

NBER WORKING PAPER SERIES

THE GREAT DISCONNECT:
THE DECOUPLING OF WAGE AND PRICE INFLATION IN JAPAN

Takeo Hoshi
Anil K Kashyap

Working Paper 27332
<http://www.nber.org/papers/w27332>

NATIONAL BUREAU OF ECONOMIC RESEARCH
1050 Massachusetts Avenue
Cambridge, MA 02138
June 2020

The views expressed are those of the authors only and should not be attributed to any of the institutions with which they are affiliated. We are grateful to comments by Joshua Hausman, Yuzo Honda, Daiji Kawaguchi, Sachiko Kuroda, Etsuro Shioji, Shigenori Shiratsuka, Takashi Unayama, Johannes Wieland, and participants of the conferences on Abe administration at Stanford University (February 2018 and March 2019), NBER Japan Project Meeting (July 2019), Japan Economic Association Meeting (October 2019), and seminars at the Financial Services Agency of Japan, Hitotsubashi University, Kobe University, and University of California, Santa Cruz. Kashyap thanks the Initiative on Global Markets at the University of Chicago for financial support. We thank Masahiro Abe, Masayoshi Amamiya, Yoichi Arai, and Jess Diamond for helpful conversations at the early stages of this research. Dongchen Zou and Jun Xu provided expert research assistance. We acknowledge financial support from Center for Advanced Research in Finance (CARF) at the University of Tokyo. All mistakes are ours alone. The views expressed herein are those of the authors and do not necessarily reflect the views of the National Bureau of Economic Research.

At least one co-author has disclosed a financial relationship of potential relevance for this research. Further information is available online at <http://www.nber.org/papers/w27332.ack>

NBER working papers are circulated for discussion and comment purposes. They have not been peer-reviewed or been subject to the review by the NBER Board of Directors that accompanies official NBER publications.

© 2020 by Takeo Hoshi and Anil K Kashyap. All rights reserved. Short sections of text, not to exceed two paragraphs, may be quoted without explicit permission provided that full credit, including © notice, is given to the source.

The Great Disconnect: The Decoupling of Wage and Price Inflation in Japan
Takeo Hoshi and Anil K Kashyap
NBER Working Paper No. 27332
June 2020
JEL No. E31,E50,J31

ABSTRACT

We take some well-known observations about the structure of the Japanese labor market and add new evidence about how it has evolved to study inflation in Japan. Our key finding is that labor market dynamics shifted after 1998 so that correlations between labor market tightness and wages weakened noticeably. This change was accompanied in a break in the relationship between wages and prices, so wage inflation has become a much less important determinant of price inflation.

Takeo Hoshi
University of Tokyo
7-3-1 Hongo
Bunkyo-ku, Tokyo 113-0033
Japan
and NBER
hoshireiwa@gmail.com

Anil K Kashyap
Booth School of Business
University of Chicago
5807 S. Woodlawn Avenue
Chicago, IL 60637
and NBER
anil.kashyap@chicagobooth.edu

1. Introduction

Japan's persistently low inflation is puzzling in two respects. First, the Bank of Japan (BoJ) since 2013 has engaged in unprecedented monetary stimulus. This began with a massive asset purchase program (concentrated on Japanese government bonds), which was followed by driving short term interest rates below zero and ultimately targeting the yield on the 10 year bond rate. Despite these efforts, and the conventional view that a determined central bank can raise the price level, inflation has remained below the BoJ's target of 2% per year.

Second, the labor market in Japan has been relatively tight. There is no broadly accepted estimate of the natural rate of unemployment in Japan, but speeches by BoJ officials often indicate that they believe that once the unemployment rate reaches about 3%, the only people unemployed are in that situation because of search frictions. With unemployment rate below 2.5 percent, one would expect to see rising wage and price inflation (even if the monetary policy stance were neutral). Likewise, standard estimates of potential growth in Japan are about 0.5 percent. The growth rate for the economy has regularly been above this level since early 2013. Thus, adherents of the Phillip's curve might also find the subdued inflation puzzling.

In this paper, we explore the role of Japan's dual labor market in driving the low inflation outcomes in Japan. Economists have long studied the differences in employment conditions between full-time regular workers and part-time employees in Japan. As the Bank of Japan (2017) notes, there has been a steady rise in part-time workers and their wages are more sensitive to market conditions than full-time workers. However, the level of part-time workers' wages is far below those for full-time workers. This change in composition has depressed firm's wage bills. We investigate the effects of this factor on inflation outcomes in Japan.

We begin our analysis in 1981, just after the second global oil shock, which marked the beginning of Japan's relatively low inflation era. Starting in 1981, inflation gradually drifted down before rising a bit and then settling around zero by the middle of the 1990s. This pattern holds for both headline measures of inflation and those that exclude food and energy prices. We show that the behavior of wages and prices in this period is very conventional. Wages are reliably connected to labor market tightness and wage inflation has important explanatory power for prices.

Sometime in the late 1990s, these patterns begin to change. We date the shift as starting in 1998. Precisely identifying the exact break point is hard, but there are several good reasons to impose a break in 1998. One is that the Bank of Japan gains its legal independence then. A second is that the acute phase of the Japanese banking crisis begins in late 1997. A third, most importantly, is that past research has found that a number of other structural relations in the economy changed

around this time (Hamada, Kashyap, and Weinstein (2011)).¹ Thus, our analysis focuses on a number of differences between the pre- and post-1998 eras.

We organize our investigation into five parts. First, we briefly review the literature on inflation in Japan. Past work can be separated into two broad approaches. One begins with the kind of Phillips curve that has been estimated in many countries and then tries to modify it to account for particular factors in Japan. The other is closer to our approach and puts the structure of the labor market at the center of the story.

Section 3 presents the evidence that supports our contention that it is wise to analyze inflation separately before and after 1998. We include both our own statistical analysis and review relevant related prior work that argues for the important structural break around 1998.

The fourth section of the paper covers our summary of the labor market facts. One novel aspect of our analysis is to study separately the determination of bonuses from wages. We find that the bonuses and wages exhibit different dynamics and that their responsiveness to labor market tightness also varies. More importantly, we find that there was a significant shift in the connection between the unemployment rate and wage inflation after 1998.

Section 5 investigates the joint links between prices and wages. We show how the trends in wages and prices changed in 1998, and how the trend changes also correspond to a shift in the dynamic relationship between the two series.

Section 6 presents our conclusions.

2. Literature Review

There is an enormous literature on the Japanese inflation experience over the last two decades. Since the BoJ was given formal independence in 1998, many of these papers have focused on the operating tactics and strategies of the BoJ. Many observers criticized the BoJ for being ambivalent about whether it should fight the ongoing deflation and if so whether it in fact had the necessary tools.

One influential analysis by Bernanke (2000) argued that the BoJ had been insufficiently aggressive in using the tools at its disposal to combat deflation. In a 2003 speech, Bernanke (2003) followed up this analysis and gave a number of suggestions about steps that could be taken to raise the price level in Japan. Svensson (2003) offered what has come to be known as the “foolproof” way to overcome deflation by relying on monetary induced changes in the exchange rate to eventually drive prices up.

¹ For instance, one widely studied question is the connection between monetary policy and the economy. Many studies have found a large shift at some point during the 1990s, although they differ in the variables they examine and the exact timing of the break. See, for example, Arai and Hoshi (2006), Kimura, Kobayahi, Muranaga, and Ugai (2003), Kuttner and Posen (2001), and Miyao (2000).

These diagnoses were in part a reaction to the BoJ's contention that deflation was occurring for reasons outside of its control. For example, in January 2002 Masaru Hayami, the first post-independence BoJ Governor, gave a speech describing recent BoJ policy decisions (Hayami, 2002). One key passage was (with emphasis included by us):

“We changed the main operating target from call rates to a quantitative indicator of liquidity, that is, the outstanding balance of current accounts at the Bank of Japan, and we have substantially increased the balance.

Because this was a very drastic easing measure and was unprecedented in the history of central banking worldwide, we had to consider various issues very carefully before deciding it. *Above all, it was uncertain whether and how expansion of liquidity provision in a situation where the rate is virtually zero percent would influence the economy. Needless to say, the mechanism through which such an expansion affects the economy has not been demonstrated either theoretically or empirically.*”

As late as 2011, the Bank of Japan was still making similar arguments. For instance, Governor Shirakawa gave a speech (with a nearly identical title to Hayami's) in which he claimed (Shirakawa, 2011):

“The prolonged, albeit moderate, deflation since the end of the 1990s cannot be explained only by short-term and cyclical factors. A more fundamental cause is the long-term downtrend in the growth potential of Japan's economy. When the growth rate continues to decline for a protracted period, people's expectations for future income growth are reduced and firms and households restrain their spending. As a result, downward pressure on prices continues (Chart 8).

It is sometimes said that deflation will be solved only if the central bank provides liquidity more aggressively. Provision of ample liquidity is important, of course, but this alone does not solve the problem of deflation.”

These arguments were met with continued criticisms from external observers. See, for example, Ito and Mishkin (2006) for a detailed assessment of the first few years of the BOJ independence and IMF (2012) and Kuttner, Iwaisako and Posen (2015) for subsequent critiques.

Yet, since 2013, when Governor Kuroda took the helm at the BoJ, these critiques no longer apply. The BoJ has become very aggressive and implemented many of the ideas advocated by its critics. It has stopped questioning its responsibility for inflation outcomes and has disavowed the idea that it is impossible to end deflation. The recent literature, therefore, has shifted to try to explain why, even with extremely accommodative monetary policy, inflation in Japan has remained below 2 percent.

One strand of research takes a Phillips curve approach and seeks to relate inflation to measures of slack in the economy and expectations. Bernanke (2017) surveys this literature and adds his own conjectures about the reasons for persistently low levels of Japanese inflation. The conventional view is that the sensitivity of inflation to measures of slack have declined in many advanced economies including Japan. The Bank of Japan (2017) gives a specific example of this argument, contrasting the estimated slope of the Phillips curve before and after 2013 and concluding that the curve is much flatter after 2013.

This reduced sensitivity is supplemented with the view that expectations for inflation in Japan are unanchored. Kuroda (2017) argues that expectations in Japan are much more adaptive or backward looking than in other countries, so that factors such as oil price swings that change realized inflation can be particularly important in Japan. Bernanke (2017) argues the long-period when inflation undershot the BOJ's target might still be influencing expectations. In this sense, the BOJ may still be suffering from the past performance despite the change in leadership.

Not everyone accepts the idea that the Phillips curve is broken in Japan. Gagnon (2017) argues instead that potential output and full-employment have been chronically mis-measured in Japan. As he notes, standard measures of potential output are constructed under the assumption that over the sample being considered, output is both above and below potential. If instead, the economy was consistently depressed so that potential output was never reached (and the economy was never at full employment), then standard statistical approaches to deduce potential are doomed. Gagnon argues that this was likely the case in Japan between 1995 and 2016, so the more puzzling issue is why there was not more deflation. He conjectures that downward wage rigidity prevented an acceleration of deflation. He predicts that as the economy continues to recover, it will soon pass the level of full-employment and inflation will appear when it does. This explanation seems less persuasive after having seen that steady growth that continued through the middle of 2019 did not lead to a pickup of inflation.

Some researchers have focused on the wage Phillips curve rather than the price Phillips curve, and have emphasized the role of the labor market structure in influencing wage and price dynamics. An excellent collection of the essays on this topic is Genda (2017). The 16 chapters in this volume explore a variety of reasons why wages have stagnated in the presence of a tight labor market. Three common themes emerge from these essays. One is that the dual labor market is important and that full-time workers (or regular workers) and part-time workers (or non-regular workers) are paid and treated very differently. The increasing share of part-time workers in the recent decades is highlighted in many of the chapters.

A second theme is the prevalence of downward wage rigidity and the extent to which firms hesitate to cut wages. One essay by Yamamoto and Kuroda notes that there are many firms that never cut wages over a ten year period. These same firms also fail to raise wages when the economy improves. Some authors call this "upward wage rigidity."

A third consideration is the supply side of the labor market. One aspect of labor supply is the steady demographic shift in Japan. As the society has aged, many elderly people continue to want to work past the mandatory retirement age, and have stayed in the labor market often by taking part-time positions. This trend has perhaps been supplemented by a collapse in training within firms. On-the-job-training was once an important factor in raising skill-levels and the decline in this practice has reduced the supply of certain types of high-skilled workers. In cases where there is a mismatch between the hiring needs of firms and the supply of suitable workers, wage increases may not be very effective in clearing the market and the wage can stagnate even with a tight labor market.

The hypothesis that we pursue in this paper is very much in line with the arguments found in Genda (2017). While none of the essays specifically matches our story, we see our story as a convex combination of the different pieces of evidence in the book. Our main contribution is to explicitly connect inflation developments to the wage developments.

3. Structural Breaks in Japanese Inflation

This paper examines two price inflation indicators and two wage inflation indicators. Figure 1 shows the two price series from the first quarter of 1971 to the last quarter of 2018: the so-called “core-core” inflation rate which is the consumer price index excluding food and energy (the solid red line in the figure) and the headline inflation rate as computed from the total consumer price index (the dashed blue line in the figure). For both of the CPI measures we adjusted the series to remove the mechanical effects of the three increases in the consumption tax on April 1 in 1989, 1997, and 2014. To eliminate seasonal fluctuations, the figure shows the four quarter change in the natural logarithm of the series. Throughout our analysis, we will measure wage and price inflation this way.

We construct the wage series by dividing a measure of earnings by a measure of hours worked. We distinguish between two components of earnings for a worker: wages (including overtime), and bonuses.² The source of the data is *Monthly Labour Survey* (<https://www.mhlw.go.jp/toukei/list/30-1.html>, English page: <http://www.mhlw.go.jp/english/database/db-1/monthly-labour.html>). The wage series is calculated by dividing the contracted salary by the total number of hours worked (including overtime). The bonus series is calculated by dividing the bonus payments received in the last 12 months by the total number of hours worked for the last 12 months. We look at the last 12 months because the bonus is typically paid only twice a year: once in June or July and then in December. We use series that relate to establishments with 30 or more employees. Figure 2

² In earlier versions of this paper we separated overtime and regular wages, but the differences were mostly small, so we have combined them here.

shows the two wage inflation indicators: wage inflation in the solid blue line and bonus inflation in the dashed red line.

Simple inspection of Figures 1 and 2 reveals the three main points that are important for our subsequent analysis. First, the period from the start of the sample for price inflation series and wage inflation series through 1980 looks qualitatively different from the rest of the data. This period contains the end of the “high growth era”, when Japan’s economy averaged more than 9 percent growth, and the two spikes in price inflation that accompanied the disruptions in global oil markets in 1974/75 and 1980, although the spike for 1980 is smaller than that for 1974/75 and is nearly absent for wage and bonus inflation. Price inflation, even excluding food and energy, is much higher and more volatile than the rest of the sample. Both our measures of inflation, and wage and bonus growth, rise sharply and then fall during this period.

The episode of the 1970s is so different from what followed after the 1980s that any econometric exercises to examine the connections between the variables would be driven by the events of the 1970s (even though they are not representative of the rest of the sample). We do not believe the experience from the 1970s is relevant for our question about why inflation has been so low for the last two decades. So for the remainder of the paper we begin the analysis in 1981.

The second important observation is that starting in 1981 inflation begins falling and declines gradually through 1988 before rising a bit. For the entire time through 1997 inflation sits below four percent. Headline inflation moves more than the core-core measure, but the two variables track each other closely. Wages also move along with the price measures.

Finally, note that all these measures fall to about zero by 1998. Starting in 1998 all price and wage inflation rates hover around zero. Price inflation measures also become more stable after 1998 than in the prior sample.

To confirm these visual impressions that the periods before and after 1998 are different, we estimated Box-Jenkins style time series models for each of the four series in Figures 1 and 2 and tested for the stability of the models. Table 1 consists of four panels showing the best fitting models for each of the four series. The models were selected to fit the 1981 to 1997 sample as parsimoniously as possible. The model was then re-estimated over the post-1998 sample to investigate whether the dynamics of the series were stable.

For the headline CPI inflation rate, the best fitting model had one autoregressive term and lagged moving average terms at quarters three and five. For the core-core inflation rate, the best fitting model also had one autoregressive term, and a lagged moving average term at quarter two. The wage series was modeled as having two lagged autoregressive terms, at quarters one and two. The best fitting model for the bonus series had a single autoregressive term at quarter one.

We draw four conclusions from these estimates. First, for the two price inflation series, the coefficient on the autoregressive term is close to one, indicating a high degree of persistence.

This is consistent with (unreported) unit root test results that suggested that inflation series (especially headline CPI) is $I(1)$. As Cecchetti et al (2017) observe in many countries, a relatively good model for inflation assumes that the first difference of inflation follows a first-order moving average process. Our result suggests that this characterization applies for Japan. Second, for both of the price inflation series, the levels of persistence fall after 1998. Both the autoregressive coefficients and the moving average coefficients are smaller in magnitude and have lower degree of statistical significance. For the headline series, one of the MA coefficients flips sign.

Third, the two wage series are also very persistent (but not as much as are prices). The models have large coefficients on the autoregressive terms. Fourth and finally, as with the price inflation measures, the persistence declines after 1998, although for the bonus series the drop is inconsequential.

Formal tests for coefficient stability show that for all four series, the coefficients across the two samples are significantly different. For example, a Chow test that supposes a break date of the first quarter of 1998 rejects the equality of coefficients at levels of significance below 1 percent for three of the four series. The exception is the core-core inflation rate, for which the standard Chow test using F-statistics fails to reject the null hypothesis that the coefficients are equal across the two sample periods. In that case, the test using the likelihood ratio rejects the null at 5 percent level and the test using the Wald statistic rejects the null at below 1 percent.

Alternatively, a Quandt-Andrews test allows for a potential break at any date (other than those that are too close to the beginning or the end of the sample period). We consider a potential break in the middle 85% of the sample (1986Q4 to 2013Q2). This test also generally rejects the null hypothesis that there were no break points. Again the exception is the core-core inflation rate. According to the likelihood ratio test, the most likely breakpoint of 1995Q2 is not statistically significant, while the Wald statistic suggests the breakpoint of 1993Q4 and is statistically significant. For headline inflation, the break date that is mostly likely is 1999Q4 according to the likelihood ratio test and 2008Q3 for Wald test. For wage inflation, the likelihood ratio test selects 2000Q1 and Wald test selects 1998Q1 as the most likely breakpoint. Suggested breakpoints are a little bit earlier for bonus inflation and are 1995Q2 and 1992Q2.

Combining all of this direct evidence, with the aforementioned analysis in Hamada, Kashyap and Weinstein suggesting that a number of other macro relations changed around 1998, leads us to examine separately the pre- and post-1998 data for the remainder of the paper. Our focus now shifts to trying to understand what might be responsible for the shift.

4. Wages and the Labor Market

The structure of the labor market began to shift following the Japanese banking crisis. Figure 3 shows annual data for the levels of average hourly wages (as opposed to rates of changes in Figure 2) in Japan from 1993 to 2018. The starting point for the graph is dictated by data availability because the full-time and part-time distinction only becomes available in 1993. Each panel of the figure shows the wage rate for full-time and part-time workers along with the average for the economy that accounts for both types (the green solid line) for wages (panel A) and bonuses (panel B). To calculate these wage series, we start with an estimate for the level of wages in yen for full-time, part-time and average workers in 2018, using earnings in yen (and number of hours worked) reported in the *Monthly Labour Survey*. We then project the wage series in back in time using indices of wages and bonuses by different types of workers at establishments with 30 or more employees.

Panel A of Figure 3 shows the movements of the level of wages. Note that the left axis is the scale for wage series for full-time workers and all workers and it differs from the scale on the right axis that measures wage for part-time workers. The average level of wages peaked in 1999 and did not exceed the level again until 2017. The patterns for full-time and part-time wages are very different. The wage for full-time workers has been remarkably steady sitting around 2,100 yen per hour and have only slightly increased during the last 20 years. The part-time wage has risen by about 20 percent from below 1,000 yen to just under to 1,200 yen per hour between 1999 and 2018. The part-time wage also has been more sensitive to improved business conditions since 2013.

Bonus earnings divided by total hours worked is very different than the wage levels. The average bonus peaked in 1997 and then trended down as Panel B of the figure shows. The level has been recovering since 2014, but the 2018 level is less than 80 percent of the 1997 level. The movements of the bonus for full-time workers are essentially the same as those of the average. This is because few part-time workers receive bonuses. As we can see from Panel B, the level of bonus divided by total hours worked has been very low (and trending down) for part-time workers.

Figure 4 shows that the main reason for the flat average wages despite rising wages for part-time jobs and (to a lesser degree) for full-time jobs is the changing composition of the workforce. We use the employment index for each type of job at establishments with 30 or more employees in *Monthly Labour Survey* and convert it into actual number using the ratio of the index value to the actual value in year 2018. Here we show the annual average of each series. The number of full-time workers is measured on the left axis (in millions) while the level of part-time workers is measured on the right axis (in millions). The number of full-time workers peaked in 1994, dips a bit afterwards, before it began a precipitous decline in 1998 that continued through 2003. The number of part-time workers was relatively stable until 1996 and then began a climb that continued over the next 20 years. The replacement of high cost full-time employees with much less expensive part-time workers is a major reason why average regular and overtime wages in 2018 are almost the same as in 1997.

The last section documented changes of dynamics for both prices and wages. For wages, the reason for the changing dynamics is specifically attributable to the interaction of the sharp recession that began in 1997 and the dual labor market. Unfortunately, data on wages for part-time and regular workers in *Monthly Labour Survey* is only available starting in 1993. This prevents us from being able to directly show that there was a break in the link between the labor market conditions and the wages for full-time as well as part-time workers. Consequently, we proceed indirectly, building up evidence in three steps.

First, using data on average wages for all workers, we show that the connection between average wages and labor market tightness changed around 1997. We do this by augmenting the ARMA models for the two measures of wage inflation that we considered in the last section with the unemployment rate, which is the most widely used measure of labor market slack (or tightness) and checking whether the response of wage to labor market conditions changed before and after 1997.

This analysis is presented in Table 2. We use the same autoregressive specifications that we used in the last section for each wage measure. Panel A of Table 2 examines the regular wage inflation. The panel shows the estimation results for two different sample periods: 1981-1997 and 1998-2018. For both samples, one period lag of the seasonally adjusted unemployment rate is statistically significant, but the size of the coefficient in the later period is less than one-third of the earlier period. Thus, the wage does respond to labor market conditions in the expected direction in both periods, but the magnitude of the effect drops substantially after 1998. These estimates imply that all else equal, between 1981 and 1997, when unemployment rose by 0.2 percentage points in one quarter, inflation would fall by about 0.15 percentage point in the next quarter. A similar increase after 1998 would predict less than a 0.05 percentage point reduction in the next quarter.

The results for bonus wage inflation in Panel B are very different. For the bonus, the responsiveness to the unemployment rate increased after 1998. The estimated coefficient on the unemployment rate for the pre-1998 period is not statistically significant. The point estimate suggests that a 0.2 percentage point reduction in the unemployment rate would raise bonuses by about 0.4 percentage point before 1998 while the reduction in the same magnitude would lead to 0.7 percentage point increase in bonuses in the post-1998 period.

Given the fraction of total compensation that comes from bonuses, the overall sensitivity of earnings to labor market conditions is much lower after 1998. For instance, in 2018 the fraction of overall earnings from regular and overtime wages over the course of a year was 80%. So the fact that these wages have decoupled from labor market conditions is much more relevant than the increase in sensitivity for bonus wages.

The flattening of the wage Phillips curve in Japan has been noted in various studies including the paper by Muto and Shintani (2017). So the estimates in Table 2 can be read as confirming the

observation that average wages now seem only weakly connected to excesses in the labor market.

To investigate what might be behind this change, we turn to data on market conditions for full-time workers. We do this by looking at how the proportion of enterprises that report excess full-time workers changed over time using data from *Rōdō Keizai Dōkō Chōsa* (*Survey of Labour Economy Trend*) conducted by the Ministry of Health, Labour and Welfare in February, May, August, and November of each year.

Figure 5 shows the proportion of enterprises that express they have excessive full-time workers. This variable is clearly cyclical, and the level of excess workers jumps in 1998 and stays elevated till 2004, even though there is a partial economic recovery in 2000. By 2005, the excess employment indicator is back to the 1997 level and it remains there for 2 more years, before spiking again during the global financial crisis. The strong cyclicity of excess full-time employment is consistent with Yokoyama, Higa, and Kawaguchi (2019), which finds that Japanese manufacturing firms tend to hoard regular workers while shedding non-regular workers when the yen appreciates (which they consider to be an exogenous shock). Looking back at Figure 4, it is clear that the periods of excess correspond to times when full-time employment falls. Our contention is that this adjustment was incomplete, and if firms had not hoarded workers the number of full-time employees would have fallen much more sharply and presumably would have recovered more quickly.

This hunch leads to our third piece of evidence that explores whether the labor market condition has been equally important for full-time and part-time wages. To do this we estimate ARMAX models for wages separately for full-time and part-time workers. Because the wage data for full-time and part-time jobs separately are available only from 1993, we conduct the analysis for the post-1998 period only.

These results are shown in Table 3. The first panel compares the sensitivity of full-time wages to that of part-time wages. For both full-time and part-time wages, the specification with a second order autoregression is augmented by adding the (economy wide) unemployment rate. For both full-time workers and part-time workers, the wage growth is negatively correlated with lagged unemployment rate and the coefficient estimates are statistically different from zero. The magnitude of the unemployment rate coefficient, however, is different. One fifth of a percentage point increase in the unemployment rate would predict a 0.03 percentage point decrease in full-time worker wages in the next quarter while the same increase would lead to twice as large a decline in part-time wages. Notice also that the R^2 is substantially lower for the model for full-time wages.

Panel B examines the bonus wage inflation. In this case, we use the specification with a single autoregressive term (as in Table 2). Here the full-time workers' bonuses show a response to the unemployment rate that is as large as the part-time workers' (though we need to note that the

bonuses for part-time workers are much smaller than bonuses for full-time workers). One fifth of a percentage point increase would reduce the bonuses for full-time workers by 0.06 percentage point and that for part-time workers by 0.07 percentage point.

In sum, Table 3 suggests that wages for full-time workers do not move as much as the wages for part-time workers in response to changes in labor market conditions. For bonuses, the responses for both types of workers are similar.

Given that the unemployment rate is not predictive of what happens to full-time wages, and the evidence in Section 3, we are lead to the following account of the data. The market for full-time workers was often out of balance after 1998. This meant that labor market tightness did not influence full-time wages. Instead, the marginal equilibrating factor in the labor market occurs via part-time workers. When the market is relatively tight for full-time workers, wages respond for part-time workers. This is not so surprising since many people would prefer to work full-time, so to keep them in part-time positions, their wages must rise.

On the other hand, the bonuses for both full-time workers and part-time workers do respond to labor market condition. This is consistent with the finding in Section 3 that the response of bonuses to changes in the unemployment rate did not decline in the post-1998 period (and actually increased).

5. Wages and Prices

We now turn to the implications of these facts for prices. In brief, the story we propose is that the break in the labor market helps us understand some, but not all of the puzzling features for inflation. In particular, prior to 1998 the labor market operated in a fairly conventional way: slack helped determine wage dynamics and wage changes were an important determinant of price changes. After 1998, there was a persistent excess supply of full-time workers and the marginal adjustments in labor came through the adjustment of part-time workers. Full-time wages were not an important factor in determining price changes and part-time wage changes were a statistical significant factor in affecting prices, but their quantitative impact was small. We proceed by first documenting the important pre-1998 facts before showing the post-1998 patterns.

Figure 6 plots the levels of headline CPI and core-core CPI with the indices for wages and bonuses for all workers. The structural break around 1998 that we found above is apparent in this figure as well. Before 1998, all the series were trending up, but they became stagnant or started to fall after 1998.

The bonus wage series stands out as a particularly extreme version of this pattern, as the level at the end of the sample is about 25% below the 1998 level. Recall that we had computed bonus

wages by taking bonus payments over the last four quarters divided by total hours over that period. That smoothing is important because of the erratic timing of when bonus payments occur. Figure 7 plots both the smoothed bonus inflation rate that we use in the analysis below and the simple bonus inflation rate that is calculated as four quarter changes in the bonus paid in each quarter divided by total hours. We can clearly see the simple inflation rate is much, much more volatile than the smoothed inflation rate.

We next compute a vector auto regression (VAR) of a three variable system that includes the core-core inflation rate, wage inflation, and bonus inflation for the sample between 1981 and 1997. Given the ambiguity over degree of integration of the variables we also include a linear time trend in the system. Table 4 shows the estimated coefficients of the system. We focus on the standard diagnostics for describing VARs: Granger causality tests, impulse response functions and variance decompositions. For the latter two diagnostics, we have ordered the series in the system so that the price inflation variable is first, wage inflation is second, and bonuses are last. We then use a Cholesky decomposition to impute the explanatory power of the different series. As Table 4 shows, the standard deviations of the respective equations, which represent the size of the shocks for the impulse responses are 0.0021, 0.0070, 0.0113 for core-core inflation, wage inflation and bonus inflation, respectively.

Panel A of Table 5 shows the Granger causality tests for core-core inflation. Both the wage inflation and bonus inflation rates are significant predictors of core-core inflation prior to 1997.

The impulse response functions are shown in Figure 8 for the response of the core-core inflation series to the three types of shocks. The solid blue shows the mean response at each quarter and the dashed lines show 95% confidence intervals. By using the Cholesky decomposition, the wage series are presumed to have no impact on price inflation in the first period. The impact of the wage shock on core-core inflation grows and reaches a maximum between 5 and 8 quarters. The pass-through is meaningful, a one standard deviation shock to wages moves prices by about two-thirds of a standard deviation. For bonus wage inflation there is also a notable link to core-core price inflation. The impulse response shows that the maximum effect occurs at around 4 quarters and the quantitative effect is about the same as for wages.

Panel B of Table 5 shows the decomposition of the variance of core-core price inflation. Both wage and bonus inflation explain important amounts of the variance of prices. For instance, at the eight quarter horizon, together they explain over half the variation in price inflation.

The overall results from Tables 5 and Figure 8 paint a very conventional view of inflation determination and the role of the labor market. When wages or bonuses rise, these increases are passed on to prices and quantitatively this mechanism explains a lot of the movements in prices.

The linkage between wages and prices changed dramatically after 1998. Table 6 shows the coefficient estimates of the same VAR system for the period 1998-2018. Table 7 repeats the analysis Granger causality tests, and Figure 9 shows the impulse response functions and variance

decompositions. One interesting observation is that the R^2 for the wage inflation equation drop significantly in the later period; the core-core fit is also a bit lower (though still high).

More importantly, the Granger causality tests in Panel A of Table 7 suggest neither wage or bonus inflation have any additional explanatory power for the core-core inflation process beyond what can be explained by the lagged core-core inflation rate. Even both series combined have no incremental ability to predict core-core inflation during this period.

The impulse response functions in Figure 9 point to the same conclusion. An increase in wages or bonuses does not have any visible impact on core-core inflation. The decomposition of the variance of core-core inflation (Panel B of Table 7) suggests that almost all the variation in core-core inflation is explained by its own shocks. For example, at the eight quarter horizon, wage and bonus inflation explain less than 5% of the core-core inflation variation.

The contrast between the 1981-1997 period and the 1998-2018 period is clear. Before 1998, both wages and bonuses had significant and sizable impacts on prices. After 1998, those linkages between wages and prices were lost. Combined with the results from the last section, the VAR estimation suggests that around 1998, not only the response of wages to the labor market conditions got weaker but also prices also became disconnected from the wages.

We also tried another approach to examine how the connection between price inflation and wage inflation changed over time. We start by estimating an unobserved components model of the following form for each of the four series: core-core inflation, wage inflation for all workers, and bonus wage inflation for all workers.

$$y_t = \mu_t + \sigma^y \varepsilon_t$$

$$\mu_t = \mu_{t-1} + \sigma^\mu v_t$$

where y is the series, μ is the unobserved trend, and ε and v are identical and independently distributed normal random variables with mean zero and variance one.

We then compute the correlations between the estimated μ 's for the price series and each of the wage series for rolling windows of 25 quarters. Figure 10 shows the evolution of the correlation between the core-core inflation and wage inflation for all workers. Here each point shows the correlations calculated for 25 quarters centered on the date. For example, the observation for 1995q1 is the correlation calculated over [1992q1, 1999q1].

The correlation is positive and quite stable between 1989 and 2000, which covers rolling windows moving from [1986q1, 1993q1] to [1997q1, 2004q1]. As the rolling windows ceases to include the pre-1998 period (which first occurs in 2001q1), the correlation drops substantially. The correlation seems to move up again in the late 2000s, but it never reaches the level of the 1990s. The result is again consistent with the idea that prices and wages disconnected around 1998.

6. Conclusion

This paper looks at why Japan's inflation has not changed much despite the extremely aggressive monetary easing and the expansion of the real economic activity under Abenomics. Our explanation focuses on the role of dual labor market that made wages less sensitive to the labor market conditions. Japan's labor market has become increasingly segmented into full-time workers, many of whom are on lifetime employment and hence rarely fired, and part-time workers, whose employment can be adjusted more flexibly over business cycles. Following the recession in the late 1990s, many firms ended up hoarding an excessive number of full-time workers. Attempts by many firms to increase the proportion of part-time workers to gain the ability to adjust their employment more effectively in globally competitive markets, which preceded the recession, intensified the surplus of regular full-time workers.³ The surplus of regular workers meant that there was no pressure on their wages. The wages for part-time workers do depend on business conditions, but since the level of their wages is much lower than full-time workers, the substitution of part-time for full-time employees has meant that the average wage for the economy has stagnated even as economic conditions have improved.

While these broad trends are known, especially to labor economists, their role in understanding inflation has been less studied. We provide some evidence on aspects of the story that bear on inflation.

We find that the link between labor market conditions and regular and overtime wages that existed before 1998 substantially weakened after 1998. Looking at wages for full-time workers and part-time workers separately in the period after 1998, we find that the response of the wages for full-time workers to tightness of the labor market is much weaker than that of the wages for part-time workers. The increasing proportion of part-time workers, who are paid much less than full-time workers, during the period also dampened the wage increases that might have occurred as unemployment fell. Since the response of the wages for part-time workers after 1998 itself is weaker than the response of the average wage for all workers before 1998, the excess of full-time workers (and reduced sensitivity of their wages to the labor market condition as a result) is not likely to explain all of the weakening of wage responses to labor market conditions.

For bonuses, we do not find any weakening in their link to labor market conditions. The average bonuses for all workers respond more strongly to the unemployment rate after 1998. Moreover, the bonuses for both full-time workers and part-time workers (although they receive much less of this kind of compensation than full-time workers) respond to the labor market conditions.

Thus, one reason why Japanese inflation does not seem to have responded to economic recovery is the decoupling of average wages and labor market conditions. Looking at the relationship between wages and prices, however, shows that this is not the whole story. We find that the link

³ For example, see Abe and Hoshi (2007) for some evidence on increased adjustment of employment and reduced emphasis on lifetime employment.

between wages (including bonuses) and prices changed also around 1998. Before 1998, wage inflation and bonus inflation were important determinants of price inflation. The link, however, seems to have disappeared after 1998. Further understanding the causes of the disconnect between wages, bonuses, and prices after 1998 is an important topic for future research.

References

- Abe, Masahiro, and Takeo Hoshi, 2007, “Corporate Finance and Human Resource Management in Japan” in Masahiko Aoki, Gregory Jackson, and Hideaki Miyajima, eds., *Corporate Governance in Japan: Institutional Change and Organizational Diversity*. Oxford, UK: Oxford University Press, pp.257-281.
- Arai, Yoichi, and Takeo Hoshi, 2006, “Monetary Policy in the Great Stagnation,” in Michael Hutchison and Frank Westermann, eds., *Japan’s Great Stagnation: Financial and Monetary Policy Lessons for Advanced Economies*, Cambridge, MA: MIT Press, pp.157-181.
- Bank of Japan, 2016, “Comprehensive Assessment: Developments in Economic Activity and Prices as well as Policy Effects since the Introduction of Quantitative and Qualitative Monetary Easing (QQE),” Bank of Japan: Tokyo.
(http://www.boj.or.jp/en/announcements/release_2016/k160921b.pdf)
- Bank of Japan, 2017, “Outlook for Economic Activity and Prices (July 2017)”, Bank of Japan: Tokyo.
- Bernanke, Ben S., 2017, “Some Reflections on Japanese Monetary Policy,” Brookings Institution, Ben Bernanke’s Blog, May 23, 2017.
- Bernanke, Ben S, 2000, “Japanese Monetary Policy: A Case of Self-Induced Paralysis?” in *Japan’s Financial Crisis and Its Parallels to U.S. Experience*, Ryoichi Mikitani and Adam Posen, eds., Institute for International Economics.
- Gagnon, Joseph E., 2017, “There Is No Inflation Puzzle—Japan Edition”, Realtime Economics Watch, Peterson Institute for International Economics, <https://piie.com/blogs/realtime-economic-issues-watch/there-no-inflation-puzzle-japan-edition>
- Genda, Yuji, 2017, *Hitode-busoku na no ni naze chingin ga agaranai no ka (Why Are Wages Not Rising Despite the Shortage of Labor?)*, Keio University Press.
- Hamada, Koichi, Kashyap, Anil K and David E Weinstein, 2011, “Introduction” in *Japan’s Bubble, Deflation and Long-term Stagnation*, Koichi Hamada, Anil K Kashyap and David E. Weinstein eds., MIT Press, pp. 1-16.
- Hayami, Masaru, 2002, “Revitalizing the Japanese Economy”, Speech at the Keizai (Economic) Club, on January 29, 2002.
http://www.boj.or.jp/en/announcements/press/koen_2002/ko0201a.htm/
- International Monetary Fund, 2012, “Japan: 2012 Article IV Consultation”, IMF Country Report No. 12/208, Washington D.C.

Kimura, Takeshi, Hiroshi Kobayashi, Jun Muranaga, and Hiroshi Ugai, 2003, “The Effect of the Increase in the Monetary Base on Japan’s Economy at Zero Interest Rates: An Empirical Analysis,” in BIS Report No.19 (*Monetary Policy in a Changing Environment*), pp.276-312.

Kuroda, Haruhiko, 2017, “The Role of Expectations in Monetary Policy: Evolution of Theories and the Bank of Japan's Experience”, Speech at the University of Oxford, June 8, 2017.
http://www.boj.or.jp/en/announcements/press/koen_2017/ko170609a.htm/

Kuttner, Kenneth, and Adam Posen, 2001, “The Great Recession: Lessons for Macroeconomic Policy from Japan,” *Brookings Papers on Economic Activity* 2: 93-185.

Kuttner, Kenneth, Iwaisako, Tokuo, and Adam Posen, 2015, “Monetary and Fiscal Policies During the Lost Decades” in *Examining Lost Decades*, Yoichi Funabashi and Barak Kushner eds, Routledge, 17-36.

Miyao, Ryuzo, 2000, “The Role of Monetary Policy in Japan: A Break in the 1990s?” *Journal of the Japanese and International Economies*, 14, 366-384.

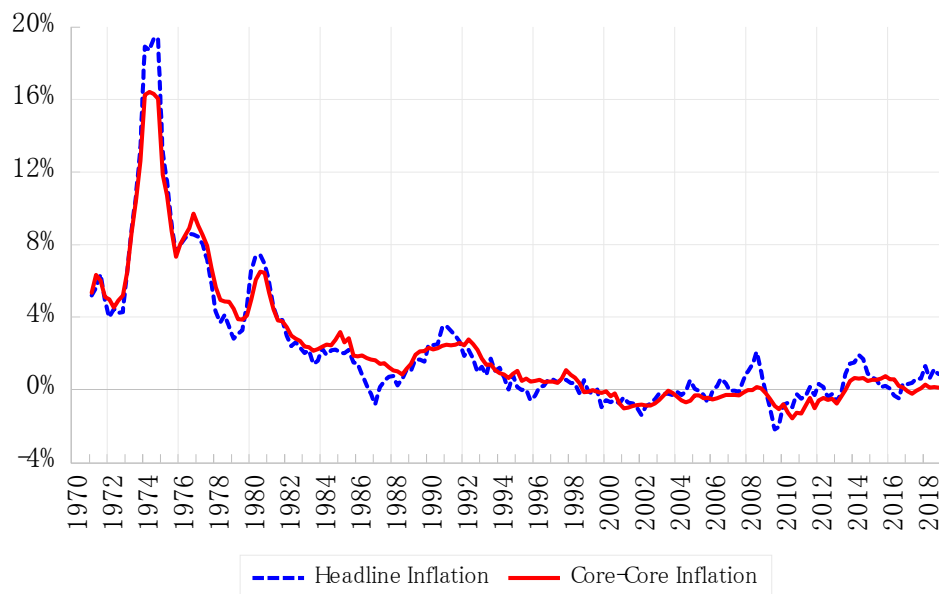
Muto, Ichiro, and Kohei Shintani, 2017, “An Empirical Study on the New Keynesian Wage Phillips Curve: Japan and the US,” *The B.E. Journal of Macroeconomics*, ahead of print.

Shirakawa, Masaaki, 2011, “Toward a Revitalization of Japan's Economy”, Speech at the Foreign Correspondents' Club of Japan, February 7, 2011.
http://www.boj.or.jp/en/announcements/press/koen_2011/ko110207a.htm/

Svensson, Lars E. O., 2003, “Escaping from a Liquidity Trap and Deflation: The Foolproof Way and Others,” *Journal of Economic Perspectives* 17(4), 145-66.

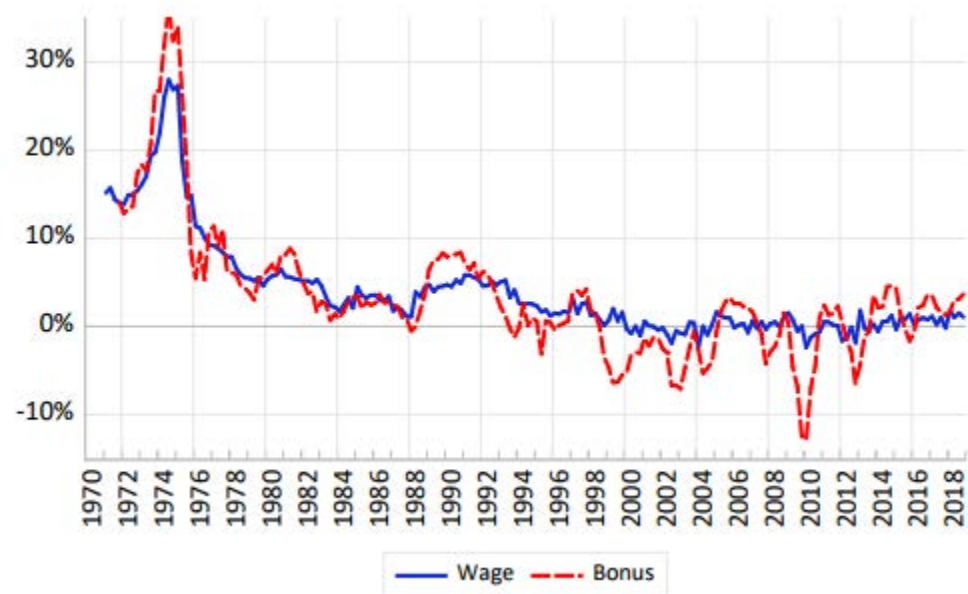
Yokoyama, Izumi, Kazuhito Higa, and Daiji Kawaguchi (2019). “Employment Adjustments of Regular and Non-Regular Workers to Exogenous Shocks: Evidence from Exchange-Rate Fluctuation,” *ILR Review*, forthcoming.

Figure 1: Japanese Price Inflation: 1971-2018



Source: Authors' calculation based on Ministry of Internal Affairs and Communications, Statistics Bureau, *Consumer Price Index*.

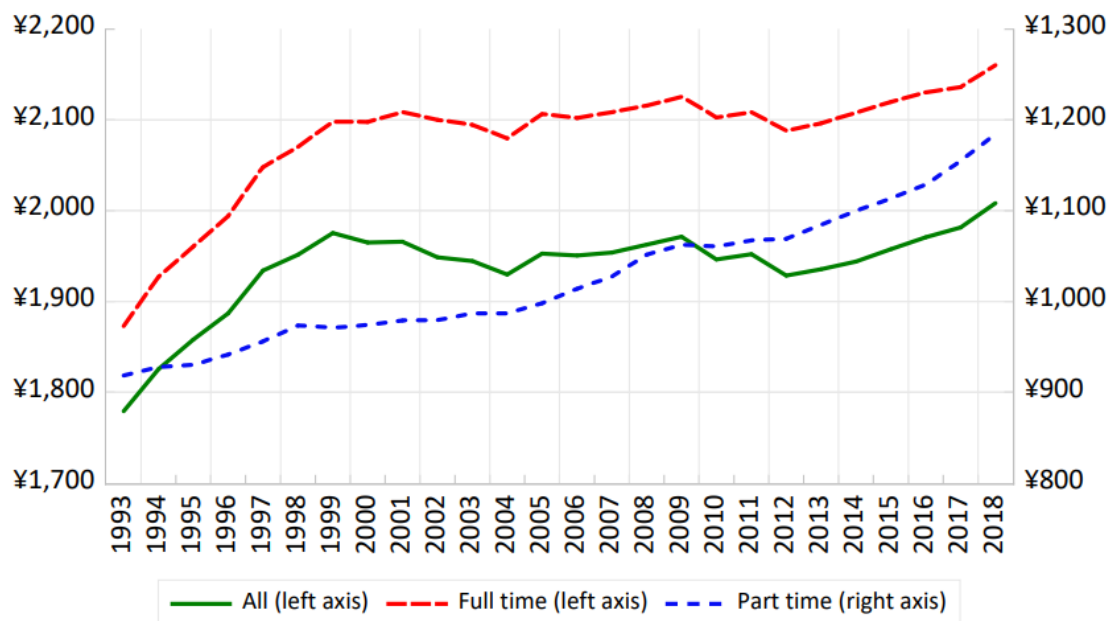
Figure 2: Japanese Wage Inflation: 1971-2018



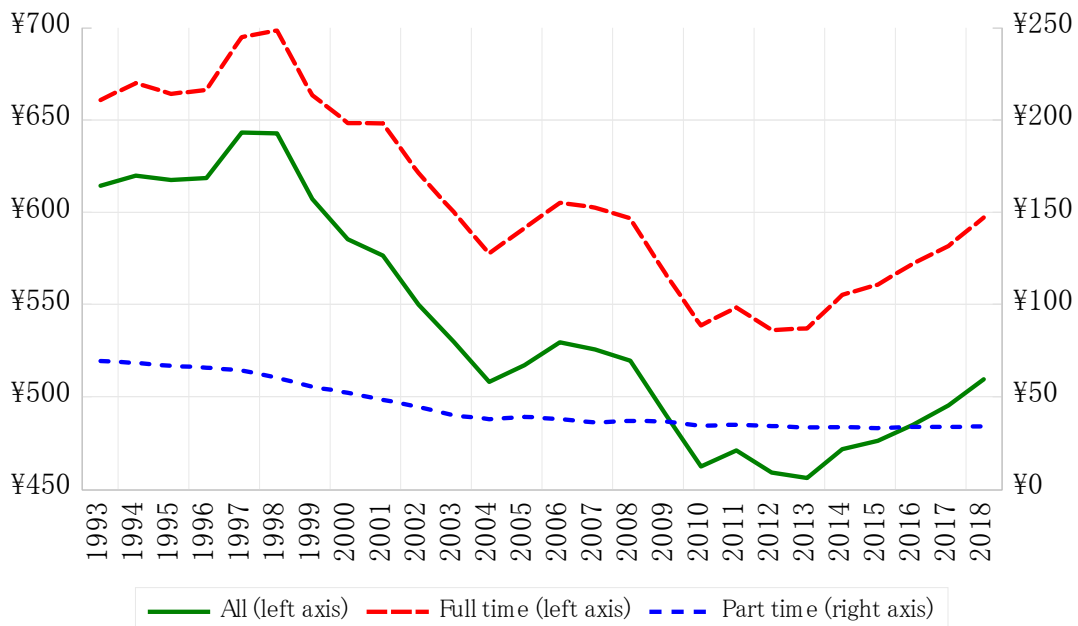
Source: Authors' calculation based on Ministry of Health, Labour and Welfare, *Monthly Labour Survey*.

Figure 3: Wages in Japan, 1993-2018

A. Wages

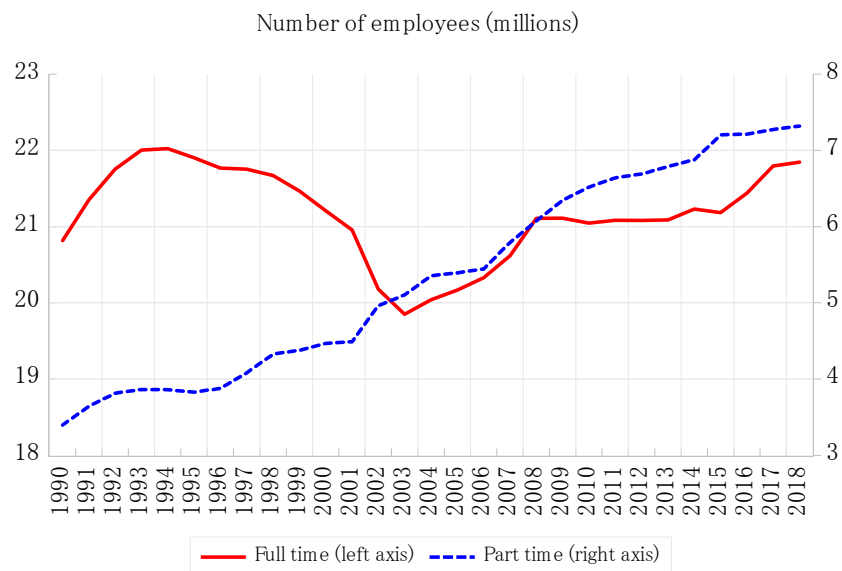


B. Bonuses



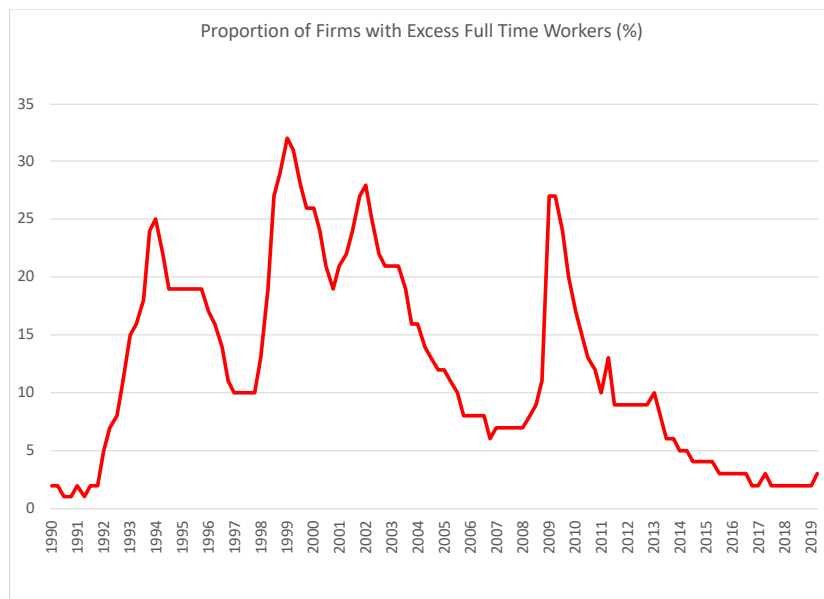
Source: Authors' calculation based on Ministry of Health, Labour and Welfare, *Monthly Labour Survey*.

Figure 4: Composition of the Japanese Workforce (Establishments with more than 30 employees)



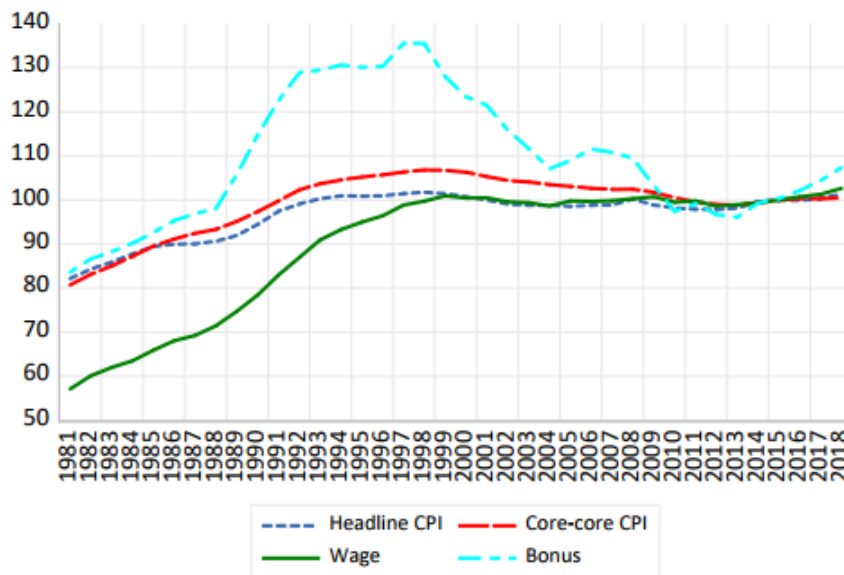
Source: Authors' calculation based on Ministry of Health, Labour and Welfare, *Monthly Labour Survey*.

Figure 5: Proportion of Firms with Excess Full Time Workers (%)



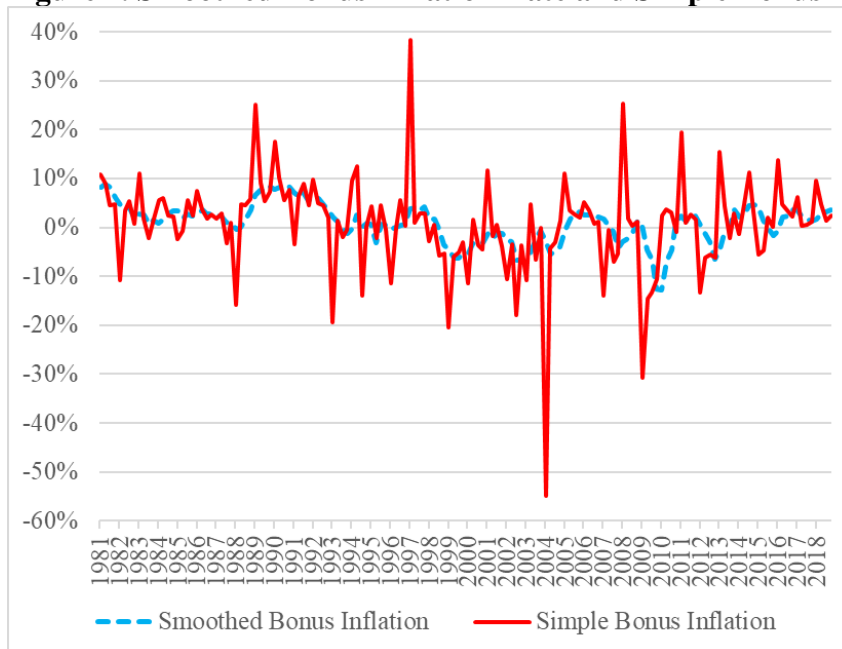
Source: Ministry of Health, Labour and Welfare, *Survey of Labour Economy Trend*.

Figure 6: Japanese Price and Wage Levels: 1981-2018 (2012=100)



Source: Ministry of Internal Affairs and Communications, Statistics Bureau, *Consumer Price Index*, and Ministry of Health, Labour and Welfare, *Monthly Labour Survey*.

Figure 7. Smoothed Bonus Inflation Rate and Simple Bonus Inflation Rate

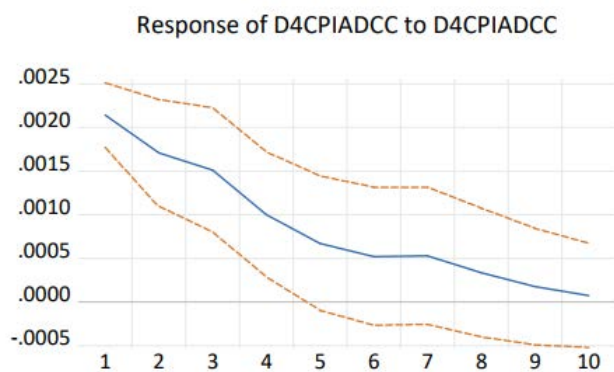


Source: Authors' calculation based on Ministry of Health, Labour and Welfare, *Monthly Labour Survey*.

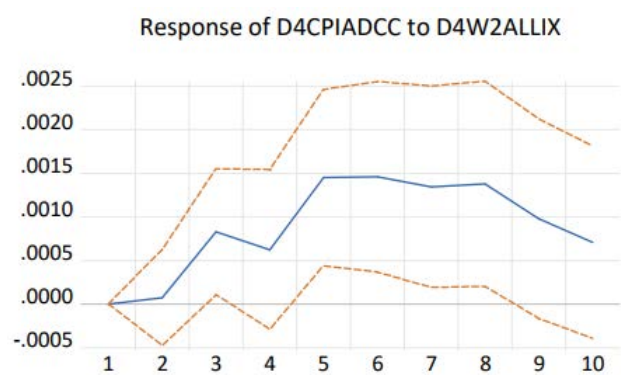
Note: Smoothed bonus inflation is calculated by taking bonus payments over the last four quarters divided by total hours over that period. Simple bonus inflation is just the four quarter change in bonuses divided by total hours.

Figure 8: Impulse Response of Core-Core Inflation to Cholesky One Standard Deviation Innovations: 1981q1-1997q4

To Core-Core Inflation



To Wage Inflation



To Bonus Inflation

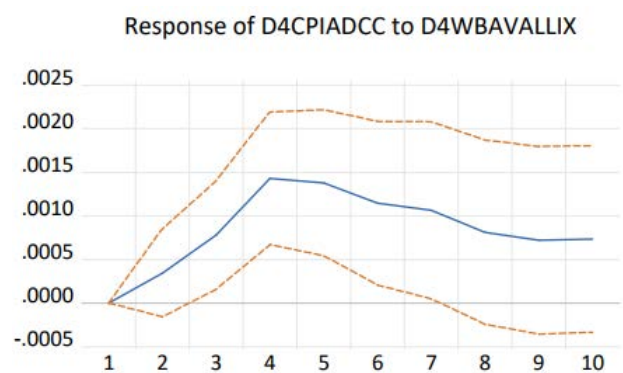
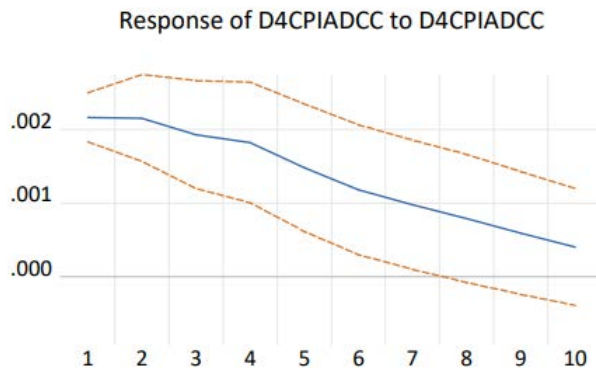
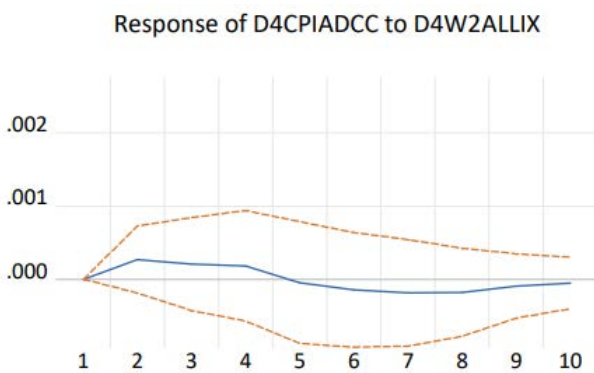


Figure 9: Impulse Response of Core-Core Inflation to Cholesky One Standard Deviation Innovations: 1998q1-2018q4

To Core-Core Inflation



To Wage Inflation



To Bonus Inflation

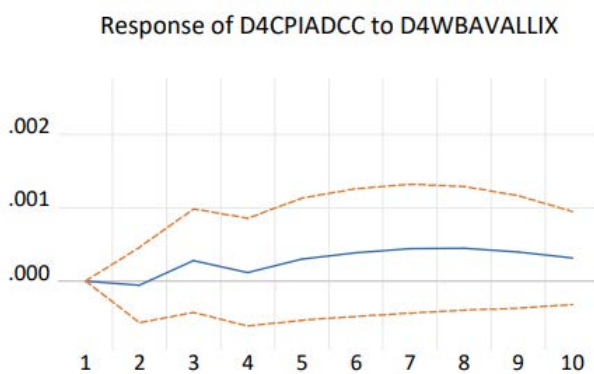
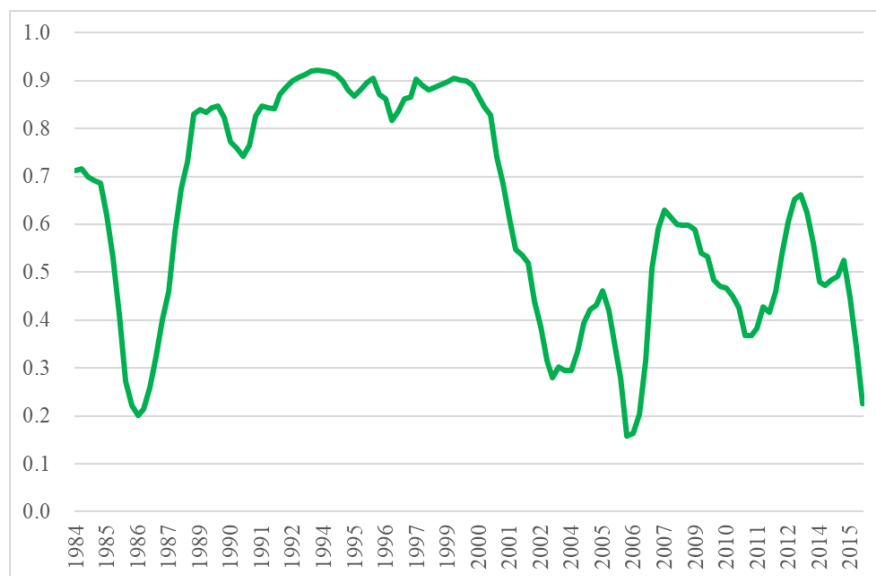


Figure 10: Correlation between Unobserved Trends for Core-core CPI Inflation Rate and Wage Inflation Rate for All Workers



Source: Authors' estimation

Table 1: ARMA Models for Price and Wage Inflation**Headline CPI Inflation**

	Sample: 1981 - 1997			Sample: 1998 - 2018		
Variable	Coefficient	Standard Error	T statistic	Coefficient	Standard Error	T statistic
Constant	0.0240	0.0124	1.93	0.0003	0.0023	0.13
AR(1)	0.9473	0.0451	20.99	0.7986	0.0757	10.55
MA(3)	0.3772	0.1190	3.17	0.1406	0.1217	1.15
MA(5)	0.4360	0.1488	2.93	-0.1945	0.1096	-1.77
R ²	0.88			0.67		
Approximate P-value Q statistic	0.78 (at lag 17)			0.01 (at lag 19)		

Core-Core Inflation

	Sample: 1981 - 1997			Sample: 1998 - 2018		
Variable	Coefficient	Standard Error	T statistic	Coefficient	Standard Error	T statistic
Constant	0.0291	0.0135	2.15	-0.0014	0.0023	-0.60
AR(1)	0.9802	0.0333	29.43	0.8968	0.0483	18.55
MA(2)	0.3842	0.1019	3.77	0.2015	0.1070	1.88
R ²	0.93			0.84		
Approximate P-value Q statistic	0.95 (at lag 17)			0.58 (at lag 19)		

Wage Inflation for All Workers

	Sample: 1981 - 1997			Sample: 1998 - 2018		
Variable	Coefficient	Standard Error	T statistic	Coefficient	Standard Error	T statistic
Constant	0.0370	0.0068	5.41	0.0022	0.0021	1.05
AR(1)	0.5827	0.1418	4.11	0.2352	0.1111	2.12
AR(2)	0.3089	0.1242	2.49	0.3026	0.1242	2.44
R ²	0.88			0.67		
Approximate P-value Q statistic	0.78 (at lag 17)			0.01 (at lag 19)		

Bonus Inflation for All Workers

	Sample: 1981 - 1997			Sample: 1998 - 2018		
Variable	Coefficient	Standard Error	T statistic	Coefficient	Standard Error	T statistic
Constant	0.0391	0.0130	3.01	-0.0065	0.0170	-0.38
AR(1)	0.8997	0.0482	18.67	0.8517	0.0556	15.33
R ²	0.80			0.72		
Approximate P-value Q statistic	0.53 (at lag 17)			0.00 (at lag 19)		

Table 2: ARMAX Models for Wage Inflation with Unemployment Rate (UNEMP)

A. Wage Inflation for All Workers

	Sample: 1981 - 1997			Sample 1998- 2018		
Variable	Coefficient	Standard Error	T statistic	Coefficient	Standard Error	T statistic
Constant	0.1074	0.0120	8.94	0.0352	0.0116	3.04
AR(1)	0.2659	0.1141	2.33	0.0945	0.1040	0.91
AR(2)	0.2305	0.1384	1.67	0.2016	0.1209	1.67
Lagged UNEMP	-0.0756	0.0121	-6.25	-0.0234	0.0078	-2.99
R ²	0.78			0.28		

B. Bonus Inflation for All Workers

	Sample: 1981 - 1997			Sample 1998- 2018		
Variable	Coefficient	Standard Error	T statistic	Coefficient	Standard Error	T statistic
Constant	0.0888	0.0473	1.88	0.1334	0.0394	3.39
AR(1)	0.8635	0.0822	10.50	0.7708	0.0716	10.76
Lagged UNEMP	-0.0195	0.0189	-1.03	-0.0342	0.0084	-4.07
R ²	0.80			0.76		

Table 3: ARMAX Models for Wage Inflation with Unemployment Rate: Full Time and Part Time Workers

Sample Period is 1998Q1-2018Q4

A. Wage Inflation for Both Types of Workers

	Full time workers			Part time workers		
Variable	Coefficient	Standard Error	T statistic	Coefficient	Standard Error	T statistic
Constant	0.0265	0.0116	2.28	0.0595	0.0121	4.92
AR(1)	0.0473	0.1091	0.43	0.3603	0.0871	4.14
AR(2)	0.2430	0.1221	1.99	0.1692	0.1533	1.10
Lagged UNEMP	-0.0168	0.0079	-2.12	-0.0344	0.0086	-3.99
R ²	0.18			0.58		

B. Bonus Inflation for Both Types of Workers

	Full time workers			Part time workers		
Variable	Coefficient	Standard Error	T statistic	Coefficient	Standard Error	T statistic
Constant	0.1252	0.0376	3.32	0.1170	0.0633	1.85
AR(1)	0.7734	0.0714	10.84	0.7005	0.0913	7.68
Lagged UNEMP	-0.0313	0.0080	-3.90	-0.0354	0.0139	-2.55
R ²	0.75			0.62		

Table 4: VAR Estimates of (core-core inflation, wage inflation, bonus inflation):1981q2-1997q4

Included observations: 67

Standard errors in ()

	CORE-CORE INFLATION	WAGE INFLATION	BONUS INFLATION
CORE-CORE INFLATION (-1)	0.758*** (0.129)	0.261 (0.423)	-1.011 (0.680)
CORE-CORE INFLATION (-2)	0.0228 (0.158)	-0.262 (0.519)	0.496 (0.834)
CORE-CORE INFLATION (-3)	-0.131 (0.156)	0.0388 (0.512)	1.492 (0.824)
CORE-CORE INFLATION (-4)	0.00481 (0.0996)	0.0950 (0.328)	-1.522** (0.527)
WAGE INFLATION (-1)	-0.00394 (0.0402)	0.435** (0.132)	0.455* (0.213)
WAGE INFLATION (-2)	0.0765 (0.0442)	0.377** (0.145)	0.169 (0.234)
WAGE INFLATION (-3)	-0.101* (0.0457)	0.0248 (0.150)	-0.341 (0.242)
WAGE INFLATION (-4)	0.0771 (0.0416)	-0.340* (0.137)	0.0678 (0.220)
BONUS INFLATION (-1)	0.0327 (0.0237)	-0.0532 (0.0780)	0.770*** (0.125)
BONUS INFLATION (-2)	0.0239 (0.0294)	0.167 (0.0968)	0.205 (0.156)
BONUS INFLATION (-3)	0.0405 (0.0298)	-0.00957 (0.0981)	0.0882 (0.158)
BONUS INFLATION (-4)	-0.0580* (0.0234)	0.0487 (0.0768)	-0.306* (0.124)
TREND(1981Q1)	-0.0000853*** (0.0000251)	0.0000276 (0.0000826)	-0.000212 (0.000133)
Constant	0.00604*** (0.00166)	0.00897 (0.00547)	0.0140 (0.00879)
R-squared	0.97	0.81	0.88
S.E. equation	0.0021	0.0070	0.0113

Table 5: VAR System with Core-Core Inflation, Wage Inflation, and Bonus Inflation: 1981q1-1997q4

Panel A. Granger Causality from Wages Inflation to Core-Core Inflation: 1981q1-1997q4

Included observations: 67

Dependent variable: Core-core inflation			
Excluded	Chi-sq	df	Prob.
Wage inflation	9.433	4	0.051
Bonus inflation	20.343	4	0.000
All	18.363	8	0.019

Panel B. Variance Decomposition of Core-Core Inflation Rate (%): 1981q1-1997q4

Quarter	Core-core inflation	Wage inflation	Bonus inflation
1	100.00%	0.00%	0.00%
2	98.37%	0.07%	1.56%
3	87.30%	6.18%	6.52%
4	73.64%	7.40%	18.97%
5	58.83%	16.67%	24.50%
6	50.45%	23.29%	26.26%
7	45.29%	27.35%	27.35%
8	41.47%	31.42%	27.11%
9	39.50%	33.02%	27.47%
10	38.20%	33.52%	28.28%

Table 6: VAR Estimates of (core-core inflation, wage inflation, bonus inflation):1998q1-2018q4

Included observations: 84
Standard errors in ()

	CORE-CORE INFLATION	WAGE INFLATION	BONUS INFLATION
CORE-CORE INFLATION (-1)	0.991*** (0.114)	0.542 (0.404)	1.859* (0.889)
CORE-CORE INFLATION (-2)	-0.126 (0.162)	-0.240 (0.575)	-0.567 (1.266)
CORE-CORE INFLATION (-3)	0.0599 (0.159)	-0.397 (0.565)	-1.291 (1.244)
CORE-CORE INFLATION (-4)	-0.106 (0.112)	1.000* (0.398)	0.804 (0.876)
WAGE INFLATION (-1)	0.0374 (0.0315)	0.0195 (0.112)	-0.0509 (0.246)
WAGE INFLATION (-2)	-0.0208 (0.0313)	0.261* (0.111)	0.0559 (0.244)
WAGE INFLATION (-3)	-0.00124 (0.0313)	-0.0261 (0.111)	0.102 (0.244)
WAGE INFLATION (-4)	-0.0323 (0.0306)	-0.359*** (0.108)	-0.305 (0.239)
BONUS INFLATION (-1)	-0.00333 (0.0159)	0.114* (0.0564)	1.005*** (0.124)
BONUS INFLATION (-2)	0.0196 (0.0215)	-0.104 (0.0763)	-0.133 (0.168)
BONUS INFLATION (-3)	-0.0250 (0.0217)	0.0467 (0.0768)	-0.224 (0.169)
BONUS INFLATION (-4)	0.0210 (0.0153)	0.00254 (0.0542)	-0.0319 (0.119)
TREND(1981Q1)	0.0000119 (0.0000118)	-0.0000284 (0.0000417)	0.000201* (0.0000917)
Constant	-0.00172 (0.00148)	0.00820 (0.00523)	-0.0238* (0.0115)
R-squared	0.87	0.45	0.83
S.E. equation	0.0022	0.0077	0.0169

Table 7: VAR System with Core-Core Inflation, Wage Inflation, and Bonus Inflation: 1998q1-2018q4

Panel A. Granger Causality from Wages Inflation to Core-Core Inflation: 1998q1-2018q4

Included observations: 84

Dependent variable: Core-core inflation			
Excluded	Chi-sq	df	Prob.
Wage inflation	3.2335	4	0.52
Bonus inflation	2.9511	4	0.566
All	9.1963	8	0.326

Panel B. Variance Decomposition of Core-Core Inflation Rate (%): 1998q1-2018q4

Quarter	Core-core inflation	Wage inflation	Bonus inflation
1	100.00%	0.00%	0.00%
2	99.18%	0.79%	0.03%
3	98.51%	0.88%	0.61%
4	98.53%	0.90%	0.57%
5	98.22%	0.81%	0.98%
6	97.52%	0.84%	1.64%
7	96.59%	0.95%	2.45%
8	95.69%	1.06%	3.25%
9	95.07%	1.07%	3.86%
10	94.69%	1.07%	4.24%

Appendix 1. Construction of data series from the *Monthly Labor Survey*

The wages and employment data that are used in this paper are constructed from the data series published by Japan's Ministry of Health, Labor, and Welfare (MHLW) in its *Monthly Labor Survey*. A brief explanation of the survey in English is available at <https://www.mhlw.go.jp/english/database/db-slms/dl/slms-01.pdf> (accessed on July 15, 2019).

The survey was first conducted in July 1923 when it was called the *Monthly Wage Survey of Production Workers and Miners*. The current form of the monthly survey that cover almost all major industries including services was established in January 1970. The survey aims to capture the fluctuations in employment, earnings, and working hours for various regions and industries in Japan. The survey consists of three parts: the National Survey, the Prefectural Survey, and a Special Survey that is conducted annually for tiny enterprises (that have between one and four employees). We use the data from the National Survey.

The National Survey covers establishments with 5 or more employees. For this survey employees are workers who were (1) hired without a fixed term or for a term longer than one month or (2) hired by the day or for less than one month but for 18 days or more in each of the two preceding months of the survey. In January 1993, the survey began to distinguish between full-time workers and part-time workers, where part-time workers are defined to be those who are scheduled to work less hours per day or less days per week than the full-time workers.

National Survey samples the establishments to be surveyed based on the latest *Economic Census (Establishments and Enterprises Census)* before 2009, which has been conducted every 2 to 3 years. For the establishments that have 500 or more employees, all of them are sampled. For the establishments with the number of employees between 30 and 499, samples are drawn randomly with cells stratified by prefecture, industry and enterprise size. For the small establishments, having between 5 and 29 employees, another sampling method is used, but we do not discuss that here, because we do not study establishments with fewer than 30 employees. As we discuss below, the data are supposed to be aggregated using the sampling ratio as weights, but it was revealed this was not consistently done and we will explain how we corrected that problem.

The sample of National Survey changes every 2 or 3 years when the new results of *Economic Census* becomes available. Thus, the aggregate numbers are not comparable over time. Along with the raw data, the survey reports an index number that standardizes the data by dividing each observation by the average value of the series in certain year (2015 currently), but the index also would exhibit a break when the sample rotation occurs. To mitigate this problem, the survey adjusts the total number of employees to be equal to the actual number whenever the new results of the *Economic Census* come out and the sample rotation occurs. Then, the revised total number of employees are used to aggregate the numbers and re-calculate indices for all the series. For most of our analysis, we use these index data.

In January 2019, the MHLW revealed that they found biases in the *Monthly Labour Survey* data because of a faulty procedure that started in 2004. The survey is supposed to gather data from every establishment with 500 or more employees, but starting in 2004 it turned out for Tokyo-based establishments only about third of those large establishments were sampled. The published

aggregate data series were not properly corrected for this sampling mistake, so resulting the data from large companies in Tokyo were underweighted.

Since the employees of large establishments tend to receive higher earnings than smaller establishments, the underweighting of the large establishments resulted in underestimation of the level of average earnings. This developed into a political scandal because the results of the *Monthly Labor Survey* are used to determine the level of benefits in some important government programs including for unemployment insurance.¹ By late January, the MHLW quickly re-estimated and published the data series using the original data for individual establishments going back to 2012. Based on the corrected data, they started calculating how much they owe to the recipients of the unemployment insurance. For the period between 2004 and 2012, the MHLW contended that some critical information to re-estimate the aggregate series is missing and hence the data correction cannot be made.

The opposition parties used this opportunity to attack the government for having manipulated the statistical data to make Abenomics economic policy look good, even though it does not make sense for the government to under-report the wage levels intentionally.

For our analysis, the problem is that we do not have proper data for 2004-2011. Before 2003, the data did not suffer from this incorrect procedure. After 2012, the corrected data have been published. So we make the corrections to the data series from January 2004 to December 2011 in the following way.

First, using the observations from January 2012 to December 2018, for which both the original series and the corrected series (published in January 2019) are available, we estimate a linear regression model of the corrected series on the original series, a constant term, and eleven monthly dummies. We have also experimented with specifications including liner trend, quadratic trend, or cubic trend, but none of those noticeably improved the fit, which is already very good with the simple model with just the original series and monthly dummies. Second, use the estimated model to predict the corrected series for January 2004 to December 2011. Finally, create the time series for our analysis by combining the three series: (i) original series up to December 2003, (ii) predicted series from January 2004 to December 2011, and (iii) corrected series from January 2012 to December 2018.

As mentioned above, we use mostly the index series for our analysis. The source data files (for both original data and corrected data) are available at <https://www.e-stat.go.jp/stat-search/files?page=1&layout=datalist&toukei=00450071&tstat=000001011791&cycle=1&tclass1=000001035519>. The data files are named “maikin-k.csv” (and “sai-maikin-k.csv” for corrected data). In particular, we use the following seven index series for three categories of workers (all workers, full-time workers, and part-time workers) at enterprises with 30 or more employees.

¹ An early news on the problem is found in an article “Tens of Billions of Yen in Jobless Benefits Unpaid Due to Faulty Labor Ministry Data: Sources” *Japan Times*, January 10, 2019. (<https://www.japantimes.co.jp/news/2019/01/10/national/tens-billions-yen-jobless-benefits-unpaid-due-faulty-labor-ministry-data-sources/#.XDgTH89KiMI>)

The data are extracted by specifying Column A of maikin-k file to be “I M” (for monthly index series) and Column D to 0 (for 30 or more employees).

- Employment index (Column I of maikin-k file)
- Regular working hours index (Column L of maikin-k file)
- Overtime working hours index (Column M of maikin-k file)
- Contracted salary index (this includes overtime) (Column N of maikin-k file)
- Total hours worked index (Column Q of maikin-k file)
- Total salary index (this includes bonus as well as overtime) (Column R of maikin-k file)
- Regular salary index (this does not include overtime) (Column S of maikin-k file)

In some figures, we show level data, such as number of workers in millions or wages in yen. We construct these series by converting the index data using the average level data for 2018 as following:

$$Number = Index * \frac{\text{Average of Number during 2018}}{\text{Average of Index during 2018}}$$

The level data are extracted by specifying Column A of maikin-k file to be “E1M” (for monthly level series) and Column D to 0 (for 30 or more employees). The level data that correspond to the seven series above are:

- Number of workers at the end of the current month (Column I of maikin-k file)
- Average number of regular hours worked per worker (Column L of maikin-k file)
- Average number of overtime hours worked per worker (Column M of maikin-k file)
- Average contracted salary per worker (Column N of maikin-k file)
- Average number of total hours worked per worker (Column Q of maikin-k file)
- Average total salary per worker (this includes bonus as well as overtime) (Column R of maikin-k file)
- Average regular salary per worker (this does not include overtime) (Column S of maikin-k file)

Let us go through how we calculate the series for the contracted salary index (for all workers) as an example. First, using both corrected series and original series for 2012-2018, we estimate the regression model. The estimation result is given by:

$$\begin{aligned} \text{Corrected Contracted Salary Index} = & -0.269 + 1.002 * (\text{Original Contracted Salary Index}) \\ & (2.551) \quad (0.025) \\ & - 0.012 * D1 - 0.027 * D2 + 0.028 * D3 - 0.002 * D4 + 0.030 * D5 - 0.0001 * D6 + 0.0002 * D7 \\ & (0.109) \quad (0.107) \quad (0.105) \quad (0.109) \quad (0.107) \quad (0.105) \quad (0.105) \\ & + 0.044 * D8 + 0.044 * D9 + 0.057 * D10 + 0.014 * D11 \\ & (0.107) \quad (0.106) \quad (0.106) \quad (0.105) \\ R^2 = & 0.96 \end{aligned}$$

The variables D_i ($i=1, \dots, 11$) is the monthly dummy variables that takes one in the i -th month of the calendar year (1 for January, 2 for February, and so on) and zero otherwise. The numbers in the parentheses are the standard errors of the coefficient estimates. In this regression, none of the monthly dummies are significantly different from zero.

Figure A-1 shows the original values (blue broken line), the corrected values (red dotted line), and the fitted values (green solid line) for the contracted salary index. We can see the corrected series is not much different from the original series. This is generally the case for the index data. The fit of the simple regression model is quite good, and the fitted value (though not much different from the original values) trace the corrected values very well.

Figure A-2 shows the original series (blue broken line) and the estimated series (green solid line) that we use for this paper, which is a combination of (i) original series before 2003, (ii) predicted series from the regression between 2004 and 2012, and (iii) corrected series after 2012. The difference between the two series is very small.

Although we do not use level data directly in our analysis, we applied the same procedure to adjust the original series. For example, the regression estimation result for the average contracted salary per worker (for all workers) is given by the following equation.

$$\begin{aligned} \text{Corrected Average Contracted Salary Per Worker} = & 12361.15 \\ & (10203.22) \\ & + 0.966 * (\text{Original Average Contracted Salary Per Worker}) - 386.59 * D1 - 392.52 * D2 \\ & (0.035) & (351.84) & (337.23) \\ & - 261.73 * D3 - 91.65 * D4 - 209.31 * D5 - 166.95 * D6 - 127.14 * D7 - 126.19 * D8 \\ & (322.69) & (336.16) & (331.93) & (322.70) & (323.39) & (330.10) \\ & - 77.56 * D9 + 125.75 * D10 - 7.49 * D11 \\ & (326.00) & (322.79) & (322.68) \end{aligned}$$

$$R^2 = 0.95$$

Again the numbers in the parentheses are standard errors, and none of the monthly dummies are significant in this regression.

Figure A-3 shows the original values (blue broken line), the corrected values (red dotted line), and the fitted values (green solid line) for the average contracted salary per worker. Now we see the corrected series is consistently larger than the original series, reflecting the (erroneous) under-representation of large firms that tend to have higher salaries. The fit of the simple regression model is still good, and the fitted value, which is now noticeably larger than the original values trace the corrected values very well.

Figure A-4 shows the original series (blue broken line) and the estimated series (green solid line), which is a combination of (i) original series before 2003, (ii) predicted series from the regression between 2004 and 2012, and (iii) corrected series after 2012. The estimated series is consistently above the original series after 2004, and the drop from 2003 to 2004 is less pronounced.

Figure A-1. Original values, corrected values, and fitted values: Contracted salary index (all workers)

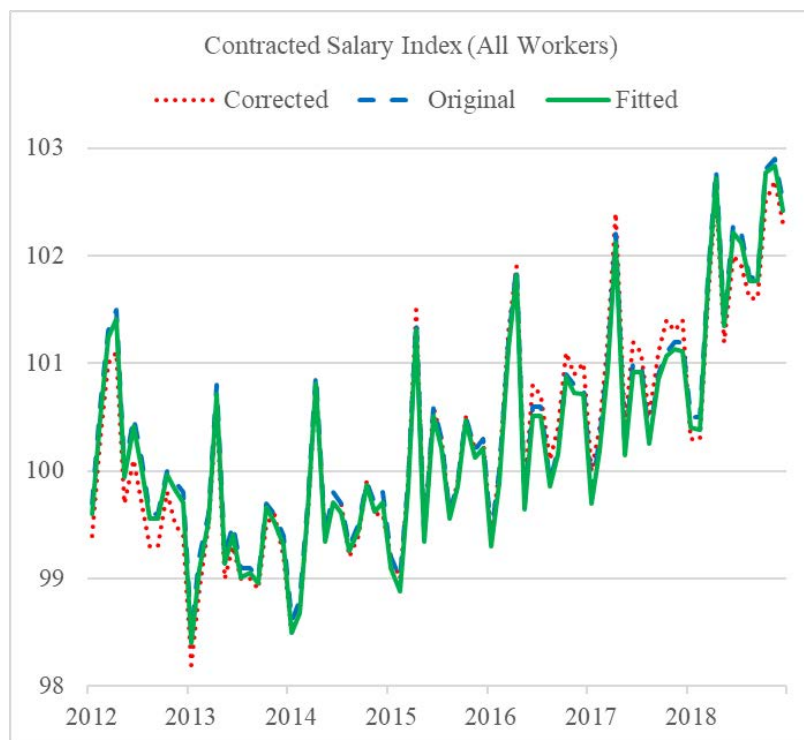


Figure A-2. Original series and estimated series: Contracted salary index (all workers)

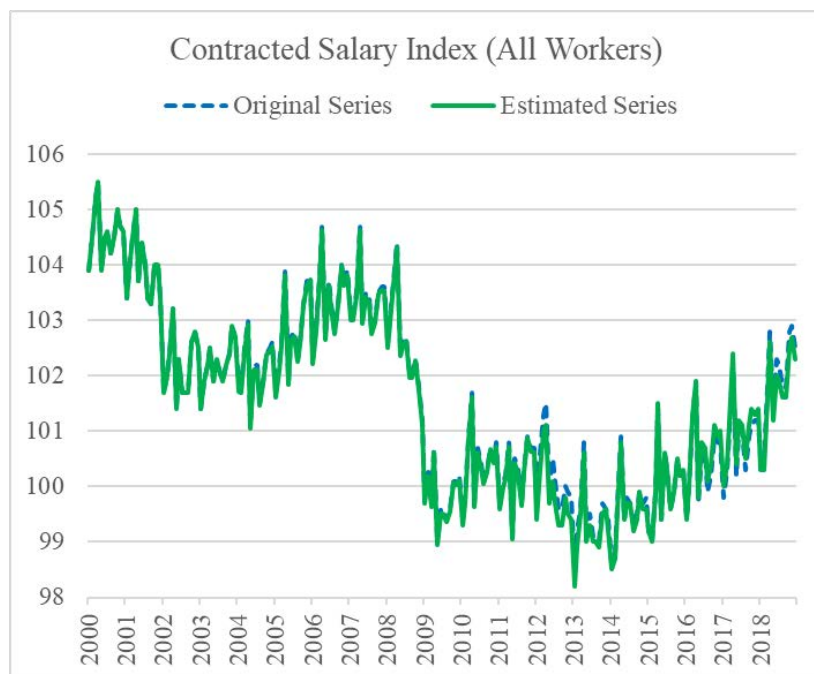


Figure A-3. Original values, corrected values, and fitted values: Average contracted salary per worker (all workers)

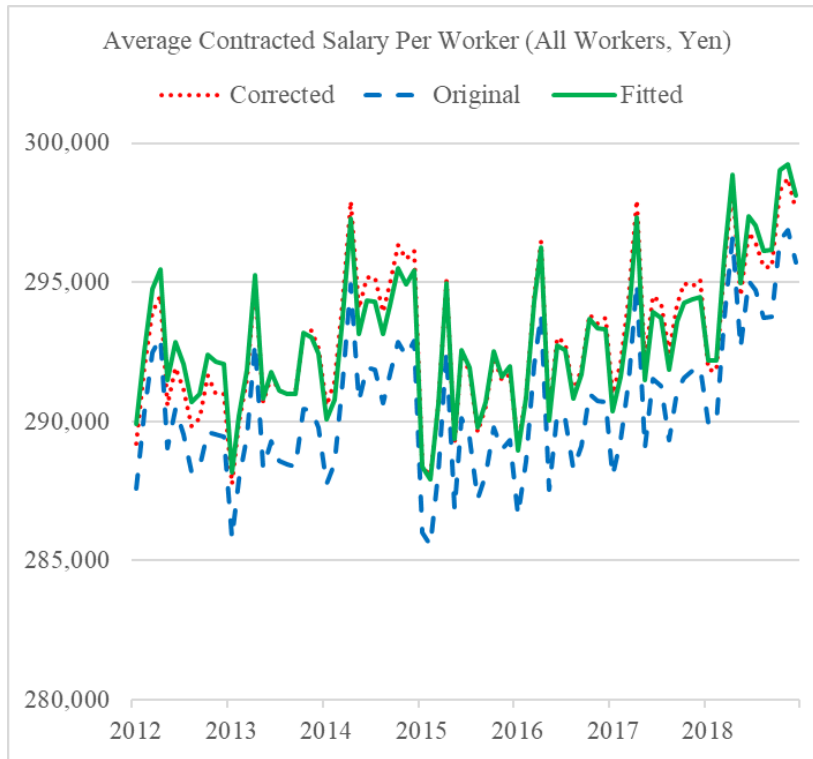


Figure A-4. Original values, corrected values, and fitted values: Average contracted salary per worker (all workers)

