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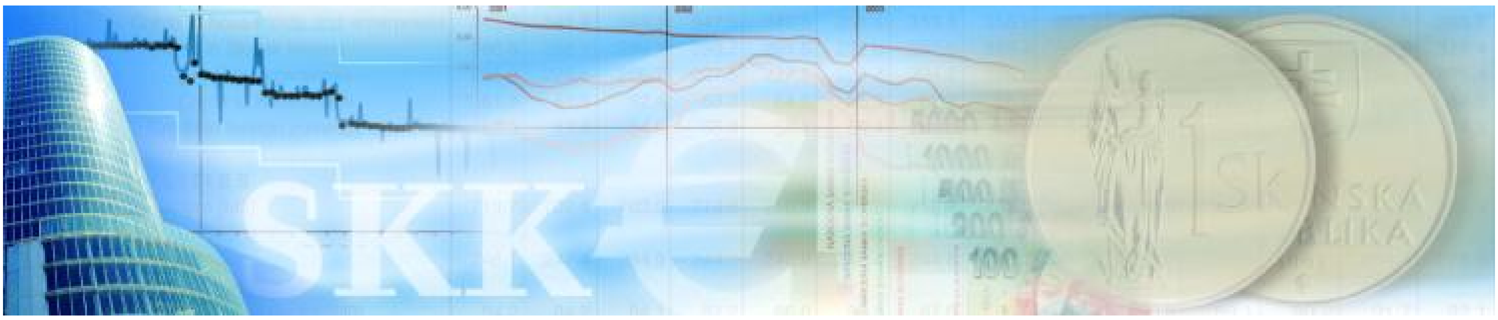

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DOWNWARD WAGE RIGIDITIES IN SLOVAKIA*

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Abstract

The concept of wage flexibility is especially important for economic policies after the Slovak euro adoption. The aim of this study is to assess the extent of wage rigidities in Slovakia. We first reproduce Holden and Wulfsberg (2007) approach with data on industrial level drawn from recent decade and we include both old and new EU Member States countries. In case of Slovakia, however it is difficult to interpret results obtained from sectoral data, since too few negative observations are present in the sample. We therefore turn to micro-approach and apply slightly modified methodology on the company level data. The estimated extent of both nominal and real rigidity is relatively small. Conclusion that hourly compensations are rather flexible supports the decision of euro adoption in 2009.

Keywords: E24, J3
JEL classification: nominal and real wage rigidity, Slovakia

Reviewed by: Steinar Holden (Department of Economics, University of Oslo)
Jan Babecký (Czech National Bank)

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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 thinking about optimum level of inflation and consequent setting of inflation target.

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

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

Wage setting is in its nature a behavioral process occurring at the level of single economic agents (employees and employers).[2] Wage rigidity in the mind of single economic agent is based on loss aversion, which translates in perceived fairness of wage, which in consequence affects worker's effort (Fehr and Goette, 2000). Therefore, recent studies on wage rigidities prefer using personalized micro data of job-stayers. Since such personalized 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 (enterprises), identify imperfections in measuring transitive economy data with these methods and produce the most plausible estimates. Since flexible component in wage (bonuses) is relatively important, the definition of wages as compensations better captures the concept of wage cost of a company.

In contrast to personalized micro-data, using micro-data on the level of enterprises 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, to our knowledge 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.[3] Huitfeldt (2001) searches on 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 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

[1] See Groshen and Schweitzer (1999) who closer elaborate on „grease“ and „sand“ effect of inflation.

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

[3] The estimate for Slovakia forms a part of wage curve estimation for central and eastern European 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.

for Slovakia after 2000 as well as for most of CEE countries. These three studies have looked for some kind of wage flexibility measure through the wage curve and Phillips curve in the past. No studies estimating downward wage rigidity in Slovakia has however 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 not realized wage cuts to all wage cuts that should occur in fully flexible environment.

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 labour market”. He claimed that higher inflation provides for a cushion, in which employer may manipulate wages avoiding nominal 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 these 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.[4]

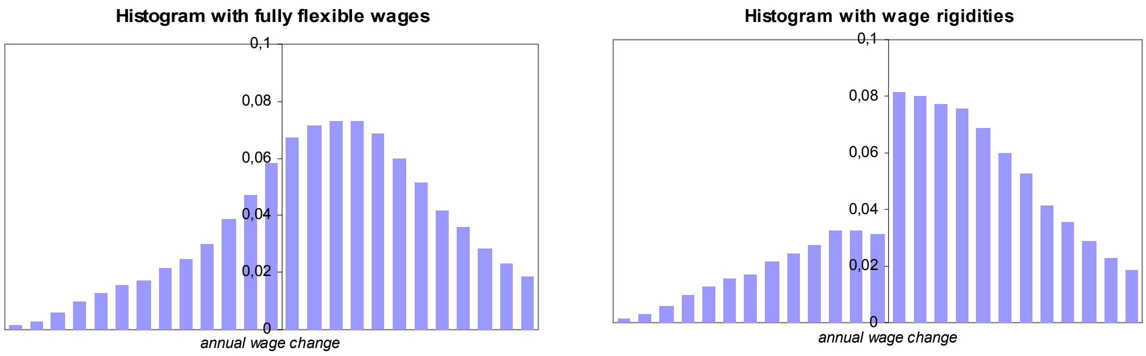
Due to level of inflation, wage rigidity has to be considered as a mixed concept of downward nominal and real rigidities (often in literature abbreviated as DNWR/DRWR); however, both being neither alternative nor always simply cumulative concepts. DNWR may become an irrelevant concept in case nominal 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.[5] On the other hand, institutional settings of labor market, especially those indexed by inflation are likely to make real wages more rigid.[6]

[4] 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.

[5] 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).

[6] 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: General shape of distribution without/with wage rigidities



Source: own

Within this paper, we understand downward wage rigidity as a certain number of wage freezes or moderate wage increases that would realize as wage cuts if wages were fully flexible (Figure 1). The rationale is that any wage cut causes loss of employee motivation, therefore some moderate wage cuts are too costly for an employer to realize. In such case, it is cheaper for employer to freeze wage or to slightly raise it.

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.

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 wage cuts, 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. (2006) 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 (2007) also realize restrictiveness of both assumptions and proposes to construct hypothetical distribution from those actual ones, which they identifies 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., 2006, Knoppik and Beissinger, 2005), its significant cross-country variations (Dickens, 2006 and 2007) and more nominal rigidity in the U.S. compared to Europe (Knoppik and Beissinger, 2005).

3. Measuring downward wage rigidities on aggregate data

3.1 Data and methodological issues

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 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).

Considering our assumptions, we follow Holden and Wulfsberg (2007) approach. In short, the original algorithm goes as follows. All wage change observations in industry j, country i and year t produce a full set S. Then country-years observations with top country-year median wage changes are selected and produce a subset S^{sub}. Observations within S^{sub} are normalized according to specific country-year variances and medians to a vector with overall median of S^{not} equal 0. This is our normalized hypothetical distribution which we suppose reflects full flexibility (no rigidity hypothesis). The shape of this normalized distribution is then laid over all country-year datasets calculating a notional incidence rate for each country-year dataset. This may be interpreted as an incidence rate of wage cuts in case no rigidity hypothesis is valid in the specific country-year set of observations. Empirical incidence rate is normally lower then notional incidence rate, because some wage cuts do not realize. This fraction of unobserved wage cuts (FWCP)[7] represents the extent of rigidity, i.e. share of missing empirical wage cuts with respect to calculated number of notional wage cuts (see technical record in the Appendix 1).

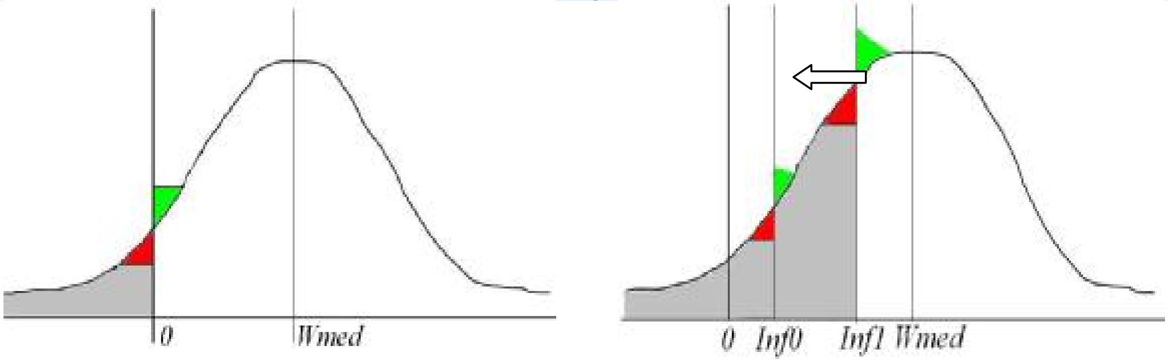
[7] FWCP reflects the proportion of companies, which do not cut the total compensations to companies which would cut the compensations in the absence of rigidity.

Statistical significance of estimated FWCP is than derived by simulating the probability of a wage cut. This is done by drawing sufficient number of times from binomial distribution (in our case 5000 simulations) of respective number of industries and the probability equal to respective notional incidence rate. We count the number of drawings, where simulated number of negative observations is higher than that of empirical and test it against the null hypothesis of no-rigidity, i.e. empirical incidence rate is equal to notional incidence rate. Such procedure helps us to test the statistical significance of nominal or real rigidity. By conducting the simulation we are able to answer the question whether the simulated extend of the rigidity is significant or not.

In order to derive a non-rigidity hypothesis we need to identify those empirical distributions, where we assume the lowest pressure on zero wage growth. This is solved by picking those empirical distributions, which have the highest nominal and real median wage changes within the sample. While observing that distributions have normal-like shape; the more the vertical *Wmed* line shifts to the right (away from zero wage growth), the higher is the median wage change and the lower shall be the presence of wage rigidities (DNWR - Figure 2a and DRWR - Figure 2b, adjusted for inflation).

We will assume that constructed hypothetical distribution serves as a proxy of no rigidity environment. If such assumption holds, incidence rate of wage cuts yielding from this hypothetical distribution would equal to empirical incidence rate.

Figure 2a, 2b: Downward nominal and real wage rigidities on histogram



Note: portion of wage change observations below zero nominal/real wage growth (red portion of grey field) transforms into wage freezes or slight wage increases (green) forming a spike at zero growth and/or step like shape of distribution around zero growth.

In our sample, maximum number of industries per country-year is 23, minimum is 12. Overall, we observe 235 nominal wage cuts, i.e. incidence rate of 6% of all observations. These wage cuts 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 the following table.

Table 1: Statistics of the data sample

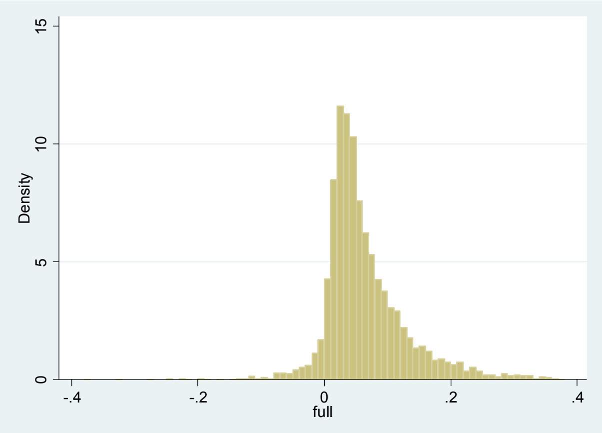
	Total sample	1996-2000	2001-2006	new EU	V4 countries	Baltics	Slovakia	EU-15
number of observations	3925	1616	2309	1817	962	612	236	2006
number of countryyears	189	78	111	85	43	31	11	95
inflation	0.040	0.057	0.028	0.064	0.069	0.057	0.068	0.020
Statistics nominal wage changes								
number of nominal wage cuts	235	95	140	93	23	67	2	142
number of country-years with no nominal wage cuts	89	40	49	49	29	12	9	31
standard deviation of nominal wage changes	0.073	0.090	0.054	0.088	0.076	0.116	0.061	0.036
P75-P35 - nominal wage changes	0.056	0.084	0.039	0.068	0.072	0.096	0.036	0.026
median of nominal wage changes	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 countryyears with no cuts	47.1%	51.3%	44.1%	57.6%	67.4%	38.7%	81.8%	32.6%
Statistics real wage changes								
number of real wage cuts	926	382	544	423	229	159	70	501
number of country-years with no real wage cuts	21	9	12	7	3	4	0	7
standard deviation of real wage changes	0.061	0.074	0.049	0.079	0.061	0.111	0.062	0.036
P75-P35 - real wage changes	0.034	0.038	0.032	0.047	0.041	0.071	0.044	0.023
median of real wage changes	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 countryyears with no cuts	11.1%	11.5%	10.8%	8.2%	7.0%	12.9%	0.0%	7.4%

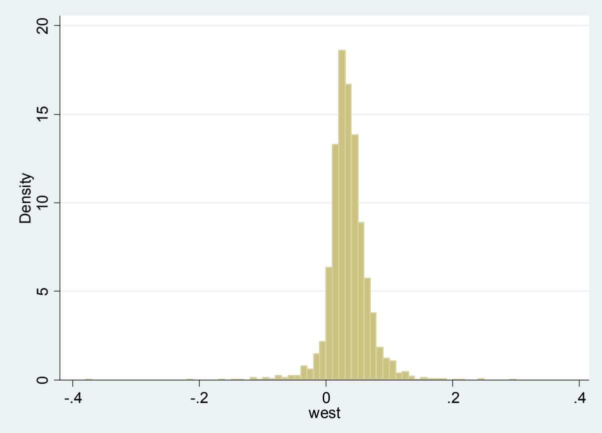
Source: authors' calculation.

3.2 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.[8]

Figure 3a, 3b: Histogram of nominal wage changes in full sample (left), EU-15 economies and Norway (right).





Source: authors' calculation.

Full sample of raw wage changes data is far more skewed to the right with much lower kurtosis, because of higher nominal wage growth in transition countries mainly due to

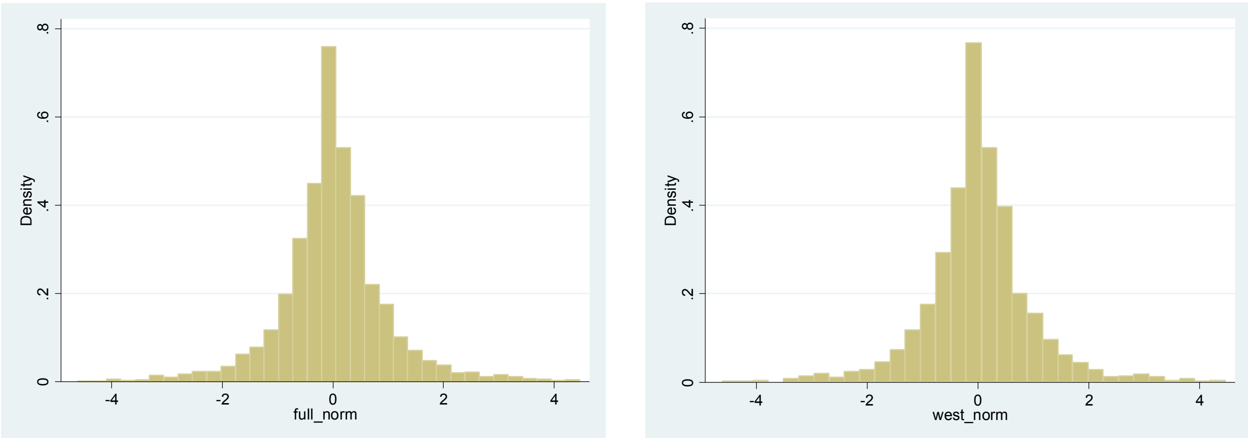
[8] Further in the text to be referred to as EU-15 for developed economies and EU-10 for transition economies.

convergence process.[9] 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.

To illustrate features of the two subsamples, we searched for the sensitivity of incidence rate to median wage growth. In average in our data sample, one percentage point shift in median real wage growth to the left translates into 4.3 to 6.3 percentage points more real wage cuts (causing higher incidence rate of wage cuts)[10]. The same size of shift in nominal terms translates into 0.9 to 2.1 percentage points more nominal wage cuts. 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 2a/2b). Looking at separate subsamples however, we produce varying coefficients. We observe that sensitivity of incidence rate to nominal wage growth for EU-15 countries increase to 2.0 to 5.5 percentage points and to real wage growth to 11.9 to 27.7 percentage points. To compare, coefficients for EU-10, both in nominal and real terms remain roughly the same as in the full sample.

If observing these data after normalization, varying features of geographic subsamples do not cause much of a problem. Distribution of full sample of countries easily passes the test of equality of distributions[11] with the one of EU-15 subsample.

Figure 4a, 4b: Histogram of normalised nominal wage changes in full sample (left), EU-15 economies and Norway (right).



Source: authors' calculation.

Distinct character of raw data for the two geographic subsamples then does not represent any problem if normalized and if resulting notional incidence rates and their relationship to empirical incidence rates are not distorted due to this disparity.

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. As we will

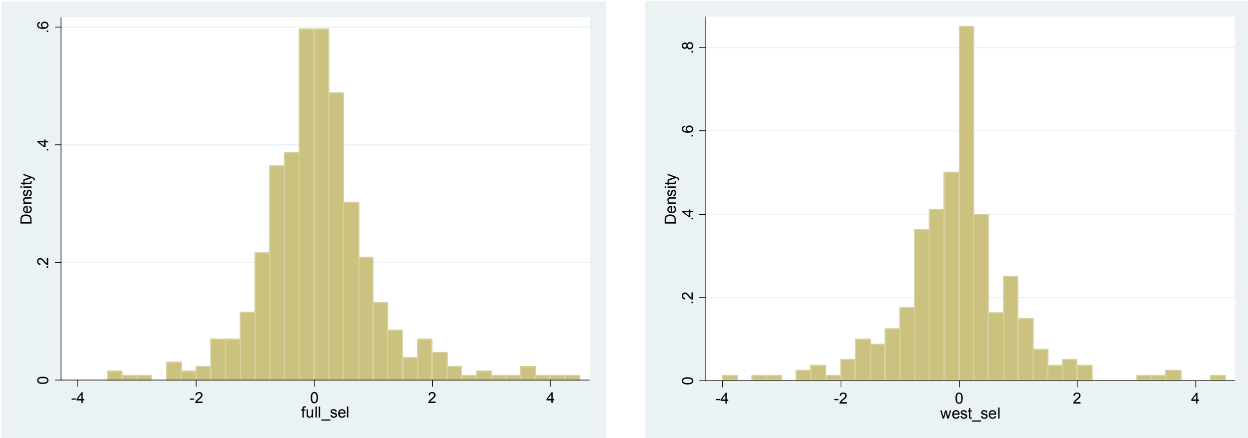
[9] Skewness of the full sample is 1.19 compared to 0.26 of EU-15 countries; kurtosis of the full sample is 15.6, compared to 28.1 of EU-15. Mean nominal wages of EU-15 is 3 percentage points lower than of the full sample, resp. 1.5 percentage points in terms of median nominal wages.

[10] Underlying relationship is non-linear. Inspired by Nickell and Quintini (2001) we regress incidence rate of wage cuts on respective median wage change and its square and standard deviation.

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

first reproduce this approach on extended number of more unlike countries, such qualifying criteria will depend on statistical parameters of raw wage changes (not-normalized). Having geographical subgroups with such median wage changes in one pool, criteria will always be met only by the EU-10 country-years, which posses 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.

Figure 5a, 5b: Histogram of nominal wage change observations qualifying in the upper quartile selection in full sample (left), EU-15 economies and Norway (right).



Source: authors' calculation.

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.

However, we need to pay more attention to the harmony of the two steps of methodology: construction of hypothetical distribution and derivation of notional distributions. Since quartile selection in full sample is being drawn from right fat tail of the distribution (fig. 3a), it comprises only of EU-10 country-years. Incidence rate (the share of negative observation) in raw wage change data of EU-15 and full sample is about the same level, but the two sets differ largely in symmetry (full sample data being positively skewed, while EU-15 more or less symmetric - Figure 3a/3b). Right tail observations drawn from the full sample then represent very much of an outlier relative to EU-15 set of observations. Even though normalization through median and variance absorbs much of the noise, notional incidence rates of EU-15 country-years 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 EU-15 country-years are pushed downwards (by 25% in average in proposed composition) if they are calculated in full sample with EU-10.

Having no other attributes that could possibly serve as a proxy for non-rigidity environment, one may think of some manipulation of qualification criteria. If we do that and narrow the criteria from upper quartiles to deciles, hypothetical distribution remains with fewer selected observations of even more outlier 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.

No matter how is the criterion set, we are able to estimate the extent of possible downward shift. We shall not yet therefore disqualify the approach in effort to estimate downward wage rigidities in our full sample; just interpret it with caution.

3.3 Results and their robustness

When a full sample of both transition and developed economies was used, only EU-10 countries´ country-year data had classified into the hypothetical distribution. Greater variance and median changes of these country-years then reflected into the distribution, giving distorted information to notional distributions of developed countries (EU-15). Further to this, low empirical incidence rates mainly in EU-10, distort the calculated fraction of wage cuts prevented -FWCP).

Table 2: Downward wage rigidity of full sample

Countries	No.of years	All Obs	q_emp	q_not	q_sim	fwcp sim	p-val
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
Czecb rep.	10	220	0.0182	0.0167	0.0165	-0.1014	0.7032
	189	**3925**	**0.0599**	**0.0654**	**0.0684**	**0.1242**	**0.0124**

Note: AllObs – number of all observations, q_emp – empirical incidence rate, q_not – notional incidence rate, q_sim – simulated notional incidence rate, fwcp_sim – simulated fraction of wage cuts prevented, p-val – probability of significance.

Source: authors' calculation.

Comparing nominal wage rigidities across countries from the full sample should be carried out with caution. Calculating the same for EU-15 sample separately yields fully comparative results of wage rigidities. Comparing notional incidence rates and fractions of wage cuts prevented for relevant countries between the Table 3 and the Table 2 we may observe differences, which occur when distributions with higher wage changes enter into the sample.

Table 3: Downward wage rigididty- old EU-15

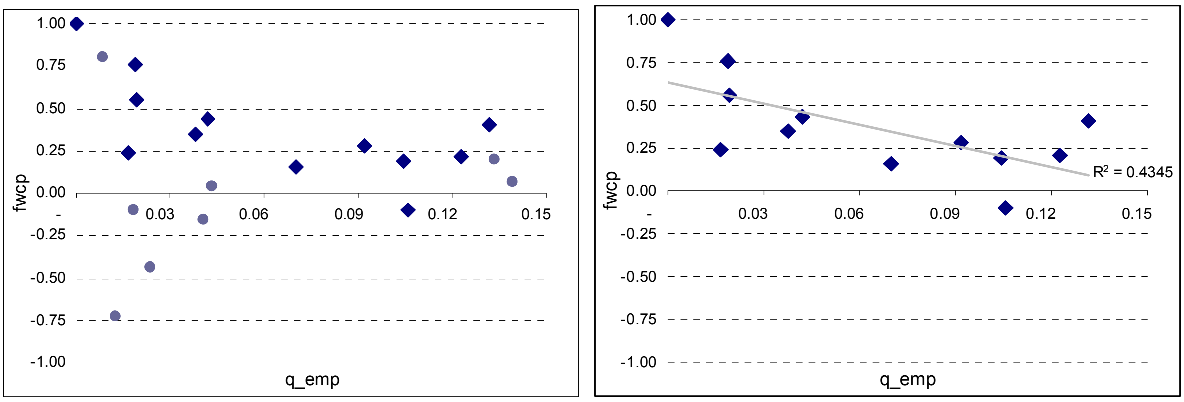
Countries	No.of Years	All Obs	q_emp	q_not	q_sim	fwcp sim	p-val
Austria	7	161	0.0186	0.0763	0.0766	0.7567	0.0006
Belgium	5	114	0.1316	0.2200	0.2213	0.4053	0.0104
Denmark	10	230	0.1043	0.1294	0.1294	0.1937	0.1400
France	9	207	0.0193	0.0434	0.0434	0.5547	0.0548
Ireland	10	120	0.0167	0.0222	0.0219	0.2386	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
	104	**2108**	**0.0674**	**0.0863**	**0.0944**	**0.2863**	**0.0000**

Source: authors' calculation.

In standard situation higher FWCP means more rigidity, FWCP approaching zero means more downward wage flexibility. Negative FWCP values are present in situations, where calculated notional incidence rate of wage cuts is lower than measured empirical incidence rate of wage cuts. 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 therefore disturbances are eliminated.

As it arises from (5) in appendix, fraction of wage cuts prevented should be negatively sloped relative to empirical incidence rate. This is true in EU-15 sample, however not so in the full sample (See Figure 6a, 6b).

Figure 6a, 6b: Empirical incidence rate and FWCP in full sample (left), EU-15 economies and Norway (right).



Source: authors' calculation.

Points in the graph 6a do not visually follow the logic of the equation as they do in 6b, because of high insignificance (p-val) of FWCP in EU-10.

Low empirical incidence rate is caused by high median wage change (Table 1). Small number of industries per country-year reflects in discontinuous values of incidence rate with relatively high increments. If incidence rates are close to zero, fraction of wage cuts prevented becomes extremely sensitive to random disturbances, e.g. between no-wage-cut-recorded situation and one–wage-cut-recorded situation. Consequently, the countries with low aggregate empirical incidence rate tend to be more exposed to sensitivity to random disturbances in individual country-years (prone to distortions) and therefore do yield more variable FWCP values. Resulting FWCP of countries with empirical incidence rate in immediate distance from zero (empirical evidence suggests less than 0.02, which in our data translates to at most 3 overall negative observations) does not testify properly about the wage rigidity. Results on wage rigidity in such countries (Slovakia, Slovenia, Austria, Ireland, Norway) are then difficult to interpret.

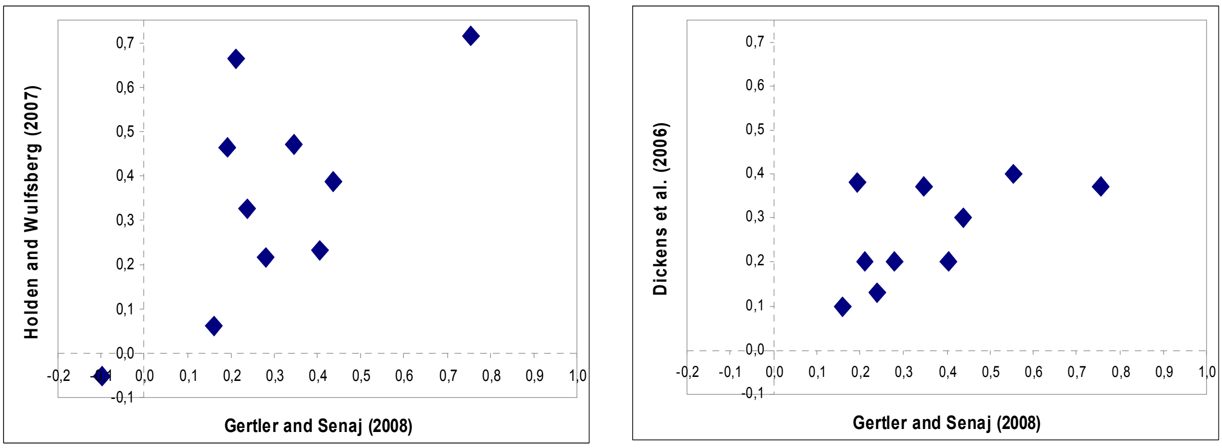
Thus we may conclude that if calculating wage rigidity for developed and transition economies together, we face two possible sources of distortion. First, coming from construction of non-rigidity hypothesis of two distinct sets of data and second from too few wage cut observations, which origin partly in higher median wage changes.[12]

3.4 Results - interpretation

From the above reported tables we may confirm some downward nominal wage rigidity (29%) in the EU-15 sample. Based on 5000 simulations, we observe nominal wages being significantly rigid downwards especially in Austria, France, the Netherlands and Belgium, where over 40% of wage cuts are being prevented.[13] 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 U.K. and Finland on 10% significance level. These findings are generally in line with other results from cross-country studies., whose downward nominal wag rigidity estimate of the full sample reaches 26%.[14]

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. (2006).

Figure 7: Our country results of FWCP compared to country results of Holden and Wulfsberg (2007) and Dickens et al. (2006).



Source: authors' calculation.

[12] Besides Slovakia and Slovenia, Ireland and Norway may be considered so due to its excess growth relative to EU average in the time observed.
[13] We do not consider Norway, where there is no empirical wage cut observed, therefore FWCP is always equal to one no matter all other parameters. Testing however proves the high value of Norwegian FWCP being insignificant.
[14] They include some extra OECD countries and uses data from longer period further in history (1973-1999).

For EU-10 countries we may confirm more downward wage flexibility 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). From the data we have, we cannot conclude for Slovakia. This is because of very few negative observations and therefore being exposed to random disturbances.

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.

3.5 Reasons for turning to microdata

We have identified two sources of possible distortion to the output data while applying histogram location approach of Holden and Wulfsberg (2007) on mixed sample of old and new EU member states wage growth data.

The first is an incomparability of resulting FWCP in transition economies and developed economies. It origins in heterogeneity of median wage changes, rates of inflation and in variance of country-year observations in the two subsets. Much of this heterogeneity is absorbed by normalisation, however selection criteria to construct non-rigidity hypothesis inclines to the EU-10 country-years. Notional incidence rates are then shifted downwards and consequently are the extent of wage rigidity upwards.

The second is the deficiency coming from too few observations in partial distributions (country-year). Having only 20 observations (industries) in one country-year may be a source of noise, which may be crucial if empirical incidence rate is too close to zero. This is particularly true in some countries, which makes interpretation of wage rigidity for these countries more complicated.

The last, but not less important is the difficulty in interpreting resulting FWCP. Ideally, we would like to say that some share of wages was prevented from dropping over the year. Since our single observation is an entire industry/sector, we may only say that certain percentage of average sectoral wage cuts over the year was prevented.

Knowing that we lose much of within-sector wage information and being unable to reliably estimate wage flexibility for Slovak republic, we turn our attention to microdata. As individual chained wage data are not available for Slovakia (neither in most of the transition countries), we will use the micro-data on company level. Results of aggregate data will serve as a reference and a useful starting point to compare all the next results with.

4. Measuring wage rigidity on the company level

4.1. Data

Departing from the findings above, we put the emphasis on the analysis of the company level micro-data. To our knowledge, company level microdata have been used in histogram location approach in two studies so far. In Lebow et. el. (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 total compensations are less affected by the downward nominal wage rigidity than base wages alone. Since we are using similarly compensation-type wage definition, we shall account for larger flexibility from margins of adjustment in flexible components of wage.

We employ similar type of data source as Brzoza-Brzezina and Socha (2007). 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[15] were merged in order to obtain as representative sample as possible. We use total compensations in a company. 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. The following table compares data for the economy as a whole and the sample used.

Table 4: Comparison of the data sample and the Slovak economy.

	2007	2006	2005	2004	2003	2002	2001
data set							
Number of enterprises	5 498	5 494	5 039	4 932	5 138	4 904	4 812
Respective number of employees	834 749	849 470	732 986	749 790	790 487	735 650	774 872
slovak economy (production sector)							
Number of employees	1 766 541	1 712 702	1 668 034	1 621 704	1 616 513	1 608 622	1 607 552

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

We consider both full time and part time employees. The central variable we use is the change of average hourly compensation (in both nominal and real terms) in the company.[16] Further, we filter the database to eliminate an impact of assumed error inputs, which originate mainly from incorrectly filled in questionnaires[17].

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 compensations are different across the sample.[18] The basic statistical properties of the analyzed data sample are as follows:

[15] 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).

[16] $\Delta wage_{t/t-1} = wage_t / wage_{t-1} - 1$. For wages we use the definition of compensations, i.e. wages including bonuses and premiums since partial components of wages are not available from this survey. 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.

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

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

Table 5: Statistical properties of the changes in compensations and basic macro indicators

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

Source: SO SR, authors' calculation.

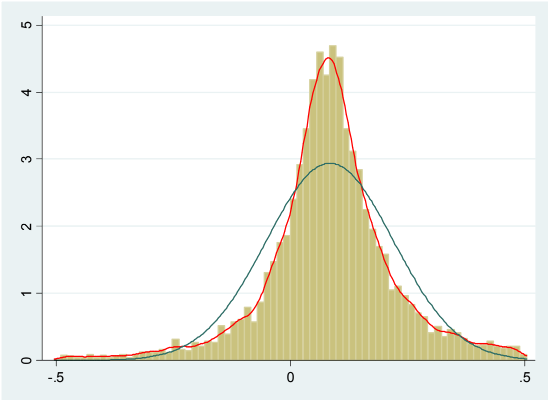
An interesting difference between industry and company level data can be seen from Figure 8, which shows the distributions of the annual changes in total compensations. Although Slovak industry level data (used in the previous part) displays hardly any wage cuts during the whole sample, almost 30% of observed companies cut their hourly compensations.[19] Considerable different results compared to sectoral analysis are most likely a mixed effect of above mentioned aggregation issue, flexibility of employers in handling the number of hours worked or by the fact that company level micro-data includes over 60% of other observations than the ones from manufacturing.

Another interesting issue is that despite strong average wage growth of 6 % to 10 % during the years 2000 and 2007, almost 30% of analyzed enterprises cut their hourly compensations in each year. This paradox may be explained by at least the following three reasons. Firstly, changes in the composition of workforce may have changed the average compensation even if the wage rates stayed on the same level. Secondly, changes in the number of hours worked may have modified the average hourly compensation even if hourly wage remained the same. And finally, cutting bonuses in aiming to decrease total costs of the company could also lower total compensations. 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.

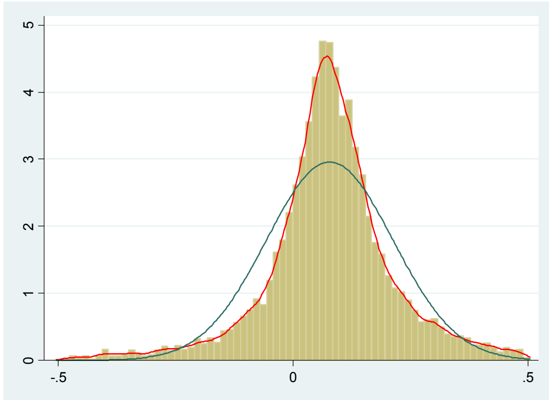
[19] Blinder and Choi (1990) discovered that the money wage cuts were more common in the US than they had imagined even they analyzed a time period characterized by low unemployment.

Figure 8: Distribution of changes of hourly compensations. Kernel vs. normal density functions.

2007/2006



2006/2005



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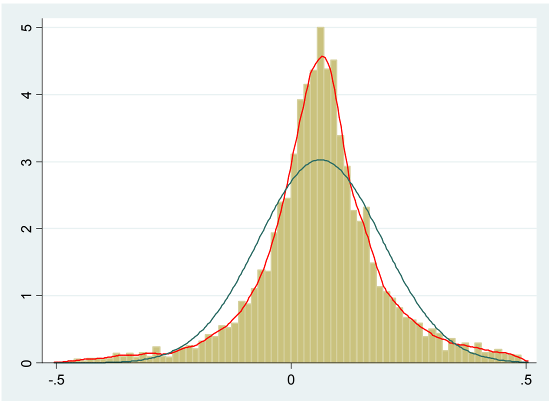

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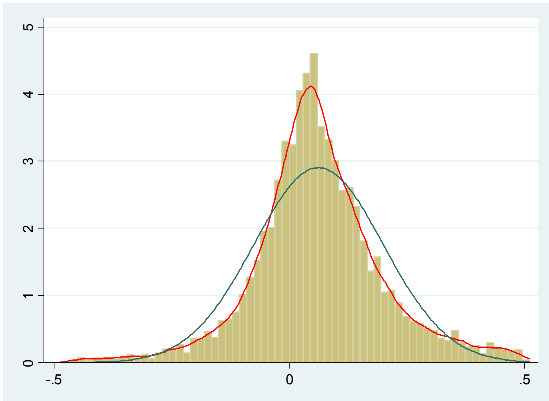
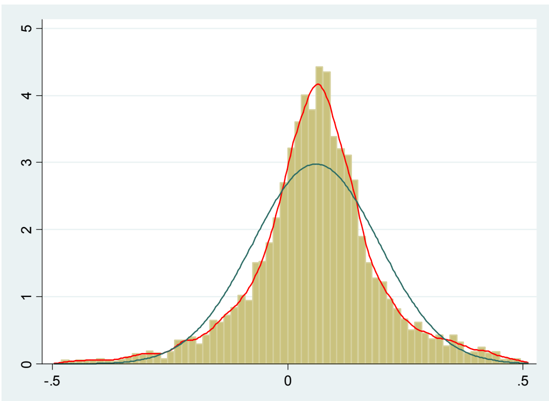
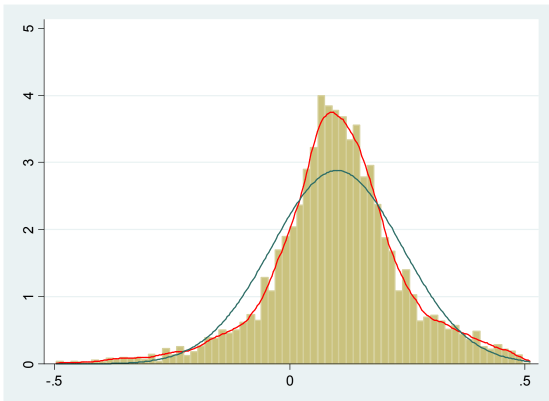


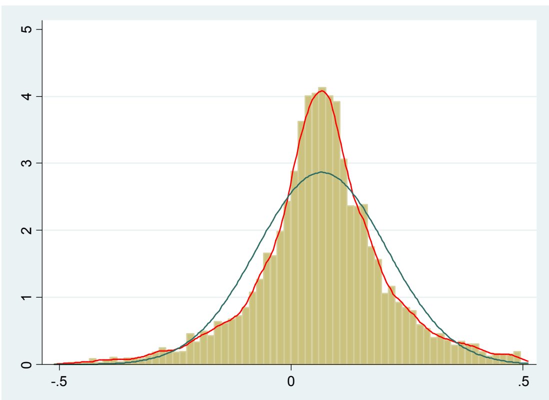
2003/2002



2002/2001



2001/2000



Source: authors' calculation.

4.2 Results

4.2.1 Results for Slovakia

In order to apply the original approach proposed by Holden and Wulfsberg (2007) 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 as in chapter 3.2) out of our sample with highest median of nominal and real growth of the total hourly compensations. According to our data, there is no doubt for choosing the year 2002.[20] 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.

An empirical investigation shows interesting results. Table 6 presents the outcomes of analysis of nominal rigidity in total hourly compensations. 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 cuts 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 cut compensations in the absence of rigidity, are affected by downward nominal wage rigidity (in 2005).[21] 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 1.5 % to 2.2 %, which means that at least 1.5 % of companies were affected by wage rigidity in 2005.[22]

Table 6: Nominal wage rigidity – Slovakia

Years	All Obs	q_emp	q_not	q_sim	fwcp sim	nwr	p-val
2007/2006	5498	0.194	0.214	0.214	**0.096**	0.021	0.000**
2006/2005	5494	0.207	0.229	0.229	**0.094**	0.022	0.000**
2005/2004	5039	0.248	0.263	0.263	**0.058**	0.015	0.006**
2004/2003	4932	0.288	0.299	0.299	**0.036**	0.011	0.051
2003/2002	5138	0.268	0.268	0.268	**0.000**	0.000	0.504
2002/2001	4904	0.185					
2001/2000	4812	0.257	0.266	0.266	**0.033**	0.009	0.085

**Note: DNWR are statistically significant at 1% level of significance.

Note: AllObs – number of all observations, q_emp – empirical incidence rate, q_not – notional incidence rate, q_sim – simulated notional incidence rate, fwcp_sim – simulated fraction of wage cuts prevented, nwr – share of companies affected by nominal rigidity, p-val – p value.

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.

[20] Further we follow the algorithm described in the Appendix 1.

[21] 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.

[22] 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).

An interesting question arises about the impact of detected rigidity in hourly compensations 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 - Slovakia

Years	All Obs	q_emp	q_not	q_sim	fwcp sim	rwr	p-val
2007/2006	5498	0.268	0.289	0.289	**0.072**	0.021	0.000**
2006/2005	5494	0.347	0.371	0.371	**0.063**	0.024	0.001**
2005/2004	5039	0.343	0.353	0.353	**0.028**	0.010	0.080
2004/2003	4932	0.584	0.578	0.578	**-0.011**	NA	0.811
2003/2002	5138	0.598	0.585	0.585	**-0.022**	NA	0.969
2002/2001	4904	0.259					
2001/2000	4812	0.530	0.525	0.525	**-0.008**	NA	0.732

**Note: DRWR are statistically significant at 1% level of significance.

Note: AllObs – number of all observations, q_emp – empirical incidence rate, q_not – notional incidence rate, q_sim – simulated notional incidence rate, fwcp_sim – simulated fraction of wage cuts prevented, rwr – share of companies affected by real rigidity, p-val – p value.

Source: authors' calculation.

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.

4.2.2 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 according to size of the company

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

Source: authors' calculation.
** (*) Note: DRWR are statistically significant at 1% (5 %) level of significance.
Note: fwcp_sim – simulated fraction of wage cuts prevented, nwr – share of companies affected by nominal rigidity, p-val – p value.

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 according in manufacturing and services

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

Source: authors' calculation.
** (*) Note: DRWR are statistically significant at 1% (5 %) level of significance.
Note: fwcp_sim – simulated fraction of wage cuts prevented, nwr – share of companies affected by nominal rigidity, p-val – p value.

5. Conclusions

Having reproduced a histogram location approach on the industrial level, we may conclude as follows:

From the accessible data of recent years, 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. Unification of all observations into one full sample (of EU-15 and EU-10 countries) may be a subject to distortion originating in specific features of data in the two subgroups. Extent of distortion however may be quantified and therefore interpretation of unified sample is possible with caution.

Nominal wages are rigid downward especially in Austria, France, Belgium and the Netherlands with wage cuts prevented in excess of 40%. 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 U.K. and Finland. These findings are generally in line with other results from cross-country studies. Further it suggests that decreasing trend of downward nominal wage rigidities in time identified in Holden and Wulfsberg (2007) experienced its bottom point in the 1990s′ while since trending upwards again.

Nominal wages in new EU member states are relatively flexible all across the countries we have included in the sample. In case of Slovakia and Slovenia however, final result cannot be drawn. Having too few negative observations in the sample, there is higher sensitivity to random disturbances, which makes 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 of this paper is the adoption of the methodology proposed by Holden and Wulfsberg (2007) to a company level data. The data sample we used covers hourly compensations in the time period between 2000 and 2007. The estimated extent of both nominal and real rigidity following the methodology used is relatively small. Conclusion that total compensations are rather flexible supports the decision of euro adoption in 2009.

We have identified and measured nominal wage rigidity 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 300 million Sk (estimated number) 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 companies 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 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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7. Appendix

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

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

The main assumption of this approach is that absence of rigidity is present in some country years[23] in the sample. Thus the first task is to choose those country years which represents the environment where wage rigidity doesn't 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 index 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 the constructed as follows:

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

[23] Note: We use the term country year. However, in the part 4.2 it stands for one year as we focus only on Slovakia.

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

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

The empirical incidence rate is computed similarly:

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

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:

$$FWCP\_not = 1 - \frac{q_{it}\_emp}{q_{it}\_not}. \tag{5}$$

FWCP reflects the share of industries/firms which didn’t realize the wage cut thought they were supposed to cut wages to the total number of industries/firms supposed to cut wages in the no rigidity environment.

Testing for significance

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

We employ the test to examine the significance of rigidity procedure in part 3.3 for every country and for the whole sample and in part 4.2 for every year.

We use the binomial test however in a slightly simplified version. Instead of computing the exact probabilities we rather simulate draws from binomial distribution 5 000 times. Such a simplification dramatically decreased the computational requirements. It is important to add that part of the results were double-checked and normal approximation was used for the Binomial distribution. Both tests gave us the same results.

First step is to draw from the standard binomial distribution *B(n,p)* n times, where *n* stands for the number of trials and *p* is 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 5 000 times. Afterwards we compute the average number of successive draws: $S^{it} = \frac{1}{5000}\sum_{k=1}^{5000} S_k^{it}$. Dividing S^{it} by *n* we obtain simulated incidence rate (q_{it}_sim) and also are able to compute belonging fraction of wage cuts prevented ($fwcp_{it}\_sim$).[24] We then count the simulated amount of wage cuts S^{it} higher than the number of observed cuts in the corresponding empirical distribution. We call it H^{it}. Finally, the p-value is obtained as a $p = 1 - \frac{H^{it}}{5000}$. Based on the p-values, if the p-value is smaller than the significance level, one rejects the null hypothesis of no rigidity.

[24] Note: $fwcp_{it}\_sim$ is very similar to $fwcp_{it}\_not$ by construction. The higher is the number of simulations, the more these two values converge.