Downward Wage Rigidity in Europe: A New Flexible Parametric Approach and Empirical Results

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Abstract

We suggest a new parametric approach to estimate the extent of downward nominal wage rigidity in ten European countries between 1994 and 2001. The data base used throughout is the User Data Base (UDB) of the European Community Household Panel (ECHP). The proposed approach is based on the very flexible generalized hyperbolic distribution which allows to model wage change distributions characterized by thick tales, skewness and leptokurtosis. Significant downward nominal wage rigidity is found in all countries under analysis, but the extent varies considerably across countries. Yearly estimates reveal increasing rigidity in Italy, Greece and Portugal, while rigidity is declining in Denmark and Belgium. The results imply that the costs of price stability differ substantially across Europe.

1 Introduction

As most of European countries experience high unemployment rates, the question of possible gains from lessening the rather restrictive monetary policy is discussed controversially. Underlying the assumption of negative correlation between unemployment rates and inflation is often the hypothesis of downward rigidity of prices, especially of wages.[1] But whether downward nominal wage rigidity is present and of relevant extent is discussed controversially in the literature.

Recently evidence for the existence of downward nominal wage rigidity of considerable extent in Europe has been provided by Knoppik and Beissinger (2005) using the histogram location approach proposed by Kahn (1997). Holden and Wulfsberg (2004) adapted the histogram location approach by means of bootstrap methods to allow the use of much less suitable data at the industry level. Their analysis also yielded strong evidence of nominal wage rigidity in the EU. Christofides and Leung (2003) applied the approach to Canadian contract data finding strong nominal wage rigidity which might be due partly to the use of union contract data. In a somewhat different context, Iara and Traistaru (2004) analyze wage flexibility in EU accession countries using a Phillips curve approach and finding only moderate unemployment elasticities of wages for most accession countries. Based on survey results, asking employees directly about their attitude towards wage cuts Agell and Lundborg (2003) find strong resistance to wage cuts even in high-employment and relatively low-inflation environments.

Nickell and Quintini (2003) proposed a different approach based on two truncated normal distributions with different dispersions below and above 0 wage changes. They provided evidence on nominal wage rigidity in the UK based on the New Earnings Survey but concluded that while there is statistically significant evidence of downward nominal wage rigidity, the extent is too small to be of concern. Smith (2000) investigated the issue of wage rigidity for the UK using data of the British Household Panel Study. She also finds evidence of substantial downward nominal wage rigidity. Discussing the issues of rounding and measurement error in some detail led her conclude that these potentially lead to overestimation of the extent of rigidity measures when using survey data.

The histogram location approach used in most empirical studies on downward nominal wage rigidity is a distribution free approach. One severe shortcoming of this approach is that the rigidity parameter can not be estimated using a single cross section as in this case the number of frequencies of bins is less than the number of parameters to be estimated. This is especially unfortunate as it prevents the analysis of policy effects directed to increase labor market flexibility over short periods of time. Secondly, the histogram location approach as proposed by Kahn (1997) assumes constant dispersion of the wage change distribution over time. When overcoming this problem by standardizing the distributions by means of dispersion measures, after standardization zero wage changes will no longer be located in the center of the relevant bin. And thirdly, the histogram location approach suffers from a severe underestimation of the standard deviation of the rigidity parameter leading to highly anticonservative significance tests.

In this paper we suggest a new method for estimating the extent of downward nominal wage rigidity based on the estimation of very flexible generalized hyperbolic models. The approach allows to estimate the extent of rigidity accurately using single cross sections only, thereby allowing to assess the time path of wage rigidity within countries. Due to the flexibility of the generalized hyperbolic model, we avoid shortcomings of

[1] See e.g. Akerlof, Dickens and Perry 1996 for a macroeconomic oriented discussion.

alternative parametric approaches previous applied assuming e.g. symmetry of wage change distributions (Card and Hyslop 1997).

We estimate the extent of downward rigidity in nominal wage changes in ten European countries for individual years 1995 to 2001. The data base used throughout is the User Data Base (UDB) of the European Community Household Panel (ECHP). The ECHP data set has been analyzed in detail by Peracchi (2002), Watson (2003) and Behr et al. (2005).

Our findings provide evidence of the existence of statistically significant and economic meaningful extent of wage rigidity in Europe. This evidence implies costs of the restrictive monetary policy and the low inflation rates across Europe during the last decade. As the extent of rigidity varies strongly between European countries, costs of low inflation stability are distributed very unevenly across Europe. Analyzing the change in rigidity also reveals a very heterogeneous picture across Europe.

The paper is structured as follows. In Section 2 we introduce the generalized hyperbolic distribution which we apply subsequently to the distribution of wage changes. To demonstrate the flexibility and suitability of the approach we provide Monte Carlo results of the suggested approach showing its clear superiority compared to the histogram location approach. The data base is described briefly in Section 3. Section 4 contains the empirical results and Section 5 concludes.

2 A flexible parametric approach for estimating the extent of wage rigidity

Distributional approaches which allow the estimation using single cross sections have been criticized mainly because lacking sufficient flexibility to model the distribution of wage changes adequately. Especially the feature of strong asymmetry of the wage change distribution[2] led to critique regarding the use of symmetric distributions, e.g. the normal distribution (Card and Hyslop 1997). Nickell and Quintini (2003) propose a different approach based on two truncated normal distributions with different dispersions below and above 0 wage changes. Using a time series approach they provide only very indirect estimates of the extent of downward rigidity by courageously interpreting dummy variables for classes of different inflation rates in a multiple regression setting.

We propose a new estimation approach based on the very flexible generalized hyperbolic distribution, which has been used lately in financial economics (Eberlein and Keller 1995 and Küchler et al. 1999). This five parameter family includes skew leptokurtic densities with thicker tails than the normal while still having moments of all orders. These features make the generalized hyperbolic distribution especially attractive for modelling wage change distributions. This parametric approach overcomes the shortcomings of the histogram location approach (Kahn 1997) as well as the unrealistic assumption of symmetry (Card and Hyslop 1997) and allows a much more intuitive and direct estimation than the Nickel and Quintini approach (2003).

2.1 The rigidity model

Our approach starts with the notion of a counterfactual density of wages $f(x)$ which would prevail under the absence of downward nominal wage rigidity. Because of down-

[2] See e.g. the evidence provided by Lebow et al. (1995) using an asymmetry measure based on the median for the PSID.

ward nominal wage rigidity the observed density of wages $g(x)$ differs from the hypothetical density $f(x)$ for negative and zero wages. A share ρ of employees facing hypothetical wage cuts experience a wage change of 0 instead.

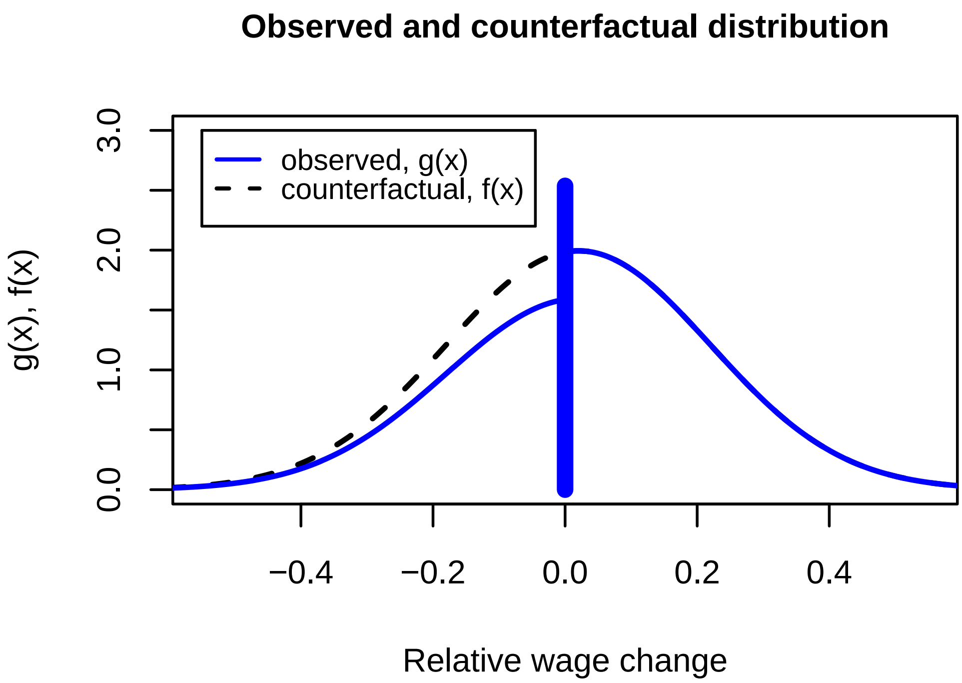

Figure 1: Observed and counterfactual wage change distributions

Therefore we find

$$
\begin{aligned}
f(x) &> g(x) \quad if \quad x < 0 \\
f(x) &= g(x) \quad if \quad x > 0
\end{aligned}
$$

The observed density around $x = 0$ is the sum of the counterfactual probability of an interval including 0, $\int_{-\varepsilon}^{\varepsilon} f(x)\, dx$, and the shifted frequency of prevented negative wage changes $\eta = \rho \int_{-\infty}^{-\varepsilon} f(x)\, dx$.

Using the indicator function $I(\cdot)$ we have the following relation between observed and counterfactual wage change distributions:

$$
\begin{aligned}
g(x) = {} & I(x > \epsilon) f(x) + I(x < -\epsilon)(1-\rho) f(x) \\
& + \frac{I(-\epsilon \leq x \leq \epsilon)}{2\epsilon} \left[\int_{-\varepsilon}^{\varepsilon} f(u)\, du + \rho \int_{-\infty}^{-\varepsilon} f(u)\, du \right]
\end{aligned}
$$

Including both densities $f(x)$ and $g(x)$, Figure 1 visualizes the working of the rigidity mechanism. The missing area for x values below 0 in the counterfactual density $f(x)$ is shifted towards the observed density around the value of 0.

2.2 The generalized hyperbolic distribution

The hyperbolic distribution has been used by geomorphologists to model the shape of dunes of windblown sand (Barndorff-Nielsen 1977). Due to its flexibility the hyperbolic model was found to provide a good model for the distribution of asset returns (Eberlein and Keller 1995 and Küchler et al. 1999) and has been applied for value at risk modelling (e.g. Bauer 2000).

The generalized hyperbolic distribution is described by five parameters $(\alpha, \beta, \delta, \mu, \lambda) =: \Psi$. Its probability density function is given by:

$$f_{GH}(x; \Psi) = \kappa \left\{\delta^2 + (x-\mu)^2\right\}^{\frac{1}{2}\left(\lambda - \frac{1}{2}\right)} K_{\lambda - \frac{1}{2}}\left(\alpha\sqrt{\delta^2 + (x-\mu)^2}\right) e^{\beta(x-\mu)}$$

where

$$\kappa = \frac{(\alpha^2 - \beta^2)^{\frac{\lambda}{2}}}{\sqrt{2\pi}\alpha^{\lambda - \frac{1}{2}} K_\lambda\left(\delta\sqrt{\alpha^2 - \beta^2}\right)}$$

and $\delta > 0$, $0 \leq |\beta| < \alpha$.

The function $K_\lambda(t)$ is the modified Bessel function of the third kind with index λ, also known as the MacDonald function. It can be represented as

$$K_\lambda(t) = \frac{1}{2}\int_0^\infty x^{\lambda-1} e^{-\frac{1}{2}t\left(x + x^{-1}\right)}\, dx, \quad t > 0$$

Further integral representations are discussed by Watson (1966, chap. 6.22). The distribution function has no closed form expression and is generally found from numerically integrating the density. The density is unimodal, the distribution is infinitely divisible and moments of all order exist. The form of the density can accommodate all of the stylized facts about distributions of wage changes, allowing for leptokurtic and right skewed distributions depending mainly on the parameter values of (α, β). The tails are of order $|x|^{\lambda-1}\exp((\mp\alpha + \beta)x), x \to \pm\infty$ and are thus thicker than the tails of the normal density. The cumulant generating function is

$$k(s; \Psi) = \frac{\lambda}{2}\log\left(\frac{\sqrt{\alpha^2 - \beta^2}}{\alpha^2 - (\beta - s)^2}\right) + \log\left(\frac{K_\lambda\left(\delta\sqrt{\alpha^2 - (\beta + s)^2}\right)}{K_\lambda\left(\delta\sqrt{\alpha^2 - \beta^2}\right)}\right) + s\mu$$

Since $\alpha > |\beta|$, $k(s; \Psi)$ is defined for s in a neighborhood of 0, thus one can calculate the expectation and variance:

$$\begin{aligned}
\mathbb{E}(X) &= \mu + \beta\frac{\delta K_{\lambda+1}(\nu)}{\sqrt{\alpha^2 - \beta^2} K_\lambda(\nu)} \\
\mathrm{V}(X) &= \delta^2\left(\frac{K_{\lambda+1}(\nu)}{\delta\sqrt{\alpha^2 - \beta^2} K_\lambda(\nu)} + \frac{\beta^2}{\alpha^2 - \beta^2}\left(\frac{K_{\lambda+2}(\nu)}{K_\lambda(\nu)} - \left(\frac{K_{\lambda+1}(\nu)}{K_\lambda(\nu)}\right)^2\right)\right)
\end{aligned}$$

with $\nu := \delta\sqrt{\alpha^2 - \beta^2}$. Barndorff-Nielsen and Stelzer (2005) discuss higher (absolute) moments.

The generalized hyperbolic distribution can be represented as a normal variance-mean mixture where the mixing distribution is the generalized inverse Gaussian distribution with any λ. From this representation one can construct quite efficient simulation methods.

2.3 The estimation procedure

We estimate the vector of parameters $(\alpha, \beta, \delta, \mu, \lambda)'$ by maximizing numerically the Log Likelihood, which is given under the assumption of n independent wage changes as

$$l(\rho, \Psi|x) = \sum_{i=1}^{n} \log \left(\begin{array}{c} I(x_i > \epsilon) f_{GH}(x_i; \Psi) + I(x_i < -\epsilon)(1-\rho) f_{GH}(x_i; \Psi) \\ + \frac{I(-\epsilon \leq x_i \leq \epsilon)}{2\epsilon} \left[\int_{-\varepsilon}^{\varepsilon} f_{GH}(u : \Psi)\, du + \rho \int_{-\infty}^{-\varepsilon} f_{GH}(u; \Psi)\, du \right] \end{array} \right)$$

To satisfy the restrictions $\delta > 0$, $0 \leq |\beta| < \alpha$ we parameterize the parameters Ψ as $\alpha = \exp(a)$, $\beta = \alpha \tanh(b)$, and $\delta = \exp(d)$.

2.4 Simulation results

To provide suggestive evidence of the adequacy of the proposed generalized hyperbolic model, we present some Monte Carlo evidence. We are especially interested in whether the approach leads to consistent estimation of the rigidity parameter and its standard error.

The set up of the simulation is as follows and is aimed to mimic empirical wage change distributions, which are known to show strong asymmetry and leptokurtosis. Both characteristics can be reproduced by a two component Gaussian mixture distribution.[3] Additionally, we regard it as a test towards robustness of the proposed estimation procedure based on the generalized hyperbolic model when being applied to different data generating mechanism than the hyperbolic model. Because we allow the proportion of the two components as well as the means and standard deviations to vary considerably and independently, an extraordinary variety of wage distributions will occur in the simulations:

$$\begin{array}{rcl} x^{unr} & \sim & N(\mu_j, \sigma_j), \quad \mu_j \sim U(0.02, 0.1), \quad \sigma_j \sim U(0.1, 0.2) \\ x^{obs} & = & \left\{ \begin{array}{ll} x^{unr} & \text{if } x^{unr} \geq 0 \\ I \cdot x^{unr} & \text{if } x^{unr} < 0 \end{array} \right. \\ I & = & \left\{ \begin{array}{ll} 1 \text{ with} & \Pr = 1-\rho \\ 0 \text{ with} & \Pr = \rho \end{array} \right. \\ \rho & = & 0.2, \quad \varepsilon = \{0.0005, 0.001, 0.0015\}, \quad j = 1,..,1000, \quad n = \{500, 1000, 5000\} \end{array}$$

One might suppose that the estimation procedure is sensitive towards the choice of the width of the interval capturing zero wage changes ($x = 0$), which is 2ε. Therefore, we analyze three different choices of $\varepsilon : \{0.0005\ , 0.001 \text{ and } 0.0015\}$.

Estimation results are given in Table 1. We present simulation results for three different $n : \{500, 1000, 5000\}$. The consistency of the estimation of ρ and the accuracy of the estimated standard error hold for all sample sizes and all choices of ε. For each choice of ε, we give in the first line the average of estimated ρ, below the square root of the average estimated variance ($\hat{\sigma}_\rho$) and in the third line the square root of the "true" variance (σ_ρ) calculated as the square root of the variance of estimated ρ coefficients.

We find that the rigidity parameter ρ is estimated consistently, with high precision and that the "true" standard deviation is on average estimated with high precision which increases with n.

[3]Everitt and Hand (1981) provide an extensive discussion of mixture models.

Table 1: Simulation results for generalized hyperbolic approach

		0.0005	0.001	0.0015
500	ρ	0.202	0.202	0.202
	$\hat{\sigma}_\rho$	0.034	0.035	0.036
	σ_ρ	0.029	0.031	0.033
$1,000$	ρ	0.200	0.200	0.200
	$\hat{\sigma}_\rho$	0.024	0.025	0.025
	σ_ρ	0.022	0.020	0.023
$5,000$	ρ	0.200	0.201	0.200
	$\hat{\sigma}_\rho$	0.011	0.011	0.011
	σ_ρ	0.011	0.011	0.011

For comparative reasons we also analyze the widely used histogram location approach. As the approach can not be applied to a single cross section, we apply the estimation procedure to samples of seven cross sections. The simulation setup is the same as described above. As the approach might be sensitive towards the choice of the width of bins, we analyze six different bin sizes $\{0.0025, 0.005, 0.01, 0.015, 0.02, 0.03\}$. The simulation results for cross sections each of size $n = 1000$ are given in Table 2.

Table 2: Simulation results for histogram location approach

	0.0025	0.005	0.01	0.015	0.02	0.03
ρ	0.200	0.200	0.201	0.202	0.202	0.206
$\hat{\sigma}_\rho$	0.002	0.005	0.009	0.014	0.019	0.031
σ_ρ	0.011	0.012	0.012	0.014	0.014	0.020
$\hat{\sigma}_\rho/\sigma_\rho$	0.182	0.417	0.750	1.000	1.357	1.550

We find that ρ is estimated consistently but the standard deviation is estimated very poorly. For small bin width we find a strong underestimation of the standard deviation which is decreasing with the bin width. Simultaneously the precision of the estimation is slightly decreasing. This causes inference based on the estimated standard error to be anticonservative for small bin width. Because in empirical data bin width has to be chosen rather small due to little variation in the location of the cross sections, in most applications a bin width of about 1% is chosen, the simulation results hint at an underestimation of the standard deviation.

3 The European Community Household Panel

The ECHP is a longitudinal survey of households and individuals covering countries of the European Union (EU). Due to its far-reaching harmonization, the ECHP facilitates cross-country comparisons within the EU in many different aspects of economic and social life.

Comparability across countries is the main objective of the ECHP. While great effort has been devoted to harmonizing the surveys, they are still not completely standardized. The differences occur mainly in sampling procedures at the start of the ECHP, the panel's follow-up rules and field operations.

Peracchi (2002) provided a comprehensive description of the ECHP and detailed information about the organization of the survey. The first wave of the ECHP in 1994 covered about 130,000 individuals older than 16 years resident in about 60,000 households. Twelve countries participated in the first wave: Belgium, Denmark, France, Germany, Greece, Ireland, Italy, Luxembourg, the Netherlands, Portugal Spain and UK. While Austria took part from the second wave onwards in 1995, Finland started its participation in 1996.

The ECHP was developed "in response to the increasing demand in the European Union for comparable information across the member states on income, work and employment, poverty and social exclusion, housing, health, and many other diverse social indicators concerning living conditions of private households and persons".[4] The most attractive feature of the ECHP for research is its standardization.

In most of the participating countries, the survey had been newly commenced, whereas a few countries used already existing panel surveys. In Belgium and the Netherlands, already ongoing panels were used for data collection, while in three countries, Germany, Luxembourg and the UK, a unique situation emerged, because ongoing panels ran parallel with the new ECHP national subsamples for three years. In 1997, these three national subsamples were terminated and from that year onwards, the data for the ECHP are derived from the existing national panels. These are the German Social Economic Panel (GSOEP), the Luxembourg's Social Economic Panel (PSELL) and the British Household Panel Survey (BHPS). The ECHP-User Data Base covers only the ECHP survey in Luxembourg. Since our objective is to analyze wage growth between 1994 and 2001, we consider only national surveys in Germany (GSOEP) and the UK (BHPS) in our analysis by country. This analysis is based on the 2004 version of the ECHP-User Data Base which contains all available 8 waves 1994 to 2001. In our analysis we include ten countries which took part in all 8 waves: Germany, Denmark Belgium, France, UK, Ireland, Italy, Greece, Spain, Portugal.[5] Perracchi (2002), Watson (2003) and Behr et al. (2005) provide analysis of panel participation and attrition in the ECHP.

Contrary to previous studies (e.g. Kahn 1997), we do not restrict the sample to "on-the-job-stayers"Ḟirstly, because nominal wage rigidity could also prevent job movers from accepting wages below previous wage levels and secondly, we want to assess overall nominal wage rigidity irrespective of possible influences such as low or high shares of job movers. In the sample finally used for estimation, we include all employees aged between 18 and 65, working at least twenty hours a week. Allowing for changes in work hours from year to year, we use hourly nominal wages to calculate yearly wage changes. Because we regard observations with extreme relative wage changes as highly suspect, observations outside the central 98% interval of the distribution will not be regarded in the analysis.

4 The empirical evidence for nominal wage rigidity in the EU

In this section, we first provide descriptive evidence on the existence of downward nominal wage changes as well as for the occurrence of "unnatural" frequencies of constant wages for ten European countries. Using the proposed estimation procedure based on the most flexible generalized hyperbolic distribution, we then provide estimates of the extent of downward nominal wage rigidity.

[4]Eurostat (1996), cited after Peracchi (2002), p. 64.

[5]Due to severe data problems we did not include the Netherlands in our analysis

4.1 Descriptive evidence

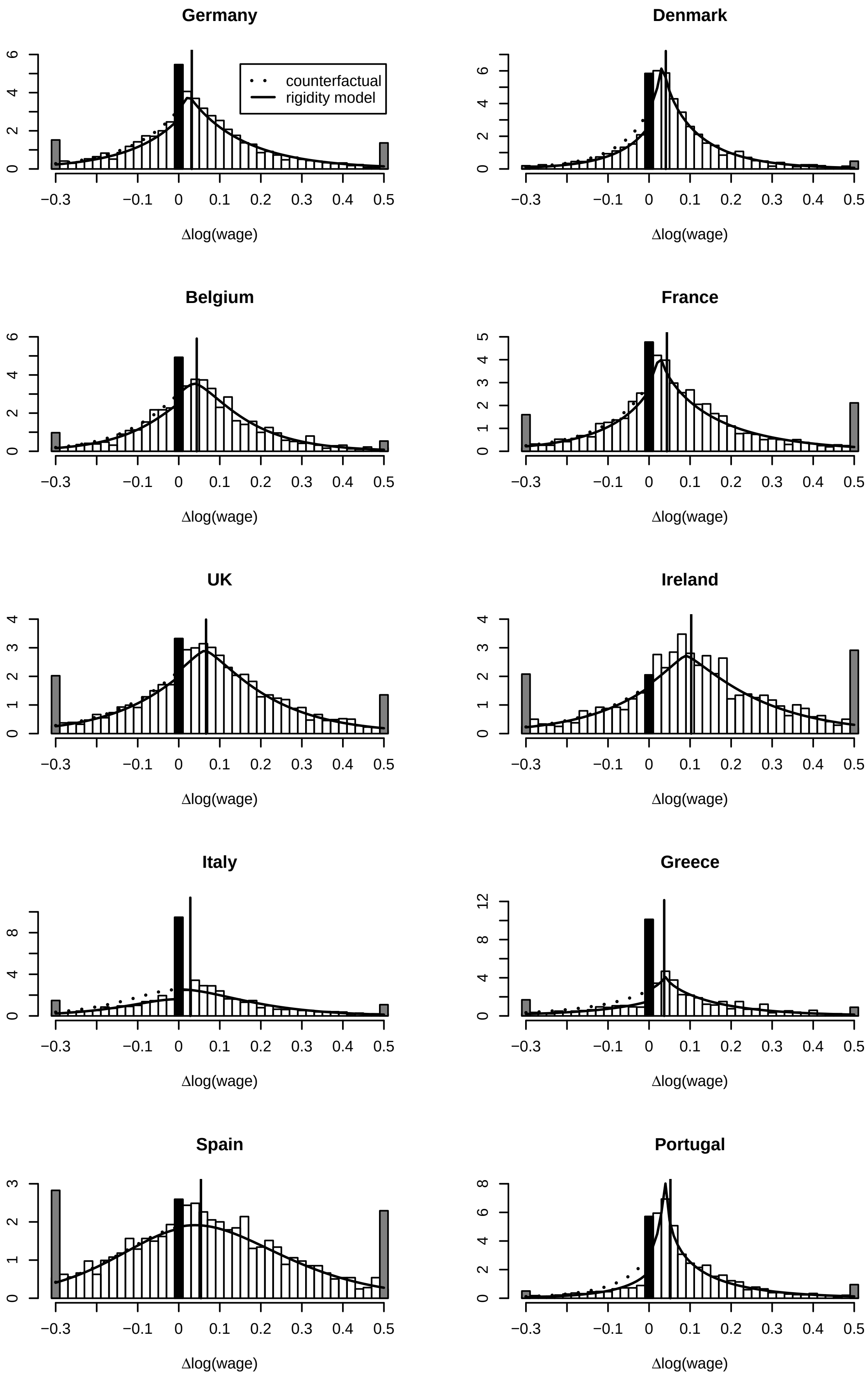

Figure 2: Histograms and estimated rigidity model, 2001

Histograms of the wage change distributions 2001 for all countries are given in Figure 2. The median is indicated by a vertical line and the bin containing zero wage changes is black.

To emphasize the relevant area of the distribution using a bin width of 2%, only the range −30% up to +50% is depicted in the figure. The frequencies below and above these values are transferred to the most outward bins in the histogram. It is evident that the observed distribution $g(x)$ contains a considerable peak at the value $x = 0$. Below the value $x = 0$ the densities are considerably below the densities one would "intuitively" expect. The histograms indicate strong wage rigidity in Denmark, Greece and Portugal, while there is no clear sign of rigidity for Ireland and Spain. For Italy and Greece we find an extremely high density for the bin containing 0 wage changes of about 16% in 2001.

Table 2 contains some descriptive statistics characterizing the wage change distributions 2001.

Table 3: Descriptive statistics of wage change distributions 2001

	n	*median*	*IQR*	$x \leq 0\,(\%)$	$x = 0\,(\%)$
Germany	4,186	0.032	0.159	0.400	0.067
Denmark	1,794	0.041	0.105	0.306	0.088
Belgium	1,600	0.044	0.152	0.364	0.062
France	3,053	0.043	0.169	0.353	0.040
UK	3,266	0.066	0.205	0.318	0.025
Ireland	1,313	0.103	0.232	0.246	0.011
Italy	3,501	0.028	0.153	0.447	0.164
Greece	1,880	0.037	0.128	0.387	0.168
Spain	3,146	0.054	0.282	0.379	0.010
Portugal	3,688	0.052	0.119	0.229	0.093

4.2 Estimates of the wage rigidity in Europe

Table 4 contains the estimated wage rigidity parameter using the Maximum Likelihood estimator for the model discussed in Section 2 based on the generalized hyperbolic distribution.

Table 4: Estimated rigidity parameter, 2001

	$\hat{\rho}$	$\hat{\sigma}_\rho$	t_ρ	$\hat{\alpha}$	$\hat{\beta}$	$\hat{\delta}$	$\hat{\mu}$	$\hat{\sigma}$	n
Germany	0.16	0.009	17.06	7.35	0.48	0.00233	0.024	0.956	4,186
Denmark	0.27	0.020	13.79	9.13	0.81	0.00063	0.033	0.771	1,794
Belgium	0.17	0.016	10.24	10.81	0.38	0.00061	0.037	1.449	1,600
France	0.12	0.011	11.23	6.36	0.92	0.00069	0.026	0.808	3,053
UK	0.09	0.009	9.37	7.79	0.13	0.00103	0.064	1.279	3,266
Ireland	0.05	0.014	3.77	6.82	0.52	0.00092	0.089	1.192	1,313
Italy	0.36	0.012	29.49	11.67	1.14	0.00206	−0.012	2.359	3,501
Greece	0.42	0.019	22.83	6.20	−0.21	0.00060	0.039	0.828	1,880
Spain	0.03	0.005	4.80	12.08	1.30	0.00537	−0.002	3.797	3,146
Portugal	0.40	0.017	22.83	7.03	1.37	0.00129	0.038	0.554	3,688

Throughout, we set the parameter ε, which is half the width of the interval containing zero wage changes at the value of 0.001. We only present in the table the detailed estimates for 2001.

We find wage rigidity to be especially strong in Portugal, Italy and Denmark and lowest in Ireland, Spain and the UK. These estimation results confirm strongly the graphical evidence given in Figure 2. All estimates are statistically significant at the 1% -level.

Figure 2 shows the histograms of the observed wage changes and the estimated generalized hyperbolic distributions. The fitted wage change distribution is depicted with a solid line (note that observed and counterfactual wages are identical above zero wage changes) and the left part of the hypothetical parametric distribution in the absence of rigidity with a dashed line. It is evident, that the estimated model fits the data extremely well.

When interpreting the empirical results, it has to be kept in mind that the actual share of employees subject to nominal wage rigidity is the product of the unobservable share of employees facing wage cuts in the absence of rigidity, multiplied by the potential rigidity share (ρ). Therefore, countries with high potential rigidity will experience stronger effective downward nominal wage rigidity, the further the wage change distribution is located to the left.

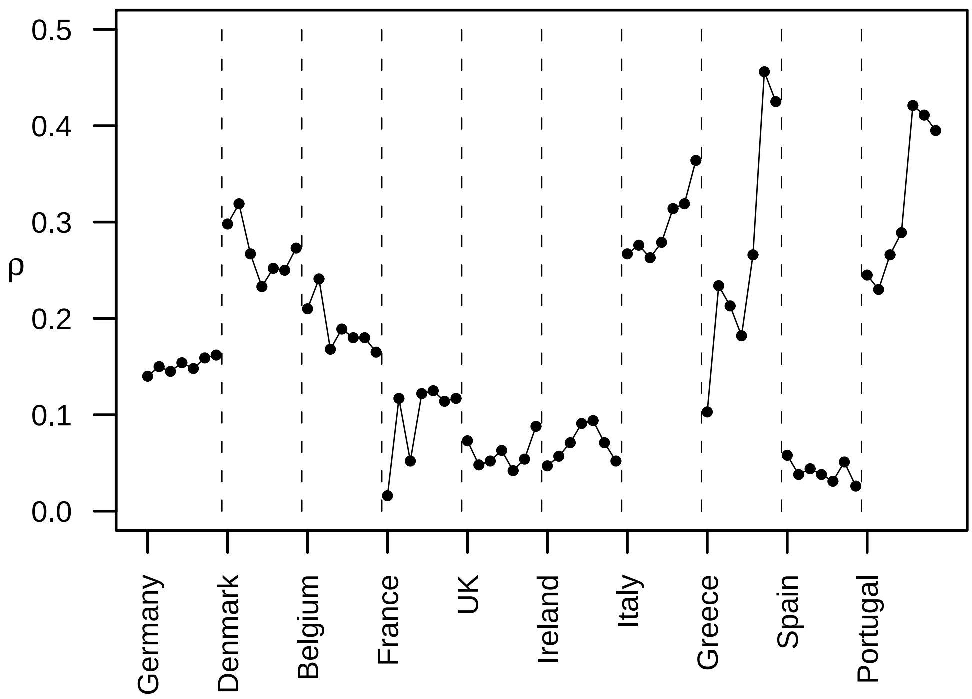

Figure 3: Estimated rigidity parameters, 1995-2001

The extent and change of downward nominal wage rigidity in all countries is visualized in Figure 3, which depicts the yearly estimates for all ten countries.

No general conclusion regarding the direction of development can be reached. We find increasing nominal downward wage rigidity in France, Italy, Greece and Portugal. Downward nominal wage rigidity has been reduced in Denmark, Belgium and Spain.

4.3 Comparison with histogram location approach estimates

For comparison reasons only, we apply also the widely used histogram location approach, which does neither allow yearly estimates of ρ nor reliable significance judgements. In Table 3 the estimates for the histogram location approach are given beside the simple average of our yearly estimates making use of the flexible parametric approach. The histogram location approach[6] is described in detail in Kahn (1997) and is adapted using a binwidth of 0.01 after standardizing the wage changes by subtracting the country and year specific medians and division by percentile difference $q_{90} - q_{50}$ to account for different dispersion in different years.[7]

Table 5: Histogram location and generalized hyperbolic estimates

	$\hat{\rho}_{hist}$	$aver.\hat{\rho}_{gen.hyp.}$
Germany	0.146	0.159
Denmark	0.301	0.274
Belgium	0.181	0.165
France	0.058	0.118
UK	0.056	0.088
Ireland	0.064	0.051
Italy	0.294	0.364
Greece	0.156	0.428
Spain	0.038	0.026
Portugal	0.344	0.399

We find that the estimates are similar for most countries. The ranking of countries according to the extent of rigidity is almost identical. But the average of the yearly estimates using the proposed parametric generalized hyperbolic approach leads to higher estimates of the wage rigidity parameter for France and especially for Greece. When inspecting the histograms given in Figure 2 the estimates obtained using the flexible parametric approach based on the generalized hyperbolic distribution seem much more plausible.

5 Conclusions

We suggest a flexible parametric approach based on the generalized hyperbolic distribution to estimate the extent of downward nominal wage rigidity across Europe. Our approach overcomes the severe shortcomings of the histogram location approach which does neither allow for yearly estimates nor for reliable inference. By means of a Monte Carlo Simulation we show this approach to allow for consistent estimation of the rigidity parameter of interest as well as for valid inference.

Our empirical analysis for ten European countries revealed strong differences in the extent of wage rigidity, ranging from about $4 - 6\%$ for the UK, Ireland and Spain up to about 33% for Portugal. When analyzing the change in downward nominal wage rigidity, increasing rigidity is found in Italy, Greece and Portugal. Rigidity declined in Denmark

[6] We apply the proportional model of Kahn (1997), which assumes a constant share of counterfactual wage changes below 0 to be shifted towards 0.

[7] We multiplied the obtained standardized wage changes by the average of the quintile differences used for standardization to maintain approximately the original average dispersion of wage rates.

and Belgium. For the UK, Ireland and Spain rigidity is found to be stable at very low levels throughout the period 1995-2001. These findings allow for no conclusion regarding a general trend of the extent of wage rigidity. Nevertheless, the strong differences of wage rigidity imply an extremely uneven distribution of costs of low inflation policies across the EU.

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