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Robustness and real consequences of nominal wage rigidity ☆

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Abstract

Nominal wage rigidity has been shown to exist in periods of high inflation, while reduction in nominal pay has been hypothesized to occur in times of low inflation. Nominal wage rigidity would therefore become irrelevant because there is little need to cut nominal pay under high inflation, while the necessary cuts would occur under low inflation. We test this hypothesis by examining Swiss data in the 1990s, where wage inflation was low. *Nominal wage rigidity proves robust in a low inflation environment, constituting a considerable obstacle to real wage adjustments*. Real wages would indeed respond to unemployment without downward nominal rigidity. Moreover, wage sweep-ups caused by nominal rigidity correlate strongly to unemployment, suggesting *downward nominal wage rigidity fuels unemployment.*

JEL classification: J30; E31; E52

Keywords: Wages; Nominal rigidity; Inflation; Unemployment

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1. Introduction

The extent and the nature of downward nominal wage rigidity are likely to have strong implications for the functioning of the labor market and for questions of monetary policy. There are several reasons why firms may be reluctant to cut nominal wages; they may be constrained by efficient nominal wage contracts (MacLeod and Malcomson, 1993; Holden, 1999), the existence of nominal loss aversion (Kahneman and Tversky, 1979; Genesove and Mayer, 1998), or nominal fairness standards (Kahneman et al., 1986; Campbell and Kamlani, 1997; Bewley, 1999; Fehr and Falk, 1999).

We examine two important unresolved questions in the empirical literature on nominal wage rigidity in this paper. First, there is no information to our knowledge regarding the rigidity of nominal wages in an *environment of low nominal wage growth*. This question is important because there is little need to cut nominal wages in an environment with high wage inflation and, hence, nominal wage rigidity—if it exists—probably has no major real effects. In contrast, wage rigidity may well be a binding constraint on wage setting for large segments of the work force in a low inflation environment. Hence, non-negligible real effects of nominally rigid wages are far more likely in an environment with low nominal wage growth. However, little is known about wage behavior in this situation.

Second, there is little empirical support for the claim that nominal wage rigidity affects the real side of the economy. This knowledge is important, however, because even if nominal rigidity frequently inhibits wage cuts, the real effects which it causes cannot be taken for granted. Many labor relations are long-term; the employer could, in principle, smooth the time path of individual wages without affecting the expected marginal costs of labor. For example, a worker in a long-run employment relation could pay for the absence of wage cuts in this year with lower wage increases in future years, leaving the present value of his labor costs constant. Applications of the theory of repeated games to long run labor relations show, however, that these relations are characterized by infinitely many equilibria (MacLeod and Malcolmson, 1989). Therefore, it is far from obvious that the wage smoothing equilibria are relevant. Thus, whether real effects are associated with widespread nominal wage rigidity is ultimately an empirical question.

The lack of data forced previous studies to examine the existence of nominal wage rigidity in an environment with relatively high rates of wage inflation. The early studies by McLaughlin (1994) and Lebow et al. (1995) found little evidence. Further studies by Akerlof et al. (1996), Card and Hyslop (1996) and Kahn (1997) report more favorable evidence and two recent papers found quite strong evidence for downward rigidity (Altonji and Devereux, 1999; Lebow et al., 1999). However, since all these studies used US data from the last four decades and since inflation was quite high during this time period, it is difficult, if not impossible, to draw reliable inferences about the behavior of nominal wages in a low inflation environment from these studies.[1] The average rate of wage inflation in these studies ranged from 3.4 percent in Lebow et al. (1999) to 7.4

[1]The most prominent low inflation episode is probably the Great Depression, for which to our knowledge no micro-level data on individual wage changes exists. Aggregate evidence suggests that

percent in McLaughlin (1994). Moreover, annual wage inflation in the US was below 3 percent in only six years between 1959 and 1999.[2] Gordon (1996) and Mankiw (1996) have forcefully argued that it is very problematic to infer from the presence of nominal wage rigidity in a high inflation environment that wages will also exhibit nominal rigidity in a low inflation environment. The reason is that the microeconomic behavior of workers and firms may well change in response to the change in the macroeconomic environment. "The … attempt, to reason from evidence on nominal wage rigidity in an environment of rapid *positive* average nominal wage change to a hypothetical situation of *zero* average nominal wage change is subject to the Lucas critique. If the macroeconomic environment were different, microeconomic behavior would be different. Nominal wage reductions would no longer be seen as unusual if the average nominal wage was not growing. Workers would not see them as unfair, and firms would not shy away from imposing them." (Gordon, 1996, p. 62). If this argument is valid, there would be little reason to be concerned about nominal wage rigidity because it is likely to have little impact on employment in a high inflation environment, while nominal rigidity will be absent in a low inflation environment.

The empirical results presented in this paper challenge the argument above, however. We provide evidence for the presence of strong nominal wage rigidity in an environment with sustained low nominal wage inflation. Our method for examining the extent of nominal wage rigidity is similar to that developed by Altonji and Devereux (1999). However, since their empirical model has important counterfactual implications, we generalize their method by allowing for individual heterogeneity in nominal rigidity. The model, therefore, does not imply counterfactual predictions. Our study is based on the Swiss experience between 1991 and 1997. Switzerland experienced very low inflation rates over several consecutive years in this period. Following a rapid decline in average nominal wage growth from 7 percent to roughly 1 percent between 1991 and 1994, nominal wage growth remained at these low levels for four years. Thus, individual agents had enough time to adjust their behavior to this macroeconomic environment and intense downwards pressure on nominal wages probably prevailed throughout this period. Yet, the results indicate that the low inflation environment only slightly reduced the reluctance to cut nominal wages. This decrease was far too small to accommodate the greater need for nominal wage cuts as inflation approached zero. Instead of a decrease in the quantitative relevance of nominal wage rigidity, we actually observe an increase over time. For example Swiss wage inflation in 1991 approximated that of a typical year of the US studies. Nominal rigidity then prevented wage cuts for one-third of the job stayers and the average *prevented* wage decrease for these workers was 2.7 percent. These results are similar to those reported in Altonji and Devereux (1999). In contrast, the fraction of job stayers who did not receive wage cuts due to nominal rigidity in 1997, after four years of low

(*footnote continued*)
downward nominal wage rigidity played an important role in amplifying (or causing) the Great Depression (Akerlof et al., 1996; Bernanke and Carey, 1996).

[2]The years are 1961, 1963, 1986, 1987, 1992, 1993 (see Table B-47,Economic Report of the President, 2003).

wage inflation, was 62 percent and the average prevented wage decrease for these workers was 6.5 percent. These results leave little doubt that the rigidity of nominal wages was very persistent in these years. Moreover, the results also show that real wages would have been quite flexible in the absence of nominal wage rigidity. This indicates that nominal wage rigidity was an important determinant of real wages in an environment with low nominal wage growth.

In view of this result, it is interesting to examine whether nominal wage rigidity is associated with important real effects. Previous research has either not dealt explicitly with this question or has found no strong effects. Altonji and Devereux (1999) found evidence at the micro-level that workers protected by a nominal wage floor are less likely to quit. Whether nominal rigidity also affects layoffs, promotions, and relative wage growth, however, remains an open question according to these authors. There seems to be even less evidence for the macro-level. To our knowledge, so far no evidence yet exists suggesting that nominal wage rigidity is associated with higher unemployment. The recent paper by Lebow et al. (1999) even poses a so-called micro–macro puzzle. They found that despite the large wage sweep-ups caused by nominal wage rigidity in the US in the 1980s, the unemployment rate even decreased in this period. Moreover, the paper reports that their measure of nominal rigidity is insignificant in Phillips curve estimates, suggesting that nominal rigidity may be unimportant at the macro-level. However, in view of the arguments above, nominal wage rigidity might only have small effects in an environment with relatively high nominal growth while causing important real effects in a low-growth environment.

To examine whether nominal wage rigidity is associated with unemployment, we computed the average wage sweep-up nominal rigidity caused in every canton and every industry in Switzerland in each year between 1991 and 1997 (Switzerland is a highly decentralized federation consisting of 26 cantons). This enables us to see whether the wage increasing effect of nominal rigidity is related to the unemployment rates in the different cantons and industries. Our analysis yields a striking result: we observe a positive relation between the unemployment rate and the average wage sweep-up caused by nominal rigidity in every single canton and in most industries. Our best interpretation of this result is that the wage sweep-ups indeed represent sweep-ups in labor costs, which induce firms to lay off workers.

The remainder of the paper is structured as follows: Section 2 discusses the characteristics of the Swiss labor market. Section 3 provides descriptive evidence on wage rigidity from personnel files and Section 4 shows descriptive evidence from representative random samples. Section 5 discusses the empirical model of wage changes applied in this paper. Section 6 shows to what extent nominal rigidity persists in a low growth environment and discusses the real consequences for unemployment. Section 7 concludes the paper.

2. Characteristics of the Swiss labor market

The Swiss labor market is one of the least regulated and least unionized labor markets in Europe. Swiss employers have, for example, the legal entitlement to enforce wage cuts by proposing a lower nominal wage to incumbent workers. If a worker refuses to accept the new wage, the law allows the employer to fire the worker. This employer right cannot be waived, i.e., it cannot be relinquished contractually, in stark contrast to most other European countries. In this respect, the Swiss labor market is perhaps closer to the US labor market than to the labor markets in most other European countries. Despite the employers' opportunities for firing individual workers, nominal wage rigidity may nevertheless occur if behavioral forces like nominal fairness standards and nominal loss aversion are sufficiently strong. The most important feature in the Swiss situation for our purposes is a dramatic decline in nominal wage growth between 1991 and 1993 (accompanied by a decline in real GDP growth), followed by four years of very low inflation rates. Nominal wage growth never exceeded 1.5 percent between 1994 and 1997. Low wage inflation implies that structural changes in the economy are likely to be associated with the necessity for cutting many workers' nominal wages. The downward pressure on these nominal wages means that firms face a strong temptation to cut these workers' nominal wages, and, consequently, nominal wage cuts should become more customary. This is the ideal situation for examining whether nominal wage rigidity indeed erodes. When can we expect an erosion of nominal wage rigidity, if not in this situation? However, if nominal rigidity persists, this is the ideal environment for the study of its real consequences because nominal rigidity prevents many real wage cuts.

It is instructive to compare the macro-environment in this study with the macro-environments in previous studies of nominal wage rigidity. When we examine nominal wage growth in the US between 1965 and 1999, we find no comparable episode with such a rapid decline in wage inflation followed by a sustained low level of wage inflation below 1.5 percent. (Table B47, Economic Report of the President, 2003). Even during the 1990s, when inflation was relatively low, wage inflation was 3 percent or higher in 8 out of 10 years.

3. Descriptive evidence from personnel files

The ideal data set for examining nominal wage rigidity would be a representative sample of firms' personnel files including precise information on wages, individuals' productivity, and other individual characteristics. Unfortunately, there is no study with such a data set to our knowledge. Although non-representative firm-level data is less informative, its examination is still instructive for our purposes. We obtained personnel records from a large and a medium-sized Swiss firm. Firm A is a large firm in the service industry with approximately 10,000 employees; the available personnel records cover the period from 1993 to 1999. Firm B is a medium-sized firm in the service industry with a declining activity in manufacturing; its records start in 1984 and end in 1999. Employment in Firm B first dropped from about 2000 in the 1980s to 1000 in 1998 and then started to rise again. We calculate wages in both firms as total compensation divided by the contractual number of work hours. Average wage growth in Firm A was 3.8 percent (s.d.: 5.3 percent). Wages in Firm B grew an average of 5.7 percent (s.d.: 5 percent) in Firm B.

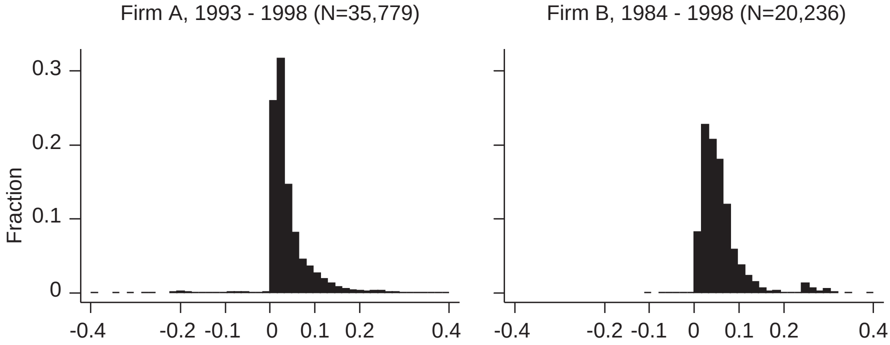

Fig. 1. Distribution of nominal wage changes.

Fig. 1 displays the distribution of wage changes (measured in log wage differences) in the two firms for the periods 1993–1999 and 1984–1998, respectively. The striking feature of both distributions is that there are *almost no wage cuts*. In Firm A ($N = 35,779$), only 1.7 percent of all observations are wage cuts. In Firm B ($N = 20,236$), the fraction is even lower (0.4 percent). Both distributions exhibit a discontinuity at zero that could hardly be more pronounced. If we restrict attention to the years with low nominal wage growth, the picture remains essentially the same. Average nominal wage growth between 1993 and 1997 also amounted to 3.8 percent in Firm A and the percentage of negative wage changes was 1.5. Firm B experienced 4.2 percent average nominal wage growth in this period and the percentage of wage cuts was again 0.4 percent. Therefore, nominal wage cuts are extremely rare in these firms, irrespective of the period considered. These data are thus certainly consistent with the view that employers are reluctant to cut nominal wages. Yet, it is unclear to what extent the wage change regularities in these firms are representative for the whole economy.

4. Descriptive evidence from representative samples

We examine two large data sets to obtain representative information on the extent of nominal rigidity. The first data source is the Swiss Labor Force Survey (SLFS) for the years 1991–1998. The SLFS is a rotating panel that follows individuals for five years. In total, the SLFS provides 21,144 wage change observations. The second data source is a large random sample from the Social Insurance Files (SIF). The SIF contains information about all employees in Switzerland. This sample gives us 140,628 observations of wage changes and covers essentially the same time period as does the SLFS data.[3] The major advantage of examining both data sets is that this

[3]The Social Insurance Files are December to December data, while the SLFS is conducted in May. Hence, referring to wage changes in 1993, for example, we mean wage changes between May 1993 and May 1994 for the SLFS and wage changes between December 1992 and December 1993 for the SIF.

provides a very useful robustness check of our results. We will show below that both data sources have their specific advantages and disadvantages. If both data sources lead to similar results despite their peculiarities, we can be more confident that the results are robust.

We consider non-self employed individuals who stayed with the same firm for at least one year in both data sources, and refer to these individuals as "job stayers". We trimmed both samples by excluding all observations with an absolute wage change in excess of 50 percent, as wage changes for job stayers of this size are utterly implausible. We lose approximately 3 percent of the observations in both data sets when we apply this criterion. However, all our conclusions remain qualitatively identical and quantitatively very similar if we use the whole sample for the estimation. The measure of wages for the SLFS data is total compensation (net of social security contributions) divided by hours specified in the labor contract. We use a different measure of wages for the SIF sample, as discussed below.

The advantage of the SLFS is that it provides extensive information on the characteristics of individuals, such as tenure, labor market experience, education levels, gender, age, nationality, etc. The disadvantage is that reporting error is likely to distort surveys. The advantage of the SIF data is that all financial transactions between firms and workers are recorded in the Social Insurance Files. Hence, reporting error is not an issue, and the earnings information obtained from the SIF is accurate. In addition, the SIF sample is comfortably large. Since the SIF data covers the same time period as does the SLFS data, we can replicate the empirical analysis we conduct with the SLFS. We should also mention that the SIF data have three problems. First, we cannot identify job stayers with absolute certainty. We only consider those workers in the SIF sample who were insured by the same local social insurance agency in two consecutive years, as these are very likely to be job stayers. However, if a worker moves to another employer, but both employers are associated with the same local agency, the individual may remain in the sample. Thus, we may wrongly include job movers in the SIF sample, which could understate the true degree of nominal wage rigidity. Second, we have precise information about the total annual compensation but not about hours worked. The change in total annual compensation therefore determines our measure of observed wage changes in the SIF sample. Temporary variations in hours due to differing reasons, such as a change in overtime in two years, thus appear to be a "wage change" in the sample. As we will illustrate below, this can generate a substantial number of observations that appear to be wage cuts but which are actually reductions in actual hours worked. This is particularly important for the time period considered because firms may use working time reductions as an alternative to nominal cuts in a recession. Third, the available worker characteristics in the SIF sample are not the same as those in the SLFS. They include age, nationality, gender, details on the agency that recorded the payment, and the applicable period of time.

Fig. 2 summarizes the distribution of nominal wage changes (measured in log wage differences) for job stayers in Switzerland between 1991 and 1997. Consider first the figure on the left which displays the histogram obtained from the SLFS. This histogram exhibits the following properties:

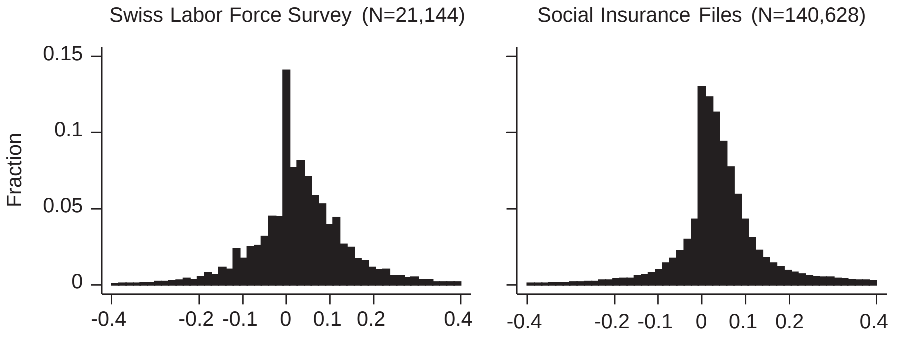

Fig. 2. Distribution of nominal wage changes.

1. There is a *spike at zero*: The largest bin is the one containing no or small positive nominal wage changes (between zero and 2 percent).
2. There is an *asymmetry* in the distribution of wage changes. Small negative wage changes are observed less frequently than are small positive wage changes.
3. Despite the asymmetry there is a *considerable fraction of negative wage changes*.

Compare this to the right panel of Fig. 1a, which is based on the SIF data using identical bins. Three features deserve to be mentioned here:

1. The SIF distribution exhibits less dispersion, i.e., it is more centered around zero than the SLFS distribution. While 59 percent of all observations in the SIF are between zero and 10 percent, for example, the corresponding figure for the SLFS is only 45 percent.
2. The asymmetry between positive and negative wage changes is much more pronounced in the SIF sample. There is a striking discontinuity around zero and the pile-up of observations just above zero is very pronounced.
3. The fraction of negative wage changes is considerably smaller in the SIF sample.

Table 1 provides additional information on wage changes in the two data sources and includes the inflation rate (measured by CPI changes) and average nominal wage growth. The table shows that the sharp decrease in the rate of inflation at the beginning of the period considered is associated with more observed wage cuts and more zero wage changes in the SLFS. The fraction of job stayers with a zero nominal wage change rises from 5 percent in 1991 to 15 percent in 1997. The fraction who reported wages that implied wage cuts is, in general, quite high. It also rises from 20 percent in 1991 to 33 percent in 1997. Interestingly, however, the fraction of workers with wage cuts is always lower in the SIF sample than in the SLFS sample. This suggests that reporting error influences the labor force survey strongly. Imagine that the distribution of true wage changes has no, or only a few, negative entries. Assume further that reporting error is important. Then, as the distribution moves closer to zero over time, reporting error creates a larger number of negative observations.

Table 1
Descriptive statistics of wage freezes and wage cuts

Year	Rate of inflation (CPI) (%)	Nominal wage growth (%)	Source: Swiss labor force survey			Source: Social insurance files		
			Fraction with zero nominal wage change	Fraction with nominal wage decrease	*N*	Fraction with zero nominal pay change	Fraction with nominal pay decrease	*N*
1991	4.7	7	0.05	0.20	2,941	0.02	0.11	18,450
1992	3.7	4.7	0.08	0.29	3,337	0.02	0.15	20,087
1993	1.1	2.5	0.09	0.31	3,476	0.03	0.20	20,870
1994	1.6	1.5	0.06	0.31	3,379	0.05	0.21	20,699
1995	0.9	1.5	0.06	0.31	2,606	0.04	0.25	19,556
1996	0.6	1.3	0.14	0.38	2,742	0.05	0.26	20,285
1997	0	0.5	0.15	0.33	2,754	0.09	0.31	20,681

Sources: Federal Office of Statistics, Swiss Labour Force Survey 1991–1998, Social Insurance Files 1990–1997; own calculations.

Therefore, we observe more wage cuts in the SLFS sample. The fact that we cannot control for hours variation in the SIF sample only strengthens this argument because it is likely to produce false negatives in this sample, too. We will examine this point below.

Fig. 3 shows the evolution of the distribution of log wage differences over time, using the SIF sample. The sequence of distributions conveys the impression that the decline in inflation is associated with a rise in downward rigidity. Consider, first, the three panels for 1991, 1992, and 1993. The distribution in these years is—except for the small spike at zero—relatively symmetric around its median. The bins to the left and to the right of the median are of similar size. Compare this to the distribution of wage changes in the low inflation years 1995–1997, where the median is much closer to zero. In these years there is a sharp discontinuity at zero and the distribution also exhibits a pronounced asymmetry around zero. Note also that there is only a relatively small increase in the frequency of negative wage changes during these years.

The upshot of the descriptive evidence in Table 1 and Figs. 2 and 3 can be summarized as follows: The asymmetry in the distribution of wage changes and the spike at zero may be interpreted as an indication of nominal wage rigidity. The fact that the asymmetry becomes much more pronounced over the years provides support for this interpretation. However, the relatively large fraction of observed wage cuts in the SLFS and the SIF provide much less convincing evidence for nominal wage rigidity than do the descriptive evidence from the personnel files. This raises the question whether the non-negligible number of observed wage cuts represent true wage cuts or whether they are mainly the result of reporting error (in the SLFS) or of unobserved hours variation (in the SIF). The much smaller number of observed wage cuts and the generally smaller dispersion of wage changes in the SIF suggest that reporting error is a serious problem, at least in the SFLS. Thus,

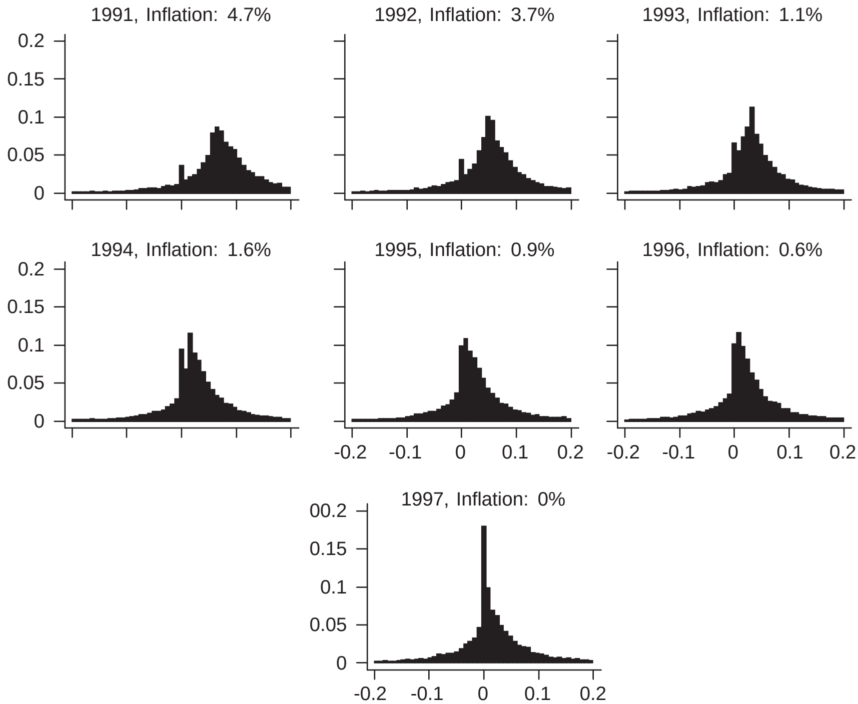

Fig. 3. Distribution of wage changes over time.

many of the observed wage cuts in the SLFS might be spurious. In addition, the absence of a direct measure for working time in the SIF may pollute the SIF data in a similar way as reporting error pollutes the SLFS data.

In order to gain some insights into the potential role of unobserved variations in working time, we took advantage of the fact that the personnel file of Firm B provides precise information on overtime payments for each individual. Therefore, we could compute the distribution of wage changes in Firm B in the presence and in the absence of controlling for overtime payments. The results show that if one does not control for variations in overtime, a sizeable fraction of spurious wage cuts (7.6 percent) occur. In addition, the true wage change distribution is much more centered around zero than is the "polluted" distribution.

5. An empirical model of wage changes

The upshot of the previous discussion is that we need an econometric model that explicitly allows for the presence of measurement error, so that one can separate true wage changes from wage changes that merely reflect reporting error or reductions in actual hours worked. The general idea behind the model is that there may be reasons, such as efficient nominal wage contracts, nominal fairness standards, and nominal loss aversion, that render nominal wage cuts costly for the firms. Therefore, firms will not implement all desired wage cuts and, as a consequence, there will be a difference between the desired or "notional" wage cuts and wage cuts actually implemented. However, the larger the notional wage cut, the more likely it is that the benefits will outweigh the costs. Hence, a threshold value c_{it}, may exist for individual i at time t which, together with the notional wage cut, determines whether the actual wage will be cut or not. If the notional wage cut is below c_{it} the firm will not implement the cut, but if the notional cut is above c_{it} the pay reduction will be implemented. Our main focus is to estimate the mean μ_c and the variance σ_c of the distribution of thresholds. Since we also estimate the distribution of measurement errors and the distribution of notional wage changes, we can compute the frequency of true wage cuts and the share of workers affected by nominal rigidity. Workers are affected by nominal rigidity if their notional wage change is negative but since the notional wage cut is below their threshold c_{it} their actual wage is not cut.

The general structure of the estimated model is as follows:

$$\Delta y_{it} = \begin{cases} x'_{it}b + e_{it} + m_{it} & \text{if } x'_{it}b + e_{it} \geqslant 0, \\ m_{it} & \text{if } -c_{it} \leqslant x'_{it}b + e_{it} < 0, \\ x'_{it}b + e_{it} + m_{it} & \text{if } x'_{it}b + e_{it} < 0, x'_{it}b + e_{it} < -c_{it}, \end{cases} \tag{1}$$

where Δy_{it} is the *observed* log nominal wage change of individual i in period t, $x'_{it}b + e_{it}$ is the *notional* nominal wage change that would be implemented in the absence of downward nominal wage rigidity, x_{it} is a set of observable variables that are likely to affect wage growth, e_{it} represents the usual error term, and m_{it} denotes the measurement error, which can be interpreted as reporting error in the SLFS and unobserved hours variation in the SIF. Model (1) is similar to, but more general than that in Altonji and Devereux (1999). A main difference between our approach and that taken by Altonji and Devereux is that we allow for individual heterogeneity in the thresholds c_{it} whereas Altonji and Devereux impose the restriction that the threshold be the same for all workers. This restriction counterfactually implies that there are no wage change observations in the interval $[-c, 0]$. By allowing for individual heterogeneity in wage cut thresholds we avoid such counterfactual implications. Both questionnaire evidence (Shafir et al., 1997) and experimental evidence (Fehr and Gächter, 2000; Fehr and Tyran, 2001) indicate that individuals differ with regard to their fairness standards and their degree of money illusion. Thus, individual heterogeneity may be important, leaving some workers with flexible wages while others with rigid wages. In the model, those workers who have a negative threshold ($c_{it} < 0$) exhibit perfectly flexible wages. Note also that our model nests that of Altonji and Devereux as a special case. As the variance of c_{it} approaches zero, the two models become identical.

In addition to allowing for individual heterogeneity, we also allow for a nonzero correlation between the error term e_{it} and the individual thresholds c_{it} and we estimate the value of this correlation. This is potentially important because there is considerable survey evidence that nominal wage cuts occur when a firm is in financial distress, as several studies (e.g., Bewley, 1999; Campbell and Kamlani, 1997) document. Individuals are more likely to accept wage cuts when their firm is in trouble. Allowing for a nonzero correlation between e_{it} and c_{it} offers a simple way of incorporating this feature because changes in firm productivity are presumably an important component of e_{it}. Based on the survey evidence one would, therefore, expect that if e_{it} is very low (negative) a worker's threshold c_{it} is very small, too, so that the correlation between e_{it} and c_{it} is positive.

We also allow for some heterogeneity with regard to reporting error (in the SLFS) and overtime work (in the SIF sample). We assume that a fraction p (that will be estimated) of the individual data in every year has no measurement error, but that the rest of the sample draws a normally distributed error. This means that in the SLFS a fraction p of all respondents states the correct income, but the rest makes normally distributed errors. In analogy, a fraction p of all individuals in the SIF sample has no variation in hours between the previous and the current year.

It is important in the empirical estimates below that x_{it} contains variables that capture both business cycle variation in wages and individual characteristics correlated with wage growth. We use the change in the regional unemployment rate as well as year fixed effects as business cycle variables. Variables that systematically affect wage growth across workers are labor market experience, age, tenure, and observable skills of worker i (see, e.g., Topel, 1991). It is a stylized fact that wages grow at a decreasing rate with experience and tenure. Likewise, several studies indicate that wage growth varies for different types of workers (e.g. Baker et al., 1994). As an additional control, we also included the firm size because there is evidence for firm size effects in Switzerland (Winter-Ebmer and Zweimüller, 1999). We use a worker's age as a proxy for experience in the estimates with the SIF sample. In addition, a foreigner dummy variable, as well as an interaction term with log age, captures the systematic differences in experience and job status between Swiss employees and employees from other countries.

Intuitively, the estimator examines whether individuals with low predicted real wage growth in high-inflation years have on average higher than expected wage growth during low-inflation years because their characteristics required a cut in their nominal wage. Thus, it examines whether an individual's observed wage change is higher than expected when its characteristics would have predicted a wage cut. This, together with the addition of symmetric measurement error, identifies the extent of downward nominal wage rigidity. Notice that this identification is not biased towards finding downward nominal wage rigidity. If predicted vs. actual wage growth in low-inflation years does not differ from predicted vs. actual wage growth in high-inflation years, the estimator will conclude that there is no—or very little—downward nominal wage rigidity and leave this part of the model unidentified. Because the estimator identifies downward nominal wage rigidity by assessing the local asymmetry around zero, it will only imperfectly capture rigidity in wages that stem from multi-year contracts, for example. If the costs of renegotiating a contract are significant, a longer contract period when inflation is low is optimal because the benefits from frequent wage adjustments are small relative to the cost. The important point here is that this kind of rigidity prevents both small nominal wage decreases and increases. Thus, multi-year contracts will not lead to an asymmetry around zero, and will not be fully reflected in the estimates. We believe, however, that this kind of wage rigidity is rather unimportant in Switzerland because multi-year contracts are rarely observed. Moreover, the histograms in Figs. 2 and 3 exhibit a pronounced asymmetry around zero wage changes because small wage decreases are much less frequent than small wage increases.

Observed wage changes can, in principle, fall into one of the following three regimes:

(i) If the notional wage change $x_{it}'b + e_{it}$ is positive, there are no forces inhibiting this wage change Δw, i.e., we observe $x_{it}'b + e_{it} + m_{it}$ in the data (see (1) above) and the likelihood of this occurring is—in slight abuse of notation:

$$f_{\Delta y|\Delta w>0} = f_{e+m}(\Delta y_{it} - x_{it}'b | x_{it}'b + e_{it} > 0),$$

where $f_{e+m}(\cdot)$ is the density of the sum of e and m.

(ii) If $x_{it}'b + e_{it}$ lies between $-c_{it}$ and zero, the firm will not cut the worker's wage but freeze his pay instead. The observed "wage change" is then entirely due to unobserved variation. Hence the likelihood of falling in this regime only depends on the distribution of m and is given by

$$f_{\Delta y|\Delta w=0} = f_m(\Delta y_{it} | -c_{it} < x_{it}'b + e_{it} < 0).$$

Note that we do *not* assume that sufficiently small notional wage cuts result in a pay freeze. Whether a notional wage cut is executed or not depends on the distribution of c_{it}; its parameters are jointly estimated with all other parameters of the model.

(iii) If the notional wage cut is larger than c_{it}, the firm will implement the wage cut. The conditional density for this event is

$$f_{\Delta y|\Delta w<0} = f_{e+m}(\Delta y_{it} - x_{it}'b | x_{it}'b + e_{it} < -c_{it}, x_{it}'b + e_{it} < 0).$$

Since the regime which generated a particular observation is unknown, the likelihood of an observation sums up to

$$\begin{aligned} l_{it} = {} & f_{\Delta y|\Delta w>0} \cdot \Pr(x_{it}'b + e_{it} > 0) + f_{\Delta y|\Delta w=0} \cdot \Pr(-c_{it} < x_{it}'b + e_{it} < 0) \\ & + f_{\Delta y|\Delta w<0} \cdot \Pr(x_{it}'b + e_{it} < -c_{it}, x_{it}'b + e_{it} < 0). \end{aligned} \tag{2}$$

We assume that e and m are i.i.d. normal and estimate the parameters by maximum likelihood.[4]

Our approach nests both the case of perfect wage flexibility and the case of perfect wage rigidity. As μ_c approaches minus infinity, there is no downward wage rigidity and only the sum of e and m is identified. If, at the other extreme, μ_c is very large (and σ_c finite), there are no true wage cuts and the third regime drops out. Hence, the model nests both extreme cases, as well as any intermediate one. It allows for

[4]We derive the explicit expression for (2) that can be directly used for estimation purposes in an appendix available on request.

resistance only towards small wage cuts, or larger ones. It provides joint estimates of the distribution governing the cost c_{it} of cutting nominal wages, and the variance of the distribution of e and m. We should also point out a limitation in the model. We assume that the notional wage change in period t does not depend on whether downward nominal wage rigidity constrains the individual's wage in period $t-1$. To see how this could affect the estimator, assume that an individual is hit by a negative productivity shock in $t-1$. Instead of cutting the wage, the firm freezes the individual's wage in $t-1$ and pays a smaller wage increase in t to compensate for the rest of the negative shock in $t-1$. This has two implications: First, when we estimate the notional wage changes in t, they will be understated. The individual's wage increases only very little in t, due to his wage history in $t-1$. Therefore, our estimate of the distribution of notional wage changes will display too little variation, which leads us to underestimate the extent of "static" downward nominal wage rigidity. Second, however, if yesterday's wage freeze causes a lower wage increase today "static" nominal rigidity may not necessarily be associated with an increase in labor cost. "Static" wage rigidity may, therefore, not automatically cause lower employment. For this reason we discuss the employment effects associated with our measure of wage rigidity explicitly in Section 6.4.

Finally, the model also enables us to examine important determinants of μ_c (and σ_c). Instead of imposing the restriction (as in model (1)) that μ_c be the same for all workers in all years, we can allow for year-specific μ_c's or for different μ_c's for different groups of workers. In particular, the estimation of year-specific μ_c's permits us to observe whether μ_c is lower in low-inflation years, which would provide direct evidence for the validity of the conjecture Gordon (1996) and Mankiw (1996) put forward. Also, by allowing variations of μ_c across different categories of workers, we can examine, for instance, whether μ_c is different for full-time and part-time workers or for job stayers and job movers. This question is important insofar as the role of fairness standards is presumably more relevant the stronger the workers' attachment to their firm. If this argument is true, we should observe more wage rigidity for job stayers than job movers and for full-time workers compared to part-time workers.

6. Results

In this section, we discuss the results obtained by estimating the above model. We first present the overall tests for the presence of downward nominal wage rigidity. We then evaluate the stability of these estimates as inflation becomes very low. Next, we assess the implications of the model for different types of workers and the extent to which downward wage rigidity prevents real wage cuts. Finally, we examine the consequences of nominal wage rigidity for regional and industry-specific unemployment.

6.1. *Are wages flexible?*

The basic results for both samples are displayed in Table 2. We estimated 3 different models for both samples. Model (1) estimates μ_c under the assumption that there is no heterogeneity in individual thresholds ($\sigma_c = 0$) and that the correlation between e_{it} and c_{it}, denoted by ρ_{ec}, is zero. In model (2), we also allow for $\sigma_c \neq 0$, and we estimate both σ_c and ρ_{ec} in model (3). We control for year effects in all regressions by including year-dummies and can also control for firm size effects in the SLFS sample. The major result of Table 2 is that regardless of which data set we use and regardless of which model we take, the mean threshold μ_c is positive and significant, indicating the existence of nominal wage rigidity. Moreover, the value of σ_c is significant in all models where we estimated σ_c so that a large percentage of individual thresholds is positive. In model (2) for the SIF sample, for instance, the mean threshold is 0.383 and the standard deviation is 0.21, implying that only about 3 percent of all individuals have no positive thresholds. Thus, only about 3 percent of the individuals have perfectly flexible wages, whereas 97 percent of the individuals exhibit some rigidity. Moreover, 91 percent of the individuals in model (2) have such high thresholds that the actual wage will only be cut if the notional wage cut is above 10 percent. The quantitative importance of nominal wage rigidity is very similar, regardless of whether we use the estimates from the SLFS or the SIF, as can be seen in the remaining columns of Table 2.

The relevance of nominal wage rigidity can be inferred from rows 4 and 5 of Table 2, which show the quantitative implications of the estimated distribution of thresholds for the frequency of true wage cuts and for the share of workers who would have experienced wage cuts in the absence of nominal rigidity. According to the estimates where σ_c is unconstrained (models (2) and (3)), the frequency of true wage cuts is between 7 and 8 percent in the SLFS sample and between 6 and 7 percent in the SIF sample. The share of workers affected by nominal rigidity, i.e. those who experience notional but not actual wage cuts, varies between 48 and 54 percent. Thus, the quantitative importance of nominal rigidity is high and very robust across models and across data sets. The estimates of model (3) also reveal that ρ_{it} is highly significant, positive, and of similar size for both data sets. This is consistent with the view that negative idiosyncratic productivity shocks render people more willing to accept a nominal wage cut.

The extent of measurement error in the survey data is substantial, although lower than expected. Our estimate of the standard deviation σ_m of the measurement error in the SLFS sample is between 6 and 7 percent (see second page of Table 2). This is low compared to what validation studies of labor force surveys found for the US (see Angrist and Krueger, 1999 for a survey). The standard errors obtained from validation studies for the US are never below 10 percent, and sometimes considerably higher. The measurement error due to overtime variations is between 3 and 4 percent in the SIF sample. These numbers indicate measurement errors must be taken into account in order to generate a true picture of nominal wage rigidity.

What are the estimates for the determinants of the notional wage changes? We find that a rise in experience diminishes wage growth (see the estimates for the SLFS sample in Table 2). The estimated coefficient is negative and highly significant. Increasing labor market experience from one to ten years decreases wage growth by

Table 2
The extent of nominal wage rigidities—ML estimates

	Swiss labor force survey			Social insurance files		
	(1)	(2)	(3)	(1)	(2)	(3)
Mean threshold for wage cuts μ_c	**0.268****	**0.513****	**12.01***	**0.208****	**0.383****	**0.89****
	(0.006)	**(0.06)**	**(5.34)**	**(0.002)**	**(0.01)**	**(0.03)**
Standard deviation σ_c (Conditional standard deviation when $\rho_{ec} \neq 0$)	Zero[c]	**0.358****	**7.19***	Zero[c]	**0.21****	**0.441****
		(0.04)	**(3.14)**		**(0.01)**	**(0.025)**
Correlation of c_{it} with idiosyncratic wage change e_{it}: ρ_{ec}	Zero[d]	Zero[d]	**0.52****	Zero[d]	Zero[d]	**0.48****
			(0.074)			**(0.025)**
Implied frequency of nominal wage cuts	0.023	0.08	0.069	0.047	0.071	0.063
Share of workers affected by nominal wage rigidities	0.556	0.522	0.483	0.48	0.542	0.494
Log experience	−0.012**	−0.017**	−0.02**	—	—	—
	(0.002)	(0.002)	(0.002)			
Log tenure	−0.005**	−0.004*	−0.004*	—	—	—
	(0.002)	(0.002)	(0.002)			
Individual has subordinates (dummy variable)	0.029**	0.031**	0.032**	—	—	—
	(0.006)	(0.007)	(0.007)			
Individual is member of higher management (dummy variable)	−0.01**	−0.011**	−0.013**	—	—	—
	(0.003)	(0.003)	(0.004)			
Change in regional Unemployment Rate	−0.007*	−0.007*	−0.0082*	−0.008**	−0.008**	−0.008**
	(0.004)	(0.003)	(0.004)	(0.003)	(0.002)	(0.002)
Log(Age)	—	—	—	−1.12**	−1.15**	−1.21**
				(0.05)	(0.06)	(0.06)
Log^2(Age)	—	—	—	0.132**	0.146**	0.154**
				(0.007)	(0.008)	(0.008)
Foreigner (dummy variable)	—	—	—		−0.07**	−0.07**
					(0.021)	(0.021)
Foreigner*Log(Age)	—	—	—		0.019**	0.018**
					(0.006)	(0.006)
σ_e	0.121	0.118	0.137	0.113	0.115	0.139
σ_m	0.073	0.058	0.061	0.041	0.033	0.033
p	0.394	0.424	0.418	0.33	0.344	0.341
Year effects	Yes	Yes	Yes	Yes	Yes	Yes
Firm-size effect	Yes	Yes	Yes	—	—	—
Number of observations	21,144	21,144	21,144	58,297	58,297	58,297
Log likelihood	8,330	8,513	8,530	43,221	44,770	44,904

Notes: (a) standard errors in parenthesis, adjusted for clustering on cantons and years. *, ** denotes significance at the 5 percent and 1 percent level, respectively. (b) σ_e and σ_m denote the standard deviation of e_{it} and m_{it}, respectively. (c) Model with $\sigma_c = 0$ corresponds to the model estimated in Altonji and Devereux (1999). (d) Correlation of c_{it} with idiosyncratic wage change e_{it} is restricted to zero.

2.7 percent. Table 2 also shows that a rise in tenure decreases wage growth. The tenure effect is roughly one-third of the size of the experience effect. The estimates indicate a much faster decline of wage growth with experience than that obtained from an OLS regression. This should hardly come as a surprise, since our model takes the fact into account that small wage cuts, which result from a decreasing productivity over the life-cycle, for example, may not be implemented but rather turned into a wage freeze. This introduces an upward bias into the OLS estimate of the experience profile. Table 2 also indicates that the position of workers in the firm's hierarchy is important for wage growth. If the individual is a superior, wage growth is higher while if the individual is a member of higher management wage growth is lower.[5]

We also find evidence that the change in regional unemployment rate causes a substantial reduction in notional wage growth. The estimates imply that a one percentage point increase in unemployment growth reduces wage growth by at least 0.7 percentage points in the SLFS sample and by 0.8 percentage points in the SIF. The estimates are thus very robust across samples and indicate that wages would be quite flexible in the absence of downward wage rigidity. We also experimented with the level of the regional unemployment rate in the regressions. However, while the *change* in the unemployment rate has a sizeable and significant impact on wage growth, the coefficient of the unemployment rate is always rather small and insignificant. As with the experience profile above, we find that the coefficient of the change in the unemployment rate in OLS regressions is smaller in magnitude than in our model. This indicates that ignoring the impact of downward nominal wage rigidity understates the impact of changes in the unemployment rate on notional wage changes.

We find that wage growth strongly declines with age in the SIF sample as indicated by the negative and highly significant coefficient on log age. The SIF estimates also shows that wage growth is smaller for foreign workers, reflecting most likely systematic differences in job status between Swiss and Non-Swiss employees. In addition, the positive coefficient on the interaction term between foreigner status and age indicates that wage growth declines less for Non-Swiss employees. We also conducted several regressions in which we included a gender dummy and interactions between gender and age. However, the inclusion of these control variables has little impact on the estimated distribution of thresholds.[6]

[5]A superior is defined as an employee who has the power to direct the activities of several other employees without being a member of higher management.

[6]We also experimented with education variables in the SLFS sample. Their impact on wage growth was insignificant, however, in the period under consideration. This is not surprising, in view of the severe recession of the Swiss economy during this time. However, the lack of information on education other individual characteristics in the SIF might be problematic, as one of our discussants pointed out. While the striking similarity of the results obtained from the SIF and the SLFS do not necessarily support this conjecture, we further explore it in Table A1 of Fehr and Goette (2002). We interact the age profile fully with nationality and gender to see whether differences in education and tenure across these demographic groups affect our quantitative conclusions. The results in columns (2) and (3) do not point towards a significant bias of this sort: They are very close to the baseline results where we omit most of these interactions. The only notable difference is that the addition of the interaction terms increases the standard errors of the estimates somewhat, but not by much.

6.2. Are nominal rigidities easily malleable?

This section examines whether nominal wage rigidity tends to vanish in the course of a period with persistently low nominal growth. A natural way to test for this is to estimate year-specific distributions of wage cut thresholds. We then can calculate the share of individuals displaying some nominal rigidity (i.e., $c_{it}>0$) and strong nominal rigidity (i.e., $c_{it}>0.1$) on the basis of this information. Remember that inflation declined from roughly five percent in 1991 to zero percent in 1997. Real growth was slightly negative between 1991 and 1993 and slightly positive between 1994 and 1996. We should observe a decline in the impact of nominal rigidity as it weakens over time. We report the full results in an earlier version of this paper (Fehr and Goette, 2002, Table 4). We only present the graphical illustrations of these results here, due to space limitations. Panels (a) and (b) in Fig. 4 show the percentage of workers exhibiting some ($c_{it}>0$) and strong ($c_{it}>0.1$) rigidity.[7] The share of individuals displaying strong rigidity in the SIF sample is rather stable over the years and fluctuates between 88 and 92 percent (see Panel b in Fig. 4). The share declines from 92 to 82 percent between 1991 and 1996 in the SLFS sample and returns to 92 percent (see Panel a in Fig. 4) in 1997. The overall prevalence of downward nominal wage rigidity (the fraction of individuals with $c_{it}>0$) decreases somewhat from almost 100 percent to about 90 percent, in both the SLFS and the SIF samples.

To see whether this was enough to eliminate, or substantially reduce, the impact of downward nominal wage rigidity, we calculate the frequency of wage freezes and wage cuts for every year. The results are presented panels (c) and (d) in Fig. 4. We obtain the same outcome, irrespective of the data source: there is essentially no or only a minor increase in the frequency of true wage cuts during the sample period. The share of workers who did not receive wage cuts due to nominal wage rigidity rises sharply in both samples. Thus, the small reduction in the resistance against wage cuts was not nearly large enough to lead to a meaningful increase in the number of nominal wage cuts. Quite the contrary, the share of workers experiencing wage freezes because of nominal rigidity more than doubles by the end of the sample period.

6.3. Who is most affected?

There are various reasons why nominal rigidity is likely to be different for different categories of workers. First, fairness standards that render nominal wage cuts costly are likely to arise through a history of repeated interactions between the worker and the firm. Employers are less likely to feel constrained by fairness standards in the absence of such a history. Therefore, it seems much easier to impose pay cuts on job movers than on job stayers. Second, the loyalty and work morale of full-time

[7] Recall that the SLFS is based on May-to-May data. Hence, we use May-to-May changes in the CPI measure of inflation. Analogously, we use December-to-December CPI changes whenever we use the SIF data. Therefore, inflation rates differ somewhat between panel (a) and (b) of Fig. 4.

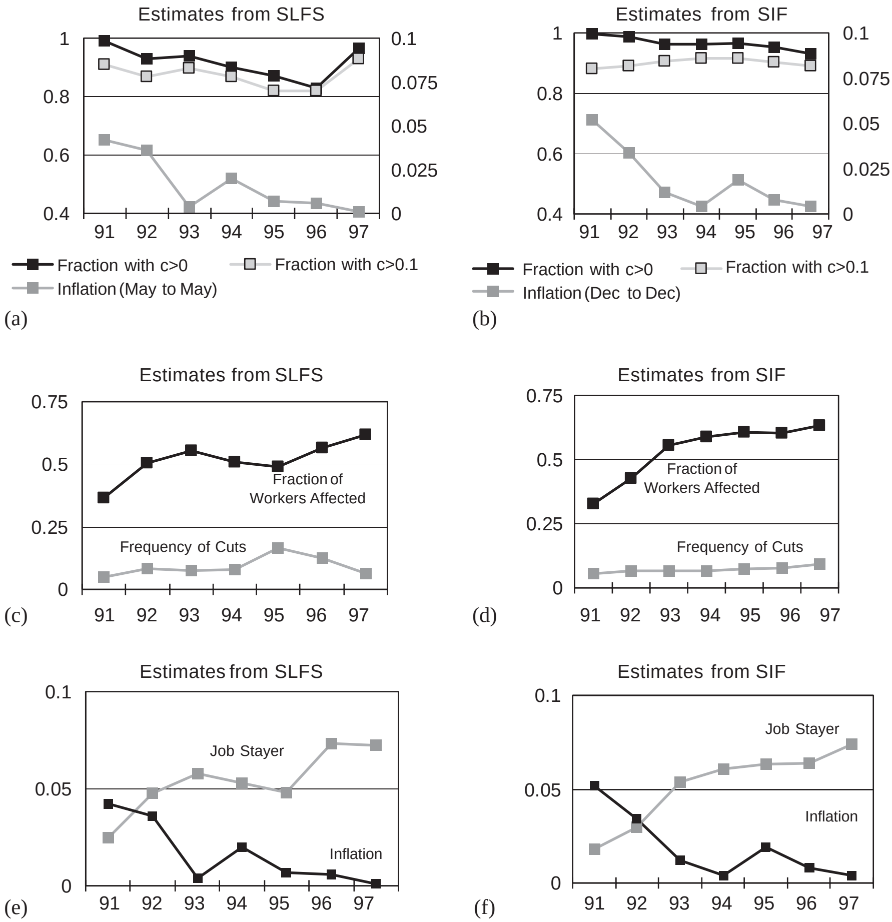

Fig. 4. Are nominal rigidities fading? (a) Inflation rate and resistance against wage cuts; (b) Inflation rate and resistance against wage cuts; (c) Extent of nominal wage rigidities over time; (d) Extent of nominal wage rigidities over time; (e) Average prevented real wage cut; (f) Average prevented real wage cut.

workers is generally more important for a firm than the loyalty and work morale of part-time workers. Moreover, the relevance of fairness standards is likely to be more important for workers with a greater attachment to the firm. Therefore, one would expect more wage rigidity among full-time workers. A third reason is related to the theory of efficient nominal wage contracts (MacLeod and Malcomson, 1993; Holden, 1999). These contracts serve the purpose of protecting the relation-specific investments of firms and workers efficiently. They are therefore more important for those workers who have more firm-specific human capital. Job stayers have, by definition, more firm-specific human capital than job movers. In addition, it seems likely that full-time workers have more specific human capital than part time

Table 3
Nominal rigidities for different groups of workers ML estimates from swiss labor force survey, 1991–1997

	Full-time vs. part-time work		Job stayers vs. job movers	
	Full-time job stayers	Part-time job stayers	Job stayers	Job movers
Mean threshold for wage cuts μ_c	0.987**	0.20**	0.644**	0.098**
	(0.03)	(0.06)	(0.04)	(0.01)
Standard deviation of threshold distribution σ_c	0.69**	0.155**	0.465**	0.07**
	(0.02)	(0.02)	(0.03)	(0.02)
Share of individuals displaying				
Some nominal rigidity[c]	0.923	0.905	0.917	0.917
Strong nominal rigidity[d]	0.901	0.748	0.879	0.487
Frequency of wage freezes and wage cuts				
Frequency of wage cuts	0.068	0.155	0.084	0.206
Frequency of wage freezes	0.572	0.48	0.552	0.406
σ_e	0.139		0.145	
σ_m	0.058		0.059	
Number of observations	21,144		22,971	
Log likelihood	8,513		8,929	

Notes: (a) Standard errors in parenthesis, adjusted for clustering on cantons and years. *, ** denotes significance at the 5 percent and 1 percent level, respectively. (b) Same specification as in Table 3, column (2). (c) Some rigidity is defined by a positive threshold wage cut ($c_{it} > 0$). (d) Strong rigidity is defined by a threshold wage cut of $c_{it} > 0.1$.

workers, meaning that efficient nominal wage contracts are more important for full-time workers. Therefore, the theory of efficient nominal wage contracts also suggests that nominal wage rigidity is more important for job stayers and for full-time workers.

The results expounding the differences between full-time and part-time job stayers are displayed in Table 3. As argued above, we find large differences between the two groups of employees. The estimated mean threshold μ_c is 0.2 for part-time job stayers, while amounting to 0.987 for full-time job stayers (see Table 3). Together with the estimated standard deviations, this difference translates into sizeable differences in the impact of wage rigidity. For instance, only 6.8 percent of the full-time job stayers experience wage cuts while 15.5 percent of part-time job stayers had to accept wage cuts. Likewise, nominal wage rigidity constitutes a binding constraint for 57.2 percent of the full-time job stayers, that is, there wages would have been cut in the absence of nominal rigidity, whereas this is the case for only 48 percent of part-time job stayers.

A similar picture emerges with regard to the difference between job stayers and job movers (see Table 3). Job stayers have a much larger average threshold, the frequency of true wage cuts is much smaller for them (8.4 percent versus 20.6 percent for job movers), and the share of workers for whom nominal rigidity is binding is much larger for job stayers (55.2 percent versus 40.6 percent). Thus, taken together, the evidence in this section is consistent with the arguments above that predict differences in nominal rigidity across these groups of workers. This lends support to the view that fairness standards and efficient nominal wage contracts are relevant factors behind the rigidity of nominal wages.

6.4. The consequences of downward nominal wage rigidity

The estimates provide two further pieces of information. First, we can calculate the average notional wage cut $x'_{it}b + e_{it}$ that did not occur because $-c_{it} < x'_{it}b + e_{it} \leqslant 0$ holds. For brevity, we call this the average prevented wage cut and denote it by $\mathrm{E}(\Delta w^*_{it}| - c_{it} < \Delta w^*_{it} \leqslant 0)$, where $\Delta w^*_{it} \equiv x'_{it}b + e_{it}$. Second, we can compute a measure of the average wage sweep-up due to downward wage rigidity $\mathrm{E}(\Delta w_{it} - \Delta w^*_{it})$ where Δw_{it} is the true wage change. The average wage sweep-up can be interpreted as the increase in average labor costs due to downward rigidity of nominal wages. If this interpretation is correct, a rise in the average wage sweep-up should be associated with a rise in unemployment or a decline in employment in the different industries and cantons.

Panels (e) and (f) in Fig. 4 exhibit the evolution of $\mathrm{E}(\Delta w^*_{it}| - c_{it} < \Delta w^*_{it} < 0)$ for the job stayers. The panels show that downward nominal wage rigidity had less impact at the beginning of the period considered when inflation was still relatively high. The prevented wage cut at this time was roughly 2 percent in both data sets. This changes substantially in years where inflation rates are closer to zero. From 1993 onwards, the prevented wage reductions are, on the average, 5 percent or more. This shows again that nominal rigidity became increasingly important during the period of low nominal growth.

We now turn to the question whether downward nominal wage rigidity has consequences for the real side of the economy. For this purpose we compute the average wage sweep-up $\mathrm{E}(\Delta w_{it} - \Delta w^*_{it})$ for every canton and every industry and relate them to the unemployment *rate* in the cantons and the industries. Since there are large variations in the level and in the changes of unemployment across cantons and across industries, it is interesting to examine extent to which variations in the wage sweep-up can explain these variations in unemployment. Note that the changes in the unemployment rate in our sample are almost exclusively driven by the changes in the employment level because labor supply was roughly constant. Therefore this examination also provides direct insights into the relation between employment and average wage sweep-ups across cantons and industries. Note also that the *rate* of unemployment is *not* an explanatory variable in our estimate of the wage sweep-up. This is important because otherwise there would be a relation between wage sweep-up and unemployment by construction.[8]

[8]Remember (from Section 6.1) that the *level* of the unemployment rate does not affect notional wage changes. Instead, notional changes are affected by labor market experience, tenure, unemployment *growth*, age, etc. The differences in these variables across cantons and industries determine, together with our estimate of μ_c and σ_c, the different wage sweep-ups in cantons and industries. Note also that the

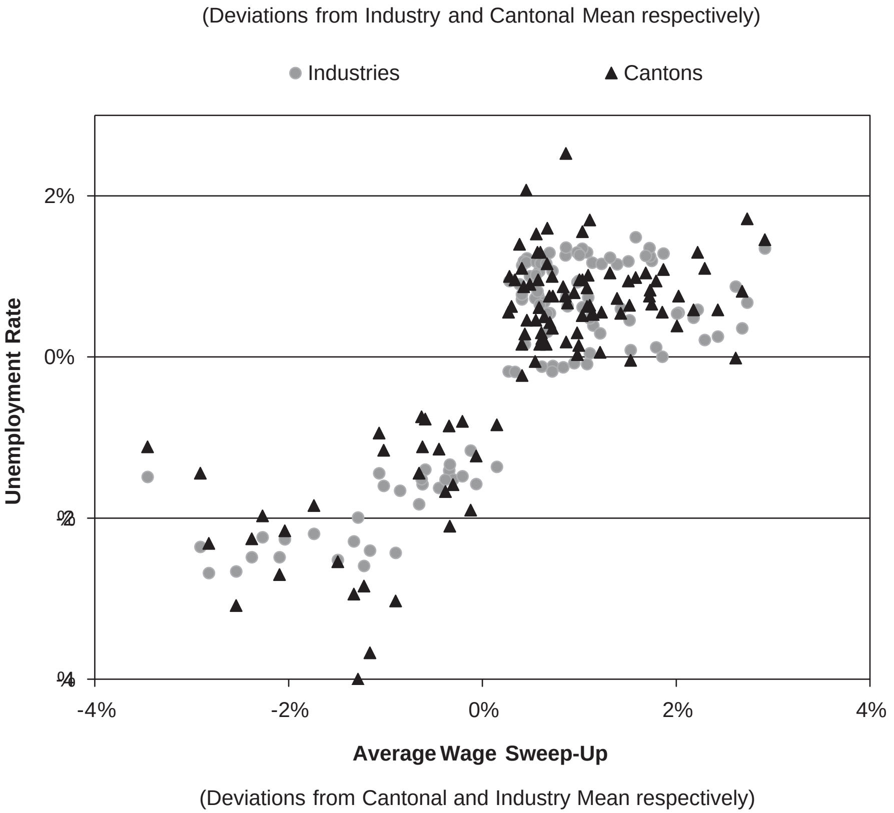

Fig. 5. Average wage sweep-up and unemployment.

In Fig. 5, we plotted the relation between average wage sweep-up and unemployment rate for each canton and industry with more than 1 percent of the labor force, relative to the canton's and industry's mean respectively (in total we lose less than 2 percent of all observations by excluding the small cantons). Fig. 5 conveys a striking message: we can observe an unambiguous positive relation between the wage sweep-up and the unemployment rate. It is important to emphasize that a positive relation between the annual unemployment rate and the annual wage sweep-up also exists for each canton and for each industry,

(*footnote continued*)
correlation between cantonal (industry) unemployment *rates* and cantonal (industry) unemployment *growth* is negligible (−0.01 for the cantons and 0.13 for the industries). Hence, the cantonal (industry) wage sweep-ups can be used as an independent variable in the explanation of cantonal (industry) unemployment rates.

separately (see Fehr and Goette, 2002). In addition to Fig. 5 we ran the following regression:

$$u_{jt} = const. + bE_{jt}(\Delta w - \Delta w^{*}) + e_{jt} \tag{3}$$

where u_{jt} is the rate of unemployment in canton j and year t, and $E_{jt}(.)$ denotes the average wage sweep-up in canton j and year t. The OLS estimate of (3) yields a highly significant and large positive point estimate of 1.17 for b (s.e. $= 0.11$, adjusted for clustering on cantons): A one percent increase in the wage sweep-up increases unemployment by 1.17 percentage points. The R^2 of regression (3) is 0.49, meaning that variations in the wage sweep-up alone explain 49 percent of the variance in the unemployment rate. When we add cantonal and year fixed effects, the result remains unchanged. The point estimate for b is 1.11 (s.e. $= 0.09$) when we add cantonal fixed effects that control for permanent regional differences in labor market conditions. Hence, permanent regional differences that affect the unemployment rate and the wage sweep-up simultaneously do not drive the result. When we add year fixed effects, the point estimate of b is again significant and positive ($b = 2.24$, s.e. $= 0.88$). The size and the standard error of b is now higher. That b remains positive and significant means that the estimate of b is not just driven by year effects that affect the wage sweep-up and the unemployment rate simultaneously. In fact, the year fixed effects do not add much to the explanation of unemployment, once one controls for the wage sweep-up. They mainly inflate the standard error of the estimate, rendering the differences between the different estimates of b insignificant. We add year and cantonal fixed effects to the regression in the strictest specification and again find a positive and highly significant point estimate of $b = 1.69$ (s.e. $= 0.44$).

We repeated this exercise for unemployment and wage sweep-ups in different industries (see also Fehr and Goette, 2002). The wage sweep-up has a sizeable and significant impact on industry unemployment in all specifications. Interestingly, the size of b obtained from the industry sample is quantitatively very similar to the estimated size of b from the canton regressions.

Thus, Fig. 5 and the results of these regressions show that variations in unemployment rates across cantons and industries are strongly related to the corresponding variations in wage sweep-ups caused by nominal rigidity. This represents strong evidence that nominal wage rigidity had negative employment effects in the low inflation environment which characterized the Swiss economy in the 1990s.

7. Concluding remarks

It has been argued that the downward rigidity of nominal wages will vanish in a macro-environment with persistently low nominal wage growth. Workers will become accustomed to more frequent nominal wage cuts and employers will, therefore, not shy away from cutting nominal pay. If this argument were valid, nominal wage rigidity would be largely irrelevant because there is little need to cut nominal pay to achieve real wage adjustments in an environment with high wage inflation while nominal rigidity would be absent in a low inflation environment.

This paper uses three different data sources to examine this conjecture for the Swiss situation between 1991 and 1997. Switzerland went through a unique macroeconomic phase during this time, with a rapid decline in wage inflation, and four years of intense pressure on nominal wages that never allowed nominal wage growth to exceed 1.5 percent. All three data sources used in this paper show that nominal wage rigidity also persists in periods of low wage inflation. The personnel files of two firms indicate that wage cuts almost never occur. The data from the Swiss Labor Force Survey indicate that at most 8 percent of the job stayers receive wage cuts while nominal rigidity prevents wage cuts for 50 or more percent of the job stayers. The data from the Social Insurance Files suggest even fewer wage cuts. Our estimates also show that the impact of nominal rigidity does not decline in this period of sustained low inflation. While there was a tiny increase in the fraction of employees willing to take wage cuts, this increase was far too small to accommodate the greater need for wage cuts. The fraction of workers whose wages are *not* cut because of nominal rigidity increases considerably over time, while the frequency of true wage cuts remains roughly constant. This indicates that the downward rigidity of nominal wages remained a binding constraint for many employees, even though the downward pressure on nominal wages increased over time. Moreover, the relatively large coefficient on the unemployment change in the wage growth equation suggests that wages would be quite flexible in the absence of nominal rigidity.

Theories of nominal wage rigidity based on the existence of efficient nominal contracts or on nominal fairness standards in repeated work relations predict that the wages of job movers show less rigidity than the wages of job stayers. These theories also suggest that the wages of part-time workers exhibit less rigidity than the wages of full-time workers. Our results confirm these predictions and lend thus support to these theories.

Our examination also suggests that nominal wage rigidity has important macroeconomic effects in an environment with low real wage growth and low inflation. The wage sweep-up due to nominally rigid wages explains a large part of the variations in the rate of unemployment across industries and cantons: The higher the wage sweep-up, the higher is the unemployment rate. This lends support to the view that the downward rigidity of nominal wages is sufficiently strong to cause an increase in real labor costs and a decrease in employment.

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