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Downward Wage Rigidities in Slovakia

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Abstract The degree of labor market flexibility is especially important for countries considering entry into monetary union. The aim of this article is to assess the extent of wage rigidities in Slovakia. The novelty of this paper is in the employment of Holden and Wulfsberg (2009) approach to the micro data. Firstly, we apply the original methodology on industrial level data drawn from recent decade. The results obtained from sectoral data are ambiguous for Slovakia. Secondly, we turn to micro-approach, where we apply slightly modified methodology on company level data. The estimated extent of both nominal and real rigidities is relatively small. We conclude that flexible hourly wages favored the euro adoption in 2009.

Keywords Nominal and real wage rigidity, Slovakia
JEL classification E24, J30

1. Introduction

Wage flexibility is an important concept for monetary policy. It enters into central banks' thinking about optimum currency areas as well as into its reasoning about optimum level of inflation and consequent setting of inflation target.

Knowing the extent of wage flexibility is therefore important in any monetary environment; whether exercising own monetary policy or being a part of a larger monetary union. In case a domestic monetary policy is present, monetary authorities attempt to set inflation targets considering the extent of wage rigidity. If nominal wages are rigid downwards, it may be desirable to accept some inflation to buffer for wage growth especially when its nominal average is close to zero.[1] In case of being a part of a larger monetary union, other flexible economic policies should be set to compensate for the extent of wage rigidities. Slovakia adopted the common Euro currency on 1st January 2009. Thus knowing the degree of wage flexibility is in the interest of the National Bank of Slovakia.[2]

Following extensive literature, we may distinguish two main measures of wage flexibility. The first is the sensitivity of wages to regional unemployment (so called

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[1] See Groshen and Schweitzer (1999) who closer elaborate on „grease“ and „sand“ effect of inflation.
[2] Artis, Fidrmuc and Scharler (2008) show that rigid labor markets decrease business cycle correlations in the new member states of the EU.

"wage curve") and the other is aversion to wage cuts (so called "downward nominal/real wage rigidity"). In this paper we will search for an answer to the second of the two measures on Slovak wage data on the macro level and on the company level.

Wage setting is in its nature a behavioral process occurring at the level of single economic agents (employees and employers).[3] Wage rigidity in the mind of a single economic agent is based on loss aversion, which translates into perceived fairness of wage, which in consequence affects worker's effort (Fehr and Goette 2000). Therefore, recent studies on wage rigidities prefer using individual micro data of job-stayers. Since such individual micro data are not available for Slovakia, our strategy is to start from distribution based aggregate approach and go further into the structure of wage changes in single economic units (companies), identify imperfections in measuring transition economy data with these methods and produce the most plausible estimates.

In contrast to individual microdata, using data on the company level does not allow us to search where do the rigidities come from. Instead, we will treat rigidities as exogenous, and rather provide for a prudent answer on what is their extent.

A rich list of literature has been devoted recently to the issue of downward wage rigidities. However, only three studies so far used Slovak data to estimate some form of wage rigidity. Blanchflower and Oswald (2000) study uses one year (1995) micro data and finds an elasticity of wages -0.049.[4] Huitfeldt (2001) searches regional data for effects of unemployment and labor market policies on real wages in Czech Republic and Slovakia in 1992–1998 and finds significantly less wage rigidity in Slovakia than the previous study (elasticity under -0.1) as well as compared to Czech republic. Babecký (2008) studies labour market adjustments and also confirms the elasticity below -0.1 with Phillips curve estimates on 1995–1999 aggregate data. He also adds that the relationship cannot be found in the data for Slovakia after 2000 as well as for most of Central and Eastern European (CEE) countries. These three studies have looked for some kind of wage flexibility measure through the wage curve and Phillips curve in the past. However, no study estimating downward wage rigidity in Slovakia has taken into account wage change distributions. The aim of this paper is therefore, in the first place, to provide the first estimates of the extent of downward wage rigidity in Slovakia on this basis.

In scope of this paper, we understand downward wage rigidity as a share of unrealized wage cuts compared to all wage cuts that should occur in a fully flexible environment. Since the data used are not of individual nature, we link the concept of wage cuts to observed negative wage change.

2. Downward wage rigidities: concept and literature overview

At the roots of wage rigidities, literature mostly cites Tobin (1972) for his famous claim that "inflation greases the wheels of labor market". He claimed that higher inflation provides for a cushion, in which employer may manipulate wages avoiding nominal

[3] These conclusions are confirmed e.g. by Fares and Lemieux (2000) and Card and Hyslop (1997).

[4] The estimate for Slovakia forms a part of a wage curve estimation for CEE countries in the period of 1990–1997. Elasticity equal to -0.1 means that an employee may expect his real wage to decrease by 1% in average if unemployment rate in the region of his workplace grows by 10%, ceteris paribus.

wage cuts. A counterforce called "sand effect", i.e. distortionary effects of higher inflation on price and wage fluctuations and formation of precise expectations, is then referred to Friedman (1977). A discussion on optimal level of inflation, where both separated effects cancel out (Groshen and Schweitzer 1997) used to be regarded as central to monetary policy, because optimum level of inflation provided effective alleviation of wage pressure and thus involving a permanent reduction in unemployment.[5]

Due to level of inflation, wage rigidity has to be considered as a mixed concept of downward nominal and real rigidities (often abbreviated as DNWR/DRWR in literature); however, both being neither alternative nor always simply cumulative concepts. DNWR may become an irrelevant concept in case nominal wage growth is too high (non-effective) or too low (vanish, real rigidities take over). Therefore, downward real wage rigidities are usually more relevant in periods with higher inflation, when nominal growth illusion is being distorted.[6] On the other hand, institutional settings of labor market, especially those indexed by inflation are likely to make real wages more rigid.[7]

Within this paper, we understand downward wage rigidity as a certain number of wage freezes or moderate wage increases that would realize as negative wage changes if wages were fully flexible (Figure 1). The rationale is that any negative wage change causes loss of employee motivation, therefore some moderate wage changes are too costly for an employer to realize. In such case, it is cheaper for employer to freeze wage or to slightly raise it. Wages consist of total remuneration received by employees including payments for time not worked (such as for annual vacations) and bonuses.

The most common approach used to identify and measure downward wage rigidities in literature in recent decade is the histogram location approach. The problem to be coped with is to compare actual wage change distribution with a notional distribution, which reflects the no-rigidity hypothesis. It is therefore central to define, how notional distribution shall be constructed.

In the method proposed by Kahn (1997), the shape of a distribution of no rigidity hypothesis is assumed to be constant in time. This means that a proportion of observations accumulated in a histogram bar given distance from median should remain constant over time. A presence of DNWR in Kahn's paper is then represented by the extent of misalignment in a relative number of observations in neighboring histogram bars reflecting the position of median. Another method proposed by Lebow et al. (1995) assumes symmetry of a notional wage change distribution. This method comprises simple tail analysis (so called LSW test) of any actual wage change distribution.

[5] While discussing optimum level of inflation, findings of Elsby (2006) need to be considered, too. He argues and shows evidence on US and UK micro data that in case of presence of DNWR, besides avoiding wage cuts employers tend to compress also large wage increases in case inflation is high to buffer for future. He therefore concludes that accounting for such weakening of the "grease" effect, optimum level of inflation is to be somewhat lower than previously expected.

[6] Nickell and Quintini (2001) use U.K. NES (New Earnings Survey) data to provide for evidence that spikes at zero nominal wage change are more marked when inflation is low. Besides, they show evidence that since nominal rigidities are focused on zero nominal wage changes, it induces the more distortion in real wage changes the higher is inflation rate (the closer to average nominal wage growth).

[7] Bauer, Bonin and Sunde (2004) conclude that most of the wage rigidity in Germany with central wage bargaining can be attributed to real wage rigidity, which seems to increase with inflation and centralized bargaining outcomes.

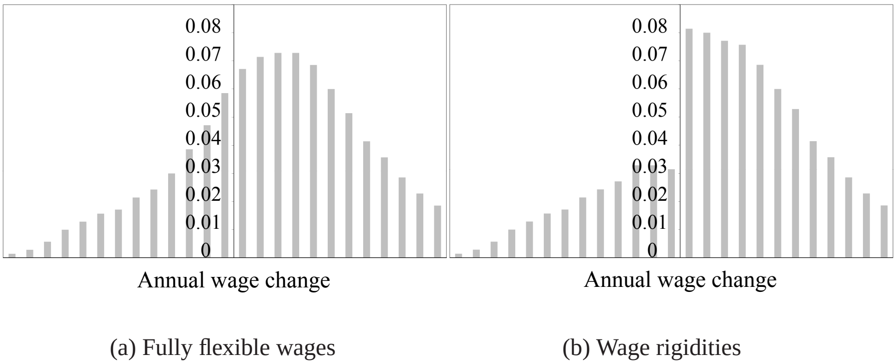


Figure 1. Hypothetical shape of distribution without/with wage rigidities

Both these assumptions are rather restrictive, though many other factors causing asymmetries and/or non-constant shape of distributions have been found later. For instance Nickell and Quintini (2003) argue that lower inflation supports asymmetry of distribution. They use U.K. Earnings Survey to show that size of spike and step at zero wage growth depends negatively on the rate of inflation (and other statistical parameters of a distribution, too). Lebow et al. (2003) concentrate on other than wage measures that employer may use to compensate for negative wage changes, as e.g. cutting social benefits. Consequently they conclude that rigidities may not be seen properly in data. Christofides and Leung (2003) consider the effect of unions' will to temporarily trade off employment for wage adjustments especially as far as temporary contracts are concerned. Some consented wage freezes may thus infiltrate in data and distort results. Elsby (2006) brings an evidence of leveling off wage changes in time by employers. He argues that especially in case of volatile annual inflation rate and rigid wages, employers tend to restrict wage growth in good times in order to buffer for "low inflation–low wage growth" periods in future. All these effects may have significant effect on symmetry and/or shape of distribution.

Dickens et al. (2007) also begins from a simple symmetry assumption, adjusting however for various possible asymmetries derived from both country data and common cross-country observations in wage distributions. This way they produce one of the most complex and extensive paper so far in this area.

Besides adjustments of Kahn's or Lebow's method, some studies use hybrid methods. One of them, by Nickell and Quintini (2003) uses non-parametric estimation of wage change statistical parameters to depict nonlinearities and links wage change distribution to estimated relationships. As the estimation needs to be undertaken on time series, one needs longer time span of data. Yamaguchi (2005) avoids this necessity on Polish data with using more information from wage growth distributions by Kahn-like bar method.

Holden and Wulfsberg (2009) also realize restrictiveness of both assumptions and propose to construct hypothetical distribution from those actual ones, which they identify as no-rigidity state. By constructing individual notional distributions from hypothetical distribution adjusting for specific median and variance they conceptually avoid the two restrictive assumptions, too.

Further theoretical and empirical literature reviews on nominal wage rigidity are condensed in e.g. Camba-Mendez (2003). Results of empirical findings are generally in line to conclude with finding an evidence of downward nominal wage rigidity in Europe (Dessy 2005; Dickens et al. 2007; Knoppik and Beissinger 2005), its significant cross-country variations (Dickens 2007) and more nominal rigidity in the U.S. compared to Europe (Knoppik and Beissinger 2005).

3. Methodological issues

In this part we briefly introduce the methodology which helps us to identify measure and test the extent of prevented wage changes. Detailed description can be found in Holden and Wulfsberg (2007).

3.1 Construction of the notional distribution and measurement of the downward wage rigidity

The main assumption of this approach is that absence of rigidity is present in some country years[8] in the sample. Thus the first task is to choose those country years which represents the environment where wage rigidity does not bind. We decided to pick those with the highest nominal and real median wage growth within the sample. Selected wage change distributions are normalized by subtracting the corresponding medians and dividing by standard deviations (1). The resulting wage change distribution is called the hypothetical distribution and can be described in the following mathematical notation:

$$\Delta w^{hyp} = \left(\frac{\Delta w_{jit} - med_{it}}{\sigma_{it}} \right), \tag{1}$$

where j stands for industry or firm, i is a symbol of the country and t denotes year.

The hypothetical distribution is used to construct the notional distribution for each country year which represents the hypothesis of no rigidity. Therefore we multiply the common hypothetical distribution by corresponding standard error and then we add the country year median (2). The notional wage changes distribution is constructed as follows:

$$\Delta w_{it}^{not} = \Delta w^{hyp} \cdot \sigma_{it} + med_{it} \tag{2}$$

The notional incidence rate is a share of the number of industries/firms that are supposed to decrease wages (according to notional assumption of no rigidity) to the total number of firms:

$$q_{it}^{not} = \frac{\#(\Delta w_{it}^{not} < 0)}{\# \Delta w_{it}^{not}} \tag{3}$$

The empirical incidence rate is computed similarly:

[8] We use the term country year. However, in Section 6 it stands for one year as we focus only on Slovakia.

$$q_{it}^{emp} = \frac{\#\left(\Delta w_{it}^{emp} < 0\right)}{\#\Delta w_{it}^{emp}} \tag{4}$$

The extent of rigidity is measured by a comparison of the amount of negative empirical and notional wage changes, represented by the incidence rates. Thus we are interested in the $fwcp$ index:

$$fwcp^{not} = 1 - \frac{q_{it}^{emp}}{q_{it}^{not}} \tag{5}$$

Fraction of wage changes prevented ($fwcp$) index reflects the share of industries/firms to total, which do not report negative wage changes despite they would do so if wages were assumed not rigid.

In order to apply the approach proposed by Holden and Wulfsberg (2009) to company level data, we slightly modify their method of choosing the hypothetical (underlying) distribution. We also assume no rigidity in the hypothetical distribution, but here we are constrained by shorter time period. The analyzed data sample consists of seven years, thus we pick only one year (instead of bulk of country years) out of our sample with highest median of nominal and real hourly wage growth.[9]

3.2 Testing for significance

In order to test the significance of computed shares of industries/firms affected by wage rigidity we conduct the following test/procedure. We depart from the null hypothesis that wage rigidity are statistically insignificant (no rigidity in wages).

A simplified version of binomial test is used. Instead of computing the exact probabilities we rather simulate draws from binomial distribution 5,000 times. This much decreased the computational requirements. Certain part of the results was double-checked and normal approximation was used for the Binomial distribution. Both tests gave us the same results.

The first step is to draw from the standard binomial distribution $B(n, p)$ n times, where n stands for number of trials and p for a success probability. Particularly, in this context, n is a number of empirical observations belonging to the respective country year and p is the notional incidence rate (q_{it}^{not}). We proceed by repeating this step 5000 times. Afterwards we compute the average number of successive draws:

$$S^{it} = \frac{1}{5000} \sum_{k=1}^{5000} S_k^{it} \tag{6}$$

Dividing S^{it} by n we obtain simulated incidence rate (q_{it}^{sim}) and respectively fraction of wage changes prevented ($fwcp_{it}^{sim}$).[10] We then count the number of simulated negative wage changes S^{it}, which are higher than the number of observed negative wage

[9] According to our data, there is no doubt for choosing the year 2002. Nevertheless, there is still possibility, that wage rigidity was present also in 2002 data. If this is the case, the presented figures stand for the lower bound of the actual extent of rigidity.

[10] $fwcp_{it}^{sim}$ is very similar to $fwcp_{it}^{not}$ by construction. The higher is the number of simulations, the more these two values converge.

changes in the corresponding empirical distribution (labeled H^{it}). Finally, the p-value is obtained as $1 - H^{it}/5000$. If p-value is smaller than chosen significance level, the null hypothesis of no rigidity should be rejected.

4. Data

The following part describes datasets that we have used. Firstly, we present industry level data employed in cross-country analysis. Secondly, detailed individual company level micro data from Slovakia is depicted.

4.1 Industry level data

We use cross-country wage data in sectors of old EU member states extended by 8 new EU member states. The aim of this is to bring in the cross-country factor into the analysis, which allows for comparison of rigidities in wage formation internationally. To do this, we use an unbalanced panel of wage growth data in manufacturing from ILO database. Overall, we have collected 3925 annual wage change observations

Table 1. Statistics of the data sample

	Total	1996–2000	2001–2006	New EU	V4 countries	Baltics	Slovakia	EU-15
Observations	3925	1616	2309	1817	962	612	236	2006
Country-years	189	78	111	85	43	31	11	95
Inflation (%)	4.0	5.7	2.8	6.4	6.9	5.7	6.8	2.0
Nominal wage changes								
Nominal wage cuts	235	95	140	93	23	67	2	142
Country-years with no nominal wage cuts	89	40	49	49	29	12	9	31
S.D.	0.073	0.090	0.054	0.088	0.076	0.116	0.061	0.036
Median	0.048	0.065	0.042	0.088	0.088	0.090	0.091	0.032
Incidence rate (%)	6.0	5.9	6.1	5.1	2.4	10.9	0.8	7.1
Share of country-years with no cuts (%)	47.1	51.3	44.1	57.6	67.4	38.7	81.8	32.6
Real wage changes								
Real wage cuts	926	382	544	423	229	159	70	501
Country-years with no real wage cuts	21	9	12	7	3	4	0	7
S.D.	0.061	0.074	0.049	0.079	0.061	0.111	0.062	0.036
Median	0.019	0.021	0.018	0.030	0.028	0.044	0.024	0.014
Incidence rate (%)	23.6	23.6	23.6	23.3	23.8	26.0	29.7	25.0
Share of country-years with no cuts (%)	11.1	11.5	10.8	8.2	7.0	12.9	0	7.4

Source: authors' calculation.

from 20 countries (EU-25 excluding Malta, Cyprus, Luxemburg, Portugal, Greece and Italy; including Norway), forming 189 country-years in up to 11 year-on-year changes (starting 1996/1995 ending 2006/2005).

In our sample, maximum number of industries per country-year is 23, minimum is 12. Overall, we observe 235 nominal negative wage changes, i.e. incidence rate of 6% of all observations. These negative wage changes are distributed unevenly, all of them within 100 country-years; other 89 country-years do not include a single industry, with year-on-year wage decline in nominal terms. Further statistics of the sample is presented in Table 1.

4.2 Company level data

To our knowledge, company level microdata have been used in histogram location approach in two studies so far. In Lebow et al. (2003) wages are defined as hourly costs of wages and benefits in an establishment. Their data source is the Bureau of Labor Statistics' employment cost index. Likewise, Brzoza-Brzezina and Socha (2007) employed enterprise level data from a survey of medium sized and large enterprises in Poland. Besides other findings, both of these papers provide evidence that the wage costs are less affected by the downward nominal wage rigidity than basic wages alone. Since we are using similar wage definition, we shall account for larger flexibility from margins of adjustment in flexible components of wage.

Since we cannot track individual wages over time in Slovak data we find business surveys conducted annually by the Statistical Office of the SR as the most appropriate data sources for this type of analysis in Slovak environment. Particularly, three surveys[11] were merged in order to obtain as representative sample as possible. Although small businesses (up to 19 employees) are not fully represented in the database, (this is one of the drawbacks of our data source) medium (from 20 to 99 employees) and large companies (with more than 100 employees) are surveyed exhaustively. The database used covers about half of the employees in the production sector of the economy. Table 2 compares data for the economy as a whole and the sample used.

Table 2. Comparison of the data sample and the Slovak economy

	2001	2002	2003	2004	2005	2006	2007
Data sample							
Enterprises	4,812	4,904	5,138	4,932	5,039	5,494	5,498
Employees	774,872	735,650	790,487	749,790	732,986	849,470	834,749
Slovak production sector							
Employees	1,607,552	1,608,622	1,616,513	1,621,704	1,668,034	1,712,702	1,766,541

Source: Statistical Office of the SR (SO SR), authors' calculation.

We consider both full time and part time employees. The main variable we use is

[11] E.g. annual questionnaire on business statistics (ROC 1-01), Annual questionnaire in banking and non-banking financial institutions (PEN P 5-01), Annual questionnaire in insurance (POI P 5-01).

the change of average hourly wage (in both nominal and real terms) in the company.[12] Further, we filter the database to eliminate an impact of assumed error inputs, which originate mainly from incorrectly filled in questionnaires.[13]

The dataset covers the period from 2000 to 2007. Due to the methodological changes in the surveys, the years before 2000 are not considered. Selected time period includes years with lower (2.8%) as well as higher (8.5%) level of inflation. The difference between highest and lowest inflation rate is almost 5.7% what guarantees that the distributions of changes in wages are different across the sample.[14] The basic statistical properties of the analyzed data sample are shown in Table 3.

Table 3. Statistical properties of wage changes and basic macro indicators

	2001	2002	2003	2004	2005	2006	2007
Changes in nominal total compensation							
Median	0.066	0.101	0.063	0.054	0.063	0.078	0.084
Mean	0.066	0.101	0.060	0.062	0.063	0.078	0.084
S.D.	0.139	0.138	0.134	0.137	0.132	0.135	0.136
Changes in real total compensation							
Median	−0.007	0.068	−0.022	−0.021	0.036	0.033	0.056
Mean	−0.007	0.068	−0.025	−0.013	0.036	0.033	0.056
Macro indicators							
Unemployment rate (%)	19.2	18.5	17.4	18.1	16.2	13.3	11.0
Employment growth (%)	1.0	0.2	1.8	0.3	2.1	3.8	2.4
Average wage growth (%)	8.2	9.3	6.3	10.2	9.2	8.0	7.2
Inflation rate (%)	7.3	3.3	8.5	7.5	2.7	4.5	2.8

Source: SO SR, authors' calculation.

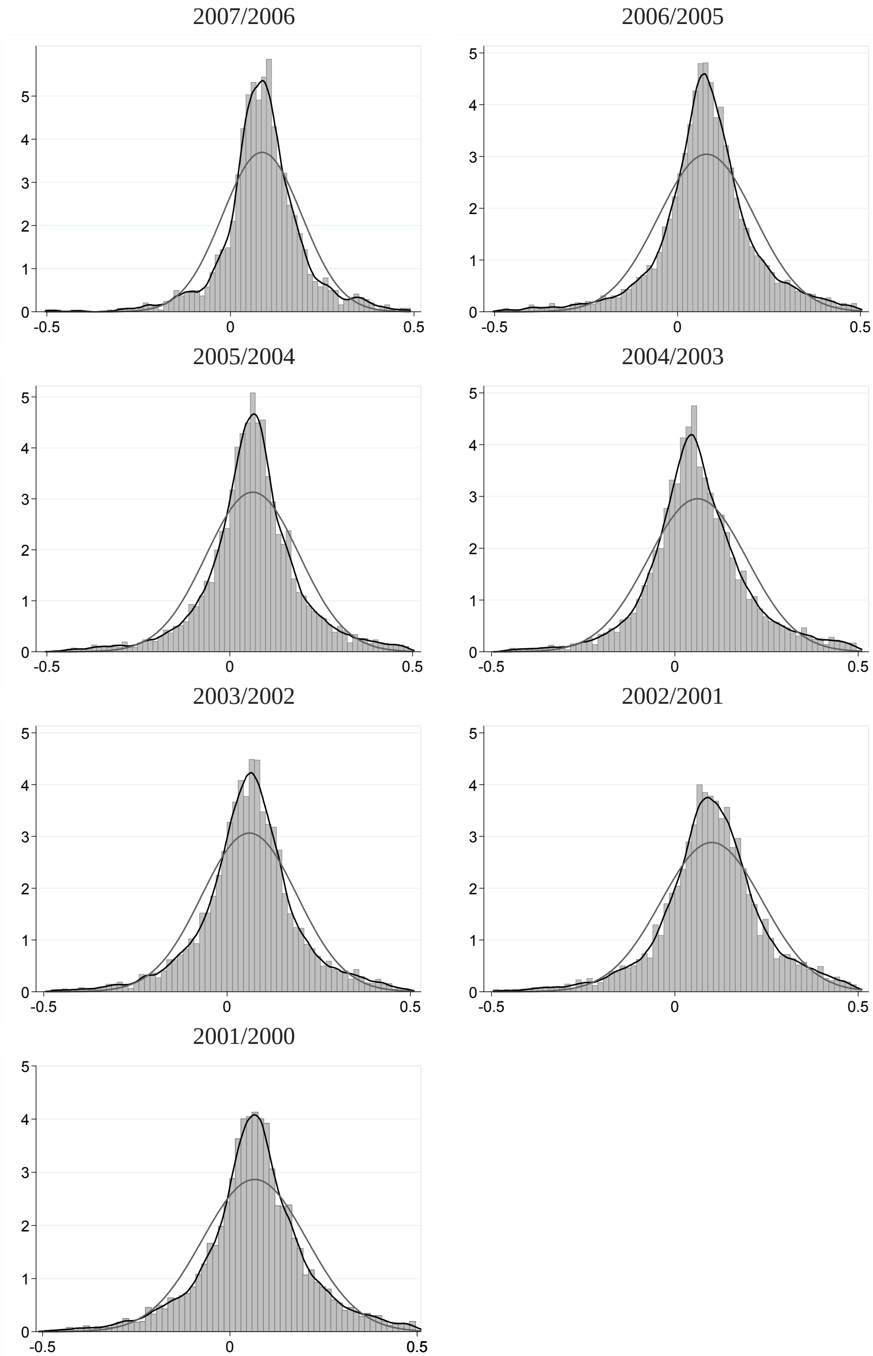
An interesting difference between industry and company level data can be seen from Figure 2, which shows the distributions of the annual wage changes. Although Slovak industry level data (used in the previous part) displays hardly any wage changes during the whole sample, almost 30% of observed companies change their hourly wages.[15] Moreover, average wage growth was from 6% to 10% during the years 2000 and 2007 in Slovakia. This paradox may be explained by at least the following three reasons. Firstly, changes in the composition of workforce may have changed the average wage costs even if the wage rates stayed on the same level. Secondly, changes in the number of hours worked may have modified the average hourly wage even if

[12] $\Delta wage_{t/t-1} = wage_t / wage_{t-1} - 1$. The total amount of wage costs were divided by the total amount of hours worked. Although, both numbers are reported by companies, such definition may lead to measurement errors.

[13] Annual wage change of more than 50% is considered as incorrect input in any of the two years and such observation is therefore eliminated. Observations with missing values were eliminated, too.

[14] Kramarz (2001) claims that wage change distributions in years of high inflation strongly differ from those observed in years of low inflation.

[15] Blinder and Choi (1990) discovered that the money wage cuts were more common in the US than they had imagined even they analyzed a time period characterized by low unemployment.



Source: authors' calculation.

Figure 2. Distribution of hourly wage changes: kernel vs. normal density functions

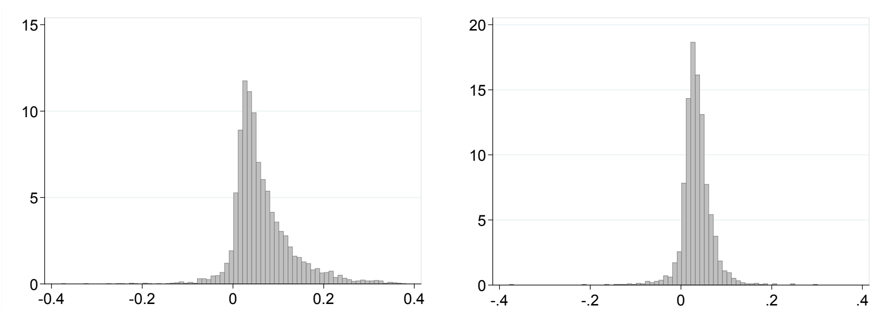
hourly wage remained the same. And finally, cutting bonuses in aiming to decrease total costs of the company could also lower wage costs. It has been shown by Babecky et al. (2008), that changes in bonuses, non-pay benefits and slowing down promotions belongs to potential margins used by companies to reduce labor costs. They also present survey results on the particular case of the Czech Republic that 31% of companies prefer to reduce bonuses, 9% prefer cheaper hires, 9% choose early retirements and 50% of the companies use other labor cost reduction strategy.

5. Results: industry level data

5.1 Examining effects of full sample heterogeneity

The fact that our data come from both developed and transition economies results in significantly different statistics for these two groups.[16]

Full sample of raw wage changes is more positively skewed with lower kurtosis. This is because of higher nominal wage growth in transition countries mainly due to economic convergence.[17] Different statistics of the two subsamples of raw wage changes suggest that we should examine, whether some effect of this disparity is transferred into other relationships.



(a) Full sample (b) EU-15 and Norway

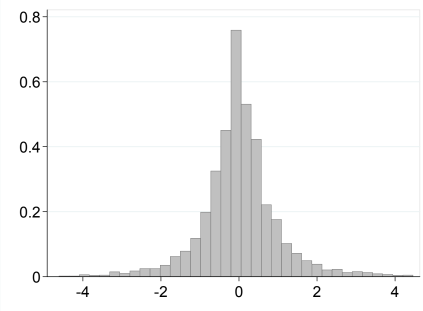
Figure 3. Histogram of nominal wage changes

To illustrate features of the two subsamples, we calculated the sensitivity of incidence rate to median wage growth. In full sample, one percentage point shift in median real wage growth to the left translates into 4.3 to 6.3 percentage points more real negative wage changes (causing higher incidence rate of wage changes).[18] The same size

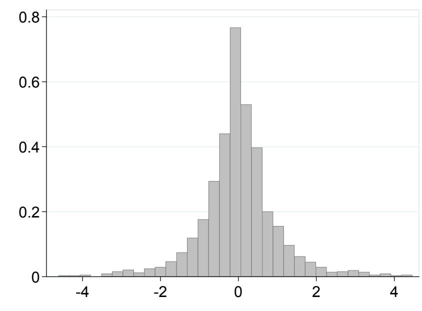
[16] Further in the text to be referred to as EU-15 for developed economies and EU-10 for transition economies.
[17] Skewness of the full sample is 1.19 compared to 0.26 of EU-15 countries; kurtosis of the full sample is 15.6, compared to 28.1 of EU-15. Mean nominal wages of EU-15 is 3 percentage points lower than of the full sample, resp. 1.5 percentage points in terms of median nominal wages.
[18] Underlying relationship is non-linear. Inspired by Nickell and Quintini (2001) we regress incidence rate of negative wage changes on respective median wage change and its square and standard deviation.

shift in nominal terms translates into 0.9 to 2.1 percentage points more nominal negative wage changes. These findings confirm higher sensitivity of incidence rate in real terms due to smaller distance of wage changes from the level of inflation than is their distance from nominal zero growth (see Figure 3). Looking at separate subsamples however, we produce very different results. Sensitivity of incidence rate to nominal wage growth for EU-15 countries increase to 2.0–5.5 percentage points and to real wage growth to 11.9–27.7 percentage points. Coefficients for old EU member states are in line with the full sample both in nominal and real terms.

Observing these data after normalization (see Figure 4), the geographic subsamples do resemble to a larger extent. Distribution of full sample of countries easily passes the test of equality of distributions[19] with the one of EU-15 subsample.



(a) Full sample



(b) EU-15 and Norway

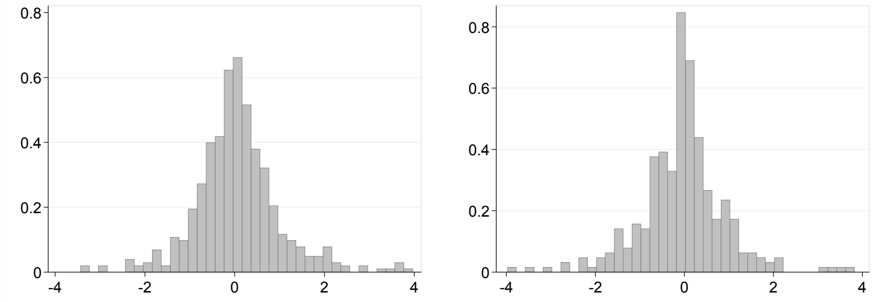
Figure 4. Histogram of normalised nominal wage changes

Perhaps more sensitive issue is a selection procedure, which identifies such country-years that shall be assumed to represent non-rigidity environment. Holden and Wulfsberg (2007) suggest populating hypothetical distribution with those empirical distributions, where median wage growths (both nominal and real) qualify in their respective upper quartiles. Criteria to qualify however are represented by statistics of raw wage changes (not-normalized). Therefore, criteria will favor new EU member states country-years, which do possess higher median values. Resulting distributions of "non-rigidity assumed" normalized wage changes of full sample compared to those of EU-15 subgroup already yields some visible differences (see Figure 5).

While controlling for medians, mean is located more to the left in EU-15 subgroup, moreover distribution is less positively skewed. Nevertheless, testing for equality (by two-sample KS test) does not rule out that the two distributions are alike.

The two steps (constructing hypothetical and deriving notional distribution) are linked and this link should be reviewed. Selection of partial distributions in the construction phase is made by draws from the right tail of median wage change distribution. As symmetry of the two geographical subsets differ, the selection from full

[19] Tested with two-sample Kolmogorov-Smirnov test of equality.



(a) Full sample (b) EU-15 and Norway

Figure 5. Histogram of nominal wage change observations qualifying in the upper quartile selection

sample behaves as an outlier set within the old EU member states subgroup. Even though normalization through median and variance absorbs much of misalignments, notional incidence rates of old EU member states subgroup are for this reason subject to downward shift by 1 to 2.5 percentage points (difference of notional incidence rates in Table 2 and Table 3). We may therefore conclude that resulting $fwcp$ of old EU member states subgroup are pressed down (by 25% in average in proposed composition) if they are calculated in full sample with new EU member states data.

We have not found any feasible alternative proxy for construction of non-rigidity hypothesis. Manipulating qualification criteria (e.g. narrowing the criteria to deciles) does not make results any better. Hypothetical distribution thus remains with fewer selected observations of the more distant outlying data. The above described effect is then even stronger. Besides, hypothetical distribution with fewer observations produces larger risk of non-normality, further hurting reliability of notional incidence rates and consequent $fwcp$. For further calculation we will therefore stick to the selection of at least top quartile observations.

5.2 Results and their robustness

When the full sample is used, only new EU member states country-year data classify into the hypothetical distribution. Greater variance and median changes of these country-years then reflect into the hypothetical distribution, giving imperfect information to notional distributions of old EU member states. Further to this, low empirical incidence rates mainly in new EU member states also somewhat complicate the output of calculated $fwcp$.

Overall results suggest that 12% of annual averaged nominal wage declines in sectors do not realize due to downwards wage rigidities. Significance of this result is confirmed by the p-value. Individual countries results are however largely insignificant except for few. Moreover, significant results for Slovakia (and to certain extent for Austria) are undermined by low empirical incidence rate. Arguments depicting imperfections of calculations in full sample made in Section 5.1 also have to be taken into consideration.

Table 4. Downward wage rigidity of full sample

Countries	Years	Obs.	q^{emp}	q^{not}	q^{sim}	$fwcp^{sim}$	P-value
Austria	7	161	0.0186	0.0601	0.0601	0.6897	0.0106
Belgium	5	114	0.1316	0.1953	0.1955	0.3269	0.0514
Denmark	10	230	0.1043	0.1078	0.1077	0.0309	0.4908
France	9	207	0.0193	0.0325	0.0325	0.4056	0.1960
Ireland	10	120	0.0167	0.0155	0.0157	−0.0632	0.7130
Hungary	11	253	0.0237	0.0164	0.0165	−0.4412	0.8772
Finland	10	228	0.1228	0.1320	0.1324	0.0725	0.3760
Estonia	10	172	0.0407	0.0357	0.0351	−0.1586	0.7432
Latvia	11	232	0.1336	0.1667	0.1660	0.1949	0.0792
Lithuania	10	208	0.1394	0.1486	0.1495	0.0674	0.3836
Netherlands	10	190	0.0421	0.0552	0.0553	0.2389	0.2644
Norway	9	102	0.0000	0.0006	0.0007	1.0000	0.9354
Poland	11	253	0.0435	0.0449	0.0453	0.0401	0.5204
Slovakia	11	236	0.0085	0.0442	0.0423	0.7995	0.0022
Slovenia	11	243	0.0123	0.0072	0.0072	−0.7233	0.9022
Spain	7	161	0.1056	0.0731	0.0733	−0.4399	0.9582
U.K.	9	207	0.0918	0.1049	0.1045	0.1215	0.3158
Sweden	8	159	0.0377	0.0429	0.0433	0.1284	0.4644
Germany	10	229	0.0699	0.0674	0.0668	−0.0462	0.6478
Czech Rep.	10	220	0.0182	0.0167	0.0165	−0.1014	0.7032
Total	189	3925	0.0599	0.0654	0.0684	0.1242	0.0124

Source: authors' calculation.

Calculating the same for old EU member states sample separately goes around these imperfections and yields already interpretable results of wage rigidities. The results suggest that high nominal wage rigidity is present in Belgium and Netherlands (over 40%), somewhat elevated nominal wage rigidity in U.K. (28%) and Finland (21%), while significant rigidities has been confirmed for several other countries as Austria and France, but these results are partially undermined by low empirical incidence rate (below 0.02).[20]

Comparing notional incidence rates and fractions of wage changes prevented for relevant countries between the Table 5 and the Table 4 we may observe differences, which occur when distributions with higher wage changes enter into the sample.

[20] As described earlier, higher median wage change yields incident rate closer to zero. Low empirical incidence rate in turn means higher probability of misalignment between continuous nature of notional and discrete nature of empirical incidence rate (e.g. 0.02 levelling roughly to overall 3 negative observations per country). Results in such cases (Slovakia, Slovenia, Austria, Ireland, Norway) must be then interpreted with special care.

Table 5. Downward wage rigidity: old EU-15

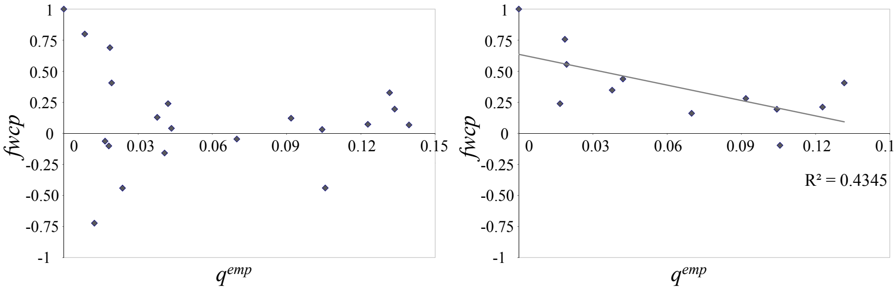
Countries	Years	Obs.	q^{emp}	q^{not}	q^{sim}	$fwcp^{sim}$	P-value
Austria	7	161	0.0186	0.0763	0.0766	0.7567	0.0006
Belgium	5	114	0.1316	0.2200	0.2213	0.4053	0.0104
Denmark	10	230	0.1043	0.1294	0.1294	0.1937	0.1400
France	9	207	0.0193	0.0434	0.0434	0.5547	0.0548
Ireland	10	120	0.0167	0.0222	0.0219	0.2386	0.5140
Finland	10	228	0.1228	0.1550	0.1556	0.2110	0.0964
Netherlands	10	190	0.0421	0.0750	0.0749	0.4375	0.0448
Norway	9	102	0.0000	0.0017	0.0017	1.0000	0.8378
Spain	7	161	0.1056	0.0960	0.0963	-0.0970	0.7102
U.K.	9	207	0.0918	0.1281	0.1276	0.2805	0.0682
Sweden	8	159	0.0377	0.0570	0.0578	0.3474	0.1772
Germany	10	229	0.0699	0.0841	0.0833	0.1609	0.2614
Total	104	2108	0.0674	0.0863	0.0944	0.2863	0.0000

Source: authors' calculation.

In standard situation $fwcp$ closer to one means more downward wage rigidity, $fwcp$ closer to zero means more downward wage flexibility. Negative $fwcp$ values are present in situations, where calculated notional incidence rate of wage changes is lower than measured empirical incidence rate of wage changes. Such situation may therefore also be considered as wage flexibility. All these findings apply only in case the two incidence rates are significantly distant (p-value) and hence disturbances are eliminated.

As it emerges from (5), $fwcp$ should be negatively sloped relative to empirical incidence rate. This is true in EU-15 sample, however not so in the full sample.

Points in the left part of Figure 6 do not visually follow the logic of the relationship as they do in the right part, mostly because of high insignificance (p-value) of $fwcp$ in



(a) Full sample

(b) EU-15 and Norway

Figure 6. Empirical incidence rate and simulated fraction of wage changes prevented

EU-10. This confirms the above conclusion that essential relationship for this analysis does not hold for common sample.

Thus we may conclude that if downward wage rigidity for developed and transition economies is calculated in common sample, we face two possible sources of distortion. First, coming from construction of non-rigidity hypothesis of two distinct sets of data; second coming from too few observations of negative wage growth, having its origin partly in higher median wage changes.[21]

The results of EU-15 findings are generally in line with the results of Holden and Wulfsberg (2007) full sample across all periods (1973–1999), whose downward nominal wag rigidity estimate of the developed economies sample reaches 26%.[22]

Our results for downward nominal wage rigidities for separate EU-15 sample may be confronted with past evidence of identical approach of Holden and Wulfsberg (2007) and of Dickens et al. (2007), see Figure 7.

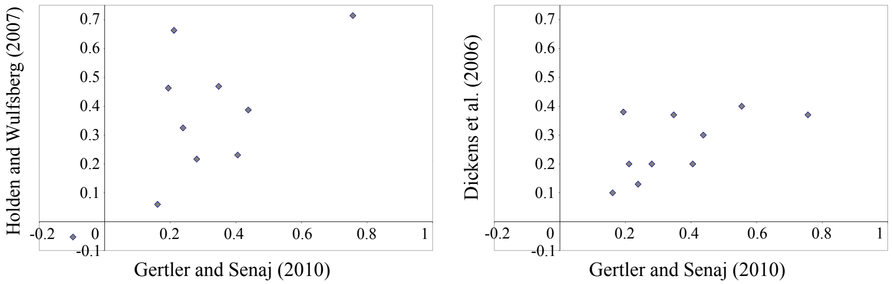


Figure 7. Country results of $fwcp$ compared to results of Holden and Wulfsberg (2007) and Dickens et al. (2007)

As for entire sub-samples we may confirm less downward wage rigidity in EU-10 countries than in EU-15, while most of the significant $fwcp$ values are closer to zero. However, for most of the EU-10 countries in the sample we could not measure any wage rigidities (being insignificant). We also cannot draw any conclusion for Slovakia. This is because of the second listed source of distortion above, i.e. too few negative observations.

The ability to compare downward wage rigidities between old and new EU member states was the supporting idea for choosing the histogram location approach. However, now we see that due to structural differences in our data, any effort to estimate the full sample together leads us to incomplete information.

[21] Besides Slovakia and Slovenia, Ireland and Norway may be considered so due to its excess growth relative to EU average in the time observed.

[22] They include some extra OECD countries, but exclude new EU member states.

5.3 Reasons for turning to microdata

Some drawbacks are present if applying histogram location approach of Holden and Wulfsberg (2009) on full sample of EU member states aggregate wage growth data.

Since selection criteria are nominal, high inflation country data are favored to qualify. These are predominantly new member states. Higher inflation is however a side-effect of their economic boom, providing extra points for less negative wage changes to be reported. This additional downward push effect on incidence rates shifts calculated wage rigidities upwards.

Lacking observations in partial distributions (from 12 to 23 industries) makes more likely empirical negative wage changes to be zero. If empirical incidence rate is too close to zero, difference between observing no and one negative wage change per country-year makes too large an impact on overall result.

Interpreting resulting $fwcp$ in this setting is not straightforward. Ideally, we would like to say that some share of wages was prevented from dropping over the year. Since single observation represents an industry/sector, we may only say that certain percentage of average sectoral wage changes over the year was prevented.

On top of the above we lose much of valuable information from within the sectors and observe extremely low incidence rates of wage changes in Slovakia. We therefore turn our attention to company level microdata, because individual chained wage data are not available for Slovakia (neither in most of the transition countries). Results of aggregate data will serve as a reference and a useful starting point to compare all the next results with.

6. Results: company level data

Departing from the findings above, we put the emphasis on the analysis of the company level microdata.

6.1 Results for Slovakia

Table 6 presents the outcomes of analysis of nominal rigidity in hourly wages. In the early years of the sample we did not find a presence of rigidity. Notional incidence rate (q^{not}) significantly exceeds empirical incidence rate only after 2005. Consequently, the fraction of wage changes prevented rises from about 5% in 2005 to almost 10% in 2007. The estimated $fwcp$ are statistically significant. Thus we can conclude that at least 5% out of those companies, which would change wages in the absence of rigidity, are affected by downward nominal wage rigidity (in 2005).[23] Another important finding is that the degree of rigidity tends to slightly increase in recent years. For the sake of simplicity we calculated shares of the companies affected by nominal rigidity and they are reported in column labeled as nominal wage rigidity (*nwr*). *nwr* ranges from

[23] Since the obtained results could be affected by adjustments in the company structure (such as by substituting expensive employees by cheaper ones), Brzoza-Brzezina and Socha (2007) suggest to treat the results as the lower bound of the true DNWR at enterprise level.

1.5% to 2.2%, which means that at least 1.5% of companies were affected by wage rigidity in 2005.[24]

Table 6. Nominal wage rigidity in Slovakia

Years	Obs.	q^{emp}	q^{not}	q^{sim}	$fwcp^{sim}$	nwr	P-value
2001/2000	4812	0.257	0.266	0.266	0.033	0.009	0.085
2002/2001	4904	0.185					
2003/2002	5138	0.268	0.268	0.268	0.000	0.000	0.504
2004/2003	4932	0.288	0.299	0.299	0.036	0.011	0.051
2005/2004	5039	0.248	0.263	0.263	0.058	0.015	0.006**
2006/2005	5494	0.207	0.229	0.229	0.094	0.022	0.000**
2007/2006	5498	0.194	0.214	0.214	0.096	0.021	0.000**

Note: ** DNWR are statistically significant at 1% level.
Source: authors' calculation.

Our results are in line with those reported for Poland. Brzoza-Brzezina and Socha (2007) concluded that the extent of rigidity at the enterprise level was relatively small during the period 1996–2005.

An interesting question arises about the impact of detected rigidity in hourly wages on the labor market, particularly on wage growth (and consequently on inflation). The estimated impact of downward nominal wage rigidity on wage growth is relatively low and can be considered negligible. For instance, in 2006 ($fwcp$ equals to 9.4%) downward nominal wage rigidity caused additional costs to employers in amount of 296 million SK (9.8 mil. EUR). If we translate this to annual wage dynamics, this amounts to 0.14 percentage points of the wage growth if compared to fully flexible environment.

Applying the same methodology on inflation adjusted data; the extent of the downward real wage rigidity can be analyzed.

Table 7. Real wage rigidity in Slovakia

Years	Obs.	q^{emp}	q^{not}	q^{sim}	$fwcp^{sim}$	rwr	P-value
2001/2000	4812	0.530	0.525	0.525	−0.008		0.732
2002/2001	4904	0.259					
2003/2002	5138	0.598	0.585	0.585	−0.022		0.969
2004/2003	4932	0.584	0.578	0.578	−0.011		0.811
2005/2004	5039	0.343	0.353	0.353	0.028	0.010	0.080
2006/2005	5494	0.347	0.371	0.371	0.063	0.024	0.001**
2007/2006	5498	0.268	0.289	0.289	0.072	0.021	0.000**

Note: ** DRWR are statistically significant at 1% level.
Source: authors' calculation.

[24] It is important to stress that the results may be partly influenced by the business cycle. During the period studied, Slovakia recorded strong economic growth (employment growth can be found in Table 5).

After 5,000 simulations it turns out that real wage changes are affected by real wage rigidity only in the last two years, $fwcp$ grows from 6% in 2006 to 7% in 2007. The extent of real rigidity measured as a share of companies affected by real rigidity (column labeled as *rwr* in Table 7) is almost comparable to the share of companies affected by nominal wage rigidity. It should be noted that applying wide definition of wage (including bonuses) makes it easier for employer to adjust pays in any of the years; therefore level of reported rigidities represents its minimum bound.

6.2 Into the attributes

The overall wage rigidity may not correspond to those in different segments of corporate sector. Next, we therefore measure the degree of rigidity in different subgroups classified by company size and sector of economic activity (according to primary NACE classification). Firstly, we split the sample into two subsamples according to the average annual number of employees in the company. Secondly we aim at rigidities in manufacturing and services.

We distinguish between small and large companies. Small companies are those, which have up to 40 employees. On the other hand, large companies have at least 90 employees. Thresholds 40 and 90 employees were set in order to split the sample into three subsamples with similar number of observations. Table 8 reports the results. Since we did not find statistically significant presence of rigidity we can conclude that small employers can better adjust wage costs according to their needs. On the other hand, we found significant nominal wage rigidities in larger companies in most of the years of the period studied (from 2004 up to 2007).

Table 8. Nominal wage rigidity by company size

Years	Small (<40 employees)			Large (>90 employees)		
	$fwcp^{sim}$	*nwr*	P-value	$fwcp^{sim}$	*nwr*	P-value
2001/2000	−0.021		0.730	0.115	0.022	0.011*
2002/2001						
2003/2002	−0.055		0.944	0.014	0.003	0.391
2004/2003	0.007	0.002	0.434	0.077	0.021	0.031*
2005/2004	0.004	0.001	0.467	0.129	0.030	0.003**
2006/2005	0.038	0.010	0.167	0.150	0.029	0.001**
2007/2006	0.037	0.009	0.181	0.152	0.025	0.003**

Note: **(*) DNWR are statistically significant at 1% (5%) level.
Source: authors' calculation.

Further, we divided the sample according to economic activity. Here we report the results only for manufacturing and service (Table 9). It turns out that companies in the service sector can better adjust wage costs according to their needs, whereas manufacturing seems to be more rigid in wage formation.

Table 9. Nominal wage rigidity in manufacturing and services

Years	Manufacturing			Services		
	$fwcp^{sim}$	*nwr*	P-value	$fwcp^{sim}$	*nwr*	P-value
2001/2000	−0.013		0.630	0.023	0.007	0.289
2002/2001						
2003/2002	0.015	0.003	0.374	−0.040		0.872
2004/2003	0.042	0.012	0.135	−0.002		0.527
2005/2004	0.073	0.017	0.041*	0.021	0.007	0.284
2006/2005	0.171	0.035	0.000**	0.009	0.002	0.419
2007/2006	0.092	0.018	0.023*	0.072	0.020	0.027*

Note: **(*) DNWR are statistically significant at 1% (5%) level.
Source: authors' calculation.

7. Conclusions

Having reproduced a histogram location approach on the industrial level, we may conclude as follows. It is relevant to use histogram location approach and thus search for downward nominal wage rigidities in EU-15 and in EU-10 countries separately. Integration of all observations into one full sample (of EU-15 and EU-10 countries) may be a source of distortion, which originates in specific economic background of data in the two subgroups. Extent of the distortion, however, may be quantified and therefore interpretation of a full sample is possible with caution.

Nominal wages are rigid downward especially in Belgium and the Netherlands (possibly also in Austria and France) where more than 40% of wage changes were prevented. For all the other countries of the EU-15 sample we have not found significant wage rigidities, even though we found over 20% downward wage rigidities in the UK and Finland. These findings are generally in line with other results from cross-country studies. Furthermore it suggests that decreasing time trend of downward nominal wage rigidities identified by Holden and Wulfsberg (2007) reached its low point in the 1990s and it started to grow again.

Nominal wages in the new EU member states are relatively flexible across the sample. In case of specific countries, however, final results cannot be safely concluded due to very few negative observations in the sample, which yield higher sensitivity to random disturbances, hence making such results difficult to interpret.

In the second part of the paper we employ histogram location approach on company level data in Slovakia. The modification in this paper is the adoption of the methodology proposed by Holden and Wulfsberg (2009) to a company level data. The data set we used covers hourly wages in the time period between 2000 and 2007. The estimated extent of both nominal and real rigidities detected by the methodology used is relatively small. We can conclude that flexible wages favored the decision of euro adoption in Slovakia in 2009.

We have identified and measured nominal wage rigidities only in the second part of the observed period (2005–2007). Although the methodology allows us to estimate lower bound of wage rigidity, based on estimated figures we can conclude that downward wage rigidity is small in the Slovak Republic. The computed share of companies affected by nominal wage rigidity ranges from 1.5% in 2005 to 2.2% in 2006. As a result, companies paid almost 10 million euros (estimated) more due to nominal wage rigidities in 2007. In macroeconomic sense this makes additional 0.14 percentage point of wage growth, which is a negligible effect. According to the methodology used, the extent of real wage rigidity is comparable with the degree of nominal wage rigidity and ranges between 2.1% and 2.4%.

Detailed analysis shows that small businesses can better adjust wage costs according to their needs. On the other hand, we found significant nominal wage rigidities in larger businesses in most of the years in the period studied. We can also conclude that companies in the service sector can better adjust wage costs according to their needs whereas manufacturing seems to be more rigid in wage formation.

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