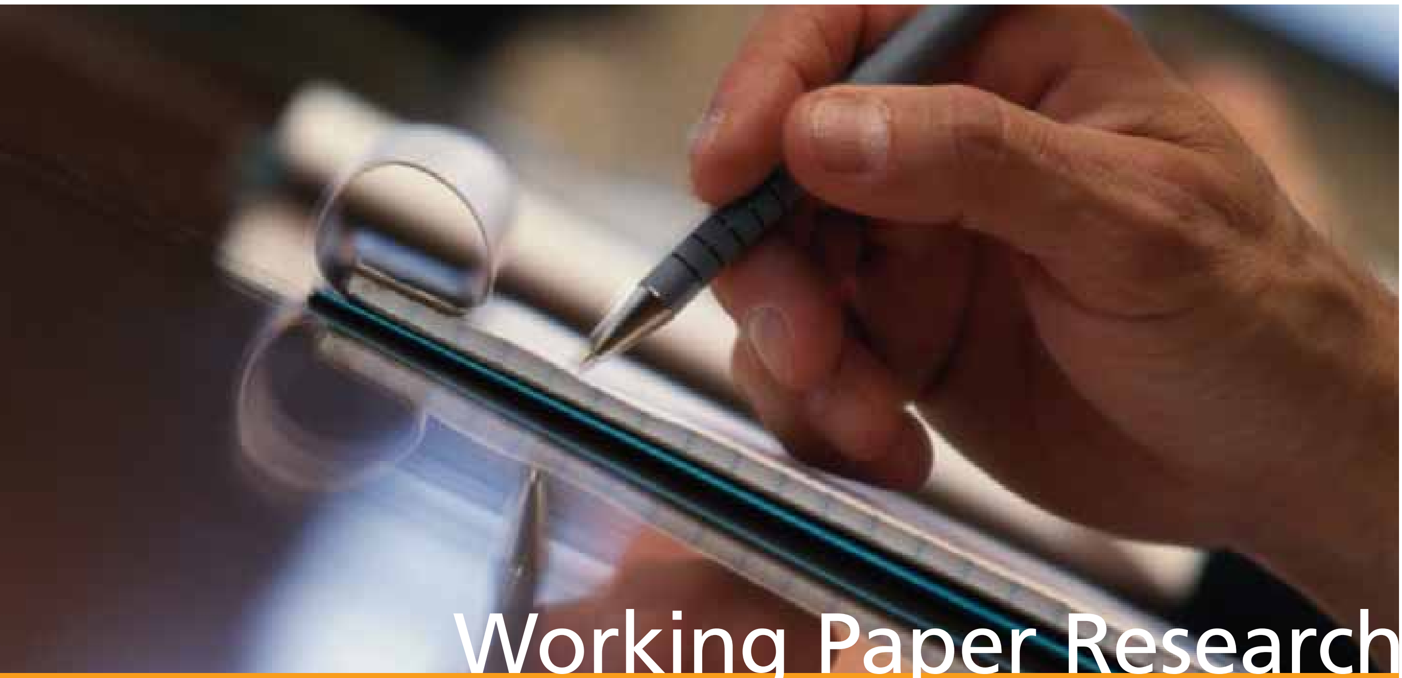
Downward wage rigidity for different workers and firms : an evaluation for Belgium using the IWFP procedure



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Abstract

This paper evaluates the extent of downward nominal and real wage rigidity for different categories of workers and firms using the methodology recently developed by the International Wage Flexibility Project (Dickens and Goette, 2006). The analysis is based on an administrative data set on individual earnings, covering one-third of employees of the private sector in Belgium over the period 1990-2002. Our results show that Belgium is characterised by strong real wage rigidity and very low nominal wage rigidity, consistent with the Belgian wage formation system of full indexation. Real rigidity is stronger for white-collar workers than for blue-collar workers. Real rigidity decreases with age and wage level. Wage rigidity appears to be lower in firms experiencing downturns. Finally, smaller firms and firms with lower job quit rates appear to have more rigid wages. Our results are robust to alternative measures of rigidity.

JEL-code: J31.
Key-words: wage rigidity, matched employer-employee data.

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This paper contains research conducted within the Wage Dynamics Network (WDN). The WDN is a research network consisting of economists from the European Central Bank (ECB) and the national central banks (NCBs) of the EU countries.

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1. INTRODUCTION

Evaluating and understanding wage rigidities has led to a rich set of research over the last few decades. Labour market institutions have been singled out as an important source of sluggish labour market adjustment. In particular, labour market rigidities have been put forward as an important cause of the high level of unemployment in Europe as compared to the US (e.g. Jackman et al., 1999). One of the arguments is that labour market rigidities, such as firing costs, firing restrictions, minimum wages, and so on, prevent wage cuts when necessary. In this case employment flows may be a substitute for wage flexibility. If, in addition, firing costs are high, new hirings may be discouraged even during expansions as firms anticipate that their adjustment margin will be low in downturns. Cross-country analyses like those of Jackman et al. (1999) suggest that countries with more rigid labour markets experience higher unemployment rates. Recently, the International Wage Flexibility Project (IWFP) has coordinated the estimation of wage rigidities across a large number of countries, based on extensive databases on individual wages. The results presented in Dickens et al. (2006) suggest that unionisation and collective bargaining coverage are positively related to real wage rigidity, and that differences in the degree of wage rigidity may partly explain differences in unemployment rates across countries. Holden and Wulfsberg (2007) show that downward nominal wage rigidity estimated from industry-level data of OECD countries is higher in cases where employment protection legislation is stricter, and union density and inflation higher; and that lower unemployment is associated with lower nominal wage rigidity.

Not only can wage rigidity impact on unemployment, but it may also affect inflation dynamics. The findings of the Eurosystem Inflation Persistence research Network (IPN) conclude that wage rigidity can be a cause of price stickiness observed in the euro area. Numerous papers document that prices change less frequently for products with a larger labour share, like services (Altissimo et al., 2006; Álvarez et al., 2006; Dhyne et al., 2006; Vermeulen et al., 2007). It was suggested that this may be due to sluggish marginal costs, in particular rigid wages. Dhyne et al. (2006) report evidence of downward consumer price stickiness in the services sector, which might be related to downward wage rigidity. In addition, Aucremanne and Collin (2006) find that changes in the wage formation process in Belgium have had a significant impact on the inflation process.

In sum, wage rigidity is one of the aspects of labour market rigidity. The macroeconomic consequences of wage rigidity may go beyond those on job flows and unemployment. Price stickiness implies that output becomes the prominent adjustment variable to shocks, leading to higher real volatility (see Altissimo et al., 2006). Further inflation persistence implies that monetary policy requires stronger interest rate changes to impact on inflation; leading in turn to stronger output variations. The nature of wage rigidity is also of macroeconomic relevance. When nominal wages are rigid, inflation may "grease" the economy because it allows a reduction in real wages (see among others Akerlof et al., 1996). On the other hand, the influence of inflation on real wages is limited or absent when real wages are rigid.

The theoretical and empirical literature on wage rigidity, as reviewed in Camba-Mendez et al. (2003), Holden (2004) and Kramarz (2001), is large and has initially focused on downward nominal rigidity, i.e. the resistance of workers to nominal wage cuts. Studies on the United States, like Altonji and Devereux (2000) and Akerlof et al. (1996), consistently find evidence of downward nominal rigidity. Studies on Europe, like Dessy (2005), Dickens et al. (2006, 2007) and Knoppik and Beissinger (2005), find a lot of cross-country variation and generally less nominal rigidity than in the United States.

There have been relatively few studies of downward real rigidity based on micro data, contrary to the large literature measuring real rigidity with macro data (Campbell, 1997; Layard et al., 1991). Macroeconomic estimates of wage rigidity typically take the sensitivity of wage changes to unemployment rates or demand variables as an indicator of wage rigidity. Downward wage rigidity is then measured as the resistance of wage cuts to adverse economic shocks (as in Biscourp et al., 2005). The present paper rests on individual earnings data. Downward wage rigidity is measured as the fraction of workers who experience a (nominal/ real) wage freeze when they were scheduled for a (nominal/ real) wage cut. So, when wages are downwardly rigid in our sense, they will not respond to changes in economic conditions and a macroeconomic estimation should also highlight wage rigidity. The reverse is not necessarily true. For a given macroeconomic shock, the firm may need to change its average wage bill, and may easily do so when the shock is positive. However, it may want to distribute the wage gain unevenly across workers, due to differences in individual productivity, effort compensation policy, and so on. Assuming that this implies (real or nominal) wage cuts for some workers, a microeconomic analysis may reveal wage rigidity where a macroeconomic one will not.

This paper contributes to the understanding of wage rigidity by evaluating the degree of downward real and nominal rigidity (DRWR and DNWR) across several groups of workers and firms. The aim is threefold. First, we provide measures of downward real and nominal wage rigidities and evaluate their relative importance. Consistent with institutional features of the Belgian labour market and in accordance with previous estimates for Belgium,[1] our results point to a high degree of real wage rigidity and a very low degree of nominal rigidity. Second, we examine the differences in wage rigidity across several categories of workers defined by occupational status, age, wage level, and gender. Wage rigidity may be heterogeneous across worker types due to differences in hiring and firing costs, monitoring costs, differences in productivity etc.. Third, we evaluate wage rigidity across different types of firm and their economic situation. More precisely, we examine differences across firm size and firm quit rates. Finally, although wage rigidity may be high in normal times, workers may accept earnings concessions as the fear of job loss increases when the firm experiences bad times (see Carneiro and Portugal (2006) for evidence on this). We test whether wage rigidity is higher in adverse economic conditions.

Several theoretical explanations have been put forward to explain wage rigidities. Efficiency wage models rest on the assumptions that unobservable effort of workers may be stimulated by high/fair

[1] Dickens et al (2006, 2007), as well as Knoppik and Beissinger (2005), consider Belgium as a country with rigid wages when compared to other EU countries.

wages (see Akerlof, 1982; Akerlof and Yellen, 1990; and Shapiro and Stiglitz, 1984). The turnover model assumes that persistently high wages might increase profitability by reducing the quit rate and hence lowering expenditure on hiring and training (Hashimoto and Yu, 1980, and Stiglitz, 1974). Higher wages may also raise the quality of firm's applicant pool (Weiss, 1980). Insider-outsider theories also generate real wage rigidity (Lindbeck and Snower, 1988). Since workers' individual characteristics such as age or tenure, education, job type or wage level may imply different worker productivity, on-the-job experience, replacement costs, ability to find a job and monitoring cost, these theories also predict that wage rigidity may vary across blue-collar and white-collar workers, across workers of different age classes, or different wage levels.

In addition to these theoretical predictions, institutional features of the Belgian labour market have to be taken into consideration. Full automatic indexation and high coverage and scope of collective wage bargaining could have a positive impact on wage rigidity. On the other hand, extra-wage components of earnings are more flexible than the base wage. As these are more important for older workers and higher wage earners, wage rigidity may be reduced for these categories of workers. Note also that collective bargaining in Belgium is organised separately for white and blue collars.

Empirical estimates of downward wage rigidity for Belgium are scarce and rather limited in the methodologies and data sets applied.[2] We rely on a new large microeconomic data set on earnings from administrative sources for Belgium over the period 1990-2002. The data is collected by the social security administration and is used to compute individual retirement benefits. Administrative data tend to be more accurate than survey data (see Biscourp et al., 2005). In general, survey data are less reliable because they often suffer from measurement and reporting errors. In particular, rounding errors may bias wage changes towards zero, leading to an overestimation of nominal wage rigidity. Our administrative data set reports annual earnings without distinguishing between the base wage and other components of labour compensation. This feature is likely to be present in survey data as well, where different respondents may also have different definitions of wage in mind. One drawback of our administrative dataset is that it measures total earnings per working day and not base wage per hour worked. In the period under review, cuts in working time were often negotiated as a substitute for wage increases, in particular for blue-collar workers. This should not have too big influence on our wage measure. On the other hand, cyclical variations in hours per working day - e.g. overtime hours - can bias our wage measure. In the way that hours worked adapt more quickly to changes in economic activity than the number of employees. Consequently, daily wage increases could be biased upwards (downwards) at the beginning of upturns (downturns).

The paper is set out as follows. Section 2 describes the main institutional features of the Belgian labour market. The third section surveys the predictions of labour market models concerning the degree of wage rigidity for worker categories considered in the empirical section. Section 4 introduces

[2] For Belgium, Borghijs (2001) and Knoppik and Beissinger (2005) analyse downward nominal wage rigidity based on survey data. Royer and Van Audenrode (2002) rely on a sample of administrative wage data for the period 1978-1985. Their data set is also used in the IWFP exercise (Dickens et al., 2006, 2007).

our data set and presents the IWFP methodology. Section 5 discusses our results and wraps up with several robustness analyses. Section 6 concludes.

2. WAGE FORMATION INSTITUTIONS IN BELGIUM

In Belgian companies, gross wages are mainly determined through agreements concluded in joint committees[3] organised per sector of economic activity. The outcome of these sector-specific negotiations cannot undercut the legally determined guaranteed minimum wage.[4] However, it can possibly be supplemented with agreements concluded at the firm level, which are bound by the sectoral agreements. All employees' gross wages are linked to an index of consumer prices through an automatic indexation mechanism. Moreover, in the period under review, a lot of employees receive automatic wage increases with age and, to a lesser extent, tenure.

The indexation mechanism implies that nominal gross wages of Belgian employees are automatically index-linked according to the evolution of a the national index of consumer prices.[5] From 1994 onwards, wages have been adapted according to a lagged moving average of the so-called health index, i.e. the national index of consumer prices excluding alcoholic beverages, tobacco and motor fuels. As a result of this policy measure, indexation slowed down in 1995 and 1996.

Real wage increases are negotiated in the joint committees, sometimes followed by firm-level agreements. The joint committees establish a job grading for employees. A pay scale is then assigned to this job grade, which specifies a minimum wage for each specified employee category. Belgian labour legislation makes a strict distinction between blue-collar and white-collar workers. This is historically so, partly because blue-collar workers were regarded as less specialised and therefore more easily substitutable than white collars. White collars typically had more specific jobs; making on-the-job experience more important than for blue-collar workers. Hiring and training costs may be higher for white-collar workers. Firing costs and regulations are also heavier for white collars. All this explains why most of the joint committees are responsible for just one of these occupations in each sector, blue-collar workers receiving an hourly wage and white-collar workers receiving a monthly salary. Only a few committees set wages for both blue-collar and white-collar workers.

In the joint committees for blue-collar workers, pay scales are primarily defined solely in relation to the job description. Variations depending on age or length of service are not common. For white-collar workers, the pay scale usually varies not just by category, but also depending on age or length of

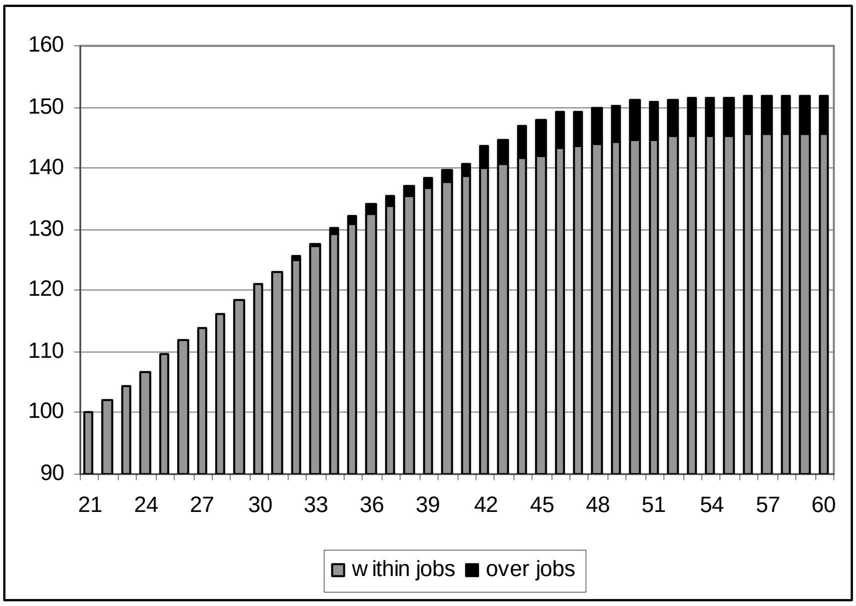
3 They are called joint committees ('commissions paritaires'), because employers and employees share an equal representation in them. As the notion of economic sector is sometimes very narrowly defined, the number of joint committees exceeds 100.

4 The actual minimum wage in almost every joint committee exceeds the legally guaranteed minimum, with some exceptions for workers less than 21 years old.

5 The way this automatic price indexation of wages is implemented constitutes an agreement in the joint committees. In some committees, wages are indexed at fixed points in time (e.g. every two, three or four months), in others wages (e.g. the minimum wage) are indexed each time the index exceeds a certain threshold (typically, the threshold value is defined as the previous value plus two percent).

service.[6] Moreover, these workers can in many cases expect to be automatically promoted merely because of their age at some points in their career. An age-related earnings profile is therefore most prevalent among white-collar workers, particularly the higher categories, but much less common for blue-collar workers.[7] From the start of their career, and even if they remain within one category (i.e. without any form of promotion), white-collar workers can expect to receive significant pay increases on the basis of their age.

Figure 1 – Average pay scale for white-collar workers as a function of their age
(index figures, wage level of youngest employee in the lowest grading = 100)



Source: FPS Employment, Labour and Social Dialogue.

Based on data from the Federal Public Service Employment, Labour and Social Dialogue (FPS ELSD) for 1999, the influence of age and/or length of service, including the effect of automatic age-related promotions, can be investigated.[8] Figure 1 reports how the average pay scale of white collars automatically increases with age. Pay scales are fixed for all workers of the same job/scale/category. It appears that white-collar workers receive an automatic wage increase of around 1 percent on average each year. Most of the automatic increase stems from a rise along the pay scale of one job (i.e. within jobs), another part is due to automatic age-related promotions to a job with a higher pay scale (i.e. over jobs). The figure shows that these automatic pay rises are strongest in the first half of the career and decrease with age to become negligible after the age of 50. Section 3.2 gives a short overview of economic theories explaining these institutional features.

6 During the period under review, age-related pay scales were not against European anti-discrimination rules and were applicable to the majority of Belgian white-collar workers.

7 According to the FPS ELSD, the joint committees for which age or length of service affect the scale structure include 5 joint committees or subcommittees for blue-collar workers (responsible for 7.8 p.c. of the total number of workers in these sectors), 17 for white-collar workers (97.0 p.c.) and 22 combined joint committees (51.5 p.c. of employees in the sectors for which they are responsible, or 27.6 p.c. of the blue-collar workers in question and 65.0 p.c. of the white-collar workers).

8 In most cases, age is the determining variable rather than tenure, the latter is often defined as years of service in the sector. Also given the relatively long average tenure of Belgian workers, the age-related wage profile is very relevant. An analysis of these data and the consequences of age-related wages can be found in Delhez et al. (2006).

During the period under review, the government has intervened directly in the wage formation process. After wage increases that were regarded as excessive in the early 1990s, the indexation mechanism was changed in 1994 and a real-wage freeze was enforced in 1995-1996. It was forbidden to negotiate real wage increases in the joint committees, but automatic increases due to indexation, age, tenure or changes in category were still allowed.

Table 1 illustrates the lag between the CPI and indexation. Further, it highlights the impact of government interventions on the labour market in 1995-1996, which essentially amounts to strong wage moderation. Wage increases due to indexation and collectively agreed real increases were at their lower levels in these years, as shown in the first three columns in Table 1. Table 1 also shows that nominal wage increases were 30 to 40 percent lower in 1995 and 1996 than over the rest of the period. These measures induce a shift of the wage change distribution to the left; the median decreases while the standard deviation did not change. This explains the increase in the proportion of negative wage changes observed in years 1995 and 1996.

Table 1 - Descriptive statistics on inflation, indexation and the earnings change distribution

				Δln (wage)			
year	CPI inflation	indexation	"collective"	mean	st. dev.	median	%Δln(w)<0
1991	0.031	0.035	0.048	0.069	0.074	0.062	0.055
1992	0.024	0.026	0.043	0.053	0.073	0.046	0.066
1993	0.028	0.027	0.035	0.053	0.073	0.046	0.066
1994	0.023	0.014	0.027	0.042	0.074	0.033	0.079
1995	0.015	0.013	0.015	0.031	0.075	0.022	0.093
1996	0.020	0.017	0.017	0.030	0.074	0.019	0.107
1997	0.016	0.015	0.017	0.041	0.081	0.029	0.083
1998	0.010	0.012	0.019	0.043	0.082	0.029	0.088
1999	0.011	0.011	0.017	0.045	0.088	0.030	0.091
2000	0.025	0.015	0.028	0.055	0.090	0.038	0.086
2001	0.025	0.025	0.033	0.056	0.090	0.045	0.086
2002	0.016	0.023	0.038	0.051	0.090	0.041	0.096

Note: "collective" refers to automatic indexation plus collectively agreed real wage increases; Δln(wage) stands for the first difference of the logarithm of daily earnings. %Δln(w)<0 refers to the percentage of wage changes below zero.

After that period of strong wage moderation, the so-called wage norm came into practice, which constitutes an overall maximum margin for the growth of nominal hourly labour costs in Belgian enterprises. According to the law of July 1996 for the promotion of employment and the safeguarding of firms' competitiveness, social partners[9] should fix such a norm every other year for a two-year period, taking into account a report written by the Central Economic Council (CEC).[10] In this report, the CEC estimates the maximum scope for a rise of firms' hourly labour costs as a weighted average of

[9] In the event of no agreement between the social partners, the government can fix a wage norm that contains at least indexation and other automatic increases, which happened in 1997-1998.

[10] Social partners have representatives in the Council.

the expected nominal labour cost evolution in Belgium's three main neighbouring countries (Germany, France and the Netherlands) over the coming two years. Official estimates of expected automatic indexation of nominal wages, based on inflation projections by the Federal Planning Bureau, and estimates of labour cost growth through automatic increases are subtracted from the nominal wage norm, thus determining the margin for real wage increases.

The joint committees at sector level not only determine to a large extent the structure of pay scales between different worker types, but they are also the main bargaining unit for the negotiations on collective wage increases, taking into account the wage norm. Quite often, these collective wage increases are defined as an absolute rise of the (sometimes only minimum) pay scales, meaning that employees earning wages above the scale can obtain a lower percentage collective wage increase.

For the analysis of wage rigidity, it is important to bear in mind that part of all employees' nominal wage increases is automatic due to indexation and therefore almost equal for everyone. The remainder of individual wage increases is determined by collective agreements at the sector and firm level and by individual factors, and is thus more variable. This implies that the automatic part of wage increases that is almost equal for every worker decreases when inflation is low. One should also remember that wages and wage increases for blue-collar workers and for white-collar workers are mostly bargained separately, and that collective wage increases can be relatively less important for high-wage earners. White-collar workers have larger automatic wage increases than blue-collar workers, and these automatic pay rises decline with age. Finally, the period 1995-1996 was atypical, with direct government intervention in wage formation.

3. PREDICTIONS OF LABOUR MARKET THEORIES

In this section, we review several prominent labour market theories, such as the efficiency wage, turnover, insider-outsider and contract theories, and discuss their predictions regarding the degree of rigidity for different categories of workers and firms considered in the paper. The most readily available predictions are related to occupational status, tenure, age of workers and turnover costs of the firm. In our data set, we only have information on age and hence we have to rely on the correlation between tenure and age in cases where the model predictions relate to tenure. As explained in Section 2, a majority of workers in Belgium in the period under review experienced automatic wage increases according to age rather than tenure.

According to the efficiency wage theory, workers' productivity (effort) depends positively on their wage, and hence firms might refrain from cutting wages because it could reduce profits. There are several possible explanations why productivity might depend on wages. In the shirking model of Shapiro and Stiglitz (1984), a cut in earnings lowers the cost of job loss, thereby inducing more workers to shirk. In the gift-exchange model (Akerlof, 1982) and the fair wage-effort hypothesis (Akerlof and Yellen, 1990), a fall in earnings leads to lower gratitude and loyalty to the firm, again reducing effort.

Because the effort of white-collar workers is very difficult to monitor, firms may be more reluctant to cut wages of white-collar workers than blue-collar workers whose output can often be quantified. As a result, the efficiency wage theory predicts that earnings of white-collar workers are more rigid.

When considering the tenure profile of wages predicted by Lazear (1984) together with the shirking model, we conclude that the cost of job loss is higher for older workers and workers with higher tenure. Indeed, it is typically more difficult for older workers to find a new job and workers with long tenure often lose their tenure component of compensation when changing employers. As a result, a wage cut - *ceteris paribus* - induces more younger workers to shirk which implies lower likelihood of a wage cut for young workers and higher rigidity for them.

The relative wage level influences not only productivity but also the propensity of employees to quit. Wage cuts might increase the turnover of employees and have a negative impact on profitability. In the turnover model of Stiglitz (1974), firms that cut wages will experience more job quits and incur higher costs of hiring and training new workers. Since the training and hiring costs are typically higher for white-collar workers than for blue-collar workers, the turnover model predicts higher wage rigidity for white-collar workers.

The turnover model also predicts that firms with high turnover costs invest in creation of long-term bonds with their employees (e.g. in the form of the implicit contracts of Lazear, 1979). If successful, such firms would exhibit fewer (voluntary and involuntary) quits. Hence, we expect to find a lower degree of rigidity among firms with lower quit rates, all else equal.

Hashimoto and Yu (1980) point out that current employees who have acquired firm-specific human capital are more productive than identical individuals with no experience at the firm. It is reasonable to assume that firm-specific human capital has much stronger impact on the productivity of white-collar workers than blue-collar workers and hence we again expect more rigid wages of white-collar workers. As firm-specific human capital increases with tenure, firms will be less willing to cut wages of employees with higher tenure and run the risk of them leaving. It predicts that employees with higher tenure will have more rigid wages.

When applying the adverse selection model of Weiss (1980) to quits, the most productive workers are most likely to quit their job after a wage cut. As white-collar workers are more difficult and costly to replace due to their specialised skills, firms are less willing to cut their wages leading to higher wage rigidity. Higher cost of job loss for older and more tenured workers imply that younger workers are more likely to quit after a given wage cut, all else equal. This leads to more rigid wages of young workers.

According to the insider-outsider theory (Lindbeck and Snower, 1988), firms do not dismiss their current workers and replace them by job-seekers at lower wage because insiders can harass or refuse to cooperate with newly hired entrants. This implies that workers with higher tenure have more power in the wage-setting process than recently hired employees, something which leads to higher wage rigidity for tenured employees. The productivity of white-collar workers is typically more directly linked to their integration into the work process (e.g. because blue-collar workers at an assembly line do not need much cooperation with other workers while teamwork is common for white-collar workers). As a result, the model predicts that white-collar workers exhibit a higher degree of wage rigidity than blue-collar workers.

The contract theory of Fisher (1977) and Taylor (1979) explains wage rigidity as a result of long-term contracts between firms and workers that set wages in advance and are negotiated on a staggered basis. Since short-term contracts are much more common for young workers, the contract theory predicts lower wage rigidity of young workers. According to the implicit contract theory (Baily, 1974), wage rigidity is a result of workers' risk aversion. Since workers prefer a stable real wage, a firm can offer its workers a steady wage that would be on average below what it would otherwise have to pay because the stable wage forms a compensating differential. Based on the relative importance of labour income and asset income over the lifecycle, the lifecycle risk aversion hypothesis predicts that risk aversion increases with age.[11] Using time series data, Bakshi and Chen (1994) find evidence that supports the lifecycle risk aversion hypothesis. Hence, if firms accommodate workers' preferences with respect to the stability of their earnings, the earnings of older workers would be more steady and hence more rigid.

In summary, all the theories discussed above, except for the contract theory, predict higher wage rigidity for white-collar workers. The efficiency wage theories and the adverse selection model applied to quits suggest that younger workers are subject to a higher degree of wage rigidity. On the other hand, the firm-specific human capital model and insider-outsider theory predict more rigid wages for workers with higher tenure. The contract theory concludes that younger workers should have less rigid wages. The turnover model expects to find a lower degree of rigidity among firms with lower quit rates. In their survey, Campbell and Kamlani (1997) find strong support for explanations of wage rigidity based on the dependence of quits and effort on wages but hardly any support for the insider-outsider theory.

[11] The further a person is from retirement, the more risk he is willing to accept in his investments since the number of paychecks he expects to get is large and labour income can offset any adverse investment outcomes.

4. DATA AND METHODOLOGY

4.1. Data description

We rely on an administrative database on labour earnings for Belgium collected by the social security system. The data set contains a sample of around one-third of workers in the private sector and covers the period 1990-2002. The data we use contain information on annual gross earnings (including bonuses), annual working days, age, sex and occupation category (blue-collar or white-collar). Our data set offers two advantages compared to previous studies for Belgium. First, administrative data are often considered more reliable than survey data (Biscourp et al., 2005). In particular, misperception and rounding errors are typical measurement errors of survey data. Second, the period covered is longer and more recent than similar administrative data for Belgium used by Royer and Van Audenrode (2002). Their data set covers the period 1976-1986. Our analysis thus includes more recent Belgian labour market developments and institutional changes related to the wage bargaining process, such as government intervention in the wage formation and indexation mechanisms, and the wage norm.

For confidentiality reasons, natural persons and firms with less than 5 employees are left out of the sample. The data set covers all sectors of activity including services. It includes all persons that were born between the 5th and the 15th day of any month. As the selection criterion is independent of workers' or employers' characteristics, our sample is representative with respect to the entire population. We restrict the sample to full-time permanent job-stayers in firms in branches with NACE codes from C to K, aged between 18 and 64 for men and 59 for women, and having no more than one month of sick leave (or other "abnormal" days off) per year, and working at least 11 months for the same employer. We also exclude earnings below the legal minimum wage and we drop the same number of observations from the upper tail of the distribution.[12] Tables A3 and A4 in the Appendix provide summary statistics on the earnings and earnings change distribution. Typical features of the wage structure are also apparent in our data set: women earn 20 percent less than men; earnings increase with age; blue-collar workers have lower earnings levels, smaller wage increases and lower dispersion of earnings than white-collar workers. Finally, large firms pay on average higher wages and have a more heterogeneous wage structure than smaller firms.

Notwithstanding the uncertainties surrounding the methodological choice and sample selection, it is important to stress two characteristics of the data we analyse, and their implication for measuring downward wage rigidity. We evaluate DRWR and DNWR from the distribution of the changes in the

[12] The legal minimum wage is defined as the average guaranteed minimum monthly income for workers above the age of 21.5 years and with a tenure of at least six months. Under certain circumstances, the reported earnings can be lower, especially for younger workers.

log of annual earnings divided by the number of work days of full-time job stayers.[13] First, annual earnings include other components of compensation than the base wage, such as bonuses, premiums, overtime hours paid, and so on. Histograms of earnings changes reported in the Appendix indicate that, in spite of full indexation, there are some wage changes below indexation, denoted as I, and even below zero. The reason is that total earnings include extra-base wage components mentioned above. These may be more flexible than the base wage and may not be subject to labour market mechanisms such as indexation and collectively agreed real wage increases.

Second, restricting the sample to full-time job stayers might blur the picture of wage rigidity if job movers, temporary workers or part-time workers have a different degree of wage rigidity. Evaluating wage rigidity for part-time workers is difficult since we have no reliable information on the percentage of time worked. Excluding temporary workers and manpower workers might have some incidence on our measure of wage rigidity. Indeed, Kleinknecht et al. (2006) report that the use of temporary contracts and self-employed (freelance) workers in the Netherlands allows firms to save on their average wage bill.

Concerning job mobility, Fehr and Goette (2005) found that job movers have more flexible wages than job stayers and hence our estimates may instead provide an upper bound of wage rigidity for the entire population of workers. We have performed two sets of analyses in order to gain a better understanding of the potential impact of job movers on our measures of wage rigidity.[14] Firstly, we compare the first difference of the log earnings of movers with that of stayers. On average, job movers experience larger wage increases than stayers (0.057 and 0.045, respectively). But the main difference between the two groups is that the standard deviation of earnings changes is much larger for movers than for stayers (0.24 compared to 0.08). This means that some job movers experience much larger earnings increases than job stayers, and some movers incur much larger earnings losses than job stayers.[15] In short, from the point of view of workers, earnings of job movers are more flexible than those of job stayers.

Next, we consider the point of view of the firm. We compute the median wage of stayers by firm, occupation (white collar vs blue collar), sex and age category. We then compare the relative wages of entrants with respect to this firm specific median, with the relative wages of stayers (again by occupation, sex and age category). In contrast, to the previous findings, the volatility of earnings of entrants is only 15% larger than that of incumbents (the standard deviation of the relative wage is 0.28 for entrants and 0.24 for incumbents). The relative wage of new entrants is slightly lower than that of incumbents, which may be explained by the fact that firms in Belgium do not pay holiday allowance the first year. This suggests that, on average, due to fairness considerations, or some institutional features, entrants do not substantially increase wage flexibility within the firm. Rather, these two pieces of evidence suggest that workers move from low-paying firms to well-paying firms, or vice

13 The maximum number of work days is essentially the same for all full-time employees as it includes all work days, i.e. everyday except Sunday. The number of days not worked and days for which there is no employer compensation (such as sick days) are excluded from these.

14 The analysis is performed over the 1992-2001 period.

15 Unfortunately, we cannot make any distinction between voluntary quits and layoffs.

versa, but that wage flexibility within firms is quite similar for entrants and incumbents. Since this paper focuses on wage rigidity rather than on wage and job mobility, we consider that the point of view of firms is more relevant than the point of view of workers. Therefore, the finding of similar variance in the wage of entrants and that of stayers suggests that focusing on job stayers alone should not be harmful for our measures of rigidity.

Finally, excluding very small firms, and some sectors of economic activity (agriculture, fishery, non-commercial services and the public sector) may have an indeterminate impact on our estimates of wage rigidity. However, this should not modify our analysis of the *relative* wage rigidity across worker or firm types.

4.2. Estimation of DNWR and DRWR

Measures of downward wage rigidity based on microeconomic data rest on the idea that one is likely to observe fewer wage cuts and more wage freezes under rigidity. This will impact on the properties of the distribution of individual wage changes, such as symmetry, spike at zero (or another defined reference point such as expected inflation), or on the behaviour of wage changes, in particular their sensitivity to economic shocks. Alternative empirical measures of wage rigidities based on these ideas have flourished over the last ten years.

Mc Laughlin's (1994) starting point is that downward wage rigidity (and upward wage flexibility) induce a spike at zero, few wage cuts and positive skewness. Simple measures of wage rigidity, as used in Dickens et al. (2007) are based on the notions of symmetry and spike of the distribution of wage changes. In the presence of DNWR, some of the wage changes that would have been negative in the absence of rigidity are concentrated at zero. This generates a spike at zero in the distribution of price changes (see Figure A1 in the Appendix). Dickens et al. (2007) define a simple measure of nominal rigidity as the ratio of the height of the spike at zero and the area of the histogram below and at zero. In the absence of DNWR, the simple measure approaches zero. The simple measure of real rigidity also rests on the idea that in case of DRWR, some of the wage changes that would have been below expected inflation, π^e, are concentrated around this reference point (π^e varies across individuals). Because part of these real wage freezes fall just below π^e, and part fall just above π^e, this generates asymmetry in the distribution of price changes (see Figure A2 in the Appendix). More precisely, the area of the histogram of wage changes below π^e is smaller than that above 2*median - π^e. Assuming that the spike around π^e is symmetric, the difference between the two areas (the top tail minus bottom tail), equals one half of the spike around π^e. The simple measure of DRWR again divides the area of the spike by the area of the histogram at or below the spike.

The approach of Kahn (1997), the so-called histogram-location approach, consists of two steps. First, annual histograms of wage changes are constructed in order to compute factual bin sizes. She compares bins at a given distance from the median, and computes their size for each year; and distance from median. Second, these factual bin sizes are regressed on dummies for the case where the bin refers to a negative wage change and a dummy for a zero (or around zero) wage change.[16] The larger the positive coefficient on the dummy for zero wage changes, the higher the spike at zero, i.e. the larger the proportion of wage freezes. The larger the negative coefficient on the dummy for negative wage changes, the higher the proportion of wage changes that have not been cut. Taken together, these provide evidence of downward wage rigidity. In essence, the method compares the size of the bins at a given distance from the median in years when rigidity may be binding (when those bars fall below zero) with their size in years where rigidities are absent (when they fall above zero). The method is non-parametric as it requires no assumption on the distribution of wage changes. It depends on observing years with wage increases at a particular distance from the median bin and years of wage decreases at the same distance from the median bin. Further, it ignores the possibility of the dispersion of wage changes varying over time.

Card and Hyslop (1997) compare for each year the factual distribution of wage changes with the counterfactual distribution that would hold in the absence of nominal wage rigidity. The latter is assumed to be symmetric around the median wage change, and they assume that a given fraction of jobs are lost due to wage rigidity. Further, they account for rounding and measurement errors. Their measure of rigidity is given by the cumulative density of the notional distribution that is "swept up" to the nominal wage rigidity spike. Their method is non-parametric as it imposes no assumption on the distribution function of wage changes. Contrary to the simple measure described above, it does not take into account the height of the spike.

Another strand of the literature rests on the notion of wage sluggishness. It estimates wage rigidity from the (in)sensitivity of wages to given shocks or variables. Among this literature, the "earnings-function approach" of Altonji and Devereux (1999) defines the notional wage change that holds under wage flexibility as a function of individual characteristics. They estimate a latent variable model where factual wage increases are equal to the notional increases, but wage cuts may be frozen or dampened in the event of wage rigidity. Their specification nests both the flexible wage formation model and the model with downward rigidity, so that they can be tested against each other. Although appealing in its definition of wage rigidity, this method requires extensive and relevant data characterising the individuals and/or firms.

Our estimates of downward nominal and real rigidity are based on a new methodology to estimate DNWR and DRWR that was recently developed by the IWFP. A technical discussion of the method can be found in Dickens and Goette (2006).[17] Briefly, these measures of rigidity attempt to capture the fraction of workers who would receive a (nominal or real) wage freeze when they were scheduled for a (nominal or real) wage cut, no matter what the reason for the wage cut. The methodology has several advantages. First, from microeconomic data on wages, it provides an estimate of both DNWR and DRWR. Second, when focusing on nominal wage rigidity, the natural cut-off point is at zero wage change. When examining real wage rigidity, correctly defining the relevant index to compute real wages becomes an important issue. The IWFP methodology estimates jointly DNWR, DRWR and the

[16] The interval around zero wage changes is intended to capture menu costs.
[17] More specifically, we use the IWFP routine in its November 15, 2006 version.

reference point for downward real wage rigidity, π^e. Third, Dickens and Goette (2006) also correct the factual distribution of wage changes for measurement errors.[18] The corrected distribution is dubbed "true" distribution. DNWR and DRWR are estimated by the Mixed Method of Moments. This method estimates the notional distribution that would prevail under flexibility, assuming it follows a symmetric two-sided Weibull distribution. A comparison between the corrected factual ("true") distribution and notional distribution gives rise to the measures of DNWR and DRWR.[19] The procedure allows for different specifications for the mean and variance (across individuals) of the expected bargaining focal point, π^e.[20] Section 5.4 discusses the sensitivity of the results to the various restrictions that can be placed on the mean and variance of π^e. The method is parametric and assumes that wage changes follow a Weibull distribution. As in Kahn (1997), or Card and Hyslop (1997), the method relies on the availability of a large employer-employee data set. However, it requires only one measure of wages and no information on workers and company characteristics. The major drawback is that identification of DRWR and DNWR becomes an issue in years with very low inflation, where the reference point for DRWR (π^e) shifts very close to the reference point for DNWR (zero).

In order to illustrate the procedure, Figure 2 reports for the year 2002 the histogram of earnings changes, the factual or *empirical distribution*, together with the distribution corrected for measurement errors, i.e. the *true distribution*, and the *notional distribution* that is assumed to hold in the fully flexible case. Note first that there are few differences between the empirical and true distribution (in general, the empirical distribution has heavier tails than the true distribution but there are less observations around the modal bin in the empirical distribution). This suggests that measurement errors may be limited, as it is generally the case with administrative data. Second, there is no apparent spike at zero, consistent with the evidence in this paper and findings of very low DNWR in Belgium in Dickens et al. (2006, 2007). Third, on the contrary, a mass of observations that would have fallen below the estimated expected focal bargaining point (dashed line) π^e, lie above. Figure 2 also reports the indexation level *I* (solid line), and the "collective" wage increases, namely the sum of automatic indexation and collectively agreed real wage increases (dash-dotted line). Note that, in 2002, the estimated focal bargaining point was very close to the indexation level.

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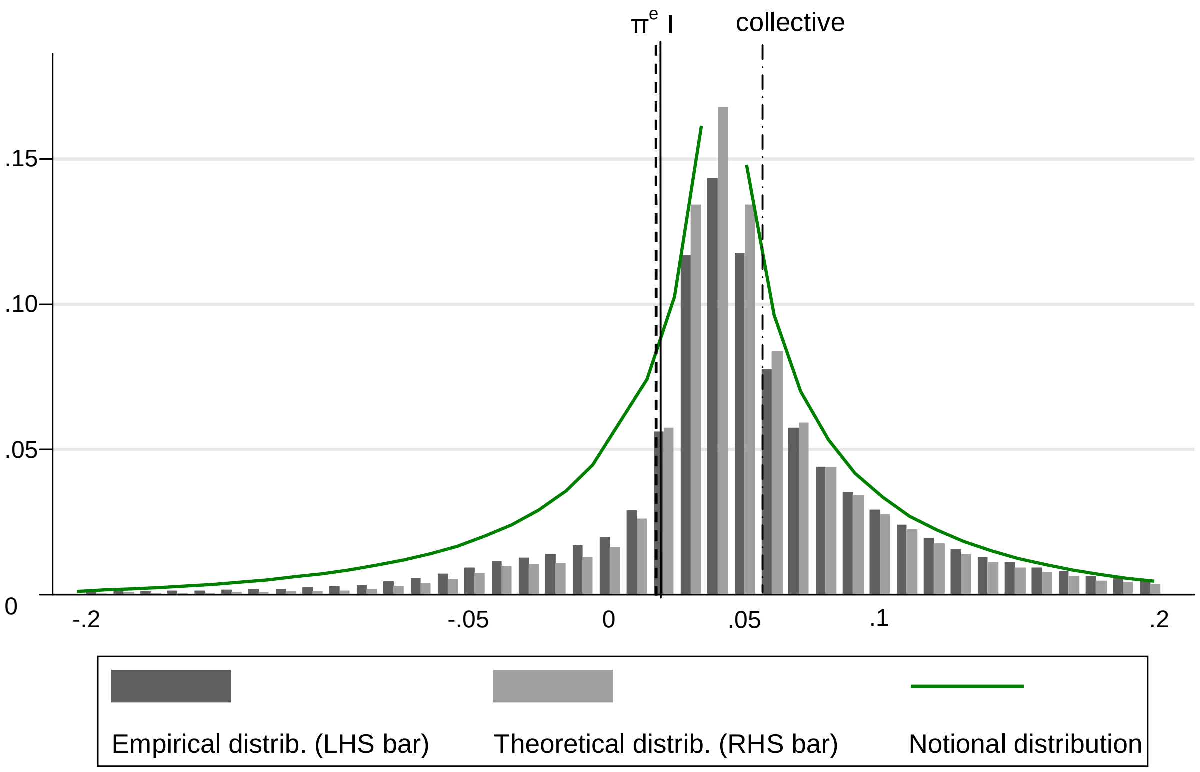
[18] The identification of the error distribution is based on the idea that a large wage increase followed by a negative wage change in the next year, and vice versa, indicates the possibility of a measurement error. Since our annual earnings typically combine two wage levels, this induces a positive correlation in wage changes in addition to the negative correlation caused by errors. However, similar information can be recovered from the autocorrelation of higher moments.

[19] The model assumes that a fraction of the population is potentially subject to DRWR. If the notional wage change of individuals subject to DRWR falls below their expected bargaining focal point, π^e, they will receive a wage change equal to π^e instead of the notional wage change. Another portion of the population is assumed to be potentially subject to DNWR. Such individuals with negative notional wage change, who are not subject to DRWR, will receive a wage freeze instead of wage cut.

[20] We use the "income procedure" that accounts for the fact that we proxy wages by annual earnings divided by annual days worked. This is important because wage changes in Belgium are typically scattered over the entire year and hence do not coincide with the end of the calendar year for which annual earnings are reported. For instance, if someone's wage changes every year in May, then in the annual earnings data we would observe zero wage change for this individual only if his or her wage did not change for two consecutive years.

In sections 5.1, 5.2 and 5.3, we allow the mean of π^e to be unrestricted over the 0-4 percent band, and the variance to range from 4E-06 to 3.6E-05.

Figure 2 - Wage change distribution, year 2002



Note: The solid vertical line shows the level of indexation, dashed line is at the expected bargaining focal point estimated by the MMM procedure and finally the dash-dotted line shows the "collective" wage increases (as a result of automatic indexation and collectively agreed real wage increases).

The method accounts for changes in the mean and dispersion of the distribution of earnings changes over years and samples, as well as for changes in the bargaining focal point. Therefore, estimates of rigidity for sub-samples do not necessarily average out to the estimate for the entire sample. In addition, although the full automatic indexation makes real rigidity very strong, the estimated real rigidity may lie below 100 percent for two reasons. First, our data refer to total earnings rather than the base wage. Second, π^e does not necessarily always coincide with *I* or "collective". So there may be a mass of observations between π^e and indexation or "collective".

5. RESULTS

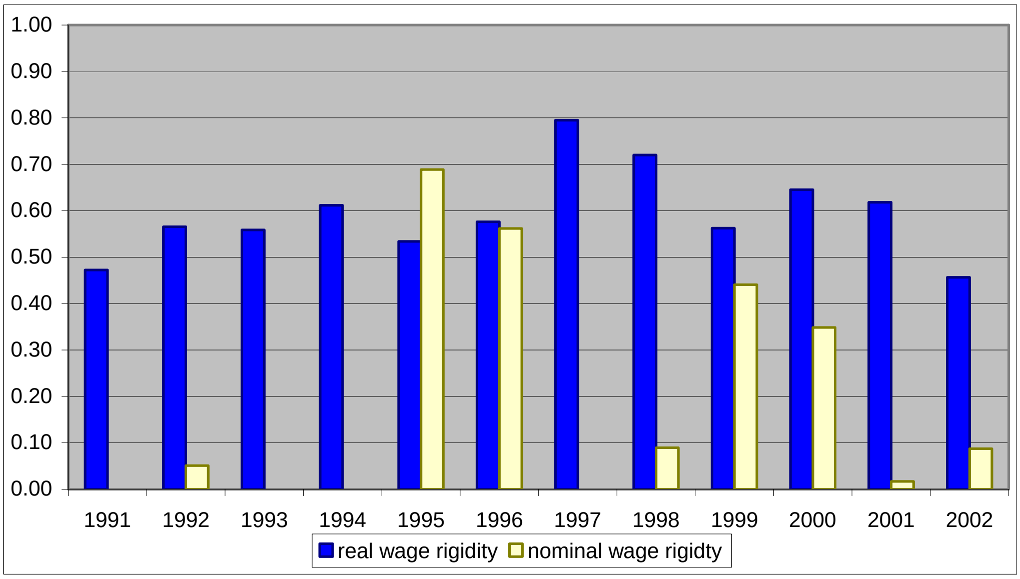
This section presents our estimates of DRWR and DNWR for Belgium. First, we discuss the evolution of wage rigidity over time. Next, we evaluate the extent of real and nominal rigidity for different groups of workers, defined according to occupation, age, and earnings level. Then, we assess differences across firm types and firm situations. Firm types are defined according to size, employees turnover and training intensity. Firm situations are defined according to real value added growth, profits and employment growth. Finally, we consider robustness tests with alternative specifications, simple measures of rigidity and different definitions of the firm situation.

5.1. DNWR and DRWR in Belgium

Figure 2 and the plots of distributions of earnings changes in Belgium provided in the Appendix already provide some indication of the degree of nominal and real wage rigidity. First, all the distributions are smooth around zero without any spike, which suggests that nominal rigidity can play only a marginal role in Belgium. Second, the empirical histograms are asymmetric with more observations in the upper tail than in the lower tail, which might be an indication of real rigidity.

Figure 3 below reports the MMM measures of wage rigidity in Belgium for the period 1991-2002. Real rigidity appears to be much more pervasive than nominal rigidity. On average, it is equal to 0.59, more than three times higher than nominal rigidity (0.19). When compared to other industrialised countries participating in the IWFP, Belgium becomes the country with the highest degree of DRWR, followed by France, Finland and Sweden (see Dickens et al, 2006). On the other hand, nominal rigidity is very low, placing Belgium among the countries with the lowest degree of DNWR. Such combination of high real wage rigidity and low nominal rigidity stems from the specific institutional characteristics of Belgium, in particular full automatic indexation that applies to most components of annual earnings, preventing strong and continuous falls in real earnings.

Figure 3 – Downward real and nominal rigidity in Belgium between 1990 and 1992



Real rigidity is relatively stable over time. Conversely, nominal wage rigidity shows two peak periods in 1995-1996 and in 1999-2000. Excluding these two episodes, nominal rigidity would be close to zero (0.03 on average). These two peaks should be treated with great caution because identification of nominal and real rigidity becomes less accurate when the MMM estimates of the expected bargaining focal point, Π^e, are low. This is the case in 1995-1996, and in 1999, where Π^e is below 0.02.[21]

[21] Although the spike in 1995-1996 could be related to the episode of government intervention and wage moderation (see Section 2), this is not the case for 1999-2000. Therefore similar increases might be due to measurement problems rather than institutional changes.

5.2. Wage rigidity across workers

Our results above suggest that Belgium is characterised by strong downward real wage rigidity and very low nominal rigidity. Table 3 reports averages of nominal and real rigidity measures over the period 1991-2002 for different categories of workers. In general, DNWR is very low for all sub-categories of workers, except for those with very low earnings. In some cases, the evolution of DNWR over time is unstable. For those two motives, this section focuses primarily on the measures of DRWR. For the sake of brevity, we report only the averages over the entire period. Note that estimates for each category may differ from the results for the entire distribution.[22] Therefore, we focus our analysis on the relative degree of real earnings rigidity across categories. As explained in Section 4.2, the estimates of DRWR do not necessarily take CPI inflation, or indexation, as a reference point for computing real wages. The aim of the procedure is precisely to estimate the expected inflation forecast used by agents in wage bargaining. Nevertheless, in order to have an idea of how real wages evolve, we report in Table 3 the percentage of observations below indexation and below CPI inflation.[23]

[22] First, the expected bargaining focal point from which real rigidity is computed may differ for each group. Second, the distribution of wage changes and the estimated notional distribution differ in each exercise.

[23] This provides a poor indicator of wage rigidity. Among others, it depends on the mean of the distribution. A shift in the distribution of wage changes to the right will reduce the percentage of observations below inflation, even if the spike of observations at expected inflation over the number of workers who should have received a real wage cut, i.e. the simple measure of DRWR used in this paper, remains unchanged.

Table 3 - Downward real and nominal wage rigidity according to worker category (MMM measures)

	MMM measures		relative rigidity		% of observations below	
	DRWR	DNWR	DRWR	DNWR	indexation	CPI
entire sample	0.59	0.19				
by job type			% blue collar			
blue-collar	0.55	0.10	1.00	1.00	27.3	30.2
white-collar	0.70	0.13	1.27	1.36	23.6	25.1
by age category			% 18-25			
18≤ age <25	0.65	0.22	1.00	1.00	19.5	20.8
25≤ age <35	0.58	0.13	0.89	0.59	22.2	23.9
35≤ age <45	0.56	0.15	0.85	0.69	26.0	28.1
45≤ age < 55	0.42	0.15	0.64	0.68	29.0	31.4
55≤ age <65	0.42	0.05	0.64	0.23	34.0	36.5
by earnings level			% $w<P_{15}$	% $P_{15}<w<P_{35}$		
$w < P_{15}$	0.62	0.64	0.65	1.00	26.1	28.8
$P_{15} < w < P_{35}$	0.95	0.36	1.00	0.56	21.4	24.8
$P_{35} < w < P_{65}$	0.78	0.30	0.82	0.47	23.7	26.3
$P_{65} < w < P_{85}$	0.74	0.36	0.78	0.57	24.5	26.3
$w > P_{85}$	0.60	0.15	0.63	0.23	26.6	27.8
by gender			% men			
men	0.62	0.08	1.00	0.50	25.8	27.8
women	0.62	0.16	1.00	1.00	22.7	24.5

Note: "w" stands for total annual earnings per working days, "P_x" is the x^{th} percentile of the wage distribution. The percentage of observations below indexation and CPI is calculated from the factual (empirical) distribution.

Earnings of white-collar workers are substantially more rigid than those of blue-collar workers. This holds both for nominal and real rigidity and it is in line with predictions of all labour market theories discussed in Section 3, with the exception of the contract theory. Firms may be reluctant to cut wages of workers whose effort is less easily monitored or those with high replacement costs to avoid them reducing their effort or leaving the firm. These characteristics are typical for white-collar workers. In addition, as white-collar workers in Belgium obtain automatic wage increases with age or tenure, they are less likely to experience real cuts in earnings, as compared to blue-collar workers who typically do not have such assurance. Our finding of higher DRWR and DNWR for white collars is consistent with Campbell's (1997) results. Using macroeconomic data for the US, he finds that wages of more skilled workers, and in particular white-collar workers, are less responsive to fluctuations in unemployment. In addition, he reports evidence that wages of more skilled workers adjust more rapidly to inflation.

Both real and nominal rigidity decline with age. Real rigidity is 35% lower for people over 45 than for the youngest workers.[24] This finding is in line with the prediction of the shirking model and the adverse selection model applied to quits. Because the cost of job loss is higher for older workers, and in particular for workers over 45 years old, they are less likely to quit or shirk, even if their earnings increases are below their expected bargaining reference point. This translates into lower DRWR. On the other hand, the contract theory, insider-outsider models and the firm-specific human capital model predict the opposite pattern of rigidity. As short-term contracts are more frequent for younger workers, they allow for larger earning variations due to contract renewals. Furthermore, if mobility across

[24] The estimates of DRWR for the 45-55 and over 55 years categories are not so stable over time but they are always below the remaining categories. We therefore consider these categories in our analysis.

employers is higher among younger workers, they may face lower DRWR as entrants/outsiders have less bargaining power than incumbents/insiders. Although these arguments are valid in general, they are not dominant in the data set.

In addition to these theoretical predictions, low rigidity observed for the oldest workers can also be related to the fact that automatic increases due to age or tenure flatten out with age (see Figure 1). As a result, wage changes among older workers are, *ceteris paribus*, lower and hence more susceptible to a cut in real earnings. In addition, as the extra-wage components of earnings become more important for people with more experience and responsibilities, real decreases in total earnings could be more likely. At the other end of the distribution scale, real and nominal rigidity is highest for the youngest workers. An extra reason for the high level of nominal rigidity for the youngest category of workers is that wages are lower and thereby closer to the minimum wage. This reflects the fact that there are more workers with very low education and poorly-paid jobs in the lowest age category. Indeed, the fraction of workers with earnings exceeding the minimum wage by at most 5 percent is 0.026 for people below 25 compared to around 0.0025 for the rest of the sample.

A similar pattern is found across earnings levels. We consider five earnings categories delimited by the following percentiles of the earnings distribution: 15, 35, 65, 85. Because individual earnings depend on the business cycle etc., we calculate the percentiles (and earnings categories) separately for each year.[25] Nominal rigidity is extremely high at the bottom of the earnings distribution, equal to 0.64, compared to the average of 0.19 for the entire sample. Indeed, for workers with very low earnings close to the minimum wage, nominal rigidity is more likely to bind. Another possible explanation is that the lowest earnings level corresponds to more precarious and temporary jobs where the bargaining power of workers is much lower and unions less well represented. Low earnings are indeed also characterised by a relatively low level of real rigidity. Conversely, real wage rigidity is extremely high for workers in the second lowest wage category and then decreases with earnings. As explained above, collectively-agreed wage changes can be relatively less important for workers with high wages, making this category more flexible. The result may also be due to the fact that total earnings for better-paid jobs involve a much larger non-wage component. For example, bonuses and premiums, which are much more flexible over time than wages, are positively related to the wage level. As shown in Table A4 in the Appendix, this leads to a higher dispersion of earnings changes; the standard deviation of earnings changes as well as the interdecile range are respectively 50% and 34% higher for the top wage category than for the preceding one. This also translates into a larger fraction of earnings changes below indexation, as shown in the last column of Table 3.

Men's earnings exhibit the same degree of DRWR as women's. This is in spite of the fact that women are overrepresented in the lowest age category (14% of females versus 9% of males) and underrepresented among the oldest workers in the data set (2.5% of females versus 6% of males). This disproportion would suggest a higher degree of DRWR for women, all else equal. However, the

[25] Individual earnings are naturally related to tenure and age. Unfortunately estimating DRWR by age and earning category would not be possible/not deliver accurate estimates because this would leave too few observations in many categories. So we cannot disentangle the effect of age from the pure impact of wage level on DRWR.

composition of blue collars and white collars among women works in the opposite direction, predicting *ceteris paribus* lower DRWR for women (more than 83% of female observations in the sample are classified as blue-collar workers, compared to 52% of men).

To sum up, our evaluation of wage rigidity in Belgium indicates that the country is characterised primarily by high real rigidity, as can be expected in a labour market with a full indexation mechanism. Real rigidity is stronger for white-collar workers than for blue-collar workers. Real rigidity decreases with age, as non-wage components of earnings may become more prominent with age or tenure. Except for very low earnings, it decreases with the earnings level, too; due to a larger fraction of income attributable to extra wage compensation such as bonuses and premiums. Very low earnings show a low degree of real rigidity; possibly because they correspond to more temporary and precarious jobs with lower bargaining power. Nominal rigidity is essentially absent. However, nominal rigidity becomes binding in certain cases, such as very low earnings due to their proximity to the minimum wage. The results are in line with the predictions of the shirking model, the turnover model and the adverse selection model applied to job quits. Mixed evidence was found for the insider-outsider theory and the firm-specific human capital model. Finally, the patterns found in the data contradict the predictions of the contract theory.

5.3. Wage rigidity across firm types and situations

Table 4 reports the average real and nominal rigidity estimates for firm-specific categories. For this purpose, we merged the administrative employer-employee data set with firms' annual accounts in order to add variables like value added, profits and employment. As a result, the number of wage observations fell from 4.5 million to approximately 3 million (depending on the variable).[26] Since 1996, firms have also been required to fill out the so-called social balance sheet, which includes information on, among other things, flows of workers. So, wage rigidity for categories measuring quit rates and turnover can be estimated solely for the years 1996-2002. For similar reasons as in Section 5.3, we focus our analysis on DRWR.

[26] Almost all firms in Belgium have to draw up annual accounts and hence the coverage is virtually exhaustive. However, in some cases, no univocal relation could be made between social security employer identification and its counterpart in the annual accounts. More importantly, some employers do not report annual accounts in the same manner. This is the case, for instance, for bank and credit institutions.

Table 4 - Downward real and nominal rigidity at the level of firm categories (MMM measures)

	MMM measures		**relative rigidity**		% of observations below	
	DRWR	DNWR	DRWR	DNWR	indexation	CPI
entire sample	0.59	0.19				
by size			% ≤25 employees			
≤25 employees	0.78	0.12	1.00	1.00	25.6	28.5
26-50 employees	0.70	0.12	0.90	1.02	25.2	27.8
51-100 employees	0.72	0.08	0.93	0.70	24.5	26.7
101-500 employees	0.62	0.02	0.80	0.14	24.4	26.2
>500 employees	0.44	0.21	0.57	1.85	24.2	25.8
by quit rate			% no quit rate			
very low or zero quit rate	0.72	0.17	1.00	1.00	26.4	26.8
low quit rate	0.70	0.09	0.97	0.50	25.3	27.1
medium quit rate	0.70	0.07	0.98	0.39	27.6	29.5
high quit rate	0.57	0.12	0.79	0.71	31.1	32.8
by real value added growth			% expansion			
$\Delta\log(va)_t>0$	0.67	0.07	1.00	1.00	23.3	25.3
$\Delta\log(va)_t<0$	0.61	0.13	0.91	1.86	25.8	28.0
by profits			% expansion			
$\Pi_t>0$	0.62	0.10	1.00	1.00	23.8	25.9
$\Pi_t<0$	0.53	0.09	0.85	0.91	27.8	29.8
by employment growth			% expansion			
$\Delta\log(L)_t>0$	0.68	0.11	1.00	1.00	23.3	25.4
$\Delta\log(L)_t<0$	0.55	0.12	0.81	1.09	25.9	28.0
by employment growth and turnover			% high turnover			
low turnover $\Delta L<0$	0.55	0.18	0.90	3.26	26.6	28.4
high turnover $\Delta L<0$	0.61	0.05	1.00	1.00	29.4	31.2

Note: Averages for quit rate and volatility categories are based on estimates over 1996-2002. The entire sample includes estimates for 1991-2002. The percentage of observations below indexation and CPI is calculated from the factual (empirical) distribution.

We first examine differences across firms of different size classes, as measured by the number of employees at the end of the year.[27] DRWR is lower for very large firms and much higher for very small firms (below 25 employees). Very large firms usually have firm-level collective wage agreements. These agreements provide a wage cushion above the sector-level agreement, which enhances wage flexibility.[28] In general, large firms also have a more complex compensation policy, with more variable and therefore flexible extra-wage components. On the other hand, very small firms may be start-up businesses that cannot afford high wages and big wage rises, as can be seen in Tables A3 and A4. Smaller firms are therefore closer to the DRWR bound.

[27] Note that the definition of the number of employees in the balance sheet has changed over the period under examination. Since 1996 (and in some case 1997), firms report the total number of employees at the end of the year. Before 1996, only information on the average number of employees per year is available. The break in the employment series, however, does not seem to have any substantial impact on the MMM estimates of wage rigidity.

[28] As shown in Tables A3 and A4 in the Appendix, average daily earnings in our sample are lower and less widely dispersed for firms with fewer than 25 employees (about 75 euros on average with a standard deviation of 32.31) than for firms with more than 500 employees (105 euros on average with a standard deviation of 46.70). Further earnings changes are lower for smaller firms than for larger firms (0.042 for firms with less than 25 employees against 0.049 for firms with more than 500 employees).

Next, we analyse differences in quit rates across firms. The turnover model implies that firms with high turnover costs will try to stabilise their workforce by minimising fluctuations in employees' earnings, in order to save on training and hiring costs. High turnover costs would thus imply low quit rates and a high degree of rigidity, all else equal. To examine this question, quit rates are defined as the total number of exits divided by the number of employees at the beginning of the year (both in full-time equivalent).[29] We define four categories of quit rates. The first consists of firms with quit rates below 5 percent.[30] The others are delimited by the 33rd and 66th percentiles of the distribution of quit rates across firms, excluding zero quit rates. Our estimates show that firms with the lowest or zero quit rate exhibit 20% higher DRWR than firms with the highest quit rates.[31] In addition, statistics reported in Table A4 indicate that the standard deviation of earnings changes is larger for firms with high quit rates (0.11) than for firms with low or medium quit rates (0.08 and 0.09 respectively). This supports the view that employees tend to leave their jobs less frequently when their wages are more downwardly rigid. Therefore, firms with higher turnover costs should avoid (real) wage cuts in order to reduce (costly) quits. Our findings are in line with the predictions of the turnover model.

Finally, we investigate whether the high degree of real rigidity observed for Belgian firms is restricting their ability to cut wages under unfavourable conditions. An expanding firm can afford real wage increases or might be forced to raise wages if the labour market is tight. On the other hand, a contracting firm primarily tries to cut costs. According to the legislation on restructuring companies, firms have to follow strict procedures and interact with unions and local authorities when they want to cut costs through collective lay-offs. Employees in shrinking firms may be more likely to accept wage cuts as they fear that they could be fired in the next round of dismissals. This implies a lower degree of wage rigidity. One should also note that, since annual earnings include overtime hours paid, we may observe a decline in earnings due to a reduction in hours worked in adverse times.

We have experimented with several variables indicating the situation of a firm - real value added growth, profits and employment growth. We define "good times" as a situation in which real value added growth is positive, profits are positive or employment growth is positive.[32] In Table 4, we present the results based on this decomposition when the indicator is defined with respect to year t, i.e. when value added, for example, decreases within the course of year t. Table 6 in the next section presents robustness results with respect to two alternative definitions of good and bad times. The first indicator is based on one-period lagged values of value added, profits and employment.[33] The last

29 Firms with more quits than the number of employees at the beginning of the year plus the number of entries are excluded from the data set.

30 This attempts to control for the fact that small companies are more likely to observe zero quits than large companies, all else equal.

31 This cannot be attributed to the fact that quit rates proxy for firm size. Indeed, higher quit rates are observed for smaller firms and vice versa. Our findings indicate that DRWR is lower for larger firms and for firms with higher quit rates.

32 Value added growth and employment growth are negative in 40% to 45% of the observations. Profits are negative in around 18% of the cases. For large firms, nominal value added is equal to operating income minus operating subsidies and compensatory amounts received from public authorities, and the following operating charges: raw materials consumables and services and other goods. For small firms, valued added is proxied by gross operating margin. It is deflated using the 2-digit NACE deflator for value added.

33 If, for example, value added shocks occur at the end of year t-1, while wages are adjusted during year t, it is more relevant to consider this lagged indicator.

indicator considers the cumulative sum of growth rates between year t and year t-1.[34] Profits are measured as operating profits and employment is defined as the total number of employees at the end of the year.

Because the analysis is based on sample splits, we cannot control for sector- or time-specific effects, e.g. by using dummy variables. Therefore, downturns as identified in this paper may capture aggregate business cycle shocks, sector-specific downturns as well as a firm-specific adverse times.[35] If all firms in the same sector were expanding at the same time, labour market tightness could induce stronger wage increases and less or no wage decrease, which could imply a lower degree of downward wage rigidity. Except for the energy industry with only 5 firms, there is no other sector in which all firms are in downturn or upturn at the same time. Nor are all firms in downturn or upturn in the same year. Below, we also report robustness with another definition of adverse economic conditions that attempts to control for sector-specific conditions. We consider the sample of firms for which value added growth is larger than the sector-specific median, where the sector is defined at the NACE-2 level. Results reported in Table 6 are of the same order of magnitude.

The results, presented in Table 4, univocally conclude that observed DRWR is lower when firms face adverse economic conditions. Firms with declining value added, negative profits or reduced employment exhibit lower degrees of estimated real rigidity.[36] This result is robust to alternative definitions of adverse situations and to alternative measures of real rigidity (see the next section). It suggests that cuts in real earnings are more likely in bad times. This may occur because workers accept wage moderation or because firms are able to reduce the extra wage components of earnings, like bonuses, premiums and overtime hours, when the situation takes a turn for the worse. Indeed, there is usually some form of wage moderation in bad times (wage growth is around 4.5% in bad times against 4.9% in good times, as shown in Table A4). Furthermore, a higher fraction of workers experience a decline in real earnings, as shown in the last column of Table 4. These results are consistent with the findings of Carneiro and Portugal (2006) that workers accept wage concessions as the probability of firm closure increases.[37] We examine this question in more detail and split the sample of firms with declining employment into those with a high turnover rate and those with a low turnover rate. Turnover is defined by the sum of entries and exits over the average number of employees in the previous year (all variables in full-time equivalent). Our estimates suggest that when employment declines, DRWR is lower the smaller the turnover. This suggests that if firms do not cut

[34] Such an indicator aims to capture shocks with longer-lasting effects, or shocks that are large enough to compensate for possible previous (exceptionally) good outcomes.

[35] Indeed, if we compute the percentage of firms in upturn, weighted by their value added, we find a correlation of around 70 percent between that measure and the business cycle index computed by the National Bank of Belgium from its business cycle survey for the manufacturing and construction sectors. These are also strongly correlated with the aggregate business cycle index.
Furthermore, regressing the percentage of firms in downturns by NACE-2 sector on time and industry dummies, the R^2 amounts to 0.32 for time dummies and 0.14 for industry dummies. So, we cannot rule out that our measure of downturns is a mix of aggregate sector- and firm-specific economic conditions.

[36] This result is independent of the size of the firm. For example, numbers not reported for the sake of brevity show that smaller firms (with less than 25 employees) experienced real value added declines more frequently, but employment reductions less frequently.

[37] They also find that firms experiencing a decline in sales growth and smaller firms and high-paying firms are more likely to close.

employment to a large extent, they may reduce their labour costs through higher earnings concessions from their employees.

All in all, our findings suggest that observed DRWR may fluctuate according to economic conditions. Small firms experience stronger downward real wage rigidity than large firms. Our results suggest that firms with low quit rates are characterised by stronger real rigidity. Finally, real wage rigidity is lower when the firm faces adverse economic conditions. One observes more (real) earnings cuts when real value added growth, employment growth or profits are negative. The effects are even stronger for firms with low turnover, suggesting that wage cuts may substitute for job cuts when the firm's situation deteriorates. Note that although the degree of real rigidity declines for firms that have an incentive to cut wages, the absolute level of real wage rigidity remains high from a cross-country comparison (see Dickens et al., 2006).

5.4. Robustness analysis

This section provides robustness tests of the above findings along three lines. First, we consider alternative specifications for the MMM estimates of DRWR and DNWR. Second, we evaluate the robustness of our conclusion with respect to simple measures of rigidity as described in Section 4. Third, we also examine the sensitivity of our results with respect to alternative definitions of adverse economic situations.

The MMM procedure assumes that the bargaining focal point, Π^e, is normally distributed. Alternative specifications provide different bounds for the grid search for its mean and/or variance. In the above analysis, we allow the unrestricted mean to range from 0 to 4 percent[38], and the restricted variance to take values between 4E-06 and 3.6E-05. When the mean is restricted, we limit the grid search for expected inflation forecasts to a minimum width of 0.015, and to include realised CPI inflation, its one-period lagged value, a within-sample AR(1) forecast of CPI inflation and the official forecast for CPI inflation produced by the Federal Planning Bureau.[39] In the specification with unrestricted variance of Π^e, the variance can take any value between 4E-06 and 0.1.

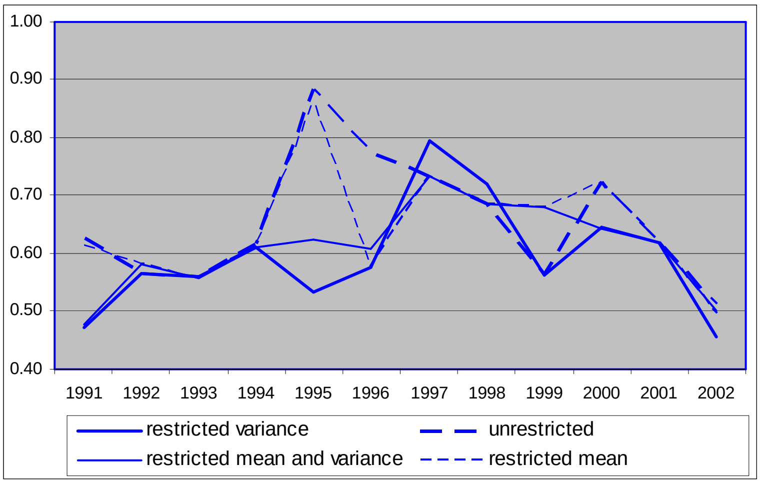
Examining the estimates of rigidity year by year gives a better view of the differences across the four MMM specifications. Figure 4 documents that the DNWR and DRWR estimates differ substantially from each other in three instances – the initial observation (year 1991) and the periods 1995-1996 and 1999-2000. As baseline model we chose the restriction that provides in our opinion the best description of the three periods under consideration. The years 1995, 1996 and 1999 are characterised by a very low average bargaining focal point (Π^e) which might pose problems for

[38] The original procedure allows the grid search to go up to 10 percent. For efficiency, we limit the range to the 0-4 percent band, which is much more realistic in view of the inflation rates seen over the 1990-2002 period. In fact, CPI inflation ranged from 0.010 to 0.031 over the period.

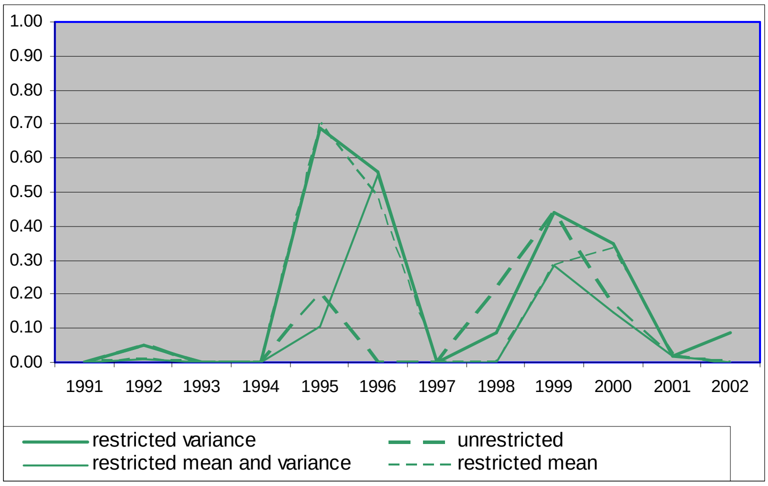
[39] With respect to the original IWFP procedure, we impose the additional criterion that the range for the mean of expected inflation forecasts includes the official forecast of the CPI inflation prepared by the Federal Planning Bureau (FPB), that is used in the collective bargaining by the social partners. Further, we extend the band around its mean so that its width is at least 1.5 percentage points. Otherwise, the band would have become very narrow in some years as compared to other years.

identifying DNWR and DRWR. The Belgian government directly intervened in the labour market in the years 1995-1996, causing wage moderation and a real wage freeze. However, there is nothing that would justify a big variation in DNWR or DRWR from the year 1995 to 1996. This condition is satisfied only by the specification which restricts the variance of Π^e but not its mean (see Figure 4). It picks up the episode of wage moderation in 1995-1996 as an increase in nominal rigidity. When restricting both the mean and variance of Π^e, nominal rigidity peaks in 1996 alone. In the specification where both the mean and variance are unrestricted, real rigidity peaks in 1995-1996 and nominal rigidity peaks only in 1996. When only the mean of Π^e is restricted, this induces an increase in real rigidity in 1995. Therefore, we think that the specification with restricted variance and unrestricted mean of Π^e provides the most consistent view and we used it as our preferred specification in the previous section.

Figure 4 - Real and nominal rigidity according to alternative specifications



(4.a) MMM estimates of DRWR



(4.b) MMM estimates of DNWR

Note: Restrictions with respect to the mean and variance of the bargaining focal point (Π^e).

Table 5 compares the average estimates of DNWR and DRWR for the four alternative MMM specifications together with the simple measures of Dickens et al. (2007) described in Section 4 and illustrated in Figures A1 and A2 in the Appendix. Simple true measures are based on the distribution of earnings changes corrected for measurement errors, i.e. the "true" distribution. Simple empirical measures are constructed from the factual (uncorrected) distribution. In all five specifications, real wage rigidity is much stronger than nominal rigidity. Real rigidity is around 60 percent in all cases, except for simple empirical cases where it falls to 0.49.

Table 5 - Downward real and nominal rigidity with respect to alternative specifications

	restricted variance	restricted mean and variance	unrestricted	restricted mean	simple true	simple empirical
real rigidity	0.59	0.61	0.65	0.64	0.62	0.49
nominal rigidity	0.19	0.15	0.09	0.15	0.06	0.05

For the entire sample, results with restricted variance, and restricted mean and variance lead to the most sensible findings. For these two specifications, our assessments of relative wage rigidity across groups are also consistent. Our quantitative evaluation of real rigidity for the various groups is very close in the two methods; discrepancies appear to be stronger for nominal rigidities. Our qualitative conclusions are unaffected: real and nominal rigidity are stronger for white collars, and they decrease with age and wage level. Nominal rigidity is the strongest for very low wages and younger workers. Nominal and real rigidity are low for very high wages. Estimated real rigidity decreases in bad times. The same conclusions hold if one considers simple measures of rigidity, except for the case of declining employment and low versus high employment turnover.

Table 6 - Robustness with respect to alternative measures of rigidity

	***baseline*: restricted variance of Π^e**		**restricted mean and variance of Π^e**		**simple empirical measures**		**simple true measures**	
	DRWR	DNWR	DRWR	DNWR	DRWR	DNWR	DRWR	DNWR
entire sample	0.59	0.19	0.61	0.15	0.49	0.05	0.62	0.06
by job type								
blue-collar	0.55	0.10	0.55	0.04	0.31	0.06	0.40	0.08
white-collar	0.70	0.13	0.63	0.14	0.55	0.04	0.71	0.06
by age category								
18≤ age <25	0.65	0.22	0.67	0.13	0.70	0.04	0.85	0.05
25≤ age <35	0.58	0.13	0.63	0.10	0.60	0.05	0.71	0.06
35≤ age <45	0.56	0.15	0.58	0.10	0.42	0.05	0.57	0.07
45≤ age < 55	0.42	0.15	0.45	0.08	0.25	0.05	0.36	0.08
55≤ age <65	0.42	0.05	0.40	0.17	0.17	0.05	0.24	0.08
by wage category								
$w < P_{15}$	0.62	0.64	0.67	0.66	0.39	0.08	0.65	0.12
$P_{15} < w < P_{35}$	0.95	0.36	0.96	0.35	0.55	0.08	0.82	0.13
$P_{35} < w < P_{65}$	0.78	0.30	0.71	0.24	0.51	0.06	0.77	0.09
$P_{65} < w < P_{80}$	0.74	0.36	0.75	0.19	0.45	0.06	0.72	0.11
$P_{80} < w$	0.60	0.15	0.51	0.20	0.39	0.04	0.57	0.07
by gender								
men	0.62	0.08	0.60	0.09	0.47	0.05	0.58	0.07
women	0.62	0.16	0.63	0.14	0.57	0.05	0.69	0.06

Note: "w" stands for total annual earnings per working days, "P_x" is the x^{th} percentile of the wage distribution. The entire sample includes estimates for 1991-2002. Our baseline specification in Section 5.2 is restricted variance and unrestricted mean of Π^e.

Finally, Table 6 also considers alternative definitions of adverse economic situations. We consider both the current and lagged situation, to account for the fact that the change in value added, employment or profits might first be observed at the end of the year. We also consider the cumulated sum of value added (employment) over two consecutive years so as to take into account longer-lasting effects. This also ensures that we do not consider as an adverse time a situation where value added (employment) falls in time t-1 following a large increase in t, so that the current level can be considered as normal. Lastly, in order to take into account sector-specific business cycle conditions, we consider value added growth relative to the sector median. Whatever the indicator and measure of rigidity considered, DRWR is always lower in adverse times.

Table 6 (continued) - Robustness with respect to alternative measures of rigidity

	***baseline*: restricted variance of Π^e**		**restricted mean and variance of Π^e**		**simple empirical measures**		**simple true measures**	
	DRWR	DNWR	DRWR	DNWR	DRWR	DNWR	DRWR	DNWR
entire sample	0.59	0.19	0.61	0.15	0.49	0.05	0.62	0.06
by size								
≤ 25 employees	0.78	0.12	0.79	0.11	0.47	0.05	0.58	0.07
26-50 employees	0.70	0.12	0.70	0.09	0.52	0.05	0.61	0.06
51-100 employees	0.72	0.08	0.74	0.07	0.59	0.04	0.73	0.05
101-500 employees	0.62	0.02	0.59	0.07	0.50	0.05	0.65	0.06
>500 employees	0.44	0.21	0.41	0.23	0.41	0.05	0.54	0.07
by quit rate								
very low or zero quit rate	0.72	0.17	0.72	0.11	0.59	0.07	0.66	0.08
low quit rate	0.70	0.09	0.68	0.07	0.57	0.05	0.73	0.08
medium quit rate	0.70	0.07	0.71	0.06	0.52	0.05	0.62	0.06
high quit rate	0.57	0.12	0.51	0.15	0.38	0.04	0.48	0.06
by real value added growth								
$\Delta va_t > 0$	0.67	0.07	0.64	0.10	0.56	0.05	0.70	0.07
$\Delta va_t < 0$	0.61	0.13	0.58	0.15	0.42	0.05	0.60	0.06
$\Delta va_{t-1} > 0$	0.64	0.08	0.66	0.13	0.56	0.05	0.73	0.06
$\Delta va_{t-1} < 0$	0.54	0.12	0.56	0.10	0.48	0.05	0.58	0.07
$\Delta va_t+\Delta va_{t-1} > 0$	0.67	0.03	0.66	0.05	0.58	0.05	0.70	0.06
$\Delta va_t+\Delta va_{t-1} < 0$	0.57	0.14	0.56	0.14	0.44	0.05	0.55	0.07
$\Delta va_t >$ sector median_t	0.67	0.09	0.67	0.11	0.63	0.05	0.77	0.07
$\Delta va_t <$ sector median_t	0.63	0.13	0.63	0.13	0.50	0.05	0.64	0.07
by profits								
$\Pi_t > 0$	0.62	0.10	0.61	0.06	0.66	0.06	0.54	0.05
$\Pi_t < 0$	0.53	0.09	0.54	0.07	0.48	0.06	0.39	0.05
$\Pi_{t-1} > 0$	0.63	0.09	0.63	0.06	0.54	0.05	0.66	0.07
$\Pi_{t-1} < 0$	0.52	0.12	0.53	0.14	0.36	0.05	0.49	0.06
by employment growth								
$\Delta L_t > 0$	0.68	0.11	0.67	0.10	0.58	0.05	0.70	0.07
$\Delta L_t < 0$	0.55	0.12	0.52	0.10	0.41	0.05	0.55	0.06
$\Delta L_{t-1} > 0$	0.64	0.08	0.62	0.09	0.58	0.05	0.69	0.06
$\Delta L_{t-1} < 0$	0.60	0.12	0.55	0.17	0.48	0.05	0.61	0.07
$\Delta L_t+\Delta L_{t-1} > 0$	0.68	0.02	0.65	0.09	0.56	0.05	0.74	0.06
$\Delta L_t+\Delta L_{t-1} < 0$	0.54	0.10	0.53	0.13	0.44	0.05	0.56	0.07
by employment growth and turnover								
low turnover & $\Delta L<0$	0.55	0.18	0.52	0.22	0.50	0.06	0.65	0.08
high turnover & $\Delta L<0$	0.61	0.05	0.60	0.07	0.41	0.05	0.52	0.06

Note: Averages for quit rate and volatility categories are based on estimates over 1996-2002. The entire sample includes estimates for 1991-2002. Our baseline specification in Section 5.3 is restricted variance and unrestricted mean of Π^e.

6. CONCLUSION

This paper evaluates the extent of downward nominal and real wage rigidity in Belgium for different categories of workers, under different company characteristics and economic situations, using the recently developed IWFP procedure. The analysis is based on an administrative data set on individual earnings covering approximately one-third of employees in the private sector in Belgium over the period 1990-2002.

Our results show that Belgium is characterised by strong real wage rigidity and very low nominal wage rigidity, which is consistent with the Belgian wage formation system of full indexation. Nominal rigidity is essentially absent, except for cases in which it becomes binding, such as very low earnings that are close to the minimum wage. This is mainly the case for younger workers with low wage levels. The finding of very low nominal real rigidity points to almost no grease effects of inflation in Belgium. On the contrary, real rigidity will translate inflation into nominal wage increases.

In this paper, we further highlight differences in the degree of rigidity across workers and firms. We explain the patterns by considering both the general predictions of labour market theories and specific wage formation institutions in Belgium. First, we found higher real wage rigidity for white-collar workers than for blue-collar workers. Because white-collar workers are more difficult to replace and harder to monitor, firms are less inclined to cut their wages. In addition, automatic wage increases are largely non-existent for blue-collar workers in Belgium. Second, real rigidity decreases with age. Since the cost of job loss is higher for older workers, they are less likely to quit their jobs or shirk, even if their earnings increases are below their expected bargaining reference point. Furthermore, the automatic tenure-related and age-related wage increases become less prominent with age. Third, DRWR decreases with earnings level, except for very low earnings. As income grows, a larger fraction is attributable to extra wage compensation such as bonuses. Very low earnings show a low degree of real rigidity, possibly because they correspond to more temporary and precarious jobs, with lower bargaining power for real wage increases.

Fourth, downward real wage rigidity is more prevalent in small firms than in large firms. The latter often apply a firm-level wage agreement with more variable wage components that enhance their flexibility. Fifth, our results also suggest that firms with low quit rates are characterised by stronger real rigidity. Provided that firms with low quit rates are those with high turnover costs, they have an incentive to avoid (real) wage cuts in order to reduce (costly) quits.

Sixth, observed DRWR fluctuates with firms' economic conditions. Real wage rigidity is lower when the firm faces adverse economic conditions. There are more (real) earnings cuts when value added growth, employment growth or profits are negative. The effects are even stronger for firms with low turnover, suggesting that wage cuts may substitute for employment cuts when firm’s situation deteriorates. Note that although the degree of real rigidity declines for firms that have an incentive to cut wages, the absolute level of real rigidity remains high in a cross-country comparison.

The results are in line with the predictions of the shirking model, the turnover model and the adverse selection model applied to quits. Mixed evidence was found for the insider-outsider theory and the firm-specific human capital model. The patterns found in the data contradict the predictions of the contract theory.

Our results are robust to alternative specifications of the estimator, as well as to alternative simplified measures of rigidity.

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APPENDIX

Our initial sample contains 32 percent of dependent employees from the private sector over the period 1990-2002. This represents over 21 million observations on annual individual earnings.[40] Table A1 below describes our trimming procedure. We first exclude temporary and part-time workers. Permanent workers are defined as those who work for the same employer for at least 11 months over two consecutive years. We focus on the manufacturing, construction and commercial services sectors (branches D to K). Next, we remove inconsistent observations[41] and outliers with respect to age and earning level, as described in Section 4. Finally, we consider only job stayers, i.e. workers who are employed by the same firm over two consecutive years. Note that these are the only ones for which we can compute the wage changes by employer. We end up with 20.9 percent of wage observations from the initial sample.

Table A1 - Trimming the sample

	Av. number of workers in		Number of earnings-year	P.c. of
	Belgium	data set	observations	total
Total	3 240 339	1 035 073	21 359 155	
excluding part-time workers and workers with more than 1 month of leave per year (not paid by the firm)		584 077	8 316 224	38.9
excluding agriculture, fisheries and social services		430 610	6 027 217	28.2
excluding inconsistent observations		381 559	4 960 262	23.2
excluding observations where the individual worked less than 310 days in 2 consecutive years		347 920	4 522 962	21.2
excluding workers based on their age and wages		343 005	4 459 064	20.9
excluding observations for which wage change cannot be calculated (job movers, initial observations, discontinuity)			3 417 527	16.0

Our initial sample can be considered a random draw from the population of dependent employees from the private sector in Belgium because it includes all employees born between the 5th and the 15th day of any month. Table A2 documents the changes in the structure of the data set due to trimming and sample restrictions. After dropping part-time workers from the initial sample, the percentage of blue-collar workers increases from 32.4 to 52.6 percent. But because blue-collar workers are more likely than white-collar workers to have more than 1 month of non-paid leave in a given year, their proportion drops to 42.3 percent. The final data set contains substantially more men than women. We lose more observations for women than for men in each step of trimming and sample selection: when excluding part-time workers, workers with more than 1 month of leave per year and after excluding agriculture, fisheries and social services. In addition, we lose a relatively large number of young workers when restricting our data set to full-time regular workers (excluding student jobs, etc.).

[40] Workers might earn more than one income per year (e.g. if they work for more than 1 employer).
[41] In this step, we exclude workers who report more than one income from the same employer in a particular year and individuals for whom there are not enough observations to calculate any wage change.

Table A2 - Impact of trimming and sample selection on the structure of the data set

	Percentage of earnings-year observations	
	Initial random sample	Data set after trimming
Blue-collar workers	32.36	40.33
Men	52.73	75.52
Up to 24 years	18.76	10.29
25 to 34 years	35.51	35.84
35 to 44 years	26.06	28.95
45 to 54 years	15.14	19.84
55 years or more	4.53	5.08

Table A3 - Descriptive statistics on the distribution of gross earnings per day (in euro)

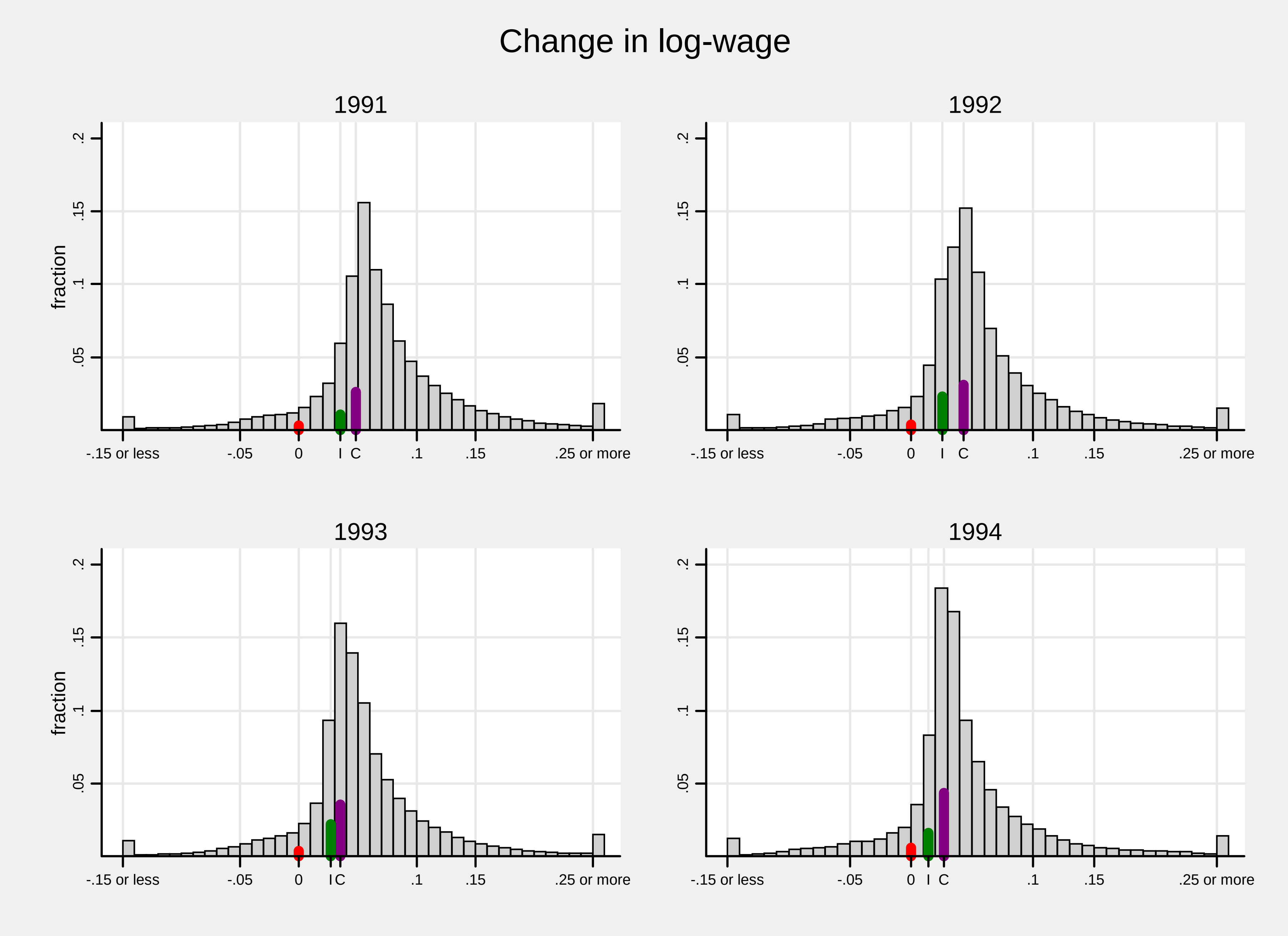
category	observation	mean	st. dev.	p10	p25	p50	p75	p90	pct
Total	**4 459 064**	90.3	43.44	52.8	62.7	77.8	103.9	143.4	
Male	3 367 553	94.8	45.46	56.1	65.5	80.8	109.1	151.7	75.52
Female	1 091 511	76.7	32.97	46.3	54.6	68.6	89.0	115.5	24.48
Up to 24 years	458 871	61.5	15.44	44.3	50.6	59.0	69.3	81.2	10.29
25 to 34 years	1 598 172	79.7	29.78	51.8	60.5	72.6	90.9	115.8	35.84
35 to 44 years	1 291 072	96.7	44.86	57.0	67.3	83.6	112.1	153.5	28.95
45 to 54 years	884 489	107.7	51.59	60.5	72.4	93.3	127.6	174.6	19.84
55 years or more	226 460	119.9	61.55	61.6	75.5	102.9	146.9	202.3	5.08
$w < P_{15}$	667 996	51.3	6.92	42.4	46.2	51.1	56.0	60.7	14.98
$P_{15} < w < P_{35}$	891 609	63.6	7.13	54.4	58.4	63.3	68.5	73.4	20.00
$P_{35} < w < P_{65}$	1 338 330	78.2	10.12	65.7	70.7	77.4	84.8	91.9	30.01
$P_{65} < w < P_{85}$	892 068	105.1	14.96	87.2	94.0	103.3	114.5	125.6	20.01
$w > P_{85}$	669 061	169.7	50.99	121.4	134.9	156.7	189.6	234.5	15.00
Blue-collar	1 798 460	71.8	19.58	51.2	58.9	68.5	80.6	96.0	40.33
White-collar	2 660 604	102.9	50.14	54.6	68.4	90.3	123.1	166.6	59.67
≤25 employees	550 261	74.7	32.31	49.0	56.8	66.9	80.9	107.1	18.42
26-50 employees	432 677	79.6	35.60	50.7	59.0	70.1	87.0	118.4	14.48
51-100 employees	313 366	87.0	40.72	54.0	62.8	75.2	96.9	134.3	10.49
101-500 employees	732 702	94.3	44.24	56.5	66.5	81.5	107.5	148.1	24.52
>500 employees	959 089	104.8	46.70	62.8	74.4	92.2	120.7	163.0	32.10
very low or zero quit rate	123 610	94.9	41.22	59.4	69.0	83.9	108.1	142.2	6.50
low quit rate	1 219 324	106.3	49.68	63.7	74.0	91.7	122.3	167.8	64.15
medium quit rate	344 554	89.1	42.19	55.7	64.6	76.7	98.2	136.1	18.13
high quit rate	103 175	78.4	35.56	50.6	58.4	69.3	84.4	114.3	5.43
$\Delta va_t > 0$	1 619 958	91.1	42.74	54.4	64.3	78.8	103.7	142.2	56.18
$\Delta va_t < 0$	1 263 728	91.7	43.75	54.5	64.3	79.0	104.5	144.7	43.82
$\Pi_t > 0$	2 427 230	90.8	43.08	54.1	63.8	78.3	103.5	143.0	80.66
$\Pi_t < 0$	581 893	92.3	43.38	55.1	65.5	80.2	104.9	143.2	19.34
$\Delta L_t > 0$	1 634 084	87.9	41.27	53.3	62.7	76.2	99.0	136.2	57.39
$\Delta L_t < 0$	1 213 265	96.3	45.30	56.6	67.2	83.4	110.8	152.0	42.61
low turnover & $\Delta L<0$	560 191	110.2	51.14	64.7	76.3	96.3	127.6	173.7	30.44
high turnover & $\Delta L<0$	216 606	90.8	43.63	55.5	65.0	77.8	101.2	140.8	11.77

Note: "pct" gives the percentage of observations in a particular category. "p10" to "p90" refer to respective percentiles of the earnings distribution.

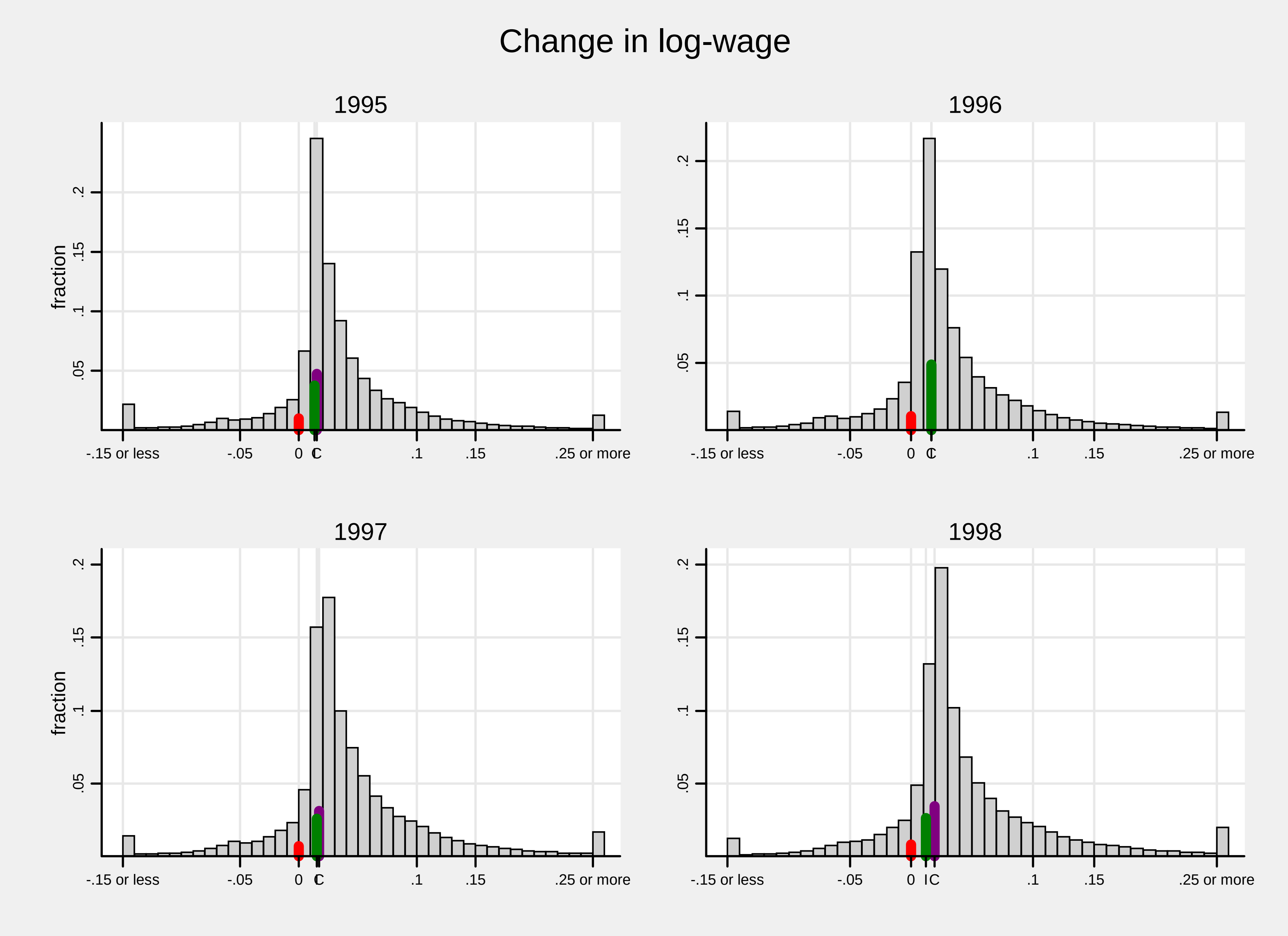
Table A4 - Descriptive statistics on the distribution of changes in earnings per day

category	observation	mean	st. dev.	p10	p25	p50	p75	p90	pct
Total	**3 417 527**	**0.047**	**0.08**	**-0.01**	**0.02**	**0.04**	**0.07**	**0.12**	
Male	2 597 384	0.046	0.08	-0.01	0.02	0.04	0.07	0.12	76.00
Female	820 143	0.052	0.08	-0.01	0.02	0.04	0.08	0.13	24.00
Up to 24 years	253 367	0.067	0.08	0.00	0.02	0.06	0.10	0.16	7.414
25 to 34 years	1 200 765	0.057	0.09	-0.01	0.02	0.05	0.09	0.14	35.14
35 to 44 years	1 030 555	0.043	0.08	-0.01	0.02	0.03	0.06	0.11	30.16
45 to 54 years	734 532	0.035	0.07	-0.01	0.01	0.03	0.05	0.09	21.50
55 years or more	198 308	0.032	0.10	-0.03	0.01	0.03	0.05	0.10	5.80
$w < P_{15}$	444 950	0.031	0.06	-0.03	0.01	0.03	0.06	0.10	13.02
$P_{15} < w < P_{35}$	645 600	0.040	0.06	-0.01	0.02	0.03	0.06	0.10	18.89
$P_{35} < w < P_{65}$	1 031 043	0.045	0.07	-0.01	0.02	0.04	0.07	0.12	30.17
$P_{65} < w < P_{85}$	730 948	0.051	0.08	-0.01	0.02	0.04	0.08	0.14	21.39
$w > P_{85}$	564 986	0.067	0.12	-0.02	0.02	0.05	0.09	0.18	16.53
Blue-collar	1 299 656	0.037	0.06	-0.01	0.02	0.03	0.05	0.09	38.03
White-collar	2 117 871	0.054	0.09	-0.01	0.02	0.04	0.08	0.14	61.97
≤25 employees	418 956	0.042	0.07	-0.01	0.02	0.03	0.06	0.11	18.07
26-50 employees	332 495	0.044	0.07	-0.01	0.02	0.03	0.06	0.11	14.34
51-100 employees	241 594	0.047	0.08	-0.01	0.02	0.04	0.07	0.12	10.42
101-500 employees	569 885	0.049	0.08	-0.01	0.02	0.04	0.07	0.13	24.58
>500 employees	755 676	0.049	0.08	-0.01	0.02	0.04	0.07	0.12	32.59
very low or zero quit rate	106 701	0.039	0.07	0.00	0.02	0.03	0.05	0.10	6.75
low quit rate	1 044 894	0.048	0.08	-0.01	0.02	0.04	0.07	0.13	66.10
medium quit rate	277 995	0.047	0.09	-0.02	0.01	0.03	0.07	0.13	17.59
high quit rate	79 748	0.048	0.11	-0.04	0.01	0.03	0.07	0.14	5.04
$\Delta va_t > 0$	1 245 048	0.049	0.08	-0.01	0.02	0.04	0.07	0.13	54.89
$\Delta va_t < 0$	1 023 033	0.044	0.08	-0.01	0.02	0.03	0.06	0.11	45.11
$\Pi_t > 0$	1 877 217	0.047	0.08	-0.01	0.02	0.04	0.07	0.12	80.40
$\Pi_t < 0$	457 620	0.045	0.09	-0.02	0.02	0.04	0.07	0.12	19.60
$\Delta L_t > 0$	1 233 064	0.049	0.08	-0.01	0.02	0.04	0.07	0.12	55.06
$\Delta L_t < 0$	1 006 270	0.045	0.08	-0.01	0.02	0.04	0.07	0.12	44.94
low turnover & $\Delta L<0$	497 806	0.045	0.08	-0.01	0.02	0.03	0.06	0.12	32.57
high turnover & $\Delta L<0$	183 864	0.044	0.09	-0.02	0.01	0.03	0.07	0.12	12.03

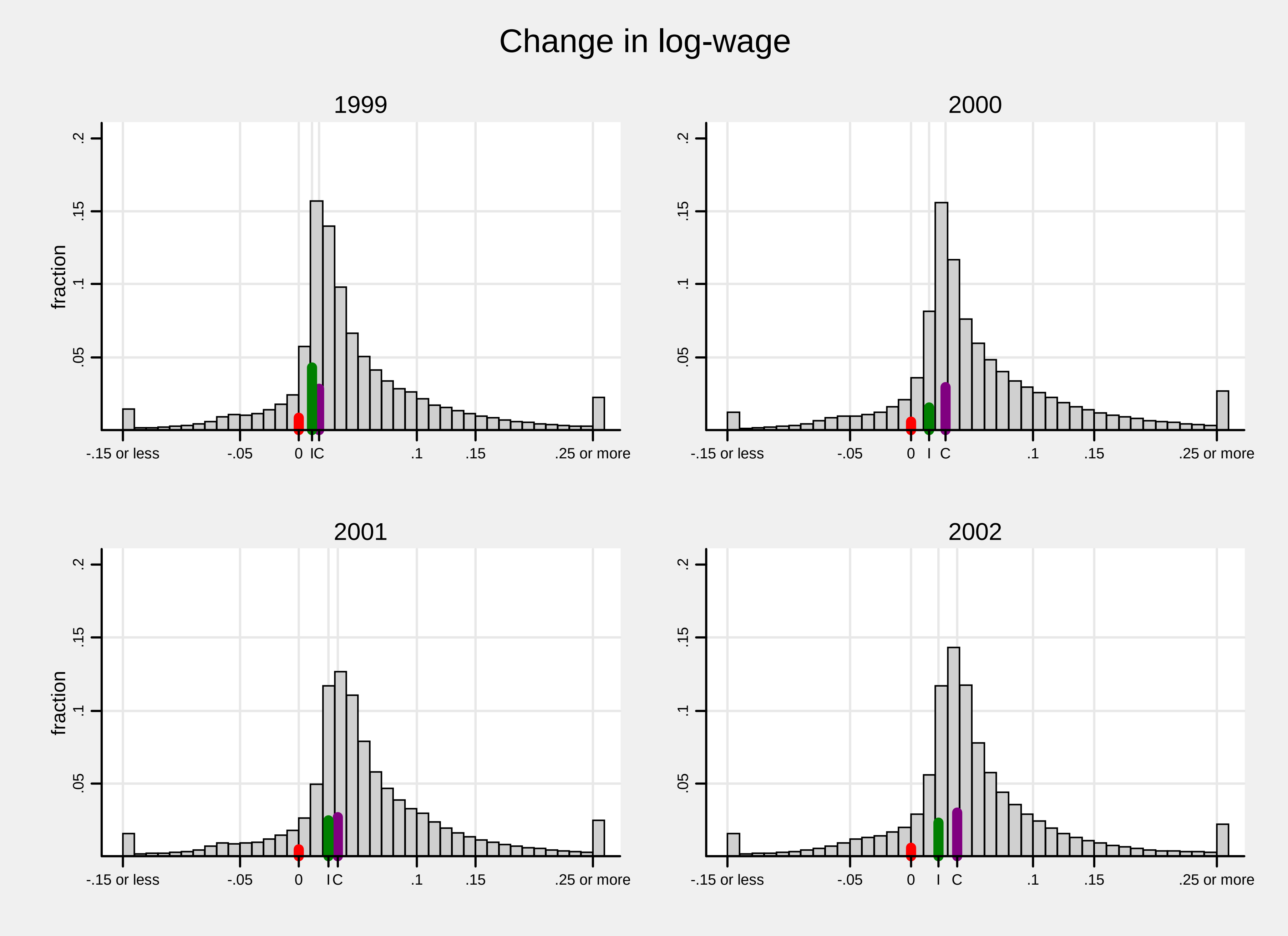
Note: "pct" gives the percentage of observations in a particular category. "p10" to "p90" refer to respective percentiles of the earnings change distribution.



Change in log-wage
1991
1992
1993
1994
fraction
fraction
.05
.1
.15
.2
-.15 or less
-.05
0
I
C
.1
.15
.25 or more

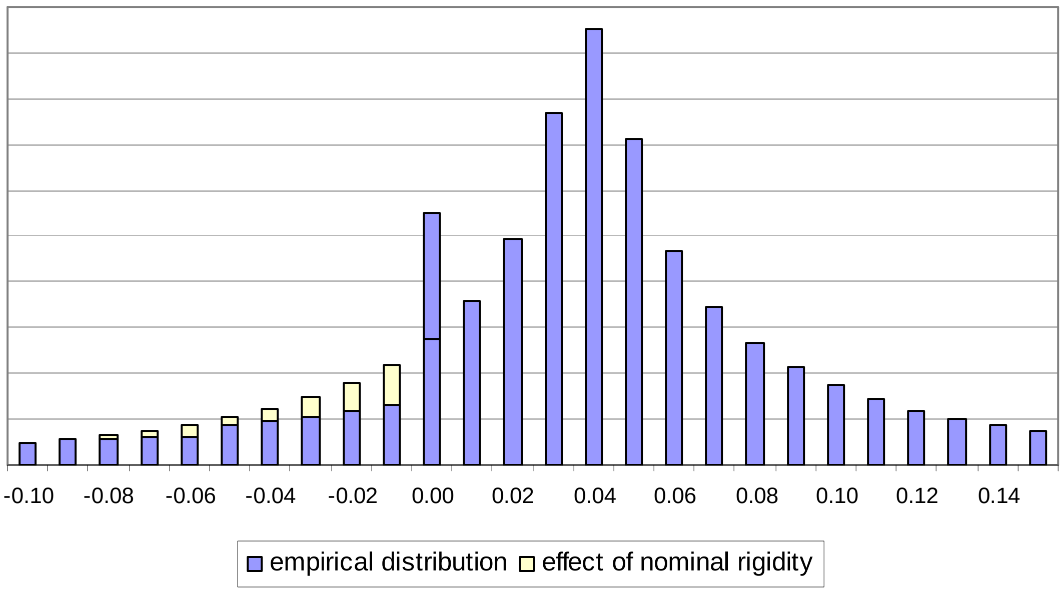


Change in log-wage
1995
1996
1997
1998
fraction
fraction
.05
.1
.15
.2
-.15 or less
-.05
0
I C
.1
.15
.25 or more



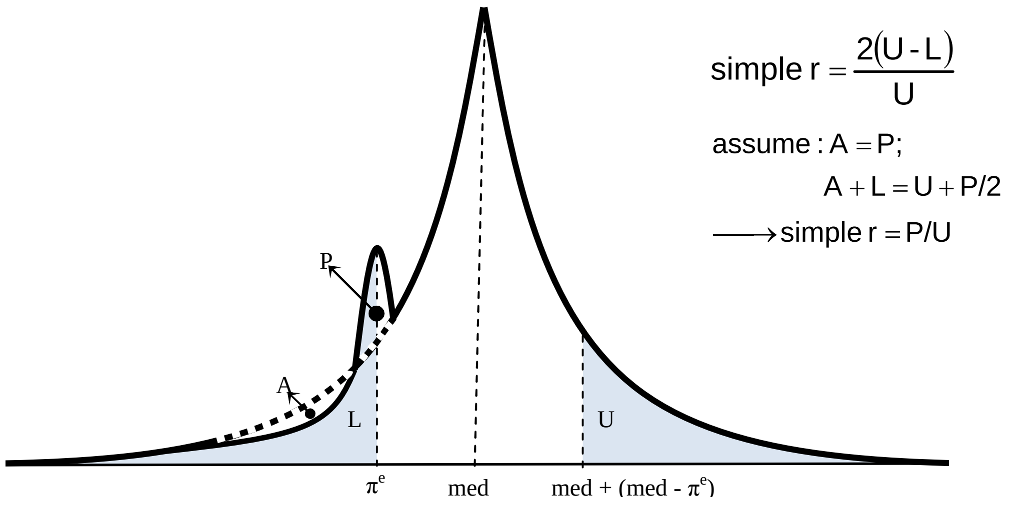
Note: I stands for indexation, C is total collective wage increase

Figure A1 - Measuring nominal rigidity



Note: Due to nominal rigidity, we observe fewer wage decreases (beige area in the histogram) and more wage freezes (spike at zero). The simple measure of DNWR is the ratio of the height of the bin at zero and the area of the empirical histogram at and below zero.

Figure A2 – Measuring real rigidity



Note: Solid line is the histogram of the observed wage change distribution. Dotted line shows the part where the observed distribution deviates from the notional distribution under the assumption of no real rigidity. Notional distribution is based on the Weibull distribution. π^e is the mean of the expected bargaining focal point, "med" stands for median, "L" is the area of the observed distribution below π^e, "P" is the area of the peak (as compared to the notional distribution).

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