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Inflation and Wage Rigidity/Flexibility in the Short Run*

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Abstract

A recent literature uses accurate wage data from payroll records and provides compelling evidence against the conventional belief that nominal wages are downward sticky. This paper provides a unique contribution to this literature by conducting a formal analysis of the role of inflation in *cyclical* wage rigidity/flexibility. Analysis of payroll-based wage data from the Korean labor market for the period 1971 to 2014 finds that the degree of downward nominal wage flexibility is countercyclical, and the countercyclicality becomes stronger during a deflationary, relative to inflationary, recession. This serves as a counter-example to the conventional theory of *cyclical* wage rigidity.

JEL Codes: E24, E32, J30, J64

Keywords: cyclicality, downward nominal wage rigidity, inflation, recession, establishment

*This paper uses confidential data provided by the South Korean Ministry of Employment and Labor. The data can be obtained by filing a request directly with the Ministry of Employment and Labor (http://www.moel.go.kr/english/main.jsp). The authors are willing to assist (Seonyoung Park, ypark@udel.edu; Donggyun Shin, don.shin@vuw.ac.nz). The Stata code needed to replicate the paper's results is available at http://udel.edu/ ypark/Young/Research_files/Stata_code.zip.

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1 Introduction

On the basis of aggregate time series evidence, macroeconomists have long believed that real wages are nearly acyclical. This belief has spawned numerous theories of real wage stickiness.[1] However, as demonstrated by Solon et al. (1994), aggregate wage data (such as the series published by the Bureau of Labor Statistics) are countercyclically biased by their tendency to put greater weight on low-skilled workers during expansions than during recessions. A stream of research uses various longitudinal data sets to control for the cyclically-changing composition of the workforce and finds that real wages are strongly procyclical.[2]

Despite the repeated reports that real wages are procyclical, studies investigating the nature of real wage cyclicality are relatively rare. A common approach in the literature is to estimate a parameter that summarizes the average responsiveness of real wages to a cyclical indicator over a sample period. Macroeconomic environments --- inflation rates in particular --- vary across recessions. During a recession with high inflation, employers are able to reduce real wages while granting nominal wage increases. In a deflationary recession, employers may have to cut nominal wages to reduce real wages. Economists dating back to at least Keynes (1936) have often noted that workers' resistance to nominal wage reductions is responsible for downward real wage stickiness, which in turn exacerbates high unemployment during recessions. Averaging real wage movements across multiple business cycle episodes without distinguishing the role of inflation from that of nominal wage adjustments may obscure these important macroeconomic adjustment processes over the business cycle.

This paper investigates the nature of wage adjustments over the business cycle. We examine how the patterns of nominal wage adjustments vary across recessions with different inflation levels. This investigation is motivated by the experience of the United

[1] See Solon and Barsky (1989) and Solon et al. (1992), among others, for a good summary of time series evidence and how such evidence has affected the formation of macroeconomic theories.

[2] See Martins et al. (2012) and references therein. Bils (1985) is the first study that investigates the cyclicality of real wages using longitudinal data. Real wage procyclicality is a feature of several macroeconomic theories, including those of Lucas and Rapping (1969) and Mortensen and Pissarides (1994).

States (henceforth US) during the Great Recession. The coincidence of sluggish real wage adjustment when inflation rates were low and a historic surge in unemployment suggests that downward nominal wage rigidity (henceforth DNWR) might have been binding during the Great Recession (e.g., Daly et al., 2012). The cost of low inflation was previously emphasized by Tobin (1972) and Akerlof et al. (1996), among others, who argued that moderate levels of inflation may "grease the wheels of the labor market" by making DNWR less binding and therefore making a unit of labor less costly than it would otherwise be under low inflation.[3] The crucial assumption of this grease-the-wheels hypothesis, which originates from Keynes' premise of the labor market, is that nominal wages cannot be cut. But are nominal wages really downward sticky? How prevalent is DNWR when inflation is low and labor demand is weak? Would the extent of downward real wage adjustments be smaller in a recession with lower, relative to higher, inflation?

These questions have led many studies to assess the extent of DNWR or downward nominal wage flexibility (henceforth DNWF) using longitudinal data on individual wages. Because wage changes for job changers (those who change jobs from one year to the next) are very difficult to explain, these longitudinal studies focus on wage changes for job stayers (those who stay in the same job) under the implicit assumption that, if DNWR is sufficiently prevalent to cause a lot of layoffs, it also should be observed among job stayers. More precisely, the literature has commonly adopted the fraction of job stayers who experience either nominal wage reductions or wage freezes from one year to the next as a measure of the extent of DNWF or DNWR. Relatively early studies analyzed reported wage changes of job stayers obtained from household surveys.[4] As emphasized by Elsby et al. (2016), among others, household-survey-based wage information is often subject to considerable response error and therefore leads to biased results regarding the extent of DNWR/DNWF. In response, a strand of recent studies has sought more accurate wage data from employers' payroll records and pay slips. After conducting a comprehensive survey of this research, which includes twelve studies across eleven countries, Elsby and

[3]Another channel through which deflation can have harmful effects on real economy is given by the debt-deflation theory suggested by Fisher (1933): Deflation makes firms invest less by raising firms' real burden of debts, which works in the direction of worsening a recession.

[4]See Card and Hyslop (1996), Kahn (1997) and McLaughlin (1994), among others.

Solon (2018) conclude,[5] "Except in extreme circumstances (when nominal wage cuts are either legally prohibited or rendered beside the point by very high inflation), nominal wage cuts from one year to the next appear quite common, typically affecting 15–25 percent of job stayers in the periods of low inflation. And, consistent with this picture of downward flexibility, nominal wage freezes are found to be much less frequent, typically affecting fewer than 8 percent of job stayers,..." They further conclude that these recent studies, while not denying the existence of any type of nominal wage rigidity, are surely evidence against the conventional belief that nominal wages cannot be cut, even in the face of inefficient layoffs or hiring decisions.

This paper extends and contributes to the recent literature in several ways. First, we investigate the effects of inflation on the extent of DNWR/DNWF in the short run. A careful examination of the recent studies suggests that there might be an upward secular trend in the degree of DNWF.[6] Our results will confirm this trend's existence. At the same time, inflation rates have generally subsided in most countries studied during the last several decades. This implies that the frequently-observed downward nominal wage reductions during periods of low inflation may at least partially reflect the responsiveness of nominal wages to the long run trend rate of inflation. Intuitively, workers adapt their expectations to a low inflation environment and are more likely to accept a nominal wage cut when inflation remains low for a longer period.[7] However, it remains unclear how DNWR/DNWF reacts to an inflationary/deflationary environment in the short run. Would workers accept a nominal wage cut even when inflation is temporarily low? To understand the nature of real wage procyclicality observed in many of the aforementioned longitudinal studies, it is important to focus on how *cyclical* wage rigidity/flexibility is related to price dynamics in the short run. Furthermore, considering that Keynes' premise of DNWR has played a crucial role in explaining cyclical fluctuations of the labor market, it is appropriate to assess the importance of DNWR in the short run as well.

[5]Among these counties are included Great Britain, the United States, West Germany, Austria, Italy, Spain, Mexico, Ireland, South Korea, Portugal, and Sweden.

[6]For example, see Elsby et al. (2016) for the UK and the US.

[7]This consideration led several economists to examine historical data for the test of DNWR. See Hanes and James (2003) and references therein.

Second, we examine the prevalence of DNWR/DNWF across multiple recessions with different inflation levels within the same country and controlling for workforce composition. Despite the repeated documentation of frequent nominal wage cuts and infrequent wage freezes, relatively little effort has been made to pin down the effect of low inflation on the extent of DNWR/DNWF. For example, Park and Shin (2017) present evidence of these patterns in the Korean labor market for a deflationary recession period (2008–2013). While their evidence is clearly against the conventional belief that nominal wages *cannot* be cut, it remains unclear whether the high (low) degree of DNWF (DNWR) results from low inflation, the recession or the specifics of Korean wage-setting practices.[8] These concerns are heightened by the great heterogeneity in the extent of observed DNWF across countries (Elsby and Solon, 2018). The results of Park and Shin (2017) are similar to those found by Doris et al. (2015), OECD (2014), and Smith (2000), who present evidence of DNWF in the Irish, Spanish, and the British labor market, respectively, for a recessionary period with low inflation. However, in order to be able to attribute the high (low) degree of DNWF (DNWR) to low inflation, we need to compare a deflationary recession and an otherwise-comparable recession with relatively higher inflation *within* the same country. Furthermore, the composition of the workforce may change over the business cycle and across different recessions. Generally, the probability of nominal wage reductions is affected by who is in the workforce, which makes it difficult to apply the experience of a particular recession to a general case even within the same economy. This paper studies the effect of inflation on *cyclical* DNWR/DNWF by comparing multiple recessionary periods with different inflation levels and by controlling for the changing composition of workforces across different periods.[9]

[8]Another major difference between Park and Shin (2017) and this paper lies in our emphasis on the effect of inflation on *cyclical* wage rigidity/flexibility. In addition, while Park and Shin (2017) examine microeconomic causes of DNWF, this paper investigates macroeconomic determinants of cyclical components of DNWR/DNWF with an emphasis on the role of short-run changes in inflation.

[9]Short run or long run, we believe that the grease-the-wheels hypothesis can be more effectively tested by comparing the degree of DNWR/DNWF between a deflationary recession and an otherwise-comparable recession with moderate inflation. The recent studies (aforementioned), however, often report evidence of DNWF focusing on a period of deflationary recession. First, as emphasized by Hyslop and Townsend (2016) and Jardim et al. (2018), among others, even payroll/administrative wage data are not error-free. Second, there does not exist a consensus method that formally tests the existence of DNWR. A portion of the literature uses asymmetry of the distribution of individual wage changes as measures of DNWR. In particular, many papers interpret excess mass at zero wage change and missing mass to

Third, we examine firms' roles in cyclical nominal wage adjustments, with a focus on wage cuts. Bewley's (1999, pp 173–174, 199–200) anecdotal evidence suggests that employers are generally reluctant to cut nominal wages; they do so only when the existence of the firm is threatened due to financial distress; and when they do, they tend to cut pay for most workers. This implies that the frequent nominal wage reductions observed at the individual level during a recession would be explained by some employers cutting wages for most of their workers (between-firm effects) instead of most employers cutting wages for a fraction of their workers (within-firm effects). His morale-based prediction of the large between-firm effects during a recession --- deflationary recessions in particular --- is empirically testable. More generally, because wage and employment decisions are commonly made at the establishment level, it is more appropriate to study wage adjustments at both the establishment and worker levels, as opposed to just the worker or aggregate levels.[10] The results will provide further details of the nature of cyclical wage adjustment.

We investigate these issues using Korean data from 1971 to 2014. The case of Korea interests us for a number of reasons. First, our sample period, 1971–2014, covers at least three severe recessions. The severity of these recessions, combined with the different inflation rates across them, presents 'ideal' conditions under which patterns of wage adjustments can be investigated. Second, despite the large volume of empirical studies that report procyclical real wages and downward flexible nominal wages, most existing micro-data-based studies focus on the North American and European labor markets, especially the labor markets in the US and the UK.[11] Third, the Occupational Wage

the left of zero relative to what a symmetric distribution would imply as indicators of DNWR. This approach, however, is also problematic, as DNWR may affect the extent of wage increases (e.g., Elsby, 2009). Therefore, instead of asking how prevalent DNWR or DNWF is during a sample period, we adopt a rather simple and transparent measure of DNWR/DNWF commonly used the recent literature (the faction of stayers with nominal wage cuts or freezes) and ask if the measured degrees of DNWF (or DNWR) are different across different recessions in a manner consistent with what is implied by the grease-the-wheels hypothesis.

[10]Several other papers have also used administrative employer-employee matched data to study the extent and consequences of downward nominal wage rigidity See, for example, Ehrlich and Montes (2017) for Germany and Kurmann and McEntarfer (2017) for the US, Caju et al. (2007) also used administrative employer-employee matched data to study degrees of downward nominal and real wage rigidity for different categories of workers and firms in Belgium. Unlike these studies, this paper discusses macroeconomic causes of cyclical wage rigidity/flexibility focusing on the role of inflation.

[11]Shin (2012) uses longitudinal data on individual wages and reports that real wages are strongly

Survey (OWS) data used in the current study enables us to construct employer-employee linked data, which is essential for understanding employers' wage adjustment behavior. Further, because the earnings and hours data come from payroll records, they are likely to be more accurate than similar data gathered from household surveys. This high level of accuracy is essential to effective analysis of DNWR/DNWF. (See Section 2 for additional advantages of the current data set.)

Our major findings are as follows. First, while real wages move procyclically in every recession over the sample period, the nature of real wage procyclicality varies across different recessions. In the major recessions of the early 1980s and the late 1990s, the countercyclicality of the price deflator contributed to the downward real wage adjustments. During the Great Recession, however, the inflation rate remained low, and the large reduction in real wages is attributed to significant nominal wage reductions. Interestingly, real wages were reduced by a larger amount in a deflationary, relative to inflationary, recession. Second, analysis of the empirical distribution of year-to-year changes in job stayers' nominal wages, while confirming the recent findings of frequent nominal wage reductions and infrequent nominal wage freezes, concludes that, holding demand conditions and workforce composition constant, a lower inflation rate significantly increases (reduces) the probability of a nominal wage reduction (freeze) in both the short run and the long run. This finding contradicts the conventional view that DNWR is negatively related to inflation. More importantly, cyclical wage rigidity (flexibility) becomes weaker (stronger) during a deflationary, relative to inflationary, recession: During a recession, nominal wages become downward flexible when inflation does not help adjust real wages to the market-desired level. Third, analysis at the establishment level finds that all the patterns of wage adjustments observed at the worker level are mostly explained by the

procyclical in the Korean labor market from 1997 to 2008. While Shin (2012) focuses on the extent of real wage procyclicality for his sample period, the current study analyzes the nature of procyclical real wages by investigating the role inflation in cyclical nominal wage adjustments and comparing patterns of wage adjustments across different recessions with different inflations. While Shin (2012) analyzes wage adjustments at the aggregate and individual levels, the current study investigates how they are linked to employers' wage behavior. Compared to Shin (2012), the current study also adopts a much longer sample period and a richer data set in terms of sample size and variables. In addition, the current study analyzes more accurate payroll-based wage data whereas Shin (2012) uses household-survey-based wage data.

behavior of a 'typical' employer. For example, while between-establishment effects become somewhat more important during a recession, the majority of the frequent nominal wage reductions observed at the individual level are driven by within-establishment effects even at the height of the (deflationary) recession, a finding contradictory to Bewley's morale-based prediction of firms' wage behavior. The fraction of employers who reduce the average wage of their job stayers also becomes greater during a deflationary, relative to inflationary, recession.

The findings of this paper, when juxtaposed with the fact that the unemployment rate did not rise significantly during the Great Recession when there was low inflation, suggest that the wheels of the Korean labor market were working without being greased by moderate inflation rates, and the costs of deflation accrued through the labor market may not be as great as often suggested by the DNWR hypothesis. At a minimum, this paper's findings, although they may not be generalized to other countries, serve as a counter-example to the conventional theory of *cyclical* wage rigidity based on Keynes' premise of downward nominal wage rigidity.

The organization of this paper is as follows. Section 2 introduces our sample and summarizes the history of several macroeconomic variables since the early 1970s. In Section 3, we estimate the cyclicality of real wages in Korea and compare the results to those for other countries. Section 4 is devoted to an investigation of the role of inflation in cyclical nominal wage adjustments. In Section 5, we assess the role of employers in explaining cyclical variation of nominal wage cuts in conjunction with inflation. Section 6 concludes.

2 Data and Some Macroeconomic Indicators

2.1 Data

We analyze wage data from the Occupational Wage Survey (OWS), which is administered annually by the South Korean Ministry of Employment and Labor. Since 1968, the survey has selected a sample of establishments that hire at least 10 employees and collected information on working conditions (e.g., hours, wages) of individual workers. As sampled employers are required by law to report to the survey, attrition/non-response is not an issue in this dataset. The survey increased the coverage of establishments to those that employ at least 5 workers in 1999, and further to all establishments in 2008.[12] However, to maintain a consistent population for the time series information, we restrict our sample to only those establishments that hire 10 employees or more throughout the entire sample period, 1971–2014.[13] Additionally, we focus on prime age workers between the ages of 25 and 59, and exclude the top 1% and bottom 1% of individuals in each year's wage distribution.

This dataset suits the current research purposes for the following reasons. First, as we will discuss in a subsequent section, the sample period, 1971–2014, is long enough to include at least three major recessions which have different macroeconomic environments. Second, to investigate the role of employers in cyclical wage adjustments, (for example, to examine what percentage of workers in an establishment experience nominal wage reductions from one year to the next), we require that each establishment has a sufficient number of individual workers included in the sample. The OWS tends to sample proportionally more employees for smaller establishments. For example, for those establishments with 29 employees or less, all workers are included in the sample. For those establishments that employ a minimum of 30 and a maximum of 99 workers, 90 percent of the workers in each establishment are included in the sample, and so on.[14] This structure ensures that a reasonable number of employees are sampled from all employers, regardless of size. Third, the information on earnings and work hours elicited from the employers pertains to payroll information for a reference month (June 1 through June 30).[15] Because the earnings and hours data come from payroll records, they are

[12] At this time, the name of the survey was also changed to the Survey on Labor Conditions by Type of Employment (SLCTE).

[13] Data for 1968–1970, 1975, and 1977 are not available at the individual level.

[14] The OWS has changed the selection probability over time. When averaged across years, the probability of being in the sample is 100% for those employed in establishments with 5 to 29 employees, 81.99% for 30 to 99, 53.75% for 100 to 299, 39.27% for 300 to 499, 36.04% for 500 to 999, 22.93% for 1,000 to 4,999, and 10% for 5,000 or more.

[15] June is regarded as the month when the Korean labor market is the most stable with most recruiting processes closed and little wage bargaining occurring.

thought to be more accurate than similar data gathered from household surveys.[16] As emphasized by the recent studies summarized in Elsby and Solon (2018), this is essential for the purpose of investigating DNWR.

However, there are limitations to the OWS that must be recognized. Although the survey releases employer identifiers, it does not contain individual identifiers, which may limit the longitudinal analysis of wage adjustments at the individual level. As an alternative, we follow Park and Shin (2017) in using various individual and job characteristics to match individual workers in an establishment from June of one year to June of the next. To be included in the final sample of job stayers, an employee should have the same employer identifier between two adjacent survey years, the same starting date of employment at the current establishment, and the same gender status. In addition, as the survey collects information during the same reference month (June) every year, ages should grow by one year between two neighboring surveys. While this process produces a probability of an incorrect match of 1.5 percent,[17] there is no reason to believe that the probability varies over the business cycle, which is the main concern of this paper.

In total, the sample restrictions leave us with 1,456,656 observations over 16 matched years of data on year-to-year changes in stayers' wages. The 16 matched years are the year pairs beginning in 1986, 1988, 1990, 1991, 1993, 1994, 1996, 1997, 1999, 2000, 2002,

[16] As discussed by Elsby et al. (2016), among others, the extent of nominal wage rigidity measured by the proportion of job stayers who receive the same wage between two adjacent years tends to be exaggerated by the nature of rounding errors that appear in household-survey-based wage data. At the same time, the existence of classical measurement error in reported wages tends to understate the degree of nominal wage rigidity. Which one dominates is an empirical matter. Elsby et al. (2016) conclude that the effects of rounding errors dominate, and therefore, analysis based on household-survey-based reported wages tends to overstate the extent of nominal wage rigidity. Although not reported for brevity, it can be shown that, even though reported wages are subject to classical measurement error, the estimated proportion of job stayers who experience nominal wage cuts also overstates the true proportion, as long as wages grow over the course of the lifecycle. Consequently, when it comes to measuring the degree of wage flexibility/rigidity, access to more accurate payroll-based wage data is a top priority.

[17] Whenever two or more individuals share the same characteristics, all of them are deleted from the sample. This process guarantees that only correct matches are included in the final sample for workers in relatively small establishments where all workers are surveyed. This is so because, with all workers in an establishment being included in the sample, the process rules out the possibility of an individual being replaced by another worker with the same characteristics (aforementioned) and leaves only those who have unique characteristics in the sample. There still remains a possibility that, for relatively larger establishments that sample a fraction of their workers, an individual in a year is replaced by another worker with the same characteristics in the following year. Using the SLCTE sample for the 2008–2009 to 2012–2013 period, however, Park and Shin (2017) demonstrate that the probability that two different workers with the same characteristics are incorrectly matched in an establishment is not greater than 1.5 percent.

2003, 2008, 2009, 2011, and 2012.[18] Thus, the average sample size per matched year is approximately 91,000. The smallest sample size is 31,847 for 1991–1992, and the largest is 198,358 for 2012–2013. The same sample restrictions leave us with 4,014 establishments for an average matched year, with sample sizes ranging from 1,768 establishments for 1991–1992 to 9,058 establishments for 2012–2013. On average, about 23 job stayers are linked to an establishment in the dataset.

2.2 Growth, Unemployment, and Inflation

As shown in Figure 1, the Korean economy has undergone three major recessions since the early 1970s. As measured by the growth rate of real GDP per capita, the most severe recession is associated with the 1997 exchange rate crisis. The growth rate of negative 6.2 percent (observed in 1998) is the lowest growth rate observed during our sample period. The next most severe recession followed the second oil shock and the political instability of the 1979 to 1980 period, when the Korean economy showed another negative growth rate of 3.3 percent in 1980. It is known that the recent financial crisis (Great Recession) had a relatively minor impact on the Korean economy, compared to the United States and European economies. Still, the Korean economy showed a growth rate of approximately zero (0.2 percent) in 2009. The order of severity of these three recessions is preserved in the unemployment rate. The unemployment rate was as high as 7 percent and 5.2 percent in 1998 and 1980, respectively. The adverse impact of the Great Recession on the unemployment rate, relative to that of the previous severe recessions, appears smaller than what is implied by the comparison of growth rates.[19]

Figure 2 displays inflation rates measured by the annual Consumer Price Index (CPI) deflator and the Producer Price Index (PPI) deflator from 1971 to 2014. Both deflators indicate that the inflation rate was much higher in the 1970s and the early 1980s than in later years. Focusing on the three recessionary periods, the inflation rate as measured

[18]The OWS has been resampling establishments every three years, on average. In addition, reliable employer identifiers are not available prior to 1986 nor for the 2005–2006 and 2006–2007 matched years.

[19]The first oil shock that broke out in the mid-1970s had a relatively small impact on the Korean economy in terms of both the real growth and unemployment rates. Korea also experienced a credit market crisis in 2003–2004.

by the CPI was as high as 29 percent in 1980 when the growth rate was negative 3.3 percent. In 1998, when the growth rate reached its lowest level during our sample period, the inflation rate was relatively lower, but still as high as 7.5 percent. In 2009, when the growth rate was approximately zero, the inflation rate was even lower at 2.7 percent. Corresponding figures from the PPI are 40 percent, 12.2 and –0.2 percent, respectively. Considering that the PPI is more relevant for employers who count the relative cost of labor to the price of output they produce, 2009 is characterized by a deflationary recession period.

For brevity, we will denote the three recessions by R1, R2, and R3, with the respective troughs being 1980, 1998, and 2009. The three recessionary periods reveal different macroeconomic conditions regarding wage adjustments. Judging by the growth (or unemployment) rate, downward real wage pressure would be the greatest during R2 and the smallest during R3. Inflation also matters to real wage adjustments because during a period of high inflation, employers are able to cut real wages while granting nominal wage increases to workers. During a period of deflation, however, real wage reductions require nominal wage reductions. In this sense, the downward nominal wage pressure would be greatest during R3. Whether nominal wages are actually adjusted downward depends on workers' resistance to nominal wage cuts, among other factors. Consequently, whether and by how much real wages are actually adjusted downward during a recession would be determined by a combination of the countercyclicality of the price level and the procyclicality of nominal wages.

3 Cyclicality of Real Wages

We begin our analysis by replicating existing micro-data-based studies that examine the average responsiveness of real wages with respect to a cyclical indicator for a sample period. The main purpose of this exercise is to assess the degree of overall real wage cyclicality in Korea and compare the results to those from existing studies for other countries, including the UK and the US, in particular.

Figure 3 provides a visualization of how real wages move over the business cycle. The mean log real wage rate in a year is computed as the simple average of individual log real wages, and the individual real wage rate is computed as the ratio of total monthly pay to total monthly hours (including overtime) in June deflated by the CPI (2010=100). Panels (A) and (B) use the real GDP growth rate and the unemployment rate, respectively, as cyclical indicators. The upward trends in real wages for both genders make it somewhat difficult to discern the cyclical movements of real wages from their long term trends. Still, the general impression is that both men's and women's real wages are strongly procyclical in Korea. Focusing on the three recessionary periods, real wages went down in R1 (1980), R2 (1998), and R3 (2009), relative to their respective previous years. These downward real wage adjustments are more apparent when viewed against the overall trends in real wages.[20] The results are generally similar across genders.

To assess real wage procyclicality quantitatively, we follow the common approach in the literature (e.g., Bils, 1985; Solon et al., 1994) by estimating a wage equation which includes a cyclical indicator, a cubic trend, and various wage determinants as regressors. Table 1 presents these results. Panels (A) and (B) show results based on the CPI and PPI deflators, respectively. We use three alternative cyclical indicators: per capita real GDP, the unemployment rate, and per capita employment. In each panel, estimates in the first six columns are obtained by applying Ordinary Least Squares (OLS) to the regression of year-to-year changes in the mean log real hourly wage rate (used in Figure 3) on a constant, year and its square, and changes in the cyclical indicator without controlling for individual characteristics. Real wages are strongly procyclical. For example, when the CPI is used to calculate real wages, the estimated cyclical elasticities of real wages with respect to per capita real GDP are 0.79 and 0.85 for men and women, respectively. When the unemployment rate is used as a cyclical indicator, a one percentage point increase in the unemployment rate leads to a fall in real wages of 2.6 percent for men and 3.2 percent for women. The estimated cyclical elasticities with respect to per capita employment are 1.49 and 1.45 for men and women, respectively. As revealed in the last

[20] In addition, real wage growth rates were lower for 1973–1974 (the first oil shock) and 2003–2004 (the credit market crisis) compared to their respective previous non-recessionary periods.

six columns, these estimates remain virtually identical when we control for observable individual characteristics in the wage function (see the Table 1 notes for further details), implying that the countercyclical composition bias associated with observable worker characteristics is not an issue in Korea.[21] These estimated real wage procyclicalities become greater by about 50 percent when the PPI is used instead of the CPI, suggesting that the PPI is more countercyclical compared to the CPI.

Because we control for cyclical composition effects associated with observable worker characteristics, our estimates may still be subject to countercyclical composition bias associated with unobservable attributes. There are, however, several reasons to believe that the bias is negligible. First, using longitudinal information on individual wage data received from the Korean Labor and Income Panel Survey (KLIPS) for 1997–2008, Shin (2012) shows directly that the estimated real wage cyclicality remains similar whether unobservable and/or observable characteristics are controlled for. Second, our OWS data suggest that the portion of the variation in the individual hourly wage rate that is not explained by a set of observable variables used in this paper is relatively small. Our R^2 is as high as 0.9 when industry dummy variables are included at the two-digit level along with year dummies, education, potential experience and its square, tenure and its square, a dummy for full-time/part-time status, and establishment size, and about 0.8 when industry dummies are included at the one-digit level. Third, our analysis excludes various labor force transients from the sample and focuses on workers who have a relatively strong labor force attachment. The sample includes those workers who are between 25 and 59 and excludes workers from relatively small establishments that hire fewer than 10 workers. Lastly, our later analysis based on wages of longitudinally-matched job stayers also finds a much greater reduction (smaller increase) in nominal wages during R3 (R2) compared to other non-recessionary periods.[22]

[21]This is partly explained by the fact that the mean wage rate in the first six columns is computed as a simple average (instead of hours-weighted average) of individuals' average hourly earnings, placing an equal weight on different skill groups. It is also worth noting that the importance of composition bias could be different depending on the labor market under consideration. Elsby et al. (2016, p280) write, "Although composition bias repeatedly has been found to be an important issue for measuring wage cyclicality in the United States, it matters much less for the UK."

[22]To examine whether the substantial real wage procyclicality is dependent on the quadratic time trend assumed in the wage level equation, we detrend the log real wage and the cyclical indicator for

The estimates in Table 1 suggest that real wages are more procyclical in Korea compared to the UK and the US, which have the most flexible labor markets among developed countries. For example, Solon et al. (1994) and Martins et al. (2012) summarize existing micro-data-based studies by reporting that a consensus estimate of the coefficient of the unemployment change is –0.015 in the US. Similar estimates are reported by Hart (2006) and Devereux and Hart (2006) for the UK and by Verdugo (2016) for eight major Eurozone countries.

What interests us more is the size of the real wage adjustment in each recession. During R1 (1980), men's and women's mean log real wages were reduced by 0.02 and 0.05 points, respectively, compared to their 1979 levels. In R2 (1998), men's and women's mean log real wages went down by 0.06 and 0.07 points, respectively. R3 (2009) witnessed the largest real wage reduction during our sample period, as both men's and women's mean log real wages decreased by 0.07 points from 2008 to 2009. The impression of greater real wage procyclicality during R3 relative to R1 or R2 is even stronger considering that growth rates (unemployment rates) were relatively higher (lower) during R3 than during R1 or R2. In addition, during R1 and R2, real wages dropped only for the year when the economy showed a negative growth rate, but real wages were reduced for two consecutive years during R3 (2007–2008 and 2008–2009). Specifically, men's and women's mean log real wages decreased by 0.162 and 0.097 points, respectively, from 2007 to 2009. Subsequent discussions are devoted to investigating whether the larger real wage reduction during R3, compared to previous recessions, is attributable to the larger nominal wage reduction in a lower inflation environment in R3.

the entire sample period using the Hodrick-Prescott (HP) filter. Following the existing literature, the smoothing parameter of the HP filter is set at 100. Then the change in the HP-filtered log real wage is regressed against a constant and the change in the HP-filtered cyclical indicator. The results are similar to those in Table 1. For example, when the CPI is used as a deflator, the estimated cyclical elasticities of real wages with respect to per capita real GDP are 0.818 (s.e.=0.210) and 0.988 (s.e.=0.238) for men and women, respectively. The estimated coefficients of the unemployment change are –0.0256 and –0.0317 for men and women, respectively, with associated standard error estimates of 0.0079 and 0.0091. This implies that the measured wage procyclicality is robust with respect to different filtering methods, which is common when annual data are analyzed (Liu, 2003).

4 Inflation and Nominal Wage Adjustments

As a first step to understanding the nature of real wage adjustments, Figure 4 displays the mean log nominal wage series and the log of the price level (CPI) along with the difference between the two; that is, the mean log real wage series previously shown in Figure 3. Panels (A) and (B) are for men and women, respectively. During R1, inflation was unusually high, and employers could reduce real wages substantially even while allowing considerable nominal wage increases. Focusing on men, mean nominal wages increased by 0.23 log points; the CPI deflator increased by 0.25 log points, and consequently, men's real wages decreased by 0.02 log points. A similar pattern can be observed in R2. For 1997–1998, when the log CPI deflator increased by 0.073 points, men's mean log nominal wages increased by 0.01 points, and as a result, men's real wages fell by 0.063 log points. During R3, however, the CPI deflator increased by only 0.027 log points. As nominal wages were *reduced* by 0.044 log points, real wages went down by 0.071 points. Dating back to Keynes (1936) or even earlier, macroeconomists have firmly believed that nominal wages are sticky downward due to workers' resistance to nominal wage cuts, and the DNWR can constrain the response of real wages to slack labor demand, exacerbating rising unemployment during recessions. The current results, however, are not consistent with this conventional view. Despite the fact that growth rates were lower for R2 and R1 compared to R3, real wages went down by a larger amount in R3. As noted previously, inflation rates were much lower in R3. Therefore, the larger reduction in real wages is attributable to the larger reduction in nominal wages in the zero-inflation environment. The results for women are generally consistent with the men's results.

A more appropriate evaluation of the conventional belief (negative correlation between the degree of DNWR and inflation) would require more information than just the mean wage change. For example, the large reduction of average nominal wages during R3 may result from high rates of job loss among the highest earners with few job stayers experiencing nominal wage reductions, which lines up neatly with the prediction of the DNWR hypothesis. This very concern motivated many longitudinal studies to investigate the patterns of nominal wage adjustments at the individual level. Following the recent literature summarized in Elsby and Solon (2018), we use accurate wage information from payroll records, focus on wage changes of those who remain in the same job for reasons stated previously,[23] and measure the extent of nominal wage flexibility and inflexibility by computing the proportions of wage reductions and freezes, respectively, in the distribution of year-to-year nominal wage changes of job stayers.[24] Because men and women show little difference in cyclical patterns of wage adjustments (see Figures 3 and 4 and Table 1), we pool both genders in the sample.[25]

Figure 5 displays histograms of year-to-year nominal wage changes among job stayers for the 16 matched years mentioned in Section 2. The hourly wage rate is defined by the ratio of actual monthly regular pay to actual monthly regular hours, excluding overtime and incentive pay and overtime hours.[26] The bin to the right of zero shows the percentage of workers whose change in log nominal wage was positive but less than or equal to 0.02. The next bin contains those whose change in log nominal wage was greater than 0.02 and less than or equal to 0.04, and so on. The bins to the left of zero are constructed symmetrically. To limit the histograms to a readable scale, we stack workers with a log nominal wage change greater than 0.6 in the rightmost bin and those with a change less than –0.4 in the leftmost bin. A thin line at zero shows the percentage of the workers that reported the exact same wage in both years. Table 2 contains summary statistics

[23]We define job stayers more strictly compared to existing studies. To be in the final sample of job stayers, individual workers must stay in the same establishment from June of one year to June of the next, work in the same occupation category at the 4-digit level with the same industry code at the 3-digit level, maintain the same employment type (permanent vs. temporary worker), the same work type (full-time, part-time, work at home, shift work, etc.), and even the same union status. In contrast, most existing studies analyze wage changes among employer (or firm) stayers.

[24]A better measure of nominal wage rigidity would be the fraction of desired nominal wage cuts that were not pursued, not only among surviving matches, but also on matches that were destroyed. To the best of our knowledge, however, such a measure is still understudied. Instead, the implicit assumption in this literature is that, if downward nominal wage rigidity is sufficiently common to cause a number of job losses, it should also be commonly observed among job stayers. More importantly, for reasons stated previously, we adopt this simple and transparent measure of DNWR/DNWF and focus on the pattern of changes in the measured degree of DNWF/ DNWR across different recessions and check if they are consistent with the prediction of the grease-the-wheels hypothesis.

[25]We combine hourly and non-hourly workers, as hourly workers constitute only a small fraction (about 5 percent) of the entire population.

[26]Focusing on straight-time pay works in the direction of making the nominal wage rate more rigid, compared to the case of including overtime pay in the hourly wage measure. Jardim et al. (2018) note that the economic interpretation of a measured wage cut is less clear when it arises from a reduction in the share of a worker's hours that are overtime work paid at time-and-a half.

for the sixteen empirical distributions.

Figure 5 and Table 2 produce a general impression that DNWR is not as prevalent as often suggested by existing studies based on household survey data (e.g., Card and Hyslop, 1996; Kahn, 1997; McLaughlin, 1994). First, few job stayers experience nominal wage freezes from one year to the next. When a nominal wage freeze is defined as a change in log nominal hourly wage rate between –0.005 and 0.005 (approximate zero change), our estimates of the fraction of job stayers with nominal wage freezes in column (7) range from a low of 1.11% in 1988–1989 to a high of 4.92% in 1997–1998. Second, a substantial proportion of job stayers experience nominal wage reductions from one year to the next. Our estimates of the fraction of job stayers with nominal wage cuts in column (9) range from a low of 12.3% in 1990–1991 to a high of 55.9% in 2008–2009. These findings of infrequent nominal wage freezes and frequent nominal wage reductions are altogether consistent with recent findings based on accurate wage information from payroll records or pay slips. Third, while some distributions show some degree of missing mass on the left of the central tendency,[27] many others show almost symmetric shapes.[28]

More importantly, changes in the distribution between inflationary and deflationary years are inconsistent with the conventional view that the degree of DNWR is inversely related to the inflation rate. Focusing on the comparison of R2 and R3, it is worth re-emphasizing that the inflation rate was much lower in R3 (PPI inflation= –0.21%, CPI inflation= 2.7%) than R2 (PPI inflation= 12.2%, CPI inflation= 7.5%), even though the R2 recession was more severe than R3. The fraction of nominal wage reductions, however, is higher for R3 compared to R2, and the fraction of nominal wage freezes is higher for R2 than R3. Consequently, the smaller extent of DNWR in R3, as evidenced by the greater fraction of wage cuts and the smaller fraction of freezes, is attributed to the greater downward nominal wage pressure induced by the lower inflation environment of R3. Changing the definition of a nominal wage freeze from ‘an approximate zero change’

[27] This is particularly true for 1986–1987, 1988–1989, 1993–1994, 1997–1998, 1999–2000, 2000–2001, and 2002–2003.

[28] Figure 5 also reveals a large dispersion in the distribution of individual nominal wage changes, implying that rigidity of entry wages, if any, would be less consequential as a driving force of high unemployment.

to 'an exact zero change' makes little difference to these results. In addition, as revealed in Figure 5, while the empirical distribution shows a certain degree of missing mass to the left of the central tendency in R2, it is approximately symmetric around the central location in R3. Furthermore, as shown in Table 2, the central location of the distribution shifted to the left more significantly during R3 compared to R2. Consequently, the greater reduction in the mean nominal wage rate during R3 relative to R2 that appears in Figure 4 is explained by the wage experience of a 'typical' worker, not a special group of workers. These observations are in contrast with a series of empirical studies that report a negative relationship between nominal wage rigidity and inflation (e.g., Card and Hyslop, 1996).

A careful examination of the estimates in Table 2 shows that there exists an upward trend in the extent of DNWF. A similar, even stronger, uptrend in the extent of DNWF is observed in the UK data (Table 6 of Elsby et al. (2016)). At the same time, inflation rates have generally decreased over time, implying that the negative relationship between the extent of DNWF and the inflation level might reflect this long run relationship at least partly. Given that our goal is to understand the nature of observed real wage procyclicality, it is appropriate to detrend both the extent of DNWR and inflation and focus on their short run relationship.

To examine the effects of inflation on cyclical wage rigidity/flexibility and to derive the results with all periods included in the analysis while holding other factors (e.g., the workforce/job characteristics) constant, we augment the model by Elsby et al. (2013) as follows. Suppose that workers always stay employed with the same employer and that, in the absence of any tendency towards nominal wage stickiness, the process determining worker i's real wage growth between years $t-1$ and t is

$$\Delta \log(W_{it}/P_t) = \beta_0 + \beta_1 C_t + \varepsilon_{it}, \tag{1}$$

where W_{it} is the worker's nominal wage rate, P_t is the price level, C_t is a measure of business cycle conditions, and $\beta_1 > 0$ if both C_t and real wage growth are procyclical. Conditional on C_t and P_t, ε_{it} is normally distributed with mean zero and variance σ^2. Then the probability that the worker's nominal wage growth would be negative is expressed as the following probit function:

$$\begin{aligned} Prob(\Delta \log W_{it} < 0) &= Prob(\varepsilon_{it} < -\beta_0 - \Delta \log P_t - \beta_1 C_t) \\ &= \Phi\Big[- \Big(\frac{\beta_0}{\sigma}\Big) - \frac{1}{\sigma}\Delta \log P_t - \frac{\beta_1}{\sigma} C_t \Big], \end{aligned} \tag{2}$$

where $\Phi(\cdot)$ is the standard normal cumulative distribution function. According to equation (2), the proportion of workers with negative nominal wage growth clearly is negatively related to both the inflation rate and the business cycle indicator. We may use equation (2) to compare R2 and R3 in the proportion of workers with nominal wage cuts. The lower growth rate in R2 compared to R3 works in the direction of making the fraction of workers with nominal wage cuts greater in R2 than in R3. The lower inflation rate in R3, however, will have the opposite effect. With the former dominated by the latter, the actual fraction of workers with wage reductions is greater in R3. In this setup, we may regard the conventional view of a negative relationship between nominal wage rigidity and inflation as the other polar case of extreme nominal wage stickiness: Because of DNWR, everyone that otherwise would have negative wage growth instead has zero wage growth. Under this alternative assumption, the proportion of workers with zero nominal wage growth would be the same probit function above. In reality, with C_t and $\Delta \log P_t$ given, the fraction of job stayers who experience nominal wage reductions or freezes depends on, among other things, how workers resist nominal wage reductions. Therefore, whether low inflation leads to a higher degree of DNWR or a greater extent of DNWF is an empirical matter.

Finally, to focus on cyclical components of DNWF/DNWR and inflation, control for the effects of various worker and job characteristics on the probability of wage reduction/freeze, and to examine the effect of inflation on cyclical wage flexibility/rigidity, equation (2) is further augmented as follows:

$$\begin{aligned} &Prob(\Delta \log W_{it} < 0) \; or \; Prob(\Delta \log W_{it} = 0) \\ &\qquad = \Phi\Big[\gamma_1 + \gamma_2 \Delta \log P_t + \gamma_3 C_t + \gamma_4 \Delta \log P_t \times C_t + \gamma_5 t + \gamma_6 t^2 + \theta' X_{it}\Big]. \end{aligned} \tag{3}$$

With a quadratic trend included,[29] γ_4 captures the effect of inflation on cyclical wage flexibility/rigidity, γ_2 the short-run relationship between DNWF/DNWR and inflation that is independent of business cycle conditions, and γ_3 reflects the extent of cyclical nominal wage adjustments that are independent of inflation. Focusing on the probability of nominal wage cuts, with a procyclical indicator (the growth rate of per capita real GDP or employment) being used, $\gamma_3 < 0$ implies procyclical nominal wage adjustments. With $\gamma_4 < 0$ ($\gamma_4 > 0$), the procyclicality of nominal wage adjustment becomes weaker (stronger) as inflation is *lowered*, supporting (contradicting) the conventional belief in the short run. The augmented model is estimated on the whole sample pooled over the 16 matched years.

Table 3 reports the estimation results of the probit model of nominal wage reductions. Robust standard error estimates are presented in parentheses. Panels (A) and (B) contain the estimates based on the CPI and the PPI, respectively, and each panel shows three sets of estimates for three different cyclical indicators used in Table 1. Each set contains estimation results of four different specifications: (1) Including the inflation rate and the cyclical indicator; (2) additionally including a quadratic trend; (3) further including an interaction term of the inflation rate and the cyclical indicator; and (4) adopting specification (3) with the inflation rate detrended by the Hodrick-Prescott filter (with the smoothing parameter set to 100). In all specifications, we control for the experience level of an individual worker at t and a constant. The corresponding parameter estimates are omitted from the table for brevity.[30] The results are quite robust to the use of different inflation measures and different cyclical indicators. Looking at specification (1), the probability of a nominal wage cut is inversely related to inflation, holding demand conditions and other individual characteristics constant. This finding is inconsistent with the conventional view that the degree of DNWR is inversely related to the inflation rate.

[29] This implicitly controls for trends in both $\Delta \log P_t$ and C_t as well as the trend in the probability of nominal wage reductions/freezes.

[30] This specification effectively controls for all the observable and unobservable individual-specific time-invariant characteristics such as natural ability, motivation, gender, and education. The results are robust to the inclusion or exclusion of the experience variable. The results also remain robust even when we control for the following individual and job characteristics in the wage change (cut) equation: tenure, squared tenure, education, a dummy variable for full-time/part-time status, establishment size, gender, and dummy variables for nine major industries.

When a quadratic trend is included (specification (2)),[31] the estimated coefficients on both t and t^2 are very precise. With a quadratic trend included, the estimated coefficient of the inflation rate still remains negative, but the magnitude is reduced to some degree in absolute terms, implying that the long run relationship between inflation and the degree of DNWF is also negative. This result is intuitive considering that workers are more likely to accept nominal wage reductions when they adapt their expectations to declining inflation over a longer run period. More interestingly, the relationship between DNWF and inflation remains negative *even in the short run*. In all sets of results, the estimates in row 2 suggest that nominal wage adjustments are procyclical. For example, a rise in the unemployment rate leads to an increase in the probability of a nominal wage cut.

In specification (3), which is our preferred specification, we examine how the *cyclical* component of DNWF reacts to an inflationary or deflationary environment. The results show that the procyclical nominal wage adjustment during a recession becomes greater when the inflation rate is lower. For example, when the real growth rate is used as a cyclical indicator, the estimated coefficient on the interaction term is positive, implying that the increase in the probability of a nominal wage cut associated with a *lowered* growth rate becomes greater when the inflation rate is lower. The sign of the estimated coefficient on the interaction term is also positive when per-capita employment is used as a cyclical indicator. With the unemployment rate used as a cyclical indicator, the estimated coefficient on the interaction term becomes negative. In all six cases, the sign of the estimated coefficient on the interaction term is the opposite of the sign of the coefficient on the cyclical indicator. This finding reinforces our previous observation that, despite the lower growth rate in R2 relative to R3, proportionally more job stayers experienced nominal wage cuts during R3 than R2 due to the lower inflation rate. Now the previous observation is reconfirmed even in the short run and even when controlling for the composition of the workforce. The results change little when we further detrend the inflation rate using the HP filter in specification (4).

We next repeat the analysis of Table 3 with the dependent variable being replaced

[31] The results remain similar when controlling for a linear trend.

by a new dummy variable which equals one if an individual experiences a nominal wage freeze and zero otherwise. The estimates produced by this exercise are presented in Table 4. The take-away result is that the sign of the estimated coefficient on the interaction term appears exactly opposite to that in Table 3, implying that, other things being equal, a lower inflation rate makes the degree of DNWR smaller during a recession. Once again, this finding reconfirms the main result appearing in Table 3 that cyclical DNWF is negatively responsive even to short run reductions in the inflation rate. The rest of the results also generally corroborate the findings in Table 3. For example, in specification (1), contrary to the conventional view, the degree of DNWR is positively related to the inflation rate: In all cases, the estimated coefficients of the inflation rate appear positive. Including a trend in specification (2) reduces the size of the estimated coefficient of inflation, confirming our previous observation in Table 3 that people are more likely to accept a nominal wage cut when inflation is lowered over a longer run period. As a minor difference, evidence of the short run DNWR-inflation relationship is somewhat different depending on the price deflator used. Finally, in specification (2), the estimated coefficient of the cyclical indicator suggests that the degree of DNWR is also somewhat countercyclical, though less so compared to the degree of DNWF. All these results remain robust when the definition of a nominal wage freeze is changed from an exact zero to an approximate zero.

Put together, the evidence so far does not support the conventional belief of a negative correlation between DNWR and inflation even in the short run. As such, the results reveal the nature of real wage procyclicality observed by numerous longitudinal studies: Nominal wages move procyclically during a recession when inflation stops functioning to adjust real wages downward to the market-desired level.

5 Analysis at the Establishment Level

Our analysis so far has focused on wage adjustments at the aggregate and worker levels. Since wage and employment decisions are made at the establishment level, it is appropriate to address the current issue at that level as well. This allows us to discern the role of employers in cyclical nominal wage adjustments. We can further answer the question of whether the frequent nominal wage reductions during a recession and more frequent reductions during a deflationary, relative to inflationary, recession are explained by a group of establishments that are under severe financial distress and cut most of their workers' wages. Our basic strategy is to construct an employer-employee linked data set, group individual wage changes by establishment, and compute the proportion of job stayers in an establishment who experience nominal wage cuts. As it turns out, a non-negligible portion of the establishments have only a few employees in the final sample. To obtain reliable estimates, we focus on those establishments that have at least 10 stayers in the sample. To derive distributions comparable to those based on individual wage changes in Figure 5, the fraction of job stayers with wage cuts in each establishment is weighted by the share of each establishment among the total stayers.

Figure 6 displays the 16 empirical distributions of the proportion of job stayers who experience nominal wage cuts in an establishment. A general impression is that employers (establishments) cut nominal wages for a fraction of their employees fairly routinely. Estimates in Figure 6, though not reported in a separate table for brevity, show that the share of establishments that cut nominal wages for more than 10, but less than or equal to 90 percent of their stayers ranges from a low of 27 percent for 1990–1991 to a high of 71 percent for 2008–2009 (R3). Focusing on the cyclical patterns, a recession is associated with a reduction in the proportion of employers who cut none of their stayers' wages and an increase in the proportion of employers who cut all of their stayers' wages. For example, among the 16 matched years, R3 and R2 show the smallest and the next smallest fractions of employers who cut none of their workers' wages at 4 and 7 percent, respectively. R3 and R2 also show the greatest and the next greatest proportions of employers who cut all of their workers' wages with respective numbers of 6 and 4 percent. In addition, the empirical distribution, which is skewed to the right in a 'normal' period, becomes more uniformly distributed during a recession, implying that more individuals experience nominal wage reductions in a recession as more employers cut wages for more of their employees. Even for the two severe recessions (R2 and R3), however, the frequent nominal wage reductions observed at the individual level are not purely driven by a small group of employers who cut wages for all of their workers. A comparison of R2 and R3 shows that nominal wages are more flexible downward during a deflationary recession than an inflationary recession. As a crude measure of downward nominal wage flexibility at the establishment level, we consider the fraction of employers who cut wages for more than 10 percent of their stayers. Estimates in Figure 6 show that this fraction is greater in R3 relative to R2 (90 percent vs. 75 percent), which is attributable to the lower inflation environment in R3 as compared to R2. Even at the height of the Great Recession (R3), however, the vast majority of employers cut wages for some of their workers, but not for others. This finding does not support Bewley's morale-based prediction of the large between-firm effect during a recession, deflationary recessions in particular. All of these estimates remain quite similar when the required number of stayers in an establishment in the sample is extended to 15 or more or when all establishments are included in the analysis.

To conduct the analysis of Table 2 at the establishment level, we compare the average nominal wage of all job stayers between two matched years for each establishment and compute the fraction of establishments that reduce the average wage from one year to the next. Naturally, this statistic reflects not only the frequency but also the size of wage cuts experienced by stayers within each establishment. As shown in the fourth column of Table 5, this new measure shows similar estimates and cyclical patterns to those based on individual wage changes (columns 8 and 9 of Table 2). This reconfirms our previous finding that the cyclical patterns of nominal wage adjustments observed at the individual level are explained by the behavior of a typical employer (within-establishment effects). Importantly, despite the much lower growth rate during R2 relative to R3, employers are more likely to cut their stayers' wages during a deflationary (R3), compared to inflationary (R2), recession (56.1 percent vs. 45.6 percent), which is attributed to the lower inflation rate. This observation, when juxtaposed with the lower unemployment rate and relatively higher economic growth rate in R3 relative to R2, suggests that deflation costs may not be as high as often emphasized by existing studies. Several recent studies emphasize that the macroeconomic effects of DNWR are relatively weak (e.g., Card and Hyslop, 1996; Elsby, 2009; Nickell and Quintini, 2003). This paper finds that DNWR itself is not a salient feature of a deflationary recession. As such, the current results do not support arguments against low inflation targeting as a way of avoiding deflation costs occurring through the labor market. Again, all of these results are quite robust with respect to different sample restrictions, including requiring the number of observed stayers in an establishment to be at least 15 or including all establishments in the sample.

Finally, we conduct Table 3's analysis at the establishment level with the dependent variable being replaced by a new dummy variable which equals one when the average wage of job stayers in an establishment is reduced from one year to the next.[32] For brevity, we report the result only for our preferred model that uses the PPI (as it is more relevant for employers who consider the relative cost of labor to the price of output they produce)[33] and allows for the interaction term of inflation and changes in the cyclical indicator (specification (3) in Table 3). The results reported in Table 6 suggest that all the previous findings from Table 3 survive this new exercise at the establishment level at least qualitatively. Most importantly, even a temporary reduction in the inflation rate below its long run trend rate raises the extent of cyclical downward wage adjustment made by an employer during a recession.

6 Conclusion

Since Keynes (1936), the assumption of downward nominal wage rigidity has been the cornerstone of macroeconomic analysis of cyclical fluctuations in the labor market. But where is the evidence of DNWR? How prevalent is DNWR during a deflationary recession? The recent literature summarized by Elsby and Solon (2018) uses accurate wage data from payroll records and provides compelling evidence that job stayers experience

[32]Similar to the analysis of Table 3, we include the average experience of job stayers as an additional regressor.

[33]Firms also consider the PPI when they assess the real burden of debts, as the nominal liabilities must be met by accrued revenue.

frequent nominal wage reductions and infrequent nominal wage freezes. While the recent evidence is apparently against the conventional belief that nominal wages cannot be cut, assessing the macroeconomic importance of DNWR requires further analysis of the DNWR-inflation relationship in the short run. As stated previously, existing evidence and results reported in this paper show upward trends in the extent of DNWF. It is relatively easy to understand the long-run relationship between inflation and wage rigidity/flexibility. What remains uncertain is the effect of inflation on nominal wage adjustment in the short run. The unique feature of this paper lies in its formal discussion of the role of inflation in *cyclical* nominal wage adjustment: How the *cyclical* wage flexibility/rigidity can react to a temporary reduction of the inflation rate below its long run trend rate. Analysis of payroll-based wage data from the Korean labor market for the period 1971 to 2014, while confirming most of the observations made by the recent literature, finds that cyclical wage rigidity (flexibility) becomes weaker (stronger) during a deflationary, relative to inflationary, recession. Further, employers do not play much role in explaining the large increase in nominal wage cuts in a recession or the larger increase in wage reductions in a deflationary, relative to inflationary, recession.

Stepping back and looking at the bigger picture , the results in this paper do not contradict the hypothesis that inflation greases the wheels of the labor market. Instead, they point out that positive inflation is not a necessary condition for making the wheels function: Nominal wages are flexible downward when required by a low inflation environment. At a minimum, this paper's findings, although they may not be generalized to other countries, serve as a counter-example to the conventional theory of *cyclical* wage rigidity based on Keynes' premise of downward nominal wage rigidity.

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Tables

Table 1: Estimated Real Wage Cyclicality in Korea, 1971–2014

(A) Consumer Price Index

	Change in mean log real wages						Changes in estimated coefficients on year dummy variables					
	Men			Women			Men			Women		
Changes in log real GDP per capita	0.794 (0.190)			0.850 (0.223)			0.781 (0.179)			0.858 (0.205)		
Changes in unemployment rate		-0.026 (0.009)			-0.032 (0.010)			-0.023 (0.009)	(0.010)		-0.028	
Changes in log per capita employment			1.492 (0.444)			1.451 (0.527)			1.397 (0.426)			1.543 (0.485)
R-squared	0.368	0.245	0.289	0.305	0.238	0.199	0.388	0.224	0.283	0.358	0.233	0.259
Durbin-Watson stat	1.665	1.415	1.708	2.103	1.952	2.170	1.822	1.510	1.745	1.821	1.571	1.852

Table 1: Estimated Real Wage Cyclicality in Korea, 1971–2014 (Cont'd)

(B) Producer Price Index

	Change in mean log real wages						Changes in estimated coefficients on year dummy variables					
	Men			Women			Men			Women		
Changes in log real GDP per capita	1.256 (0.236)			1.312 (0.271)			1.243 (0.215)			1.320 (0.254)		
Changes in unemployment rate		-0.040 (0.012)			-0.045 (0.013)			-0.036 (0.011)	(0.013)		-0.042	
Changes in log per capita employment			2.054 (0.599)			2.014 (0.685)			1.960 (0.566)			2.106 (0.647)
R-squared	0.437	0.236	0.248	0.384	0.244	0.190	0.476	0.226	0.253	0.423	0.228	0.228
Durbin-Watson stat	1.527	1.225	1.497	1.789	1.565	1.799	1.673	1.286	1.512	1.558	1.281	1.540

Data source: The Occupational Wage Survey data for the period 1971–2014.

Notes: Estimates in the first six columns are obtained by applying Ordinary Least Squares (OLS) to the regression of year-to-year changes in the mean log real hourly wage rate on a constant, year and its square, and changes in a cyclical indicator without controlling for individual characteristics. To obtain estimates in the last six columns, we carry out the following two-step procedure (see, among others, Solon et al., 1994; Shin, 1994; Devereux, 2001). In the first step, we apply OLS to the regression of the log individual wage rate on a vector of year dummies and observable characteristics (education, potential experience and its square, tenure and its square, a dummy for full-time/part-time status, the establishment size, and industry dummies). In the second step, OLS is applied to the regression of changes in the estimated year effects on a constant, year and its square, and changes in a cyclical indicator. The coefficient of changes in the cyclical indicator represents the cyclicality of real wages.

Table 2: Patterns of Nominal Wage Adjustments at the Individual Level

Year	Real Growth Rate	Inflation CPI/PPI	Mean Change (Log Wage)	Median Change (Log Wage)	Percentage of Workers with Zero Nominal Wage Change (%)		Percentage of Workers with Negative Nominal Wage Change (%)	
					Exact Zero	Approximate Zero	Exact Zero	Approximate Zero
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
1986–1987	11.4	3.1/0.5	11.7	9.7	0.98	2.53	25.6	24.8
1988–1989	6.0	5.7/1.5	19.6	19.0	0.41	1.11	16.5	16.1
1990–1991	9.3	9.3/4.7	20.4	20.2	0.58	1.44	12.6	12.1
1991–1992	5.1	6.2/2.2	10.4	9.4	0.17	2.12	27.5	26.4
1993–1994	8.1	6.3/2.7	12.6	12.0	0.55	1.82	17.2	16.6
1994–1995	8.5	4.5/4.7	13.9	13.8	0.59	1.70	15.1	14.7
1996–1997	4.9	4.4/3.8	8.9	8.1	0.86	3.16	25.0	23.9
1997–1998	**–6.2**	**7.5/12.2**	**2.2**	**1.3**	**2.02**	**4.95**	**43.7**	**42.3**
1999–2000	8.0	2.3/2.1	14.1	12.9	0.75	2.41	17.0	16.4
2000–2001	3.7	4.1/–0.5	7.0	6.6	0.47	2.81	29.6	28.5
2002–2003	2.4	3.5/2.2	9.0	8.1	0.03	2.49	28.3	27.2
2003–2004	4.5	3.6/6.1	4.6	3.6	0.04	2.71	40.1	38.9
2008–2009	**0.2**	**2.7/–0.2**	**–2.4**	**–2.8**	**0.00**	**2.43**	**57.1**	**55.9**
2009–2010	6.0	2.9/3.8	6.6	5.7	0.17	2.82	34.7	33.6
2011–2012	1.8	2.2/0.7	9.4	9.5	0.02	1.49	26.8	26.1
2012–2013	2.4	1.3/–1.6	9.2	8.5	0.03	1.86	26.2	25.3

Data source: The Occupational Wage Survey data.
Notes: Exact zero change: $\Delta \log W = 0$. Approximate zero change: $-0.005 < \Delta \log W < 0.005$.

Table 3: Estimation Results of Probit Model of Nominal Wage Reductions among Job Stayers

(A) Consumer Price Index

	C_t: Growth Rates				C_t: Δ Unemployment Rates				C_t: Per capita Employment			
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
$\Delta log P_t$	-2.749 (0.064)	-1.779 (0.130)	-2.806 (0.152)	-4.365 (0.185)	-9.328 (0.074)	-7.381 (0.159)	-9.068 (0.160)	-12.652 (0.179)	-7.871 (0.070)	-7.655 (0.148)	-9.677 (0.147)	-13.038 (0.161)
C_t	-6.004 (0.034)	-5.061 (0.043)	-6.243 (0.103)	-5.482 (0.060)	0.207 (0.001)	0.179 (0.001)	0.510 (0.004)	0.302 (0.002)	-11.820 (0.060)	-10.724 (0.076)	-29.172 (0.195)	-17.765 (0.113)
$\Delta log P_t \times C_t$			21.363 (1.660)	1.691 (2.146)			-5.214 (0.063)	-4.437 (0.068)			300.000 (2.911)	276.669 (3.664)
$Year$		0.054 (0.001)	0.054 (0.001)	0.058 (0.001)		0.070 (0.001)	0.069 (0.001)	0.089 (0.001)		0.043 (0.001)	0.028 (0.001)	0.040 (0.001)
$Year^2$		-0.001 (0.000)	-0.002 (0.000)	-0.002 (0.000)		-0.002 (0.000)	-0.002 (0.000)	-0.002 (0.000)		-0.001 (0.000)	-0.001 (0.000)	-0.001 (0.000)
$Observations$	1442564	1442564	1442564	1442564	1442564	1442564	1442564	1442564	1442564	1442564	1442564	1442564
$Log-likelihood$	-880135	-877947	-877860	-877555	-881812	-877647	-873761	-874327	-876307	-874820	-869423	-871059
$Chi-squared$	35882	35342	35475	36678	33562	37309	42238	41410	42798	42977	54464	50468

Table 3: Estimation Results of Probit Model of Nominal Wage Reductions among Job Stayers (Cont'd)

(B) Producer Price Index

	C_t: Growth Rates				C_t: Δ Unemployment Rates				C_t: Per capita Employment			
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
$\Delta log P_t$	-0.385 (0.037)	-0.354 (0.047)	-0.075 (0.047)	-1.361 (0.048)	-3.951 (0.047)	-3.761 (0.058)	-2.145 (0.061)	-3.896 (0.063)	-3.446 (0.043)	-2.735 (0.053)	0.284 (0.061)	-1.064 (0.063)
C_t	-6.073 (0.034)	-4.862 (0.039)	-10.542 (0.093)	-7.818 (0.065)	0.204 (0.001)	0.187 (0.001)	0.372 (0.003)	0.307 (0.002)	-12.012 (0.064)	-9.990 (0.068)	-21.569 (0.133)	-16.972 (0.101)
$\Delta log P_t \times C_t$			89.928 (1.312)	74.276 (1.367)			-2.250 (0.032)	-1.854 (0.034)			158.002 (1.531)	141.045 (1.643)
$Year$		0.058 (0.001)	0.023 (0.001)	0.035 (0.001)		0.091 (0.001)	0.082 (0.001)	0.083 (0.001)		0.063 (0.001)	0.021 (0.001)	0.029 (0.001)
$Year^2$		-0.002 (0.000)	-0.001 (0.000)	-0.001 (0.000)		-0.002 (0.000)	-0.002 (0.000)	-0.002 (0.000)		-0.002 (0.000)	-0.000 (0.000)	-0.001 (0.000)
Observations	1442564	1442564	1442564	1442564	1442564	1442564	1442564	1442564	1442564	1442564	1442564	1442564
Log−likelihood	-880943	-878018	-875522	-875961	-885789	-876650	-873941	-872902	-879110	-874853	-869415	-869744
Chi−squared	33736	33839	33788	34021	24441	36888	37178	41453	36748	40887	48673	48980

Data source: The Occupational Wage Survey data.

Notes: The dependent variable is a dummy variable which equals one if a job stayer experiences a nominal wage reduction from June of one year to June of the next, and zero otherwise. In all specifications, we control for the experience level of an individual worker at t and a constant, whose estimation results are omitted from the table for brevity. This specification is comparable to the one adopted in Table 1, which effectively controls for all the observable and unobservable individual-specific time-invariant characteristics such as natural ability, motivation, gender, and education. The results remain quite robust whether the experience variable is excluded from the equation. The results also remain robust even when we control for the following individual and job characteristics in the wage change (cut) equation additionally: tenure, squared tenure, education, a dummy variable for full-time/part-time status, establishment size, gender, and dummy variables for nine major industries. The nine major industries are: mining, manufacturing, utilities, construction, wholesale, retail and food service, transportation and warehousing, finance, insurance, and real estate, professional, scientific, management, and administrative services. Robust standard error estimates in parentheses.

Table 4: Estimation Results of Probit Model of Nominal Wage Freezes among Job Stayers

(A) Consumer Price Index

	C_t: Growth Rates				C_t: Δ Unemployment Rates				C_t: Per capita Employment			
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
$\Delta logP_t$	12.939	-0.600	24.104	27.277	11.334	-4.160	-0.509	-0.119	12.006	-3.683	5.267	6.915
	(0.238)	(0.466)	(0.855)	(0.980)	(0.278)	(0.530)	(0.537)	(0.573)	(0.259)	(0.510)	(0.599)	(0.658)
C_t	-0.636	-3.023	19.839	7.841	0.048	0.113	-0.275	-0.053	-2.056	-6.079	25.145	8.576
	(0.114)	(0.161)	(0.674)	(0.369)	(0.004)	(0.005)	(0.014)	(0.007)	(0.188)	(0.250)	(1.076)	(0.560)
$\Delta logP_t \times C_t$			-311.967	-327.574			5.716	6.080			-433.243	-460.296
			(8.868)	(9.826)			(0.204)	(0.221)			(14.489)	(15.742)
$Year$		0.022	0.051	0.073		0.030	0.012	0.020		0.019	0.026	0.042
		(0.004)	(0.004)	(0.004)	(0.003)		(0.003)	(0.003)	(0.003)		(0.003)	(0.003)
$Year^2$		-0.002	-0.002	-0.003		-0.003	-0.002	-0.002		-0.002	-0.002	-0.002
		(0.000)	(0.000)	(0.000)		(0.000)	(0.000)	(0.000)		(0.000)	(0.000)	(0.000)
$Observations$	1442564	1442564	1442564	1442564	1442564	1442564	1442564	1442564	1442564	1442564	1442564	1442564
$Log-likelihood$	-26346	-25441	-24758	-24827	-26279	-25318	-24946	-24963	-26303	-25324	-248456	-24886
$Chi-squared$	2941	4751	6117	5979	3075	4997	5741	5707	3027	4984	5942	5861

Table 4: Estimation Results of Probit Model of Nominal Wage Freezes among Job Stayers (Cont'd)

(B) Producer Price Index

	C_t: Growth Rates				C_t: Δ Unemployment Rates				C_t: Per capita Employment			
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
$\Delta log P_t$	9.940	4.743	5.428	5.902	9.663	4.574	1.267	0.913	10.056	4.351	1.793	1.588
	(0.195)	(0.243)	(0.257)	(0.268)	(0.256)	(0.321)	(0.357)	(0.354)	(0.234)	(0.299)	(0.331)	(0.334)
C_t	2.687	-0.300	11.582	7.152	-0.050	0.010	-0.217	-0.135	3.462	-0.879	16.385	10.932
	(0.147)	(0.177)	(0.424)	(0.308)	(0.005)	(0.006)	(0.010)	(0.008)	(0.273)	(0.316)	(0.676)	(0.525)
$\Delta log P_t \times C_t$			-160.083	-155.970			2.886	2.994			-199.285	-206.355
			(5.159)	(5.026)			(0.110)	(0.112)			(6.802)	(6.892)
$Year$		0.014	0.076	0.073	0.016		0.010	0.013	0.015		0.039	0.040
		(0.004)	(0.004)	(0.004)		(0.004)	(0.003)	(0.003)		(0.004)	(0.003)	(0.003)
$Year^2$		-0.002	-0.003	-0.003		-0.002	-0.002	-0.002		-0.002	-0.002	-0.002
		(0.000)	(0.000)	(0.000)		(0.000)	(0.000)	(0.000)		(0.000)	(0.000)	(0.000)
Observations	1442564	1442564	1442564	1442564	1442564	1442564	1442564	1442564	1442564	1442564	1442564	1442564
Log−likelihood	-26082	-25246	-24761	-24778	-26214	-25246	-24912	-24920	-26174	-25243	-24813	-24813
Chi−squared	3468	5141	6112	6077	3205	5141	5808	5793	3285	5146	6007	6007

Data source: The Occupational Wage Survey data.

Notes: The dependent variable is a dummy variable which equals one if a job stayer experiences a nominal wage freeze from June of one year to June of the next, and zero otherwise. See the note to Table 3.

Table 5: Patterns of Nominal Wage Adjustments at the Establishment Level

Year	Real Growth Rate	Inflation CPI/PPI	Fraction of Employers Who Reduce Average Wage of Job Stayers (%)
1986–1987	11.4	3.1/0.5	20.4
1988–1989	6.0	5.7/1.5	11.7
1990–1991	9.3	9.3/4.7	9.7
1991–1992	5.1	6.2/2.2	20.5
1993–1994	8.1	6.3/2.7	16.2
1994–1995	8.5	4.5/4.7	13.4
1996–1997	4.9	4.4/3.8	23.5
1997–1998	**–6.2**	**7.5/12.2**	**45.6**
1999–2000	8.0	2.3/2.1	18.0
2000–2001	3.7	4.1/–0.5	28.1
2002–2003	2.4	3.5/2.2	25.5
2003–2004	4.5	3.6/6.1	40.5
2008–2009	**0.2**	**2.7/–0.2**	**56.1**
2009–2010	6.0	2.9/3.8	32.0
2011–2012	1.8	2.2/0.7	23.3
2012–2013	2.4	1.3/–1.6	22.5

Data source: The Occupational Wage Survey data.

Notes: To obtain the estimates in Column 4, for each establishment, we first compute the average nominal wage among all job stayers in a year and the change between two matched years. Then we compute the fraction of establishments that show a negative change. Estimates in the last column represent the simple average (median) of the percentage wage reductions among those establishments that reduced the average wage of job stayers.

Table 6: Estimation Results of Probit Model of Nominal Wage Reductions: Analysis at the Establishment Level

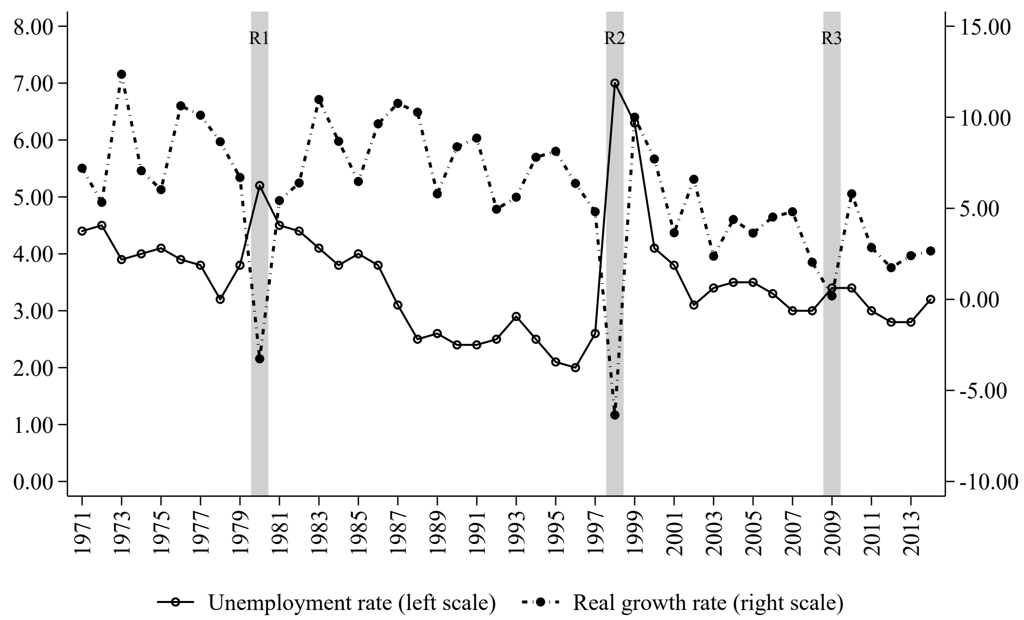
	C_t: Growth Rates	C_t: Δ Unemployment Rates	C_t: Per capita Employment
$\Delta logP_t$	-0.201 (0.216)	-2.968 (0.283)	-1.219 (0.276)
C_t	-6.131 (0.380)	0.266 (0.012)	-17.353 (0.567)
$\Delta logP_t \times C_t$	24.733 (5.471)	–1.067 (0.133)	98.918 (6.625)
$Year$	0.057 (0.004)	0.098 (0.004)	0.048 (0.004)
$Year^2$	–0.002 (0.000)	–0.003 (0.000)	–0.001 (0.000)
$Observations$	70967	70967	70967
$Log-likelihood$	–44302	–44182	–43997
$Chi-squared$	2052	2264	2656

Data source: The Occupational Wage Survey data.

Notes: Producer Price Index is used. The dependent variable is a dummy variable which equals one when the average wage of job stayers in an establishment is reduced from one year to the next. Similar to the analysis of Table 3, we include the average experience of job stayers as an additional regressor.

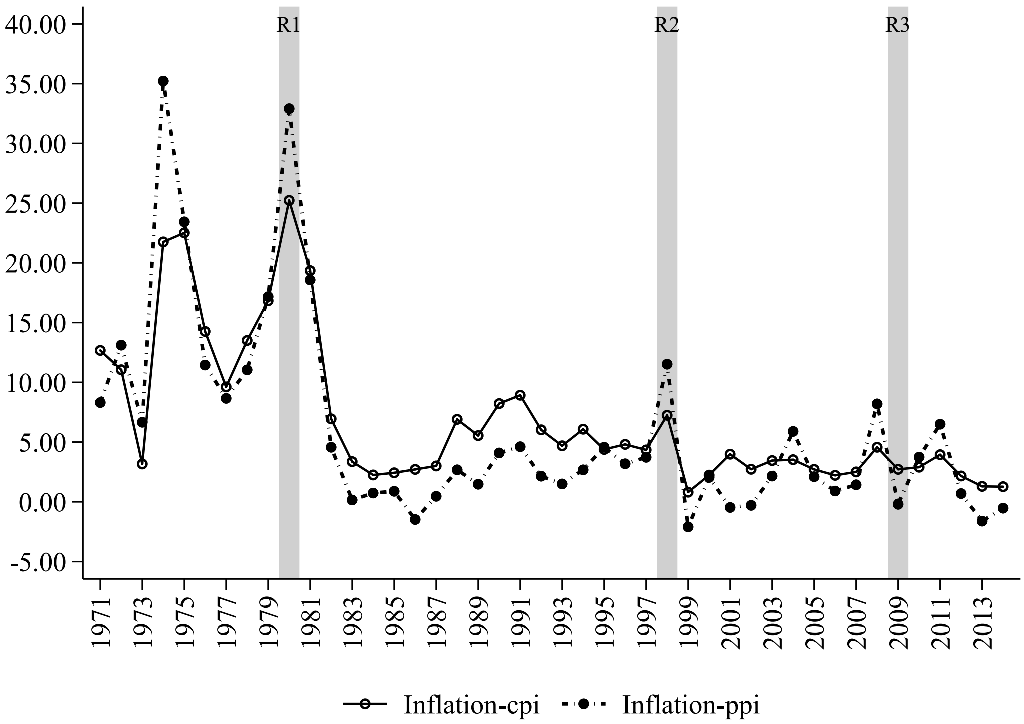
Figures

Figure 1: Real GDP Per Capita Growth Rate and Unemployment Rate in Korea, 1971–2014



Source: The growth rate of real GDP per capita: Bank of Korea, Unemployment rate: Statistics Korea.
Notes: The real growth rate in year t is the logarithm of the ratio of real GDP in year t to that in year $(t-1)$. The unemployment rate and the growth rate follow the left and the right scale, respectively.

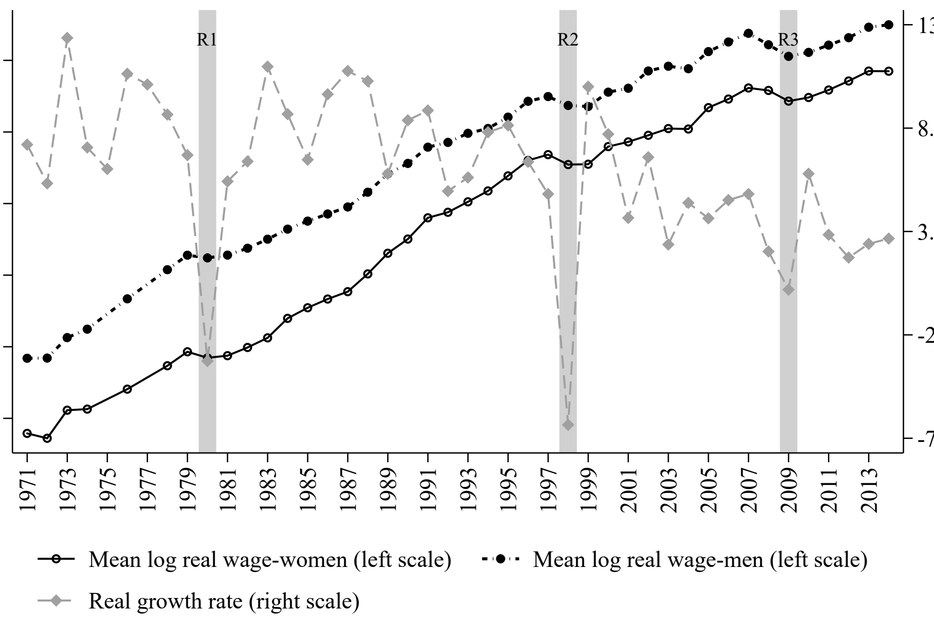
Figure 2: Inflation Rates in Korea, 1971–2014



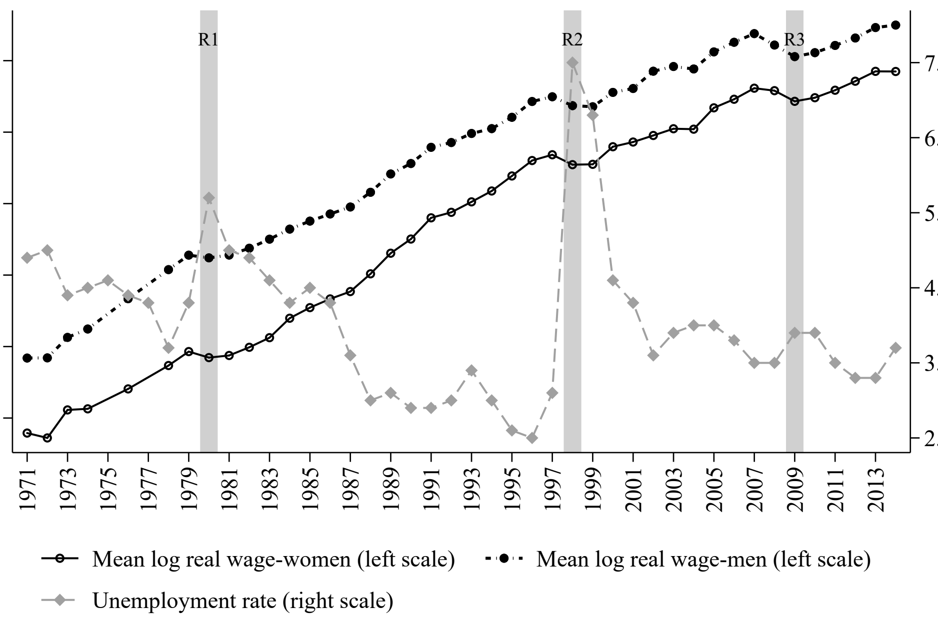
Source: Bank of Korea

Figure 3: Mean Log Real Wages and Cyclical Indicators in Korea, 1971–2014

(A) Mean Log Real Wages and the Real GDP Growth Rate



(B) Mean Log Real Wages and the Unemployment Rate



Source: The authors' calculation using the Occupational Wage Survey data.
Notes: The mean log real wage rate in a year is computed by the simple average of individual log real wages, and the individual real wage rate is computed as the ratio of the total monthly pay to the total monthly hours (including overtime) in June deflated by the Consumer Price Index (CPI, 2010=100).

Figure 4: Mean Log Real and Nominal Wages in Korea by Gender, 1971–2014

(A) Men

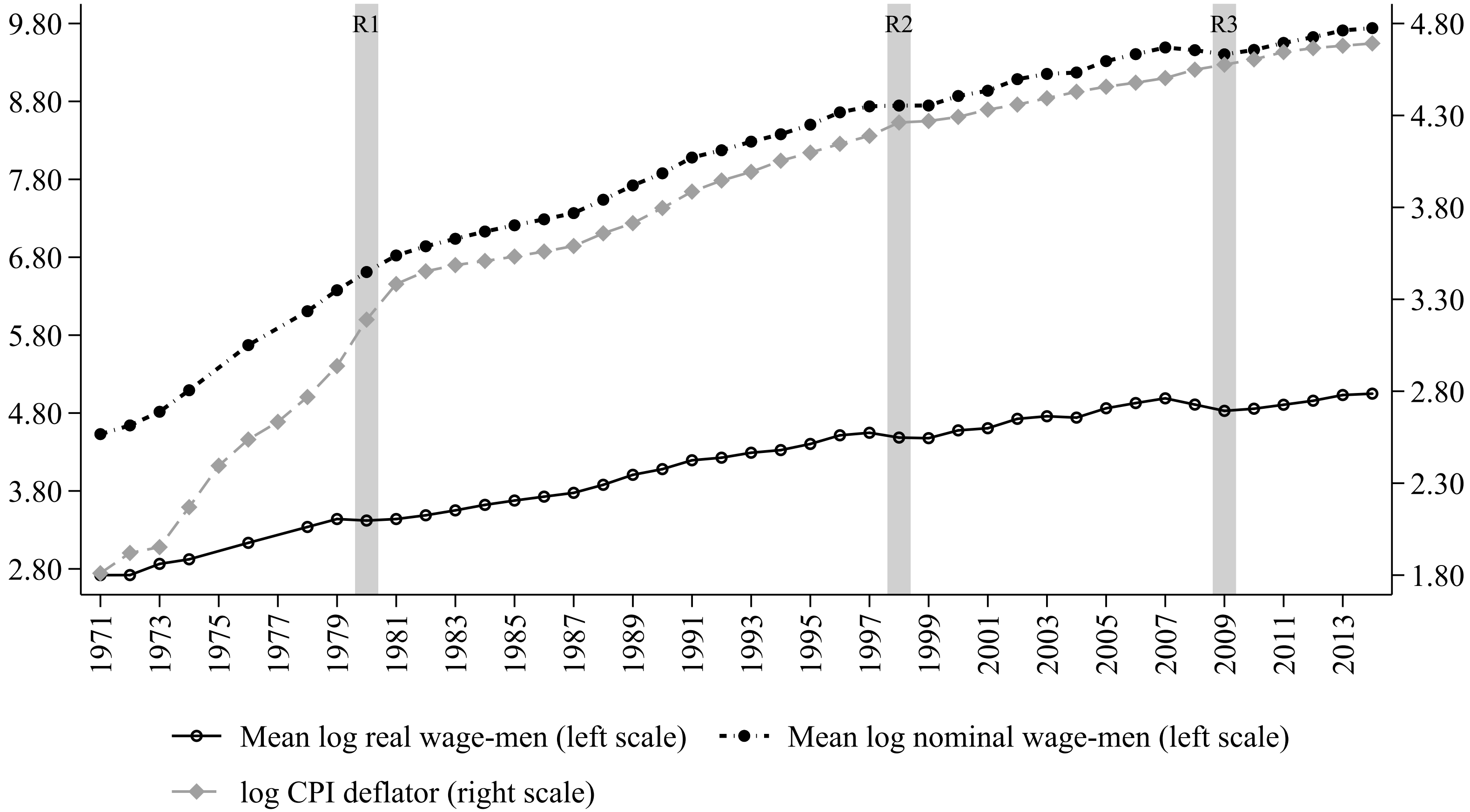
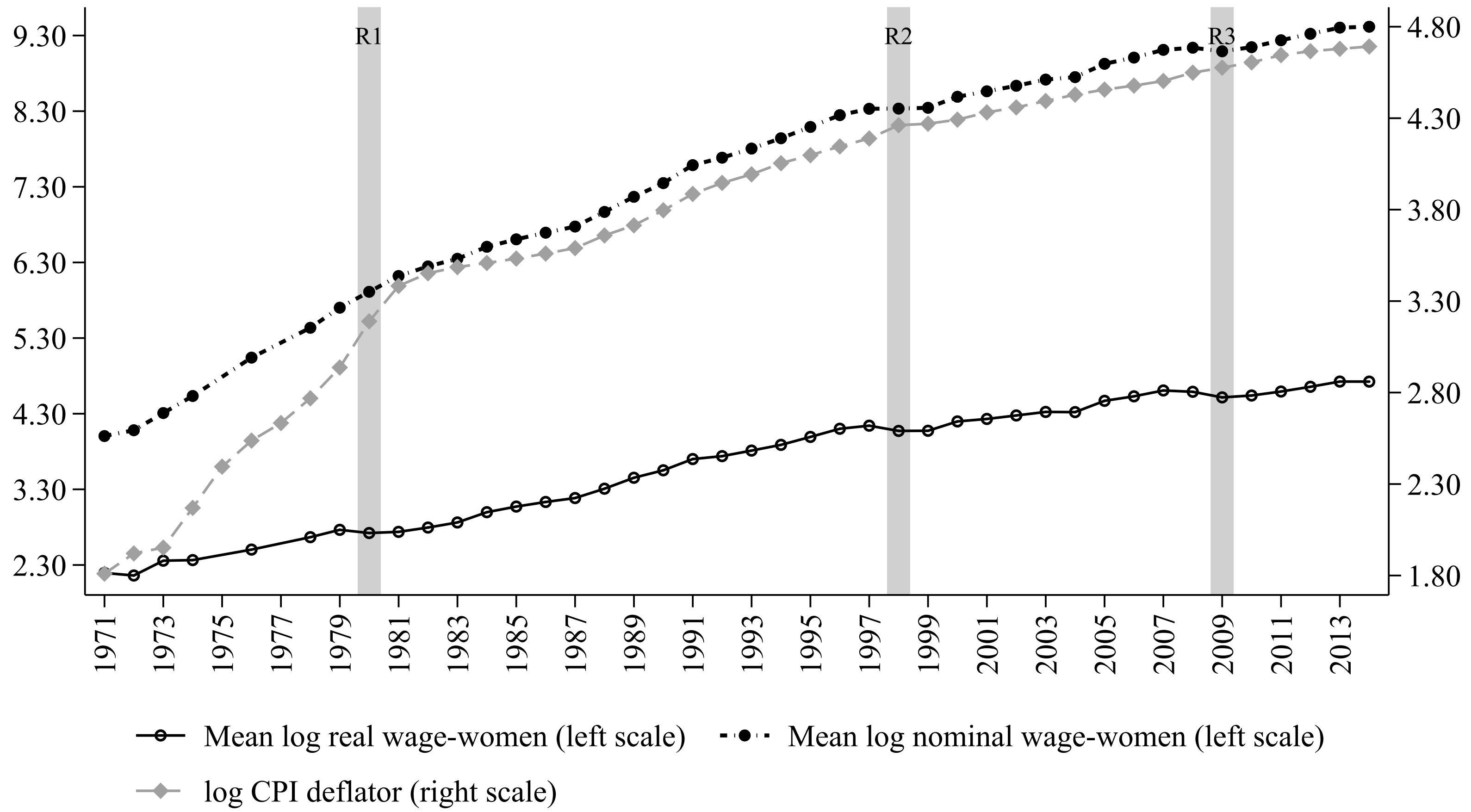


Figure 4: Mean Log Real and Nominal Wages in Korea by Gender, 1971–2014 (Cont'd)

(B) Women



Source: The authors' calculations using the Occupational Wage Survey data.

Figure 5: Distribution of Nominal Wage Changes among Job Stayers

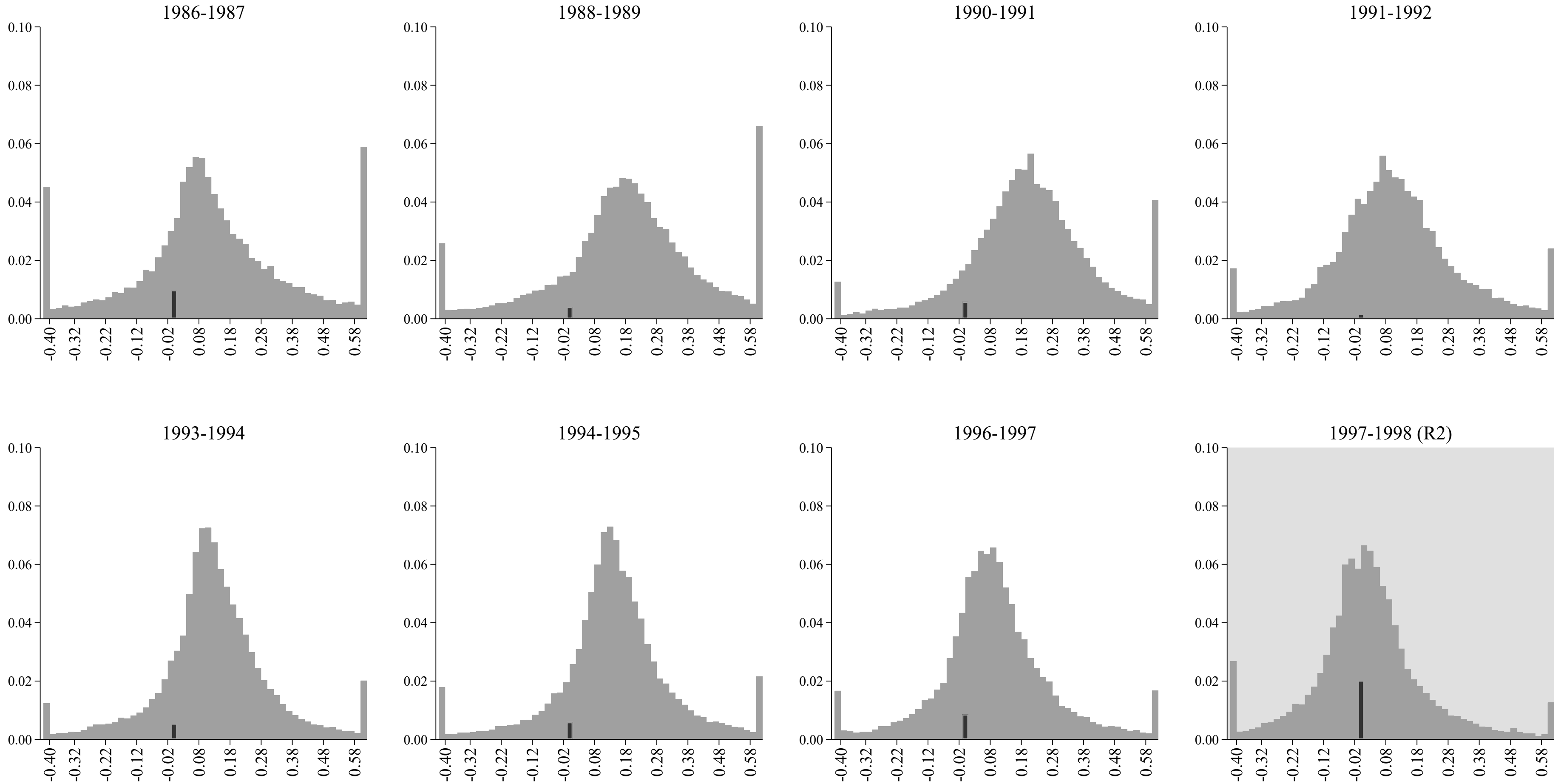
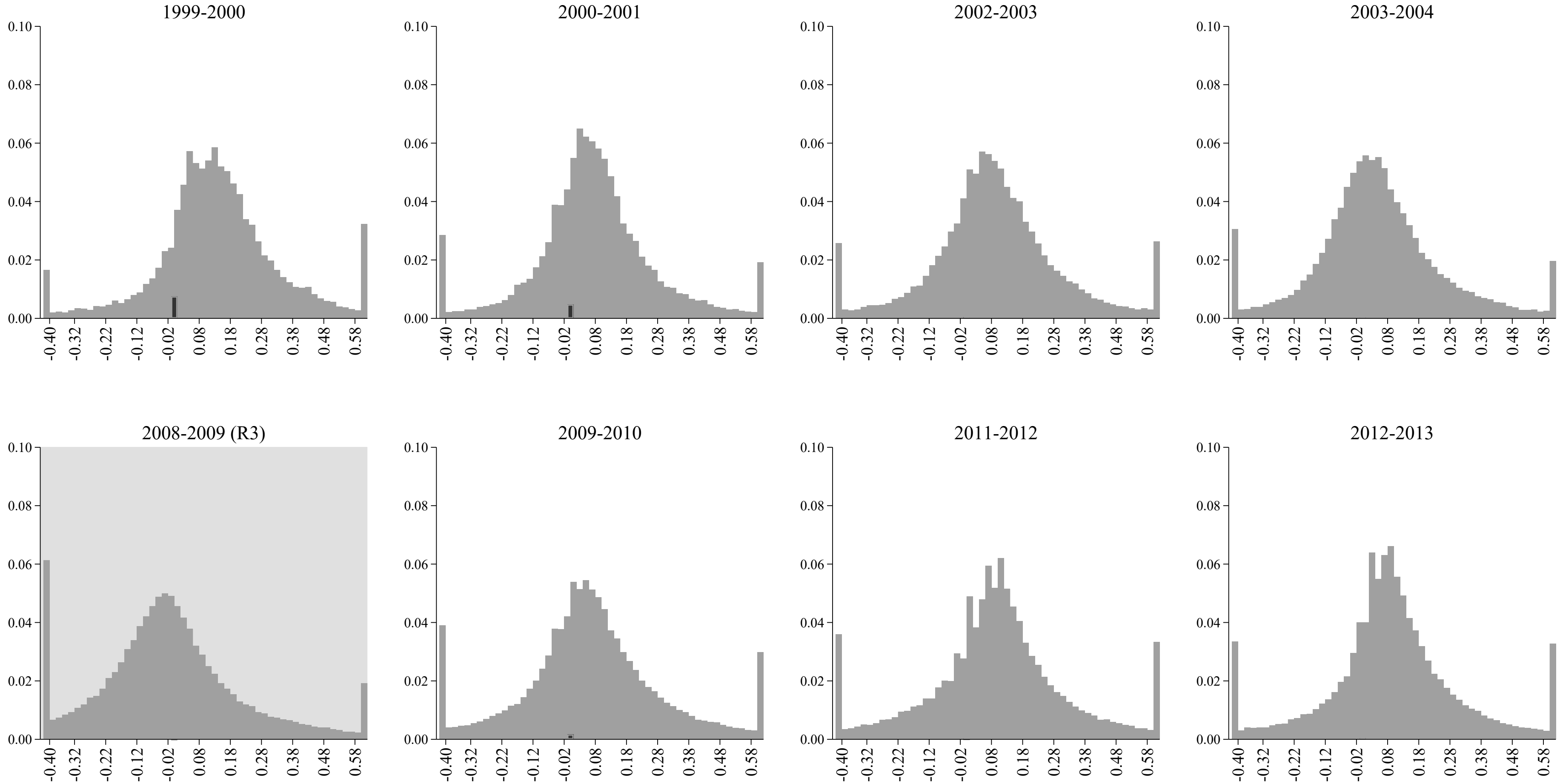


Figure 5: Distribution of Nominal Wage Changes among Job Stayers (Cont'd)



Source: The authors' calculations using the Occupational Wage Survey data.

Notes: A thin line at zero shows the percentage of the workers that reported the exact same wage in both years.

Figure 6: Histograms of the Percentage of Employees in an Establishment that Experience a Nominal Wage Cut by Year

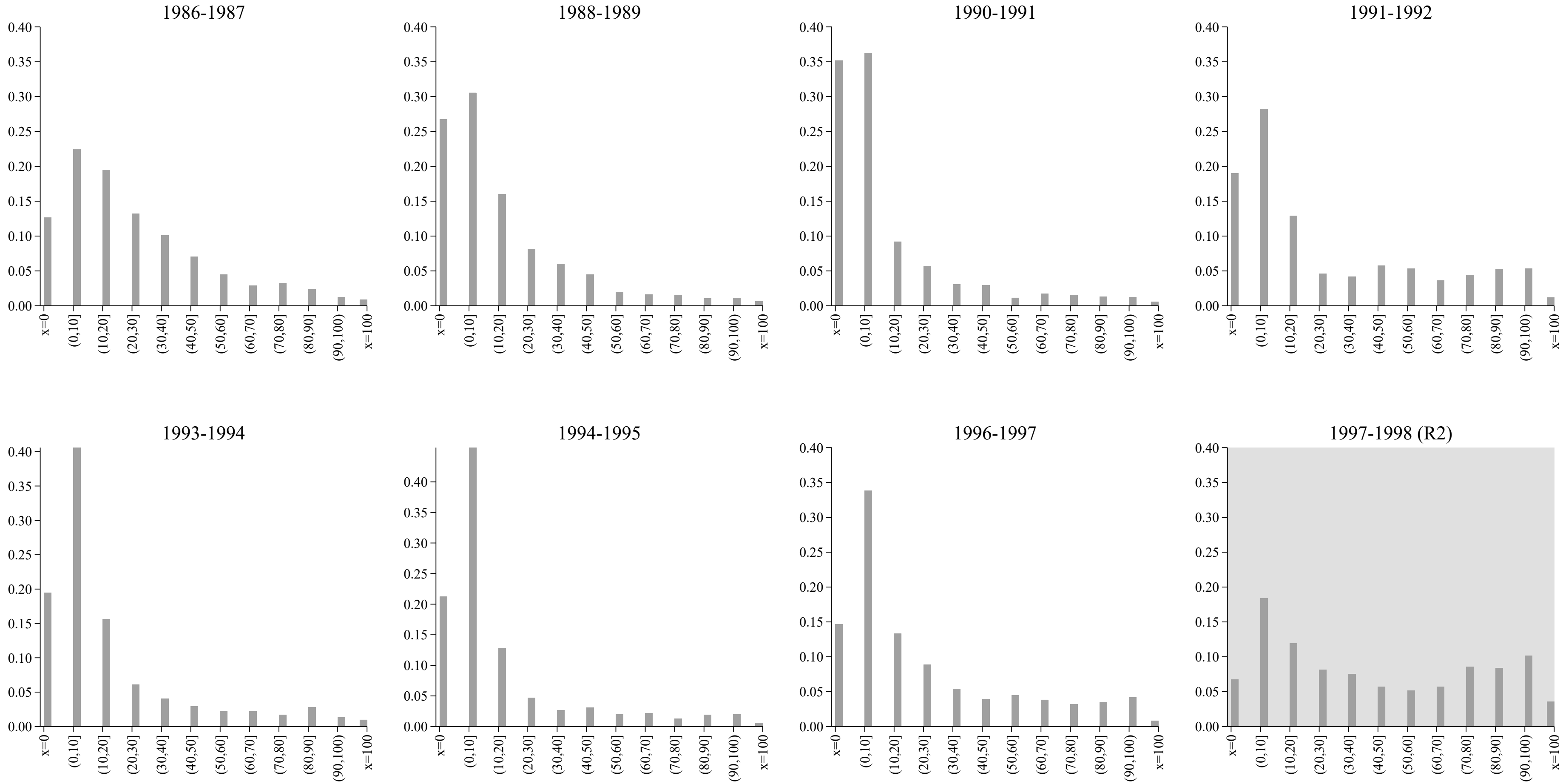
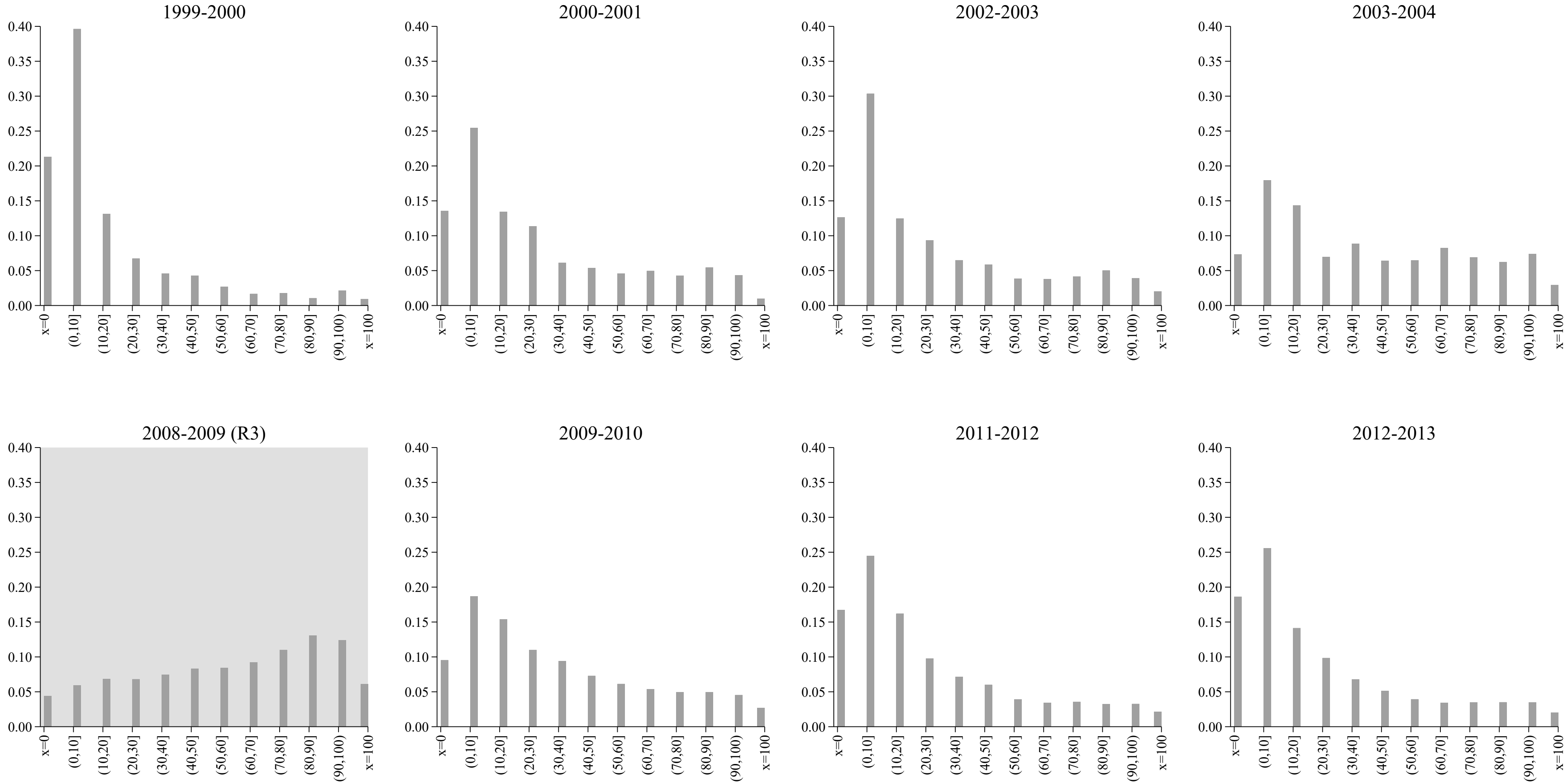


Figure 6: Histograms of the Percentage of Employees in an Establishment that Experience a Nominal Wage Cut by Year (Cont'd)



Source: The authors' calculations using the Occupational Wage Survey data.

Notes: Analysis is restricted to those establishments with 10 employees or more in the sample.

TE WHARE WĀNANGA O TE ŪPOKO O TE IKA A MĀUI

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