Empir Econ (2009) 36:321–338
DOI 10.1007/s00181-008-0197-y

ORIGINAL PAPER

Downward nominal wage rigidity in Europe: an analysis of European micro data from the ECHP 1994–2001

Christoph Knoppik · Thomas Beissinger

Received: 15 August 2006 / Accepted: 15 November 2007 / Published online: 22 April 2008

Abstract This paper substantially extends the available evidence on downward nominal wage rigidity in the European Union (EU) and the Euro Area. We develop an econometric multi-country model based on Kahn's (Am Econ Rev 87(5):993–1008, 1997) histogram-location approach and apply it to employee micro data from the European Community Household Panel for 12 of the EU's member states. Our estimates for the degree of downward nominal wage rigidity on the national as well as the EU-wide level point to substantial downward nominal wage rigidity within the EU. A detailed comparison with other cross-national studies reveals an emerging consensus about which countries can be characterized as high or low rigidity countries, although the status of some countries remains unclear. The variation in national degrees of downward nominal wage rigidity cannot convincingly be explained by institutional variables.

Keywords Downward nominal wage rigidity · Wage stickiness · European community household panel · ECHP · Histogram-location approach · European union · Euro area

JEL Classification J30 · E24

C. Knoppik (✉)
University of Regensburg, Regensburg, Germany
e-mail: christoph.knoppik@wiwi.uni-regensburg.de
URL: http://www.wiwi.uni-regensburg.de/knoppik/

T. Beissinger
University of Hohenheim and IZA (Bonn), Stuttgart, Germany
e-mail: beissinger@uni-hohenheim.de
URL: http://www.beissinger.de

1 Introduction

Whether and to which extent nominal wages are downwardly rigid are widely considered unresolved questions. Their scientific importance derives from their key role in understanding the workings of the labor market and from their implications for the shape of the long-run Phillips curve. Both questions are also relevant for economic policy since downward nominal wage rigidity may lead to unintended costs of low inflation targets in terms of higher long-term unemployment. Accordingly, the empirical evidence with respect to nominal wage rigidity is indispensable for an evaluation of recent low inflation targets of monetary policy makers.

Until recently, such evidence only existed for a few European countries, as emphasized in the survey of Rodríguez-Palenzuela et al. (2003). In several cases, the evidence available was purely descriptive, seemingly contradictory, or was hard to compare across countries, because of differences in methods and data. The European Central Bank (2003, p. 14) concluded that '... the empirical evidence is not conclusive, particularly for the euro area'. The current paper addresses this critique by substantially extending the available evidence on existence and extent of downward nominal wage rigidity in the European Union (EU) and the Euro Area.[1] Additional econometric evidence based on micro data has been presented in the cross-national studies of Behr and Pötter (2005) and Dickens et al. (2006). Holden and Wulfsberg (2006) analyze international sectoral data. The results from these studies will be discussed together with ours in Sect. 5.

Our analysis is based on the European Community Household Panel (ECHP), a large-scale annual longitudinal survey for the 'old' 15 member states of the EU carried out between 1994 and 2001. The great advantage of the ECHP is the standardized questionnaire used in the EU-countries, which makes the direct comparison of data across countries and over time possible. Using a uniform method of analysis for the whole EU and Euro Area as well as for the individual member countries facilitates the comparison of the results. We develop an econometric multi-country model based on a widespread quantitative method of analysis, the histogram-location approach introduced by Kahn (1997). The semi-parametric histogram-location approach models annual location-centered distributions of wage changes by histograms and formulates an econometric model of the histograms' bins.[2] Under a regime of downward nominal wage rigidity, the econometric model will reveal a systematic interplay of location and shape of the histograms over time. This 'joint variation of location and shape' identifies the key parameter, the degree of downward nominal wage rigidity, which measures the share of desired wage reductions that are prevented by downward nominal wage rigidity. This principle of identification is also used in other approaches, e.g. the skewness-location approach by McLaughlin (1994), the kernel-location approach by Knoppik (2007) and, jointly with identification by functional form, in the earnings-function approach by Altonji and Devereux (2000). The histogram-location approach has been outlined in detail in an earlier version of this paper, Knoppik and Beissinger (2006),

[1] Earlier versions of this paper were presented at the EPUNet, EEA and EALE conferences in 2004.

[2] The term 'wage' is used for any type of earnings from labor. The earnings variables used are discussed in Sect. 3.

and, e.g. in Beissinger and Knoppik (2001), Stiglbauer (2002), and Lebow et al. (2003). Advantages of the histogram-location approach include a high degree of comparability with earlier results, easy interpretation and, due to its semi-parametric nature, little reliance on functional assumptions, in particular if compared with approaches that rely on functional form of wage change distributions for the identification of downward nominal wage rigidity. Among the drawbacks of the histogram-location approach is its lack of treatment of measurement problems, which implies a downward bias in estimated degrees of rigidity. These issues are discussed below in more detail.

The paper is structured as follows. Section 2 explains our proposed extensions to the histogram-location approach for cross-national analysis. Section 3 describes the ECHP data used and the definition of our reference subsample. Section 4 contains a description of the empirical implementation and the results with respect to existence and extent of downward nominal wage rigidity. In Sect. 5 these results are compared with results from other cross-national studies. In Sect. 6 it is analyzed whether institutional indicators can explain differences in estimated national degrees of rigidity. Finally, in Sect. 7 we summarize our findings and offer some conclusions.

2 Extensions of the histogram-location approach for cross-national analysis

Numerous applications of the basic proportional model of the histogram-location approach can be found in the literature.[3] In addition, a number of variants of the basic model have been proposed in Kahn (1997), Beissinger and Knoppik (2001), Christofides and Leung (2003), Castellanos et al. (2004), and Kuroda and Yamamoto (2005). However, neither the basic version nor these extensions are suitable for cross-national, cross-sectional, or cross-regional analysis. To introduce the notation and as a point of reference we present a basic version of the model first.

2.1 Basic econometric model and options for cross-national analysis

The basic econometric model of the histogram-location approach explains the relative frequency P_{rt} of wage changes in histogram bin r in period t of the histogram of location-centered percent annual wage changes. The bin size P_{rt} is equal to the product of bin width b and height h, $P_{rt} = bh$. Bin r represents percent nominal wage changes that are between r and $r-1$ times the bin width b smaller than the rate of wage change at the location of the uncentered distribution. The explanatory variables are dummy variables that capture bin status in different bins and years, i.e. whether the bins contain negative, zero, or positive nominal wage changes. The unknown parameters that are to be estimated are the rigidity parameter ρ, the counterfactual bin sizes α_r that would prevail under wage flexibility, and the pile-up parameter γ. The model consists of the following system of $R = r_{\max} - r_{\min} + 1$ equations:

[3] Examples are Knoppik and Dittmar (2002) for Germany, Brzoza-Brzezina and Socha (2006) for Poland, and Lebow et al. (2003) for the US.

$$P_{rt} = \alpha_r \underbrace{(1 - \rho DN_{rt})}_{\text{thinning}} + \underbrace{\left(\gamma + \rho \sum_{j=r_{\min}}^{r_{\max}} \alpha_j DN_{jt}\right) DZ_{rt}}_{\text{pile-up}} + \mu_{rt}$$
$$\text{for} \quad r = r_{\min} \ldots r_{\max}, \tag{1}$$

where μ_{rt} is the error term in equation r. Each observed bin's status as a negative bin, zero bin or positive bin is encoded in a set of two dummy variables, DN_{rt} and DZ_{rt}. Each equation of system (1) covers the three cases of negative, zero, or positive bins. The sizes of positive bins, i.e. the bins with only positive nominal wage changes ($DN_{rt} = 0$ and $DZ_{rt} = 0$) are explained by the counterfactual bin sizes α_r. In the case of negative bins, which exclusively contain negative nominal wage changes ($DN_{rt} = 1$ and $DZ_{rt} = 0$), a proportion ρ of the counterfactual bin size is subtracted from α_r. In contrast, for zero bins, i.e. the bins that contain the zero nominal wage change ($DN_{rt} = 0$ and $DZ_{rt} = 1$) there is a pile-up in addition to the counterfactual bin size from the wage freezes in the negative bins of the same period. Parameter γ captures the contribution of those negative bins that are too far left to be explicitly modeled, or caused by reasons other than downward nominal wage rigidity. The rigidity parameter ρ can directly be interpreted as the degree of downward nominal wage rigidity, since it is equal to the proportion of nominal notional wage cuts that are prevented by the existence of downward nominal wage rigidity.[4] The counterfactual bin sizes α_r are constant parameters because of the assumption of a time-invariant counterfactual distribution (up to shifts in location).[5]

System (1) is a partial model of the total histogram including R equations, one for each bin modeled; this assumption will be relaxed later. All bins that change status at least once during the sample period contribute to the identification of downward nominal wage rigidity and should be included in the model. $r_{\min}$ should therefore be the bin with the smallest number that changes from positive to zero status at least once in the sample period, or a bin with an even lower number, and analogously for $r_{\max}$. Note that the estimation of the system is based on $N = R \cdot T$ observed bin sizes, given T observed histograms.

There are three ways in which to use the histogram-location approach in a cross-national context. The first option is to build isolated *national models*, i.e. to construct national histogram bin sizes and to estimate national models independently of each other, by using the basic econometric model (1). The main drawback of this option for our purposes is that for several countries the distribution of percent wage changes shows only very little variation in location over the sample period which tends to make estimation less reliable or even impossible. The second option is to construct one

[4] The model presented is a simplified version of the 'proportional model' or 'model 3' in Kahn (1997). The proportional model of downward nominal wage rigidity with uniform degree of rigidity for nominal wage reductions of all sizes is used, because it results in a single measure of rigidity that it easy to interpret and easy to compare to other results in the literature. There is also explicit support for this proportional form of rigidity in Knoppik (2003), an analysis of functional form of downward nominal wage rigidity.

[5] A detailed account of the assumptions underlying this and other approaches to the analysis of downward nominal wage rigidity can be found in Beissinger and Knoppik (2001).

aggregate annual histogram of wage changes for all countries together and to estimate an *aggregate model*. However, different developments over time of the location of the underlying national distributions give rise to a time-varying mixture of distributions, which violates the assumption of time-invariance of the counterfactual distribution. The third option is to pool the information on national histogram bin sizes and to estimate *pooled models*. In pooled models, the limited variation in location of the distributions of percent nominal wage changes is substituted to some degree by cross-national variation in location. Two versions of pooled models, either with uniform or country-specific degrees of downward nominal wage rigidity are considered in the following subsection.

2.2 Pooled model

The pooled model with uniform parameters essentially consists of a version of Eq. (1) that is additionally indexed with a country index c

$$P_{rct} = \alpha_r \underbrace{(1-\rho DN_{rct})}_{\text{thinning}} + \underbrace{\left(\gamma + \rho \sum_{j=r_{\min}}^{r_{\max}} \alpha_j DN_{jct}\right) DZ_{rct}}_{\text{pile-up}} + \mu_{rct} \quad \text{for} \quad r = r_{\min} \ldots r_{\max}. \tag{2}$$

Stacked data on bin sizes and status dummies from the different countries is used in this case. Note that the estimation of the pooled model is based on $N = R \cdot \sum_c T_c$ observed bin sizes, where T_c is the number of observed histograms of country c. The pooled model with national rigidity and pile-up parameters is given by the system of Eq. (3).

$$P_{rct} = \alpha_r \underbrace{\left(1 - \left(\sum_i \rho_i DC^i_{rct}\right) DN_{rct}\right)}_{\text{thinning}} + \underbrace{\left(\sum_i \gamma_i DC^i_{rct} + \left(\sum_i \rho_i DC^i_{rct}\right) \sum_{j=r_{\min}}^{r_{\max}} \alpha_j DN_{jct}\right) DZ_{rct}}_{\text{pile-up}} + \mu_{rct} \quad \text{for} \quad r = r_{\min} \ldots r_{\max}, \tag{3}$$

where DC^i_{rct} is the country dummy for country i. The uniform rigidity parameter ρ is replaced by $\sum_i \rho_i DC^i_{rct}$ and the pile-up parameter γ is replaced by $\sum_i \gamma_i DC^i_{rct}$, where summation runs over all countries covered. The assumption of invariance of the counterfactual distribution is extended in this pooled model to countries, which is reflected in the country-independent counterfactual bin sizes α_r. Any potential country differences of the counterfactual therefore have to be eliminated. Centering the national histograms takes account of the national differences in location. Additional differences in dispersion can be taken into account by standardizing the distributions, as is explained in the next subsection. Admittedly, the wage-change distributions across countries could vary in ways not captured by centering and standardizing, as they could in a single country application. One strategy to ensure the invariance of the counterfactual, which we adhere to, is to create a homogenous subsample even if it means a loss of observations and to perform many robustness checks by systematic variation of the subsample selection, the histogram construction and the econometric model used in the analysis.

2.3 Standardization

One implication of the assumption of an invariant counterfactual distribution in the histogram-location approach is that histograms from two countries that differ in the dispersion of their wage change distributions must not be used in a joint analysis, unless the analysis corrects for these differences.[6] The means for correction are histograms of *standardized* wage changes, where the standardized percent wage changes Δw^s are defined by

$$\Delta w^s = \frac{\Delta w - l}{v},$$

with location parameter l and dispersion parameter v. Under standardization, zero bin status is determined by whether (in a given period) the bin contains the standardized wage change that corresponds to the original zero nominal wage change, $\Delta w^s = (0 - l)\big/v$. Standardization effectively relaxes the assumption of time-invariant counterfactual distribution (up to variation in location) and replaces it by the weaker assumption of time-invariant counterfactual distribution (up to variation in location and some parameter of dispersion).

The choice of a suitable measure of variability depends on the question to be addressed. Holden and Wulfsberg (2004) choose the interquartile range as their preferred measure of variability, i.e. $v^{75|25} = q_{75} - q_{25}$, where q_{75} and q_{25} denote the third and first quartile (75th and 25th percentile). Since they are interested in unbiased type I errors in a test of the null hypothesis of wage flexibility it does not matter for their analysis that the interquartile range is affected by downward nominal wage rigidity. Since we are interested in estimates of the extent of downward nominal wage rigidity, our measure of variability must not be affected by downward nominal wage rigidity. We therefore propose the use of interpercentile ranges between some high percentile and the measure of location, which must not be affected by downward nominal wage rigidity either. For example, if the 60th percentile is used for location, $l = q_{60}$, the upper percentile could be q_{80} leading to

$$v^{80|60} = q_{80} - q_{60},$$

[6] Knoppik and Beissinger (2006) contains a detailed graphical illustration of the issues of differences in dispersion and standardization.

and a corresponding standardization of

$$\Delta w^s = \frac{\Delta w - q_{60}}{v^{80|60}} = \frac{\Delta w - q_{60}}{q_{80} - q_{60}}.$$

2.4 Closed model

A problem of the basic model is that it is a partial model, which could lead to inconsistent results. The solution is to 'close' the model by modeling the full left tail of the histogram. In the basic model (1), the part of the distribution to the left of $r_{\max}$ is only taken into account implicitly, by adding the 'additional pile-up' parameter γ. The construction of location-centered histograms implies that the counterfactual outer left tail has probability mass of $F(q) - \sum_{j=1}^{r_{\max}} \alpha_j$, i.e. is equal to the difference between the percentile used as measure of location and the sum of all counterfactual bin sizes up to $r_{\max}$. Because of the proportional functional form of downward nominal wage rigidity assumed in the model, the pile-up from far left must equal ρ times this difference. This restriction, $\gamma = \rho(F(q) - \sum_{j=1}^{r_{\max}} \alpha_j)$, however, is not taken into account in the partial model and may therefore be violated in estimates obtained from the basic model. In order to close the model, the restriction can be used to replace the pile-up parameter γ in systems (1), (2), or (3).

For example, system (1) then becomes:

$$P_{rt} = \alpha_r \underbrace{(1 - \rho D N_{rt})}_{\text{thinning}} + \underbrace{\left(\rho \left(F(q) - \sum_{j=1}^{r_{\max}} \alpha_j\right) + \rho \sum_{j=1}^{r_{\max}} \alpha_j D N_{jt}\right) D Z_{rt}}_{\text{pile-up}} + \mu_{rt}$$

$$\text{for} \quad r = 1 \ldots r_{\max}. \tag{4}$$

Note that no explicit equation for the probability mass to the left of $r_{\max}$ is needed since it is implied by the other bin sizes. Such an equation is not admissible either, because of the dependence of the error terms over the closed model.[7] Note also that $r_{\min}$ has to be set to one.

3 Data and definition of the reference subsample

The analysis is based on the ECHP which is a large-scale annual longitudinal survey providing household and personal information on income and socio-economic characteristics for the 15 'old' member states of the EU.[8] The ECHP has been centrally designed and coordinated by the Statistical Office of the EU (Eurostat). The great

[7] This situation is well known in the context of the estimation of expenditure shares, see, e.g. Greene (2003).

[8] EPUNet (2004) is a short introduction to the ECHP and a reference to more detailed information; see also Eurostat (2003). A large number of documents on the ECHP is provided by Eurostat (2004). Peracchi (2002) gives a detailed description of the first three waves of the ECHP data.

advantage of the ECHP is the standardized questionnaire used in the EU-countries, which allows direct comparisons of data across countries and over time.

The ECHP started in 1994 and ended in 2001, thus consisting of eight waves. In the first wave in 1994, about 60,000 nationally representative households with approximately 130,000 individuals aged 16 years and over were interviewed in the then 12 participating member states. Austria, Finland and Sweden joined the ECHP-project in 1995, 1996 and 1997, respectively. However, the Swedish data cannot be used in the analysis since it only contains cross-sectional information. Luxembourg and the Netherlands also have to be excluded because required information is missing.[9]

For the definition of a reference subsample decisions are made with respect to three broad categories, referring to the type of employees, the socio-economic characteristics of employees and the type of earnings used in the analysis. Later on, the robustness of estimation results is checked by modifying the entries in each category. Our analysis restricts the type of employees to 'job stayers', i.e. employees who have a 'stable employment relationship' with an employer. Job stayers are defined as full-time working employees who do not change the employer between two consecutive interviews.[10] Additionally, the following restrictions were imposed for our reference subsample: Interviews are at least 8 and at most 16 months apart and the employee has been in paid employment in each month between interviews according to the monthly activity calendar provided by the ECHP.[11] With respect to the socio-economic characteristics of job stayers, our reference subsample focuses on male employees who are between 21 and 65 years old and are working in industry or services on the basis of a permanent employment contract.[12] Regarding the type of earnings, the ECHP dataset provides information on monthly and annual nominal earnings from work, i.e. 'current monthly (net and gross) wage and salary earnings' and 'total regular net wage and salary earnings' (referring to the year prior to the wave year). Since the job stayer concept applied in the paper refers to the spell between interviews and not to the calendar year, we use the information on current monthly earnings. The question whether gross or net earnings are more suitable for the analysis is debatable, because arguments for and against each measure can be put forward. For example, the take-home pay may be better known to individuals, but net earnings changes may be affected by changes in the tax system. We decided to use monthly net earnings in the reference subsample,

[9] Data for Luxembourg do not contain information on the month of the interview. Moreover, information on the year of start of the current job is missing in most cases. Data for the Netherlands do not contain information on the monthly activity calendar.

[10] The 'same employer'—restriction is applied in almost all studies dealing with downward nominal wage rigidity, one exception being Christofides and Stengos (2001), who use a narrower 'same position'-restriction, i.e. only those individuals are considered who stay in the same position in the same firm over successive years. We apply the looser same-employer restriction because of insufficient data about promotions and changes in duties which may occur in the same firm.

[11] The information of the activity calendar always refers to the year preceding the respective wave year. To avoid losing the final wave, we do not perform a calendar check for the year 2001 for the reference subsample. Furthermore, we excluded all employees who were more than three days absent from work due to illness or other reasons in the last four weeks preceding the interview. Absence from work is not checked for the UK since information is not available.

[12] The type of employment contract is not checked in 1994 since in that year the information is missing in all countries.

but vary the earnings measure in our robustness checks. As a further dimension of the earnings measure we also take into account whether reported working hours changed from one interview to the next. In our reference subsample, we only considered those job stayers whose working hours remained unchanged in comparison to the preceding interview. Overall, our reference subsample contains 70,239 observations for 12 EU countries.[13]

4 Empirical implementation and results

In this section, we present national and aggregate European degrees of downward nominal wage rigidity obtained from estimates of our reference specification and from robustness checks. The overall reference specification consists of definitions concerning the reference subsample selection as outlined in Sect. 3, the histogram construction, the econometric model and the estimation procedure.

In the reference histogram construction we use exact percentage changes, a bin width of two percentage points, and a standardization based on a measure of location $l_{t,i} = q_{60,t,i}$ and a measure of dispersion $v^{80|60}$. As in other applications in the literature, e.g. Kahn (1997), exact percentages, rather than log percentages are used, since the transformation implied by using log percentages are of no consequence due to the non-parametric nature of histograms. The 2% bin width is a compromise between the 1% bin width often used in the literature and even wider bin widths suggested by the usual rules, given the numbers of observations per year and country in our sample. The main consideration behind the use of the standardization of wage changes is the need to use measures of location and dispersion that are unaffected by rigidity, as explained in Sect. 2.

The proportional, pooled, closed model with bins $r = 1 \ldots 10$ is used as the reference model for estimating an econometric model of the histograms. As discussed in detail in Sect. 2, this model is best suited for the cross-national analysis. The range of bins chosen is somewhat larger than suggested by the range of bins with status changes, $r^{\min} = 1$ and $r^{\max} = 7$, in order to be able to use the same model in variations of the reference specification where this range increases (narrower bin width).

Finally, our reference estimation procedure is iterated weighted least squares (WLS), where weighing is by equation, i.e. by bins. Consequently, the smaller bins further out in the left tail of the distribution tend to be estimated more accurately.[14]

National and European estimated degrees of downward nominal wage rigidity for the reference specification are reported in column (1) of Table 1. Degrees of rigidity are highly significant in all of the 12 individual countries included in the sample. While in a majority of seven countries the rigidity coefficient lies between 25 and 50%, there

[13] The discussion paper version of this paper, Knoppik and Beissinger (2006), includes a table on the number of observations in the reference subsample for each year and country as well as descriptive evidence with respect to the distributions of percent changes of monthly net earnings for each country, e.g. annual medians and annual histograms. Details on the variables used for data selection are available from the authors upon request.

[14] Iterated seemingly unrelated regression (SUR) is used in Kahn (1997), but was shown to lead to unstable results because of the relatively short length of longitudinal surveys in Beissinger and Knoppik (2001).

Table 1 Estimated degrees of downward nominal wage rigidity

		Degree of rigidity		Range of degree of rigidity[b]
		ρ	t values	ρ
		(1)	(2)	(3)
National	Austria	0.45[a]	(16.36)	[0.41, 0.52]
	Belgium	0.47	(13.47)	[0.41, 0.68]
	Denmark	0.35	(12.49)	[0.31, 0.60]
	Finland	0.46	(12.99)	[0.36, 0.52]
	France	0.23	(7.54)	[0.20, 0.28]
	Germany	0.28	(9.42)	[0.19, 0.33]
	Greece	0.43	(16.86)	[0.36, 0.64]
	Ireland	0.18	(7.03)	[0.00, 0.20]
	Italy	0.66	(22.38)	[0.45, 0.89]
	Portugal	0.41	(15.13)	[0.37, 0.54]
	Spain	0.07	(2.60)	[0.00, 0.10]
	UK	0.14	(5.32)	[0.10, 0.24]
European	EU[c]	0.36	(25.17)	[0.30, 0.37]
	Euro area[c]	0.37	(24.19)	[0.31, 0.40]

Column (1) contains estimated national and aggregate rigidity coefficients ρ from closed pooled models for the reference specification. These estimates are based on $N = 780$ observed bin sizes. The coefficient ρ captures the degree of downward nominal wage rigidity in the sense that it measures the share of counterfactual wage cuts that are prevented by nominal rigidity. Column (3) contains the range of ρ that results from systematic variation of the reference specification. The reference specification and its variations consist of definitions with respect to subsample used, histogram construction, econometric model, and estimation that are detailed in the text

[a] Assumption of measure of location greater than (nominal) zero violated at least in 1 year

[b] Ranges for the degree of rigidity consist of the minima and maxima of estimated ρ over the variations of the reference specification, except the inconsistent estimates from the non-closed model. Insignificant estimates in the case of Ireland and Spain are represented by a zero lower bound of the range

[c] The EU estimate is based on 12 of the 15 old EU countries (without Luxembourg, the Netherlands, and Sweden). The Euro area estimate is based on 10 of 12 member states of the European monetary union (without Luxembourg and the Netherlands)

are also four countries with lower and one with even higher degree of rigidity, within an overall range of 7% (Spain) to 66% (Italy). EU wide estimated degrees of rigidity are based on the data of 12 'old' EU countries, Euro area estimates are based on the data of ten members of the monetary union; both are shown in the lower part of Table 1. The reference specification results in highly significant estimated rigidity coefficients of 36 and 37% for these two aggregates. These results imply that more than one third of the notional nominal wage reductions for job stayers in the euro area do not take place because of the presence of downward nominal wage rigidity.

In order to check the robustness of the estimation results we varied one by one the subsample selection, the histogram construction and the econometric model, whereas the estimation procedure remained unchanged. The details of these robustness checks and the corresponding tables documenting the estimation results can be found in the discussion paper version of this paper, Knoppik and Beissinger (2006). In order to analyze the impact of subsample selection on estimation results, we systematically modified the data selection with respect to interview distance, absence from work, the monthly activity calendar, age, gender, sector, type of employment contract, mode of the interview, working hours and the earnings measure (gross earnings instead of net earnings). The estimates of the reference specification turned out to be quite robust to changes in subsample selection. Regarding the histogram construction, we varied the measure of location, the measure of dispersion (used for standardization) and the bin width. Again, these modifications barely affected the estimation results of the reference specification. Turning to variations of the econometric model, one modification was the estimation of isolated national models instead of the pooled closed model of the reference specification. Because of insufficient variation of location, the estimation could not be performed for Germany, France, UK and Portugal. The estimates for Ireland and Spain were insignificant. For the remaining countries (with the exception of Belgium), the estimated degree of downward nominal wage rigidity turned out to be higher.[15] Estimates with different bin ranges barely affected the estimates. However, the estimation results changed significantly, when the model has not been closed. This lends support to the notion that the conventional histogram-location approach in which models are *not* closed may lead to biased estimates of the extent of downward nominal wage rigidity. Column (3) of Table 1 documents the ranges for the degree of downward nominal wage rigidity found by our robustness checks, except for the estimates from the non-closed model.

5 Comparison with results from the literature

In this section, we compare our results with the econometric cross-national studies mentioned in the introduction, which use different analytical approaches and, with one exception, different data sets.

5.1 Cross-national studies

Dickens et al. (2006) use two approaches: one is a quantitative variant of the symmetry approach (their ‘simple’ method), the other postulates a parametric functional form (the symmetric Weibull distribution) for the notional distribution, after correcting the data for measurement error (their ‘model based’ method). Both approaches are applied to various national and international data sources. Behr and Pötter (2005) also use two approaches: Their preferred approach postulates a parametric functional form for the notional distribution (the generalized hyperbolic distribution), but does not include any correction of measurement error. The other is the single country histogram-location approach. Both approaches are applied to ECHP data. Holden and Wulfsberg (2006)

[15] Since the estimation of most national models is based on rather little variation in location this variant in our robustness checks has a status that differs from the other variations in specification. Therefore we would not base strong inferences on the national results. After all, these difficulties with national estimates are the reason for the cross-country analysis.

use a completely non-parametric approach. Instead of non-parametrically modeling the notional and factual distributions by histograms or kernel density estimates, they use simulations based directly on the empirical distributions. Their approach relies on the joint variation of location and shape of the observable distribution for identification (as does, e.g. the histogram-location approach). It is applied to cross-national industry level data.

5.2 Results

One way to relate results from different studies is to look at country patterns of estimated degrees of rigidity. Two of the above studies already compare their results with ours. Dickens et al. (2006, p. 21) report a coefficient of correlation with the results in our paper of $r = 0.56$ and with results from Holden and Wulfsberg (2006) of $r = 0.66$ ($r = 0.43$ without dropping the US estimate). Dickens et al. (2006) conclude 'Overall, we consider these results to be very supportive of the reliability of our country average estimates.' Holden and Wulfsberg (2006) report similar computations (p. 15 and Fig. 7, p. 17). They find a coefficient of correlation with the results in our paper of $r = 0.65$. Since the correlation with results from Dickens et al. (2006) is weaker (including the US estimates) they conclude a 'rough correspondence with micro studies' of their results. With the two sets of results in Behr and Pötter (2005) we find even higher coefficients of correlation of 0.80 for the 'generalized-hyperbolic-notional approach' and of 0.77 for the single country histogram-location approach. These pairwise Pearson correlation coefficients can be found in column (1) of Table 2. In addition, Spearman rank correlation coefficients, column (3) of Table 2, show that the studies rank high and low rigidity countries in broadly similar ways. As usual the Spearman coefficients are somewhat lower than the Pearson coefficients, except for the value for Dickens et al. (2006), which considerably drops from 0.56 to 0.31.[16]

Table 3 compares our results with ranges of degrees of rigidity and ranges of ranks from the other studies for individual countries. Columns (1)–(4) show that our estimated degrees of rigidity tend to lie within or close to intervals spanned by these other estimates, notable exceptions being Belgium and Germany. Columns (6)–(9) of Table 3 compare the 'field ranks' of our estimates (highest rigidity yields rank 1, lowest rigidity yields rank 9) to the range of ranks that the countries reach in the other studies for a core group of nine countries covered in all studies under consideration. As before, our estimates lie within or close to these intervals, which is consistent with the evidence on rank correlation from Table 2 discussed above.

This evidence suggests that there is a consensus among the studies that Italy and Portugal have rather high downward nominal wage rigidity and that the UK and Spain have rather little downward nominal wage rigidity. For other countries the degree of

[16] The sensitivity of this result is demonstrated by column (4) of Table 2, which shows rank correlation coefficients for those countries included in all five sets of results. The coefficient for Dickens et al. (2006) goes back up, but the coefficient for Holden and Wulfsberg (2006) drops. Similar, if less drastic effects occur when Pearson correlation coefficients are computed for the core group of countries that are analyzed in all five sets of results, see column (2) of Table 2.

Table 2 Correlation between sets of estimated national degrees of downward nominal wage rigidity

	Pearson correlation coefficients		Spearman correlation coefficients	
	Pairwise[a] (1)	Casewise[b] (2)	Pairwise[a] (3)	Casewise[b] (4)
Behr and Pötter (2005): HNA[c]	0.80	0.75	0.77	0.80
	10	9	10	9
Behr and Pötter (2005): HLA[c]	0.77	0.73	0.75	0.73
	10	9	10	9
Dickens et al. (2006)	0.56	0.66	0.31	0.54
	11	9	11	9
Holden and Wulfsberg (2006)	0.65	0.56	0.58	0.40
	12	9	12	9

Pearson correlation coefficients and Spearman rank correlation coefficients for the set of estimated national degrees of rigidity from column (1) of Table 1 and four sets of national estimates from other studies. Each entry consists of correlation coefficient and number of observations (i.e. countries)

[a] Correlation coefficients are computed on a pairwise basis, i.e. observations are included for countries that are jointly covered in the two sets of results under comparison

[b] Correlation coefficients are computed on a casewise basis, i.e. for a core group of countries for which observations are available in all five sets of results

[c] HNA and HLA are the results obtained by the hyperbolic-notional approach (HNA) and the histogram-location approach (HLA) in Behr and Pötter (2005)

uncertainty across studies is larger, which is reflected in wide ranges of degrees of rigidity and wide ranges of ranks, e.g. for Greece, France and Ireland.

5.3 Differences in results

If measured by ranges of national degrees of rigidity and correlation coefficients, the differences with the results in Holden and Wulfsberg (2006) seem largest and are, most likely, related to their use of industry data. While the pattern of national results in Behr and Pötter (2005) is quite similar to ours, the level of estimated degrees is distinctly lower. This is almost certainly caused by including job movers in their sample.[17] Differently from the earnings-function approach of Altonji and Devereux (2000), which postulates a normal notional distribution conditional on a vector of regressors, neither the ‘Weibull-notional approach’ of Dickens et al. (2006), nor the ‘generalized-hyperbolic-notional approach’ of Behr and Pötter (2005) use control variables, like human capital, industry or macro variables. Therefore, identification of downward nominal wage rigidity is purely by the postulated functional form of the notional distribution. Further features of the ‘Weibull-notional approach’ in Dickens et al. (2006) are the pre-correction of measurement error in the data and the modeling

[17] Bewley (2004, p. 2) convincingly argues that the concept of downward nominal wage rigidity can only be meaningfully applied to job stayers. In almost all of the literature the analysis is limited to job stayers.

Table 3 Estimated degrees of rigidity and ranks across studies

	Degree of rigidity ρ					Rank[a]				
	This paper	Other sets of results[b]				This paper	Other sets of results[d]			
	Tb.1, col.1 (1)	Min (2)	Mean (3)	Max (4)	N^c (5)	Tb.1, col.1 (6)	Highest rank (7)	Mean (8)	Lowest rank (9)	N^c (10)
Italy	0.66	0.29	0.58	1.00	4	1	1	2.25	3	4
Belgium	0.47	0.17	0.20	0.23	4	2	4	5.00	6	4
Finland	0.46	0.20	0.43	0.66	2					
Austria	0.45	0.37	0.54	0.71	2					
Greece	0.43	−0.13	0.27	0.63	4	3	1	4.25	8	4
Portugal	0.41	0.34	0.57	0.86	4	4	1	1.50	2	4
Denmark	0.35	0.27	0.35	0.46	4	5	2	3.50	5	4
Germany	0.28	0.06	0.11	0.16	4	6	6	7.00	9	4
France	0.23	−0.20	0.09	0.40	4	7	4	7.00	9	4
Ireland	0.18	0.05	0.14	0.32	4	8	4	7.00	9	4
UK	0.14	0.06	0.14	0.22	4	9	6	7.25	9	4
Spain	0.07	−0.05	0.00	0.04	3					

Estimated degrees of downward nominal wage rigidity ρ from column (1) of Table 1 are compared to ranges of estimates and ranges of ranks based on four other sets of estimates

[a] Rank: field rank within set of estimates, i.e. highest rigidity yields rank 1, lowest rigidity yields rank 9

[b] Ranges based on sets of estimated national degrees of downward nominal wage rigidity from Behr and Pötter (2005) (based on generalized-hyperbolic-notional approach and histogram-location approach), Dickens et al. (2006) and Holden and Wulfsberg (2006)

[c] N: number of sets of results underlying range for country in row

[d] Ranges based on sets of estimates as in footnote b, but only for countries for which results are available in all sets

of downward real wage rigidity. The expected effects of these features on estimates are of opposite sign: higher than without error correction, but lower than without modeling downward real wage rigidity.[18] In the histogram-location approach, the presence of downward real wage rigidity leaves the principle of identification intact under very weak assumptions, which is not true of approaches relying on identification by functional form. However, if downward real wage rigidity is present in the data, the degree of rigidity refers now to the counterfactual distribution left by real rigidity. Despite these differences, the correspondence of our results with those of Dickens et al. (2006) is remarkably high.

[18] Single-country studies based on an extension of the earnings-function approach to include downward real wage rigidity are Bauer et al. (2003) for Germany, Devicienti et al. (2003) for Italy, Barwell and Schweitzer (2005) for the UK, and Christofides and Nearchou (2007) for Canada. Cornelißen and Hübler (2006) analyze German data and include a ‘contractual wage rigidity’. With the exception of Christofides and Nearchou (2007), these studies tend to find relatively low degrees of downward nominal wage rigidity.

Table 4 Estimated degrees of downward nominal wage rigidity regressed on institutional indicators

Coefficient (p values)	Dependent variable: ρ				
	(1)	(2)	(3)	(4)	(5)
Employment protection[a]	0.03 (0.63)				
Union density[b]		0.0029 (0.23)			
Bargaining coverage[c]			0.0041 (0.18)		
Centralization[d]				0.025 (0.63)	
Coordination[e]					0.094 (0.04)
Constant	0.28 (0.09)	0.23 (0.04)	0.014 (0.95)	0.26 (0.13)	−0.00069 (1.00)
Observations	12	12	12	11	11
R^2	0.024	0.14	0.17	0.027	0.39

Estimated degrees of downward nominal wage rigidity ρ from Table 1, column (1); p values in parentheses.
[a] Summary indicator of the strictness of employment protection legislation for regular employment, Late 1990s, OECD (2004), Table 2. A2.4, p. 117
[b] Trade Union Density in 1998, OECD data taken from Holden and Wulfsberg (2006), Table A3, p. 31
[c] Coverage in 1998, Holden and Wulfsberg (2006), Table A4, p. 32. Data is taken from OECD (2004), for 1990 and 2000. Data for intervening years are calculated by interpolation
[d] Index for 1995–2000, OECD (2004), Table 3.5, p. 151
[e] Index for 1995–2000, OECD (2004), Table 3.5, p. 151

6 Explanations of national differences

It is an unresolved question whether the observed country differences with respect to downward nominal wage rigidity may be explained by labor market institutions as suggested, e.g. by Holden (1994) or may be due to differences in the relevance of fairness considerations. In order to assess the role of labor market institutions we consider simple bivariate regressions of the estimated degree of downward nominal wage rigidity on institutional variables. From OECD (2004) we use an indicator of the strictness of employment protection legislation for regular employment as well as indices for centralization and coordination, all related to the late nineties. From Holden and Wulfsberg (2006) we take indicators for union density and bargaining coverage in 1998. The results are documented in Table 4. We find a significantly positive relationship between downward nominal wage rigidity and the extent of coordination in the economy, which suggests that greater downward nominal wage flexibility may be achieved in uncoordinated wage-setting regimes. All other institutional variables turn out to be insignificant.

Two of the other multi-country studies discussed above also try to explain national differences in estimated degrees of downward nominal wage rigidity by institutional differences. Dickens et al. (2006) consider the strictness of employment protection legislation, union density, collective bargaining coverage, the influence of minimum wages or wage indexation legislation and the degree of corporatism in the economy. These authors only find a significant correlation between union density and rigidity, which is negative. This result is in contrast to Holden and Wulfsberg (2006), who find that nominal rigidity in industry wages increases with higher union density and stricter employment protection legislation. Other institutional variables like bargaining coverage, temporary employment and indices of centralization and coordination had low explanatory power in their study. If these results are taken together, the correlations between estimated degrees of downward nominal wage rigidity and institutional variables are surprisingly weak, which suggests that other explanations, such as fairness considerations, may be more relevant.

7 Summary and conclusions

This paper analyzes existence and extent of downward nominal wage rigidity in the EU, which is a question of great significance, both from a theoretical and from a policy perspective. The evidence available has been substantially extended by the first-time econometric analysis with respect to these questions using employee micro data from the ECHP for 12 of the EU's current member states.

We develop and apply a pooled multi-country version of the histogram-location approach, which exploits variation in the location of the standardized earnings-change distributions over time and over countries and infers existence and extent of downward nominal wage rigidity from the corresponding variation in the shape of observed histograms. This approach allows the estimation of the degree of downward nominal wage rigidity, which is the percentage of desired wage cuts prevented by downward nominal wage rigidity in relation to all desired wage cuts. National and EU wide estimates of this rigidity parameter support the view that downward nominal wage rigidity is a rather widespread phenomenon within the EU and the Euro Area. Modifications of our reference specification with respect to subsample selection, histogram construction and econometric model reveal that our estimation results are quite robust to changes in the specification.

The estimation results on the national level show a considerable variation in the degree of downward nominal wage rigidity across countries despite the comparable data and uniform methodology used. A detailed comparison with other cross-national studies reveals that there is a consensus among the studies that Italy and Portugal have rather high downward nominal wage rigidity and that the UK and Spain have rather little downward nominal wage rigidity. For other countries the degree of uncertainty across studies is larger, which is reflected in wide ranges of degrees of rigidity and wide ranges of ranks, e.g. for Greece, France and Ireland. Our econometric analyses of potential determinants of rigidity, together with results from other studies, show that the correlations between institutional variables and estimated degrees of downward nominal wage rigidity are surprisingly weak, which suggests that other explanations, such as fairness considerations, may be more relevant.

At the European level our estimated degree of downward nominal wage rigidity varies between 0.31 and 0.40, i.e. between 31 and 40% of employees in stable jobs in the Euro area are affected by rigidity, certainly a significant magnitude that should be taken into account in the formulation of monetary policy.

Acknowledgments We would like to thank Anita C. Bott, Laszlo Goerke, Harry Haupt, Joachim Möller, Walter Oberhofer, Friedhelm Pfeiffer, and Philippe Van Kerm, two anonymous referees and one editor of this journal for valuable suggestions. We have benefited from discussions with seminar participants at the European University Viadrina at Frankfurt/Oder, the University of Hohenheim, the University of Mainz, the University of Regensburg, the University of Bamberg, the ZEW (Mannheim), the Bundesbank, and the IAB (Nürnberg), and with participants of sessions at the 2004 conferences of EPUNET, EEA, and EALE, where earlier stages of this work have been presented. This research was funded in part by a grant of the European Commission under the 'Transnational Access to major Research Infrastructures' contract HPRI-CT-2001-00128 hosted by IRISS-C/I at CEPS/ INSTEAD Differdange (Luxembourg).

References

Altonji JG, Devereux PJ (2000) Is there nominal wage rigidity? Evidence from panel data. Res Labor Econ 19:383–431

Barwell RD, Schweitzer ME (2005) The incidence of nominal and real wage rigidities in great Britain: 1978–1998, Federal Reserve Bank of Cleveland, Working Papers WP05-08

Bauer T, Bonin H, Sunde U (2003) Real and nominal wage rigidities and the rate of inflation: evidence from west German micro data, IZA—Institute for the Study of Labor, IZA Discussion paper 959

Behr A, Pötter U (2005) Downward wage rigidity in Europe: a new flexible parametric approach and empirical results, Münster: CAWM Discussion Paper (Beiträge zur angewandten Wirtschaftsforschung) 14

Beissinger T, Knoppik C (2001) Downward nominal rigidity in West-German earnings 1975–1995. German Econ Rev 2(4):385–418

Bewley TF (2004) Fairness, reciprocity, and wage rigidity, IZA—Institute for the Study of Labor, IZA Discussion paper 1137

Brzoza-Brzezina M, Socha J (2006) Downward nominal wage rigidity in Poland, 15.11.2006, Munich Personal RePEc Archive 843, Munich. http://mpra.ub.uni-muenchen.de/843/

Castellanos SG, García-Verdú R, Kaplan DS (2004) Nominal wage rigidities in Mexico: evidence from social security records, NBER Working paper series 10383

Christofides LN, Nearchou P (2007) Real and nominal wage rigidities in collective bargaining agreements. Labour Econ 14(4):695–715

Christofides LN, Leung MT (2003) Nominal wage rigidity in contract data: a parametric approach. Economica 70(280):619–638

Christofides LN, Stengos T (2001) A non-parametric test of the symmetry of the PSID wage-change distribution. Econ Lett 71(3):363–368

Cornelißen T, Hübler O (2006) Downward wage rigidity and labour mobility. University of Hannover, Hannover, p 349

Devicienti F, Maida A, Sestito P (2003) Nominal and real wage rigidity: an assessment using Italian microdata, LABORatorio Riccardo Revelli, LRR working paper series 33

Dickens WT, Goette L, Groshen EL, Holden S, Messina J, Schweitzer ME, Turunen J, Ward ME (2006) The interaction of labor markets and inflation: analysis of micro data from the international wage flexibility project, Brookings, Working Paper Fall 2006. http://www.brookings.edu/es/research/projects/iwfp_jep.pdf, accessed 13.03.2007

EPUNet (2004) ECHP user guide. http://epunet.essex.ac.uk/ECHP_USER_GUIDE_06-07-2004b.pdf

European Central Bank (2003) Overview of the background studies for the reflections on the ECB's monetary policy strategy. In: European Central Bank (ed) Background studies for the ECB's evaluation of its monetary policy strategy. European Central Bank, Frankfurt a. M., pp 9–30

Eurostat (2003) ECHP UDB Manual—European Community Household Panel Longitudinal Users' Database—Waves 1 to 8—Survey years 1994 to 2001, 1.0. edn. 10.12.2003, DOC. PAN 168, 23 p. http://forum.europa.eu.int/Public/irc/dsis/echpanel/library?l=/user_db&vm=detailed&sb=Title

Eurostat (2004) ECHP-documents. http://forum.europa.eu.int/Public/irc/dsis/echpanel/home

Greene WH (2003) Econometric analysis, 5th edn. Prentice Hall, Upper Saddle River

Holden S (1994) Wage bargaining and nominal rigidities. Eur Econ Rev 38:1021–1039

Holden S, Wulfsberg F (2004) Downward nominal wage rigidity in Europe. University of Oslo, Oslo. http://folk.uio.no/sholden/. Accessed 10 Feb

Holden S, Wulfsberg F (2006) Downward nominal wage rigidity in the OECD, Working paper, presented at December 2006 ECB workshop. http://www.ecb.int/events/pdf/conferences/ecb_cepr/Holden.pdf
Kahn S (1997) Evidence of Nominal Wage Stickiness from Microdata. Am Econ Rev 87(5):993–1008
Knoppik C (2003) Downward nominal rigidity in US wage data from the PSID? An application of the kernel-location approach. University of Regensburg Discussion Papers in Economics 393
Knoppik C (2007) The kernel-location approach—a new non-parametric approach to the analysis of downward nominal wage rigidity in micro data. Econ Lett 97(3):253–259
Knoppik C, Beissinger T (2006) Downward nominal wage rigidity in Europe—an analysis of European micro data from the ECHP 1994–2001. University of Hohenheim, Hohenheimer Diskussionsbeiträge 275
Knoppik C, Dittmar J (2002) A semi-parametric analysis of downward nominal wage rigidity in the GSOEP 1984–2000. University of Regensburg Discussion Papers in Economics 374
Kuroda S, Yamamoto I (2005) Wage fluctuations in Japan after the bursting of the bubble economy: downward nominal wage rigidity, payroll, and the unemployment rate. Monet Econ Stud 23(2):1–30
Lebow DE, Saks RE, Wilson BA (2003) Downward nominal wage rigidity: evidence from the employment cost index. Adv Macroecon 3(1 art. 2): i–ii, 1–28
McLaughlin KJ (1994) Rigid wages? J Monet Econ 34:383–414
OECD (2004) Employment outlook. OECD, Paris
Peracchi F (2002) The European community household panel: a review. Empir Econ 27:63–90
Rodríguez-Palenzuela D, Camba-Mendez G, Garcia JA (2003) Relevant economic issues concerning the optimal rate of inflation. In: European Central Bank (ed) Background studies for the ECB's evaluation of its monetary policy strategy. European Central Bank, Frankfurt a. M., pp 91–126
Stiglbauer A (2002) Identification of wage rigidities in microdata—a critical literature review. Focus Austria 3:110–126