Downward Nominal Wage Rigidity in the United States During and After the Great Recession

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Abstract

Rigidity in wages has long been thought to impede the functioning of labor markets. One recent strand of the research on wage flexibility in the United States and elsewhere has focused on the possibility of downward nominal wage rigidity and what implications such rigidity might have for the macroeconomy at low levels of inflation. The Great Recession of 2008-09, during which the unemployment rate topped 10 percent and price deflation was at times seen as a distinct possibility, along with the subsequent slow recovery and persistently low inflation, has added to the relevance of this line of inquiry. In this paper, we use establishment-level data from a nationally representative establishment-based compensation survey collected by the Bureau of Labor Statistics to investigate the extent to which downward nominal wage rigidity is present in U.S. labor markets. We use several distinct methods proposed in the literature to test for downward nominal wage rigidity, and to assess whether such rigidity is more severe at low rates of inflation and in the presence of negative economic shocks than in more normal economic times. Like earlier studies, we find evidence of a significant amount of downward nominal wage rigidity in the United States. We find no evidence that the high degree of labor market distress during the Great Recession reduced the amount of downward nominal wage rigidity and some evidence that operative rigidity may have increased during that period.

I. Introduction

Rigidity in wages has long been thought to impede the functioning of labor markets. Such rigidity can take different forms, with differing implications for unemployment and other aspects of labor market or economic performance. Rigidity in real wages, such that nominal wages quickly or immediately adjust to changes in prices regardless of economic conditions, could arise from explicit or implicit contracting or as a byproduct of efficiency-wage setting. Rigidity in nominal wages could arise from fixed-length nominal wage agreements between employers and employees, the presence of menu costs in the wage-setting process, government regulations such as minimum wages or government pay systems, or informational or behavioral factors that leads employers and/or employees to focus on nominal rather than real wages. For example, the contracting model of Taylor (1980), which underpins many New-Keynesian models of the inflation process, assumes that nominal wages remain fixed for some period of time owing to the presence of formal or informal contracting. Similarly, menu costs are often cited as sources of symmetric nominal wage rigidities in the United States.

One strand of the research on wage flexibility in the United States and elsewhere has focused on the possibility of asymmetric rigidities in the nominal wage-setting process—most notably the downward nominal wage rigidity posited by Keynes (1936) and, later, Tobin (1972)—and what implications such rigidity might have for the macroeconomy at low levels of inflation. With inflation rates often running well over 5 percent in the 1970s and early 1980s, such concerns were seen as mostly immaterial—the costs of inflation were viewed as clearly exceeding any potential benefits. However, with consumer price inflation declining to rates at or below 2 percent by the mid-1990s, the question of whether workers or firms resist nominal wage cuts—and the consequences for labor market performance—came to be viewed as increasingly relevant. The Great Recession of 2008-09, during which the unemployment rate reached 10 percent and price deflation was at times seen as a distinct possibility, added to the relevance of this line of inquiry. And, indeed, some researchers have argued that downward nominal wage rigidity has had an important influence on the behavior of wage and price inflation in recent years (Daly and Hobijn, 2014).

In this paper, we use establishment-level data from a nationally representative compensation survey collected by the Bureau of Labor Statistics (BLS) to investigate the extent to which downward nominal wage rigidity is present in U.S. labor markets. Rather than restricting our analysis to a single method for estimating downward nominal wage rigidity, we use several distinct methods proposed in the literature to examine the distribution of wage changes and how it has changed over time. With a particular focus on the Great Recession and subsequent slow recovery in labor markets, we examine whether downward nominal wage rigidity is more severe at low rates of inflation and in the presence of negative economic shocks than in more normal economic times, or to the contrary, whether pressures on profits and the persistently low inflation for the better part of a decade reduced resistance to nominal wages cuts.

Like earlier studies, we find evidence of a significant amount of downward nominal wage rigidity in the United States, both in terms of the fraction of jobs potentially subject to downward nominal wage rigidity and the proportion of wage changes that were actually constrained by such rigidities. The distribution of wage changes over 12-month periods exhibits a sizable spike at zero, and all of the methods we use point to at least some downward nominal wage rigidity over our sample period. However, there is mixed evidence on how downward nominal wage rigidity has changed over time. Several of the estimators we examine show no clear pattern, despite the lower rates of inflation and deep economic contraction experienced during the more recent period. Two of the estimators suggest that the amount of downward nominal wage rigidity seen in practice (which we will refer to as "operative rigidity") rose noticeably during the Great Recession, while one shows evidence of a decline in rigidity that predates the recession. None of the estimators we examine, however, indicate that the labor market distress during and after the Great Recession reduced nominal wage rigidity.

Despite the overwhelming evidence for downward nominal wage rigidity in the U.S. data, many researchers find little evidence that this form of rigidity has had material consequences for the performance of the labor market. Various hypotheses have been put forward to explain this finding, some of which we can test with our data. We find the most compelling reason for the lack of macroeconomic consequences from downward nominal wage rigidity relates to the possibility that firms take a multi-year view about their labor costs when implementing their compensation practices.

II. Background

Although clearly evident in the earlier writings of Keynes, the notion that downward nominal wage rigidity might lead to undesirable macroeconomic consequences at low levels of inflation resurfaced with Tobin (1972), who argued that to "grease the wheels of the labor market," it would be optimal to target an inflation rate somewhat above zero.[1] As noted above, given the high levels of inflation during the 1970s and early 1980s, such an argument did not seem particularly germane to policymakers at the time. However, as inflation continued to trend down in the early 1990s, the question of the macroeconomic effects of downward nominal wage rigidity regained some prominence. The possibility that nominal wages were downwardly rigid

[1] A similar argument can be seen in Lipsey (1960) and Summers (1991).

also accorded with indications from a variety of surveys (Blinder and Choi, 1990; Bewley, 1999; Bertola, 2012; Smith, 2014; Du Caju et al, 2015) that declines in real wages caused by price increases are more acceptable to workers than nominal wage cuts and that employers are often reluctant to cut nominal wages because they believe such cuts would damage worker morale.

This survey evidence has been accompanied by empirical research, the first wave of which focused on micro-level data from household surveys, to assess the extent of downward nominal wage rigidity in actual wages. In particular, research by McLaughlin (1994), Lebow, Stockton, and Wascher (1995), and Kahn (1997) all used individual-level wage changes constructed from the Panel Survey of Income Dynamic to test for the presence of downward nominal rigidity, with McLaughlin and Lebow et al. finding limited supporting evidence and Kahn finding somewhat more—especially for hourly wage workers.

However, concerns about the prevalence of measurement error in the wage changes constructed from these surveys (e.g., Bound and Krueger, 1991; Gottschalk, 2004) led many to question the reliability of the findings from this research. One response to these concerns has been to try to correct for measurement error. For example, Altonji and Deveraux (2000) estimated a model that explicitly allows for measurement error in reported wages from the PSID and find that nominal wage cuts are over-reported in that dataset, while nominal wage freezes are under-reported. Similarly, Gottshalk (2004) applied methods to test for structural breaks to wage histories from the Survey of Income and Program Participation (SIPP) and finds that the frequency of nominal wage cuts is overstated in the raw data.[2] And, Dickens et al. (2007) found that the auto-covariance of individual wage changes was positively correlated with measures of

[2] See also Barattieri, Basu, and Gottschalk (2014), although their focus is more on nominal wage rigidity in general than on downward nominal rigidity.

real and nominal wage rigidity in the household-level data sets they examined, leading them to conclude that those rigidity measures are biased downward by measurement error in the data.

Other researchers turned to employer surveys, which are thought to suffer less from misreported wages. These studies generally found a large role for downward nominal wage rigidity.[3] However, much of the research that has used firm-level data has been based on case studies or on samples of only a small number of firms, and thus seems of limited applicability to the U.S. economy as a whole. That said, Lebow, Saks, and Wilson (2003) used the same nationally representative dataset that we employ in this paper and found that downward nominal wage rigidity reduced the number of nominal wage cuts by about half over their sample period.

With the research tending toward finding an identifiable presence of downward nominal rigidity, a second question was whether the magnitude of that rigidity was large enough to entail important macroeconomic consequences. Some researchers, including Akerlof, Dickens, and Perry (1996) argued that it did.[4] In particular, these authors used a simulation model and found that reducing inflation from 3 percent to zero would lead to a significant and inefficient reduction in employment and raise the sustainable rate of unemployment by 1 to 2 percentage points. They supplemented this finding with evidence suggesting that the Phillips curve is flatter at low rates of inflation.

Other researchers tended not to find sizable macroeconomic effects from downward nominal wage rigidity, suggesting that employers often can find ways to adjust their labor costs without having to cut nominal wages. For example, Card and Hyslop (1997) found little evidence that downward nominal wage rigidity affects real wage growth, while Lebow, Saks, and Wilson (1999) find only weak evidence of an effect of downward nominal wage rigidity on

[3]See, for example, Wilson (1999) and Altonji and Deveraux (2000).
[4] See also Groshen and Schweitzer (1999).

aggregate wages in a wage-price Phillips curve model. Lebow et al. attributed this partly to a tendency for employers to use benefits to offset the rigidity in nominal wages and found, in particular, that downward nominal rigidity in compensation was about one-third less than in wages and salaries. Meanwhile, Elsby (2009) and Stuber and Beissinger (2010) provided evidence that firms respond to downward nominal wage rigidity by compressing the wage structure for other employees, effectively offsetting the effects of rigidity on aggregate wage growth. And, more recently, Kurmann, McEntarfer and Spletzer (2014) reported that the downward nominal wage rigidity apparent in nominal hourly wage rates is not evident in annual earnings, suggesting that employers respond to the rigidity in wages by reducing the hours worked by their employees.

The commenters on Akerlof, Dickens, and Perry (1996) also noted that the presence of important downward nominal rigidity observed in an environment of rapid inflation need not imply that such rigidity would remain important in an environment of low inflation or severe economic distress.[5] Such a finding would be consistent with the surveys conducted by Kahneman, Knetsch and Thaler (1986) and Bewley (1995), both of which suggested that employees find nominal wage cuts mostly unobjectionable if a firm is losing money.

These considerations suggest that we might have expected to experience a decline in the degree of downward nominal wage rigidity in the United States during and after the Great Recession. However, using data from the Current Population Survey (CPS), Daly, Hobijn, and Lucking (2012) and Daly and Hobijn (2014, 2015) found a noticeable rise between 2007 and 2011 in the percentage of workers in the same job who reported no change in their wage relative to a year earlier, with the proportion of workers with no change in 2011 higher than in any period

[5] See especially the discussions by Robert Gordon and Greg Mankiw. See also Groshen and Schweitzer (1999) and Hanes and James (2003).

since the beginning of their sample period in 1983. The increase in nominal wage rigidity was widespread by education level and across industries, suggesting that a broad range of employers were reluctant to cut wages despite the adverse demand shocks associated with the financial crisis. They also argued that downward nominal wage rigidity has restrained the pace of aggregate wage growth during the recovery as employers refrained from raising wages even as the economy improved.[6]

In this paper, we make two primary contributions to the question of the evolution of downward nominal wage rigidity in recent years. First, we use data from a survey of employers, which is likely subject to less measurement error than data from the CPS. Second, we employ several estimators of the extent of downward rigidity that go beyond the size of the spike at zero wage change. This has two advantages. First, we can assess whether our conclusions are robust to alternative methods of detecting rigidities. Second, we can, under some assumptions, use our methods to assess both the extent to which *actual* wage changes were constrained by downward nominal wage rigidity, and whether there were behavioral changes on the part of employers and workers that led to a change in the *potential* for downward nominal wage rigidity to bind during or after the Great Recession – for example, whether individual or employer norms towards nominal wage cuts responded to the prolonged period of low inflation and economic stress.

III. Data

[6] Elsby, Shinn, and Solon (2016) also used the CPS data to test for the presence of downward nominal wage rigidity in the United States. In contrast to Daly and Hobijn, these researchers used the January tenure supplement to the CPS to identify individuals who had been with the same employer for at least a year. Their results showed a somewhat larger spike at zero than reported by Daly and Hobijn, with estimates after 2009 similar to those indicated by the ECI data. That said, the basic pattern of is broadly similar to the other estimates, suggestive of an increase in downward nominal wage rigidity after 2009.

Our study uses employer-based data that extends from the early 1980s through the Great Recession and subsequent slow recovery. In particular, we rely on a large, nationally representative sample of specific jobs within specific establishments from the BLS' Employment Cost Index (ECI) program. The Employment Cost Index is intended to measure how much an employer must pay to employ the same labor input in the current period as in a base period. Each quarter, the program collects data on various components of compensation per hour for, currently, about 46,000 jobs representing specific occupations within about 10,000 establishments throughout the United States.[7] In addition to wages and salaries, the ECI survey asks employers about the costs of various benefits, including paid leave, supplemental pay, insurance, pensions, and legally-required benefits.[8] Costs are converted to an annual rate and divided by annual hours worked to arrive at hourly compensation costs.

For each establishment, data are collected for a sample of jobs, with a median of 5 jobs per establishment. The jobs, which refer to the most detailed occupation and work-level recognized by the firm, are selected by randomly sampling from a list of employees in the establishment such that the probability that a job is selected is proportional to the number of workers in that job at the establishment.[9] Accordingly, sampled jobs are likely to be those in which the establishment's workers are concentrated, but they do not represent a census of jobs in the establishment. The unit of observation is the job rather than the worker, and each observation represents the average wage or compensation costs for the job as of the pay period

[7] Private and state and local government establishments are included in the survey, while the federal government is not included. The sample size has increased substantially from the beginning of the program in the early 1980s.
[8] Training and in-kind benefits are excluded, as are employee stock options.
[9] Workers are included in the data for a job at an establishment only if they are actually employees of the establishment. Outside contractors or employees of a temporary help agency, for example, would not be included in the data for a job at an establishment even if the work is performed at the establishment. (They would be included in data for the temp agency.)

that includes the twelfth day of the third month of the quarter. Each establishment is assigned a fixed weight that is proportional to its size when it enters the sample. The sample is stratified to ensure sufficient coverage of industries, regions, and establishment-size classes. Finally, an establishment typically remains in the ECI sample for about 20 consecutive quarters before being replaced.

The data collected from the survey are used by the BLS to calculate a Laspeyres index of the form

$$ECI_t = \frac{\sum_i E_{i0} W_{it}}{\sum_i E_{i0} W_{i0}}$$

where i represents the employer-occupation cells and t represents time. The BLS issues a press release each quarter that presents the Employment Cost Indexes for the United States as a whole, as well as specific indexes for major occupational categories, industries, and regions. Changes in the ECI are a key measure of wage or compensation inflation in the United States. Wage inflation so measured has ranged from about 9 percent in 1981 to less than 1½ percent in 2009 and is highly correlated with price inflation as measured by the CPI.

For our analysis of wage rigidity, we use the micro-level data from the ECI program as an unbalanced panel of observations on jobs within establishments. Starting with the same sample of observations as is used to calculate the published ECI (which, for example, excludes observations without positive wages and salaries per hour), we then restricted our sample to private-sector establishments in which at least 3 jobs were sampled in a given year; this reduces the number of observation by 15 to 20 percent in each year. In order to avoid complications arising from the seasonality of pay-setting, we also restrict our analysis to 12-month changes, from March to March in particular. In addition, we trimmed the data set by setting any log changes in wages and salaries per hour that were below the first percentile to the first percentile value by year and any that were above the 99th percentile to the 99th percentile value by year. As is indicated in Table 1, the microdata are available from 1982 to 2014, leaving us with a sample consisting of wage changes for an average of 19,787 jobs within 5,017 establishments per year over more than 30 years.[10]

As noted above, the unit of observation in our data is the job – a specific job within a specific establishment – not the worker. As we see it, there are conceptual advantages to each type of observation. The wage rate for the job may be more relevant to firms' employment, production, and pricing decisions, while wages for specific individuals may say more about the behavioral roots of wage rigidity and the implications for earnings. At the practical level, we believe that the large sample size and greater accuracy of measurement from this source of data make it a valuable object of study regardless of which unit of observation one considers conceptually superior.

IV. Preliminary Data Analysis

Table 1 also presents some simple summary statistics from our dataset. The average annual wage change in the sample was .033 log points, while the standard deviation of log wage changes was .108 points. As is indicated in Table 2, however, there has been considerable variation in the magnitude of wage changes over time, with wage increases averaging .065 points in 1982 to just .0114 points in 2011.

[10] BLS imputed values for wages and salaries per hour for the roughly eight percent of the observations that were missing data due to non-response or other reasons. In these cases, an initial value was collected, but values were imputed for quarters for which changes from the previous quarter were not reported. We include both imputed and non-imputed data in our analysis.

Figure 1 presents histograms of the wage change distribution for four selected years. The top two panels— wage changes ending in 1982 and 1989—represent relatively high inflation years, while the bottom two panels—2002 and 2010—show the distribution in years when inflation was below 2 percent. In each panel, the horizontal axis ranges from log wage declines of -0.4 to log wage increases of 0.6. The line show the proportion of wage change observations in bins of width 0.01 (except at zero, where it shows the proportion of observations with no wage change).[11]

Consistent with the idea that nominal wage rigidity is prevalent in U.S. labor markets, the most notable feature of the histograms is that all of them exhibit a sizable spike at zero. The size of the spike is presented for each year separately in the last column of Table 2, which shows that the percent of observations with a zero wage change climbed from 11 percent in 1982 to 20 percent in 1994; it subsequently dropped back to 11 percent in 2008, and then moved back up to near 20 percent after 2009. Apart from the spike at zero, the wage change distribution appears to be unimodal, with the mode tending to be slightly higher than the mean change in wages. The distribution also tends to be more concentrated around the mode than a normal distribution. In addition, there is no clear evidence of systematic asymmetry near the mode of the distribution. Finally, the direction of skewness tends to vary by year, with no clear pattern.

V. Tests of Rigidity Using Properties of the Wage Change Distribution

In this section, we describe the various tests we use to evaluate the evidence for downward nominal wage rigidity using properties of the wage change distribution. We begin by briefly summarizing the intuition underlying the various tests, focusing both on estimating the

[11] Also, the bins at the extremes of the distribution are wider because of the sparsity of the data in those regions.

actual proportion of the wage change distribution affected by downward nominal wage rigidity in each year and the proportion that are potentially subject to downward nominal wage rigidity in the event that their notional wage change is negative.

A simple measure of operative downward nominal wage rigidity is the size of the spike at zero; this is essentially the measure employed by Daly and Hobijn using household-level data from the Current Population Survey. A related test for potential rigidity, described in Dickens et al. (2007), assumes that all reported nominal wage freezes would have instead been nominal wage cuts in the absence of downward nominal wage rigidity. Under this assumption, the ratio of nominal wage freezes to the sum of nominal wage freezes and nominal wage cuts provides an estimate of the proportion of jobs that are potentially subject to downward nominal wage rigidity. Because wage changes could be set to zero for other reasons (e.g., menu costs), this measure should be viewed as an upper bound. However, it provides a good starting point for our analysis.

The second test, which was developed by Lebow, Stockton, and Wascher (1995), assumes that the wage change distribution that would obtain in the absence of rigidities, the "notional" distribution, is symmetric, and that the upper half of the distribution is largely unaffected by rigidity. This procedure (which we subsequently refer to as the LSW statistic) then uses deviations in the shapes of the upper half and lower half of the distribution as an indication of operative downward nominal wage rigidity. In particular, the difference in the mass above twice the median to the mass below zero provides an estimate of the fraction of wage observations that were constrained by downward nominal wage rigidity. The related test for potential downward nominal wage rigidity uses the ratio of the mass above twice the median to the mass below zero. Under certain assumptions, this ratio can be viewed as a measure of the proportion of observations potentially subject to downward nominal wage rigidity if their notional wage changes were to fall below zero.[12]

The third test is based on a procedure developed by Kahn (1997) that assumes the distribution of notional wage changes is fixed over time except for a variable mean. The idea underlying this test is to examine the extent to which the mass at various points in the wage changes distribution differs from what would be expected in the absence of wage rigidity, where the mass points of that notional distribution in each percentile of the histogram are based on years in which a particular type of rigidity would not be expected to affect the proportion of observations in that bin. In this case, the estimate of downward nominal rigidity is based on comparisons of the size of the bars below zero in low and high inflation years, while the estimate of menu costs is based on comparisons of the bars in the neighborhood of zero in different years. The rigidity estimates are estimated simultaneously by regressing the fraction of observations in each bin in each year on a set of dummy variables representing each cell of the distribution and a second set of dummy variables that indicate the type of rigidity expected to affect each cell in each year.

The fourth test takes a more parametric approach to the problem. It assumes that the notional wage-change distribution as a whole can be modeled as a two-sided symmetric Weibull distribution, appealing to Gottschalk (2004) to support this assumption.[13] Differences between

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[12] These assumptions include (1) that the shape of the notional distribution does not vary as the average wage change falls or rises; (2) the extent of potential rigidity is invariant to the average wage change; and (3) that the degree of potential rigidity is the same at all relevant points in the wage change distribution (that is, a job at the Xth quantile of the wage change distribution is as potentially rigid as a job in the Yth quantile of the distribution, for any X and Y that have a realistic chance of falling below zero). Dickens et al. (2007) use a broadly similar measure to test for potential real downward wage rigidity.

[13] Guvenen et al (2015) find that the empirical distribution of one-year changes in earnings across individuals is decidedly more peaked than the typically assumed lognormal distribution, providing further support to the choice of a double-sided Weibull distribution. Note that although we have chosen to specify the notional distribution to be symmetric, as in the first two tests we employ one could allow for an asymmetric distribution.

specific observed mass points of the wage-change distribution and those implied by the assumed notional distribution can be interpreted as estimates of the effect of various types of rigidities on the observed distribution. The model allows for downward nominal rigidity (e.g., $\Delta \log w = 0$ when the notional wage change is less than zero) and menu costs (e.g., $\Delta \log w = 0$ when the notional wage change is small in magnitude), and assumes that these potential rigidities take particular parametric forms. In the specification we have implemented, the probability that a notional wage change of a given sign and magnitude will, in practice, become zero due to downward rigidity or menu cost rigidity, respectively, is a linearly declining function from a highest probability near zero wage change to a zero probability at some distance from zero.

The estimated parameters of the model then provide an indication of the fraction of observations subject to each type of rigidity, both overall and at each value of notional wage change. This is a greater level of detail than is available from the other tests we employ, at the cost of making stronger assumptions about the underlying distribution and parameterization of the rigidities. In this framework, we could, in principle, simulate the degree of rigidity that would obtain if the notional distribution were to shift, and could specify the parameters of both the notional distribution and of rigidity as functions of observed characteristics, such as industry of employment. However, here, in keeping with the first two tests, we have allowed the parameters to vary year by year, but not with individual characteristics.

VI. Results

Estimates from the various tests are summarized in Tables 3 and 4 and in Figures 2 through 10. In the tables, we show the estimates averaged over the entire period for which the

ECI is available, as well as the results for selected subperiods. None of the tests is optimal in the sense that all of them rely on relatively strong assumptions about the underlying distribution of wage changes in the absence of rigidities. For this reason, we present the results from all of the tests and then evaluate the preponderance of the evidence for and against downward nominal wage rigidity.

A. Size of Spikes tests

As noted above, the size of the spike at zero provides a straightforward and simple estimate of the degree of operative nominal wage rigidity in each year. Figure 2 shows these statistics. At least 10 percent, and typically at least 15 percent, of wage changes are stacked at zero in each year. If this is, in fact, downward nominal rigidity, then we would expect the size of the spike to be negatively correlated with the rate of wage inflation.[14] Figure 2 represents wage inflation by the median log wage change. A negative relationship is not obvious to the eye, other than perhaps in the period since 2009. As indicated by the scatter plot in the bottom panel, however, the two variables are negatively correlated, with a correlation coefficient of -0.53.[15]

The top panel of Figure 3 presents the time series of the estimates of potential rigidity related to this measure, which we refer to as the relative size of zero wage changes. The relative proportion of zero wage changes centers around about 50 percent, suggesting that the number of nominal wage cuts would have been twice as large in the absence of downward nominal wage rigidity. However, this measure of rigidity was noticeably higher in the 1980s and 1990s than

[14] Of course, a negative relationship between inflation and the proportion of observations with zero wage change could also occur for other reasons. For example, symmetric rigidity around zero wage change (e.g., due to menu costs) would also be expected to be produce a larger spike at lower rates of inflation if a decline in inflation shifted the bulk of the wage change distribution towards zero.

[15] Calculating the correlation with nominal wage growth allows for the possibility that increases in productivity may limit extent of notional nominal wage cuts by raising the prevalence of notional real wage increases. Using CPI inflation instead of wage inflation yields a smaller (-0.25), but still significant, correlation coefficient.

over the subsequent 15 years. It did move back up during the Great Recession, but to a level that was no higher after 2010 than it was in, say, 2001. That is, according to this statistic, the potential for downward nominal wage rigidity was no different in the Great Recession—a period with a large negative demand shock and low inflation—than in 2001—a period with a mild negative demand shock and somewhat higher inflation. As noted above, however, this measure does not attempt to distinguish among the possible sources of nominal rigidity and thus should be viewed as an upper bound of downward rigidity in particular.

The bottom panel of the figure plots this measure of potential rigidity in each year against the median wage change in that year. There is no overall negative relationship between this measure of potential nominal rigidity and the rate of wage inflation. Indeed, the correlation coefficient is positive, suggesting that higher rates of wage inflation have historically been associated with larger relative spikes at zero. However, judging from the upper panel, this result is largely driven by the trends in the series and the increase in the relative size of the spike at zero after 2009 was accompanied by a noticeable slowing in the median wage increase.

B. LSW statistics

The LSW statistic is presented in the top panel of Figure 4. Between 1983 and 2009, the statistic is fairly flat, suggesting little change in the extent of downward nominal wage rigidity over that period. In 2010 and 2011, however, this estimate of rigidity moved sharply higher and remained elevated thereafter. As can be seen in the scatter plot in the bottom panel, the observations from recent years, coupled with the low estimate of rigidity in 1982 (a high inflation year), leads to a negative correlation of -0.74 between the estimates of downward nominal rigidity and the median wage changes, consistent with the hypothesis that operative rigidity increases at low rates of inflation. Starting the sample period in either 1983 or 1988 results in slightly smaller, though still statistically significant correlation coefficients of -0.6.[16]

Figure 5 plots the proportional version of the LSW statistic, which, like the relative size of zero statistic, can be viewed as a measure of potential rigidity – that is, the proportion of jobs that would be subject to downward nominal wage rigidity in the event that the notional wage change for that job was negative. This measure shows a more muted pattern over time than does the LSW statistic for operative rigidity. In particular, although it moved up noticeably in 2010 and has remained elevated since then, the values in recent years are only a little higher than in 2001. Over the entire sample period, the correlation coefficient between this measure of rigidity and the median wage change is negative, in contrast to our expectation that *potential* wage rigidity would not be correlated with the rate of inflation. However, this result is largely due to the inclusion of 1982 in the sample period. Beginning the sample in either 1983 or 1988 yields a correlation coefficient that is small and not statistically significant. The modest increase in potential rigidity, by this measure, in recent years suggests that the sharp increase in operative rigidity during and after the Great Recession was the result of the low average rates of inflation and productivity growth during this period, rather than a more fundamental change in households' and firms' attitudes towards rigidity. By the same token, there is no indication that the high degree of economic distress combined with low inflation during the Great Recession reduced the proclivity toward downward nominal rigidity, as at least one of the current authors had expected.

C. Kahn tests

[16] The correlation with price inflation is also negative, although a bit smaller still (-0.36).

Table 4 shows some results from the Kahn estimator. Unfortunately, at present we have these estimates for a sample that extends only through 2011.

We include estimates from three versions of the model. The first (labeled “Linear w/o pile-up”) allows for a spike at zero and for mass to be missing from the negative part of the distribution (as would be the case under general downward nominal wage rigidity), and from two positive and one negative bin close to zero (as might be the case under a menu-cost type of rigidity). However, it does not explicitly relate any missing mass from these bins to the increase in mass at zero. The second (labeled “Linear with pile-up”) is similar to the first linear model, but constrains the mass missing from the negative and near-zero bins to contribute to the “pile-up” at zero. This linear version (like the first) assumes that the amount of added or missing mass in each bin is independent of the mass that bin would have contained under the notional wage-change distribution. The third version (labeled “Proportional”) instead assumes that the increase in rigidity leads to a proportional (rather than absolute) rise in the size of the zero spike and related declines in the mass in negative and near-zero bins.

As can be seen in row 1, the linear version of the model without pile-up shows that downward nominal wage rigidity led to an average increase of 16.2 percentage points in the zero spike for the sample period as a whole (column a). However, the version of the model that looks for a piling up from particular parts of the notional wage distribution (row 2) does not suggest that the added mass at zero was augmented by a substantial dearth of wage cuts (column b), which may raise questions about the interpretation of the spike as related to downward nominal wage rigidity. In contrast, the proportional model (row 3) does find that a sizable proportion of notional nominal wage reductions pile up at zero instead, pointing to a larger role for downward nominal wage rigidity than is indicated by the linear version of the model.

Because the Kahn estimate relies on variation across years to identify nominal rigidities, we cannot produce year-by-year estimates like those for the size of spike and LSW statistics. However, we can get some sense of how the Kahn measures of nominal rigidity have varied over time by estimating the models over various subperiods of the sample. For example, rows (4)-(6) show results from a model estimated through 2007, the year prior to the Great Recession. The results for the linear model over this period find a similar increase in the mass at zero as estimated for the entire sample period, suggesting that the degree of downward nominal wage rigidity did not change after 2007. Meanwhile, and in contrast to the full sample, the proportional model shows no evidence of a pile-up at zero of negative notional wage changes in the shorter sample. While this may suggest that downward nominal wage rigidity increased in the more-recent period, the absence of a compensating increase in the pure spike makes this result somewhat difficult to interpret.

The results from the 2006-2011sample shown in rows (1)-(6) are also mixed. For the linear model, the increase in the spike at zero of 15.6 percentage points evident in row 4 is similar to that for the full sample period, suggesting that downward nominal wage rigidity did not increase after 2005. However, both the linear model that looks for a pile-up from observations that would otherwise have been negative and the proportional version of the model are more difficult to interpret. In particular, the linear model with pile-up finds *fewer* observations at zero than would be expected in the absence of nominal rigidity, although it does find some evidence of a pile-up at zero from the negative part of the notional wage distribution. Meanwhile, the estimate of the pure spike at zero from the proportional model disappears in the shorter sample, but there is substantial evidence of a piling-up of zeros from the negative part of the distribution. Overall, the evidence from the Kahn estimates for an increase in nominal rigidity during the Great Recession seems pretty weak. However, there is little evidence of a decline in nominal rigidity in recent years either.

D. Parametric model

We estimated the parametric model for wage changes ending in years 1987 to 2014.[17] The distributions of notional and operative wage changes implied by the model for selected years are shown by the histograms in Figure 6. In each histogram, the blue line shows the estimated density of notional log wage changes, while the red line shows the estimated density with rigidity operating. Thus, the difference between the lines shows the distortion caused by downward nominal and menu cost rigidity.

This estimator, like the others, finds a large amount of downward nominal wage rigidity. (It also finds some menu cost rigidity, but by and large this element is of small importance.) To summarize these findings and compare them to the earlier estimators, Table 3 and Figures 7 and 8 show the size-of-spike and LSW estimators implied by the estimated notional wage-change distribution and rigidity parameters.

As with the empirical statistic, the size of the spike at zero implied by the parametric model moves around a good deal from year to year, shows a drop in the last few years of the 2000s expansion and a rise around the Great Recession. What is distinctly different is that, whereas the empirical spike in 2010 and beyond is at least as high as in any previous year, the implied spike from the parametric estimator appears to have trended downward since the mid-1990s, leaving the spike in 2010 still considerably below the highest previous years.[18] In a similar vein, the LSW statistic for the post-2009 period implied by the parametric model falls

[17] Data limitations made estimating the model for 1982-1985 impractical.
[18] Recall that the model is estimated independently for each year; that is, there is no trend term built into the model.

during the 2000s expansion and rises during the Great Recession, but, in contrast to the empirical LSW statistics, does not rise above the levels of earlier years.

Figures 9 and 10 shows the estimated extent of rigidity in two additional ways. Figure 9 shows the implied probability that a notional log wage change of -0.1 becomes an observed change of zero because of wage rigidity. Smoothing somewhat through the year-to-year fluctuations, the probability ranges from about 30 to 40 percent from the mid-1980s to the end of the 1990s expansion. It drops below 30 percent after the 2001 recession and more-or-less remains at that new lower level thereafter (and most recently has edged below 20 percent).

Figure 10 shows the proportion of negative notional wage changes that are "swept up" to zero by rigidity. As with the probability of rigidity at -0.1, the measure of "sweep" is lower during the post-2009 period than during the mid-1980s to mid-2000s, dropping from roughly a 35-45 percent range to roughly a 30-35 percent range. But, again, the decline occurs before the onset of the Great Recession.[19]

Overall, then, in contrast to the earlier estimators, the parametric model suggests that the extent of rigidity was lower in recent years than in previous decades. However, this is the result of a downward trend that predates the Great Recession; that is, there is no suggestion in these estimates that the recession itself caused a decline in downward nominal wage rigidity.

E. Implications for Aggregate Wage Growth

[19] The sweep measure is quite similar, both in concept and in practice, to the proportional LSW statistic. Above we noted that the proportional LSW statistic may be interpreted as a measure the extent of potential rigidity under strong assumptions about the invariance of potential rigidity to movements in the notional distribution. In the context of the parametric model, however, those assumptions are both untenable and unnecessary. Rather, the parametric model provides predictions of the amount of rigidity that would be observed for any particular movement in the notional wage distribution under the assumption that the rigidity parameters are not affected by that movement.

Given the hypothesis proposed by Daly and Hobijn (2014) that downward nominal wage rigidity held up aggregate wage growth during the Great Recession and subsequently held down aggregate wage growth as a later reaction to that rigidity, it is useful to compare their estimates of wage rigidity, which are based on household responses to the Current Population Survey, with the similar concept from our establishment-based data.

As we indicated earlier, the ECI data refer to the average wage change in a specific ongoing job in a specific establishment, and thus wage changes can reflect changes in the mix of employees in a job in addition to wage changes for particular employees. (As noted above, whether this is an advantage or a disadvantage may depend upon the question at hand.) In contrast, as noted above, the CPS data used by Daly and Hobijn refer to the wage change for a specific individual and, because wages are self-reported, are thought to be more prone to measurement error.

A comparison of the two measures of the size of the spike at zero wage change (the measure used by Daly and Hobijn) is shown in Figure 11. The proportion of jobs with no wage change in our data tends to run somewhat above the proportion of job-stayers reporting no wage change over a 12-month period, with a mean difference of about 4 percentage points.

To provide a potentially more consistent comparison, we also include a measure of rigidity from a subsample of jobs for which the number of employees in the job did not change from one year to the next. Although turnover can change the mix of employees while leaving the number of employees constant, this sample does eliminate some observations in which composition surely changed. Unfortunately, this information was not available prior to 2006. This restriction greatly raises the proportion of zeros: For the years 2006-2014, the mean spike at zero in the full sample was 16%; in the restricted sample the mean was 30%. Despite these differences in levels, the evolution of the magnitude of the spike at zero over the sample period is broadly similar in the two sets of data.

More generally, we can ask how the pent-up demand for real adjustments might affect the nominal wage distribution to the right of zero and whether that pattern is evident in the establishment level distributions. According to the hypothesis put forth by Daly and Hobijn, the continued presence of desired real wage adjustments that were previously prevented by downward nominal wage rigidity leads employers to mute nominal wage increases even as the economy is improving. Daly and Hobijn argue that in their data, many of these would-be wage increases are reduced to zero, with the result that observed nominal wage rigidity, as measured by the size of the spike in the wage change distribution at zero, remains elevated, while the proportion and magnitude of positive observed wage changes falls. Taken alone, the persistence of large spikes at zero in our data in recent years (indicated in Figure 2) is consistent with this hypothesis. However, the evolution of wage changes at other parts of the distribution tells a somewhat different story. In particular, the fact that the LSW statistic has remained quite high in recent years suggests that the additional mass observed at zero continues to reflect a reluctance on the part of some employers to cut nominal wages rather than a reluctance to raise nominal wages for jobs for which the notional wage change is positive.

That said, our data do lend some support to the more general notion that employers take a longer view of wage changes that may mitigate the economic impact of downward nominal wage rigidity. That is, not only is the inability to reduce wage rates in one year less important if employers can make up for it with a lower raise in a subsequent year, but also, as suggested by Elsby (2009), an employer may provide a smaller raise in one year in anticipation of being unable to lower nominal wage rates in a subsequent year. If so, then the distribution of wage changes over a multiple-year period should be more symmetric than the distribution of wage changes over a single year.

The ECI, being a panel of establishments, allows such a comparison. In particular, we can compute the change in wages in each job over a 2-year period and compare those distributions with the distributions of one-year changes.[20] Figure 12 compares the distribution of 1-year and 2-year wage changes ending in 2014, the most recent year in our sample (as an example). Although there is still a noticeable spike at zero in the 2-year change, it is considerably smaller than the spike in the 1-year change. In addition, even apart from the spike, the 2-year changes appear less peaked around the mode of the distribution than the 1-year changes. These comparisons hold for other years as well.

Table 5 shows the size of spike and LSW statistics for the 2-year changes. Comparing this to Table 3, across all of the years in our sample the size of the spike at zero averages 7 percent for the 2-year changes as opposed to 16 percent for the 1-year changes. Similarly, the LSW measure of rigidity falls from an average of 11 percentage points for the 1-year changes to 6 percentage points for the 2-year changes.

Using the relative size of the spike as a metric, the mean fraction of jobs estimated to be potentially subject to downward nominal wage rigidity over our sample period declines from 47 percent for 1-year changes to 32 percent for 2-year changes. Likewise, the proportional LSW statistics are 37 percent for the 1-year wage change distribution and 28 percent for the 2-year wage change distribution.

[20] Using 2-year wage changes reduces the average number of jobs in the sample each year from about 22,000 to roughly 15,500.

Given the relative magnitudes of the various measures of rigidity at the 1- and 2-year horizons, it seems clear that nominal rigidities are less important when one takes the longer view of wage changes over more than one year, suggesting that time is, indeed, an ally of wage flexibility. Even at the 2-year horizon, however, operative wage rigidity appears to have increased in the low-inflation environment of recent years. In particular, the size of the spike at zero in the 2-year changes rose from an average of about 7 percent between 2000 and 2007 to more than 10 percent after 2010. Similarly, the LSW statistic increased after 2010 to levels noticeably above those seem in the pre-recession period. Moreover, for the sample as a whole, the correlations of these statistics with the median 2-year wage change is negative, especially for the size of the spikes at zero, indicating that operative rigidity tends to be higher at lower rates of inflation or productivity growth even at a 2-year horizon.

Another hypothesis for the absence of strong macro effects from downward nominal wage rigidity relates to the possibility that employers compress contemporaneous wage increases in the presence of downward nominal wage rigidity, thus reducing the effect of such rigidities on average wage growth (Elsby, 2009; Stuber and Beissenger, 2012). Elsby suggests examining the upper tail of the wage change distribution during periods of greater downward nominal wage rigidity to look for signs of compression. While we have not tested this proposition as such, at a quick glance the ECI data do not provide much support for this hypothesis. In particular, the proportion of nominal wage increases that were greater than twice the median rose from about 30 percent during the mid-2000s to more than 40 percent after 2009. In addition, for the sample as a whole, the proportion of wage changes above twice the median is negatively correlated with both the median wage change and the rate of inflation, in contrast to the predictions from Elsby's model.

VII. Conclusion

On the whole, we interpret our results as indicating that the wage-setting process in the United States is characterized by a significant degree of downward nominal wage rigidity. In our non-parametric estimators, we find no evidence that the degree of operative or potential downward nominal wage rigidity declined during the late recession or its aftermath, and some evidence that operative rigidity may have increased. In partial contrast, estimates from our parametric estimator suggests a downward trend in operative and, especially, potential rigidity that resulted in a lower degree of rigidity during and after the recession than had prevailed in the 1990s. Thus, the parametric estimator suggests that the degree of nominal wage rigidity has been lower in recent years than in earlier decades, but does not suggest that the labor market distress since the onset of the Great Recession is responsible for that decline.

References

Akerlof, George A., William T. Dickens, and George L. Perry. 1996. “The Macroeconomics of Low Inflation.” *Brookings Papers on Economic Activity*, no. 1. pp. 1–75.

Altonji, Joseph G., and Paul J. Devereux. 2000. “The Extent and Consequences of Downward Nominal Wage Rigidity.” In Worker Well-Being, ed. S. Polachek, 383–431. *Research in Labour Economics*, vol.19. New York: Elsevier.

Bewley, Truman F., 1995. “A Depressed Labor Market as Explained by Participants”, *American Economic Review*, vol 85, no. 2, May, pp.244-249.

Bewley, T.F., 1999. *Why Wages Don’t Fall During a Recession*. Harvard University Press, Cambridge & London.

Blinder, Alan S. and Don H. Choi (1990). “A Shred of Evidence on Theories of Wage Stickiness,” *Quarterly Journal of Economics*, 105: 4 (November), pp. 1003-1015.

Bound, John and Alan B. Krueger (1991). “The Extent of Measurement Error in Longitudinal Earnings Data: Do Two Wrongs Make a Right?” *Journal of Labor Economics* (9)1: 1-24.

Card, D. and Hyslop, D., 1997. Does Inflation “Grease the Wheels of the Labor Market”? In C. Romer and D. Romer (Eds.), *Reducing Inflation: Motivation and Strategy*. Chicago, London: The University of Chicago Press, pp. 71-121.

Daly, Mary C. and Bart Hobijn, 2014. “Downward Nominal Wage Rigidities Bend the Phillips Curve,” *Journal of Money, Credit and Banking*, Supplement to vol. 46, No. 2, October, pp. 51-93.

Daly, Mary C. and Bart Hobijn, 2015. “Why Is Wage Growth So Slow?” *FRBSF Economic Letter* 2015-01, January 5.

Daly, Mary, Bart Hobijn, and Brian Lucking, 2012. “Why Has Wage Growth Stayed Strong?” *FRBSF Economic Letter* 2012-10, April 2.

Dickens, William T., Lorenz Goette, Erica L. Groshen, Steinar Holden, Julian Messina, Mark E. Schweitzer, Jarkko Turunen, and Melanie E. Ward et al., “How Wages Change: Micro Evidence from the International Wage Flexibility Project”, *Journal of Economic Perspectives*, vol. 21, no.2, Spring 2007, pp.195-214.

Elsby, Michael W.L., 2009. “Evaluating the Economic Significance of Downward Nominal Wage Rigidity,” *Journal of Monetary Economics*, 56, 154-169.

Elsby, Michael W.L., Donggyun Shin, and Gary Solon, 2016. “Wage Adjustment in the Great Recession and Other Downturns: Evidence from the United States and Great Britain,” *Journal of Labor Economics*, vol. 34, no. S1 Part 2, pp. S249-S291.

Gordon, Robert J. (1996), comment on Akerlof, George A., William T. Dickens, and George L. Perry. 1996. “The Macroeconomics of Low Inflation.” *Brookings Papers on Economic Activity*, no. 1. pp. 60–66.

Gottschalk, Peter, “Downward Nominal-Wage Flexibility: Real or Measurement Error?” *Review of Economics and Statistics*, August 2005, v. 87, iss. 3, pp. 556-68.

Groshen, E. and Schweitzer, M., 1999. Identifying inflation's grease and sand effects in the labor market. In The costs and benefits of price stability (pp. 273-314). University of Chicago Press.

Hanes, Christopher and John A. James, 2003. “Wage Adjustment under Low Inflation: Evidence from U.S. History,” American Economic Review, vol. 93, no. 4, September. Pp.1414-1424.

Kahn, S., 1997. “Evidence of Nominal Wage Stickiness from Microdata”, *American Economic Review*, 11(5), 993-1008.

Kahneman, Daniel, Jack L. Knetsch, and Richard Thaler, 1986. “Fairness as a Constraint on Profit Seeking: Entitlements in the Market”, *American Economic Review*, vol. 76, no. 4, September, pp.728-41.

Keynes, John Maynard (1936). *The General Theory of Employment, Interest and Money*.

Kurmann, Andre, Erika McEntarfer and James Spletzer, 2014. “Downward Wage Rigidity in the U.S.: New Evidence from Worker---Firm Linked Data”, manuscript, June.

Lebow, David E., Raven E. Saks, Beth Anne Wilson. 2003. “Downward Nominal Wage Rigidity: Evidence from the Employment Cost Index.” *Advances in Macroeconomics*, 3(1): Article 2.

Lebow, D.E., D.J. Stockton, and W.L. Wascher. 1995. “Inflation, Nominal Wage Rigidity, and the Efficiency of Labour Markets.” U.S. Board of Governors of the Federal Reserve System, Finance and Economics Discussion Series No. 95–45.

Lipsey, R.G., “The Relation Between Unemployment and the Rate of Change in Money Wage Rates in the United Kingdom, 1962-1957: A Further Analysis”, *Economica*, vol. 27 (1960), pp. 1-31.

Mankiw, N. Gregory (1996), comment on Akerlof, George A., William T. Dickens, and George L. Perry. 1996. “The Macroeconomics of Low Inflation.” *Brookings Papers on Economic Activity*, no. 1. pp. 66–70.

McLaughlin, K. J., “Rigid Wages?” *Journal of Monetary Economics* 34:3 (1994), 383–414.

Stueber, Heiko and Thomas Beissinger, 2012. “Does Downward Nominal Wage Rigidity Dampen Wage Increases?” *European Economic Review*, vol. 56, 870-887.

Summers, L., “How Should Long-Term Monetary Policy Be Determined?” *Journal of Money, Credit, and Banking*, vol. 23 (1991), pp.625-31.

Taylor, J. “Aggregate Dynamics and Staggered Contracts” *Journal of Political Economy*, vol. 88 (1980), pp. 1-23.

Tobin, J., 1972. Inflation and Unemployment. *American Economic Review*, 62, 1-18.

Wilson, B. A., “Wage Rigidity: A Look Inside the Firm,” Federal Reserve Board finance and economics discussion paper no. 1999-22 (1999).

Table 1

Dimensions of the Data

Years	1982-2014
Average number of jobs per year	19,787
Average number of employers per year	5017
Average median log wage change	0.028
Mean log wage change	0.033
Average std. deviation of log wage change	0.108
Average skewness of log wage change	-0.
Average kurtosis of log wage change	

Notes: Wage rates refer to nominal hourly wages, and annual changes are defined as the change over the 12-month period ending in March. Region is defined by Census region and occupation is defined by the major occupation group in which the job is classified. The counts refer to the sample of annual wage changes.

Table 2

Summary Statistics for the Wage Change Distribution

Year	Median Log Wage Change	Standard Deviation	Mean	Skewness	Size of Spike at Zero
1982	0.072	0.109	0.065	-0.776	11.4%
1983	0.047	0.096	0.047	0.198	17.8%
1984	0.042	0.112	0.047	0.535	15.9%
1985	0.036	0.128	0.033	-0.830	16.7%
1986	0.032	0.118	0.040	0.556	16.4%
1987	0.030	0.172	0.028	-0.431	16.5%
1988	0.031	0.114	0.040	0.047	18.6%
1989	0.036	0.123	0.041	-0.075	15.0%
1990	0.034	0.111	0.040	0.163	15.7%
1991	0.038	0.124	0.044	0.302	14.7%
1992	0.032	0.103	0.034	-0.849	17.4%
1993	0.027	0.099	0.029	-0.018	18.3%
1994	0.024	0.134	0.030	0.388	20.5%
1995	0.026	0.127	0.029	0.266	17.1%
1996	0.025	0.099	0.031	0.258	18.0%
1997	0.029	0.120	0.035	0.463	15.9%
1998	0.031	0.106	0.036	-0.452	14.7%
1999	0.029	0.108	0.033	-0.127	15.7%
2000	0.030	0.105	0.036	0.252	16.9%
2001	0.037	0.115	0.045	0.266	13.9%
2002	0.030	0.112	0.032	-0.063	14.1%
2003	0.025	0.097	0.027	0.038	15.3%
2004	0.021	0.095	0.023	-0.102	16.9%
2005	0.021	0.098	0.026	0.221	16.1%
2006	0.024	0.103	0.024	-0.684	13.7%
2007	0.028	0.105	0.034	0.458	12.1%
2008	0.028	0.100	0.031	-0.046	11.2%
2009	0.023	0.102	0.022	-0.452	14.2%
2010	0.010	0.092	0.016	-0.057	19.7%
2011	0.010	0.090	0.014	-0.341	18.9%
2012	0.009	0.091	0.017		19.6%
2013	0.011	0.082	0.016		18.3%
2014	0.012	0.086	0.016		17.7%

Table 3

Estimates of Downward Nominal Wage Rigidity

Measure	1982-2014	1982-1986	1987-1999	2000-2008	2009-2014
Operational rigidity:					
Size of Spike	16.2	15.6	16.8	14.5	18.1
LSW	10.3	6.6	10.4	9.1	15.0
Parametric Distribution:					
Implied Size of Spike	12.0*	n.a	13.8	10.9	10.1
Implied LSW	10.3*	n.a	11.0	9.9	9.3
Proportion swept to zero	38.0*	n.a	41.1	36.7	33.1
Potential rigidity:					
Relative Size of Spike	48.2	53.0	50.8	44.4	44.4
Proportional LSW	35.9	28.6	39.0	33.6	39.0

*Mean calculated from 1987-2014.

Table 4

Kahn Estimator

				(a)	(b)	(c)	(d)
	Sample	**Dates**	**Model**	Pure spike at zero	Pile-up from negatives	Pile-up from nearby positives	Pile-up from nearby negatives
1	All	1982-2011	Linear w/o pile-up	16.2 pp (0.2)	insig.	insig.	insig.
2			Linear with pile-up	14.4 pp (0.7)	0.3 pp (0.1)	insig.	insig.
3			Proportional	14.5% (0.5)	20.6% (4.5)	insig.	insig.
4	All	1982-2007	Linear w/o pile-up	16.0 pp (0.2)	insig.	insig.	insig.
5			Linear with pile-up	15.6 pp (0.7)	insig.	insig.	insig.
6			Proportional	15.6% (0.5)	insig.	insig.	insig.
7	All	2006-2011	Linear w/o pile-up	15.6 pp (0.6)	insig.	insig.	insig.
8			Linear with pile-up	*-4.8 pp (1.2)*	2.2 pp (0.1)	1.1 pp, 1.1 pp (0.2), (0.2)	*-0.5 pp (0.2)*
9			Proportional	insig.	58% (2.4)	26%, 26% (0.4), (0.4)	*-17% (4.9)*
10	No change in employment	2006-2011	Linear w/o pile-up	28.7 pp (0.7)	insig.	insig.	insig.
11			Linear with pile-up	7.2 pp (1.7)	2.1 pp (0.1)	1.6 pp, 1.0 pp (0.4), (0.4)	insig.
12			Proportional	insig.	85% (3.0)	61%, 40% (9.7), (10.7)	*-17% (8.6)*

Note: Standard errors in parentheses.

Table 5

Estimates of Downward Nominal Wage Rigidity for 2-Year Changes

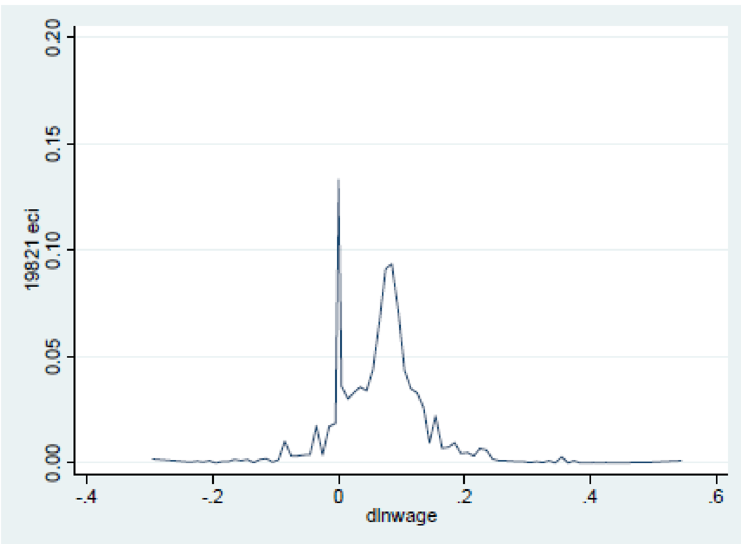
Measure	1988-2014	1988-1999	2000-2008	2009-2014
Operational rigidity:				
Size of Spike	7.4	6.7	6.9	9.3
LSW	6.0	6.0	5.4	6.8
Potential rigidity:				
Relative Size of Spike	31.9	32.8	31.8	30.3
Proportional LSW	27.8	30.7	26.4	23.9

Figure 1

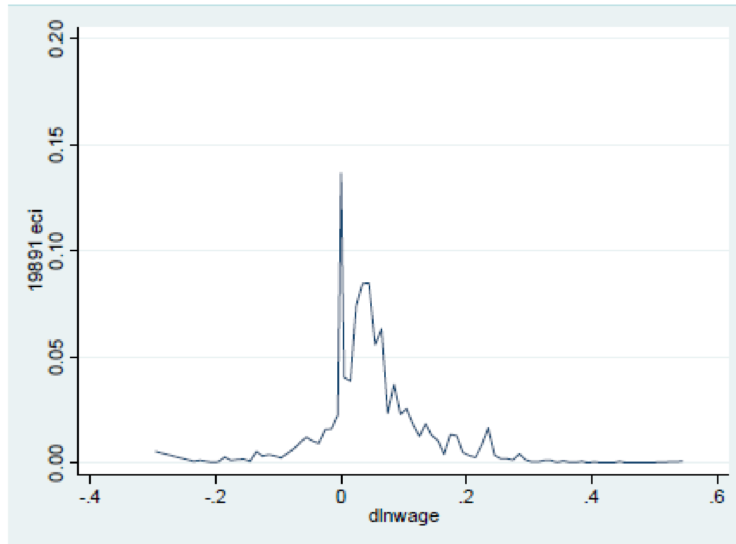
Distribution of 1- Year Wage Changes

(Selected Years)

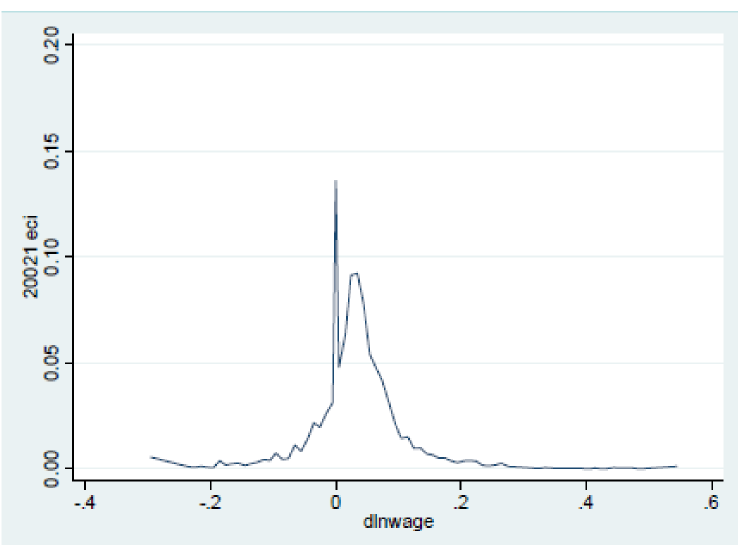
1981-1982



1988-1989



2001-2002



2009-2010

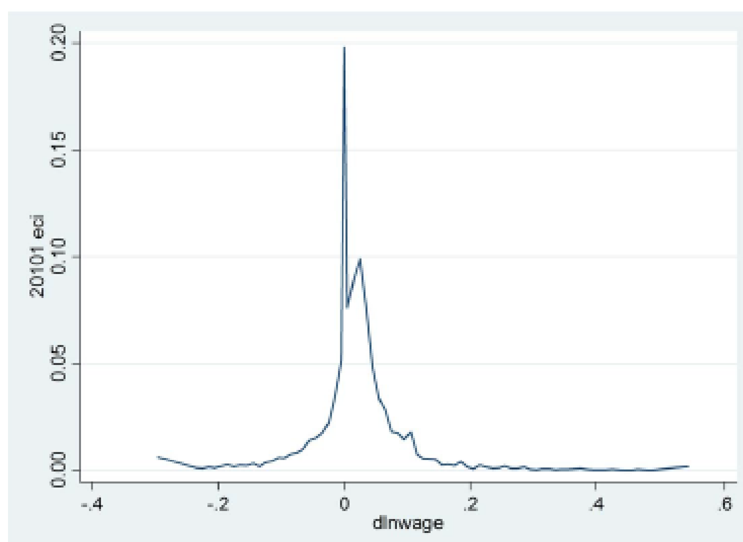
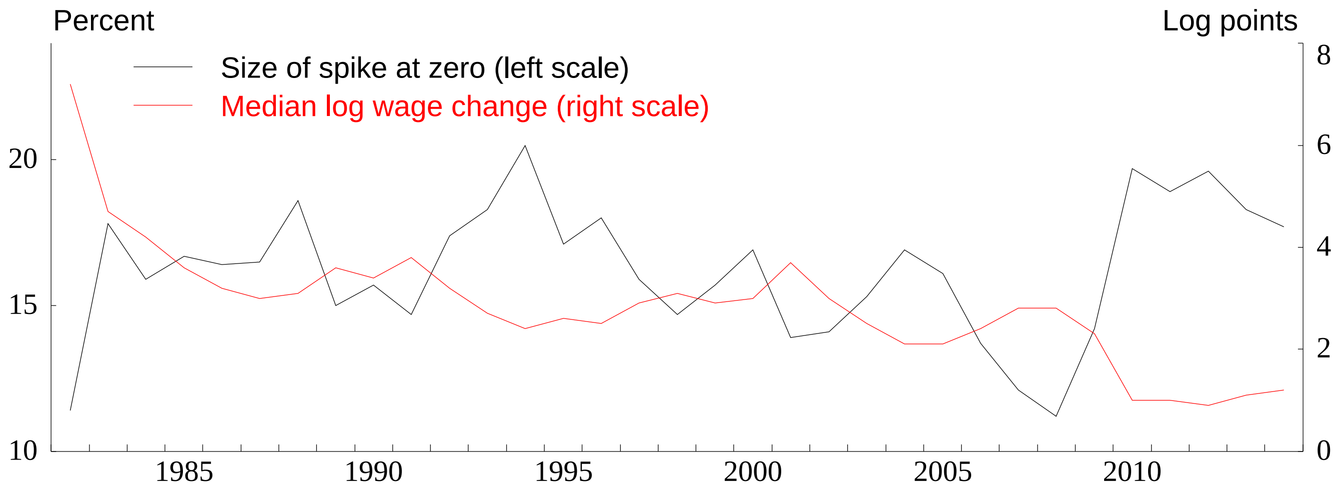


Figure 2

Wage Inflation and Size of Spike at Zero



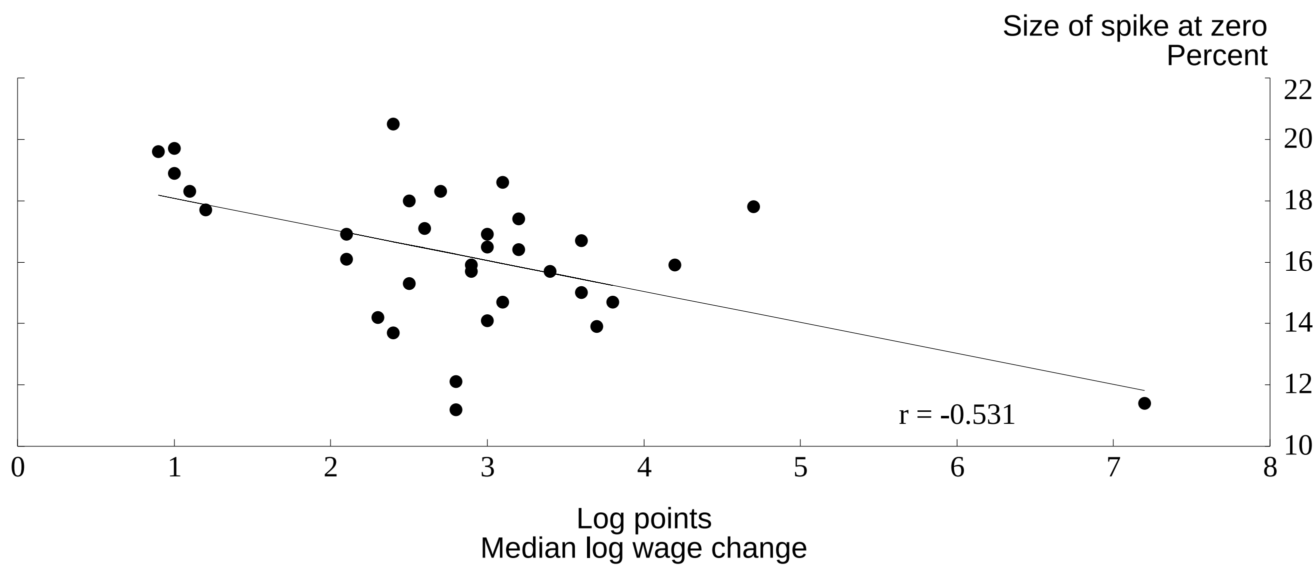
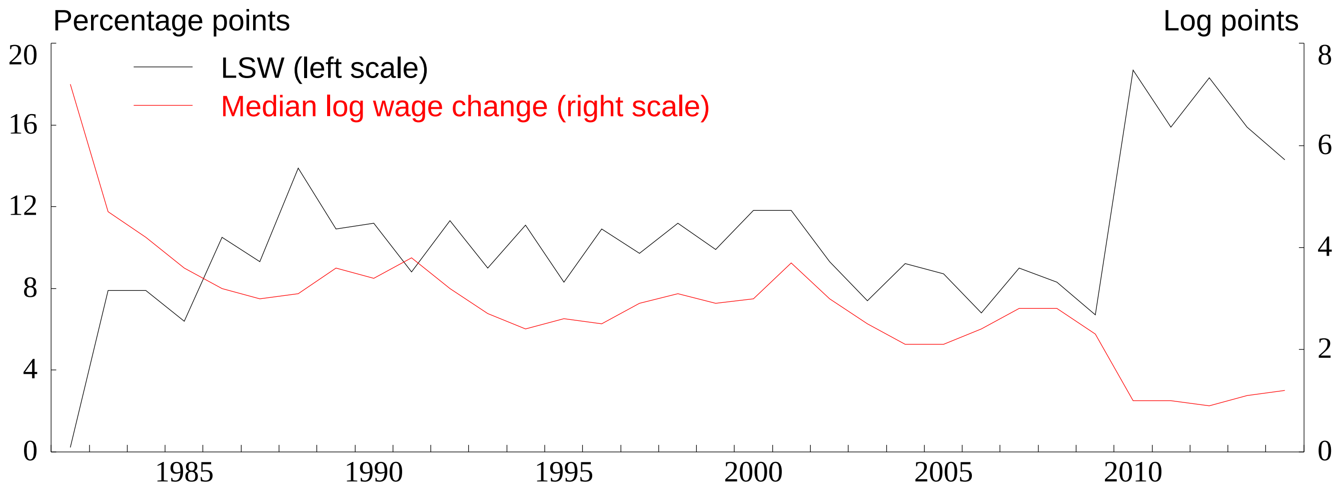


Figure 3
Wage Inflation and Relative Size of Zero

Figure 4

Wage Inflation and the LSW Statistic



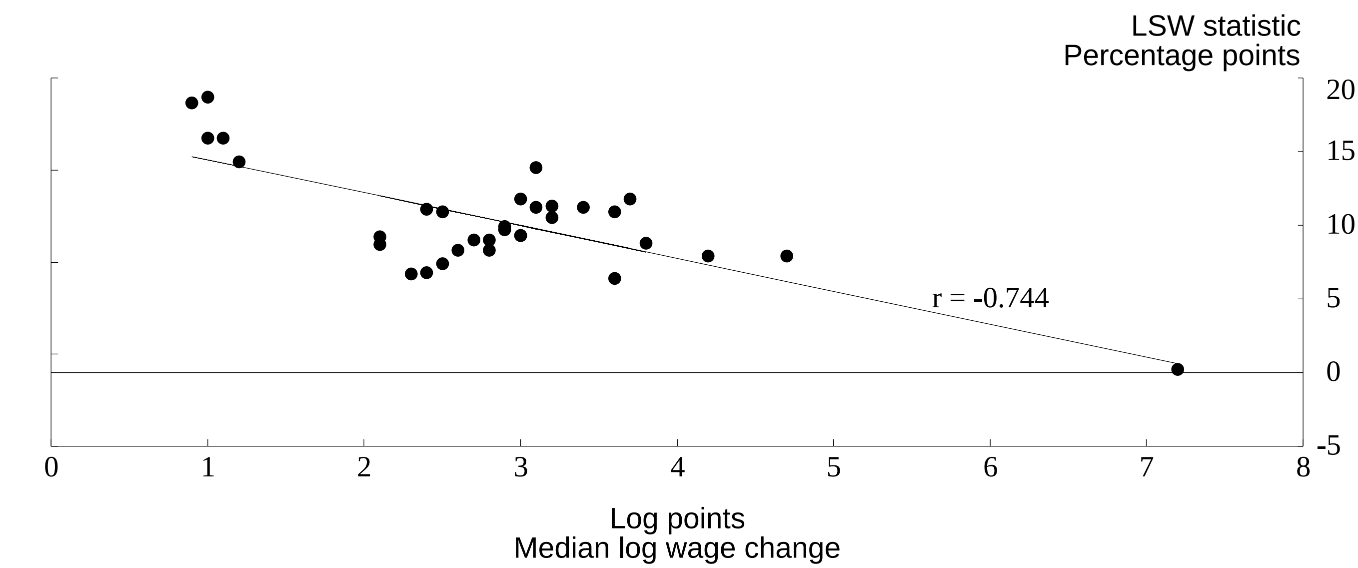
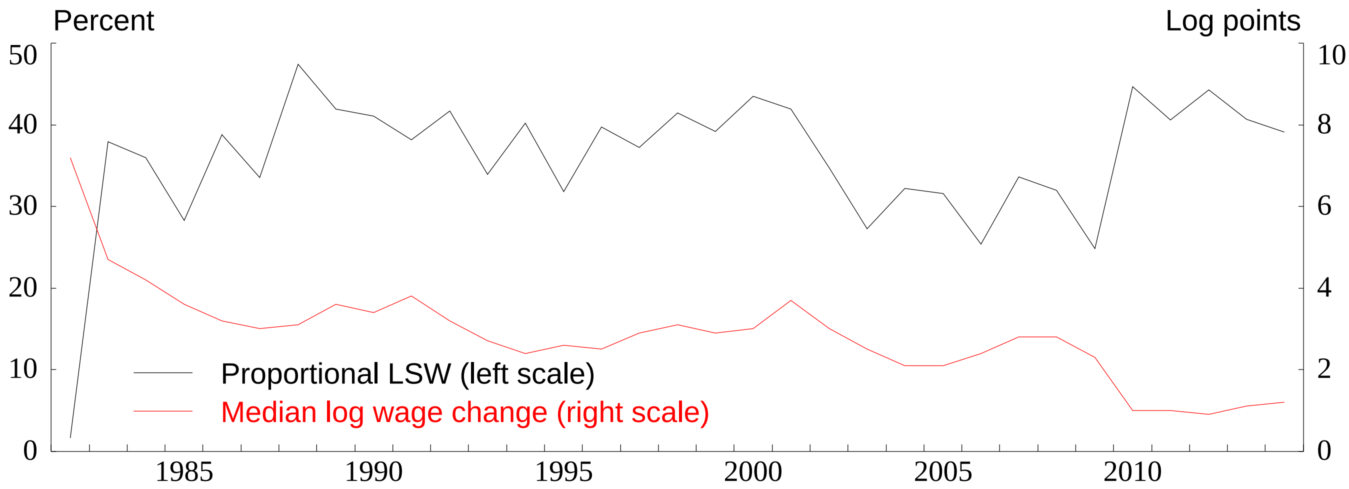


Figure 5
Wage Inflation and the Proportional LSW Statistic



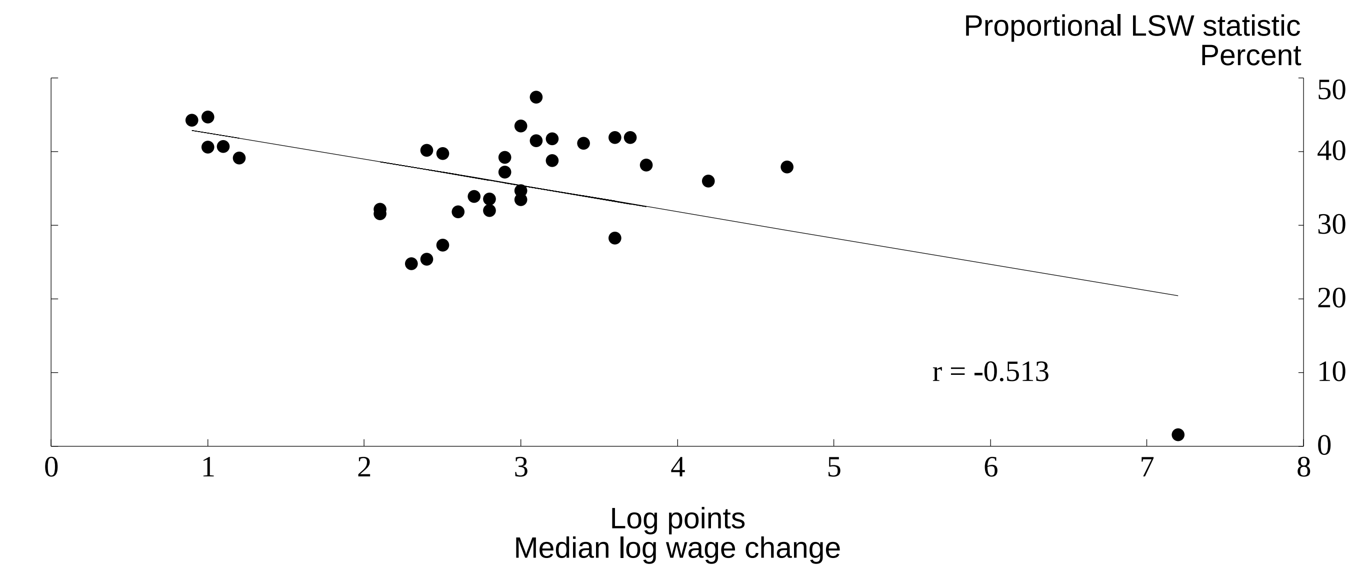
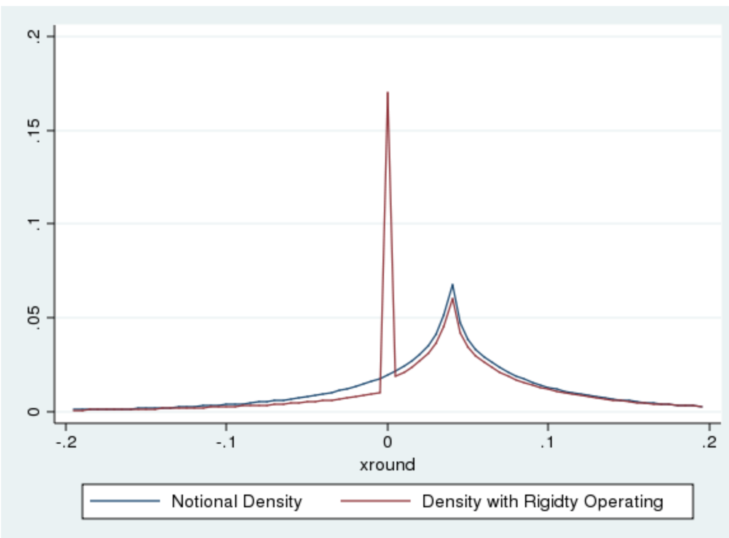


Figure 6

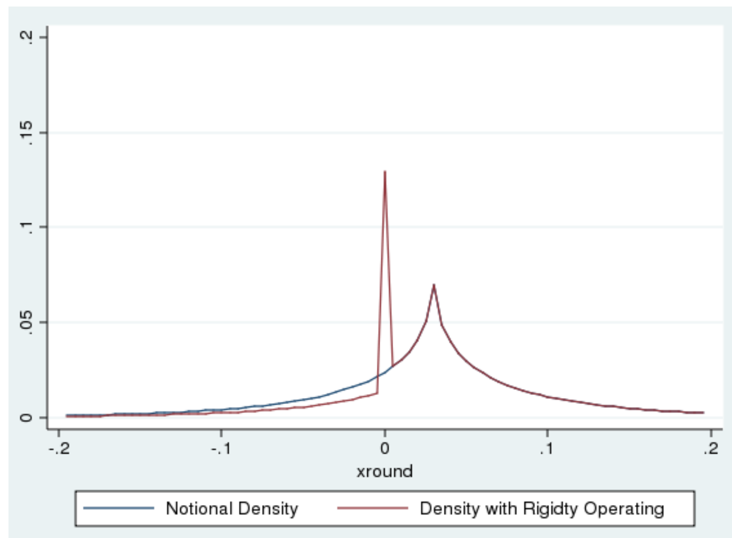
Implied Distributions of Notional and Operational Wage Changes from the Parametric Model

(Selected Years)

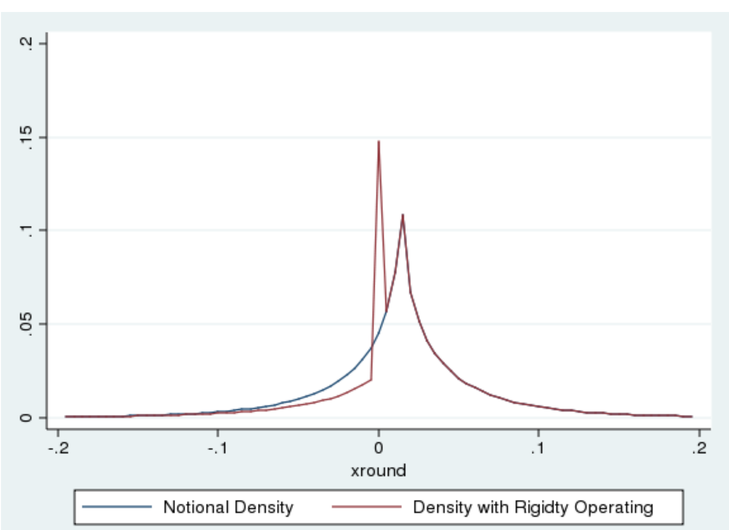
1989



2002



2010



2014

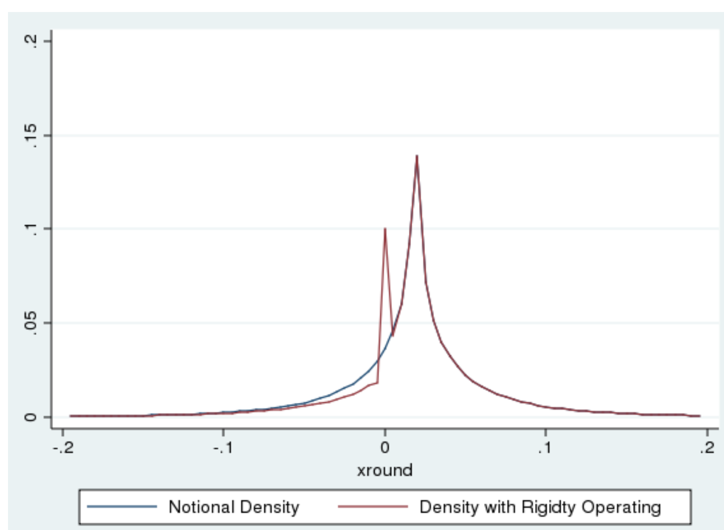


Figure 7

Implied Size of Spike Statistic from Weibull Distribution

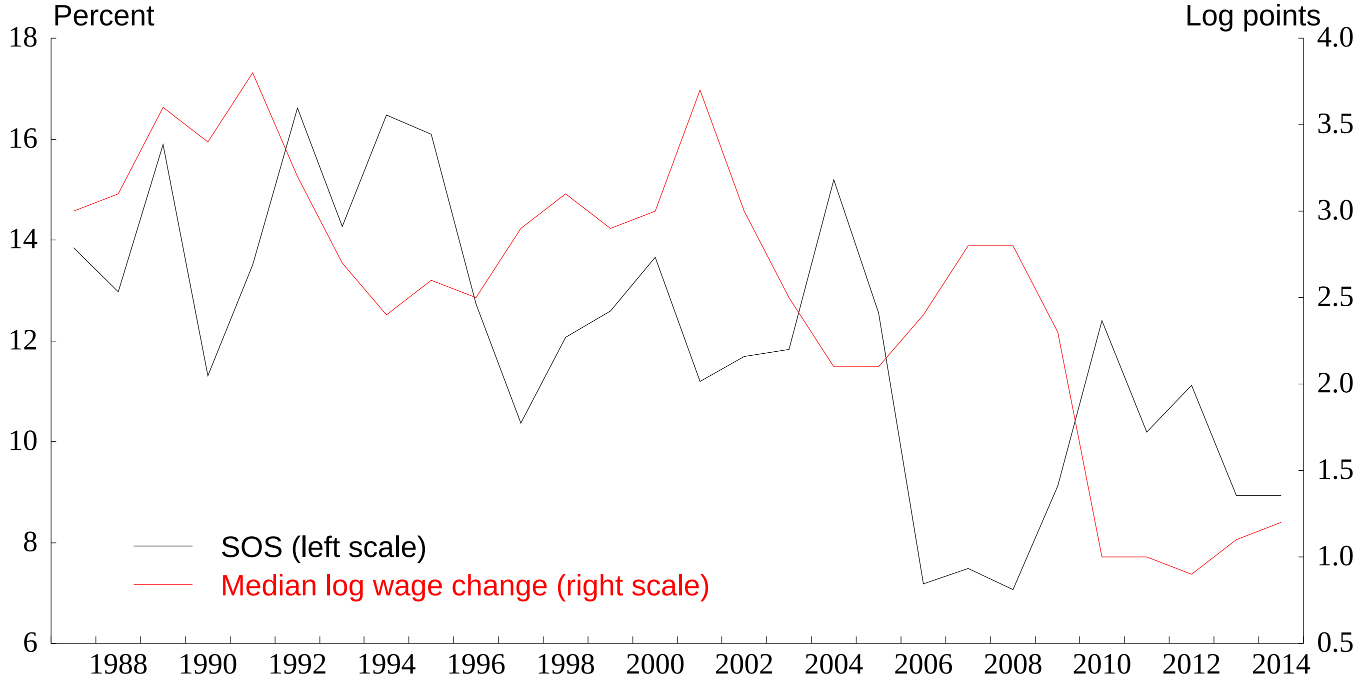


Figure 8

Implied LSW Statistic from Weibull Distribution

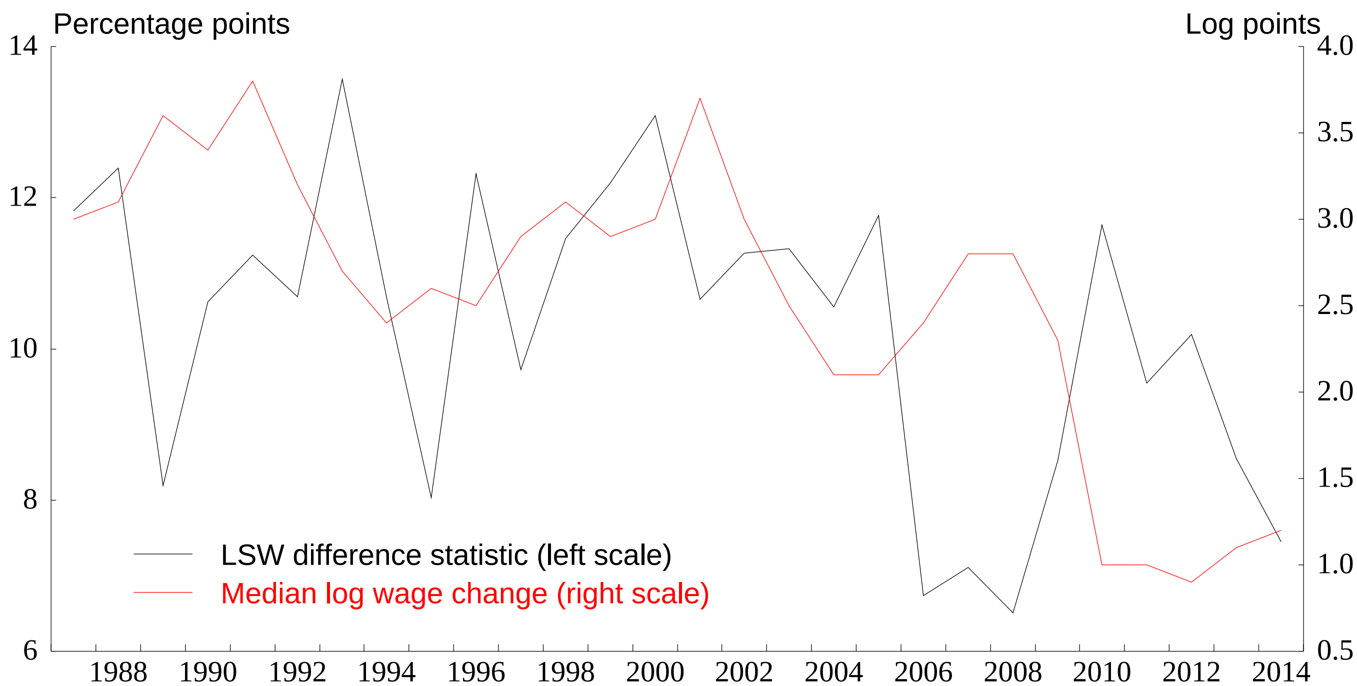


Figure 9

Probability that a Notional Log Wage Change of -0.1 is Constrained at Zero

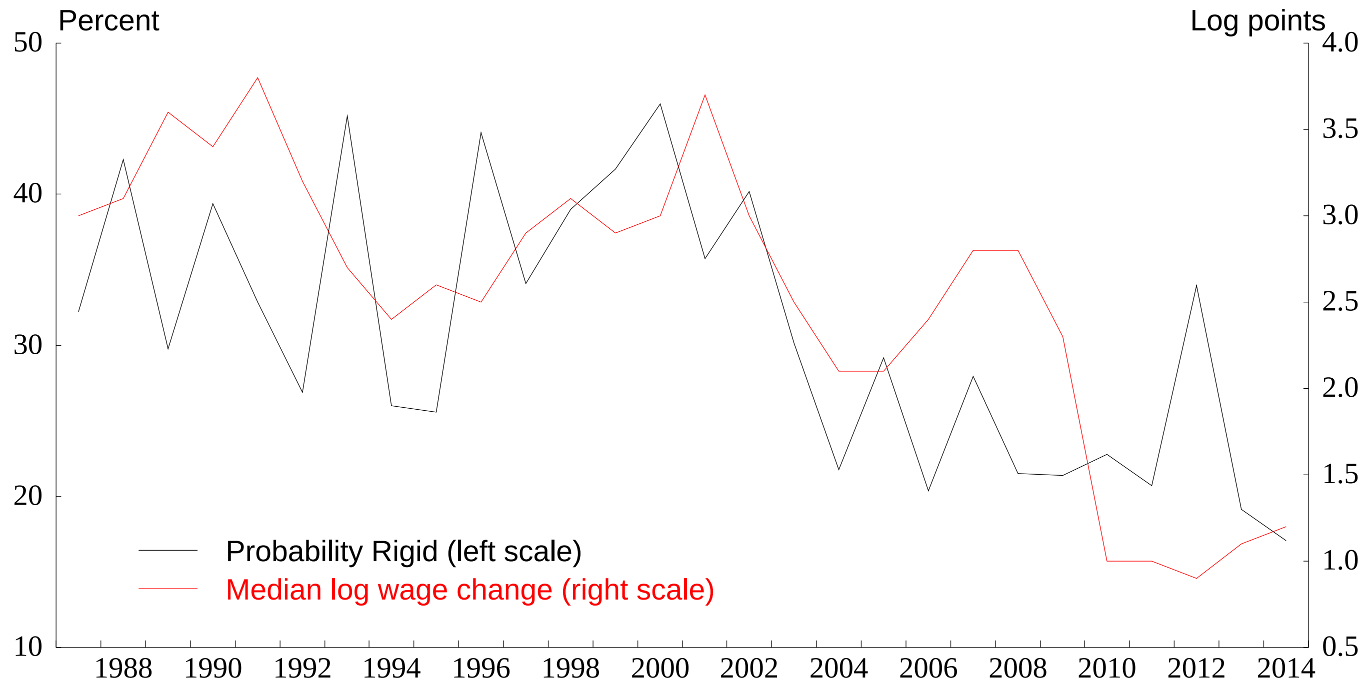


Figure 10

Percent of Notional Wage Declines that are Estimated to be "Swept" to Zero by Rigidity

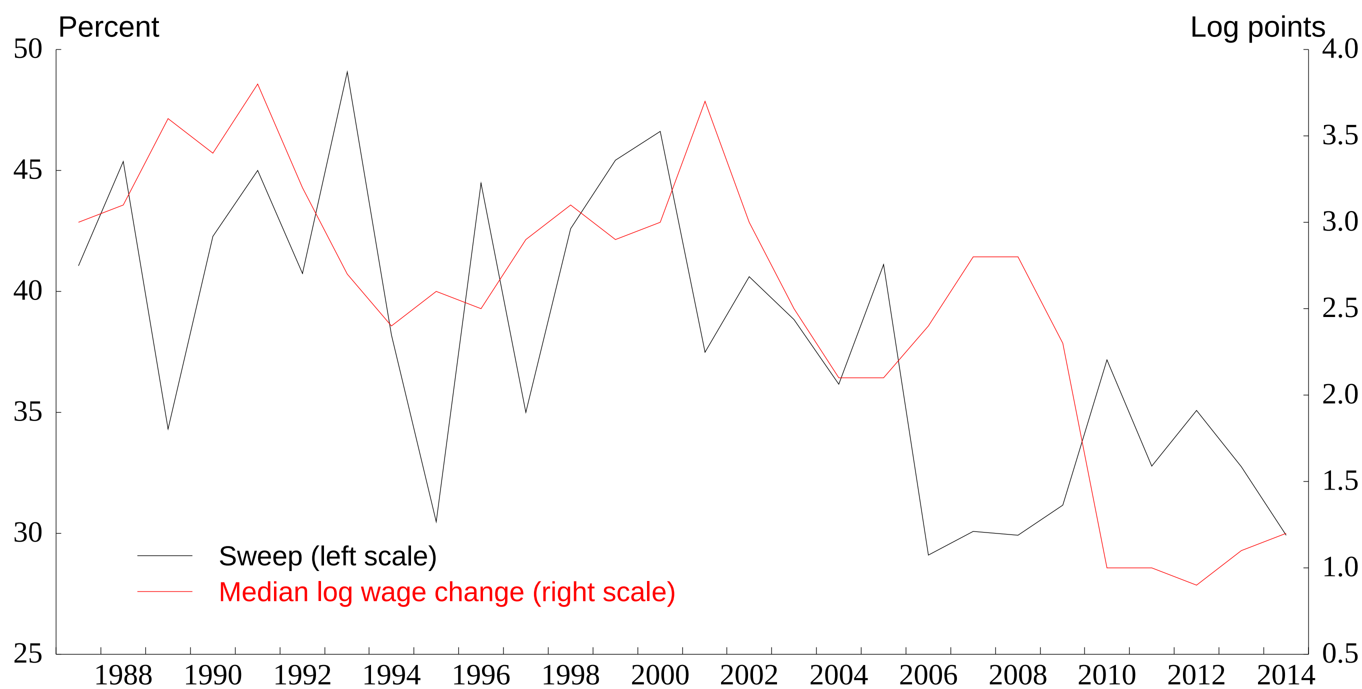
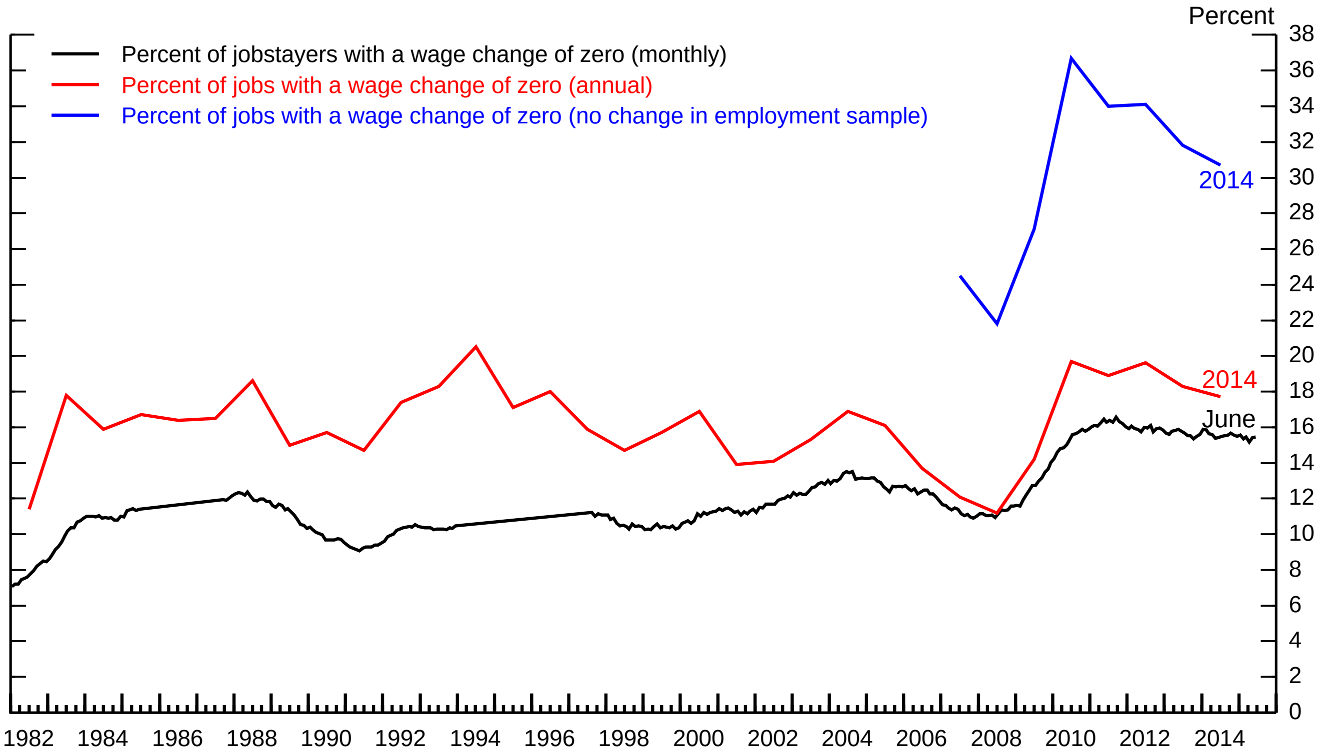


Figure 11

Comparison of CPS and ECI Measures of the Spike at Zero

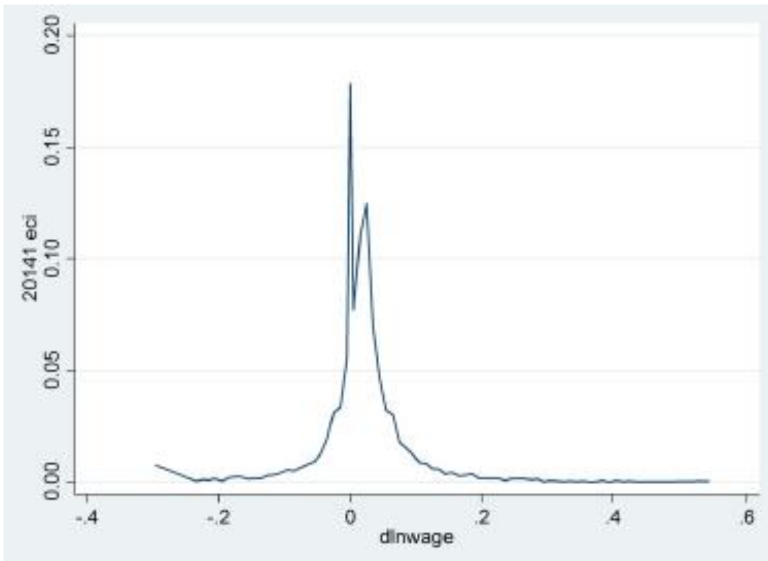


Source: For jobstayers, updated calculations from Mary Daly, Bart Hobijn, and Brian Lucking (2012). "Why Has Wage Growth Stayed Strong?," FRBSF Economic Letter 2012-11 (April 2). For jobs, authors calculations.

Figure 12

Comparison of 1-year and 2-year Wage Change Distributions –2014

1-year Wage Change Distribution



2-year Wage Change Distribution