The Causes and Consequences of Nominal and Real Wage Rigidity: a Sectoral Approach

Julián Messina (University of Girona, IZA and FEDEA)[1]

Philip Du Caju (National Bank of Belgium), Claudia Filipa Duarte (Bank of Portugal),

Mario Izquierdo (Bank of Spain), Niels Lynggård Hansen (Danmarks Nationalbank),

PRELIMINARY

Abstract

This paper presents estimates based on individual data of downward nominal and real wage rigidities for thirteen sectors in Belgium, Denmark, Spain and Portugal in order to examine the causes and consequences of rigid wages. Our methodology follows the approach recently developed for the International Wage Flexibility Project (IWFP), whereby resistance to nominal and real wage cuts is measured through departures of observed individual wage change histograms from an estimated counterfactual wage change distribution that would have prevailed in the absence of rigidity. We evaluate the role of wage bargaining institutions and worker and firm characteristics in shaping both types of rigidities as well as their consequences for the determination of employment, productivity and the dispersion of wage changes. Preliminary results indicate higher real wage rigidity for prime-age workers and white collars. Real wage rigidity decreases if firms apply firm-level wage agreements, whereas nominal wage rigidity is limited by the use of flexible pay instruments. Nominal and real rigidity have a negative impact on employment, while only nominal rigidity affects labour productivity. These findings can be related to standard labour market theories.

---

[1] We would like to thank William Dickens for his discussions and suggestions throughout this research project. We would also like to thank Juan Francisco Jimeno, Pedro Portugal and Ladislav Wintr for their comments, and Vania Stavrakeva for her patience in helping us running the IWFP protocol. Raquel Vegas, Maria Lucena Vieira and Bo William Hansen provided expert assistance in setting up the different datasets, and are therefore gratefully acknowledged. The views expressed in this paper are those of the authors, and do not necessarily coincide with those of the institutions they are affiliated with. All errors and omissions are ours.

Introduction

The moderate levels of inflation experienced in the industrialized countries during the last decade have awakened renewed interest on an old argument: can inflation grease the wheels of the labour market? In an influential paper, Tobin (1972) argued that if central bankers aim at too low inflation rates they might hamper the functioning of labour markets. In his reasoning, moderate levels of inflation help the adjustment of relative wages if workers (or firms) are reluctant to nominal wage cuts. If inflation is too low, downward nominal wage rigidity implies higher wages and consequently higher unemployment (Akerlof et al. 1996).

Recently, a growing literature has emphasized the importance of real, rather than nominal wage rigidities for understanding macroeconomic fluctuations. Hall (2005) provides an answer to the so-called Shimer's puzzle arguing that the dynamic properties of standard matching models are greatly improved when wage rigidity is taking into consideration. Within the new Keynesian literature, Blanchard and Gali (2007) show the importance of real wage rigidity to understand the dynamic tradeoffs between inflation and unemployment found in the data, and as a fundamental source of inflation inertia.

This renewed interest and the increasing availability of individual and firm level data with relatively accurate information on individual wages materialized in a flourishing literature assessing the extent of downward nominal wage rigidities in different countries and periods (see references in Section 2). Most previous literature has focused on downward nominal wage rigidity (see surveys in Camba-Mendez, Garcia and Palenzuela (2003), and Holden (2004)). Recently, the micro literature has been extended to consider downward real wage rigidities. The International Wage Flexibility Project (IWFP), a large network studying wage rigidities from individual data in 17 OECD countries showed that in many wage change distributions (mostly observed in European countries) there are asymmetries around the expected rate of inflation, rather than at zero wage changes (Dickens et al. 2007). This was interpreted as evidence of downward real wage rigidity, and raised a number of questions such as the determinants and consequences of nominal versus real rigidities, and their relationship with inflation.

This paper applies the methodology from the IWFP to study the causes and consequences of wage rigidity. Unlike Dickens et al. (2007 and 2008) where nominal and real rigidity are measured from individual wage change distributions at the aggregate level, we estimate downward nominal wage rigidity (DNWR) and downward real wage rigidity (DRWR) based on individual data for 13 sectors (both manufacturing and services) in 4 countries: Belgium, Denmark, Spain and Portugal. The time frame of the study includes 1990-2006, although the available years vary from country to country. To our knowledge, this is the first paper exploiting sectoral measures of wage rigidity based on individual data.[2]

The sectoral approach of the paper has several advantages, which allow us adding to the existing literature in a number of dimensions. First, we provide a test for robustness of previous results. Our sectoral data easily allow us to control for country and sector unobserved heterogeneity and compositional effects. Hence, all the analysis presented here will be free of confounding effects that remain fixed across countries and sectors and consequently less subject to possible omitted variable biases. Second, we extend previous analysis on the determinants of wage rigidity. We explore the role of compositional effects including worker characteristics such as the gender, age and skill composition, and firm characteristics such as the size distribution of sectors in the determination of downward nominal and real rigidities.[3] Moreover, we explore the impact of two crucial elements in the determination of wage rigidities such as the role of collective wage agreements and flexible wage components in the remuneration policies of firms. Finally, we extend the analysis of the consequences of nominal and real rigidity for the macroeconomy. While previous attempts concentrated on how rigidities shape the aggregate unemployment rate (see Dickens et al., 2008) we concentrate on the impact on employment, productivity and the dispersion of wage changes in the upper half of the distribution.

Our findings indicate that both compositional effects and structural features of the labour market shape the prevalence of DNWR and DRWR across countries and sectors, and highlight important differences in the determinants of both types of rigidity. While the availability of firm level union contracts (as opposed to contracts bargained at the sectoral or national level) ease real wage cuts, firms use flexible pay elements such as bonuses and overtime payments to try to circumvent nominal wage inflexibility. As regards their consequences for the labour market, we find a similar negative impact of DNWR and DRWR on employment. Interestingly, we fail to find a negative impact of DRWR on labour productivity, but our preliminary evidence suggests a positive and statistically significant effect stemming from DNWR. This is consistent with survey evidence (Campbell and Kamlani, 1997), which attributes efficiency wage considerations and adverse selection as driving factors in the resistance of workers to receive nominal wage cuts.

The rest of the paper is organized as follows. Section 2 describes the methodology used for the study and discusses some suggestive evidence of DNWR and DRWR from selected wage change histograms in our countries and sectors. Section 3 describes the main characteristics of

---

[2] Holden and Wulfsberg (2007, 2008) also study DNWR and DRWR at the industry level, but their estimates are based on industry data, hence on average wages at the industry level.

[3] See Du Caju et al. (2008) for a similar disaggregated approach for Belgium

the data. Sections 4 to 6 present the main results in the paper. Section 4 describes the results obtained, disentangling the role of sectors and countries in the determination of rigidities, while sections 5 and 6 discuss the causes and consequences, respectively, of each type of rigidity. Section 7 concludes.

2. Methodology

The empirical literature on downward wage rigidity (DWR) is organised along two distinct lines of research. In the spirit of Layard et al. (1991), many authors have studied the reaction of wages to changes in relevant variables, i.e. unemployment and productivity, mainly using macroeconomic data. This paper adds to a second line of research, where measures of downward wage rigidity rest on the idea of an asymmetric behaviour of wage changes in response to notional wage increases versus notional wage cuts, using microeconomic data.

Estimates of DNWR based on individual micro data can be largely grouped into three broad families. Estimates that seek for asymmetries in the wage change distribution, assuming that the effects of rigidity are seen only below the median and that the distribution would be symmetric in the absence of rigidity (see Dickens et al. 2007 and Card and Hyslop, 1997). Estimates based on the assumption that, in the absence of changes in the extent of rigidity certain aspects of the wage change distribution are constant. Kahn (1997) pioneered this approach, consisting in testing whether the size of the bins in the wage change histograms at a given distance from the median, is smaller when they correspond to wage decreases, than when they refer to wage increases. This approach has been recently extended to consider DRWR by Christofides and Nearchou (2008). Lastly, estimates are based on the assumption that there is an ideal type of wage change distribution (often called notional) and departures from this ideal distribution are attributed to either DNWR or DRWR. Altonji and Devereux (2000) and Dickens et al. (2008) follow different versions of this methodology, the former focusing on DNWR and the latter studying the joint importance of DNWR and DRWR. These methodologies estimate the parameters of the notional wage change distribution making use of moments that are assumed not to be affected by rigidity (for example the 90th and 80th percentile of the distribution).

The IWFP engaged in extensive testing of each of these three methodologies and concluded that the most versatile approach to deal with the diversity of data and realities under study was the latter, based on an ideal distribution. This methodology, reviewed at length in Dickens and Goette (2006), is the one applied in this paper. Our method estimates DWR at the individual level (using employee wage data), but from the perspective of the firm (looking only at wage changes of workers that stayed with the same firm in two consecutive years). Hence, we abstract from wage flexibility associated with worker turnover.

The IWFP method first corrects the observed distribution of individual wage changes for measurement errors, assuming that an observed wage cut that is compensated the year after with a wage increase constitutes a measurement error. This assumption, that all auto correlation in wage changes is due to measurement error, is suggested by the findings of Abowd and Card (1989) and has been extensively verified using data from Gottschalk (2007). Controlling for measurement error is crucial, since studies correcting for measurement error consistently find more evidence of DWR, as reviewed in Dickens et al. (2007).

Once an error free wage change distribution is available, the IWFP procedure applied here jointly estimates downward nominal wage rigidity (DNWR) and downward real wage rigidity (DRWR), together with the average reference point for real wage rigidity (expected inflation or bargaining focal point). The measures of DWR attempt to capture the fraction of workers who would not receive a nominal or real wage cut when they were scheduled for one, no matter what the reason for the expected wage cut is. Hence, these measures are designed to be largely independent of macroeconomic conditions, in order to reflect structural features in the functioning of the labor market.

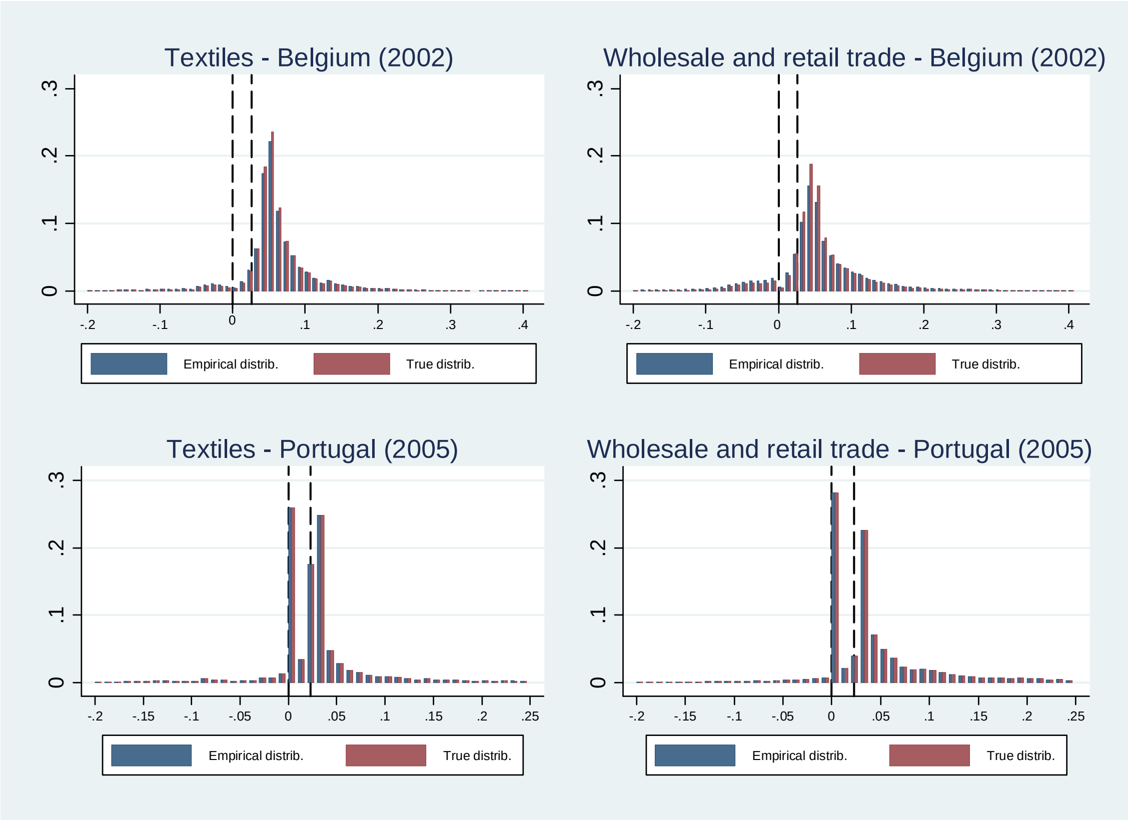
Using the “true distribution”, the IWFP procedure consists of fitting a model of wage changes that jointly estimates the parameters of the notional distribution, the share of workers affected by DNWR and DRWR as well as the relevant focal point for DRWR, using GMM. It is assumed that the so-called “notional distribution” of wage changes under flexibility follows a symmetric two-sided Weibull, which parameters can change year by year and sector by sector and are estimated by the IWFP protocol. However, a fraction of the population is potentially subject to DWR, and if their notional wage change falls below their reference point (zero in case of DNWR and expected inflation or a bargaining focal point in case of DRWR), they will receive a wage change equal to this reference point, instead of the notional wage change. It is important to highlight that the focal point relevant for the estimation of DRWR is estimated by the protocol, rather than assumed at a given rate (e.g. expected inflation). The estimation is based on a grid search for asymmetries in the wage change distribution around the expected inflation rate. As will be shown below, in highly centralized countries the focal point of wage changes might differ from expected inflation, being either below or above depending on the conditions for negotiating wages in each year.

A simple illustration following two selected cases from the individual wage change distributions in each sector, country and year can help illustrate this methodology. Figure 1 presents the wage change distribution of workers staying for two consecutive years in the same job in the Textiles and Wholesale and retail sectors in Belgium and Portugal. The Belgium data refers to the wage changes in 2001-2002, and the Portuguese shows wage changes for the period 2004-2005. The blue bars refer to the observed wage change distribution, while the red bars present the true wage change distribution, once measurement error in the data has been corrected. The vertical line to the left shows the zero wage change, while the vertical line to the right of each graph denotes expected (national) inflation in each year. Several features are worth noting from the graphs. There is virtually no distinction between the observed wage change distributions and the estimated true wage change distributions. This is not surprising; given the high quality administrative data used in this study (see more details about the data in the next section).

Concentrate on the bottom-left graph, displaying wage changes in the textile sector in Portugal. This graph shows signs of DNWR. There is a large spike at zero wage changes, and a missing mass of observations below this point. Note also that there is missing mass just above the zero wage change. This might be an indication of symmetric (e.g. menu costs), rather than downward nominal wage rigidity. An additional advantage of the IWFP is that it will jointly estimate symmetric wage rigidities, since failing to take into account this feature of the data might bias upwards the estimates of downward wage rigidities. The graph also clearly displays an indication of DRWR. A large mass of wage changes are clustered around the expected inflation rate, and again, we observe missing mass below this point. The IWFP will measure the departures highlighted above of this true wage change distribution from an estimated symmetric two sided Weibull distribution as indications of DNWR and DRWR respectively. Let us now consider the bottom right graph, which measures wage changes in the Wholesale and Retail trade sector in the same country. The evidence regarding DNWR is very similar. As in the previous graph, there is a large spike at zero and missing mass below it. With regards to DRWR however, there is a slight difference. There is a large spike in the positive wage change histogram, and missing mass below, but this new spike lies slightly above the expected inflation rate. This concentration of observations could be related to a bargaining focal point in the sector during that year, and highlights the importance of estimating, rather than imposing, the focal point of asymmetries in the positive wage change range.

Let us turn now to the first row in Figure 1, which displays wage change histograms for the two sectors in the Belgium case. In contract with the Portuguese case, there is no evidence of DNWR. No spike at zero and no missing mass below it. There is however a clear sign of DRWR, and similarly to the Wholesale and Retail trade sector in Portugal, the focal point seems to lie slightly above the expected inflation rate. A final observation worth doing from these two graphs is that country differences seem much more relevant than sectoral patterns. This issue will be further explored below.

Figure 1. Wage Change Distributions in Belgium and Portugal. Selected Sectors



3. The data

In this paper we analyze individual wage changes for four countries: Belgium, Denmark, Portugal and Spain. In all four cases the sources are administrative databases covering most sectors in the economy. There are several advantages in using administrative sources. Since we derive summary measures of wage rigidity from wage change histograms we need relatively large sample sizes. The sample sizes typically encountered in household survey databases might be appropriate for measuring wage rigidities at the country level, but would not allow for the sectoral analysis we are aiming at. Additionally, administrative instead of household and/or employer surveys are often seen as more reliable than survey data, being less prone to misperception, misreporting and rounding errors (Biscourp et al. (2005)).

Even if our four databases are relatively error free and extremely well suited for the analysis, it is important to bear in mind that building a cross-country database is quite challenging. Despite our efforts towards harmonization, the total dataset is bound to include intrinsic concept differences, which reflect the diversity of data sources considered. We provide next with a brief description of the main characteristics of each data set.

In the case of Belgium, we use an administrative database on labour earnings, which covers about one third of the workers in the private sector, referring to all individuals born between the 5th and the 15th day of any month, for the period from 1990 to 2002. This database contains information on annual gross earnings, annual working days, and worker characteristics, such as age, sex and occupation category (blue- or white-collar), covering all sectors of activity (including services). The annual gross earnings are the base wage plus bonuses, premia, overtime hours paid, and so on. Adding to the exclusion of natural persons and firms with less than 5 employees, for confidentiality reasons, the sample is further restricted to the following: full-time permanent job-stayers, who work in firms classified with NACE codes from C to K; workers aged between 18 and 64 for men and 59 for women; workers who have not more than one month of sick leave (or other "abnormal" days off) per year, and who worked at least 2 years for the same employer. Furthermore, we exclude individuals whose earnings are below the legal minimum wage and we drop the same number of observations from the upper tail of the distribution.

Regarding Portugal, the dataset used was made available by the Instituto de Informática e Estatítica da Solidariedade (Social Security's Statistical Office) and refers to all individuals that paid contributions to the general social security system, in the period from 2000 to 2006. This database covers all activity sectors and contains information on monthly declared earnings reported in October of each year, number of working days in that month, worker characteristics, such as age, sex, worker status (dependent worker, self-employed or other) and tenure, and firm characteristics, like region and size. The monthly declared earnings encompass the base wage and other types of remuneration (variable or other). The database is restricted to a 10 per cent random sample of the dependent workers registered at least once in the period considered, who declared a base wage not inferior to the minimum wage. We further restricted the sample to job-stayers working at least for two consecutive years in the same company, who worked a full month. In this case, due to dataset restrictions, it is not possible to distinguish between full-time and part-time workers.

The Spanish data come from the "Muestra Continua de Vidas Laborales 2005" which is a novel dataset containing a sample of 4 per cent of individuals with any type of relationship with the Social Security System in 2005. From this dataset, we get information about the whole labour market career of these individuals including personal characteristics (sex, age, and a proxy for educational attainment), job characteristics (sector of activity, firm size, type of contract) and earnings. In particular, we have information about monthly and yearly earnings including almost any type of bonuses or overtime payments. This sample is restricted to include only full-time job-stayers working at least for two consecutive years for the same employer in manufacturing firms, construction and private services sectors of the economy, for the period

1990 to 2005. In addition, the earnings variable is top censored for individuals with earnings above the maximum level of contribution, so we exclude these individuals from the sample. We also exclude earnings below the legal minimum wage, which coincides with the minimum level of contribution.

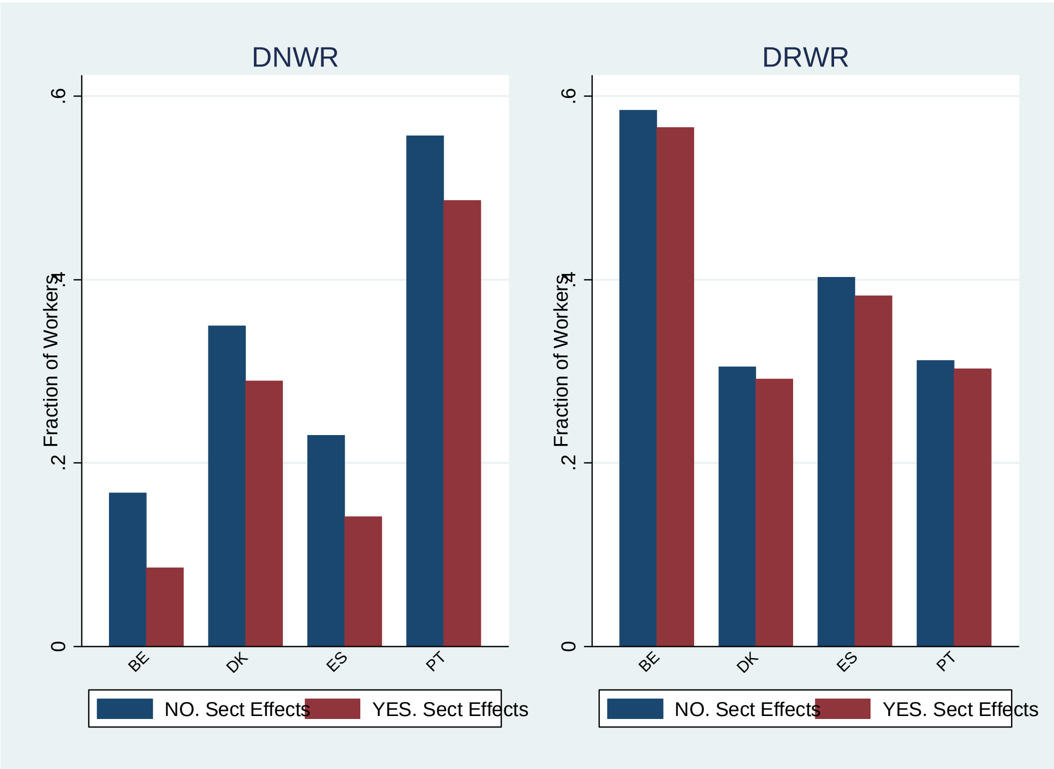
Finally, the Danish dataset comprises annual observations on individual earnings, i.e. base wages per hours worked including pension contributions, as well as information on a number of background variables, like age, sex, education, occupational experience, work function, and sector. The data are collected electronically directly from the administrative earnings registers at the firms and are part of the Integrated Database for Labour Market Research, IDA. It comprises all workers who are employed in a firm with at least 10 full time employees, i.e. around 90 per cent of all employees in the private sector. Here we only look at job stayers employed at a full-year basis in the age group 20-65 years. This leaves us with 4.1 million individual wage observations, and the average wage trajectory is around 3 years.

4. Downward nominal and real rigidity: a first look at the data

In this section we examine the relationship between both types of rigidities. Before moving forward, we start searching for systematic differences in the data. If technology is an important determinant of rigidities in the labour market, we would expect the sectoral dimension in our dataset to be a crucial element at the time of explaining nominal and real rigidities. On the contrary, institutional features of the labour market are expected to be largely determined at the national level, although sector specific practices within countries could also play a role. If institutions are behind differences in estimated rigidity, we would expect the country effects to explain the largest portion of the variance in the data. A simple analysis of variance provides the answer. Both regarding DRWR and DNWR, country effects clearly dominate the picture. One way ANOVA analyses show that country effects explain 24% (26%) of the variability in DRWR (DNWR) while sectoral effects explain only 7% (0.6%) of the variance respectively. However, two-way ANOVA analyses featuring countries and sector explanatory variables reject the null of the sectoral effects equal to zero for both types of rigidities. It is important to note that, in spite the prevalence of country effects there is considerable variability in the rigidity estimates within countries and years. The largest average standard deviation within country-year observations corresponds to nominal and real rigidity in Denmark (0.3 and 0.24 respectively) and the lowest to DRWR in Spain (0.12). Moreover, ANOVA analysis shows that the interaction of countries and sectors is significant in regressions of DNWR and DRWR (F-values: 2.33 for DRWR and 4.24 for DNWR), suggesting the importance of technology and institutions.

Figure 2 shows country averages of DNWR and DRWR. The blue lines are simple averages, while the red lines show country means after controlling for sectoral effects. As expected, sectoral effects have a limited impact on country averages, especially in the case of DRWR. Among the four countries studied, Portugal displays the highest level of DNWR, competing for the lowest ranking in DRWR with Denmark. At the other extreme, Belgium displays the highest level of real rigidity and the lowest of DNWR. Spain displays higher DRWR than DNWR, the opposite of Denmark, which is the country that presents overall, lower levels of rigidity. This country ranking is virtually identical to that found in Dickens et al. (2008), a reassuring fact given that the datasets used in the cases of Portugal and Denmark do not coincide with those used in the original IWFP.

Figure 2. Downward Nominal and Real Wage Rigidity. Country Summaries.



Is there a relationship between nominal and real rigidity? Table 1 shows simple correlations and partial correlations of DNWR and DRWR after controlling for the different dimensions in our data. In all cases we find a negative association between nominal and real rigidity, which is significant at the standard levels of testing. Note that our measures of rigidity are designed to be independent of macroeconomic conditions. Hence, the negative relationship between DNWR and DRWR should reflect structural features of the labour markets, and not a mechanical association whereby lower inflation is translated into more rigid nominal wages and less real rigidity. We have nonetheless tested this hypothesis, and failed to find a relationship between both sectoral or national inflation rates and the negative association between DNWR and DRWR.

Table 1. The relationship between DNWR and DRWR

	Correlation	Spearman
Simple Correlation	-0.33	-0.38
Partial Correlation Controling for:		
Country Effects	-0.17	-0.18
Country and Year Effects	-0.17	-0.18
Country, Year and Sector Effects	-0.22	-0.19
Country*Year and Sector Effects	-0.22	-0.2
Country*Sector and Year Effects	-0.27	-0.19

Note: Number of observations: 416. All correlations are significant at the 99 percent level.

5. The relevance of composition effects in explaining real and nominal wage rigidity.

In this subsection we focus on the relevance of workers and job characteristics to explain differences in real and nominal wage rigidity. The literature has related downward wage rigidity to workforce composition (Campbell (1997) and Du Caju et al. (2007)) and structural features at the sector level (see e.g. Du Caju et al., 2008). However, none of these papers had an international dimension. In this section we confront our sector estimates of DRWR and DNWR for four countries to compositional effects and structural characteristics of the sectors. Alongside information on the composition of the workforce (shares of female workers, share of blue-collar the age distribution of workers), our data include information on wage bargaining institutions, firms' variable-pay policy and competition in the sector.

We start first investigating the role of worker and firm characteristics and explore the role of structural features below. Our database contains information about the sectoral distribution of workers characteristics such as age and gender, and firm's characteristics such as the size distribution or the share of blue and white collar workers. The role of each of these dimensions in determining wage rigidity can provide us some guidance regarding the relative relevance of different theories of pay determination. For instance, theories about firm-specific human capital predict firms will be less prone to cut wages of older workers, if age is a good proxy for tenure at the firm. The gender distribution could affect wage rigidity in a model of insiders-outsiders, where a wage cut is less likely for the insiders, given their higher wage bargaining power. In this case, the female employment share (and share of young workers) could proxy for the share of outsiders in a sector and country.

Also, job characteristics can be related to wage rigidity according to different theories about the functioning of the labour market. The share of white collar workers is positively related to wage rigidity in a model of efficiency wages that assumes that the effort of white-collar workers is more difficult to monitor. Similarly, monitoring might be more difficult in larger than in smaller firms. The size distribution of the firms can also be seen as a proxy for competition in the product market, and hence, we would expect more rigid wages in larger firms according to a rent-sharing model.

Our next set of regressions aims at determining the effect of worker and job characteristics in DWR. The dependent variables are the share of workers subject to DNWR or DRWR. Since both variables lie within the interval [0,1] OLS is not appropriate inasmuch the predicted values could lie outside this range. Papke and Wooldridge (1996) suggest solving this problem suing a technique called Fractional Logit, whereby E(y|x) is modeled as a logistic function:

$$E(y|x) = \exp(X\beta)/[1+ \exp(X\beta)]$$

This ensures that the predicted values for y are in the interval [0,1] and the effects of interest can be easily presented as marginal effects. Tables 2 and 3 show marginal effects from fractional logit models investigating the relationship between real and nominal wage rigidity, respectively, and firm and worker characteristics. The regressions always include time and country effects, and we present results with and without sectoral fixed effects in order to check whether composition effects hold once we control for unobserved sectoral factors.

Let us start with DRWR. Table 2 shows a positive and significant impact of the female share on real wage rigidity once we introduce sectoral dummies in the regression. This result does not validate theoretical predictions from an insider-outsider model since the female share should be approximating the relevance of outsiders and hence it should be negatively related to wage rigidity. However, this result might indicate that firms might refrain from real wage cuts when the collective affected (in this case women) has less attachment to the labour market, and consequently a higher probability of quitting after a wage cut. This interpretation is consistent with our finding that younger workers present more DRWR than older workers in our sample. In any case, the impact of the female share in DRWR appears to be also related to the skill distribution of the workforce, since its positive impact on wage rigidity looses significance when we control for share of blue collars. In the case of DNWR, Table 3 shows that the female share presents a similar positive and significant sign on wage rigidity, although statistical significance does not survive to the introduction of sectoral dummies in the regression.

Table 2. The determinants of DRWR: compositional effects

	(1)	(2)	(3)	(4)
Female employment share	0.04	0.68*	-0.06	0.67
	(0.08)	(0.32)	(0.09)	(0.42)
Age >16 & Age<25	1.81	2.45*	2.20	4.09**
	(0.93)	(1.03)	(1.23)	(1.33)
Age >25 & Age<55	2.30*	3.51**	3.09*	5.86**
	(1.06)	(1.27)	(1.42)	(1.70)
Firm size: 21-50	-0.56	-0.91*	-0.63	-1.21*
	(0.35)	(0.53)	(0.40)	(0.56)
Firm size: 51-250	0.60	-0.25	0.36	-0.51
	(0.32)	(0.66)	(0.31)	(0.71)
Firm size: greater than 250	-0.50*	-0.70**	-0.62*	-0.54
	(0.22)	(0.27)	(0.25)	(0.29)
Share of blue collars			0.02	-0.25*
			(0.09)	(0.11)
Sectoral Fixed Effects	No	Yes	No	Yes
Observations	416	416	356	356

Note: All the specifications include country and year fixed effects. Robust standard errors in parentheses. ** p<0.01, * p<0.05

The age distribution appears to be strongly related with real wage rigidity according to the results shown in Table 2, although this relationship is not monotonic. Real wage rigidity is lower for workers older than 55, the reference category in the regression, and higher for prime-age workers. The impact of younger workers in real wage rigidity is in the middle of these groups. These results are consistent with an insider-outsider interpretation, indicating higher wage rigidity for the core labour market (prime-age workers). Similarly, the lower real wage rigidity found when the share of older workers (>55) increases is coherent with a lower probability of re-employment for this group, which would make them more prone to accept a real wage cut. As in the case for female employment share, the impact of the age distribution in nominal wage rigidity is less clear cut. In this case, age categories are not statistically significant in any of the specifications.

Regarding firm characteristics, real wage rigidity is more prevalent in smaller firms (with less than 20 employees, the reference category), while the largest size category exhibits significantly lower DRWR, at least when we control for sectoral unobserved characteristics in the regression. This higher wage flexibility in large firms does not validate a model of rent-sharing where firms's size is a proxy of competition in the product market. Other confounding factors might be behind these results. For instance, the relevant level of wage bargaining might differ across different firm sizes. If larger firms have the capacity to apply firm level contracts rather than contracts negotiated at the sectoral or national level, they might be more able to introduce a higher degree of flexibility in the wage determination process. Similarly, larger firms might be able to apply more complex pay schemes, where rigidity in base wages if circumvented with other flexible pay elements (e.g. bonuses and flexible benefits). This hypothesis will be further investigated below. With regards to nominal wage rigidity results are less significant, although we find higher wage rigidity for medium size firms.

Table 3. The determinants of DNWR: compositional effects

	(1)	(2)	(3)	(4)
Female employment share	0.27**	-0.28	0.34**	-0.11
	(0.09)	(0.31)	(0.10)	(0.38)
Age >16 & Age<25	-1.64	-1.72	-2.18	-1.27
	(0.96)	(1.23)	(1.27)	(1.34)
Age >25 & Age<55	-1.26	-2.41	-2.65	-2.04
	(1.08)	(1.47)	(1.40)	(1.66)
Firm size: 21-50	0.10	0.94*	0.43	1.05*
	(0.44)	(0.55)	(0.45)	(0.53)
Firm size: 51-250	-0.09	0.46	-0.00	0.55
	(0.39)	(0.77)	(0.34)	(0.71)
Firm size: greater than 250	-0.11	0.03	0.31	-0.06
	(0.27)	(0.29)	(0.27)	(0.31)
Share of blue collars			-0.13	0.05
			(0.09)	(0.10)
Sectoral Fixed Effects	No	Yes	No	Yes
Observations	416	416	356	356

Note: All the specifications include country and year fixed effects. Robust standard errors in parentheses. ** p<0.01, * p<0.05

Finally, results for the skill distribution of workers within sectors are quite preliminary as this variable is not available for Portugal. Table 2 shows a significant and negative relationship between real wage rigidity and the share of blue collar workers when sector fixed effects have been controlled for. As previously mentioned, this higher rigidity for high skilled worker is predicted by a variety of models. Efficiency wage considerations are consistent with this finding, since firms may be less prone to apply a wage cut for workers whose effort is less easily monitored. Similarly, firms might be more reluctant to cut wages for high skill workers if their replacement is more costly than in the case of blue collars. As before, the impact of the skill composition in DNWR is less precisely estimated, results indicating more rigidity for blue collar workers, but never being significant at the standard levels of testing.

Next, we explore the impact of structural labour market features in the determination of nominal and real wage rigidities. Dickens et al. (2007) find that union coverage is positively related to DRWR across countries, with no impact on DNWR. According to their interpretation, in highly unionized economies workers might give more attention to real, as opposed to nominal, compensation because the participants may be more likely to understand the difference, hold expectations for the future inflation, and be more likely to be familiar with inflation forecasts. We go one step further here, investigating the impact of decentralisation of wage setting on downward wage rigidity within a set of highly unionized countries. Wage bargaining institutions are captured by the share of workers in the sector that is covered by a collective wage agreement signed at the firm level. Since the four countries we examine all have collective bargaining at a level above the firm, i.e. the sector and/or national level, the incidence of additional firm-level bargaining is a sign of decentralised wage setting in the sector relative to the national average. Since we do not expect a linear impact of firm level agreements on rigidities, we have constructed a categorical variable that ranges from 1 to 5 if, respectively, less than 10%, between 10 and 20%, between 20 and 30%, between 30 and 40% and more than 40% of the firms operating in the sector have a firm level agreement.

Firms might also use flexible compensation to increase wage flexibility in the presence of rigid base wage structures. We have collected information on the availability of such flexible payment schemes. The variable flexible pay is defined as the share of variable bonus payments in total earnings in the sector. This variable presents an extremely skewed distribution. Around 25 percent of sector-year observations have no flexible compensation whatsoever, and the median share of bonuses on basic pay is 2.8%. However, there is an important variance in the data (the standard deviation is 0.08), and in the 25% of sectors with the largest share of bonuses in pay, these flexible wage components represent more than 8% of the basic earnings. Taking into account the skewness of the variable, we have defined a dummy variable "Flexible Pay" that takes value 1 if in the sector bonuses account for more than 5% of basic earnings. Admittedly, this threshold is arbitrary, but we have experimented with different values around this level and obtained very similar results.

Table 4 reports the results of fractional logit regressions for DRWR on structural characteristics of the sector, while Table 5 does so for DNWR. All specifications include country and year dummies, the female employment share and two age category dummies. We exclude firm-size dummies since they might capture part of the effects of firm level coverage on the determination of pay. We present results without sectoral dummies in even columns, and controlling for sectoral effects in odd columns.

According to Column 1 in Table 4, the existence of decentralised firm-level bargaining reduces DRWR, although we fail to find non-linearities in this effect. All four levels of firm level bargaining have a negative and statistically significant sign, which suggests that having firm level agreements at the sectoral level increases real wage flexibility (the reference category is

Cover1, hence 0% incidence of firm level agreements). However, we cannot reject the hypothesis of equality of coefficients Cover2 to Cover5 at the 95% confidence level. Column 2 controls for sectoral fixed effects. Now we do find strong non-linearities in the impact of firm level contracts. According to these results, being in a sector where more than 40% of the operating firms have firm level agreements represent a 16% reduction real wage rigidity. A possible interpretation of these results is that since all four countries have binding wage agreements at a level above the firm, firms that set wages at a decentralised level very often pay higher wages than those agreed at a more centralized bargaining level, providing them with a wage cushion that might bring flexibility in bad times (see Cardoso and Portugal (2005)). Also, in the presence of firm specific negative shocks a firm has more margin of manoeuvre to negotiate wage moderation with its own unions in the firm than with a sector-level union.

The role played by firm level agreements in DNWR appears less clear-cut. Results in Column 1 of Table 5 suggest an inverted U-shape, with medium levels of firm level agreements delivering the lowest scores of DNWR. However, none of the firm level agreement dummies is significant when sectoral effects are accounted for in Column 2. This is consistent with Dickens et al. (2007), suggesting that collective negotiation is probably something that enhances real-wage bargaining, while DNWR being more related to efficiency wage considerations and worker morale (see Agell, and Lundborg, 1995 and Campbel and Kamlani, 1997 for survey evidence on the rationales for DNWR).

On the contrary, results in Tables 4 and 5 suggest an important role of flexible pay structures in achieving nominal wage flexibility, but no effect in the determination of DRWR. Either when entered alone in the equations or together with the set of firm level agreement dummies, the effect of flexible pay is negative and significant at the 95% level of testing in the determination of DNWR, but never statistically significant in the DRWR regressions. Hence, firms seem to be able to circumvent to some extent DNWR but not DRWR using flexible forms of payment such as bonuses and flexible benefits.

Table 4. The structural determinants of DRWR

	(1)	(2)	(3)	(4)	(5)	(6)
Firm wage agreements: >=10% & < 20%	-0.10**	-0.00			-0.10**	-0.03
	(0.03)	(0.05)			(0.04)	(0.06)
Firm wage agreements: >=20% & < 30%	-0.17**	-0.02			-0.16**	-0.01
	(0.04)	(0.07)			(0.04)	(0.07)
Firm wage agreements: >=30% & < 40%	-0.08*	0.09			-0.07*	0.09
	(0.04)	(0.07)			(0.04)	(0.07)
Firm wage agreements: >=40%	-0.12*	-0.15*			-0.11*	-0.16*
	(0.05)	(0.07)			(0.05)	(0.07)
Flexible wage pay > 5%			-0.05	-0.02	-0.04	-0.07
			(0.04)	(0.05)	(0.04)	(0.06)
Sector Fixed effects	No	Yes	No	Yes	No	Yes
Observations	416	416	416	416	416	416

Note: All the specifications include country and year fixed effects, the female employment share and two age category dummies. Robust standard errors in parentheses. ** p<0.01, * p<0.05

Table 5. The structural determinants of DNWR

	(1)	(2)	(3)	(4)	(5)	(6)
Firm wage agreements: >=10% & < 20%	-0.06	-0.02			-0.08*	-0.08
	(0.03)	(0.05)			(0.03)	(0.05)
Firm wage agreements: >=20% & < 30%	-0.11**	-0.10			-0.08	-0.08
	(0.04)	(0.06)			(0.05)	(0.06)
Firm wage agreements: >=30% & < 40%	-0.10*	-0.08			-0.07	-0.06
	(0.04)	(0.06)			(0.04)	(0.06)
Firm wage agreements: >=40%	0.08	0.02			0.15*	0.01
	(0.07)	(0.09)			(0.07)	(0.08)
Flexible wage pay > 5%			-0.14**	-0.18**	-0.17**	-0.20**
			(0.04)	(0.05)	(0.05)	(0.06)
Sector Fixed effects	No	Yes	No	Yes	No	Yes
Observations	416	416	416	416	416	416

Note: All the specifications include country and year fixed effects, the female employment share and two age category dummies. Robust standard errors in parentheses. ** p<0.01, * p<0.05

6. The consequences of nominal and real rigidity

We turn now to examine the consequences of rigidity for the labour market. Akerlof, Dickens and Perry (1996) show that in the presence of DNWR, a central banker targeting a too low level of inflation might obstruct the well-functioning of the labour market, by limiting relative wage adjustments. Hence, low levels of inflation in the presence of DNWR will result in higher unemployment. DRWR might also have a positive impact on unemployment, although in this case the increase in unemployment cannot be eased by monetary policy (Fagan and Messina, 2008). The positive impact of DNWR and DRWR on the aggregate level of unemployment has recently found empirical support (Dickens et al. 2008).

We take advantage of the sectoral nature of our data to broaden the analysis of the consequences of wage rigidity for the labour market. We consider two outcomes previously unexplored in the micro literature: employment and labour productivity. Downward rigidities are expected to limit employment insofar they increase the cost of labor. If firms cannot cut nominal or real wages they might engage in labour saving technologies, resulting in lower levels of employment. However, firms might be able to circumvent wage rigidities by using other margins of adjustment. Firm survey data analyzed by Babecký et al. (2008) shows evidence suggesting that firms facing DNWR are more likely to engage in alternative cost-reduction strategies such as: reduction or elimination of bonus payments; reduction of non-pay benefits; changes in shift assignments or shift premia; slowing down or freezing the rate at which promotions are filled; and recruiting new employees at a lower wage level than those who leave voluntarily or left encouraged by early retirement policies. Similarly, firms might be reluctant to offer generous wage increases in booms if they expect to be unable to cut wages in the future, when hit by bad times. This would limit the macroeconomic impact of wage rigidity as recently stressed by Elsby (2007). Ultimately, the impact of rigidities on employment remains an empirical question.

Next, we examine the impact of wage rigidities for the level of employment. An econometric problem arises since wage rigidities and employment are likely to be jointly determined. To avoid reverse causality, we exclude the contemporaneous rigidity indicators from the regressions and include instead lagged values of DNWR and DRWR. In this fashion, wage rigidities become predetermined variables in an econometric sense. Table 6 shows the impact of wage rigidity on the number of employees, a variable measured at the sectoral level available from EUKLEMS. All specifications include country and year fixed effects. Additionally, columns 3 and 4 add sectoral fixed effects in the regression, while columns 2 and 4 control for compositional effects including two dummies for the age structure in the sector, a female dummy, and 3 firm size dummies.

Results presented in Table 6 are very similar across specifications. In all cases we find a negative impact of both DNWR and DRWR on the number of employees, although the effect of DNWR is only significant at the 95% level or higher when sectoral unobserved fixed characteristics have been controlled for. In none of the cases we can reject the null of equal coefficients between DNWR and DRWR. Hence, both types of rigidities seem to have a similar negative impact on the level of employees. The magnitude of this effect is relatively small. According to the estimates presented in column 1, one standard deviation increase in DRWR would result in a reduction of 0.5% in the number of employees.

The small dis-employment effects of downward wage rigidities found above has two possible interpretations. As argued above, firms might use other channels to adjust labour costs in the presence of downward wage rigidities. Similarly, firms might have an incentive to compress wage increases as well as wage cuts when downward wage rigidity binds (Elsby, 2008). Hence, the resulting macroeconomic impact of wage rigidity would be diminished. The latter hypothesis will be further examined below. An alternative interpretation is that our sectoral estimates might represent a lower bound of the consequences of wage rigidity for the labor market. Akerlof and Dickens (2007) argue that the bulk of the macroeconomic impact of wage rigidities is related to general equilibrium effects, which are not possible to observe at the firm or even at the sectoral level. Hence, the small dis-employment effects found here at the sectoral level do not need to be inconsistent with the large positive consequences of wage rigidities on aggregate unemployment found in Dickens et al. (2008).

Table 6. The consequences of downward rigidities: the number of employees

	(1)	(2)	(3)	(4)
Lagged DNWR	-0.22	-0.24	-0.18	-0.22
	(1.62)	(1.94)	(2.43)*	(3.39)**
Lagged DRWR	-0.34	-0.31	-0.25	-0.25
	(2.08)*	(2.31)*	(3.19)**	(3.37)**
Time-varying compositional effects	No	Yes	No	Yes
Sectoral fixed effects	No	No	Yes	Yes
Observations	355	355	355	355
R-squared	0.57	0.72	0.93	0.94

Note: The dependent variable is log(employees). All the specifications include country and year fixed effects. Time varying compositional effects refer to the inclusion of two age category dummies, the female employment share, and three firm-size category dummies. Robust standard errors in parentheses. ** $p<0.01$, * $p<0.05$

We study the implications of downward wage rigidities for wage compression in the upper half of the wage change distribution. Following Elsby (2007), firms might compensate future labour costs due to their impossibility of cutting wages, refraining from offering generous wage increases today. This might limit the macroeconomic impact of DNWR and DRWR. Following Elsby (2007) we should observe higher wage compression in the upper tail of the wage change distribution in sectors where wage rigidity is more important. In testing for this hypothesis, we restrict the analysis to those sectors and years where expected inflation lies below the median wage change, hence to 85% of the observations in our data. When the median wage change lies above expected inflation, we do not expect an impact of wage rigidities on indicators of dispersion in the upper tail of the wage change distribution, unless firms restrict wage increases in response to the impossibility of future wage cuts. We use several indicators of the dispersion in wage changes in the upper half of the distribution: the (log of the) ratio of the 90^{th} percentile with respect to the 50^{th} percentile; and similarly with the 80^{th} to the 50^{th} percentile, the 70^{th} to the 50^{th} percentile, and the 60^{th} to the 50^{th} percentile.

Table 7 presents the estimates of DWNR and DRWR on the dispersion of wage changes in the upper half of the wage change distribution. The first panel presents estimates of DWR on the log of the percentile ratios 90/50, 80/50, 70/50 and 60/50. Panel B uses instead lagged DNWR and DRWR to exclude any possible feedback from the dispersion of wage changes on our wage rigidity estimates. All the specifications control for country and year fixed effects, and the specifications in columns 5 to 8 add sectoral effects and two age category dummies, the female employment share, and three firm-size category dummies as additional control variables.

Table 7. The Effects of Wage Rigidity on Wage Compression in the Upper Half of the Wage Change Distribution

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	90/50	80/50	70/50	60/50	90/50	80/50	70/50	60/50
Panel A. Contemporaneous Rigidity Measures								
DNWR	-0.06	-0.07	-0.07	-0.04	-0.07	-0.07	-0.08	-0.05
	(0.94)	(1.54)	(2.20)*	(2.33)*	(1.23)	(1.69)	(2.36)*	(2.57)*
DRWR	-0.10	-0.08	-0.08	-0.05	-0.06	-0.05	-0.06	-0.03
	(1.57)	(1.81)	(2.44)*	(2.30)*	(1.01)	(1.15)	(1.78)	(1.75)
Panel B. Lagged Rigidity Measures								
Lagged DNWR	-0.03	-0.02	-0.02	-0.01	-0.04	-0.03	-0.02	-0.01
	(0.41)	(0.53)	(0.60)	(0.48)	(0.77)	(0.80)	(0.83)	(0.89)
Lagged DRWR	-0.01	-0.03	-0.04	-0.03	0.04	-0.00	-0.02	-0.03
	(0.14)	(0.62)	(1.18)	(1.77)	(0.60)	(0.07)	(0.78)	(1.66)
Country/Year Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sector Fixed Effects	No	No	No	No	Yes	Yes	Yes	Yes
Compositional Effects	No	No	No	No	Yes	Yes	Yes	Yes

Note: The dependent variable is the log of the corresponding percentiles ratio. Compositional effects refer to the inclusion of two age category dummies, the female employment share, and three firm-size category dummies. Number of observations: 307 in specifications with lagged DWR and 349 with contemporaneous DWR. Robust standard errors in parentheses. ** $p<0.01$, * $p<0.05$

Our estimates in Table 7 bear little support to the hypothesis that the upper half of the wage change distribution is compressed in sectors that have more rigid wages. In all cases the signs of the DNWR and DRWR indicators (either contemporaneous or lagged) are negative, in line with this hypothesis, but in most of the specifications the coefficients are not significant at standard confidence levels. An exception is found for the effects of contemporaneous DWR measures on the 70/50 and 60/50 percentiles, which are significant at the 5 percent level (although the coefficient of DRWR becomes non-significant when sectoral unobserved characteristics and time-varying compositional effects are controlled for).

Finally, we explore the impact of real and nominal rigidity on productivity. Rigidities are likely to reduce productive efficiency by distorting firms' production choices, hence having a negative impact on productivity. However, in models with heterogeneous workers where the matching of workers to jobs is imperfect, wage rigidity will increase hiring standards such that only the most productive workers will find a job (Pisarides, 2000). This will result in higher labour productivity. Moreover, the different rationales behind the two types of rigidity studied here might result in different effects on productivity. If nominal rigidity is mostly related to efficiency wage considerations (see Franz and Pfeiffer, 2006 and Cambell and Kamlami, 1997), sectors with apparent rigid wage schedules might enhance worker morale and effort, with positive effects on productivity. Similarly, nominal wage rigidity might help retain the most able workers in a context of costly turnover due to training costs,[4] or might attract more able workers if adverse selection is important in the labour market, all these effects having a positive impact on firms' productivity. On the contrary, if real rigidity is mainly related to collective bargaining at a level higher than the firm as our previous evidence suggests, we might expect a negative impact on productivity as firms will be less able to adapt to local labour market conditions.

Table 8 presents our estimates of the impact of DNWR and DRWR on labour productivity. Labour productivity is defined as value added per employee in the sector, both variables obtained from EUKLEMS. Our results clearly indicate a positive impact of DNWR on labour productivity, which is statistically significant at the 95% level in all specifications but one, where the lowest set of controls is included. This is consistent with the efficiency wage considerations discussed above. The effects of DRWR, although positive in all specifications, are less precisely estimated and in none of the cases are statistically significant at standard levels of testing. To give a sense of the magnitude of the estimated coefficients, an increase in one standard deviation of DNWR would result in an increase in labour productivity ranging from 1.5% to 2%, depending on the specification. Similarly, if DNWR in the average sector in Belgium would increase to match the average DNWR in Portugal, labour productivity would increase between 2% and 2.5%.

---

[4] Cambell and Kamlami (1997) find this explanation to be the most relevant cause for the reluctance of firms to cut wages in a survey of US firms.

Table 8. The consequences of downward rigidities: labour productivity

	(1)	(2)	(3)	(4)
Lagged DNWR	0.06	0.08	0.06	0.07
	(1.56)	(2.40)*	(2.10)*	(2.37)*
Lagged DRWR	0.02	0.00	0.02	0.02
	(0.65)	(0.14)	(0.78)	(0.81)
Observations	355	355	355	355
Time-varying compositional effects	No	Yes	No	Yes
Sectoral fixed effects	No	No	Yes	Yes
Observations	355	355	355	355
R-squared	0.53	0.60	0.72	0.75

Note: The dependent variable is the ratio: Real VA/employees where both variables are measured as index numbers. Base year: 1995. All the specifications include country and year fixed effects. Time varying compositional effects refer to the inclusion of two age category dummies, the female employment share, and three firm-size category dummies. Robust standard errors in parentheses. ** $p<0.01$, * $p<0.05$

7. Conclusions

This paper discusses new evidence on the causes and consequences of nominal and real wage rigidity measured at the individual level. Compared to previous literature, this paper takes a sectoral perspective, which allows controlling for country unobserved characteristics throughout the analysis and extending the investigation of causes and consequences to a new set of covariates and outcome variables. Our focus regarding the causes of wage rigidities has been on the impact worker characteristics, and firm characteristics such as the use of bonuses and other flexible pay structures and the role of firm level collective bargaining. We have extended the analysis of the macroeconomic consequences of wage rigidity to examine the determination of employment, labour productivity and the dispersion of wage changes.

Our preliminary results confirm the importance of the composition of the workforce for downward wage rigidity. We find higher real wage rigidity for prime-age workers and white collars, consistent with efficiency wage theories and turnover models. In all the countries under study, there is an important role of unions in the wage negotiation process. In this context, we find that the use of firm-level collective agreements has a negative impact on real wage rigidity, a fact that may be related to the existence of a wage cushion and the ability of unions, when negotiating at a decentralized level, to adapt to the particular conditions of the firm.

The wage bargaining practices do not seem to be related to downward nominal wage rigidity, confirming that unions help workers in realizing about the consequences of inflation. On the other hand, downward nominal wage rigidity is limited by the use of flexible pay instruments such as bonuses, overtime pay and other forms of flexible compensation.

Regarding the consequences of nominal and real rigidity for the macroeconomy, we have established a negative impact, albeit small, of both types of rigidities on employment. This finding indicates that, even if firms find ways to circumvent wage rigidities, these constraints are to some extent still binding. We find no impact of real rigidities on productivity, and some indication that labor productivity increases in the presence of downward nominal wage rigidity. This last finding is consistent with survey evidence, which attributes a prominent role to efficiency wage considerations in explaining the resistance of firms to cut nominal wages.

References

Agell, J. and H. Benmarker (2007), "Wage incentives and wage rigidity: a representative view from within", Labour Economics, 14(3), 347-369.

Agell, J. and P. Lundborg (1995), "Theories of Pay and Unemployment: Survey Evidence from Swedish Manufacturing Firms", Scandinavian Journal of Economics 97, 295–307.

Akerlof, G. and W. T. Dickens (2007), "Unfinished Business in the Macroeconomics of Low Inflation: A Tribute to George and Bill by Bill and George", Brookings Papers on Economic Activity 2007:2, Brookings Institution, Washington DC

Akerlof, G., W. T. Dickens and G. L. Perry (1996), "The Macroeconomics of Low Inflation", Brookings Papers on Economic Activity 1996:1, Brookings Institution, Washington DC

Akerlof, G., W. T. Dickens and G. L. Perry (2000), The Macroeconomics of Low Inflation, Brookings Papers on Economic Activity 1996:1, Brookings Institution, Washington DC

Altonji, J. and P. Devereux. (2000). The extent and concequences of downward nominal wage rigidity. In S. Polachek (Ed.), Worker WellBeing, number 7236. Elsevier.

Biscourp, P. O. Dessy, and N. Fourcade (2005), "Les salaires sont-ils rigides? Le cas de la France à la fin des années 90", Economie et Statistique, 386, 59-79.

Blanchard, O. and J. Galí (2007) "Real Wage Rigidities and the New Keynesian Model", Journal of Money, Credit and Banking: 39(s1), 35-65

Camba-Mendez G., J.A. Garcia, and D.A. Palenzuela (2003). "Relevant Economic Issues Concerning the Optimal Rate of Inflation." Background Studies for the ECB's Evaluation of its Monetary Policy Strategy. ECB.

Campbell, C. (1997), "The variation in wage rigidity by occupation and union status in the US", Oxford Bulletin of Economics and Statistics, 59 (1), 133-147.

Campbell, C. M. and Kamlani, K. S. (1997), The Reasons for Wage Rigidity: Evidence from a Survey of Firms, Quarterly Journal of Economics 112, 759–789.

Card D. and D. Hyslop (1997), "Does inflation grease the wheels of the labor market?", in Reducing Inflation: Motivation and Strategy, C. D. Romer and D. H. Romer (eds), NBER Studies in Business Cycles, v30.

Cardoso, A and P. Portugal (2005), "Contractual wages and the wage cushion under different bargaining settings", Journal of Labor Economics, 23(4), 875-902.

Christofides, L.N, and P. Nearchou (2008), "Real and Nominal Wage Rigidities in Collective Bargaining", Labour Economics.

Dickens, W. T. , L. Goette, E. L. Groshen, S. Holden, J. Messina, M. E. Schweitzer, J. Turunen, and M. Ward (2008). Downward Real and Nominal Rigidity: Micro Evidence from the International Wage Flexibility Project. mimeo (WDN)

Dickens W.T., L. Goette, E.L. Groshen, S. Holden, J. Messina, M.E. Schweitzer, J. Turunen, and M.E. Ward (2007), "How wages change: micro evidence from the International Wage Flexibility Project", Journal of Economic Perspectives, 21(2), 195-214.

Dickens, W.T., L. Goette (2006), "Estimating Wage Rigidity for the International Wage Flexibility Project". mimeo, Brookings Institution, October.

Du Caju, Ph., C. Fuss and L. Wintr (2007), " Downward wage rigidity for different workers and firms: an evaluation for Belgium using the IWFP procedure", ECB Working Paper N° 840.

Du Caju, Ph., C. Fuss and L. Wintr (2008), "Understanding sectoral differences in downward real wage rigidity: workforce composition, competition, technology and institutions", mimeo

Elsby, M. (2007), "Evaluating the Economic Significance of Downward Nominal Wage Rigidity". NBER Working Paper No. 12611.

Franz, W. and F. Pfeiffer (2006), "Reasons for Wage Rigidity in Germany" Labour (20): 255-284

Holden, S. (2004). "Wage Formation under Low Inflation." In Collective Bargaining and Wage Formation – Challenges for an European Labour Market, (eds.) H. Piekkola and K. Snellman,39–58. Springer-Verlag.

Holden, S. and F. Wulfsberg (2007), "How Strong is the Macroeconomic Case for Downward Real Wage Rigidity?" Mimeo. University of Oslo

Holden, S. and Fredrik W. (2008), "Downward nominal wage rigidity in the OECD", The B.E. Journal of Macroeconomics Vol. 8 (1) - (Advances), Article 15

Kahn S. (1997), "Evidence of Nominal Wage Stickiness From Micro Data", American Economic Review, 87(5), 993-1008.

Papke, L. E. and J. M. Wooldridge (1996) "Econometric Methods for Fractional Response Variables with an Application to 401(k) Plan Participation Rates." Journal of Applied Econometrics 11(6):619–632.

Tobin, J. (1972) "Inflation and Unemployment". American Economic Review 62: 1-18