxembourg Lünnemann and Mathä (2009) found asymmetric effects of wage inflation on price. Aggregate cumulated wage inflation increases the probability of price change. Furthermore, automatic wage indexation is found to contribute positively to price changes and price increases and negatively to price decreases. Thus wage inflation and wage indexation have indeed important implications for the inflation process in Luxembourg.

Carlsson and Nordström Skans (2008) analyze a high-quality matched firm-employee data set for the manufacturing sector in Sweden to study the relationship between prices and marginal costs, the latter being approximated by the unit labour cost. They find a sizeable elasticity of about 0.3. [19]

The three studies above focus on manufacturing and there is no available empirical study relating to services sector as a whole. However Fougère, Gautier, Le Bihan (2008) study the impact of minimum wages on restaurant prices in France. They find that although restaurant prices are characterized by a substantial degree of nominal rigidity, the long-run pass-through of wages to prices is of the same order of magnitude as the low-wage labour cost share in production. In addition, they explain that due to discrete adjustment at the micro level, the pass-through from wages to prices may be econometrically difficult to detect with standard econometric tools.

Some factors that mitigate the intensity of the pass-through of wages to prices revealed by the econometric analysis of Bertola *et al* (2008) are the degree of competition and the size of the firm. Other things being equal, firms that face a larger degree of competition, or have a large number of employees, tend to choose less often to increase prices when faced with wage shocks. In the latter case a relevant explanation is that large firms have other margins of adjustment available. Another important factor mitigating the wage pass-through to prices is the share of foreign sales in total sales.

3.2. How prices feed into wages

The fact that about 60 percent of the firms do not acknowledge a link between the timing of their own price and wage changes, does not necessarily imply that wage changes at the firm level are not related to the general inflationary outlook captured by the dynamics of consumer prices in the whole economy.

A source of information available from the survey on how inflation developments may affect firms' wage decisions is the frequency of wage adjustments due to inflation. Indeed as discussed in section 2.2, inflation stands out as the dominant factor triggering frequent wage adjustment (at an annual or infra-annual frequency). Although sectoral heterogeneity is quite limited in this respect, the variability across countries is instead remarkably large. While in Austria, Belgium or Spain over 80 percent of firms change wages annually or more frequently due to inflation, in Italy only 15 percent of firms seem to do so.

In addition, both micro and survey evidence from the WDN document (formal and informal) wage indexation and other institutional settings that influence the speed and intensity with which inflation

[19] This elasticity still remains small when compared with the theoretical benchmark of elasticity 1 under monopolistic competition with exogenous mark-up. Accounting for short-run nominal rigidity of the Calvo-type contributes however to reduce the gap to the benchmark.

feeds through into wages. Two questions on indexation were included in the WDN survey questionnaire. In the first one, firms were asked whether or not they have a policy that adapts changes in base wages to inflation. If so, they were asked to report whether the adjustment is automatic or not, is subject to a formal rule or not, and whether it refers to past or expected inflation.

On average about one third of firms do have an internal policy that adapts base wages to inflation. Of these, nearly half adopt an automatic indexation mechanism, mostly based on past inflation. The other half has a policy that adapts wages to inflation without applying any formal rule. There is some variability across sectors; firm's policies linking base wages to inflation are less common in market services and more widespread in financial intermediation and construction. In most of the cases the link is not formal and tends to be backward looking.

Table 3.2.1 summarises the relevance across countries of these formal and informal indexation mechanisms at the firm level. It shows that, in every country of the sample, with the exceptions of Italy, some kind of adjustment of wages to inflation is at work in a fraction of the firms. The adjustment of wages to inflation is very common in Belgium (98 percent) and Spain (70 percent); in these two countries automatic indexation mechanisms are prevalent.[20] Italian firms, on the other hand, do not (or almost do not) adapt wages to inflation. Expected inflation seems to be more important than past inflation for wage setting only in Portugal. Adapting changes in base wages to inflation is a slightly less widespread practice in the euro area countries (34.7 percent of firms), than in the non euro area countries covered by the survey (38.1 percent). In the case of Germany, firms where not explicitly asked whether or not they have a policy that adapts changes in base wages to inflation. Nevertheless, when asked about the two main factors that determined the most recent wage increases, 27 percent of German firms replied that inflation was one of them.

[20] Automatic indexation of wages to past inflation is very common in Belgium. Only a very small share of the 2% of firms declaring in the survey not to belong to a joint committee, apply a different mechanism. Lünnemann and Wintr (2008) report that the frequency of wage change raises to 99% in Luxembourg the event of wage indexation.

Table 3.2.1: Policy of adjusting base wages to inflation: country overview

(percentages)

	Firm-level policy of adjusting base wages to inflation (1)					Country-level indexation (2)
	Automatic		Informal		Total	
	Past	Expected	Past	Expected		
AT	8.6	1.3	9.2	2.8	23.6	Very low
BE	98.2	0.0	0.0	0.0	98.2	High
CZ	7.0	5.2	27.9	24.1	59.8	None
DE	*Na*	*na*	*na*	*na*	*27*	None
EE	2.9	1.8	35.4	20.8	53.8	None
ES	38.3	16.2	10.9	5.0	70.4	High
FR	8.9	2.0	21.2	8.0	33.1	Very low
GR	14.8	5.2	12.1	10.6	47.1	None
HU	7.2	4.2	14.0	5.9	33.0	None
IE	6.0	2.7	18.5	10.4	30.0	None
IT	1.2	0.5	2.6	1.5	6.2	Very low
LT	7,3	3.7	24.3	12.9	48.1	
PL	4.7	2.5	17.3	6.1	30.6	Very low
PT	2.7	6.5	13.3	29.1	51.8	None
SI	20.3	2.7	32.2	5.1	60.3	Low
Total	**13.2**	**3.9**	**12.7**	**6.9**	**35.7**	
Non euro area countries	**5.5**	**3.2**	**19.8**	**10.2**	**38.1**	
Euro area countries	**16.3**	**4.1**	**9.7**	**5.5**	**34.7**	

(1) Figures weighted by employment weights, rescaled excluding non-responses. Source: Druant, *et al* (2008a). Euro area and total do not include Germany. (2) Percentage of workers covered by wage indexations clauses: Very low: 0-25%; Low: 26-50%; Moderate: 51-75%; High: 76-100%.Source: Du Caju *et al* (2008b).

The information collected by the survey qualifies and complements other information on (formal) indexation that is available at country and sector level. In particular, the dataset on wage bargaining institutions generated from the information collected within the WDN NCB questionnaire (see Du Caju et al. 2008) provides a measure of wage indexation. According to this measure, workers are to some extent covered by formal wage indexation clauses in only seven out of the sixteen countries examined in the WDN survey. Coverage is particularly high in Belgium (where indexation is State-imposed) and Spain (where indexation works through collective agreements) and low in Slovenia and very low in Austria, France, Italy and Poland, (see table 2, column "Total," indicators in brackets). In France and Slovenia, formal indexation operates only through the adjustment of the minimum wages. In the WDN survey firms from fourteen different countries report having policies that adapt wages to inflation. This is not inconsistent with the more limited prevalence of indexation pointed out by institutional evidence on (formal) wage indexation, because such policies do not necessarily imply the existence of a formal indexation rule. This is indeed the case of the Czech Republic, Estonia, Hungary, Ireland, Lithuania, Poland and Portugal, where the vast majority of firms that have a policy that adapts changes in base wages to inflation indicate that nevertheless no formal rule is applied.

The analyses of available micro data provide additional information on the way aggregate prices feed in to wages. Heckel *et al.* (2008) estimate a model of wage dynamics at the individual level, allowing for infrequent wage changes using French data. The size of wage changes are found to be related to past and expected inflation, with a higher weight of past inflation. Knell and Stiglbauer (2008) estimate an econometric model for the change in collective bargained wages in Austria. Inflation expectations are found to have a significant impact on bargained wages, but past inflation is found to be insignificant. Indexation to (past and expected) inflation is, however, only partial because "reference norms" (that depend on the past development of wages) appear to play a more substantial role than inflation developments. The empirically most relevant reference norm is the "leadership norm", that is the change in the wage rate in a leading sector (the metal industry).

On the whole, while formal indexation schemes are limited to a number of countries, about one third of the firms seem to have a policy that adapts somehow base wages to inflation.

4. Model-based analyses

The WDN has developed dynamic general equilibrium models to assess whether and to what extent the micro-level findings summarized in the previous sections translate into macroeconomic outcomes. The current report however remains quite silent on the macroeconomic implications of these micro findings as these will be studied in more detail in the near future. This section presents a number of macro models that have been examined in the WDN macro group.

Section 4.1 first illustrates how some different shocks affect wages and inflation in the standard New Keynesian model by Erceg, Henderson, and Levin (2000) and Smets and Wouters (2003). Then section 4.2 describes the key elements of the basic search and matching a la Mortensen and Pissarides, what helps to frame the discussion of the WDN macro group contributions that follows. These contributions include (i) two survey papers that were written to assess the role of labour market frictions and real wage rigidity for wage and inflation dynamics; and (ii) a number of models that address the effects of staggered wages setting in frictional labour markets, the effects wage norms and the optimal monetary policy implications of downward real wage rigidity.

4.1 Wage and price dynamics in the macro economy

A number of microeconomic elements are embedded in the standard New Keynesian model by Erceg, Henderson, and Levin (2000) and Smets and Wouters (2003) adopted also in the New Area Wide Model. In this setup firms are monopolistically competitive price setters that use labour and

capital, taking factor costs as given. Price and wage setting are subject to frictions that inhibit firms from adjusting every period.

4.1.1. Flexible price and wage adjustment

For simplicity, first consider flexible prices. The model of monopolistic price setting implies a markup equation that determines the relative price a firm chooses, taken all other prices as given

$$\frac{p_{it}}{p_t} = \mu_t mc_t$$

where μ is the markup, depending on the elasticity of demand firms face. p_{it} is a firm *i*'s price, and p_t is the price level. In turn, marginal costs are the minimum expenditure combination of inputs for producing one unit of output given factor prices. In the most familiar form, real marginal costs can be written as unit labour costs:

$$mc_t = \frac{w_t}{mpl_t}$$

where $mpl_t = (1-\alpha) a_t k_t^{\alpha} n_t^{-\alpha}$ is the marginal product of labour for a Cobb-Douglas production function with capital *k* and labour *n*, productivity a and share of labour in production $1-\alpha$.

One can see that variations in markups or marginal costs make firms change their relative product price immediately. A rise in labour productivity a increases mpl_t and reduces real marginal costs and thus leads firms to lower their price, raising product demand and thus labour demand. Assuming symmetry between all firms implies that $p_{it} = p_t$, so that $mc_t = 1/\mu_t$.

The optimal input choice between capital and labour implies that the factor ratio depends on factor prices:

$$\frac{k_t}{n_t} = \frac{\alpha}{1-\alpha}\frac{w_t}{r_t}$$

This equation illustrates in a simple form one of the adjustment margins mentioned by firms in the survey conducted in the WDN. A cost shock to wages induces firms to reduce production costs by reducing labour input relative to capital. In a more general model, labour input falls relative to any other intermediate input.

Wages in a flexible price and wage model are determined by a labour supply equation that relates the wage paid to workers marginal rate of substitution between consumption and labour. Similar to

the monopolistic setup of producers, workers charge a markup over their marginal rate of substitution:

$$w_t = \mu^w mrs_t$$

where μ^w is a markup arising from the price setting power of workers. In the New Keynesian model by Erceg, Henderson and Levin (2000), labour is regarded as total hours worked and the adjustment is entirely through this margin, and it is implicitly assumed that all workers are employed. The search and matching framework below introduces the extensive margin of adjustment, that is, the number of workers employed.

4.1.2. Sticky prices and wages

In the case of nominal frictions, firms and workers take into account their reduced ability to adjust prices and wages in the near future. In particular, if one assumes, following Calvo (1983), that prices can only be adjusted with a certain probability each period, the familiar forward-looking new Keynesian Phillips curve can be derived:

$$\hat{\pi}_t = \beta \cdot E_t \hat{\pi}_{t+1} + \kappa \cdot \hat{mc}_t$$

where $\hat{\pi}$ is the deviation of inflation from steady state, β a discount factor, E the expectation operator, and $\hat{mc}_t = \hat{w}_t - \hat{mpl}_t$ is the log-deviation of real marginal cost from steady state. Thus unit labour costs are the driving force of inflation. The parameter κ is a function of the probability of price adjustment and real price rigidity.

A similar equation can be written for real wages, together with the assumption of indexation of wage to past inflation (following Smets-Wouters, 2003):

$$\hat{\pi}_t^w = \beta \cdot E_t \hat{\pi}_{t+1}^w - \gamma^w \left(\beta \hat{\pi}_t - \hat{\pi}_{t-1}\right) + \kappa^w \left(\hat{mrs}_t - \hat{w}_t \right)$$

where $\pi^w = w_{t+1}^n - w_t^n$ is nominal wage inflation (in deviation from steady state), κ^w is a function of relevant parameters, and γ^w is the parameter governing indexation of nominal wages whenever they are not adjusted in the Calvo-manner:

$$w_t^n = \gamma^w \pi_{t-1} + w_{t-1}^n$$

Thus, when γ^w is zero, those wages that are not adjusted in period t remain constant until the next negotiation. Otherwise, they are partially adjusted to past inflation: there is real wage rigidity. If

$\gamma^w = 1$, then contract wages follow inflation perfectly, but are not affected by other economic variables.

In terms of the real wage level, this equation becomes

$$\hat{w}_t = \frac{\beta}{1+\beta} E_t \hat{w}_{t+1} + \frac{1}{1+\beta} \hat{w}_{t-1} + \frac{\beta}{1+\beta} E_t \hat{\pi}_{t+1} - \frac{1+\beta\gamma^w}{1+\beta} \hat{\pi}_t + \frac{\gamma^w}{1+\beta} \hat{\pi}_{t-1} + \frac{1}{1+\beta} \kappa^w \left(\hat{mrs}_t - \hat{w}_t \right)$$

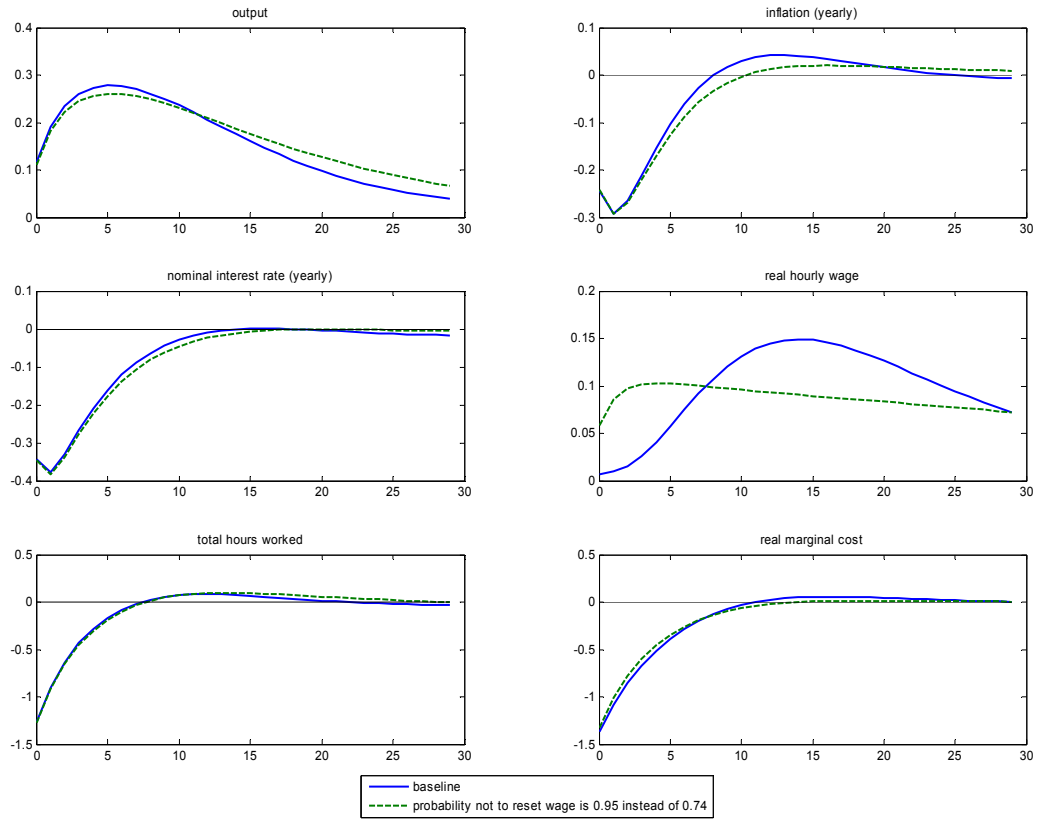
One can see here that the driving force of wage inflation, and real wage changes, is the gap between the marginal rate of substitution and the real wage. Indexation introduces persistence into wage dynamics, which in turn will make inflation dynamics more persistent. Expected inflation matters here because wage setters anticipate that, given nominal wage stickiness, their real wages fall if prices rise in the future.

4.1.3. Simulation of the model

Simulations of this model for different parameter values helps interpreting a number of the micro-economic regularities that the WDN has uncovered. The model used here mirrors that of Smets and Wouters (2003), a fully specified dynamic general equilibrium model, estimated with European data. Using this benchmark model, we can then change parameters related to the labour market. In particular, we vary the degree of wage stickiness, as measured by the frequency of wage adjustments, and the degree of wage indexation. The graphs show the impulse responses of output, inflation, the policy interest rate, real wages, employment, and real marginal costs to technology and cost-push shocks. The latter enter as an additional disturbance to the Phillips curve. The policy interest rate is assumed to follow a Taylor rule.

First, consider the simulation of the baseline model for a one percent positive technology shock with high degree of persistence. This is shown by the blue line in the graph below. The shock temporarily expands the production possibility frontier of the economy (beyond what steady-state technological growth would allow), so that output rises. At the same time, the higher productivity reduces unit labour costs, and thus real marginal costs fall, and with it inflation. This allows the central bank to lower interest rates. However, since aggregate demand adjusts relatively sluggishly due to sticky prices, labour demand actually falls, as less labour is needed to produce a given amount of output. Nevertheless, real wages rise because as income and consumption rise, households want to reduce labour supply, increasing their marginal rate of substitution.

Figure 4.1.3 a: Different degrees of wage stickiness: impulse responses to a technology shock

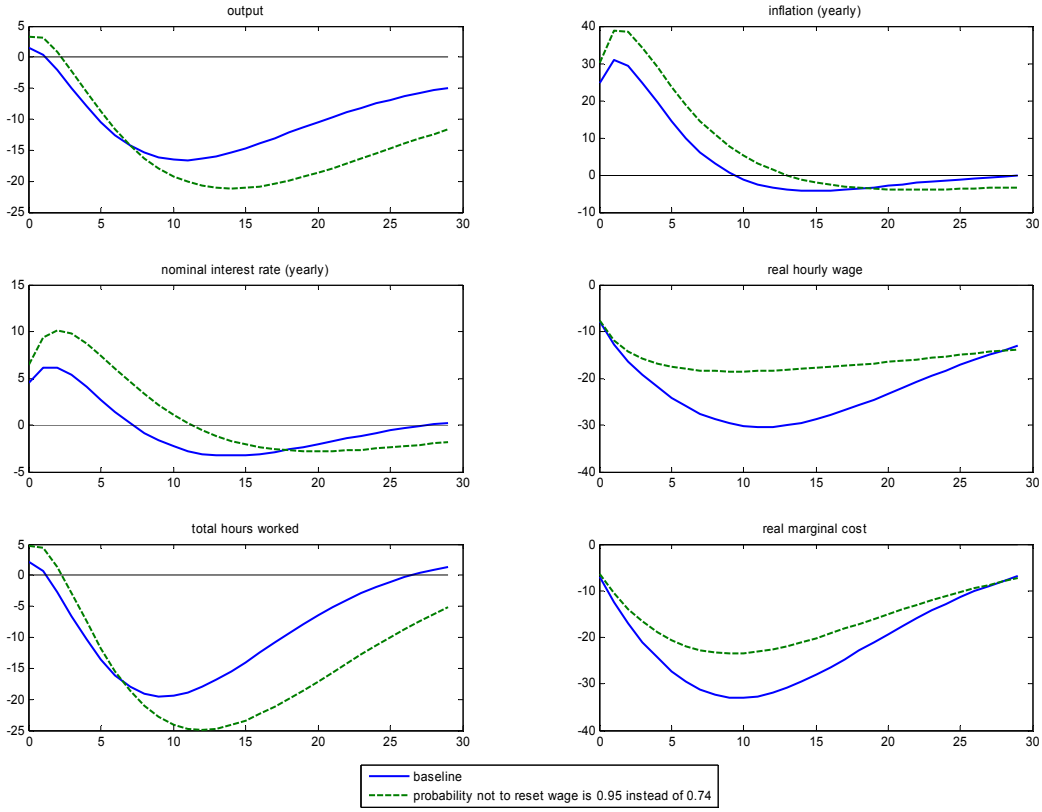


The first experiment is to vary the degree of wage stickiness in the range of values found in the WDN micro studies. As reported earlier, 86 percent percent of firms in the euro area change wages either once a year or less often. We translate this number into the Calvo-probability which governs wage stickiness in the model. To achieve a fraction of 86 percent firms not having adjusted their price within a year, we set the probability of quarterly wage adjustment to 95 percent. In light of the formerly estimated value of 0.74, this is at the high end.

The response of the economy to technology shocks is barely affected by the increase in wage stickiness, shown by the green line in the same figure. This is due to the fact that output adjustment is constrained by sticky prices, which make aggregate demand respond only sluggishly to higher productivity. Employment and inflation behave the same as under less rigid prices. Only the real wage adjusts differently to the shock.

Following a cost push shock, the picture changes. This shock induces firms to raise prices by increasing the markup, leading to an increase in inflation. To keep inflation stable, the interest rate is increased and output falls. Consequently, employment, real wages and real marginal costs fall, taking off cost pressures from inflation:

Figure 4.1.3 b: Different degrees of wage stickiness: impulse responses to a cost push shock



In this case, the higher wage rigidity substantially affects the adjustment of the economy. The real wage falls less after a cost-push shock and therefore inflationary pressures abate more slowly. The interest rate must be increased more strongly to keep inflation under control, so that output and employment losses are more pronounced. Cost push shocks generate a trade-off between output and inflation stabilization and the higher wage rigidity shows up more clearly. Countries in the euro area with a higher degree of wage rigidity will have a more costly adjustment to cost-push shocks, either in terms of inflation or output, depending on where the area-wide interest rate will be relative to the optimal one for a particular country.

In the following we discuss a change in the degree of indexation for similar types of shocks, the technology and the cost push shock. In the benchmark estimation by Smets and Wouters (2003) the indexation parameter was set to 0.76. It means that those wages not changed at the time of reoptimization follow lagged inflation to 76 percent. This is a fairly high degree of indexation. In the simulation we reduce the indexation parameter from 0.76 to zero to exemplify its role most starkly. As may be seen in the figures, it turns out that the adjustment of the macroeconomy is only slightly changed: real wages adjust a little stronger, and inflation a little weaker than before. The explanation for the similar behaviour lies in the rational expectations of wage setters who at the moment of reoptimizing anticipate and balance the implicit real wage adjustments. Again, the first

graph depicts the response to a technology shock, while the second graph shows that to a cost push shock. The dashed line gives the responses without indexation.

Figure 4.1.3 c: Different degrees of wage indexation: impulse responses to a technology shock

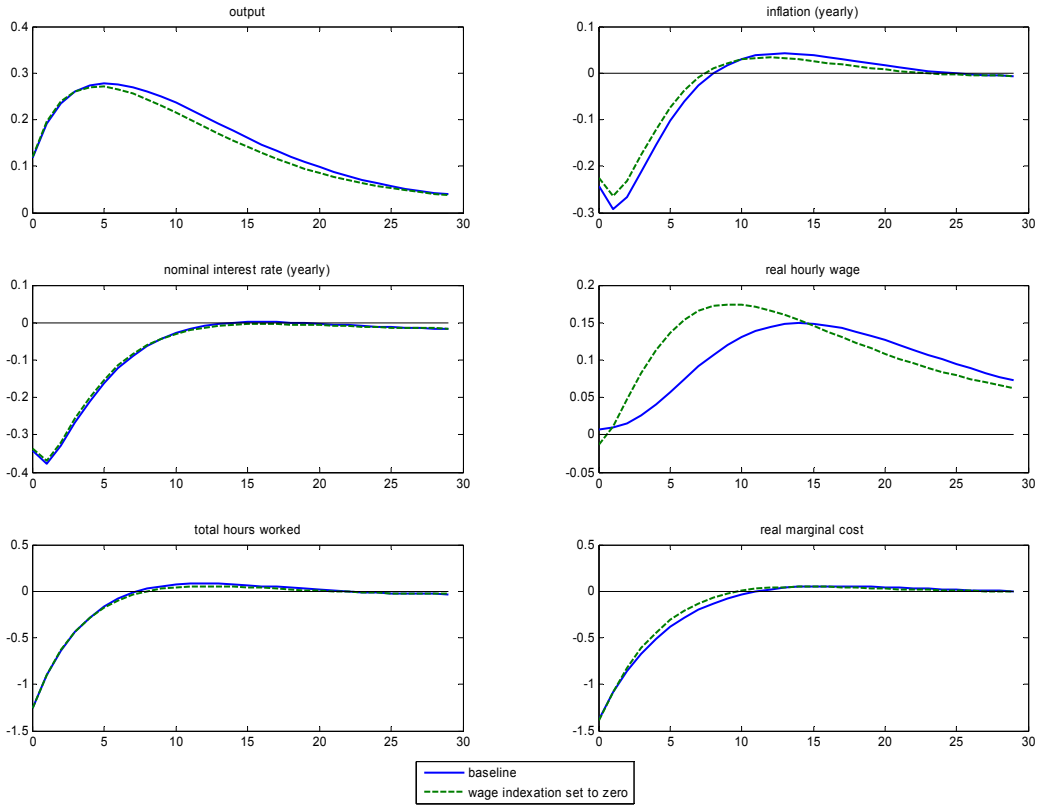
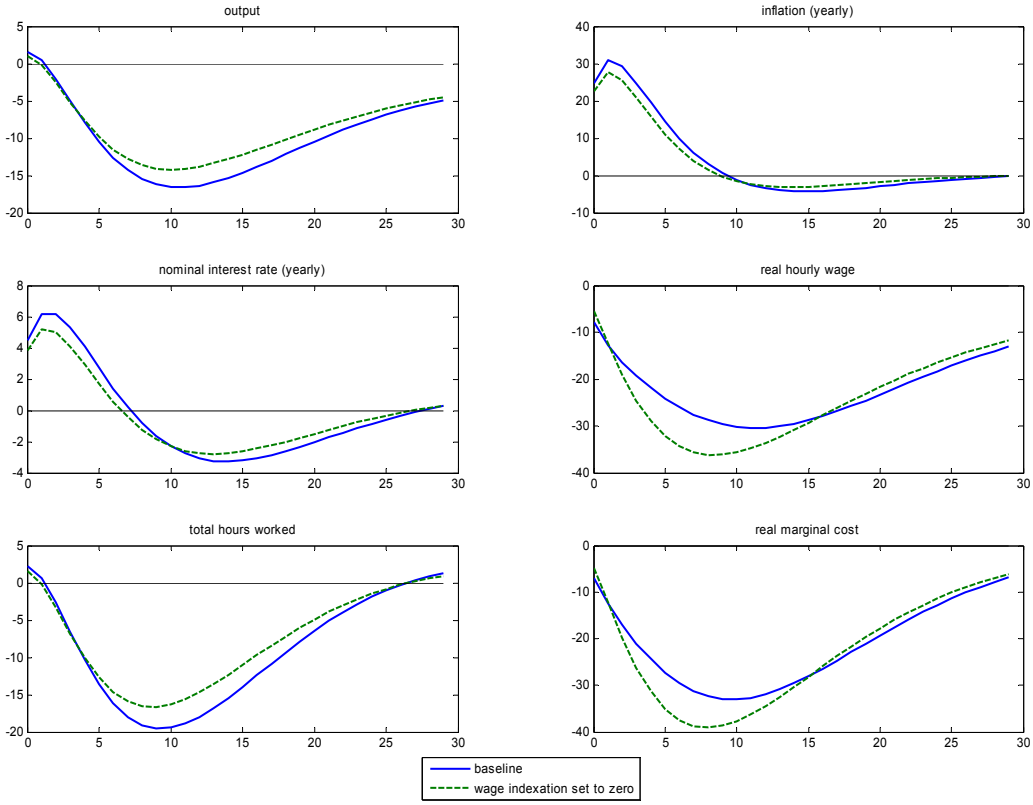


Figure 4.1.3 d: Different degrees of wage indexation: impulse responses to a cost push shock



The result that the effects of indexation are weak may not square well with intuition. But one must take into account that the simulations are conducted in a model where the central bank has established full credibility of its monetary policy conduct. In particular, the inflation target (or targeted range of inflation) is fully entrenched in wage setters' expectations, so even when wages are adjusted to inflation between wage adjustments, those adjustments themselves take place under well anchored inflation expectations. In a regime where the inflation target is assumed to be shifting, such as in the 1970s, wage indexation may well appear more dominant, and important for inflation dynamics. This may also be the case if there are elements of money illusion in wage setting. That is, if the indexed wage sets a reference point or norm for wage setting, it may lead to higher wage settlements after periods of high inflation. Of course, when there are backward looking elements to expectation formation, such as arising from learning, the transitory effects may be larger.

The Erceg-Henderson-Levin and the Smets-Wouters models incorporate economic forces at work in the labour market, but do not explain the employment adjustment at the extensive margin and the hiring behavior of firms. In addition, wage setting does not relate to an explicit bargaining process. The search and matching model adds hiring to the picture and wages are a choice by both parties, determined in bilateral negotiations between employers and employees. Incorporating both hours

per worker and number of workers is straightforward, and used in some of the WDN models in section 4.2 below. Nevertheless, we first focus on the simplest case to highlight important economic mechanisms, especially concerning new and old hires.

4.2 Labour market dynamics

Much of the current macroeconomic research on labour markets is based on the search and matching model of Mortensen and Pissarides (1994), which explains equilibrium unemployment and labour market flows. We therefore describe here the key elements of this model, as it helps organizing the discussion of the WDN contributions that follows.

The price setting decisions described earlier are not affected by this change and therefore ignored for the moment.

4.2.1. A baseline search and matching model

At the core of such a model is an aggregate matching function which represents the costly process through which searching workers (unemployed) and searching firms (posting vacancies) find each other. Each period, the aggregate number of new matches depends on the search inputs of workers and firms.

Given the matching function, the evolution of employment in an economy can be written as

$$n_t = (1-\rho)n_{t-1} + m_t$$

where n is employment, ρ is the fraction of job separations, and m is the number of newly formed matches. Matches themselves are a function of vacancies v posted, and the measure of unemployed job searchers u: The specific process by which unemployed workers and vacancies become matched is not further specified. The function m represents the process within a single functional form.

$$m_t = m(v_t, u_t),$$

where $u_t = 1 - n_{t-1}$. That is, those not matched employed last period are in the matching process in the current period. With constant returns to scale, we can write the probability of finding a worker as a function of labour market tightness θ_t : $q(\theta_t) \equiv \frac{m_t}{v_t} = m\left(1, \theta_t^{-1}\right)$ (where labour market tightness is the ratio of vacancies over unemployment) and the probability for a worker of finding a job is $s(\theta_t) \equiv \theta_t q(\theta_t) = \frac{m_t}{u_t} = m(\theta_t 1)$.

The second key assumption concerns wage setting. In contrast to the competitive model of the labour market or the monopolistic setup by Erceg, Henderson and Levin (2000) or Smets and Wouters (2003), workers and firms enjoy a joint surplus when matched stemming from their bilateral monopolistic relationship. That is, rather than being indifferent between continuing the employment relationship and finding an alternative trading partner, both parties have an interest to avoid a renewed costly search. This bilateral monopoly situation permits wages to settle within a given range, but not pinning it down precisely. For this an assumption on the bargaining procedure must be made. In most models, it is assumed that wages are set according to the Nash bargaining solution, which splits the joint present value of the employment relationship according to the bargaining power of the worker and the firm.

Given the matching function, the assumptions on bargaining, a per period cost of posting vacancies of c and free entry of firms in the matching market, the equilibrium of the economy can be described by a job creation condition, a wage equation, and the law of motion for employment:

$$\frac{c}{q(\theta_t)} = x_t A_t - w_t + (1-\rho)\mathrm{E}_t \beta \frac{c}{q(\theta_{t+1})}$$

$$w_t = \eta\left(A_t x_t + (1-\rho)\mathrm{E}_t \beta c \theta_{t+1}\right) + (1-\eta)b$$

$$n_t = (1-\rho)n_{t-1} + v_t q(\theta_t)$$

Here, the parameters β, η and b stand for the discount factor, the workers' bargaining power, and the workers' unemployment income, respectively.

The job creation condition for firms relates the expected cost of filling a vacancy (the period cost of posting a vacancy divided by the probability of filling it), to the benefit of a filled job. The latter is the revenue of the job, with x_t marginal revenue and A_t its productivity, minus the wage paid, plus the future benefit of the job due to its long-term relationship (which in equilibrium turns out to equal the cost of posting a vacancy next period).

The real wage depends on the worker's share in a job's revenue and the expected labour market conditions, and the outside option of the worker. The expected labour market conditions reflect the benefit from avoiding search costs if the parties find a wage agreement. Note that in this formulation, the wage is perfectly flexible, and thus adjusts immediately to both internal (i.e., $x_t A_t$) and external (i.e. θ_t) conditions.

The law of motion for employment is written as a function of jobs surviving an exogenous separation process, and new matches that depend on the number of vacancies posted and the probability of filling a vacancy. This in turn depends on labour market conditions.

Labour market institutions

The search and matching model has been used extensively to explain structural unemployment and the role of labour market institutions and legislation. It is employed now to illustrate some of the aggregate effects of some of the institutions in Europe surveyed earlier. Two steady-state conditions suffice for now. They are the job creation condition with the wage equation inserted, solved to determine labour market tightness $\theta = v/u$,

$$\frac{c}{q(\theta)}\frac{1+\eta s}{1-\eta} = \frac{1}{(1-\rho)\beta}(Ax-b)$$

and the steady-state employment equation

$$\frac{n}{1-n} = \frac{\theta q(\theta)}{\rho}$$

First of all, note that the higher unemployment income b relative to revenue, holding all other parameters constant, the lower θ must be. Recall that $q(\theta_t) = m(1, \theta_t^{-1})$ inversely depends on θ, implying that the value on the left hand side of the first equation is increasing in θ. From the second equation, this implies that, for given ρ employment n must be lower, or unemployment higher. As firms earn less from employing a worker when workers have a higher wage, *Ax* - *w*, their incentives to hire are reduced. Secondly, and similarly, a higher bargaining power η of workers also implies lower equilibrium tightness θ. The reason is the same as firms earning a lower profit per worker will post fewer vacancies, thus leading to a higher unemployment rate. Thirdly, regulation that increases the cost of creating jobs, *c*, increases the unemployment rate. A number of other factors, such as employment protection legislation can work in a similar way.

These effects represent in a nutshell many of the factors at work in shaping euro area labour market differences. Depending on what margin the regulations in the different countries affect the outcomes on labour markets may differ. In general, strong bargaining positions by workers in form of union power or high unemployment benefits, combined with high costs for hiring or firing workers reduces the firm's incentives to create jobs. Product market regulation that blocks firm entry into markets has complementary effects.

Labour market volatility and wage rigidity

Factors that reduce firms' hiring incentives in steady state, also make them less responses to changes in these factors. This can easily be seen from the linearized job creation condition, with wages inserted:

$$\hat{\theta}_t = \frac{q(\theta)}{c}\frac{1-\eta}{\vartheta} x\left(\hat{x}_t + \hat{A}_t\right) + (1-\rho)\beta\frac{\vartheta-\eta s}{\vartheta}\mathrm{E}_t\hat{\theta}_{t+1}$$

where $\vartheta = -\frac{q'(\theta)}{q(\theta)}\theta > 0$, so that $c/q(\theta_t) \approx \vartheta c/q(\theta)\hat{\theta}_t$. Of course, in a calibration, one would determine *c* by the above considerations, and impose empirically plausible values for q, s, ρ, and b. Recall that *s* is the worker's probability of finding a job.

The higher $q(\theta)/c$ the higher is the responsiveness of labour market tightness (and thus employment) to changes in marginal revenue or productivity. The determinants of $q(\theta)/c$ were just discussed. It rises with a higher b and a lower η. Similarly, the lower η, the more do hiring incentives respond to expectations of future labour market conditions (and thus benefits from hiring), as reflected in $\mathrm{E}_t\hat{\theta}_{t+1}$. Effectively, these parameter choices introduce a form of real wage rigidity. Therefore, real wage rigidity of this and other kinds has been identified as the key factor in explaining labour market dynamics.

4.2.2 Real wage rigidities

From the above arguments, it is clear that wage rigidity is crucial for the ability of theories to explain labour market volatility. From the simulation of the Erceg-Henderson-Levin/Smets-Wouters model it is also apparent how wage rigidity affects inflation dynamics. Konya and Krause (2008) quantitatively explore a number of formulations of real wage rigidity in a real business cycle version of the above search and matching model. The work by Christoffel et al. (2008a) reported in the next subsection merges the Erceg-Henderson-Levin/ Smets-Wouters models and search models to explore the ability of this synthesis to jointly account for labour market and inflation dynamics.

The idea of introducing rigid wages explicitly in the model was put forward by Hall (2005) as a solution to the low unemployment volatility in the original search and matching model. Typically, real wages are assumed determined by

$$w_t = \gamma w_t^{Nash} + (1-\gamma)w_t^{Norm}$$

a weighted average of the Nash bargained wage as shown earlier, and a wage norm. This wage norm can be justified by alluding to the constraint that wage negotiations take into consideration wages of a reference group, say workers in similar firms. (In this sense, the model is close to the model by Fuhrer and Moore, 1995, used below by Knell and Stiglbauer 2008). The wage norm can also be the aggregate wage previously negotiated, i.e., $w_t^{Norm} = w_{t-1}$ introducing explicitly some persistence.

Alternatively, the literature assumes that wages are explicitly negotiated in a staggered manner à la Calvo, as shown by Trigari and Gertler (2006). Then wage setters are prevented from adjusting their wages every period. This leads to sluggish wages, and increased labour market volatility.

Key to all these arguments is that wages of newly hired workers are as rigid as those of the existing workforce. As discussed earlier, if wages of new workers are perfectly flexible, the model with frictions again fails to generate volatile labour market dynamics. In fact, Pissarides (2007) and Haefke, Sonntag, van Rens (2008) argue that empirically, new hires wages are not rigid enough in the sense that they increase labour market volatility. Trigari and Gertler (2006) on the other hand argue that new hires wages are constrained by the wages of existing workers, who are quite rigid. Krause and Lubik (2007) point out, that a way to improve the behavior of the matching model is to reduce the excess sensitivity of job destruction. Kilponen and Vanhala (2008) follow this route by introducing heterogenous productivity responses of new and old matches. This shifts employment adjustment from job destruction to job creation, which increases unemployment and vacancy volatility without wage rigidity.

Konya and Krause (2008) allow for different degrees of real wage rigidity for new and existing jobs. Estimation of the model with Euro Area and U.S. data shows that in both areas, the model can explain unemployment volatility with new hires' wages that are in fact rigid, but to a lower degree than those of workers in ongoing jobs. Interestingly, euro area wages of new hires appear to be more rigid than in the U.S.

4.2.3. Labour market frictions and inflation dynamics

A priori, one would assume that a higher degree of real wage rigidity would translate into a higher persistence of inflation, because real marginal costs should be more rigid. This is not necessarily the case with labour market search frictions, as Krause and Lubik (2007) have shown in a New Keynesian sticky price model. The reason is that with search frictions, real marginal costs do not only depend on wages, but also on the cyclical hiring costs faced by firms. A number of papers have explored alternatives, either to the assumptions on wage setting, or to elements of the search and matching framework, in order to make real marginal costs more rigid.

Christoffel, Costain, de Walque, Kuester, Linzert, Millard, and Pierrard (2008a) provide the first comprehensive survey of the implications of extensions of the New Keynesian search and matching model for the dynamics of inflation. They present a baseline model similar to the one above, with the addition of endogenous hours supply by worker, and sticky prices in the product market. In this case, the output of a job depends on hours worked and inflation depends on real marginal costs. Under Nash bargaining over wages and hours, the authors show that real marginal costs do not depend on unit labour costs (real wages relative to productivity) but on the ratio of the marginal rate of substitution of workers to the marginal product. Thus more rigid wages do not need to lead to sticky real marginal costs. However, if alternatively the right-to-manage approach by Trigari (2006) and Christoffel and Linzert (2006) is adopted, where firms determine hours worked given the ex ante negotiated Nash wage, they will choose hours to equalize the wage with the marginal revenue product of workers. Then wage rigidity has a direct influence on the dynamics of real marginal cost and thus inflation. The reason is that there is then a 'wage channel' with right-to-manage in the terminology of Christoffel, Kuester, and Linzert (2008). Christoffel et al. (2008a) also emphasize the difference between wages for new hires and old hires. They confirm that wage stickiness for existing workers does not matter for labour market dynamics, while new hires' wage rigidity amplifies labour market dynamics.

A number of additional alternatives to the structure of the details of the labour market or firms are introduced, following suggestions in the literature aimed at increasing unemployment volatility. These are firm-specific labour as in Kuester (2007), Sveen and Weinke (2007) or Thomas (2008); contemporaneous hiring as in Blanchard and Gali (2008) and others; variants of the vacancy posting process as in Yashiv (2006), Gertler and Trigari (2006), and Fujita and Ramey (2005); on-the-job search as in Krause and Lubik (2007) and van Zandweghe (2007); heterogenous productivity responses of new and old matches as in Kilponen and Vanhala (2008); and finally, endogenous job destruction, as in Den Haan, Ramey, and Watson (2000).

Overall, while the effects of these extensions often work towards making inflation somewhat more persistent, the most powerful mechanism appears to be right-to-manage bargaining with rigid wages, where firms choose hours worked for given wages.

4.2.4 Bargaining over hours and staggered wage negotiation

De Walque, Pierrard, Sneessens, and Wouters (2008) introduce an interesting twist to the setup above. Rather than letting the firm choose hours unilaterally, for given wages, they allow for a separate bargaining process over hours worked. This leads to a rather general model encompassing efficient bargaining and right-to-manage as special cases while allowing for any intermediate case. A higher bargaining power of workers with respect to working time forces more labour force adjustment into the extensive margin, namely hiring of workers by firms, rather than extra hours.

This improves upon a number of models, which predict too volatile hours worked per worker. The authors present their results in an extended DSGE model with search and matching frictions along with capital utilization, investment adjustment costs, and habits formation in consumption. They also introduce the distinction between new hires and the existing workforce.

The model turns out to perform well in a number of dimensions. Not only are labour market variables more volatile than in the baseline model, and much closer to actual data but also inflation becomes more persistent. This is because the "wage channel" closes very smoothly as one departs from the right-to-manage particular case, while the substitution from hours towards heads is much more rapid. Finally, correlations with output and autocorrelations of wages are more in line with the data. Interestingly, the combination of hours and staggered wage setting makes it possible to match unemployment volatility if new hires' wages are more flexible than those of the existing matches. This model appears to have successfully synthesized a number of elements of the labour market found to be important in the micro-studies of the WDN.

4.2.5. Reference norms and staggered wage setting

The paper by Knell and Stiglbauer (2008) focuses on a particular aspect of wage negotiation. In many countries, wage negotiations at the sectoral level follow a staggered pattern. A leading sector is opening the annual negotiation rounds, and the wage settlement in that sector serves as a reference norm for the subsequent negotiations in other sectors. Given that wages are typically set for some amount of time, a staggering structure as in Taylor's original (1980) model arises. The reason that wages are set relative to reference norms may have behavioral reasons (as in fairness stories of Bewley (1999) or the relative wage comparisons in Fuhrer and Moore, 1995). This paper models the staggering structure close to what is observed in a particular country, that is, Austria.

The authors show how theoretically substantial persistence of inflation can arise from staggering of wage negotiations in the presence of wage norms, but that the precise definition of reference norms and potential asymmetries in the importance among sectors matters. In particular, ceteris paribus a structure with wage leadership implies less persistence than a structure with symmetric reference norms. Knell and Stiglbauer (2008) show that for the case of Austria the assumption of a norm that is based on wage leadership performs best to match the data.

An attractive feature of the model is that it can be applied to other countries that have other patterns of staggering of wages and/or other notions of wage norms (e.g., leadership in negotiations). The model can be structured to capture any time pattern of sectoral wage negotiations, and thus potentially explain cross-country differences in inflation persistence and wage rigidity. These differences have been difficult to match with measures of labour market institutions. It can potentially also be used to simulate and assess the macroeconomic effects of the January effect in

wage and price setting, which the WDN has uncovered in micro data. Further work using this framework is certainly warranted.

4.2.6. Downward wage rigidity and optimal monetary policy

Nominal and real downward wage rigidity has received considerable attention in the labour literature and has been analysed using micro data. However, there is a dearth of research exploring the macroeconomic consequences of downward wage rigidity and their implications for optimal monetary policy. Fahr and Smets (2008) fill this gap in a general equilibrium study of a monetary union that incorporates downward wage rigidity, using a second-order approximation.

The paper finds that, first, with asymmetric wage rigidity, nominal wage changes are skewed upward, and the optimal steady-state inflation rate is strictly positive. Second, the dynamic response of price changes also becomes asymmetric, as do changes in hours worked, though in the opposite direction. In a two-region version of the model where rigidity differs across regions, terms of trade effects to symmetric shocks are substantial, and the more rigid region adjusts persistently with relatively higher inflation rates. Finally, asymmetric shocks may lead to deflationary pressures in parts of a monetary union, because of the asymmetrically strong increase in wages, which leads to higher inflation in one region, but downward pressures in the other.

Given that there is downward wage rigidity, does this have any effects on the inflation rate that a central bank should target? After all, there would be an asymmetry in the adjustment of labour markets, and higher inflation may help to "grease the wheels" of the economy. But how large should the optimal inflation rate be? The study by Fagan and Messina (2008) addresses this question in a quantitative macroeconomic model that that is able to match the observed individual wage change distributions in countries showing different degrees of nominal and real rigidities. Asymmetries in these distributions are used to estimate the key wage setting parameters in the model.

The optimal inflation rate for the U.S. lies in the range of 2 to 5 percent, depending on the data set used. This is due to a high degree of downward nominal wage rigidity. Interestingly, the paper finds that the optimal inflation rate for selected European countries (characterized by high real rigidity and low nominal) lies between zero and 2 percent -- hence consistent with the expressed target for the ECB.

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Annex 1: WDN participants

CHAIRPERSON: **Frank Smets (ECB)** SECRETARY: **Ana Lamo (ECB)**				
GROUPS	MACRO GROUP	MICRO GROUP	SURVEY GROUP	META GROUP
CONTACT PERSON	**Frank Smets (ECB)**	**Juan F. Jimeno (Banco de España)**	**Silvia Fabiani (Banca d'Italia)**	**Frank Smets (ECB)**
Belgium	Grégory de Walque Raf Wouters	Philip Du Caju Catherine Fuss Ladislav Wintr	Martine Druant Philip Du Caju	Raf Wouters
Cyprus	Maria Papageorghiou			
Bulgaria National Bank	Mariela Nenova			
Czech Republic	Ian Babetskii Kamil Dybczak Tibor Hlédik	Kamil Galuščák Kamil Dybczak	Kamil Galuščák Kamil Dybczak Ian Babetskii	Ian Babetskii
Denmark	Peter Storgaard	Niels Lynggård Hansen		
Estonia			Aurelijus Dabusinskas Tairi Rõõm	
Finland	Juha Kilponen Juuso Vanhala	Juha Kilponen		
France	Hervé Le Bihan	Patrick Sevestre Thomas Heckel Guillaume Horny	Jeremi Montornès	Hervé Le Bihan
Germany	Michael Krause	Daniel Radowski	Daniel Radowski	Michael Krause
Greece	Daphne Nicolitsas	Daphne Nicolitsas Theodora Kosma	Daphne Nicolitsas Theodora Kosma	Daphne Nicolitsas
Hungary	István Kónya	Gábor Kátay	István Kónya Gabor Kezdi Adam Reiff	
Ireland	Karl Whelan	Martina Lawless	Martina Lawless Mary J. Keeney	
Italy	Fabrizio Venditti	Alfonso Rosolia Fabrizio Venditti	Silvia Fabiani Roberto Sabbatini	Silvia Fabiani
Lithuania			Ernestas Virbickas Ruta Rodzko	
Luxembourg	Thomas Mathae Olivier Pierrard	Patrick Lünnemann Ladislav Wintr	Thomas Mathae Patrick Lünnemann	
The Netherlands		Gerbert Hebbink	Marco Hoeberichts Ad C.J. Stokman	
Austria	Markus Knell Fabio Rumler Alfred Stiglbauer	Wolfgang Pointner Alfred Stiglbauer	Claudia Kwapil	Alfred Stiglbauer
Poland	Michał Gradzewicz	Wiktor Wojciechowski	Pawel.Strzeleck Wiktor Wojciechowski	
Portugal	Carlos Robalo Marques	Pedro Portugal Claudia Duarte	Fernando Martins	
Slovenia			Jan Grobovsek	

			Matija Vodopivec	
Spain	James Constain	Juan F. Jimeno Mario Izquierdo	Mario Izquierdo	Juan F. Jimeno
Sweden	*Mathias Trabandt*	Mikael Carlsson *Björn Andersson*		
UK	Stephen Millard			
ECB-DGR	Frank Smets Kai Christoffel Gabriel Fagan	Ana Lamo	Frank Smets Ana Lamo	Frank Smets Ana Lamo
ECB-DGE	Tobias Linzert *Boris Hofmann* Daphne Momferatou Melanie Ward-Warmedinger Keith Kuester Stephan Fahr	Jarkko Turunen Philip Vermeulen		Philip Vermeulen
Uni.Di Torino	Giuseppe Bertola		Giuseppe Bertola	Giuseppe Bertola
Univ. Girona		Julian Messina	Julian Messina	Julian Messina

Annex 2 – The main characteristics of the WDN national surveys

Country	Sectoral coverage	Firms' size	Sample size	Number of respondents *(reponse rate)*	Ad hoc survey?	Geographical breakdown	Who carried out the survey	How was the survey carried out
Austria	Manufacturing Energy Construction Trade Bus. services Fin. intermed.	≥ 5	~ 3,500	557 *(16%)*	Ad hoc	No	External Company (WIFO)	Traditional mail and Internet
Belgium	Manufacturing Energy Construction Trade Bus. services Fin. intermed.	≥ 5	~ 4,100	1,431 *(35%)*	Ad hoc on the business survey sample	No	NBB	Traditional mail
Czech Rep.	Manufacturing Construction Trade Bus. services	≥ 20	1,591	399 *(25%)*	Ad hoc	No	CNB branches	Internet
Estonia	Manufacturing Construction Trade Bus. services	≥ 5	~ 1,400	366 *(26%)*	Ad hoc	Yes (Tallinn–non-Tallinn)	External company	Internet
France	Manufacturing Trade Bus. services Non-market serv.	≥20 industry ≥ 5 services	~ 6,550	2,029 *(31%)*	Ad hoc	Yes	Local branches	Phone, mail, and face to face
Germany	Manufacturing Bus. services	All (56 firms with <5)	4,600	1,832 *(40%)*	Attached to IFO business survey	East-West	IFO	Traditional mail
Greece	Manufacturing Trade Bus. services	≥ 5	5,000	429 *(9%)*	Ad hoc	All regions	External company	Traditional mail
Hungary	Manufacturing Energy Construction Trade Bus. services Fin. intermed.	≥ 5	3,785	2,006 *(53%)*	Ad hoc	All regions, stratified by NUTS1 regions	External company	Face-to-face interview
Ireland	Manufacturing Energy Construction Trade Bus. services Fin. intermed.	≥ 5	~ 4,000	985 *(25%)*	Ad hoc	No	External company	Traditional mail, phone
Italy	Manufacturing Trade Bus. services Fin. intermed.	≥ 20	~ 4,000	953 *(24%)*	Ad hoc	Yes	External company	Internet
Lithuania	Manufacturing	≥5	2,810	500	Ad hoc	No	External	Phone, mail, face-

	Energy Construction Trade Bus. services Fin. intermed.			*(18%)*				company	to-face
Luxembourg	Manufacturing Energy Construction Trade Bus. services Fin. intermed	≥1	>7,000	survey not finished yet	Ad hoc		No	BCL	Email
Netherlands	Manufacturing Construction Trade Bus. services Fin. intermed.		≥ 5	2,116	1,068 *(50%)*	Ad hoc	No	External company	Internet
Poland	Manufacturing Energy Construction Trade Bus. services Fin. intermed.		All	~1,600	1,161 *(73%)*	Ad hoc + attached to the labour market survey	All regions	National Bank of Poland (branches)	Traditional mail
Portugal	Manufacturing Energy Construction Trade Bus. services Fin. intermed.		≥ 10	~5,000	1,499 *(31%)*	Ad hoc	No	Banco de Portugal	Traditional mail and internet
Slovenia	Manufacturing Energy Construction Trade Bus. services Fin. intermed.		≥ 5	~ 3,000	658 *(22%)*	Ad-hoc	No	Banka Slovenije	Traditional mail and internet
Spain	Manufacturing Energy Trade Bus. services		≥ 5	3,000	1,835 *(61%)*	Ad-hoc	No	External company	Mail, phone, fax or internet

Annex 3: The Structure of Earnings Survey

The Structure of Earnings Survey (SES henceforth) is a standardised survey conducted by the national statistical offices of 20 European countries. It involves interviewing a large sample of firms/plants randomly selected from the Social Security General Register records or similar firm registers in each country, and obtaining information on both the firm/plant as such, and a random sample (ca. 20 percent, depending on the size of the firm) of their employees. It was conducted for the first time in 1995. In 2002, the survey was repeated and it was then decided that it will be conducted every 4 years, starting from 2002, although at the moment only two waves are available.[21]

It contains information on several measures of pay and hours of work, age, gender, and educational attainment among other workers characteristics, and some characteristics that are job specific as type of contract, sector, occupation, etc. Information obtained about the firm includes number of employees, whether the firm is privately owned, the nature of the wage bargaining agreements, etc. The SES is uniquely suited for the WDN studies on wage structure and wage differentials as (i) is comparable across countries. (ii) It is a matched employer employee dataset and, therefore, allows controlling for individual, job-specific and firm-specific features when estimating a comparable measure of wages and "conditioning out" composition effects from both workers and firms. (iii) The data is collected at the firm level, which gives us more accurate information on pay and earnings, variables that are usually very noisy in household surveys.

The access to SES data for research is limited. So far, the WDN has had access to data for ten countries (Austria, Belgium, Czech Republic, Germany, Greece, Hungary, Ireland, Italy, the Netherlands, and Spain). This access has been granted by different channels: ECB access at the Safe Center in Eurostat premises, remote access by the ECB, and access via NCB. [22]

The table below shows some features of the sample size available in each country.

[22] DGS at the ECB provided very valuable help in the process of getting access to these data.

Country	Sample size wave 1	Sample size wave 2
Austria (1996 for wave 1)	93,941	85,481
Czech Republic (2002 & 2006 for wave 1 & 2)	541,156	957,279
Belgium (1999 for wave 1)	101,302	102,941
Germany (2001 for wave 2)	652,676	467,932
Spain	170,697	173,487
Greece	38,071	41,449
Hungary (1996 for wave 1)	91,578	119,019
Ireland	36,727	16,359
Italy	79,501	73,692
The Netherlands	66,196	37,860

Except when indicated, wave 1 refers to 1995 and wave 2 to 2002. In the case of the Czech Republic is not strictly SES data but a similar national source: MEE.

Annex 4: The IWFP methodology

The IWFP methodology involves the computation of two indicators, based on the cross-sectional distribution of individual wage changes, which provide estimates of the percentage of workers potentially subject to DNWR and DRWR. Specifically, DNWR is measured by:

$$DNWR = \frac{f_n}{f_n + c_n}$$

where *fn* is the fraction of workers with nominal wage freezes and *cn* is the fraction of workers receiving wage cuts. The assumption underlying this measure is that workers who experienced a nominal wage freeze, would in the absence of DNWR, have received a wage cut.

Measuring DRWR is more difficult, inter alia, because the "inflation rate" relevant to wage setting is not directly observable. To deal with this problem, DRWR is measured using information on the fraction of observations missing from the lower tail, below the expected rate of inflation, as compared to the equivalent area of the upper tail of the distribution (that is, the area from {median + [median _ expected inflation]} to infinity}). Specifically, the measure is:

$$DRWR = 2\frac{u - l}{u}$$

where u is the fraction of observations in the upper tail of the wage change distribution and l is the fraction of observations in the lower tail below expected inflation, which is approximated by the prediction of a regression on past values. The ratio is multiplied by two to account for the fact that even if the observed rate of inflation coincides with the median of the expected rate of inflation in each year, half of all wage changes will in fact be based on inflation expectations that are lower than actual inflation. If these workers receive a wage change equal to their own expected rate of inflation, their wage change will be below the observed rate of inflation, hence biasing downwards the estimates of DRWR.