【論文】

都道府県失業率の分析

Analysis of Prefectural Unemployment Rates in Japan

池　野　秀　弘
IKENO Hidehiro

Contents

(Abstract)

This article analyzes regional unemployment rates in Japan empirically, using prefectural data. The results show that the most recent data still indicate regional persistence, as claimed in previous studies. Areas with a higher employment rate than the national average tend to maintain a relatively high unemployment rate even two decades later. The prefectural unemployment rates show convergence over last two decades. The ratios of deviations of prefectural unemployment rates to the national average has not been converging, however. On a relative basis, the unemployment rates are not converging, however. Disparity of regional unemployment is not at an end in Japan. The observed relation between unemployment rates and job growth rates indicate that job creation does not necessarily lower the regional unemployment rate. Among the characteristics of the labor force, the age structure is the most important factor in determining regional unemployment rates. To diminish the disparity in unemployment within Japan, macroeconomic policy is not sufficient. Policies targeted at young workers would be necessary.

『商学集志』第 91 巻第 3 号（'21.12）

1. Introduction

This article analyzes regional unemployment rates in Japan empirically, using prefectural data. Unemployment is one of the most important issues in economics, and is among the most intensively investigated subjects. Unemployment has been analyzed from both the national point of view and also the regional point of view. In the literature on regional unemployment, regional disparity of unemployment within a single country is a subject of intensive study. It is not only an academic issue, but also a political issue. In particular, the regional disparity within Japan attracts much attention from academics and journalists within Japan. This article analyzes Japanese regional disparities and investigates the relation between the disparity and the national unemployment rate. A study is made of whether the prefectural unemployment rates are converging or diverging, using recently developed tests of sigma-convergence, and the factors that make difference in the prefectural unemployment rates are identified. It is discussed what should be done to mitigate the disparity from the viewpoint of economic policy.

Many studies already exist of regional unemployment rates. These include empirical studies in many countries, including Japan. Studies of regional unemployment rates in Japan include Mizuno (1992), Yugami (2005), Ito et al. (2005), Makita (2014), and Kondo (2015). Most previous studies of the Japanese situation use prefectural data. Only a few studies use time series of prefectural unemployment rates, however, since the official time series have only recently begun to be published regularly. Most previous studies use data from the National Census, which has been compiled only every five years. The National Census provides a wide range of data, but it does not provide annual series or quarterly series. The Statistics Bureau of Japan recently began to provide quarterly and annual series of prefectural unemployment rates in Japan. They have not been exploited in academic studies yet. Although the series are based on surveys of smaller samples, the time series covering a period of decades facilitate some interesting time series analysis, including such as econometric tests of convergence, which have not yet been explored in previous studies. This article uses these series to analyze regional unemployment in Japan.

Recent academic literature often stresses importance of studies of regional aspects of unemployment within a single country. Elhorst (2003) gives reasons why regional disparity of unemployment within a country should be investigated. First, differences between unemployment rates are often almost as large as those between countries. Disparity is often interpreted as a serious social problem, because the unemployment rate is one of the most important measures of socio-economic well-being. Second, standard macroeconomics discusses and explains disparities of unemployment across countries, but it does not provide an explanation for regional disparities. Third, the regional disparity of unemployment may lead to domestic inefficiency. Reducing the disparity may cause higher national output by using unemployed workers, reduce inflationary pressure, and promote social benefits.

Unemployment is not the only economic measure which reflects regional disparity within a country. Regional disparities in incomes, wages, and price levels are also important from the viewpoints of both economics and socio-economic polices. They have been already studied by many economists. However, one cannot overstress social implications of regional disparities of unemployment. Academics and governments have considered the regional disparity of unemployment in many countries.[1)]

Previous studies emphasize the following points in many countries. First, the difference in regional unemployment rates within a country is often substantial. Second, the regional unemployment rates are persistent, i.e., the ranking of the regional unemployment rates within a country is fairly stable over time. Areas where the regional unemployment rate is higher than the national average tend to maintain an unemployment rate higher than the national average over many decades. Third, regional unemployment rates are affected by regional socio-economic factors in the region.

Elhorst (2003) gives an extensive survey of differentials in regional unemployment within a country from theoretical and empirical points of view. His study stresses the importance of empirical works on the subject. Economic theory predicts that the regional unemployment rate depends on labor supply factors, labor demand factors, and wage-setting factors, but Elhorst (2003) claims that empirical works are necessary for a proper understanding of the real role of the explanatory variables. It concludes by stating that the negative relationship occasionally found between the unemployment rate and gross regional product per capita but it could be a random occurrence that does not hold over time.

Rapport (2012) is a recent empirical work on the US case. Using data across the US metropolitan areas after 1990, it claims that unemployment rates vary widely and persistently across US metropolitan areas. Rapport (2012) investigates reasons for the wide and persistent dispersion and claims the following reasons. First, workers' skill sets, such as educational backgrounds, vary considerably across metro areas. Second, the intrinsic characteristics of metropolitan areas, such as geographical locations and climatic conditions, cause unemployment rates to differ. Third, geographical moving costs between areas are high for many households and firms.

For the European case, Taylor and Bradley (1997) is an extensive work on disparities of regional unemployment rates in Germany, Italy and the UK. It confirms the persistence of regional unemployment disparity in these countries. Persistence is due mainly to three factors: unit labor costs, the industry mix, and employment density. Taylor and Bradley (1997) claim that persistence is a consequence of corresponding disparities in the competitiveness of regional economies.

For the Japanese case, Mizuno (1992) is a seminal work. His study finds that the disparity between regional unemployment rates was persistent, and that unemployment rates were generally higher in the western part of Japan than in the eastern part over many years. Mizuno (1992) makes the following points. An area which

records a high unemployment rate tends to maintain a high unemployment rate in subsequent years. The effects of the age structure of the population are not large as one might expect. An area in which the share of manufacturing is large tends to maintain a low unemployment rate. The effects of industrial structure are larger during downturns in the national economy than during upturns.

Yugami (2005) uses data from the National Census and claims that the disparity in prefectural unemployment is largely explicable by the details of the labor forces. The disparity would be much smaller than the original data indicate once the effects due the difference in composition of the labor force are removed. A substantial part of the disparity is due to the difference in composition of the labor force in each prefecture. When the age structure, gender structure, and educational backgrounds are taken into account, the disparity will be much smaller than the original data of unemployment suggest.

Ito et al. (2005) finds that regional disparities were stable during the period 1980 to 2000, due mainly to two factors: the effect of creating employment by investing funds from the central government in rural areas, and movement of labor move from regions with few employment opportunities to regions with many. It is claimed that important points in socio-economic policy are the development and expansion of education and human resource development systems. These enable local human resources to enhance their planning capabilities.

Yugami (2010) finds that the disparity in regional unemployment rates was diminishing until 2000, but then began to grow and became larger than in the era of the Bubble Economy in Japan. The background to this change is the reduction in moves of young workers between regional labor markets and a reduction in public investment.

Makita (2014) investigates prefectural unemployment rates of males and females separately, and compares them. The industrial compositions of employed workers significantly influence unemployment rates of both sexes, and the age structure of the labor force is a significant factor in determining regional unemployment rates of females.

Montgomery (1993) compares the US and Japanese regional labor markets. The Japanese regional labor markets proved to be more persistent than their US counterparts. The distribution of unemployment rates and the relative position of prefectures in that distribution did not change over a substantial period in Japan.

The present article is outlined as follows. The regional unemployment rates in Japan are first examined, i.e., the persistency in the regional unemployment rates. Correlation of unemployment rates over time is examined using data over two decades, and it is investigated whether correlations remain strong even in the most recent period. Descriptive statistics indicate that strong positive correlations are found over various sample periods. Convergence is then examined using concept of the sigma convergence. Sigma convergence is tested over various combinations of start and end times of sampling periods. It is found that prefectural unemployment rates have been converging, but this is due to general decreases in unemployment rates in Japan.

Relative to the national unemployment level, disparities in regional unemployment have not been shrinking. This article also examines the effects of demand and supply of the regional labor force on local unemployment rates. Increases in labor demand, i.e., the number of employed, is found not to be negatively correlated with regional unemployment rates. Among the supply factors, the age structure, gender composition, and educational backgrounds of the workforce are examined. The age structure of the local labor force proves to be an important factor in determining the local unemployment rate.

The remain of this article is organized as follows. Section 2 explains the data used in the empirical studies. Section 3 sets out and analyzes descriptive statistics used to check basic details. Section 4 analyzes the persistency of the prefectural unemployment rates. Section 5 investigates the relation between the unemployment rates and the job growth rates. Section 6 executes pooled regression analyses to examine the effects of characteristics of labor forces on unemployment rates. In Section 7, policy implications and concluding remarks are stated.

2. Data

This article involves unemployment rates and job growth rates. It also uses several variables to represent the characteristics of prefectural labor forces; age structure, gender composition and educational backgrounds for each prefecture. Tests of convergence use quarterly series of unemployment rates. Other empirical works have used annual averages. The data used below covers all prefectures of Japan, i.e., 47 prefectures.

2-1 Unemployment rates

Quarterly series for prefectural unemployment rates are used here as well as the national unemployment rate. The original data, which are based on the Labor Force Survey, are taken from the Statistical Bureau of Japan.[2)] The original series are not seasonally adjusted. After withdrawal from the site of the Statistical Bureau, they have been seasonally adjusted using the Census X11 by the author. The quarterly unemployment rates by prefecture were released in 2006 for the first time. The start of the original series is in 1979Q1, so the start of the quarterly series for the prefectural unemployment rate analyzed in the following analyses is mostly set to 1979Q1.

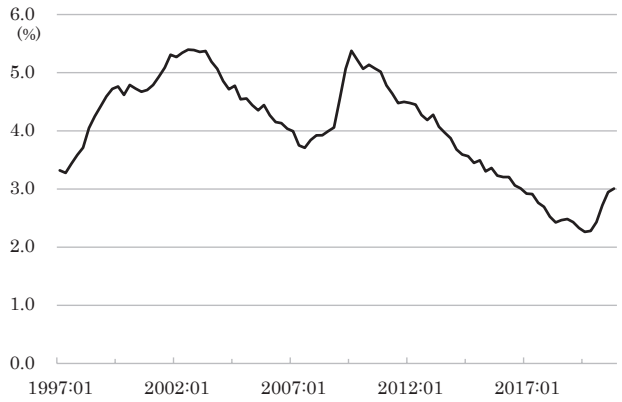
2-2 Job growth rates

For the job growth rate, this article uses the rate of increase of the number of all employed workers in each prefecture. The original data, which are based on the Labor Force Survey, have been withdrawn from the Statistical Bureau of Japan.[3)] When these data are used in empirical works, they are converted into growth rates over years. They are not therefore seasonally adjusted.

2-3 Age structure of the labor force

Because of the availability of the data, the age structure of the total population in each prefecture is used as proxy for the age structure of the labor force. The proportion of the population between the ages of 35

Figure 1　National unemployment rate



Source: Labor Force Survey

and 55 in the total population is used. The original data have been withdrawn from the site of the Bureau of Statistics.[4] These are annual series. The proportion is intended to represent the share of the age group excluding workers of high unemployment rates. The definition of this proportion is slightly modified from the traditional notion of 'prime age workers' which implies workers of ages between 25 and 55, reflecting high unemployment rates of workers in the 20s and the early 30s in the recent Japan.

2-4 Gender structure of the population

The ratio of the total male population to the total female population in each prefecture is used, not the gender composition of the labor force, because of availability of data. The original data has been withdrawn from the homepage of the Bureau of Statistics.[5] These are annual series.

2-5 Educational backgrounds

The proportion of graduates from universities and graduate schools, in all graduates from all schools, is used. This definition covers not only the labor force but the total population in each prefecture. The proportion of high school graduates is greater than 95% in all prefectures, and no substantial difference is observed among prefectures. Hence, the proportion of graduates from universities and graduate schools, which shows reasonable variance among prefectures, is used to represent the educational backgrounds of the labor force. The original data is compiled from the Employment Status Survey, which is conducted every five years. The data is consequently available with a periodicity of five years. The data has been withdrawn from the Statistics Bureau.[6]

3. Overview of prefectural unemployment rates

As background to the study of regional unemployment rates, movement in the Japanese national unemployment rate is first surveyed. Figure 1 shows quarterly series of the Japanese national unemployment rate from 1997Q1 to 2020Q4. This indicates

Table 1　The five highest unemployment rates（%）

	2000		2005		2010	
1	Okinawa	7.90	Okinawa	7.89	Okinawa	7.45
2	Osaka	6.70	Aomori	5.97	Osaka	6.89
3	Fukuoka	6.20	Osaka	5.96	Aomori	6.46
4	Hyogo	5.85	Fukuoka	5.88	Fukuoka	5.98
5	Hokkaido	5.52	Hokkaido	5.35	Miyagi	5.77

(continued)

	2015		2020	
1	Okinawa	5.08	Okinawa	3.40
2	Osaka	4.14	Osaka	3.34
3	Aomori	4.10	Tokyo	3.08
4	Fukuoka	4.10	Akita	3.03
5	Hyogo	3.75	Fukuoka	3.00

Table 2　The five lowest unemployment rates（%）

	2000		2005		2010	
1	Nagano	2.63	Shimane	2.26	Shimane	3.18
2	Gifu	2.87	Fukui	2.70	Fukui	3.27
3	Fukui	2.88	Gifu	2.78	Gifu	3.70
4	Yamagata	3.27	Mie	3.05	Kagawa	3.88
5	Toyama	3.30	Toyama	3.10	Toyama	3.90

(continued)

	2015		2020	
1	Fukui	1.90	Gifu	1.50
2	Mie	2.19	Fukui	1.53
3	Shiga	2.24	Mie	1.63
4	Gifu	2.30	Shimane	1.68
5	Ishikawa	2.34	Yamanashi	1.77

that the national unemployment rate moved between 2% and 6%. There are two peaks; one is in 2002Q3, corresponding to the long recession starting in the early 1990s, and the other in 2009Q3, corresponding to the Financial Crisis or Great Recession, which is called the 'Lehman Shock' in Japan. The upturn to the second peak started in 2007Q3, which is before the start of the Financial Crisis. The last upturn started in 2019Q3, which is before the pandemic. The national unemployment rate shows a long-term downward trend over the last decade. As shown later, this point has significant effects on the convergence of regional unemployment rates in Japan.

The persistence of regional unemployment is fairly well known in empirical studies covering Japan, the US, and other countries.

Tables 1 and 2 show prefectures with the highest and lowest unemployment

Table 3　Difference between the highest and lowest unemployment rates（%・percent points）

	2000		2005		2010	
Highest	Okinawa	7.90	Okinawa	7.89	Okinawa	7.45
Lowest	Nagano	2.63	Shimane	2.26	Shimane	3.18
Difference		5.27		5.63		4.27

(continued)

	2015		2020	
Highest	Okinawa	5.08	Okinawa	3.40
Lowest	Fukui	1.90	Gifu	1.50
Difference		3.18		1.90

Table 4　Correlations of prefectural unemployment rates over time

		year				
		2000	2005	2010	2015	2020
year	2000	1.00				
	2005	0.88	1.00			
	2010	0.87	0.94	1.00		
	2015	0.85	0.90	0.91	1.00	
	2020	0.81	0.85	0.84	0.83	1.00

rates, based on the annual averages compiled from the quarterly series. Some are repeatedly listed among the highest prefectures, such as Okinawa, Fukuoka, Osaka, and Aomori. Okinawa and Osaka are almost always the first and second highest over two decades. According to Mizuno (1992), Okinawa, Fukuoka, and Osaka are among the prefectures with the highest unemployment rates based on the data in 1980. It is remarkable that these prefectures have been classified as having the highest rates across four decades. The list of the lowest prefectures shows a similar trend. Some are repeatedly listed among the lowest prefectures, such as Fukui, Shimane, Gifu, and Mie. Overall, the highest and lowest ranking of prefectural unemployment rate shows small changes over decades. Table 3 shows the difference between the highest and the lowest unemployment rates in percentage points. The difference between the highest and lowest is substantial. In 2005, for example, the difference is 5.63 percent points, and the average of all prefectures is 4.45%. The difference becomes smaller after 2005. It is clear that one of the backgrounds is that prefectural unemployment rates has been generally decreasing as the national unemployment rate has been decreasing. In particular, the highest unemployment rate in Okinawa, decreased substantially from 2005 to 2020. On the other hand, the ratio of the difference between the highest and the lowest to the average of the highest and the lowest has not been substantially

decreasing since 2010. This suggests that the most important factor affecting the recent convergence is the general decrease in the unemployment rates. This point will be examined below using the weak sigma-convergence test.

Table 4 shows cross-time correlation coefficients of prefectural unemployment rates. These are again based on the annual averages from the quarterly series. Correlation coefficients are calculated every five years. Prefectural unemployment rates are strongly positively correlated over time. The correlation coefficients between 2000 and other years indicate that the correlation gradually weakens over time, i.e., the coefficients become smaller over time, but they are still quite strong even in the case of a twenty-year interval.

These results imply the following points. The ranking of prefectural unemployment rates is persistent over decades. Prefectural unemployment moves in line with the national average rate, although prefectures whose unemployment rates are higher than the national average rate are very likely to remain higher than the national average rate even decades later. Similarly, prefectures whose unemployment rates are lower strongly are very likely to remain lower. Differences between prefectural unemployment rates are substantial. These points are consistent with earlier findings. The persistence of regional unemployment rates is confirmed by the most recent data. For Japan, Mizuno (1992) claims regional persistence using the data from 1970 and 1975, and Makita (2014) makes a similar claim using the data up to 2010. For the US, Rappaport (2012) argues similarly by comparing the US metro area unemployment rates from 1990 to 2007. The difference between and the lowest and the highest has been decreasing in absolute value, but the decrease is not remarkable given that prefecture unemployment rates have generally been decreasing.

4. Convergence of prefectural unemployment rates

This section investigates whether prefectural unemployment rates have been converging or diverging. Several concepts of convergence and methods to test them are found in the recent literature of economics, including beta-convergence, sigma-convergence and their variants.[7] This article will test two variants of sigma-convergence by the methods, developed in Phillips and Sul (2007 and 2009) and Kong et al. (2019). The basic idea of sigma convergence is that the cross-section dispersion of the investigated series diminishes over time.

The first test was developed by Phillips and Sul (2007 and 2009), looking at relative convergence, which is taken to mean that the dispersion of values relative to the cross-section average decreases over time. This is called a log t-test, after the equation used in the test. The procedure also facilitates testing of club convergence. The test procedure is outlined as follows.

Consider N time series; y_{it} for $i = 1, \cdots, N$ and $t = 1, \cdots, T$. Suppose that a time series y_{it} can be decomposed into two elements: an idiosyncratic loading factor δ_{it}, and a common factor θ_t which is the same for all i's, as follows:

$$y_{it} = \delta_{it}\theta_t \qquad t = 1, \cdots, T.$$

Phillips and Sul consider the following model:

$$\delta_{it} = \delta_i + \sigma_i \xi_{it} L(t)^{-1} t^{-a} \quad t = 1, \cdots, T,$$

where ξ_{it} is iid(0,1) across i but is weakly dependent on t, and $L(t)$ is a slowly varying function for which $L(t) \to \infty$ as $t \to \infty$. They take convergence to mean that

$$\lim_{k \to \infty} (y_{it+k}/y_{jt+k}) = 1 \quad \text{for all } i \text{ and } k.$$

Convergence is therefore concluded when the ratio of each factor converges to unity over time. This condition is equivalent to

$$\lim_{k \to \infty} \delta_{it+k} = \delta \quad \text{for all } i.$$

Convergence is tested by a 'log t-test'. Specifically, the test uses the following null and alternative hypotheses:

$$H_0: \ \delta_i = \delta \text{ for all } i \text{ and } a \geq 0$$

$$H_1: \ \delta_i \neq \delta \text{ for some } i \text{ or } a < 0.$$

The null hypothesis implies that all times series converge; the alternative hypothesis implies failure of convergence. The null hypothesis of convergence can be tested using the following equation:

$$\log(H_1/H_t) - 2\log L(t) = a + b\log t + u_t \quad t = T_0, \cdots, T,$$

where $H_t = \Sigma_{i=1}^{N}(h_{it} - 1)^2/N$, $h_{it} = y_{it}/(\Sigma_{j=1}^{N} y_{jt}/N)$, and $T_0 = [rT]$ for some r. Phillips and Sul (2007 and 2009) show that the null hypothesis of convergence is adequately tested by a one-sided t-test with $b \geq 0$, using a variance estimator that is robust to heteroskedasticity and autocorrelation (HAC). They propose using $\log(t)$ for $L(t)$ and choosing $r = 0.3$. The null hypothesis is rejected at the 5% significance level if the t-statistic of b is less than -1.65. This test procedure can also be applied to examine club-convergence.[8)]

The second test is the weak sigma-convergence test, developed by Kong et al. (2019). This test examines cross-section variance via linear regression. With a rolling estimation, it allows various combinations of the start and end of the sample period. The basic equation used for the tests is as follows:

$$K_{nt} = \hat{a}_{nT} + \hat{\varphi}_{nT} t + \hat{u}_T \qquad t = 1, \cdots, T$$

where K_{nt} is the measure of the dispersion, and $\hat{u}_T$ is the fitted residual. Here, K_{nt} is defined as

$$K_{nt} = n^{-1}\Sigma_{i=1}^{n}(x_{it} - \bar{x}_t)^2$$

where x_{it} is the i' th investigated series at time t and $\bar{x}_t$ is the cross-section average at time t. If $\hat{\varphi}_{nT}$ is significantly negative, the dispersion K_{nt} decreases over time. The null hypothesis of no sigma-convergence is then rejected and it is concluded that the series sigma-converges. A robust t-test is possible with a Newey-West type HAC estimator for the variance of $\hat{\varphi}_{nT}$. The lag truncation parameter for the HAC is commonly set to $[T^{\kappa}]$, where $\kappa = 0.3$.

4-1 Log t-test: relative convergence

Taking the unemployment of each prefecture as y_{it}, the log t-tests are executed. The panel used for the test contains all prefectures, so that $N = 47$. The interval of the data used for the analysis is 1997q1 to 2020q4, and r is set to 0.3, as suggested by Phillips and Sul (2007 and 2009). Hence, the log t-test is executed over the period 2003q4 to 2020q4. The Newey-West estimator is used as a HAC. The estimated result is as follows:

$$\log(H_1/H_t) - 2\log L(t) = \underset{(27.12)}{-0.75} - \underset{(75.40)}{0.50} \cdot \log t,$$

where t-values are in parentheses. The t-value of b, which is the coefficient of $\log t$,

Figure 2　T-values with K_{nt}^{A} from the rolling regressions

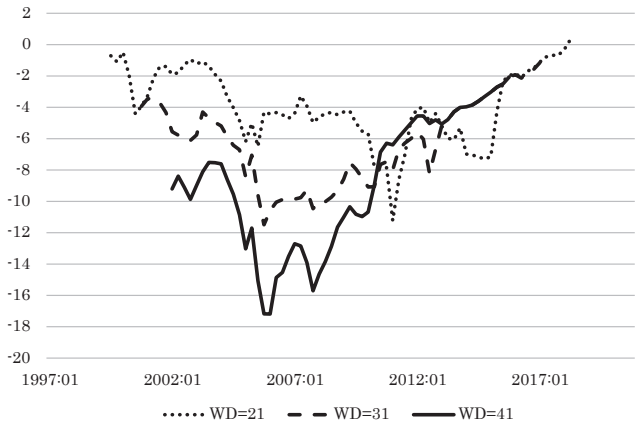


Figure 3　T-values with K_{nt}^{B} from the rolling regressions

is negatively far below the critical value of a reasonable significance level, implying that the null hypothesis of no convergence is rejected. Relative convergence is supported. As the whole set of the time series indicate convergence, the examination of club-convergence is not pursued.

4–2 Weak sigma-convergence

For the weak sigma-convergence, two kinds of dispersion measures are employed in the empirical work that follows. One is the variance of the prefectural unemployment rates, i.e., $K_{nt}^{A} = n^{-1}\Sigma_{i=1}^{T}(x_{it} - \bar{x}_t)^2$, where x_{it} is the unemployment rate of the i' th prefecture. The other dispersion measure is $K_{nt}^{B} = n^{-1}\Sigma_{i=1}^{T}(x_{it} - \bar{x}_t)^2$, where $x_{it} \equiv (y_{it} - \bar{y}_t)/\bar{y}_t$ and y_{it} is the unemployment rate of the i' th prefecture. The first measure aims to analyze the dispersion of the levels of prefectural unemployment rates, and the second aims to analyze the dispersion of the relative size of the deviation of the prefecture unemployment rates on the basis

Table 5 Correlation coefficients of the prefectural unemployment rates and the job growth rates

year	2000	2005	2010	2015	2020
Correlation coefficient	0.04	0.17	0.33	0.28	0.35

of the national average. Kong et al. (2019) give rolling regression methods, making it possible to observe detailed changes in convergence over time, which is not possible with the log t-test.

With the full sample period 1997Q1 to 2020Q4, the t-values of $\hat{\varphi}_{nT}$ are estimated to be -7.81 with K_{nt}^{A} and -3.53 with K_{nt}^{B}. The results show that the null hypothesis of no convergence is rejected at any reasonable significance level according to both measures of the dispersion. The support of convergence with the second measure of dispersion K_{nt}^{B} is consistent with the results of the log t-tests.

Rolling regressions are executed to observe changes in convergence over time. The method follows those developed in Kong et al. (2019). The window (WD) width, meaning the length of the period over which each rolling regression is executed, is set to 21, 31, and 41 periods. These roughly correspond to five years, eight years, and ten years. The econometric methods are exactly the same as those performed over the whole sample period. Figures 2 and 3 show the t-values of $\hat{\varphi}_{nT}$ from the rolling regression of K_{nt}^{A} and K_{nt}^{B} with the three windows. The figures depict t-values of the period which is the middle point of the window. They indicate that weak sigma-convergence is not always supported with K_{nt}^{B}. The period during which convergence fails to be rejected with K_{nt}^{B} is substantial. The t-values according to K_{nt}^{B} are positively larger than the critical value corresponding to a reasonable significance level, which is based on the asymptotic distribution, during much of the period. On the other hand, convergence is supported during most of the period with K_{nt}^{A}. The t-values with K_{nt}^{A} are smaller than the critical value during most of the period. Failure of convergence according to K_{nt}^{B} means that the prefectural unemployment often fails to converge to the national average on the basis of relative size.

These results are consistent with casual observation of the descriptive statistics. The results from K_{nt}^{B} support the claim that convergence of the prefectural unemployment rates is due mainly to the fact that the unemployment rates generally have been decreasing.

5. Unemployment rates and job growth

This section analyzes prefectural unemployment rates from the viewpoint of labor demand. Are high prefectural unemployment rates mainly due to lack of job growth in the area? If so, then job creation in the area of a high employment rate will mitigate the disparity in regional unemployment.

Table 5 shows correlation coefficients

of prefectural unemployment rates and job growth rates for the period 2000 to 2020 with a periodicity of five years. The job growth rates are calculated as the rate of change of the number of employed workers in the prefecture over the preceding three years. If job creation reduces the unemployment rate, there should be negative correlation. The table shows that the unemployment rate and the job growth rate are poorly and positively correlated for all years investigated. Job growth does not necessarily lead to a low unemployment rate.

The unemployment rate of Okinawa is always the highest. Yet, Okinawa is one of the prefectures where job growth rates are the highest. A similar argument applies to Osaka and Fukuoka. Over the two decades 2000–2020, the average annual job growth rate in Okinawa is 1.42%, and those in Osaka and Fukuoka are 0.44% and 0.24%, while the average of all prefectural job growth rates is -0.10%. Nationally, jobs were decreasing overall. Of course, some prefectures have a combination of a high unemployment rate and a low job growth rate, such as Aomori. The average annual job growth rate in Aomori is -0.45%, which indicates much faster shrinkage of jobs than the average over all prefectures.

Basic economics tells us that unemployment means an excessive supply in the job market. Even if labor demand increases, excess supply increases when the labor supply increases faster than does labor demand. The labor supply grows due to new entrants into the labor market in many prefectures with a high unemployment rate. This is due either to new incomers from other prefectures or to local people. If a prefecture has more people under the age of 18, then there tend to be more entrants from schools to the labor markets.

6. Pooled regressions

This section analyzes prefectural unemployment rates from the point of view of labor supply. Previous studies found that regional unemployment rates are strongly affected by the composition of the labor force as specified by age structure, gender composition, and educational backgrounds, in many countries including Japan and the US.

Pooled regressions are executed in order to analyze how those characteristics affect the prefectural unemployment rate in our data set. Observations are pooled, to increase the sample size. The following equations are estimated by the OLS:

$$u_{i,t} = a_0 + a_1 \cdot GEN_{i,t} + a_2 \cdot EDU_{i,t} + a_3 \cdot AGE_{i,t} + a_4 \cdot NAT_t$$
$$i = 1, \cdots, 47 \text{ and}$$
$$t = 2000, 2005, 2010, 2015$$

and

$$u_{i,t} = a_0 + a_1 \cdot GEN_{i,t} + a_2 \cdot EDU_{i,t} + a_3 \cdot AGE_{i,t}$$
$$i = 1, \cdots, 47 \text{ and}$$
$$t = 2000, 2005, 2010, 2015$$

where $u_{i,t}$ is the unemployment rate of the i' th prefecture, $GEN_{i,t}$ is the ratio of the total male population to the total female population of the i' th prefecture, $EDU_{i,t}$ is the proportion of residents who graduated from universities and graduate schools among residents who graduated from any school in the i' th prefecture, $AGE_{i,t}$ is the share of population of age between 35 and 54 in the total population, and NAT_t is the

Table 6　Regressions with the pooled data

t's	constant	*GEN*	*EDU*	*AGE*	*NAT*	$\bar{R}^2$
2000, 2005,	3.51	-0.03	2.36	-3.17	0.94	0.34
2010, 2015	(1.43)	(-1.44)	(1.66)	(-0.99)	(8.16)	
2000, 2005,	12.81	-0.02	-0.02	-15.68		0.10
2010, 2015	(5.06)	(-0.78)	(-0.01)	(-4.78)		
2000, 2005	3.79	-0.02	1.25	-4.42	0.99	-0.03
	(0.84)	(-0.76)	(0.38)	(-0.60)	(0.98)	
2000, 2005	5.25	-0.01	1.69	0.12		-0.03
	(1.24)	(-0.46)	(0.53)	(0.02)		
2010, 2015	4.13	-0.03	3.00	-4.20	0.93	0.58
	(1.07)	(-1.14)	(1.59)	(-0.52)	(5.72)	
2010, 2015	20.83	0.02	6.31	-43.21		0.43
	(7.07)	(0.87)	(3.02)	(-8.45)		

Note: t-values in parentheses.

national unemployment rate. The subscript t denotes the time t. Since the data relating to educational background are available with a periodicity of five years, the data for the following years are pooled; 2000, 2005, 2010, 2015; that is, t = 2000, 2005, 2010, 2015. The most recent data on the educational background, from 2020, are not available. The prefectural unemployment rate is the average of the four quarters in the year t. Subsets of the whole pooled data are also examined. The set is split into two subsets, considering structural change over time. One subset is composed of observations in 2000 and 2005, and the other subset is of observations in 2010 and 2015.

It is well known that the unemployment rate of males is higher than that of females on the national basis.[9] Consequently, α_1 is expected to be positive. Higher education is expected to increase the likeliness of being employed, and α_2 is expected to be negative. Young workers under the age of 35 and old workers above the age of 55 are more often unemployed than other workers, so that α_3 is expected to be negative. Prefectural unemployment rates are affected by the business cycles and are expected to be in positive correlation with national unemployment rate. Descriptive statistics in this work are consistent with that claim. Consequently, the average of prefectural underemployment rate is used here. The coefficient α_4 is expected to be positive.

Table 6 shows results from the OLS regressions over the pooled data. With the whole set of data, i.e., t = 2000, 2005, 2010, 2015, *AGE* has the expected sign in both equations, and is significant in the equation excluding *NAT*. *GEN* does not have the expected sign, and *EDU* has mixed results. $\bar{R}^2$'s indicate that the explanatory power of the variables is much lower with the data from the first half of the period, i.e., 2000 and 2005, than with the second half of the period, i.e., 2010 and 2015. This suggests

structural change over time. For the second half of the whole period, *EDU* has a positive sign and *AGE* has negative sign in both equations. Consequently, the equations are not valid with the first half of the whole period, and also *EDU* has a positive effect and *AGE* has a negative effect on the unemployment rate with the second half of the whole period.

The negative sign of *AGE* is interpreted to mean that the age structure of the population has an important effect on the local unemployment rate. A high proportion of the age group of 35 to 55 reduces the regional unemployment rate. The results for *EDU* are different from the expectation. Many prefectures in megalopolitan areas, such as Tokyo, Kanagawa, Osaka, and Hyogo, have a high proportion of graduates from universities and graduate schools. Those prefectures tend to have a high unemployment rate. The megalopolitan areas around Tokyo and Osaka, typically, have a combination of a high unemployment rate and high educational background.

7. Implications on the policy and concluding remarks

The results confirm the persistence of regional unemployment rates in Japan. This is consistent with the previous studies. The present study shows that the most recent data still indicate persistence. Areas of higher unemployment rate than the national average are most likely to maintain relatively high unemployment rates even two decades later. The prefectural unemployment rates show convergence over the last two decades. The prefectural unemployment rates have generally been decreasing, as well as the national unemployment rate, and this leads to the conclusion of convergence. The ratios of deviations of prefectural unemployment rates to the national average has not been converging. Results from the weak sigma-convergence indicate that these diverged over some periods. One should not therefore conclude that the disparity of regional unemployment is finished in Japan. With a rise in the national unemployment rate, disparities may rise in the future.

The results for the relation between unemployment rates and job growth rates imply that job creation does not necessarily lower the regional unemployment rate. This finding implies that high unemployment rates in some prefectures are due mainly to large numbers of new entrants to the labor market. These are either immigrants from other prefectures or new entrants comprising local people. Among the characteristics of the labor force, the age structure is the most important factor in determining regional unemployment rates.

These results suggest that macroeconomic policy aiming to reduce the national unemployment rate is not adequate to reduce disparities in regional unemployment. For example, the population growth rate of Okinawa is the highest after only Tokyo over the years studied. Its high growth rate is due to natural growth due to a high birth rate and immigrants from other prefectures. This implies that policies targeted at young workers are essential to reduce the unemployment rate. On the other hand, some prefectures, such as Aomori, are characterized by a combination of high unemployment rate and low job growth. High job

growth rates will reduce the unemployment rates in these prefectures. A single uniform unemployment policy will not be sufficient to solve the problem of disparity in regional unemployment in Japan.

Acknowledgment

This work was supported by JSPS KAKENHI Grant Number 18K01583.

Notes

1）For example, in the Japanese case, see *Annual Report of the Japanese Economy and Public Finance 2004* by the Cabinet Office.
2）https://www.stat.go.jp/data/roudou/pref/index.html
3）https://www.stat.go.jp/data/roudou/pref/index.html
4）https://www.stat.go.jp/data/jinsui/2.html#series
5）https://www.stat.go.jp/data/jinsui/2.html#series
6）https://www.e-stat.go.jp/stat-search/files?page=1&toukei=00200532&result_page=1
7）For comparison of beta-convergence and the sigma-convergence, see Young et al. (2008).
8）For club-convergence, see Quah (1997).
9）For example, see https://www.jil.go.jp/kokunai/statistics/timeseries/html/g0303_02.html

References

Elhorst J.P. (2003) "The Mystery of Regional Unemployment Differentials: Theoretical and Empirical Explanations," *Journal of Economic Surveys*, Vol.17, pp.709-748

Ito, M., K. Yugami, S. Ota, K. Okamura, and Y. Zhou (2005) "Shitsugyo shugyo no chiikikozo bunseki ni kansuru makurodeta niyoru bunseki", in Japanese ("A Study Using Macro Data with Respect to Analyses on Regional Structure of Unemployment and Employment"), *JILPT Research Report*, The Japan Institute for Labour Policy and Training

Kondo, K. (2015) "Koshitsugyoritsu ni taisuru jinkoido no hanno", in Japanese ("Estimation of Marginal Effects and Their Spillover Effects in Productivity of Prefectures"), *Journal of the Japan Statistical Society Japanese issue*, Vol.45, pp.69-98

Kong, J., P. C. B. Phillips and D. Sul (2019) "Weak σ-convergence: Theory and Applications", *Journal of Econometrics*, Vol.209, pp.185-207

Makita, S. (2014) "Todofuken betsu shitsugyouritsu no kettei yoin", in Japanese ("Important Determinants of Prefectural Unemployment Rate"), *Annual bulletin of the Research Institute of Management and Information Science* Shikoku University, Vol.19, pp.1-9

Mizuno, A. (1992) "*Nippon no shitsugyo kodo*", in Japanese ("*Unemployment Behavior in Japan*"), Tokyo: Chuo University Press

Montgometry, E. B. (1993) "Patterns in Regional Labor Market Adjustment: the United States vs. Japan",

NBER Working Paper #4414

Phillips, P. C. B., and D .Sul (2007) "Transition Modelling and Econometric Convergence tests", *Econometrica*, Vol.75, pp.1771-1855

—— and —— (2009) "Economic Transition and Growth", *Journal of Applied Econometrics*, Vol.24, pp. 1153-1185

Quah,D. (1997) "Empirics for Growth and Distribution: Polarization, Stratification and Convergence Clubs", *Journal of Economic Growth*, Vol.2, pp.27-59

Rappaport, J. (2012) "Why does Unemployment Differ Persistently across Metro Areas?", *Economic Review* Federal Reserve Bank of Kansas City, Second Quarter, pp.5-35

Young, A. T., M. J. Higgins and D. Levy (2008) "Sigma Convergence versus Beta Convergence: Evidence from U.S. County-Level Data", *Journal of Money, Credit and Banking*, Vol.40, pp.1083-1092

Yugami, K. (2005) "Todofuken deta wo mochiita chiiki rodoshijo no bunseki", in Japanese ("Analysis of Static Differentials in Unemployment and Non-employment Rates by Prefecture"), *The Monthly Journal of the Japan Institute of Labour*

—— (2010) "Chinginn koyo no chiikikan kakusa", in Japanese ("Regional Disparity of Wages and Employments") in *Rodo Bnpai to Shotoku Bunpai* in Japanese (*Distribution of Labor and Income*) ed. Y. Higuchi, Tokyo: Keiogijuku University Press

Taylor, J, and S. Bradley (1997) "Unemployment in Europe: a Comparative Analysis of Regional Disparities in Germany, Italy and the UK", *Kyklos*, Vol.50, pp.221-245

（日本語要旨）

この論文は，都道府県のデータを用いて，日本の地域失業率を実証的に分析するものである。地域失業率は全国における相対的大きさが長期間変わらないことが知られているが，この論文の結果は最新のデータでもその特質が変わらないことを示している。全国平均よりも失業率の高い地域は，20年後でも比較的高い失業率を維持する傾向がきわめて強い。都道府県の失業率の水準は過去20年間で収束している。しかし，都道府県の失業率の全国平均に対する相対的大きさは収束していない。そのために，日本で地域失業の格差が解消されたと結論されるべきではない。失業率と雇用者数の成長率の関係から雇用創出すれば必ずしも地域の失業率を低下させるわけではないことが分かる。労働力の特徴の中で，年齢構成は地域の失業率を決定する上で最も重要な要素となっている。日本国内の失業率の格差を縮小するには，マクロ経済政策だけでは不十分であり，若年労働者を対象とした政策が必要である。