ISSN: 1097-203X (Print) (Online) Journal homepage: http://www.tandfonline.com/loi/mjes19

Okun's Law and Employment Adjustment

Yoshio Kurosaka

The Japanese Economy, vol. 39, no. 2, Summer 2012, pp. 87–107.

ISSN 1097–203X (print)/ISSN 1944–7256 (online)
DOI: 10.2753/JES1097-203X390204

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Abstract: *This study estimates and conducts a factor analysis on Okun's coefficient to look at the labor productivity effect that can be derived from the Okun coefficient residual, and indirectly examines the employment adjustment speed of the Japanese economy in 1981–2010. The key findings are as follows. Okun's coefficient for the Japanese economy was calculated at 10.8 for the periods 1981–2000 and 2008–10, and 3.0 for the period 2001–7 (≒ 1÷ 0.329), with the value of Okun's coefficient falling in the 2001–7 period, but then rebounding to its original value in 2008 and after. The labor productivity effect was found by calculating the difference remaining after subtracting the direct effect, labor supply effect, and labor hours effect from Okun's coefficient. It was 6.43 in the periods 1981–2000 and 2008–10, and 1.03 in the period 2001–7 when Okun's coefficient fell. This means that corporate employment hoarding had decreased, indirectly showing that employment adjustments had been made quickly. In the period 2008–10, following the collapse of Lehman Brothers, Okun's coefficient rebounded to 10.8 and the labor productivity effect returned to its previous level, thus suggesting that the overemployment being maintained by companies was largely eliminated in the 2001–7 period. It was not so much that the pace of employment adjustment itself changed after the collapse of Lehman Brothers, but rather that the magnitude of the Lehman collapse was so large as to require massive employment adjustments to be made even at the previous pace of employment adjustment.*

The article estimates the Okun coefficient in the Japanese economy for 1981–2010. The estimated Okun coefficient takes the value of 10.8 for 1981–2000 and 2008–10,

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Yoshio Kurosaka is a professor in the Department of Economics at Musashi University.

and 3.0 for 2001–7. While the natural rate of unemployment is approximately identified with 2.1 percent for 1981–2000 and 5.1 percent for 2008–10, the value of the Okun coefficient is the same for both periods. Through a factor decomposition analysis the productivity effect due to labor hoarding is found to be smaller for 2001–7 than for 1981–2000 and 2008–10. This fact finding leads to a conjecture of faster employment adjustment for 2001–7. The productivity effect returns to the previous magnitude after the so-called Lehman Shock hit the economy, showing that the speed of employment adjustment returned to the same degree as experienced for 1981–2000. This finding suggests that the large scale of employment adjustment took place due to the relatively large magnitude of the Lehman Shock, rather than the faster speed of employment adjustment.

The statement below was made by Paul Krugman, 2008 winner of the Nobel Prize in Economics, in explaining the policy measures to be taken in response to the recession caused by the collapse of Lehman Brothers based on Okun's law:

> The natural rate of unemployment is, say, 5 percent—maybe lower. Given Okun's law, every excess point of unemployment above 5 means a 2 percent output gap. Right now, we're at 6.5 percent unemployment and a 3 percent output gap—but those numbers are heading higher fast. Goldman predicts 8.5 percent unemployment, meaning a 7 percent output gap. That sounds reasonable to me. So we need a fiscal stimulus big enough to close a 7 percent output gap. (Krugman 2008: 141)

Here, the natural rate of unemployment is a term coined by Friedman (1968), referring to the unemployment rate that is achieved when the expected and actual rates of change in the price of goods are equal. Later, the term nonaccelerating inflation rate of unemployment (NAIRU), which is the rate of unemployment that can occur without causing a higher inflation rate came into widespread use, but the natural rate of unemployment seems a better term to use in the context of the recent deflationary conditions. Okun's law is named after the late Arthur Okun, a macroeconomist who served on President John F. Kennedy's Council of Economic Advisers (CEA). It is an economic law that shows "by what percent the economic growth rate changes when the actual unemployment rate fluctuates 1 percent from the natural unemployment rate." In a 1962 paper, Okun estimated this coefficient, which indicates the degree of change in the economic growth rate that will occur in response to a change in the unemployment rate, to be 3.2 for the American economy, while Krugman estimated it to be 2, as mentioned above. "There is a strikingly close relationship between the economy's growth rate and the rate of change in the unemployment rate; indeed, it is one of the few things economists are willing to call a 'law' (Okun's Law) with a straight face" (Krugman 1997: 125). Okun's law has continued to be applicable since 1962.

When a 1 percent change in the unemployment rate yields only a 1 percent change in the employment volume, the change in gross domestic product (GDP) will be only 1 percent. The reason Okun's coefficient is larger than 1 is because changes in the labor supply and changes in labor hours occur simultaneously during the process by which the unemployment rate changes by 1 percent. If we eliminate the portion of Okun's coefficient that can be explained by changes in employment volume, labor supply, and labor hours, any remainder means that companies are engaging in some level of labor hoarding. While the existence of labor hoarding can lead to improved labor productivity through the revitalization of the labor force during good economic times, it can reduce labor productivity by leaving part of the labor force idle during an economic downturn. The degree to which labor hoarding exists is largely related to the speed at which companies make employment adjustments. That is, if a company quickly makes employment adjustments during a time of economic transition, its degree of labor hoarding will be small. If it is slow in making employment adjustments, by contrast, it will have a higher degree of labor hoarding. Thus, estimating Okun's coefficient and performing a factor analysis on that coefficient based on the labor supply and labor hours, for example, will indirectly provide some clues regarding the pace of employment adjustments being made.

Changes in the Rate of Unemployment and Real GDP

The main purpose of this article is to analyze employment adjustments in the Japanese economy since 1981 based on Okun's law. Before beginning this discussion, we look briefly at the types of changes that have occurred in the unemployment rate and the real GDP growth rate in the Japanese economy since 1981. Figure 1 shows the data on the unemployment rate and real GDP growth rate in the Japanese economy since 1981.

From 1974, when the "first oil shock" struck, to 1978, the unemployment rate, after having continued to rise to above the 2 percent level for the first time since the 1950s, suddenly fell back down to 2.02 percent in 1980. However, as a result of the "second oil shock" and the subsequent worldwide recession, it again began to rise, surpassing its previous high of 2.50 percent in 1955 to reach 2.72 percent in 1984. In 1985 (the era of new growth, the expansion phase of the tenth cycle in Table 1), the unemployment rate fell temporarily to 2.62 percent, but due to the yen appreciation recession (the retraction period of the tenth cycle), it rose again to 2.84 percent (1987). Given the bubble economy that began in 1987, relatively high economic growth was achieved (while the average real GDP growth rate in the 1980s [1980–89] was about 4.3 percent, it was 5.1 percent during the bubble period [1987–91]), and the unemployment rate began heading downward. In 1991, with the collapse of the bubble economy (the retraction phase of the eleventh cycle), the unemployment rate fell to 2.09 percent, but thereafter it continued to rise consistently. It surpassed 3 percent in 1995 and reached 4.11 percent in 1998, when negative growth was recorded for the first time since the first oil shock in 1974.

Even after 1998, the unemployment rate continued to rise, passing 5 percent in 2001 to reach its highest ever level of 5.37 percent in 2002. After this, it fell steadily from 2003 to 2007, finally dipping below 4 percent to 3.85 percent in 2007.

Figure 1. **Unemployment Rate and Real Gross Domestic Product** (GDP) **Growth Rate**

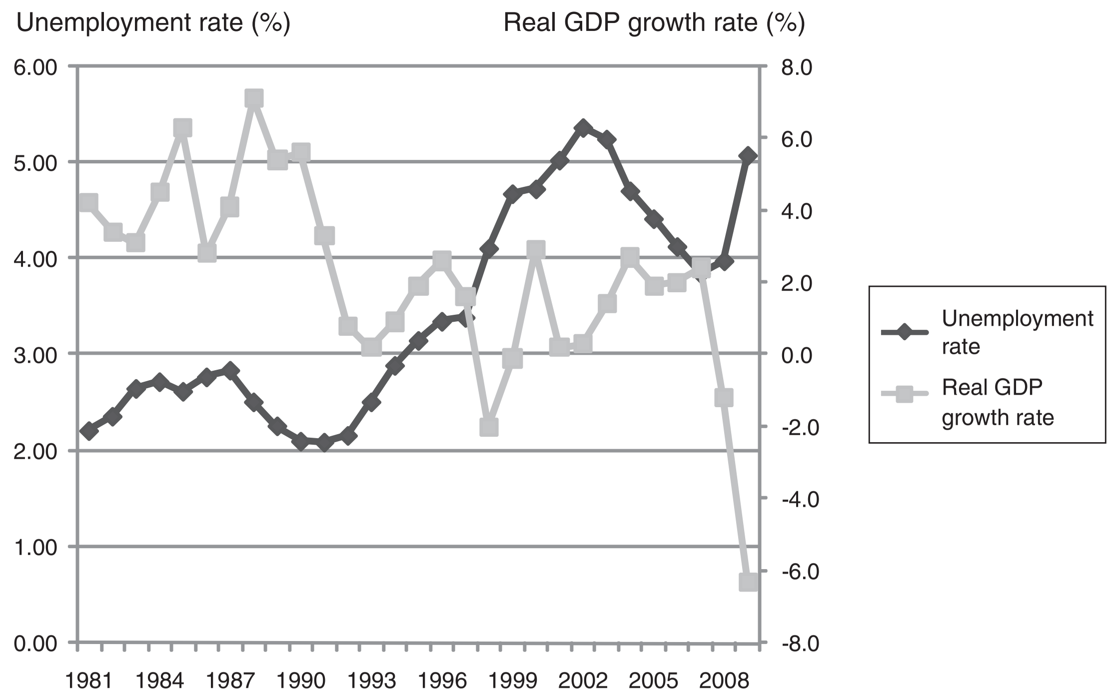


Table 1

Standard Dates in the Economic Cycles

				Period (in months)		
	Trough	Peak	Trough	Expansion	Retraction	Total cycle
Ninth cycle	October 1977	February 1978	February 1980	28	36	64
Tenth cycle	February 1983	June 1985	November 1986	28	17	45
Eleventh cycle	November 1986	February 1991	October 1993	51	32	83
Twelfth cycle	October 1993	May 1997	January 1999	43	20	63
Thirteenth cycle	January 1999	November 2000	January 2002	22	14	36
Fourteenth cycle	January 2002	October 2007	—	69	—	—

Source: Cabinet Office, "Standard Dates in the Economic Cycles."

With the collapse of Lehman Brothers, however, the unemployment rate began to climb again in 2008, shooting up to 5.08 percent in the following year, 2009. In 2010, with a recovery from the Lehman Brothers collapse finally in sight, the rise in the unemployment rate stalled at 5.07 percent. On the other hand, after the collapse of the bubble economy in 1991, the real GDP growth rate fell sharply. As a result, the average real GDP growth rate was about 1.4 percent in the 1990s (1990–99) and about 0.6 percent in the 2000s (2000–9).

While the average real GDP growth rate fell from about 4.3 percent in the 1980s to 1.4 percent in the 1990s and 0.6 percent in the 2000s, the average unemployment rate rose from 2.43 percent in the 1980s to 3.04 percent in the 1990s, and 4.65 percent in the 2000s. This shows that the unemployment rate has risen as the real GDP growth rate has fallen.

Okun's Law

I estimated Okun's coefficient for the Japanese economy in Hamada and Kurosaka (1984), Kurosaka (1988, 2000), and have analyzed the implications of the size of that coefficient for the Japanese economy. In this study, I conduct new measurements of Okun's coefficient for the period 1981–2010.

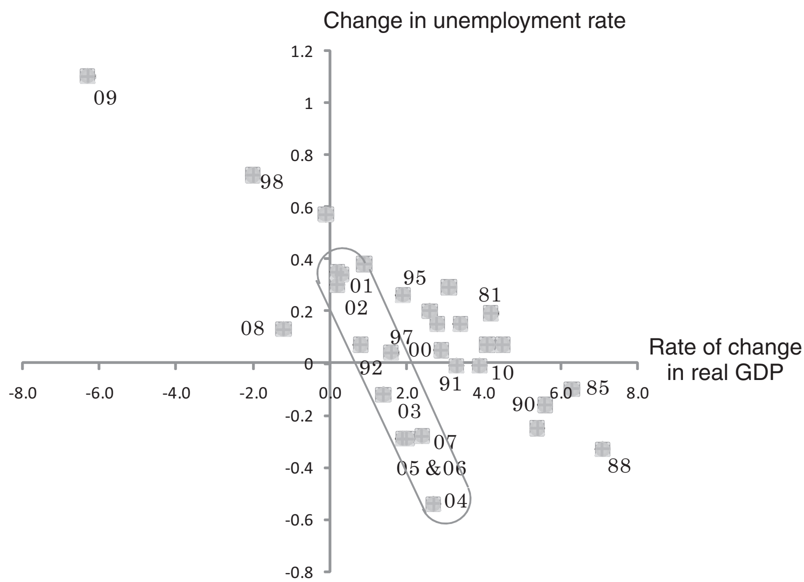
Applying the measurement method used by Krugman (1998), I regressed the unemployment rate gap on the real GDP growth rate. First, I will draw a figure like the one that appears in Krugman (1998: 168) for the period 1981–2010. Figure 2 is a scatter diagram in which the gap between the current and previous year's unemployment rate (percent) is plotted along the *x*-axis and the real GDP growth rate (percent) is plotted along the *y*-axis.

The data for each year are scattered around a straight line drawn downward to the right from 1998/2009, when the economy experienced negative growth and a large increase in the unemployment rate, and 1988, when there was high growth and a large decrease in the unemployment rate, revealing at a glance that an increase (decrease) in the real GDP growth rate is associated with a decrease (increase) in the unemployment rate. However, the encircled area in Figure 2 shows the abnormal trend in the data from 2001 to 2007 (the data from 1992 and 1997 are also in this area, but they have been excluded because they are inconsistent with the periods before and after), and suggests that in comparison with the previous observation, a large decrease in the rate of unemployment occurred with little change in the real GDP growth rate, and that some structural change influenced the value of Okun's coefficient. This period, according to the standard dates in the economic cycles shown in Table 1, aligns with the expansion phase of the fourteenth cycle and overlaps with the period during which structural reforms advocated by the Koizumi Cabinet (April 26, 2001 to September 26, 2006), as reflected in the slogan "no growth without reform," were implemented.

A dummy variable was introduced to account for the possibility of structural changes from 2001 to 2007 ($D1$, set at 1 for 2001–7 and 0 for all other periods), and

Japanese Economy 2012.39:87-107.

Figure 2. **Okun's Law**



an ordinary least squares analysis was used to estimate this down-and-rightward sloping straight line to obtain the results shown in Equation 1.

$$\Delta U = 0.389 - 0.092 * \frac{\Delta Q}{Q} - 0.237 * D1 * \frac{\Delta Q}{Q} \qquad (1)$$

(11.536) (−9.940) (−7.716)

ΔU: Change in the unemployment rate

$\frac{\Delta Q}{Q}$: Real GDP growth rate; *D1:* Dummy variable

$\bar{R}^2 = 0.85$ $DW = 2.00$ $\bar{S} = 0.13$

$\bar{R}^2$: Coefficient of determination corrected for degrees of freedom

DW: Durbin–Watson ratio

S: Standard error

The estimated constant term, real GDP growth rate without the dummy variable, and *t*-value of the coefficient of the real GDP growth rate with the dummy variable included (the figures shown in parentheses beneath the estimated coefficients) are all statistically significant at the 1 percent level, and no serial correlation in the error terms is shown to exist at the 5 percent level of significance based on the value of the Durbin–Watson statistic, indicating that Equation 1

Japanese Economy 2012.39:87-107.

produces statistically useful results. Since the coefficient of the real GDP growth rate including the dummy used to check the possibility of structural change is also estimated to be significant, this suggests that the value of Okun's coefficient changed during the period 2001–7.

Equation 1 suggests that each 1 percent change in the real GDP growth rate was met with a 0.092 percent change in the unemployment rate during the periods 1981–2000 and 2008–10, and with a 0.329 percent change (= 0.092 + 0.237) during the 2001–7 period. Based on these findings, Okun's coefficient for the Japanese economy is calculated at 10.8 for 1981–2000 and 2008–10 (≒ 1 ÷ 0.092 truncated to one decimal place) and 3.0 for the period 2001–7 (≒ 1 ÷ 0.329). The value of Okun's coefficient fell in the 2001–7 period, but rebounded to its previous level in 2008 and beyond. The important point here is that after September 2008 when Lehman Brothers collapsed, Okun's coefficient rebounded to 10.8, and the change in the real GDP growth rate in response to a 1 percent change in the unemployment rate increased.

As mentioned above, the natural unemployment rate is the rate of unemployment that occurs when the expected and actual rates of change in the prices of goods are equal, and is an indicator used as a macroeconomic policy target. As Friedman defines it, the "natural rate of unemployment," in other words, is "the level that would be ground out by the Walrasian system of general equilibrium equations, provided there is imbedded in them the actual structural characteristics of the labor and commodity markets, including market imperfections, stochastic variability in demands and supplies, the cost of gathering information about job vacancies and labor availabilities, the costs of mobility, and so on" (Friedman 1968: 8). The "'natural rate of unemployment,' a term I introduced to parallel Knut Wicksell's 'natural rate of interest,' is not a numerical constant but depends on 'real' as opposed to monetary factors—the effectiveness of the labor market, the extent of competition or monopoly, the barriers or encouragements to working in various occupations, and so on" (Friedman 1977: 458). Thus, to lower the natural rate of unemployment itself requires structural reforms in the labor market. On the other hand, Keynes writes regarding unemployment in the United States in 1932 that "Wide variations are experienced in the volume of employment without any apparent change either in the minimum real demands of labor or in its productivity" (Keynes 1936: ch. 2, 9). Keynes attributed the existence of a rate of unemployment that exceeds the natural rate of unemployment to a lack of effective demand. Okun's law, which indicates the percentage of fluctuation in the real GDP growth rate that will occur in response to a 1 percent *increase* in the unemployment rate *over* the natural rate of unemployment, verifies Keynes's principle of "effective demand," which emphasizes that the existence of an unemployment rate that is higher than the natural rate of unemployment can be attributed to a lack of effective demand. A more general way of looking at the natural rate of unemployment is to estimate the Phillips curve and view it as the rate of unemployment that occurs when the anticipated and actual inflation rates are equal. By contrast, the method of finding the natural rate of unemployment based on Okun's law involves calculating the economic growth rate at which the rate of unemployment remains constant (hereafter called the natural rate of growth), searching for years in which the actual growth rate was equal to this economic growth rate, and viewing the actual rate of unemployment in those years as the natural rate of unemployment.

Thus, if we return to Equation 1 and use it to calculate the real GDP growth rate at which the rate of unemployment remains constant, that is, the natural rate of growth, it becomes possible to identify the natural rate of growth for the periods 1981–2000 and 2008–10, and the period 2001–7. In Equation 1, if we find the

$$\frac{\Delta Q}{Q}$$

at which ΔU is zero, then

$$\frac{\Delta Q}{Q} = 4.2 \text{ percent}$$

($\fallingdotseq$ 0.389 ÷ 0.092, truncated to one decimal place) for the periods 1981–2000 and 2008–10, and

$$\frac{\Delta Q}{Q} = 1.1 \text{ percent}$$

($\fallingdotseq$ 0.389 ÷ 0.329) for the period 2001–7. If we use Figure 2 to look for years in which the rate of change in the unemployment rate was about zero, we find 1991, when the change in the unemployment rate from the previous year was –0.01 percent and the real GDP growth rate was 3.3 percent, and 2010, when the change in the unemployment rate from the previous year was –0.01 percent and the real GDP growth rate was 3.9 percent. The above calculations of the natural rate of growth yielded results of less than 0.7 percent, but these two candidates suggest a natural rate of growth of 3.5 percent. On the other hand, since we cannot find a year during the period 2001–7 in which the rate of change in the unemployment rate was virtually zero, it is difficult to confirm the suitability of the previous calculations of the natural rate of growth from the actual real GDP growth rate.

The rate of change in consumer prices in 1991 was 3.3 percent (the change from the previous year was 0.2 percent), and the rate of GDP deflation was 3.3 percent (the change from the previous year was +0.2 percent). The rate of change in consumer prices in 2010 was –0.7 percent (the change from the previous year was +0.7 percent) while the rate of change in the GDP deflator was –2.1 percent (the change from the previous year was –0.7 percent), indicating that the price of goods continued to remain fairly stable from the previous year. According to the standard dates in the economic cycles shown in Table 1, the expansionary phase of the eleventh cycle (Heisei economy) went from the economic trough of November 1986 to the economic peak of February 1991, while the retraction phase lasted from the peak of February 1991 to October 1993, indicating that 1991 constituted

Japanese Economy 2012.39:87-107.

a transitional period for the economy. On the other hand, the expansionary phase of the fourteenth cycle lasted tentatively from the economic trough of January 2002 to the peak of October 2007, while the retraction period, though its provisional end date has not yet been determined, will probably be 2010, the year in which the economy entered into a new expansionary phase after the recession that resulted from the collapse of Lehman Brothers. These observations suggest that it is reasonable to view 3.5 percent as the natural rate of growth for the periods 1981–2000 and 2008–10. However, since the actual unemployment rate was 2.09 percent in 1991 and 5.07 percent in 2010, there are two natural rates of unemployment for the same natural rate of growth of 3.5 percent. Given the empirical analysis above, it is possible to confirm that while Okun's coefficient fell to 3.0 as a result of structural changes in the 2001–7 period, it rebounded to 10.8 during the 2008–10 period, and thus that the natural rate of unemployment increased from about 2.1 percent to about 5.1 percent. Due to structural changes in the labor market in the 2001–7 period, we ended up in a situation where the natural rate of unemployment rose relative to the same Okun coefficient of 10.8.

Factor Analysis of Okun's Coefficient

The purpose of this section is to show what kinds of factors are involved when the calculated Okun's coefficient rises higher than one. Okun (1962, 1973) proposed a method of factor analysis using Okun's coefficient, as outlined below.

If we imagine a fixed coefficient production function where H is the average labor hours per person, μ is labor productivity measured in man hours, L^D is employment volume, and Δ denotes *annual change,* then the change in the production volume (Q) measured using real GDP is shown in Equation 2.

$$\frac{\Delta Q}{Q} = \frac{\Delta L^D}{L^D} + \frac{\Delta H}{H} + \frac{\Delta \mu}{\mu}. \tag{2}$$

Next, if L^S is the labor supply, the definition of the rate of unemployment (displayed in decimal format, u) can be derived from Equation 3.

$$u = \frac{L^S - L^D}{L^S}. \tag{3}$$

Further, taking the differential of Equation 3 yields Equation 4.

$$\Delta u = \frac{\Delta L^S}{L^S} - (\frac{L^D}{L^S})\frac{\Delta L^D}{L^D}. \tag{4}$$

Substituting Equation 4 with Equation 2, it ultimately yields Equation 5, indicating that rate of change in production volume can be shown as the total sum of rates of change in the rate of unemployment, labor supply, labor hours, and labor productivity.

$$\frac{\Delta Q}{Q} = -(\frac{L^S}{L^D})\Delta u + \frac{\Delta L^S}{L^S} + \frac{\Delta H}{H} + \frac{\Delta \mu}{\mu}. \tag{5}$$

Since Okun's coefficient estimated in a previous section was 10.8 in the periods 1981–2000 and 2008–10, and 3.0 in the period 2001–7, the factor analysis of Okun's coefficient is also performed for two periods. First I examined the effect that a 1 percent change in the rate of unemployment has on production volume, all other conditions remaining constant, that is:

$$-(\frac{L^S}{L^D})\Delta u = -(\frac{L^S}{L^D}) * (-1) = \frac{L^S}{L^D} = \frac{1}{1-u},$$

but since the average rate of unemployment was 3.14 percent in the target periods 1981–2000 and 2008–10 and 4.68 percent in the period 2001–7,

$$\frac{L^S}{L^D} = \frac{1}{1-u}$$

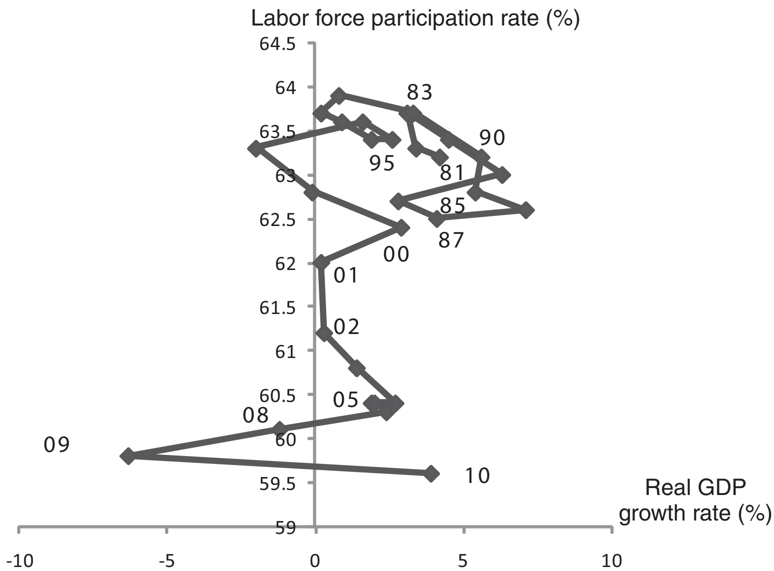
yields 1.03 and 1.04, respectively. Thus, the effect that a 1 percent change in the rate of unemployment has on production volume, all other conditions remaining constant, is just over 1 percent.

The second analysis examines the effect of the labor supply on production volume. A change in the unemployment rate influences the labor supply through two effects. The first is called the employment motivation creation effect, whereby jobs become easier to find and the labor supply increases as a result of the increase in employment opportunities associated with a decrease in the rate of unemployment. The second is the employment motivation loss effect, also known as the Douglas–Arisawa effect, whereby the additional labor supply decreases because of an increase in the income of the head of household under conditions where the rate of unemployment is decreasing. These two effects have opposite effects on production volumes. Here, I examine the effects on the labor supply associated with changes in the economic climate by examining the correlations between the real GDP growth rate and the labor force participation rate, which can more directly be seen in the movements of the economic cycle.

Figure 3 is a scatter diagram showing the real GDP growth rate on the *x*-axis and the labor force participation rate (aggregate data for men and women) on the *y*-axis. Correlations can be observed between the real GDP growth rate and the labor force participation rate through the four time-period segments. The first time period is 1981–97, followed by 1998–2000, 2001–7, and 2008–10. In all of these, a negative correlation can be seen between the real GDP growth rate and

Japanese Economy 2012.39:87-107.

Figure 3. **Labor Force Participation Rate and Real Gross Domestic Product** (GDP) **Growth Rate**



Source: Ministry of Internal Affairs and Communications, *Labor Force Survey*; Cabinet Office, *System of National Accounts.*

the labor force participation rate, suggesting that the employment motivation loss effect, whereby additional labor supply is reduced when there is an increase in the head of household's income due to overall economic improvements, is dominant in the process of economic change. The 1981–97 period was the one prior to that in which the real GDP growth rate turned negative in 1998 for the first time since the first oil shock. The 1998–2000 period was a chaotic one in which two years of consecutive negative growth were converted back to positive growth through the implementation of a zero interest rate policy and an increase in external demand. The 2001–7 period was when the Koizumi Cabinet's structural reforms were implemented, as discussed above. Finally, the period 2008–10 was the period following the collapse of Lehman Brothers. The combination of the real GDP growth rate and labor force participation rate in 1983 and 1987 seem to be aberrant in terms of the general trend. According to the standard dates in the economic cycles shown in Table 1, 1983 was the year in which the expansionary phase of the tenth cycle began, following the prolonged recession that had been caused by the second oil shock, and 1987 was the year in which the Heisei economy, or the expansionary phase of the eleventh cycle, really took hold after the yen appreciation recession ended at the close of the previous year. Thus, in the years that mark turning points in the economic cycles, the data seem to be irregular. Given these observations, I used Equation 6 to measure the effect of changes in the real GDP growth rate on the labor supply. In Equation 6, *LT* is the labor force participation rate (expressed as a percent),

$$LT = \frac{L^S}{L}, L$$

is the population of individuals aged fifteen or older), and the dummy variables are set as follows. *D2* is 1 for 1981–82, 1984–85, and 1988–97, 2 for 1983, –2 for 1987, and 0 for all other periods. *D3* is 1 for 2001–7 and 0 for all other periods. *D4* is 1 for 2008–10 and 0 for all other periods.

$$LT = \alpha_0 + \alpha_1 D2 + \alpha_3\ D3 + \alpha_4 D4 + \alpha_5\ \frac{\Delta Q}{Q} + \alpha_6 D3 \frac{\Delta Q}{Q}. \tag{6}$$

The estimation results based on Equation 6 for the period 1981–2010 are shown in Equation 7. The estimated constant term, dummy variables, and *t*-value of the coefficient of the real GDP growth rate, excluding the coefficients of the real GDP growth rate without the dummy variables (a 5 percent level of significance constitutes statistical significance), are all statistically significant at the 1 percent level, and *no serial correlation in the error terms is shown to exist at the 5 percent level of significance based on the value of the Durbin–Watson statistic*, indicating that Equation 7 produces statistically useful results.

$$\begin{gathered} LT = 63.154 + 0.346D2 - 1.472D3 - 3.405D4 - 0.069\frac{\Delta Q}{Q} - 0.505D3\frac{\Delta Q}{Q} \\ (525.495)\ (3.729)\quad (-5.531)\ \ (-14.782)\ \ (-2.706)\quad (-3.764) \\ \bar{R}^2 = 0.95 \qquad DW = 2.11 \qquad \bar{S} = 0.31. \end{gathered} \tag{7}$$

The results produced by Equation 7 indicate that a 1 percent increase in the real GDP growth rate will result in a 0.06 percent decrease in the labor force participation rate in the periods 1981–2000 and 2008–10, and a 0.56 percent decrease in the period 2001–7. If the population aged fifteen and older does not change, the rate of change in the labor force participation rate will be equivalent to the rate of change in the labor supply, if

$$\frac{\Delta LT}{LT} = \frac{\Delta L^S}{L^s} - \frac{\Delta L}{L}, \quad \frac{\Delta L}{L} = 0 \quad \frac{\Delta LT}{LT} = \frac{\Delta L^S}{L^s}.$$

Thus, the question of how much, in percentage terms, the labor supply will change as the result of a 1 percent increase in the real GDP growth rate can be obtained by dividing the values 0.06 percent and 0.56 percent, which indicate the ΔLT, by

Figure 4. **Real Gross Domestic Product** (GDP) **Growth Rate and the Rate of Change in Labor Hours**

Source: Ministry of Internal Affairs and Communications, *Labor Force Survey*; Cabinet Office, *System of National Accounts.*

the value *LT* of the average labor force participation rate in a given organization. The labor force participation rate was 62.7 percent for the periods 1981–2000 and 2008–10, and 60.7 percent for the period 2001–7. Because the values 0.06 percent and 0.56 percent, which indicate the ΔLT, are too small relative to the 62.7 percent and 60.7 percent, which indicate the *LT* values, if we truncate them to the second decimal place, we end up saying that a 1 percent increase in the real GDP growth rate produces a 0 percent rate of change in the labor supply, making it impossible to see effects that can be explained by the labor supply.

Third, we try to examine the ratio of Okun's coefficient that can be explained by fluctuations in labor hours. Figure 4 is a scatter diagram with the real GDP growth rate plotted along the *x*-axis and the rate of change in labor hours plotted along the *y*-axis (showing total labor hour data from workplaces with thirty or more employees as reported in the Monthly Labor Survey). At first glance, there seems to be a positive correlation between the real GDP growth rate and the rate of change in labor hours. However, that positive correlation is composed of two time periods:

(1) 1985 and 1988–93, and (2) all other periods. However, the year 2010, when a rapid economic recovery was seen, seems to follow an irregular pattern distinct from all the other time periods. According to the standard dates in the economic cycles shown in Table 1, 1985 is a year that includes an economic peak, which is a turning point between the expansion phase and retraction phase of the tenth cycle, while the period 1988–93 is the period corresponding to the Heisei economy in the eleventh cycle and the first Heisei recession. Given these observations, I used Equation 8 to measure the effects of changes in the real GDP growth rate on labor hours. In Equation 8, H is labor hours (percent) and $D5$ is a dummy variable set at 1 for 1985 and 1988–93, at –1 for 2010, and at 0 for all other time periods.

$$\frac{\Delta H}{H} = \beta_0 + \beta_1 D5 + \beta_3 \frac{\Delta Q}{Q}. \tag{8}$$

The estimation results based on Equation 8 for the period 1981–2010 are shown in Equation 9. The estimated constant term, dummy variables, and t-value of the coefficient of the real GDP growth rate are all statistically significant at the 1 percent level, and no serial correlation in the error terms is shown to exist at the 5 percent level of significance based on the value of the Durbin–Watson statistic, indicating that Equation 9 produces statistically useful results.

$$\begin{gathered}\frac{\Delta H}{H} = -0.8101 - 1.842 D5 + 0.310 \frac{\Delta Q}{Q} \\ (-7.357)\ (-9.756)\quad (9.248) \\ \bar{R}^2 = 0.83 \qquad DW = 1.79 \qquad \bar{S} = 0.45.\end{gathered} \tag{9}$$

Given the results produced by Equation 9, a 1 percent increase in the real GDP growth rate will result in a 0.31 percent increase (truncated to two decimal places) in labor hours in the period 1981–2000. Thus, the ratio that can be explained by the change in labor hours is 3.3 ($\fallingdotseq$ 0.31 * 10.8, truncated to *one decimal place*) in the periods 1981–2000 and 2008–10 when the value of Okun's coefficient was estimated at 10.8, and 0.93 ($\fallingdotseq$ 0.31 * 3.0) in the period 2001–7 when Okun's coefficient was estimated at 3.0.

The labor productivity effect can be calculated as the remainder left after the direct effect, labor supply effect, and labor hour effect are all subtracted from Okun's coefficient. Give these statistical observations, the results of the factor analysis of Okun's coefficient are summarized in Table 2. Table 2 shows that in the period 2001–7 when Okun's coefficient had fallen, the labor productivity effect was 1.03. This means that corporate employment hoarding had decreased and directly indicates that employment adjustments had been pursued quickly. However, in the period following the collapse of Lehman Brothers, the labor productivity effect returned to its previous level. This suggests that the overemployment being

Japanese Economy 2012.39:87-107.

Table 2

Factor Analysis of Okun's Coefficient

	Effect			
Period	Direct effect	Labor supply	Labor hours	Labor productivity
1981–2000 and 2008–10	1.03	0	3.34	6.43
2001–7	1.04	0	0.93	1.03

maintained by companies was largely eliminated in the 2001–7 period. It was not so much that the pace of employment adjustment itself changed after the collapse of Lehman Brothers, but rather that the magnitude of the Lehman collapse was so large as to require massive employment adjustments to be made even at the previous pace of employment adjustment. This predication can be made based on the results of calculating the Okun coefficients and conducting a factor analysis on them.

Measuring the Speed of Employment Adjustments

In this section I use the employment adjustment function used in Kurosaka (1988: 130–32) to measure the employment adjustment function in the manufacturing and service industries, and to compare the employment adjustment speed in both industries. If we hypothesize Harrod-neutral technical progress in which both the production factors of labor (L) and capital stock (K) are the inputs, the production volume (q) is determined based on the *CES* production function, and the work efficiency of laborers increases at the rate of n over time, we can propose Equation 10. In Equation 10, A is the level of technology, ω is allocation, and ρ is a parameter that is related to the elasticity of substitution between labor and capital.

$$q = A\left[\omega(e^{nT}L)^{-\rho} + (1-\omega)K^{-\rho}\right]^{-\frac{1}{\rho}}. \tag{10}$$

In the financial market and labor market, under the condition that perfect competition is supported, companies will behave as price-takers with respect to prices (P) and nominal wages (W). If adjustments to capital stock (capital investments) are made from a long-term perspective, one can assume that the size of the capital stock is a given when deciding the number of employees. The number of employees is set to maximize profits (R, expressed in Equation 11), which are calculated by subtracting wage costs, which are the product of the number of employees and nominal wages, from sales, which are the product of production volume and price.

Japanese Economy 2012.39:87-107.

If, given P and W, one tries to find the number of employees that maximizes profit, as expressed in Equation 11, under the constraint of the production function in

$$R = Pq - WL \tag{11}$$

Equation 10, then in stage 1 shown in Equation 12, a price that equals the marginal productivity of labor can be derived. Calculating the optimal number of employees (L^*) that will achieve the profit maximum based on Equation 12 leads to Equation 13.

$$\frac{W}{P} = \omega(\frac{q}{L})^{1+\rho}(\frac{1}{Ae^{nT}})^{-\rho}. \tag{12}$$

$$L^* = Q(Ae^{nT})^{\rho}(\frac{W}{P\omega})^{-\frac{1}{1+\rho}}. \tag{13}$$

L^* shown in Equation 13 is the optimal number of employees when a company can instantly adjust its number of employees. However, if there are costs associated with the recruitment, training, and termination of employees, it will take time to achieve the optimal number of employees, such that the actual number of employees will be determined based on the partial adjustment model shown in Equation 14. L is the number of employees in the current period; L_{-1} is the number of actual employees in the previous period, and ψ is q employment adjustment speed.

$$\frac{L}{L_{-1}} = (\frac{L^*}{L_{-1}})^{\psi}. \tag{14}$$

Substituting the optimal number of laborers shown in Equation 13 into Equation 14, and taking the natural logarithm of both sides yields Equation 15, while Equation 16 is the equation for ultimately measuring the employment adjustment function.

$$\ln\left(\frac{L}{L_{-1}}\right) = \frac{\psi}{1+\rho}\ln\left(\frac{\varpi}{A^{\rho}}\right) - (\frac{\psi n\rho}{1+\rho})^{\psi}T + \psi\ln\left(\frac{q}{L_{-1}}\right) - \frac{\psi}{1+\rho}\ln\left(\frac{W}{P}\right). \tag{15}$$

$$\ln\left(\frac{L}{L_{-1}}\right) = \gamma_0 + \gamma_1 T + \gamma_1 \ln\left(\frac{q}{L_{-1}}\right) + \gamma_2 \ln\left(\frac{W}{P}\right). \tag{16}$$

The theoretical constraints imposed on the estimation parameters in Equation 16 are $\gamma_1 < 0$, $0 < \gamma_2$, and $\gamma_3 < 0$, and the relationship between the structural parameters in the employment adjustment function in Equation 15 and the estimation parameters in Equation 16 is shown in Equation 17.

Table 3

Calculations of the Employment Adjustment Function

Industry	Constant term	Variable $D(\frac{q}{L_{-1}})$	$D(\frac{W}{P})$	$\overline{R}^2$	h-statistic	$\overline{S}$
Manufacturing industry	–0.023	0.544	0.084	0.79	–0.027	0.01
	(–4.574)	(9.452)	(0.751)			
Service industry	–0.015	0.671	0.053	0.53	–0.169	0.01
	(–1.412)	(5.650)	(0.419)			

$$\gamma_2 = \psi, \frac{|\gamma_3|}{\gamma_2} = \frac{1}{1+\rho} \equiv \text{elasticity of substitution}, n = \frac{\frac{|\gamma_1| * |\gamma_3|}{\gamma_2}}{|\gamma_3| * \left(1 - \frac{|\gamma_3|}{\gamma_{12}}\right)}. \tag{17}$$

Using Equation 18, which takes the differential of Equation 16, the number of employees is actually calculated not on a per-man basis but on a per-man-hour basis. The production volume, number of employees, labor hours, and price data come from the economic activity-specific "real domestic gross product," "number of employees," "labor hours," and "deflator" figures in the annual report on national accounts, while the nominal wage data reflect the "total cash salary by employment type" in the Monthly Labor Statistics. The estimation results are compiled in Table 3. The calculation period is 1982–2009.

$$\Delta \ln\left(\frac{L}{L_{-1}}\right) = \gamma_1 + \gamma_1 \Delta \ln\left(\frac{q}{L_{-1}}\right) + \gamma_2 \Delta \ln\left(\frac{W}{P}\right). \tag{18}$$

First, we examine the results from the manufacturing industry. Only the t-values of the constant term and the coefficient of the ratio of the production volume to the number of employees on a man-hour basis in the previous period was statistically significant at the 1 percent level. The product wage coefficient is not even significant at the 10 percent level, has absolutely no explanatory power, and does not even meet the sign condition. If the lagged value of the dependent variable is among the explanatory variables, the Durbin–Watson statistic is not effective for detecting the serial correlation. Instead, the Durbin h statistic defined in Equation 19 must be applied.

$$h = \hat{\rho}\sqrt{\frac{n}{1 - n\,\hat{\text{var}}(\hat{\gamma}_1)}}. \tag{19}$$

In Equation 19, $\hat{\rho}$ is the serial correlation of the first stage estimated from the OLS residual

$$\left(\hat{\rho} \cong 1 - \frac{DW}{2}\right),$$

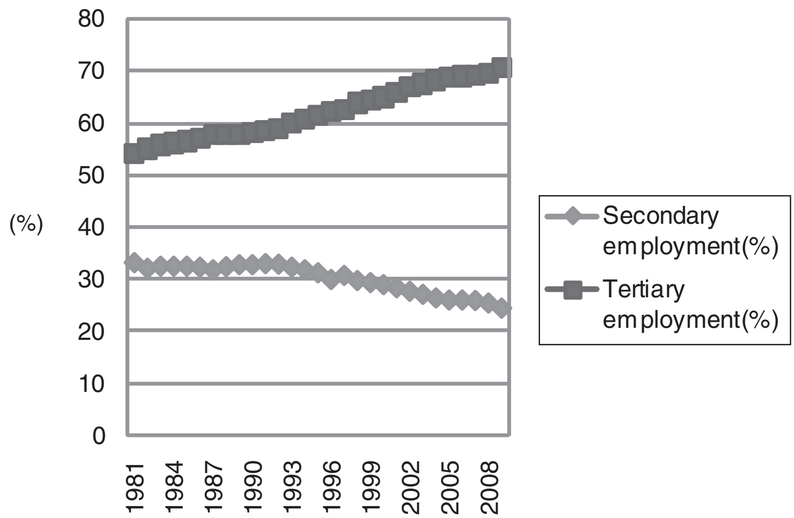
n is the number of samples, and $\hat{\text{var}}(\hat{\gamma}_1)$ is the dispersion estimated from the OLS estimated value of γ_1 in Equation 18. The h statistic calculated based on Equation 19 shows that the null hypothesis, which would suggest that there is no serial correlation at the 10 percent level of significance, cannot be rejected. The coefficient of the constant term is negative, and technical progress in manufacturing, as measured on a man-hour basis, is regressing. Thus, the coefficient of the ratio of the production volume to the number of employees on a man-hour basis in the previous period was found to be positive, indicating that about 54 percent of the optimal number of employees is achieved in a year.

Next, we look at the results for the service industry. Only the t-value of the coefficient of the ratio of the production volume to the number of employees on a man-hour basis in the previous period was statistically significant at the 1 percent level. The constant term and the product wage coefficient were not even significant at the 10 percent level, and as in the case of the manufacturing industry, the product wage coefficient has absolutely no explanatory power and does not even meet the sign condition. The h statistic shows that we cannot reject the null hypothesis, which would suggest that there is no serial correlation at the 10 percent level of significance. The coefficient of the constant term has a slight level of significance at the 20 percent level, but as in the manufacturing industry, it is a negative value and suggests that technical progress in the service industry, as measured on a man-hour basis, is regressing. However, the coefficient of the ratio of the production volume to the number of employees on a man-hour basis in the previous period was found to be positive, indicating that about 67 percent of the optimal number of employees is achieved in a year.

A comparison of the employment adjustment speed in the manufacturing and service industries based on the quantitative analysis above indicates that employment adjustments are made more quickly in the service industry than in the manufacturing industry. Figure 5 shows the changing percentage of total Japanese employment in the secondary and tertiary sectors. The secondary sector includes mining, manufacturing, and construction and the tertiary sector includes electric, gas and water utilities, wholesaling and retailing, financial and insurance companies, real estate, transport and communication, other services, government service providers, and consumer-oriented private nonprofit service providers.

Japanese Economy 2012.39:87-107.

Figure 5. **Changes in Composition of Total Employment Between Sectors**



Conclusion

This study conducts a factor analysis on Okun's coefficient to look at the labor productivity effect that can be derived from the Okun coefficient residual, and indirectly examines the employment adjustment speed of the Japanese economy in 1981–2010. The key findings are as follows.

1. Okun's coefficient for the Japanese economy was calculated at 10.8 (≒ 1÷0.092) for the periods 1981–2000 and 2008–10, and 3.0 (≒ 1 ÷ 0.329) for the period 2001–7, showing that the value of Okun's coefficient fell in the 2001–7 period, but then rebounded to its original value in 2008 and after.
2. Okun's coefficient fell to 3.0 as a result of structural changes that took place in 2001–7, but rebounded to 10.8 in 2008–10. At that point, the natural rate of unemployment rose from about 2.1 percent to about 5.1 percent, allowing us to confirm that the natural rate of unemployment increased even under the same Okun coefficient of 10.8 as a result of structural changes implemented in the labor market in 2001–7.
3. The labor productivity effect was found by calculating the difference remaining after subtracting the direct effect, labor supply effect, and labor hours effect from Okun's coefficient. It was 6.43 in the periods 1981–2000 and 2008–10, and 1.03 in the period 2001–7, when the Okun coefficient had fallen. This means that the corporate employment hoarding had decreased, indirectly suggesting that employment adjustments had been made quickly.

Japanese Economy 2012.39:87-107.

4. In the period 2008–10, following the collapse of Lehman Brothers, Okun's coefficient rebounded to 10.8 and the labor productivity effect returned to its previous level. This suggests that the overemployment being maintained by companies was largely eliminated in the 2001–7 period. It was not so much that the pace of employment adjustment itself changed after the collapse of Lehman Brothers, but rather that the magnitude of the Lehman collapse was so large as to require massive employment adjustments to be made even at the previous pace of employment adjustment.

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Japanese Economy 2012.39:87-107.