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WAGE RIGIDITY: MEASUREMENT, CAUSES AND CONSEQUENCES*

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Wage rigidity – the observation that wages cannot be adjusted downwards – has important implications for labour markets and macroeconomic performance. Empirical evidence on the extent, causes and consequences of wage rigidity on the individual level is relatively scant, however. This Feature presents articles that apply a new methodology to estimate the incidence and extent of nominal and real wage rigidity among the employed in three major European countries (Germany, Italy and Great Britain). The results document the pervasiveness of nominal and, particularly, real wage rigidity in different institutional and economic environments, and a recent decline in real wage rigidity.

The responsiveness of wages to the economic environment shapes labour market outcomes in important ways. If wages exceed the market clearing level and are rigid downwards, i.e., do not adjust in order to equilibrate supply and demand, involuntary unemployment can arise. Wage rigidities also have been identified as important determinants of the cyclical adjustment dynamics of output, as well as vacancies and unemployment that are difficult to rationalise with models with flexible wages.[1] Despite the important consequences of wage rigidities, surprisingly little is known empirically about their extent and their measurement. Nor is there a consensus in the empirical literature about what renders wages rigid, and to what extent rigid wages affect real outcomes like unemployment. This Feature provides a collection of three articles that apply a novel, common empirical framework to micro data from three major European countries, Great Britain, Germany and Italy, to address these issues.

The theoretical literature has identified different possible mechanisms that render wages rigid. One branch of the literature focuses on the role of unions and collective bargaining agreements in generating consistently higher wages than the market clearing level; see for instance Calmfors and Driffill (1988), Lindbeck and Snower (1988), Layard *et al.* (1991) and Booth (1994). Such insider-outsider theories also imply that wages are not responsive to changes in the economic environment. A different strand of literature examines under what conditions firms have an incentive to pay wages above the market clearing level. In Shapiro and Stiglitz (1984), or MacLeod and Malcomson (1998) firms pay high wages so that workers would lose a quasi-rent if fired. Workers therefore have an incentive to provide high effort, even when effort is observable but not contractible. In a variant of these models (Akerlof and Yellen, 1990), firms pay high wages because workers are reciprocal and respond to higher wages by exerting higher effort. All these theories imply that real wages are rigid in the sense that they cannot easily be adjusted, in particular downwards. Because of the

* The views expressed in this article are solely those of the authors and are not those of the Federal Reserve System or the Federal Reserve Bank of Boston.

[1] See, for example the recent contributions on the propagation of monetary shocks (Christiano *et al.*, 2004), and on labour market dynamics (Hall, 2005; Shimer, 2005).

incentives of firms to pay high wages, all of these models predict involuntary unemployment.

Another branch of the literature focuses on rigidities that prevent the nominal wage from falling. Holden (1994, 1999, 2003) has shown that when unions and workers have to bargain under the so-called holdout rule, i.e., that a contract can only be changed by mutual consent, nominal wage rigidity can be the equilibrium outcome even if all actors only care about real wages. In addition to this source, it has been a long-standing conjecture that individuals also care about changes in their nominal wage (Tobin, 1972). More recently, work by economists and psychologists has made this intuition more precise. The empirical evidence suggests that fairness judgments about wage contracts are made relative to a reference transaction (Kahneman *et al.*, 1986). This reference point seems to be the current nominal contract in many cases (Shafir *et al.*, 1997). Nominal wage cuts are therefore perceived as particularly unfair and can lead to sharp reductions in effort. Recent models have made this notion precise (Elsby, 2005).[2] Bewley (1999) documents that personnel managers strongly adhere to these arguments and refrain from cutting the nominal wage whenever possible.[3]

The distinction between real and nominal wage rigidities is important beyond the purely conceptual level. The source of rigidity is eminently important for economic policy. In the presence of real rigidity, monetary policy should primarily aim at stable prices, implying procyclical adjustments of money supply (Goodfriend and King, 1997). On the other hand, if nominal wages are downwardly rigid, a positive rate of inflation may 'grease the wheels of the labour market', which would rather ask for monetary policy to counteract demand shocks (Tobin, 1972; Akerlof *et al.*, 1996).

Despite the importance of wage rigidities, economists only began to investigate these issues using micro data in the 1990s. The focus of this early literature was mainly on nominal wage rigidity.[4] This literature has produced a disparate set of results: Some studies find almost no evidence of downward nominal wage rigidity (McLaughlin, 1994; Smith, 2000), while others find that wages are almost completely rigid (Altonji and Devereux, 2000), and some finding intermediate degrees of wage rigidity (Beissinger and Knoppik, 2003; Elsby, 2005; Fehr and Goette, 2005).[5] It is difficult to interpret these differences, as the empirical strategies differ strongly. To complicate matters further, measurement error has been a notorious problem in the empirical literature on wage rigidities: If individual level wages are measured with error, this leads to spurious wage 'changes' that may wrongly be interpreted as wage flexibility. This concern is supported by evidence from personnel files, which consistently show many more workers receiving zero wage changes, and, more importantly, fewer very small wage cuts than are observed in most labour force surveys and administrative data sets (Wilson, 1999; Altonji and Devereux, 2000; Fehr and Goette, 2005). Not surprisingly, empirical

[2] Elsby (2005) also formalises the idea that the presence of wage rigidity may influence wage setting more generally. In particular, firms may compress wage increases, as this lowers the probability that they will have to cut the employee's wage in the future.

[3] Mas (2006) uses data on wage settlements for police departments in New Jersey. He provides a compelling empirical example of how bargaining outcomes below the reference outcome can lead to very severe reductions in effort.

[4] The exception is Card and Hyslop (1997), who also examine real wage rigidity.

[5] See also Fares and Lemieux (2001) for a survey of the literature.

models that account for measurement error (Altonji and Devereux, 2000; Fehr and Goette, 2005) find stronger evidence of wage rigidity.

In this Feature, we present an empirical framework that builds on these models, but allows us to identify and estimate the extent of both nominal and real wage rigidity simultaneously. We apply the model to three major European economies: Germany, Italy and the UK. The comparison of findings for different countries is of interest not only to illustrate the model's applicability in different contexts. Our findings also provide relevant information about the nature of rigidities in different countries that have very different labour market institutions and economic conditions that also change over time: removal of the *scala mobile* in Italy, the labour market reforms implemented under Margaret Thatcher in the UK and reunification in Germany. The empirical model allows us to compare the extent of the different forms of wage rigidities across the three countries. Thus, we also provide a fresh look at how labour market institutions affect how wages change.

Figure 1 displays the distribution of wage changes for two years in each country. All distributions show that wage changes in a given year vary widely between individuals: Some receive a large wage increase, some a small wage increase, others even a wage cut. All histograms also suggest that the upper half of the distribution of wage changes can be described by a smooth distribution. However, in all countries and all years, there are two marked departures from this smoothness in two locations of the distribution of wage changes: The first is located at (nominal) zero wage change. The typical distribution exhibits a 'spike', or mass point, at zero wage changes, together with a sharp drop in the density just below zero in all three countries. This is suggestive of downward nominal wage rigidity. The pile-up of observations at zero, together with the sharp drop in the density to the left of zero, suggests that many individuals receive a wage freeze instead of a nominal wage cut. It is this departure from the smoothness of the wage change distribution that most previous studies have used as the sole indicator of wage flexibility. Like earlier studies, our estimator uses this information to assess the extent of downward nominal wage rigidity. However, just as importantly, the distributions reveal a second pile-up of observations, followed by a sharp drop in the density of wage changes, at positive nominal wage changes. The location of this pile-up varies from year to year: It is further to the right when inflation is high, as, for example in the UK in 1980, and closer to zero when inflation is low, e.g., in the UK in 1999. This feature is highly suggestive of downward *real* wage rigidity, and we have constructed the model to incorporate this feature. Thus, our model uses the same basic feature in the distribution of wage changes to identify the two forms of downward wage rigidity. By examining the relative magnitude of the pile-ups and drop-offs, we are also able to make statements about the prevalence of one form of wage rigidity relative to the other.

We apply the same empirical framework to similar data sets of individuals in Germany, Italy and the UK in this Feature. The estimates provide the first comparable cross-country evidence on the extent of downward wage rigidity, in terms of both nominal and real rigidity. Furthermore, the three country articles of this Feature provide comparable explorations concerning the causes and consequences of downward wage rigidity, thereby allowing for a comprehensive picture of rigidities under different economic and institutional scenarios.

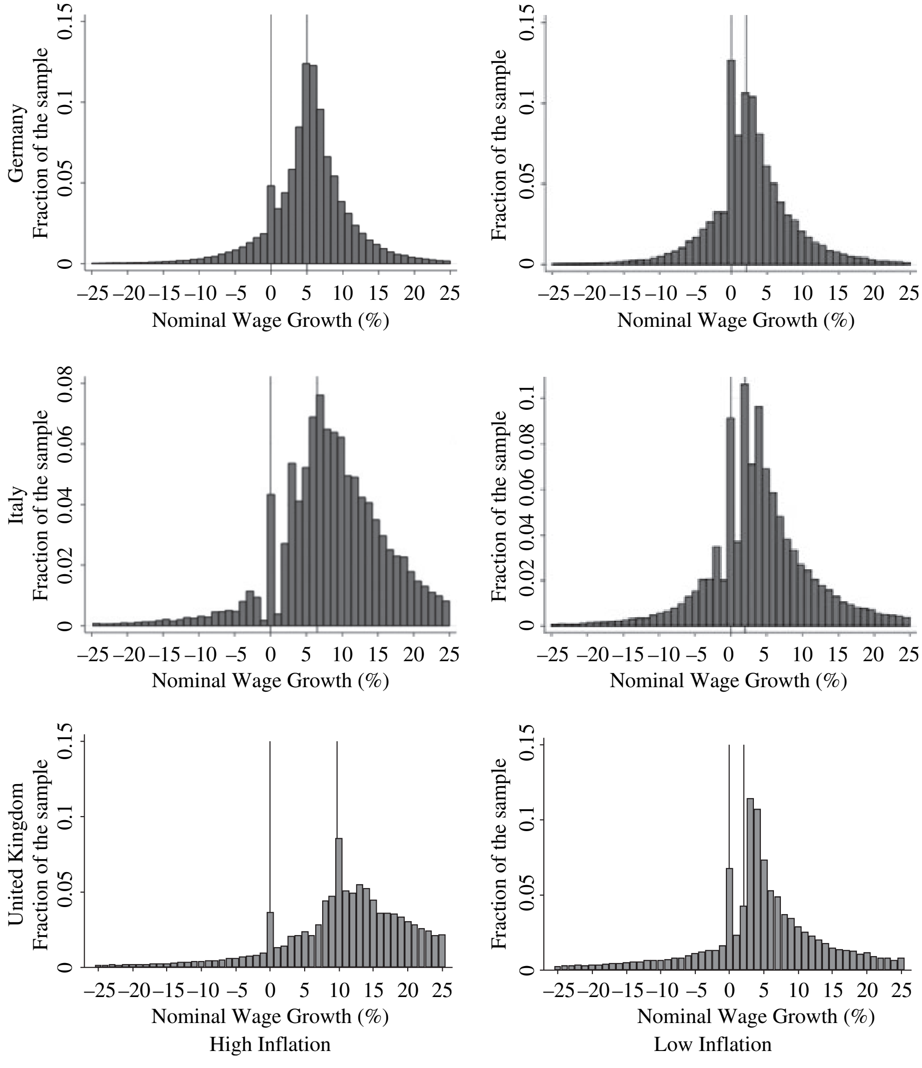

Fig. 1. *Examples for Wage Change Distributions in Germany, Italy and the UK*
Notes. For Germany, the high inflation year is 1980, the low inflation year is 2000, see Bauer *et al.* (2007) for a description of the data. For Italy, the high inflation year is 1990, the low inflation year is 1999, see Devicienti *et al.* (2007) for a description of the data. For the UK the high inflation year is 1979, the low inflation year is 1999, see Barwell and Schweitzer (2007) for a data description.

1. The Empirical Strategy in Detail

This Section describes the details of the empirical model we use in all three articles. It presents the analytical setup and how it uses the features we described in the previous Section to identify the parameters of interest. Readers who are less interested in the technical details can skip this Section.[6]

[6] An extensive formal Appendix that derives the estimated likelihood function is provided at http://www.iza.org/files/EJ-WageRigidityFeature-TechApp.zip.

1.1. *The Econometric Model*

Our setup specifies the likelihood of a given observation of wage changes belonging to one of three different possible regimes. First, in the absence of wage rigidity, wage changes Δw_{it}^* could be described by the simple regression

$$\Delta w_{it}^* = \mathbf{x}_{it}\boldsymbol{\beta} + e_{it}, \tag{1}$$

where $\mathbf{x}_{it}$ is a vector of individual characteristics and the residual e_{it} is assumed to be distributed normally. If an individual is subject to downward nominal wage rigidity, then her wage change is governed by

$$\Delta w_{it} = \begin{cases} \Delta w_{it}^* & \text{if } \Delta w_{it}^* \geq 0 \\ 0 & \text{if } \Delta w_{it}^* < 0 \end{cases}. \tag{2}$$

We denote the fraction of individuals potentially bound by downward nominal wage rigidity by p_N. If an individual is subject to downward real wage rigidity, this wage change is given by

$$\Delta w_{it} = \begin{cases} \Delta w_{it}^* & \text{if } \Delta w_{it}^* \geq r_{it} \\ 0 & \text{if } \Delta w_{it}^* < r_{it} \end{cases}, \tag{3}$$

where r_{it} is the potentially heterogenous cutoff below which the wage change becomes rigid. It is tentative to interpret r_{it} as the inflation expectation. With this interpretation, the real wage is downward rigid. This also justifies adding heterogeneity to it, as it is well documented that inflation expectations are heterogenous (Mankiw *et al.*, 2004).[7] To make the model tractable, we assume that r_{it} is normally distributed with finite mean and variance. We denote the fraction of individuals potentially prone to downward real wage rigidity by p_R. In addition, our model allows for the possibility that observed wages are polluted by measurement error. This implies that observed wage changes Δy_{it} are generated by

$$\Delta y_{it} = \Delta w_{it} + \Delta m_{it}, \tag{4}$$

where the measurement error component m_{it} is modelled as a normally distributed shock to wage levels. With probability q, the wage is measured without error, and with probability $1-q$, it is measured with a normally distributed error. The measurement error component Δm_{it} is the appropriately formed difference in the measurement error. Notice that the model merely offers the possibility to include measurement error, and does not force it onto the data.

Based on these assumptions, we are able to calculate the likelihood of each observation and to estimate all parameters by maximum likelihood. In the following, we provide an intuitive description of the features of the distribution of wage changes that are used to identify the parameters of interest.

[7] Other interpretations are also possible. For example, unions in Germany target the inflation rate plus an adjustment for productivity growth (Fitzenberger and Franz, 1999). In this case it may be somewhat misleading to call this type of rigidity a real wage rigidity, though we stick with this label for the remainder of the article.

1.2. *Identification*

Key to identifying the different types of rigidities are the local asymmetries in the distribution of wage changes that we discussed in the context of Figure 1. Intuitively, the discrete jump in the density just around zero relative to the size of the spike at zero identifies the extent of downward nominal wage rigidity. Rather than exploiting the unconditional asymmetry in the wage change distribution by simply inspecting the histogram, however, our estimator examines the asymmetry in wage changes conditional on individual characteristics, leading to more reliable estimates of the existence and extent of wage rigidities. For example, it is well known that wage growth and age are negatively correlated. Thus, if older workers are more likely to be piled up at zero, our estimator will exploit this information when estimating the extent of nominal wage rigidity. In a similar way, downward real wage rigidity is identified by asymmetries in the conditional distribution of wage changes that may occur at wages changes that are away from zero, i.e. asymmetries like the ones in Italy in 1990, or Germany in 1980 (see Figure 1), are going to be the main source of identification of the real wage rigidity regime.

Our estimator further takes into account that measurement error potentially attenuates the asymmetries in the wage change distribution used to identify wage rigidities. Two features of the data are used to identify potential measurement error. First, the size of the spike at zero is informative to estimate the probability that there is no measurement error. Because the measurement error should follow a continuous distribution, it contributes zero probability mass to the spike. Hence, the larger the spike, the less likely is measurement error. Furthermore, if there is measurement error in the data, there should be excessive probability mass close to zero; more than the notional wage changes in combination with the estimated rigidity can account for. The reason is that measurement error dislocates observations that are actually wage freezes. The closer to zero, the more measurement error should affect this part of the distribution. Thus, if there is excess mass around some part of the wage change distribution, the estimator will use this information together with the size of the spike in this part of the distribution for the estimation of the measurement error parameters and their variance. For given estimates of the distribution of measurement error, our approach corrects the estimates of the extent of wage rigidity. Intuitively, if there is excess probability mass around zero, this implies that measurement error also makes asymmetries in other parts of the distribution too smooth, which is accounted for by our estimator.

While this estimator is tractable and uses a straightforward identification strategy that can basically be seen in Figure 1, there are a number of potentially problematic issues that we discuss now. First, when inflation is low enough, our estimator will have little power to distinguish between nominal and real wage rigidities for the simple reason that the two are located at almost the same location on the support of the distribution of wage changes. Thus, the closer average wage growth is to zero, the more our estimator needs to rely on large samples to obtain an accurate estimate. Second, our estimator has greater degrees of freedom to identify real wage rigidities than nominal wage rigidities. However, Devicienti *et al.* (2007) develop a version of the estimator with the same degrees of freedom for both forms of wage rigidity. They impose the mean of the real rigidity cutoff r_{it} to be equal to the negotiated union wage increase obtained from another data source. This allows them to assess the sensitivity of the results with respect to the additional degrees of freedom in the real rigidity part of the model.

2. Preview of the Results

The estimation strategy described in the last section is applied to micro data from three countries: Barwell and Schweitzer (2007) use data for the UK, Bauer *et al.* (2007) for Germany and Devicienti *et al.* (2007) for Italy. Even though the basic estimator and identification strategy is the same for all three articles, we had to adjust the actual estimator used in the articles slightly to take special features of the available data for the three countries into account. These adjustments are discussed in detail in the respective articles.

Four broad patterns emerge. First, real wage rigidities are important in all three countries. For Germany, Bauer *et al.* (2007) find that 30% to 70% of wages are set under the real rigidity regime and 13% to 20% of wages under the nominal rigidity regime. The results of Devicienti *et al.* (2007) show that in Italy the probability of a worker being in the real wage rigidity regime varies between 45% to 65% and the probability to be in the nominal wage regime varies between 22% and 24%. Finally, Barwell and Schweitzer (2007) provide evidence that on average 41% of the workers in the UK fall into the real wage rigidity regime, whereas only slightly more than 14% fall into the nominal wage rigidity regime. The three articles in this Feature find far less downward nominal wage rigidity than earlier studies that did not allow for any form of wage rigidity other than nominal wage rigidity. It seems therefore likely that earlier studies have overstated the extent of downward nominal wage rigidity. Our results also indicate that union wage growth in particular is able to explain real wage rigidities. We are unable to distinguish between explanations for these findings that are based on the bargaining power of workers and explanations that are based on efficiency wages paid by firms. Yet, testing whether firms pay efficiency wages has proven difficult (Dickens and Katz, 1987; Groshen and Krueger, 1990; Burks *et al.*, 2005). Future research could address this issue, e.g., by using sectoral variation in union density to examine how important unions are in explaining real wage rigidity.

Second, in all countries, real wage rigidity appears to become less important over time. In Germany, for example, the estimated probability of being in the real wage rigidity regime decreases from 62% in 1975 to 30% in 1997. The probability of falling into nominal wage rigidity stayed roughly constant in this time period, and the share of workers with flexible wages increased from about 20% in the late 1970s to almost 50% in 1996. A similar picture emerges for Italy: over time, wages become more flexible through a decrease in real wage rigidities, while nominal wage rigidities stay roughly constant over time. It is tentative to attribute these developments to institutional changes that took place roughly at the same time. In Italy, for example, the decrease in the extent of real wage rigidities can be explained by the abolition of the automatic price indexation known as the *scala mobile* in the early 1990s. Real wage rigidity stayed roughly constant before this policy change, falling dramatically thereafter.

Third, low inflation decreases real wage rigidity but increases nominal wage rigidity. This finding has an intriguing interpretation: The lower the inflation rate, the more likely it appears to be ignored in wage setting. This implies that an important effect monetary policy may have on the labour market is in influencing the type of labour market rigidity that prevails. Low inflation leads to downward nominal wage rigidity, high inflation to downward real wage rigidity. Akerlof *et al.* (2000) develop a macro model for the US, incorporating explicitly this assumption. An avenue for future research is to examine this pattern more closely. A further implication of the model by Akerlof *et al.* (2000) is that price stability is not optimal. Hence, should this finding hold up, there are possibly important consequences for monetary policy.

Fourth, in all three countries, there is evidence that rigidities are associated with unfavourable labour market outcomes, in particular unemployment. In Italy, for example, the extent of real wage rigidity at the firm level is correlated with excess labour turnover, suggesting that firms attempt to replace workers instead of cutting wages. A similar result is found for the UK, where workers who are subject to wage rigidities are also more likely to lose their jobs. At a more aggregated level, there is evidence from Germany and Italy that wage rigidities precede increases in unemployment. Previous studies have found only weak evidence that downward wage rigidity has any measurable real effects; only Fehr and Goette (2005) find significant effects of nominal wage rigidity on regional unemployment rates in Switzerland, using a similar approach to estimate the impact of downward nominal wage rigidity. Other studies using alternative approaches find no impact on real outcomes (Card and Hyslop, 1997; Lebow *et al.*, 2003). The fact that all three studies included in this Feature find effects on the real side provide further evidence for the reliability of the results that this approach produces.

Overall, we hope that our findings contribute to a better understanding of how wages change over time, what impedes downward wage adjustment and how this affects the economy. The empirical framework we develop in this Feature has successfully been applied to three European countries. Applications to more countries seem the obvious next step.

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