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Regional Business Cycle and Growth Features of Japan

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Abstract

We study the features of regional business cycles and growth in Japan. We find evidence of unconditional convergence over the 1955-2008 period. For the 1975-2008 period, we find evidence of convergence conditional on TFP gap, population growth, private investment rate and TFP growth. We also find that the consumption-output correlation puzzle exists, which implies that the idiosyncratic income shocks are not shared among prefectures and regions. Financial market distortions are important in accounting for the low correlation of consumption across regions.

1 Introduction

The postwar Japanese economy has been studied extensively due to its peculiar experience of the postwar rapid growth, bubble economy in the 1980s

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and lost decade in the 1990s. In this paper we analyze the regional features of the Japanese economy during this period. In specific, we study the regional convergence of income and business cycle comovements among the 47 prefectures over the 1955-2008 period.

Japanese regional convergence has been studied by Barro and Sala-i-Martin (1992) and Shioji (2001). Barro and Sala-i-Martin (1992) find strong evidence of regional convergence over the 1930-1987 period. Shioji (2001) study the convergence of Japanese prefectures over the 1965-1995 period and find that regional public infrastructure capital stock had a modest effect on regional growth. In this paper, we focus on the 1955-2008 period and find evidence of unconditional convergence during the entire period and conditional convergence over the 1975-2008 period.

Regional business cycle features of Japan has been studied by Artis and Okubo (2011). They find that prefectures with similar GDP levels and shorter distance tend to have higher business cycle synchronization over the 1955-1995 period. In this paper, we focus on the cross-region correlation of consumption and show that the consumption-output puzzle discussed in international macroeconomic literature such as Backus, Kehoe and Kydland (1992) and Baxter and Crucicni (1995) exists in Japanese prefecture level. That is, the cross-regional correlation of output is higher than that of consumption. We conduct a business cycle accounting exercise and find that fluctuations in financial market distortions are important in accounting for the low correlation of consumption fluctuation across regions.

The remainder of the paper is organized as follows. In section 2 we describe the data facts. In section 3 we conduct quantitative analysis on regional convergence and comovement. Section 4 concludes the paper.

2 Data

In this section, we present summary statistics of the expenditure, production and income statistics components of GDP. The main data set we use is the ESRI data set on Japanese prefectural income and product accounts over the 1955-2008 period. The original data sets are compiled in several sub-periods, 1955-1975, 1975-1999, 1990-2009, 2000-2012 due to the change in the SNA basis and reference years for regional price deflators. We choose to terminate our data sample period at 2008 in order to avoid the effects of the 2008/2009 financial crisis and the 2011 earthquake.

All data are converted into 2000 constant price per capita levels. Constant price data are constructed by dividing nominal variables with the GDP deflator. In order to connect the data for the entire period, we splice the nominal variables and GDP deflators using the overlapping years. We use prefectural population data obtained from the Labor Force Survey in order to construct per capita data.

For presentation purposes, we define 9 areas: Hokkaido, Tohoku, Kanto, Chubu, Kinki, Chugoku, Shikoku, Kyushu, Okinawa. The Tohoku area consists of 6 prefectures: Aomori, Iwate, Miyagi, Akita, Yamagata and Fukushima. The Kanto area consists of 7 prefectures: Ibaraki, Tochigi, Gunma, Saitama, Chiba, Tokyo and Kanagawa. The Chubu area consists of 9 prefectures: Niigata, Toyama, Ishikawa, Fukui, Yamanashi, Nagano, Gifu, Shizuoka and Aichi. The Kinki area consists of 7 prefectures: Mie, Shiga, Kyoto, Osaka, Hyogo, Nara and Wakayama. The Chugoku area consists of 5 prefectures: Tottori, Shimane, Okayama, Hiroshima, and Yamaguchi. The Shikoku area consists of 4 prefectures: Tokushima, Kagawa, Ehime and Kochi. The Kyushu area consists of 7 prefectures: Fukuoka, Saga, Nagasaki, Kumamoto, Oita, Miyazaki, and Kagoshima. Hokkaido and Okinawa are areas that consist of single prefectures.

2.1 Regional Output

Table 1 presents the features of per capita regional output over the 1955-2008 period. The first column presents the average level of regional GDP relative to the national level. The regional income in the Kanto area is clearly much higher than other regions at 1.190 while that of Okinawa is 0.626. The variation between the richest and the poorest prefecture is quite large ranging from 1.764 in Tokyo to 0.626 in Okinawa. We also compute the simple average of all per capita prefecture GDP relative to the national level which turns out to be 0.888. This implies that the income distribution among prefectures are skewed with one very rich and large prefecture, Tokyo, and a lot of relatively poor prefectures.

The second column presents the average per capita regional real GDP growth rate. The national output growth was 3.85% where Tohoku area was the highest at 4.28% and Hokkaido area was the lowest at 3.30%. At the prefecture level, Nagano was the highest at 4.71% and Wakayama was the lowest at 2.86%. The simple average of all prefectures is 3.97%, which is slightly higher than the national aggregate growth rate. This is because large prefectures such as Tokyo, Osaka, Kanagawa and Hyogo are growing relatively slow and are bringing down the national aggregate growth rate.

The third column presents the correlation between HP filtered regional output and national output.[1] Kanto area has the highest correlation coefficient at 0.964 while Okinawa area has the lowest at 0.045 which is clearly an outlier. At the prefecture level, Mie has the highest correlation at 0.924 while Okinawa has by far the lowest correlation.

Finally, the fourth column presents the standard deviation of the HP filtered per capita regional real GDP relative to that of the national level. The national output standard deviation was 2.99% where the Kanto area was the most volatile at 1.135 and the Tohoku area was the least volatile at 0.858 relative to the national volatility respectively. At the prefecture level, Shiga was the most volatile while Kochi was the least volatile where the ratios are 1.705 and 0.842 respectively.

Figure 1 plots the Gini coefficient computed from prefecture per capita GDP and private consumption levels over time. This figure shows that inter-prefecture income inequality declined quite dramatically during the rapid growth period falling from 0.14 in 1955 to 0.08 in 1975. Therefore, we find strong evidence of the so-called σ-convergence during the 1955-1975 period. However, the Gini coefficient temporary rises during the late 1980s and remains thereafter higher relative to the 1975 level.

2.2 Expenditure, Production and Income

2.2.1 Regional Expenditure Statistics

The ESRI data set provides annual data of regional expenditure on final consumption and investment of both the household and the government. Table 2 presents the average regional expenditure shares of GDP for private consumption, private investment, public consumption, and public investment over the 1955-2008 period. The national private consumption share is 0.486 where the regional shares range from 0.542 in the Hokkaido area to 0.467 in the Kanto area. At the prefecture level, Nara has the highest share at 0.688 while Tokyo has the lowest at 0.375. The national private investment share is 0.222 where the regional shares range from 0.250 in the Okinawa area to 0.183 in the Hokkaido area. At the prefecture level, the highest is 0.332 in Ibaraki and the lowest is 0.181 in Tokyo. The national government

[1] Throughout this paper we set the smoothing parameter to 100 for HP filtering.

consumption share is 0.151 where the regional shares range from 0.267 in the Okinawa area to 0.124 in the Kanto area. At the prefecture level, the highest is 0.267 in Okinawa and the lowest is 0.096 in Aichi. The national government investment share is 0.075 where the regional shares range from 0.129 in the Hokkaido area to 0.059 in the Kanto area. At the prefecture level, the highest is 0.159 in Fukui and the lowest is 0.052 in Tokyo. It turns out that the expenditure shares of the four expenditure components in Tokyo are significantly lower than those at the national level and add up to only 72.4% of its GDP. In other words, domestic absorption in Tokyo is less than its GDP, which implies that Tokyo is a net exporter of goods and services.

Table 3 presents the intra-regional comovement of the expenditure components. Table 3a lists the intra-regional HP-filtered correlation of output with its expenditure components over the 1955-2008 period. The first column shows the intra-regional correlation between output and private consumption. The national aggregate correlation is 0.489 showing that consumption is procyclical at the national level. At the regional level, the Okinawa area has the highest correlation at 0.633 while the Hokkaido area has the lowest at 0.043. At the prefecture level, the correlation ranges from 0.817 in Gunma to -0.044 in Aichi. The second column shows the intra-regional correlation between output and private investment. The national aggregate correlation is 0.727 showing high procyclicality of investment. At the regional level, the Chubu area has the highest correlation at 0.769 while the Okinawa area has the lowest correlation at 0.072. At the prefecture level, the correlation ranges from 0.806 in Aichi to 0.072 in Okinawa. The third column shows the correlation between output and government consumption. The national aggregate correlation is 0.081. At the regional level, the Kyushu area has the highest correlation at 0.424 while the Kanto area has the lowest correlation at -0.024. At the prefecture level, Miyazaki has the highest at 0.638 and Aichi has the lowest at -0.177. The fourth column shows the intra-regional correlation between output and government investment. The national aggregate correlation is 0.193. At the regional level, the Kyushu area has the highest correlation at 0.552 and Chubu has the lowest at -0.051. At the prefecture level, Tokushima has the highest correlation at 0.606 and Aichi has the lowest at -0.139.

Table 3b shows the HP-filtered standard deviation of each expenditure component relative to that of output over the 1955-2008 period. The first column shows the standard deviation of private consumption relative to that of output. The national aggregate ratio is 0.565 ranging from 1.541 in the

Okinawa area and 0.518 in the Kanto area. At the prefecture level, Okinawa has by far the highest ratio while Hiroshima has the lowest correlation at 0.513. A ratio larger than 1 is puzzling because standard business cycle theory will predict consumption smoothing in response to income shocks. The result implies that there are forces in Okinawa that prevent efficient consumption smoothing such as financial frictions. The relative volatility of private investment to that of output is much higher than that of consumption to output with the national aggregate ratio at 3.373. At the regional level, the Chugoku area has the highest ratio at 3.549 while the Hokkaido area has the lowest ratio at 2.692. At the prefecture level, Ibaraki has the highest ratio at 4.235 while Chiba has the lowest ratio at 2.223. Consumption is less volatile and investment is more volatile than output at the government level as well. The third column shows that the ratio of the standard deviation of government consumption to that of output is 0.864 at the national aggregate level. At the regional level, the Okinawa area has the highest ratio at 1.316 while the Hokkaido area has the lowest ratio at 0.762. At the prefecture level, Fukui has the highest ratio at 1.746 while Saitama has the lowest ratio at 0.610. The fourth column shows that the standard deviation of government investment relative to that of output is 2.020 at the national level. At the regional level, the Okinawa area has the highest ratio at 4.044 while the Chubu area has the lowest ratio at 1.929. At the prefecture level, Niigata has the highest ratio at 4.413 while Aichi has the lowest ratio at 1.459.

Table 4 presents the comovement between regional and national expenditure components. Table 4a presents the HP filtered correlation of each regional expenditure component with its national aggregate counterpart. The first column shows the correlation of regional consumption and national consumption. At the regional level the Chubu area has the highest correlation at 0.919 while the Okinawa area has the lowest at 0.202. At the prefecture level, Fukui has the highest correlation at 0.856 while Okinawa has the lowest. The average of the correlation coefficients of all prefectures is 0.609. The second column presents the correlation between regional and national private investment ranging from 0.986 in the Chubu area to 0.572 in the Okinawa area. At the prefecture level, Osaka has the highest correlation at 0.974 while Aomori has the lowest at 0.539. The average of all prefectures is 0.815. The third column presents the correlation between regional and national government consumption ranging from 0.869 in the Chubu area to 0.206 in the Okinawa area. At the prefecture level, Miyagi has the highest correlation at 0.835 while Shiga has the lowest at 0.108. The average of all prefectures is 0.585.

The fourth column presents the correlation between regional and national government investment ranging from 0.918 in the Chubu area to 0.289 in the Okinawa area. At the prefecture level, Oita has the highest correlation at 0.796 while Kagawa has the lowest at 0.210. The average of all prefectures is 0.575.

Table 4b presents the HP-filtered volatility of each regional expenditure component relative to that of their national counterpart. The first column reports the standard deviation of regional consumption relative to that of the national consumption ranging from 2.861 in the Okinawa area to 1.041 in the Kanto area. At the prefecture level, Okinawa has the highest relative volatility while Tokyo has the lowest at 1.126. The average of all prefectures is 1.677 showing much greater volatility at the prefecture level compared to the national aggregate, which implies negative covariance of consumption across prefectures. The second column reports the standard deviation of regional private investment relative to that of national investment which ranges from 1.149 in the Kanto area to 0.738 in the Tohoku area. At the prefecture level, Ibaraki has the highest at 1.660 while Kagoshima has the lowest at 0.627. The average of all prefectures is 1.043. The third column reports the standard deviation of regional government consumption relative to that of national government consumption which ranges from 1.598 in the Okinawa area to 1.001 in the Chubu area. At the prefecture level, Wakayama has the highest at 2.199 while Saitama has the lowest at 0.849. The average of all prefectures is 1.498. The fourth column reports the standard deviation of regional government investment relative to that of national investment ranging from 2.099 in the Okinawa area to 1.027 in the Chubu area. At the prefecture level, Kagawa has the highest at 2.681 while Aichi has the lowest at 1.039. The average of all prefectures is 1.701.

2.2.2 Regional Production Statistics

Next, we assess the production factors: labor, capital and productivity. Total factor productivity is computed using a standard Cobb-Douglas production function

$$y_{i,t} = A_{i,t} k_{i,t}^{\theta_i} {l_{i,t}}^{1-\theta_i}, \tag{1}$$

where y is per capita GDP, k is per capita capital stock, l is per capita labor, and A is total factor productivity (TFP) for region i at time t. We assume that the labor income share $1 - \theta_i$ is constant.[2]

The data for labor input is the total man hours series (employment times hours worked per worker) from the R-JIP 2012 database which is available for the 1970-2008 period. For capital stock, we use the perpetual inventory method in order to construct the regional net capital stock series over the 1975-2008 period.[3] The details of the computation is available in the appendix. The labor income share is computed from national income data over the 1975-2008 period as described in the following sub-section.

Table 5 presents the average regional per capita production factors relative to the national level over the 1975-2008 period. The first column shows that labor is relatively abundant in the Chubu area with a ratio of 1.076 while it is relatively scarce in the Okinawa area with a ratio of 0.851 relative to the national level respectively. At the prefecture level, Tokyo has the highest per capita labor input with a ratio of 1.374 while the lowest is in Nara with a ratio of 0.669. The average of all prefectures is 0.992. The second column shows that capital stock is relatively abundant in the Chubu area with a ratio of 1.208 while it is relatively scarce in the Okinawa area with a ratio of 0.661. At the prefecture level, the highest per capita capital is in Mie with a ratio of 1.722 and the lowest is in Kumamoto with a ratio of 0.617. The average of all prefectures is 0.942. The third column presents the total factor productivity gaps between the regional and national levels defined as

$$\widehat{A_{i,t}} = \frac{y_{i,t}}{y_t} \left(\frac{k_t}{k_{i,t}} \right)^{\frac{\theta_i + \theta}{2}} \left(\frac{l_t}{l_{i,t}} \right)^{1 - \frac{\theta_i + \theta}{2}}.$$

At the regional level, the Kanto area has the highest relative TFP with a ratio of 1.134 while the Okinawa area has the lowest with a ratio of 0.882. At the prefecture level, Tokyo has the highest relative TFP with a ratio of 1.330 while Ibaraki has the lowest with a ratio of 0.784. The average of all prefectures is 0.933.

Table 6 reports the intra-regional comovement of production factors over the 1975-2008 period. Table 6a presents the intra-regional HP-filtered correlation of output with its production factors. The first column shows the

[2]Allowing time varying labor share proves problematic for TFP calculations, especially its growth over time. The computation of the labor share is explained in the following subsection.

[3]The regional private capital stock data published by R-JIP and by ESRI are both gross capital stock series.

intra-regional correlation between output and labor. The national aggregate correlation is 0.643. At the regional level, the Kyushu area has the highest correlation at 0.747 while the Okinawa area has the lowest at 0.159. At the prefecture level, Tochigi has the highest correlation at 0.727 while Tokushima has the lowest at -0.089. The average of all prefectures is 0.383. The second column shows the intra-regional correlation between output and capital stock. The national aggregate correlation is 0.428. At the regional level, the Kyushu area has the highest correlation at 0.660 while the Okinawa area has the lowest correlation at 0.166. At the prefecture level, Osaka has the highest correlation at 0.738 while Wakayama has the lowest correlation at -0.100. The average of all prefectures is 0.298. Finally, the third column shows the intra-regional correlation between output and total factor productivity. The national aggregate correlation is 0.829 showing high procyclicality of TFP. At the regional level, the Kanto area has the highest correlation at 0.887 while the Shikoku area has the lowest correlation at 0.616. At the prefecture level, Osaka has the highest correlation at 0.957 while Kagoshima has the lowest correlation at 0.487. Therefore, TFP is procyclical at the prefecture level as well. The average of all prefectures is 0.813.

Table 6b reports the HP-filtered volatility of production factors relative to that of output. The first column shows the standard deviation of labor relative to that of output. The national aggregate volatility of labor relative to output is 0.527. At the regional level, the Hokkaido area is the highest at 1.114 while the Kanto area is the lowest at 0.433. At the prefecture level Kagoshima is the highest at 1.328 while Osaka is the lowest at 0.351. The average of all prefectures is 0.671. The second column shows the volatility of capital relative to that of output which is 0.808 at the national level. At the regional level, the Shikoku area has the highest ratio at 0.918 while the Chubu area has the lowest at 0.694. At the prefecture level Kagoshima has the highest at 1.170 while Wakayama has the lowest at 0.380. Finally, the third column shows that the standard deviation of TFP relative to that of output is 0.795 at the national level. At the regional level the Okinawa area has the highest ratio at 1.084 while the Kyushu area has the lowest at 0.662. At the prefecture level Kagoshima has the highest at 1.203 while Osaka has the lowest at 0.701. The average of all prefectures is 0.940.

Table 7 reports the comovement between the regional and national production factors. Table 7a presents the HP-filtered correlation between regional and national production factors. The first column shows that the correlation between regional and national labor range from 0.962 in the Chubu area to 0.528 in the Hokkaido area. At the prefecture level, Wakayama has the highest at 0.922 while Nara has the lowest at 0.395. The average of the correlation of all prefectures is 0.749. The second column shows that the correlation between regional and national capital range from 0.986 in the Kinki area to 0.559 in the Hokkaido area. At the prefecture level Kanagawa has the highest correlation at 0.974 while Hokkaido has the lowest. The average of all prefectures is 0.861. The third column shows that the correlation between regional and national TFP is highest in the Kanto area at 0.953 while the Hokkaido area is the lowest at 0.413. At the prefecture level, Mie has the highest correlation at 0.872 while Kochi has the lowest at -0.092. The average of all prefectures is 0.583. The fourth column presents the correlation between regional and national output over the 1975-2008 period to match the sample period of the production factors. At the regional level, the Chubu area has the highest correlation at 0.957 while the Okinawa area has the lowest at 0.398. At the prefecture level, Mie has the highest correlation at 0.932 while Kochi has the lowest at 0.086. The order of the ranking is somewhat different from that for the 1955-2008 period. Moreover, the average of all prefectures is 0.664 which is much lower than that of the 1955-2008 period, 0.731.

Table 7b reports the standard deviation of regional production factors relative to that of their national counterpart. The first column reports the standard deviation of regional labor relative to that of the national labor which ranges from 1.643 in the Hokkaido area to 1.014 in the Kinki area. At the prefecture level, Nagasaki has the highest ratio at 2.362 while Gifu has the lowest at 0.876. The average of all prefectures is 1.409. The second column reports the standard deviation of regional capital stock relative to that of national capital stock which ranges from 1.209 in the Kanto area to 0.860 in the Kyushu area. At the prefecture level, Ibaraki has the highest ratio at 1.891 while Wakayama has the lowest at 0.651. The average of all prefectures is 1.027. The third column reports the standard deviation of regional TFP relative to that of national TFP which ranges from 1.347 in the Kanto area to 0.745 in the Hokkaido area. At the prefecture level, Ibaraki has the highest ratio at 2.071 while Hokkaido has the lowest. The average of all prefectures is 1.371. The fourth column reports the standard deviation of regional output relative to that of national output over the 1975-2008 period to match the sample period of the production factors. At the regional level, the Kanto area has the highest ratio at 1.209 while the Hokkaido area has the lowest at 0.777. At the prefecture level, Fukushima has the highest ratio at 1.696 while

Kagoshima has the lowest at 0.582. The average of all prefectures is 1.170 which is roughly the same as the 1955-2008 period. The relative volatility of regional output is consistent with those for the 1955-2008 period.

2.2.3 Regional Income Statistics

In this section we utilize the ESRI regional income statistics to compute the labor income share and capital depreciation rate for each region. The labor income share is defined as

$$1-\theta = \frac{\text{employees compensation} + 0.5\ \times\ \text{indirect business tax} + 0.8 \times\ \text{mixed income}}{GDP}.$$

following Hayashi and Prescott (2002).[4] The capital depreciation rate is defined as

$$\delta = \frac{\text{fixed capital depreciation}}{\text{net capital stock}}.$$

The first column in Table 8 reports the average labor income share over the 1975-2008 period. The data shows that the average labor income share is 0.593 at the national level where the regional levels range from 0.635 in the Hokkaido area to 0.540 in Okinawa area. The prefecture shares range from 0.645 in Tokyo to 0.489 in Shiga. Figure 2 plots the labor income share over the 1975-2009 period. This figure shows that the labor income share has been falling throughout the 1975-1990 period followed by an increase during the 1990s in all regions. After 2000 the labor income share has been declining until it sharply rises in 2008 in most regions.

The second column shows the correlation between the HP filtered labor income share and the HP filtered output over the 1975-2008 period. The correlation for the national level is -0.715 where that for regional levels vary from -0.716 for the Kanto area to 0.010 for the Shikoku area. Ehime has the highest positive correlation at 0.115 while Yamanashi has the highest negative correlation at -0.828. The countercyclical labor income share is consistent with the observation in the US by Young (2004) and Hansen and Prescott (2005).

The third column in Table 8 reports the average capital depreciation rate over the 1975-2008 period. The national average is 0.077 ranging from 0.087 in the Tohoku area to 0.066 in the Kinki area. The prefecture level

[4]The details of the construction of the labor income share is described in the data appendix.

depreciation rates range from 0.109 in Kumamoto to 0.046% in Mie. Figure 3 plots the capital depreciation rate over the 1975-2008 period. This figure shows that the depreciation rate has been falling until the mid 1980s and then has gradually increased. Aggregate depreciation rate should decline when investment on fixed assets that depreciate slower such as structure increases relative to those that depreciate faster such as intangible assets. One potential explanation of the evolution of the depreciation rate is that the share of investment in structure increased during the late 1970s and that of intangible assets, equipment and machinery increased after the 1980s. In order to assess this hypothesis, further analysis of fixed investment by types of assets is needed.

The fourth column shows the correlation between the HP filtered depreciation rate and the HP filtered output over the 1975-2008 period. The correlation at the national level is 0.489 where the regional correlation ranges from 0.620 in the Kanto area to 0.317 in the Kinki area. At the prefecture level, Saitama has the highest correlation at 0.773 while Hyogo has the lowest at -0.185. The average of the prefecture level correlation is 0.415 indicating procyclical depreciation rate on the average.

2.3 Efficiency

In this section we assess the regional efficiency. We first compare the marginal product of labor and capital across regions which are defined as

$$mpl_{i,t} = (1-\theta_i)\frac{y_{i,t}}{l_{i,t}}, mpk_{i,t} = \theta_i \frac{y_{i,t}}{k_{i,t}}$$

respectively.

The first column of Table 9 presents the regional marginal product of labor relative to its national counterpart over the 1975-2008 period. At the regional level, the Kanto area has the highest ratio at 1.159 while the Okinawa area has the lowest at 0.720. At the prefecture level, Tokyo has by far the highest ratio at 1.409 while Okinawa has the lowest. The average of all prefectures is 0.891. The second column reports the regional marginal product of capital relative to its national level. At the regional level, the Kanto area has the highest ratio with a ratio of 1.105 while the Chugoku area has the lowest at 0.901. At the prefecture level, Shiga has the highest ratio at 1.319 while Ibaraki has the lowest at 0.619. The average of all prefectures is 0.995. Figure 4 plots the Gini coefficients of MPL and MPK computed from prefecture level data over time in order to highlight the regional misallocation of production factors. Interestingly, after the 1990s the regional discrepancy in MPL has been falling while that of the MPK has been rising. This figure implies that the misallocation of labor has been reduced while that of capital has been increasing.

Next, we measure distortions in the labor and capital markets as the wedges between marginal products of factors and marginal rates of substitutions of the household choices following Chari. Kehoe and McGrattan (2007). Labor and capital wedges ω_{li} and ω_{ki} are defined in intratemporal labor equilibrium condition and the intertemporal capital Euler equation:

$$\begin{aligned} -\frac{u_{li,t}}{u_{pci,t}} &= \omega_{li,t} mpl_{i,t}, \\ u_{pci,t} &= \beta \left[u_{pci,t+1} \left(\omega_{ki,t+1} mpk_{i,t+1} + 1 - \delta_i \right) \right] \end{aligned}$$

where u_{li} and u_{pci} stand for the marginal utilities of labor and consumption.[5] We assume log preferences over private consumption pc_i and leisure $1 - l_i$

$$u(pc_{i,t}, l_{i,t}) = \Psi \log pc_{i,t} + (1 - \Psi) \log(1 - l_{i,t}) \quad (2)$$

where for simplicity Ψ and β are kept common across regions.[6]

The third column of Table 9 presents the regional labor wedges relative to their national counterpart. At the regional level, the Tohoku area has the highest ratio at 1.103 while the Okinawa area has the lowest at 0.932. At the prefecture level, Akita has the highest ratio at 1.238 while Fukuoka has the lowest at 0.836. The fourth column presents the regional capital wedge relative to its national counterpart. At the regional level, Chubu area has the highest at 1.132 while the Okinawa area has the lowest at 0.873. At the prefecture level, Ibaraki has the highest ratio at 1.311 while Shiga has the lowest at 0.842. The average of all prefectures is 1.016. Figure 5 plots the regional labor wedge. This figure shows that the labor wedge has been declining, i.e. the distortion in the labor market is increasing. One potential explanation is that labor income tax is increasing due to the rapid increase in social security payments as shown in Gunji and Miyazaki (2012). The figure

[5] The capital wedge presented in this section is computed from a deterministic capital Euler equation in order to simplify the treatment of expectations. In the following section we will deal with a stochastic model in which capital shares are not directly computable from data.

[6] The calibration of these parameters are described in detail in the following section.

also shows that the discrepancy across regions seems to be decreasing. Figure 6 shows the regional capital wedge over time. Capital wedge fluctuates more frequently than the labor wedge and does not seem to have any particular pattern.

3 Regional Growth and Convergence

3.1 Growth Accounting

The production function (1) can also be used for growth accounting. Deriving (1) with respect to time we get

$$\frac{\dot{y}_{i,t}}{y_{i,t}} = \frac{\dot{A}_{i,t}}{A_{i,t}} + \theta_i \frac{\dot{k}_{i,t}}{k_{i,t}} + (1 - \theta_i) \frac{\dot{l}_{i,t}}{l_{i,t}}. \tag{3}$$

The right hand side decomposes output growth into the contribution of the production factors.

Table 10 presents the regional growth accounting results over the 1975-2008 period. The numbers in each columns correspond to the average per capita output growth rate and the contributions of each production factor to it, that is, the variables on the right hand side on (3). The results for the national level show that labor was declining and reduced output growth by 0.25%. The declining labor is common across all regions except for the Okinawa area and reflects the aging population and decline in labor participation rate. On the other hand, capital growth and TFP growth contributed to output growth by 1.05% and 1.19% respectively.

At the regional level, the Chubu area has the highest regional growth rate of output at 2.28% which is led by capital accumulation which contributes to 1.41%. The Tohoku area has the second highest output growth rate at 2.12% where both capital growth and TFP growth is higher than the national average. The Hokkaido area has the lowest output growth rate at 1.68% and the lowest labor and capital growth rate. At the prefecture level, Fukushima and Nagano have the highest output growth rates at 2.74% and 2.74% which are driven by the high TFP growth at 1.78% and 1.74% respectively. On the other hand, Wakayama has the lowest output growth rate at 0.77% where its TFP growth rate is also the lowest at 0.11%. However, Hokkaido has an output growth rate lower than the national level while its TFP growth rate is much higher than the national level. Therefore the growth pattern is not monotonic.

3.2 $\beta-$Convergence

In this section we investigate the existence of absolute convergence in output levels also known as β-convergence. This concept considers convergence as a negative correlation between the growth in income over time and its initial level. According to a standard textbook Solow-Swan neoclassical growth model, countries who initially have low output due to low capital stock should grow faster because of the high initial marginal product of capital.

3.2.1 Solow-Swan Model

Solow-Swan growth model is a dynamic model of capital accumulation. The typical per capita capital law of motion looks like

$$\dot{k}_{i,t} = pi_{i,t} - (\delta_i + \dot{n}_i)k_{i,t},$$

where $\dot{n}_i$ is population growth representing the capital dilution effect. Assume that households save a fixed fraction of their income

$$s_{i,t} = \varphi_i y_{i,t}.$$

Consider a closed economy so that savings is equal to investment:

$$pi_{i,t} = y_{i,t} - c_{i,t} - g_{i,t} = s_{i,t}.$$

Finally, assume production function is (1) so that the capital law of motion is

$$\frac{\dot{k}_{i,t}}{k_{i,t}} = \varphi_i A_{i,t} k_{i,t}^{\theta_i - 1} {l_{i,t}}^{1-\theta_i} - (\delta_i + \dot{n}_i). \tag{4}$$

According to the model, when the current capital stock level is low, the marginal product of capital is high. Thus, capital accumulation leads to rapid growth in output, which increases investment until eventually the marginal product of capital decreases as capital stock approaches its steady state. In addition, a) high TFP leads to a higher steady state capital stock and thus should lead to higher growth during the transition towards the steady state; b) high labor share (low capital share) increases the diminishing of the marginal product of capital and thus should lead to slower growth during the transition; c) higher investment rate accelerates capital accumulation and hence leads to higher growth during the transition; d) higher depreciation rate and population growth rate slows down the accumulation of per capita capital stock and thus leads to lower growth during the transition.

3.2.2 Growth Regression

Empirical analysis on regional convergence goes back to Barro (1991) and Mankiw, Romer and Weil (1992) who test absolute convergence among countries. The basic cross-section estimation equation is

$$g_i = \alpha + \beta y_{0,i} + \gamma x_i + \varepsilon_i, \tag{5}$$

where g is the average GDP growth rate and y_0 is the initial GDP level in region i. The initial GDP is expressed as the ratio of regional per capita GDP to national per capita GDP in the initial year. The economic intuition of the Solow-Swan model explained above implies that the coefficient β should be negative. We further add control variables x to the regression according to the model (4) where x consists of the average TFP gap, the labor share, the capital depreciation rate, population growth rate, private investment to GDP ratio, government investment to GDP ratio. Finally, considering the growth accounting results, we also control for the differences in TFP growth rates across prefectures.

Table 11 summarizes the regression results. First we run a regression for the 1955-2008 period with no control variables which is reported as model 1. The coefficient β is negative and significant at the 95% confidence level and the R2 is 0.454. Therefore, we conclude that unconditional regional convergence exists in Japan over the 1955-2008 period. In model 2 we add all control variables and find that the negative effect of initial output is robust. In addition, TFP gap, population growth, private investment rate and TFP growth all have 95% significant effects on growth as expected. Labor share, capital depreciation and government investment rate do not have significant effects.

Next we focus on the 1975-2008 period in order to exclude the postwar rapid growth period.[7] The regression results in model 3 with no control vari-

[7] We run a Quandt-Andrews unknown breakpoint test and find that the output growth has a trend break in 1974.

ables show that for this period the initial output has no significant effects on output growth. Moreover the R2 is extremely low compared to that in model 1. Therefore, there is no evidence of unconditional convergence. However, when we add all control variables in model 4, the coefficient on initial output is negative and significant at the 90% level where the R2 increases to 0.699. In addition, the TFP gap, population growth, private investment rate and TFP growth are all significant at the 95% level. Therefore, we find evidence of conditional convergence over the 1975-2008 period.

4 Regional Business Cycle Accounting

4.1 Business Cycle Accounting Model

The business cycle accounting model follows Otsu (2010) and Lama (2011). Each prefecture is assumed to be a small open economy with a representative household, firm and government. The household provides labor and capital for the firm who produces output. The household can also borrow and lend in the international and inter-regional capital market using a non-state-contingent claim. The government charges distortionary taxes on labor and capital income in order to finance its exogenous expenditure.

4.1.1 Firm

The firm produces a single final good with a Cobb-Douglas production function:

$$Y_{i,t} = z_{i,t} K_{i,t}^{\theta_i} \left(\Gamma_{i,t} l_{i,t}\right)^{1-\theta_i}, \tag{6}$$

where Y_t, K_t, l_t stand for per capital output, capital and labor, and z_t, Γ_t represent production efficiency and labor augmented technology. We assume that Γ_t grows at a constant rate γ :

$$\Gamma_{i,t} = (1 + \gamma_i)\Gamma_{i,t-1},$$

while z_t is stationary. The economy will grow at the rate of γ in the long run so we detrend the model with Γ_t.

The firm's detrended profit maximization problem is,

$$\max \pi_{i,t} = y_{i,t} - w_{i,t} l_{i,t} - r_{i,t} k_{i,t}, \tag{7}$$

subject to the detrended production function

$$y_{i,t} = z_{i,t} k_{i,t}^{\theta} l_{i,t}^{1-\theta},$$

where π_t, y_t, w_t, k_t stand for detrended profits, output, real wage and capital while r_t stands for the real rental rate on capital.

4.1.2 Household

The detrended household problem is to maximize its life time utility

$$U = E_0 \sum_{t=0}^{\infty} \beta^t \left[\Psi \log pc_{i,t} + (1 - \Psi) \log(1 - l_{i,t}) \right]. \tag{8}$$

The detrended household budget constraint is

$$\begin{aligned} & (1 - \tau_{i,t}^l) w_{i,t} l_{i,t} + (1 - \tau_{i,t}^k) r_{i,t} k_{i,t} + \frac{\Gamma_i n_i d_{i,t+1}}{(1 + \tau_{i,t}^f) R} + \pi_{i,t} + \tau_{i,t} \\ = \; & pc_{i,t} + pi_{i,t} + d_{i,t} + \Phi_{i,t} d_{i,t} \end{aligned}$$

where τ_t^l, τ_t^k stand for labor and capital income tax, d_{t+1} stands for the international and inter-regional non-state-contingent claim, R, τ_t^f,stand for the return and tax on the international and inter-regional claim, Φ_t stands for adjustment costs on the international and inter-regional claim, and τ_t stands for the transfer income from the government and n represents population growth.[8] The detrended capital law of motion is

$$\Gamma_i n_i k_{i,t+1} = pi_{i,t} + (1 - \delta_i) k_{i,t} - \Lambda_{i,t} k_{i,t}, \tag{9}$$

Λ_t stands for the adjustment cost for capital. The functional form of the adjustment cost is assumed as

$$\begin{aligned} \Lambda_{i,t} &= \frac{\lambda_i}{2} \left(\frac{pi_{i,t}}{k_{i,t}} - \frac{\overline{pi_i}}{\overline{k}_i} \right)^2, \\ \Phi_{i,t} &= \frac{\phi_i}{2} \left(\frac{d_{i,t+1}}{\overline{d}_i} - 1 \right)^2, \end{aligned}$$

[8]The adjustment cost for the international and inter-regional claim is included in order to guarantee stationarity in the equilibrium following Schmitt-Grohe and Uribe (2003). The adjustment cost for investment is added to limit the jump in investment, which is common in small open economy models.

where $\frac{\overline{pi}}{\overline{k}}$ is the steady state private investment to capital ratio $\overline{d}$ is the steady state of the claim so that the adjustment costs are equal to zero in the detrended steady state.

4.1.3 Government and Foreign Sector

The local government collects distortionary taxes, purchases goods and services, and rebates the remainder to the household as lump-sum transfer τ_t. Thus, the government budget constraint

$$g_{i,t} + \tau_{i,t} = \tau^l_{i,t} w_{i,t} l_{i,t} + \tau^k_{i,t} r_{i,t} k_{i,t} \tag{10}$$

holds for all periods. For simplicity, we do not explicitly consider government debt or transfers among local governments.

In this model, we can define the trade balance as

$$tb_{i,t} = d_{i,t} - \frac{\Gamma_i n_i d_{i,t+1}}{(1+\tau^f_{i,t})R} + \Phi_{i,t} d_{i,t}. \tag{11}$$

Combining the government budget constraint with the household budget constraint leads to the resource constraint

$$y_{i,t} = c_{i,t} + x_{i,t} + g_{i,t} + tb_{i,t}. \tag{12}$$

4.1.4 Wedges

We define efficiency wedges, government wedges, labor wedges, international and inter-regional finance wedges, and capital wedges in equilibrium conditions as

$$\omega^e_{i,t} = z_{i,t}, \omega^g_{i,t} = g_{i,t}, \omega^l_{i,t} = 1 - \tau^l_{i,t}, \omega^f_{i,t} = \frac{1}{1+\tau^f_{i,t}}, \omega^k_{i,t} = 1 - \tau^k_{i,t},$$

so that

$$\begin{aligned}
y_{i,t} &= \omega_{i,t}^{e} k_{i,t}^{\theta_i} l_{i,t}^{1-\theta_i}, \\
y_{i,t} &= pc_{i,t} + pi_{i,t} + \omega_{i,t}^{g} + tb_{i,t}, \\
\frac{1-\Psi_i}{\Psi_i}\frac{pc_{i,t}}{1-l_{i,t}} &= \omega_{i,t}^{l}(1-\theta_i)\frac{y_{i,t}}{l_{i,t}}, \\
\frac{\Gamma_i n_i}{pc_{i,t}}\left(1-\Lambda_{i,t}'\right) &= \beta_i E_t\left[\frac{1}{pc_{i,t+1}}\left(\begin{array}{c}\left(1-\Lambda_{i,t+1}'\right)\left(1-\delta_i+\Lambda_{i,t+1}'\frac{pi_{i,t+1}}{k_{i,t+1}}-\Lambda_{i,t+1}\right) \\ +\omega_{i,t+1}^{k}\theta_i\frac{y_{i,t+1}}{k_{i,t+1}}\end{array}\right)\right] \\
\frac{1}{pc_{i,t}}\left(\omega_{i,t+1}^{f}\frac{\Gamma_i n_i}{R}-\Phi_{i,t}'\frac{d_{i,t}}{\overline{d}_i}\right) &= \beta_i E_t\left[\frac{1}{pc_{i,t+1}}\left(1+\Phi_{i,t+1}\right)\right].
\end{aligned}$$

We assume that the wedges follow a vector autoregressive stochastic process:

$$\widetilde{\omega_{i,t}} = P\widetilde{\omega_{i,t-1}} + \varepsilon_{i,t}, \varepsilon_{i,t} \sim N(0, Q_i) \tag{13}$$

where $\omega_t = (\omega_{e,t}, \omega_{f,t}, \omega_{g,t}, \omega_{l,t}, \omega_{k,t})'$ and $\varepsilon_t = (\varepsilon_{e,t}, \varepsilon_{f,t}, \varepsilon_{g,t}, \varepsilon_{l,t}, \varepsilon_{k,t})'$ and '$\sim$' denotes log deviations from the steady state.

4.1.5 Competitive Equilibrium

The competitive equilibrium is, a collection of quantities, prices and wedges $\{k_{t+1}, d_{t+1}, y_t, c_t, l_t, x_t, tb_t, w_t, r_t, \tau_t, \omega_{e,t}, \omega_{f,t}, \omega_{g,t}, \omega_{l,t}, \omega_{k,t}\}_{t=0}^{\infty}$ such that;

1. Households optimize given $\{w_t, r_t, \tau_t, \omega_{d,t}, \omega_{l,t}, \omega_{k,t}\}_{t=0}^{\infty}$ and d_0, k_0.
2. Firm optimizes given $\{w_t, r_t, \omega_{e,t}\}_{t=0}^{\infty}$.
3. Markets clear and the government budget constraint holds.
4. The resource constraint holds.
5. Wedges follow the stochastic process.

4.2 Quantitative Analysis

4.2.1 Parameters

In order to compare the effects of wedges across prefectures we assume that the parameters are common in all prefectures. We use the national aggregate data over the 1975-2008 period to calibrate steady state parameters and estimate parameters governing the stochastic process. The calibrated parameters are listed in Table 12.

The capital income share θ, depreciation rate δ, productivity growth Γ, and population growth are the period average of the data presented above. The subjective discount factor is calibrated to match the steady state capital Euler equation

$$\Gamma n = \beta \left(1 - \delta + \omega^k \theta \frac{y}{k}\right),$$

to data. The average output to capital ratio over the period is 0.547. For the steady state capital wedge ω^k, we use the average marginal capital tax rate over the 1975-2007 period from Gunji and Miyazaki (2011) which is 0.522 implying $\omega^k = 0.478$. The calibrated level $\beta = 0.995$ implies a steady state real interest rate 1.029 from the steady state international and intra regional claim Euler equation

$$\omega^f \frac{\Gamma n}{R} = \beta,$$

assuming that the steady state international and inter-regional finance wedge ω^f is equal to one. The preference weight is calibrated to match the steady state equilibrium condition

$$\frac{1-\Psi}{\Psi}\frac{pc}{1-l} = \omega^l (1-\theta)\frac{y}{l},$$

to data. The average consumption to output ratio is 0.488. The average labor input is 0.273. For the steady state labor wedge ω^l, we use the average marginal labor tax rate over the 1975-2007 period from Gunji and Miyazaki (2011) which is 0.297 implying $\omega^k = 0.703$.

The parameters governing the stochastic process are estimated with Bayesian maximum likelihood method. We use the data of output consumption, investment, government expenditure and labor. The details of the estimations are available upon request.

4.2.2 Results

Once parameter values are obtained, the linearized model is solved numerically. The wedges can be backed out using the decision rules and the data. Computed wedges are inserted into the model one by one in order to investigate their marginal contributions to business cycle fluctuations.

The result for the business cycle accounting exercise is presented using the following contribution index:

$$cont\_index(v_i^x) = corr(v_i^x, v_i^{data}) \times \frac{std(v_i^x)}{std(v_i^{data})},$$

where v_i^x stands for the response of variable v to wedge x in region i and v_i^{data} stands for the data fluctuation of variable v in region i.[9] All series are HP filtered with the HP smoothing parameter set to 100. The contribution index is essentially decomposing the data fluctuation and the contribution of all wedges will add up to one.

Table 13a presents the contribution index for each wedge on output fluctuation. The results clearly show that efficiency wedges are most important in accounting for regional business cycles where the contribution index ranges from 1.338 in Okinawa to 0.774 in Kyushu. The national aggregate contribution of efficiency wedges is 1.026. This implies that the output fluctuation can fully be accounted for by efficiency wedges. international and inter-regional finance wedges also contribute to output fluctuations where the contribution index is 0.190 at the national level and 0.131 on average for the prefecture level.

Table 13b presents the contribution index for each wedge on consumption fluctuation. At the national level, efficiency wedges has the highest contribution at 0.672 while the contribution of capital wedges is also significant at 0.391. However, the prefecture average of the contribution index of efficiency wedges on consumption is 0.319 while that of international and inter-regional finance wedges is 0.421. This reflects the high idiosyncrasy of the contribution levels of each wedge on consumption. For example, Tokyo has a very high contribution index of efficiency wedges at 0.700 and a low contribution index of international and inter-regional finance wedges at -0.019 whereas in Nagano the pattern is the opposite as the contribution indexes are -0.132 and 0.784 respectively.

In order to further investigate the comovement patterns of output and consumption, we construct a correlation index:

$$corr\_index(v_i^x, v_n^{data}) = \frac{covar(v_i^x, v_n^{data})}{std(v_i^{data})std(v_n^{data})},$$

[9]The contribution index is based on variance decomposition and does not directly measure the fit of the simulation. Mean squared error directly measures the similarity of the simulated series to data. Both indexes will give consistent results in terms of the importance of each wedge.

where v_n^{data} stands for the data fluctuation of variable v at the national level. This index essentially decomposes the correlation between the regional and national level fluctuations of variable v into the contributions of each wedge taking the national level fluctuation as given. The correlation index of all wedges will add up to the data correlation, $corr(v_i^{data}, v_n^{data})$.[10]

Table 14a presents the correlation index of each wedge for output. Over all efficiency wedges are most important in accounting for the positive regional output correlation with the national level ranging from 1.028 in Chugoku to 0.291 in Okinawa where the average of all prefectures is 0.672. international and inter-regional finance wedges also contribute to positive output correlation. The regional correlation indexes range from 0.287 in Shikoku to 0.060 in Okinawa where the average of all prefectures is 0.134. On the other hand, capital wedges generate negative output correlation in all regions where the average of all prefectures is -0.151.

Table 14b presents the correlation index of each wedge for consumption. The efficiency wedges are most important in accounting for the positive regional consumption correlation with the national level ranging from 0.781 in Kinki to 0.035 in Okinawa where the average of all prefectures is 0.319. Capital wedges also contribute to the positive consumption correlation where the correlation index ranges from 0.397 in Chubu to 0.094 in Okinawa where the average of all prefectures is 0.195. However, international and inter-regional finance wedges generate negative consumption correlation where the average correlation index of all prefectures is -0.106. This implies that financial market distortions prevent inter-regional consumption smoothing.

5 Conclusion

In this paper, we have gone over regional economic data in Japan over the 1955-2008 period. We find that the difference in per capita output levels and growth rates across regions are quite high while inter-regional output inequality decreased dramatically during the 1955-1975 period. In terms of expenditure data, the cross-regional output correlation is higher than cross-regional consumption correlation. In terms of production, labor misallocation has been declining while capital misallocation has been increasing over the 1975-2008 period. In terms of income data, the income share of labor has

[10]By definition, the correlation indexes of the national level are equivalent to the contribution indexes.

been declining during the 1975-1990 period, increasing during the 1990s and declining again in the 2000s in all regions while the depreciation rate has declined during the late 1970s and persistently increased after 1980 in all regions.

We have conducted basic growth accounting analysis and find that TFP growth and capital accumulation are equally important in accounting for regional output growth. We also conduct a growth regression and find that unconditional regional convergence exists in the 1955-2008 period but not during the 1975-2008 period. However, conditional regional convergence does exist during the 1975-2008 period controlling for the TFP gap, population growth, private investment rate, and TFP growth. Future studies on post-1975 Japanese growth should attempt to reveal the underlying reasons of regional discrepancies in these control variables. In terms of the regional business cycles, we conduct a business cycle accounting exercise and find that efficiency wedges are important in accounting for the fluctuations in output while both efficiency and international finance wedges are important in accounting for consumption fluctuation. Moreover, on average international and intra-regional finance wedges play an important role in reducing the correlation between consumption in each prefecture and national consumption.

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A Data Appendix

A.1 Net Capital Stock

We consider net private capital stock as a sum of private firm fixed assets (manufacturing firm fixed assets + non-manufacturing firm fixed assets + intangible fixed assets), and private inventory stocks. In order to compute the net capital stock series over the 1975-2008 period, we use the perpetual inventory method which is based on the net capital accumulation equation

$$K_{t+1} = K_t + PI_t - D_t$$

where K is the net private capital stock, PI is the private investment and D is the private depreciation of the capital stock.

The benchmark capital stock level for 1975 is constructed as follows. We use the ESRI Prefecture Private Capital Stock data for the benchmark regional private firm fixed asset. For the benchmark private inventory stock, we use the Private and Public Sector Balance Sheet data. Since only the national private inventory stock data is available, we allocate the stock to each prefecture using the relative size of private firm capital stock to construct the benchmark regional private inventory stock. The value of benchmark regional private capital stock is converted into constant 2000 prices using the regional GDP deflator.

Once we pin down the initial capital stock level, we can use the capital accumulation equation and annual flow data to construct the regional net capital stock series. The regional private investment is available directly from the expenditure data. We obtain regional private depreciation as the difference between total depreciation and the depreciation for government service providers using the ESRI Prefecture Gross Domestic Product by Economic Activity and Factor Income data. Both series are converted into constant 2000 price series using the regional GDP deflator. The capital depreciation rate can be computed by dividing the regional private depreciation by the constructed net capital stock.

A.2 Labor Income Share

The labor income share is constructed following Hayashi and Prescott (2002). They define labor income as the sum of compensation of employees, half of indirect business tax, and 80% of mixed income. Part of indirect business taxes paid by the firms is considered as the contribution of labor to production extracted from the government. "For lack of good alternatives" they choose to split the taxes equally between labor and capital income. They define mixed income as the "operating surplus in the nonhousing component of the noncorporate sector" of which 80% is assumed to be labor income.

The compensation of employees and indirect business taxes ('tax on production and imports') are available at the prefecture level in the Prefecture Gross Domestic Product by Economic Activity and Factor Income data. However, mixed income is not available independently as it is reported as 'operating surplus and mixed income'. In order to construct the mixed income series, we first use the Prefecture Residents Income data to compute the ratio of mixed income to the sum of operating surplus and mixed income of the residents:

$$\frac{\text{mixed income}}{\text{mixed income + operating surplus}} = \frac{\text{proprietors income - imputed rent}}{\text{nonfirm property income + business income}}.$$

Then we multiply the prefecture domestic operating surplus and mixed income by this ratio to construct the prefecture domestic mixed income series.

Finally, the constructed labor income series is divided by regional GDP to compute the labor income share. In terms of national income accounting, labor income, capital income and depreciation will add up to GDP where capital income is defined as the sum of corporate operating surplus, half of indirect business tax, 20% of mixed income, and imputed rent.

B Tables and Figures

Table 1. Summary Statistics of Regional Output: 1955-2008

	y^i/y		$g(y^i)$		$corr(y^i, y)$		$std(y^i)/std(y)$	
National	1.000		3.85%		1.000		1.000	
Hokkaido	0.932		3.30%		0.760		0.962	
Tohoku	0.792		4.28%		0.712		0.858	
Kanto	1.190		3.61%		0.964		1.135	
Chubu	1.071		4.09%		0.955		1.075	
Kinki	0.966		3.47%		0.958		1.134	
Chugoku	0.920		3.99%		0.933		1.043	
Shikoku	0.824		3.84%		0.857		1.020	
Kyushu	0.799		3.96%		0.877		0.914	
Okinawa	0.626		4.26%		0.045		1.048	
Average	0.887		3.97%		0.731		1.165	
1	Tokyo	1.764	Nagano	4.71%	Mie	0.924	Shiga	1.705
2	Osaka	1.195	Fukushima	4.65%	Chiba	0.915	Chiba	1.592
3	Aichi	1.140	Yamanashi	4.57%	Saitama	0.902	Mie	1.554
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
45	Kumamoto	0.694	Nara	3.23%	Saga	0.429	Kagoshima	0.892
46	Kagoshima	0.689	Hyogo	3.17%	Aomori	0.387	Niigata	0.844
47	Okinawa	0.626	Wakayama	2.86%	Okinawa	0.045	Kochi	0.842

Table 2. GDP Share of Expenditures (%): 1955-2008

	Private				Government			
	Consumption		Investment		Consumption		Investment	
National	48.6		22.2		15.1		7.5	
Hokkaido	54.2		18.3		21.7		12.9	
Tohoku	53.4		21.6		20.6		10.7	
Kanto	46.7		21.6		12.4		5.9	
Chubu	47.6		23.2		13.6		7.8	
Kinki	49.4		23.2		13.3		6.4	
Chugoku	47.4		23.4		17.1		8.6	
Shikoku	51.4		21.3		19.8		9.4	
Kyushu	49.7		22.3		21.1		8.9	
Okinawa	53.3		25.0		26.7		11.5	
Average	51.4		22.7		18.2		11.5	
1	Nara	68.8	Ibaraki	33.2	Okinawa	26.7	Fukui	15.9
2	Saitama	64.1	Mie	31.4	Nagasaki	25.9	Shimane	14.8
3	Chiba	64.1	Hyogo	27.5	Tottori	25.6	Iwate	14.1
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
45	Tochigi	44.2	Tottori	18.6	Osaka	11.5	Shizuoka	5.5
46	Fukuoka	43.5	Hokkaido	18.3	Kanagawa	11.4	Osaka	5.5
47	Tokyo	37.5	Tokyo	18.1	Aichi	9.6	Tokyo	5.2

Table 3a. Intra-Regional Expenditure Correlation with Output: 1955-2008

	$\text{corr}(pc^i, y^i)$		$\text{corr}(pi^i, y^i)$		$\text{corr}(gc^i, y^i)$		$\text{corr}(gi^i, y^i)$	
National	0.489		0.727		0.081		0.193	
Hokkaido	0.043		0.540		0.409		0.163	
Tohoku	0.577		0.651		0.298		0.132	
Kanto	0.510		0.765		-0.024		0.126	
Chubu	0.512		0.769		0.037		-0.051	
Kinki	0.334		0.650		0.142		0.426	
Chugoku	0.548		0.670		0.060		0.325	
Shikoku	0.589		0.620		0.244		0.343	
Kyushu	0.496		0.588		0.424		0.552	
Okinawa	0.633		0.072		0.412		0.404	
Average	0.467		0.577		0.234		0.212	
1	Gunma	0.817	Aichi	0.806	Miyazaki	0.638	Tokushima	0.606
2	Mie	0.712	Miyagi	0.749	Nagasaki	0.632	Hyogo	0.606
3	Fukushima	0.699	Kagawa	0.742	Fukui	0.499	Saga	0.557
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
45	Wakayama	00092	Oita	0.260	Kanagawa	-0.102	Kagawa	-0.058
46	Hokkaido	0.043	Nagasaki	0.240	Gifu	-0.118	Shizuoka	-0.075
47	Osaka	-0.044	Okinawa	0.072	Aichi	-0.177	Aichi	-0.139

Table 3b. Intra-Regional Expenditure Volatility relative to Output: 1955-2008

	$std(pc^i)/std(y^i)$		$std(pi^i)/std(y^i)$		$std(gc^i)/std(y^i)$		$std(gi^i)/std(y^i)$	
National	0.565		3.373		0.864		2.020	
Hokkaido	0.813		2.692		0.762		2.343	
Tohoku	0.877		2.900		1.061		2.722	
Kanto	0.518		3.413		1.184		2.237	
Chubu	0.592		3.300		0.804		1.929	
Kinki	0.603		3.302		1.138		2.422	
Chugoku	0.615		3.549		0.976		2.794	
Shikoku	0.685		3.245		0.891		2.591	
Kyushu	0.824		2.926		0.985		2.499	
Okinawa	1.541		2.983		1.316		4.044	
Average	0.829		3.041		1.130		3.018	
1	Okinawa	1.541	Ibaraki	4.235	Fukui	1.746	Niigata	4.413
2	Akita	1.174	Fukui	4.187	Gunma	1.731	Kagawa	4.308
3	Kumamoto	1.169	Kochi	3.957	Akita	1.545	Fukui	4.269
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
45	Aichi	0.576	Kagoshima	2.371	Tokushima	0.639	Fukuoka	2.256
46	Tokyo	0.535	Miyazaki	2.271	Mie	0.612	Shiga	1.755
47	Hiroshima	0.513	Chiba	2.223	Saitama	0.610	Aichi	1.459

Table 4a. Expenditure Correlation with National Aggregate: 1955-2008

	$corr(pc^i, c)$		$corr(pi^i, i)$		$corr(gc^i, gc)$		$corr(gi^i, gi)$	
Hokkaido	0.619		0.769		0.463		0.659	
Tohoku	0.782		0.859		0.813		0.725	
Kanto	0.848		0.979		0.865		0.860	
Chubu	0.919		0.986		0.869		0.918	
Kinki	0.860		0.985		0.868		0.863	
Chugoku	0.834		0.953		0.859		0.765	
Shikoku	0.760		0.918		0.780		0.659	
Kyushu	0.813		0.922		0.678		0.823	
Okinawa	0.202		0.572		0.206		0.289	
Average	0.609		0.815		0.585		0.575	
1	Fukui	0.856	Osaka	0.974	Miyagi	0.835	Oita	0.796
2	Yamaguchi	0.837	Saitama	0.948	Hyogo	0.825	Aichi	0.777
3	Chiba	0.830	Shizuoka	0.946	Yamaguchi	0.801	Saga	0.769
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
45	Oita	0.389	Akita	0.607	Okinawa	0.206	Fukui	0.329
46	Shiga	0.387	Okinawa	0.572	Nagasaki	0.170	Okinawa	0.289
47	Okinawa	0.202	Aomori	0.539	Shiga	0.108	Kagawa	0.210

Table 4b. Expenditure Volatility relative to National Aggregate: 1955-2008

	$std(pc^i)/std(pc)$		$std(pi^i)/std(pi)$		$std(gc^i)/std(gc)$		$std(gi^i)/std(gi)$	
Hokkaido	1.384		0.767		0.849		1.116	
Tohoku	1.332		0.738		1.054		1.157	
Kanto	1.041		1.149		1.557		1.257	
Chubu	1.127		1.051		1.001		1.027	
Kinki	1.212		1.110		1.493		1.360	
Chugoku	1.137		1.098		1.179		1.443	
Shikoku	1.238		0.981		1.052		1.308	
Kyushu	1.334		0.793		1.042		1.131	
Okinawa	2.861		0.927		1.598		2.099	
Average	1.677		1.043		1.498		1.701	
1	Okinawa	2.861	Ibaraki	1.660	Wakayama	2.199	Kagawa	2.681
2	Nagasaki	2.353	Shiga	1.358	Gunma	2.169	Yamanashi	2.189
3	Mie	2.304	Hiroshima	1.338	Tokyo	2.121	Nagasaki	2.120
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
45	Miyagi	1.186	Saga	0.753	Tottori	1.014	Kagoshima	1.363
46	Hiroshima	1.155	Aomori	0.744	Tokushima	0.888	Hokkaido	1.116
47	Tokyo	1.126	Kagoshima	0.627	Hokkaido	0.849	Aichi	1.039

Table 5. Production Factor relative to National Aggregate: 1975-2008

	Labor		Capital		TFP	
Hokkaido	0.979		0.861		0.961	
Tohoku	1.020		0.782		0.912	
Kanto	1.004		1.045		1.134	
Chubu	1.076		1.208		0.974	
Kinki	0.943		0.963		0.963	
Chugoku	1.021		1.066		0.905	
Shikoku	0.994		0.872		0.879	
Kyushu	0.958		0.841		0.901	
Okinawa	0.851		0.661		0.882	
Average	0.992		0.942		0.933	
1	Tokyo	1.374	Mie	1.722	Tokyo	1.330
2	Nagano	1.101	Ibaraki	1.596	Saitama	1.096
3	Fukui	1.097	Hyogo	1.339	Shiga	1.074
⋮	⋮	⋮	⋮	⋮	⋮	⋮
45	Chiba	0.740	Nara	0.626	Wakayama	0.796
46	Saitama	0.738	Saitama	0.618	Mie	0.790
47	Nara	0.669	Kumamoto	0.617	Ibaraki	0.784

Table 6a. Intra-Regional Factor Correlation with Output: 1975-2008

	$\text{corr}(l^i, y^i)$		$\text{corr}(k^i, y^i)$		$\text{corr}(z^i, y^i)$	
National	0.643		0.428		0.829	
Hokkaido	0.518		0.510		0.613	
Tohoku	0.605		0.375		0.756	
Kanto	0.504		0.259		0.887	
Chubu	0.684		0.366		0.863	
Kinki	0.725		0.569		0.884	
Chugoku	0.540		0.335		0.818	
Shikoku	0.358		0.584		0.616	
Kyushu	0.747		0.660		0.718	
Okinawa	0.159		0.166		0.800	
Average	0.383		0.298		0.813	
1	Tochigi	0.727	Osaka	0.738	Osaka	0.957
2	Aichi	0.679	Kagawa	0.698	Tochigi	0.937
3	Saitama	0.666	Fukuoka	0.636	Kanagawa	0.926
⋮	⋮	⋮	⋮	⋮	⋮	⋮
45	Kyoto	0.039	Shizuoka	-0.035	Kochi	0.602
46	Wakayama	-0.012	Fukui	-0.090	Nagasaki	0.544
47	Tokushima	-0.089	Wakayama	-0.100	Kagoshima	0.487

Table 6b. Intra-Regional Factor Volatility relative to Output

	$std(l^i)/std(y^i)$		$std(k^i)/std(y^i)$		$std(z^i)/std(y^i)$	
National	0.527		0.808		0.795	
Hokkaido	1.114		0.898		0.762	
Tohoku	0.691		0.811		0.833	
Kanto	0.433		0.808		0.885	
Chubu	0.512		0.694		0.799	
Kinki	0.463		0.768		0.704	
Chugoku	0.603		0.693		0.872	
Shikoku	0.959		0.918		0.936	
Kyushu	0.728		0.752		0.662	
Okinawa	0.800		0.844		1.084	
Average	0.671		0.729		0.940	
1	Kagoshima	1.328	Kagoshima	1.170	Kagoshima	1.203
2	Nagasaki	1.142	Ibaraki	1.014	Fukui	1.177
3	Kochi	1.117	Gifu	0.961	Yamanashi	1.131
⋮	⋮	⋮	⋮	⋮	⋮	⋮
45	Fukushima	0.419	Tochigi	0.479	Saga	0.752
46	Nara	0.407	Toyama	0.453	Iwate	0.723
47	Osaka	0.351	Wakayama	0.380	Osaka	0.701

Table 7a. Factor Correlation with National Aggregate: 1975-2008

	$corr(l^i, l)$		$corr(k^i, k)$		$corr(z^i, z)$		$corr(y^i, y)$	
Hokkaido	0.693		0.559		0.413		0.687	
Tohoku	0.906		0.910		0.764		0.816	
Kanto	0.905		0.985		0.953		0.945	
Chubu	0.962		0.970		0.946		0.957	
Kinki	0.944		0.986		0.820		0.907	
Chugoku	0.869		0.936		0.879		0.929	
Shikoku	0.871		0.967		0.486		0.613	
Kyushu	0.831		0.948		0.765		0.777	
Okinawa	0.528		0.762		0.499		0.398	
Average	0.749		0.861		0.583		0.664	
1	Wakayama	0.922	Kanagawa	0.974	Mie	0.872	Mie	0.932
2	Fukushima	0.906	Osaka	0.972	Tokyo	0.855	Hiroshima	0.909
3	Kagawa	0.904	Kyoto	0.967	Shizuoka	0.826	Aichi	0.888
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
45	Okinawa	0.528	Kumamoto	0.669	Saga	0.288	Kagoshima	0.334
46	Saga	0.471	Shimane	0.623	Ibaraki	0.231	Wakayama	0.308
47	Nara	0.395	Hokkaido	0.559	Kochi	-0.092	Kochi	0.086

Table 7b. Factor Volatility relative to National Aggregate: 1975-2008

	$std(l^i)/std(l)$		$std(k^i)/std(k)$		$std(z^i)/std(z)$		$std(y^i)/std(y)$	
Hokkaido	1.643		0.863		0.745		0.777	
Tohoku	1.309		1.001		1.046		0.998	
Kanto	0.994		1.209		1.347		1.209	
Chubu	1.042		0.921		1.079		1.072	
Kinki	1.014		1.096		1.023		1.154	
Chugoku	1.149		0.861		1.102		1.004	
Shikoku	1.513		0.944		0.979		0.831	
Kyushu	1.278		0.860		0.771		0.925	
Okinawa	1.270		0.874		1.142		0.837	
Average	1.409		1.027		1.371		1.170	
1	Nagasaki	2.362	Ibaraki	1.891	Ibaraki	2.071	Fukushima	1.696
2	Kochi	1.984	Hyogo	1.567	Wakayama	1.930	Hyogo	1.626
3	Ehime	1.947	Nara	1.540	Fukushima	1.876	Aichi	1.561
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
45	Gunma	0.967	Okayama	0.726	Miyazaki	0.914	Fukui	0.816
46	Osaka	0.881	Toyama	0.673	Kagoshima	0.881	Hokkaido	0.777
47	Gifu	0.876	Wakayama	0.651	Hokkaido	0.745	Kagoshima	0.582

Table 8. Income Statistics: 1975-2008

	Labor Income Share				Capital Depreciation			
	Level		$corr(1-\theta_i, y_i)$		Rate		$corr(\delta_i, y_i)$	
National	0.593		-0.715		0.077		0.489	
Hokkaido	0.635		-0.419		0.073		0.551	
Tohoku	0.584		-0.392		0.087		0.396	
Kanto	0.597		-0.716		0.083		0.620	
Chubu	0.586		-0.694		0.079		0.543	
Kinki	0.592		-0.686		0.066		0.317	
Chugoku	0.588		-0.610		0.069		0.541	
Shikoku	0.588		0.010		0.075		0.338	
Kyushu	0.591		-0.618		0.077		0.334	
Okinawa	0.540		-0.243		0.083		0.438	
1	Tokyo	0.645	Yamanashi	-0.828	Saitama	0.094	Saitama	0.773
2	Kochi	0.635	Saitama	-0.738	Kumamoto	0.094	Yamanashi	0.745
3	Hokkaido	0.635	Shizuoka	-0.732	Chiba	0.085	Chiba	0.718
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
45	Chiba	0.537	Saga	0.022	Ibaraki	0.045	Nagano	0.017
46	Ehime	0.529	Kochi	0.099	Wakayama	0.045	Kagoshima	-0.055
47	Shiga	0.489	Ehime	0.115	Mie	0.043	Hyogo	-0.185

Table 9. Efficiency relative to National Aggregate: 1975-2008

	MPL		MPK		Labor Wedge		Capital Wedge	
Hokkaido	0.978		0.935		1.047		1.006	
Tohoku	0.804		1.090		1.103		0.997	
Kanto	1.159		1.098		0.954		0.946	
Chubu	1.008		0.928		1.081		1.132	
Kinki	0.969		0.955		0.991		0.933	
Chugoku	0.913		0.894		1.012		1.062	
Shikoku	0.825		0.963		1.071		0.995	
Kyushu	0.852		0.978		0.959		1.041	
Okinawa	0.720		1.151		0.932		0.873	
National	0.891		1.010		1.046		1.016	
1	Tokyo	1.409	Saitama	1.350	Akita	1.238	Ibaraki	1.311
2	Osaka	1.120	Ishikawa	1.319	Tottori	1.228	Mie	1.284
3	Kanagawa	1.086	Shiga	1.299	Niigata	1.200	Yamaguchi	1.139
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
45	Ehime	0.751	Wakayama	0.667	Nara	0.877	Okinawa	0.873
46	Aomori	0.742	Mie	0.604	Aomori	0.876	Ishikawa	0.858
47	Okinawa	0.720	Ibaraki	0.600	Fukuoka	0.836	Shiga	0.842

Table 10. Growth Accounting (%): 1975-2008

	Output		Labor		Capital		TFP	
National	1.99		-0.25		1.19		1.05	
Hokkaido	1.68		-0.39		0.83		1.24	
Tohoku	2.12		-0.28		1.34		1.05	
Kanto	1.93		-0.22		1.10		1.06	
Chubu	2.28		-0.23		1.55		0.96	
Kinki	1.72		-0.30		0.96		1.06	
Chugoku	1.89		-0.31		1.10		1.10	
Shikoku	1.75		-0.25		1.11		0.89	
Kyushu	1.96		-0.22		1.30		0.89	
Okinawa	1.84		0.02		1.28		0.53	
1	Fukushima	2.74	Nagasaki	0.05	Mie	1.86	Nagano	1.62
2	Nagano	2.68	Okinawa	0.02	Ibaraki	1.79	Fukushima	1.57
3	Shiga	2.57	Saga	-0.07	Aomori	1.58	Iwate	1.47
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
45	Fukuoka	1.53	Hokkaido	-0.39	Hokkaido	0.83	Aomori	0.46
46	Kochi	1.27	Nagano	-0.40	Fukui	0.77	Mie	0.45
47	Wakayama	0.77	Tokushima	-0.41	Chiba	0.69	Wakayama	0.02

Table 11. Growth Regression

	Growth 1955-2008				Growth 1975-2008			
	(1)		(2)		(3)		(4)	
Constant	0.049	**	0.013		0.023	**	-0.013	
	(32.027)		(1.013)		(7.401)		(-1.052)	
Initial	-0.011	**	-0.014	**	-0.004		-0.009	**
Output	(-6.260)		(-5.217)		(-1.152)		(-2.249)	
TFP			0.023	**			0.023	**
Gap			(2.187)				(2.254)	
Labor			0.012				-0.007	
Share			(0.989)				(-0.617)	
Capital			-0.029				-0.018	
Depreciation			(-0.527)				(-0.396)	
Population			-0.300	**			-0.505	**
Growth			(-3.089)				(-3.032)	
Private			0.051	**			0.104	**
Investment			(2.714)				(4.195)	
Government			-0.022				-0.012	
Investment			(-1.160)				(-0.637)	
TFP			0.428	**			0.709	**
Growth			(3.764)				(6.708)	
R^2	0.454		0.707		0.007		0.650	

Table 12. Calibrated Parameters

θ	Capital income share	0.407
δ	Depreciation rate	0.077
Γ	Productivity growth	1.020
n	Population growth	1.004
β	Subjective discount factor	0.995
R	Real return on claims	1.029
Ψ	Preference weight	0.305

Table 13a. Contribution Index for Output Fluctuation: 1975-2008

	ω^e		ω^g		ω^l		ω^f		ω^k	
National	1.026		-0.031		-0.037		0.190		-0.148	
Hokkaido	0.902		-0.010		0.022		0.253		-0.167	
Tohoku	0.950		-0.020		0.071		0.115		-0.116	
Kanto	1.191		-0.033		-0.116		0.161		-0.202	
Chubu	1.070		-0.024		-0.092		0.239		-0.193	
Kinki	0.901		-0.022		-0.134		0.251		0.004	
Chugoku	1.087		-0.044		-0.021		0.150		-0.172	
Shikoku	0.859		-0.001		-0.088		0.150		0.081	
Kyushu	0.774		-0.004		0.185		0.024		0.021	
Okinawa	1.338		0.002		-0.165		0.065		-0.241	
Average	1.113		-0.015		-0.130		0.131		-0.099	
1	Wakayama	1.437	Ehime	0.027	Nagasaki	0.377	Nagano	0.357	Kochi	0.330
2	Nara	1.409	Kochi	0.021	Kumamoto	0.168	Aomori	0.326	Nagasaki	0.270
3	Yamanashi	1.385	Fukui	0.013	Saga	0.074	Shiga	0.300	Osaka	0.135
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
45	Kochi	0.528	Yamaguchi	-0.034	Shiga	-0.394	Yamaguchi	-0.042	Yamanashi	-0.289
46	Saga	0.471	Tottori	-0.047	Tokushima	-0.416	Nara	-0.112	Nara	-0.293
47	Nagasaki	0.395	Kagawa	-0.064	Shimane	-0.425	Kumamoto	-0.142	Kumamoto	-0.342

Table 13b. Contribution Index for Consumption Fluctuation: 1975-2008

	ω^e		ω^g		ω^l		ω^f		ω^k	
National	0.672		0.041		0.056		-0.161		0.391	
Hokkaido	0.129		-0.009		0.155		0.625		0.100	
Tohoku	0.413		0.029		0.167		0.154		0.236	
Kanto	0.563		0.030		0.041		0.009		0.357	
Chubu	0.719		0.044		0.010		-0.224		0.451	
Kinki	0.626		0.037		0.097		0.197		0.043	
Chugoku	0.571		0.022		0.075		0.327		0.006	
Shikoku	0.496		-0.010		-0.029		0.569		-0.026	
Kyushu	0.115		0.011		0.296		0.360		0.218	
Okinawa	0.038		0.000		0.274		0.681		0.006	
Average	0.319		0.012		0.155		0.421		0.092	
1	Hiroshima	0.830	Miyagi	0.041	Aomori	0.379	Kochi	0.811	Aichi	0.325
2	Tokyo	0.700	Hyogo	0.031	Miyazaki	0.376	Nagano	0.784	Tokyo	0.324
3	Shizuoka	0.668	Yamagata	0.031	Niigata	0.349	Yamanashi	0.720	Miyagi	0.296
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
45	Aomori	-0.116	Shimane	-0.008	Hiroshima	0.000	Miyagi	0.035	Ehime	-0.066
46	Miyazaki	-0.120	Hokkaido	-0.009	Tokyo	-0.036	Tokyo	-0.019	Yamanashi	-0.105
47	Nagano	-0.132	Kochi	-0.026	Aichi	-0.049	Hyogo	-0.023	Kochi	-0.157

Table 14a. Contribution Index for Output Correlation: 1975-2008

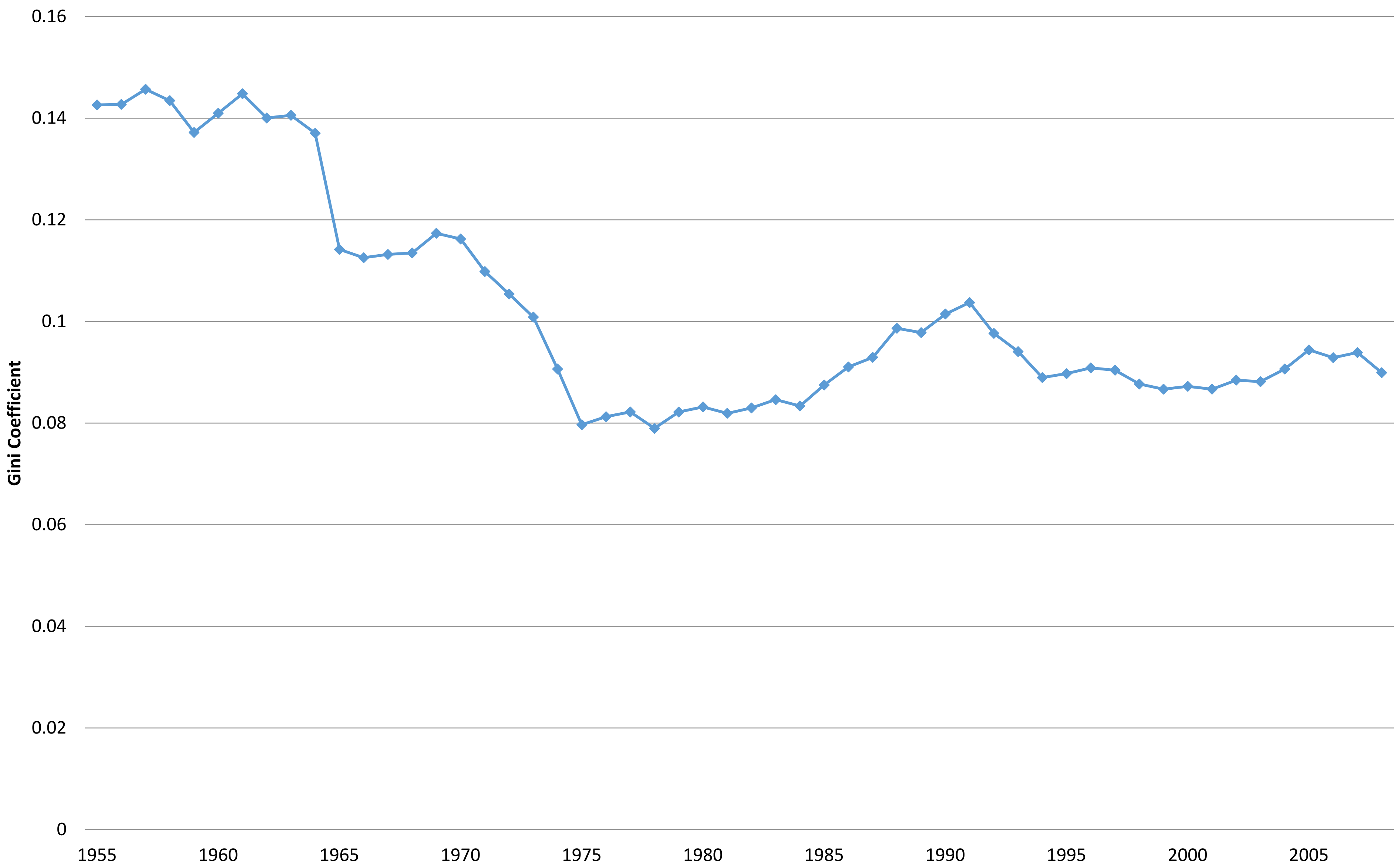
	ω^e	ω^g	ω^l	ω^f	ω^k
National	1.026	-0.031	-0.037	0.190	-0.148
Hokkaido	0.641	-0.039	0.253	0.218	-0.386
Tohoku	0.925	-0.036	0.088	0.064	-0.225
Kanto	0.955	-0.023	-0.028	0.111	-0.069
Chubu	0.962	-0.029	-0.050	0.227	-0.154
Kinki	0.962	-0.029	-0.148	0.268	-0.145
Chugoku	1.028	-0.042	-0.013	0.156	-0.199
Shikoku	0.558	-0.037	0.018	0.287	-0.213
Kyushu	0.778	-0.025	0.053	0.128	-0.156
Okinawa	0.291	-0.033	0.099	0.060	-0.020
Average	0.672	-0.029	0.038	0.134	-0.151

	ω^e		ω^g		ω^l		ω^f		ω^k	
1	Toyama	1.084	Fukui	0.023	Fukui	0.436	Kochi	0.398	Saitama	0.004
2	Kanagawa	1.032	Nagasaki	0.000	Kumamoto	0.281	Yamanashi	0.354	Tokyo	-0.001
3	Hiroshima	0.983	Fukuoka	-0.012	Yamaguchi	0.265	Miyazaki	0.315	Okinawa	-0.020
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
45	Wakayama	0.284	Wakayama	-0.050	Yamanashi	-0.148	Chiba	-0.040	Kumamoto	-0.297
46	Ibaraki	0.167	Niigata	-0.053	Shiga	-0.200	Fukushima	-0.056	Toyama	-0.306
47	Kochi	-0.343	Kagoshima	-0.067	Osaka	-0.226	Fukui	-0.060	Hokkaido	-0.386

Table 14b. Contribution Index for Consumption Correlation: 1975-2008

	ω^e		ω^g		ω^l		ω^f		ω^k	
National	0.672		0.041		0.056		-0.161		0.391	
Hokkaido	0.255		0.031		0.173		-0.231		0.109	
Tohoku	0.454		0.037		0.153		0.077		0.202	
Kanto	0.487		0.027		0.048		0.048		0.345	
Chubu	0.734		0.047		0.024		-0.337		0.397	
Kinki	0.781		0.042		-0.112		-0.488		0.380	
Chugoku	0.562		0.036		0.056		-0.103		0.223	
Shikoku	0.294		0.032		0.122		-0.420		0.287	
Kyushu	0.346		0.022		0.124		0.019		0.179	
Okinawa	0.035		0.013		0.026		-0.080		0.094	
Average	0.319		0.026		0.067		-0.106		0.195	
1	Hyogo	0.957	Hyogo	0.054	Fukui	0.280	Fukui	0.247	Tokyo	0.411
2	Hiroshima	0.825	Miyagi	0.050	Niigata	0.238	Chiba	0.214	Hyogo	0.380
3	Aichi	0.771	Niigata	0.047	Kumamoto	0.223	Kyoto	0.213	Hiroshima	0.327
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
45	Ibaraki	0.013	Nagasaki	0.007	Aichi	-0.149	Aichi	-0.495	Saga	0.075
46	Wakayama	0.008	Kagawa	0.005	Osaka	-0.153	Kagawa	-0.542	Okayama	0.074
47	Kochi	-0.175	Fukui	-0.002	Hyogo	-0.218	Hyogo	-0.715	Fukushima	0.067

Figure 1. Inequality



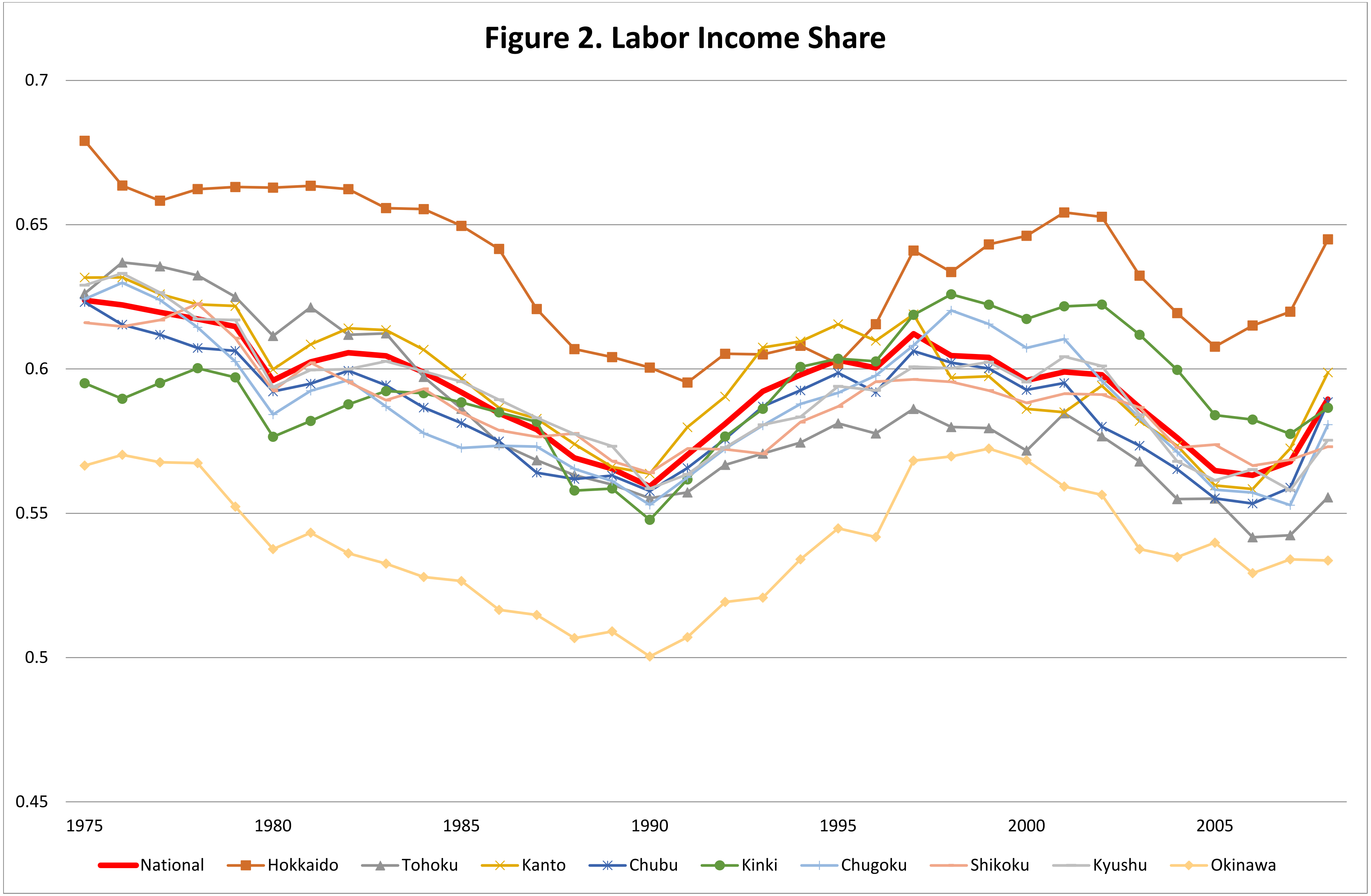


Figure 2. Labor Income Share
0.7
0.65
0.6
0.55
0.5
0.45
1975
1980
1985
1990
1995
2000
2005
National
Hokkaido
Tohoku
Kanto
Chubu
Kinki
Chugoku
Shikoku
Kyushu
Okinawa

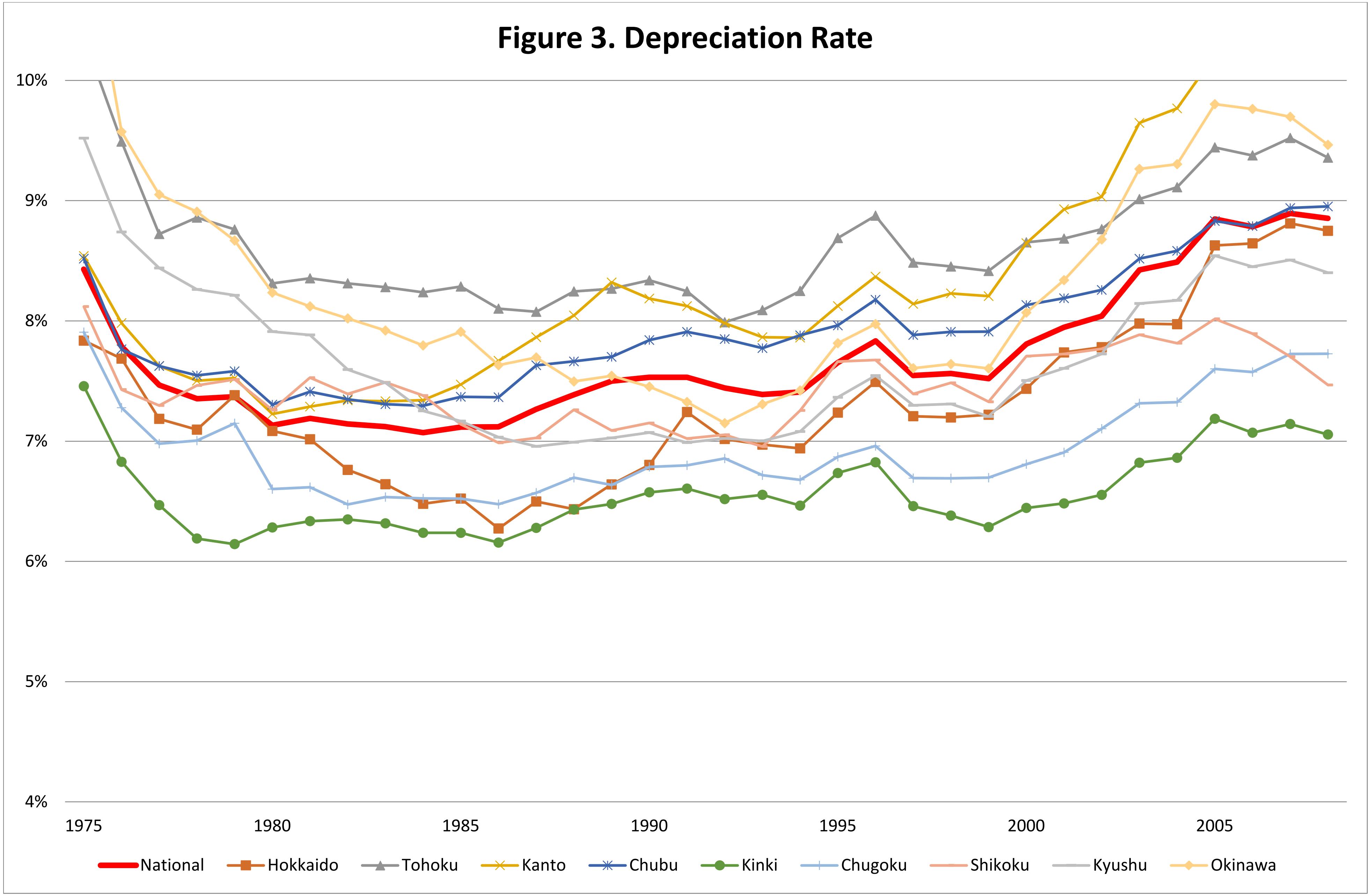


Figure 3. Depreciation Rate
10%
9%
8%
7%
6%
5%
4%
1975
1980
1985
1990
1995
2000
2005
National
Hokkaido
Tohoku
Kanto
Chubu
Kinki
Chugoku
Shikoku
Kyushu
Okinawa

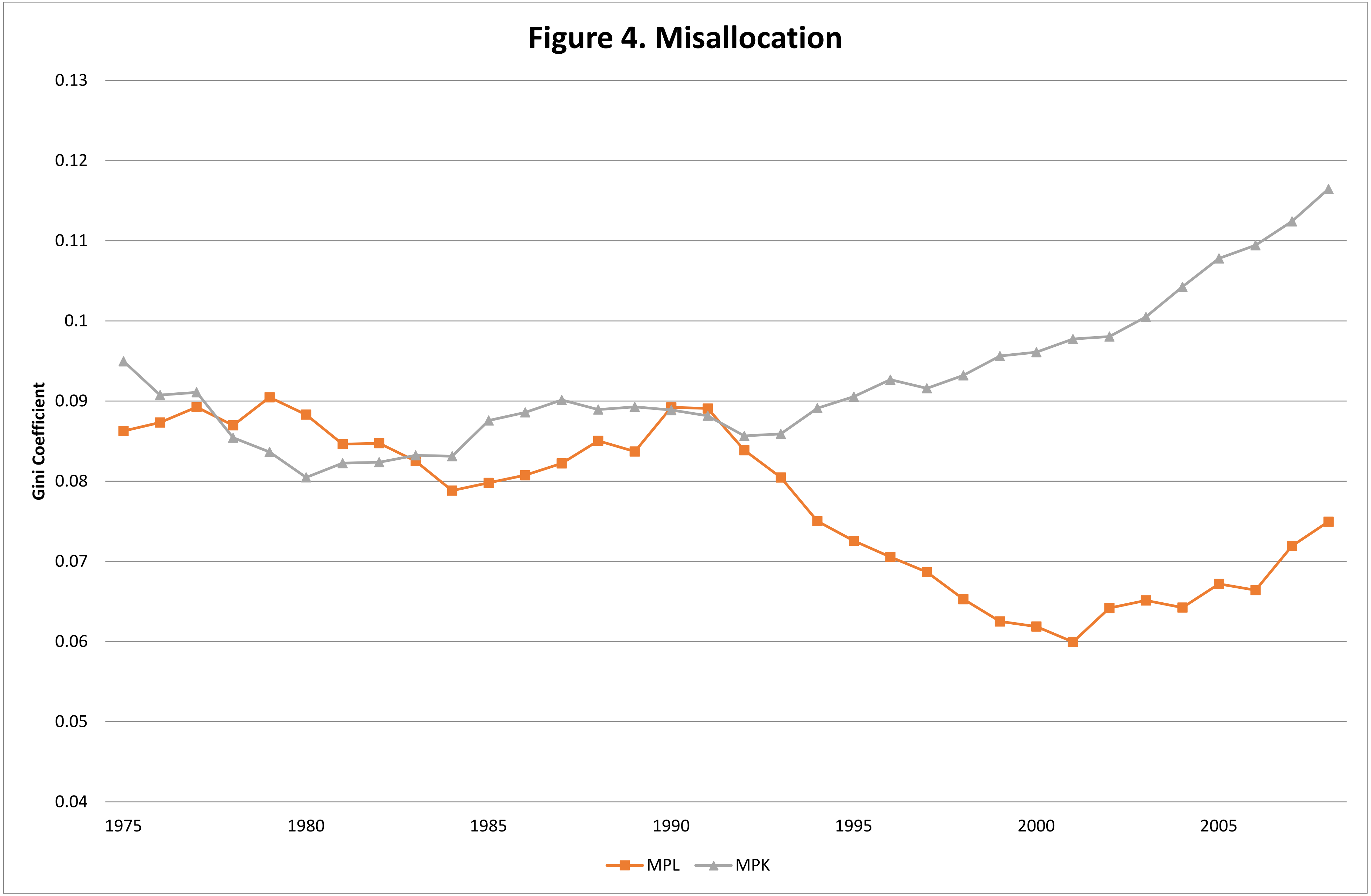
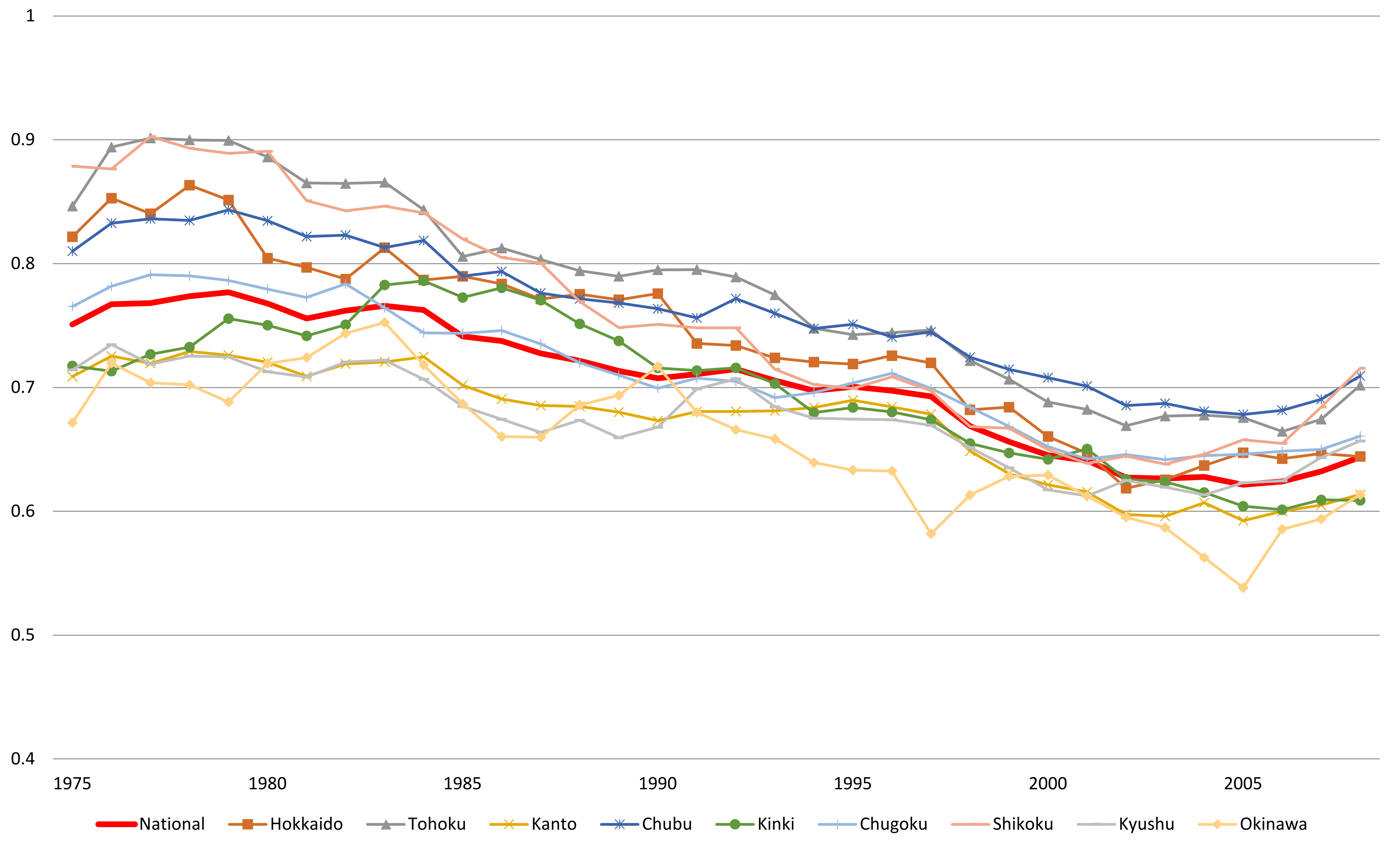


Figure 4. Misallocation
Gini Coefficient
0.13
0.12
0.11
0.1
0.09
0.08
0.07
0.06
0.05
0.04
1975
1980
1985
1990
1995
2000
2005
MPL
MPK

Figure 5. Labor Wedge



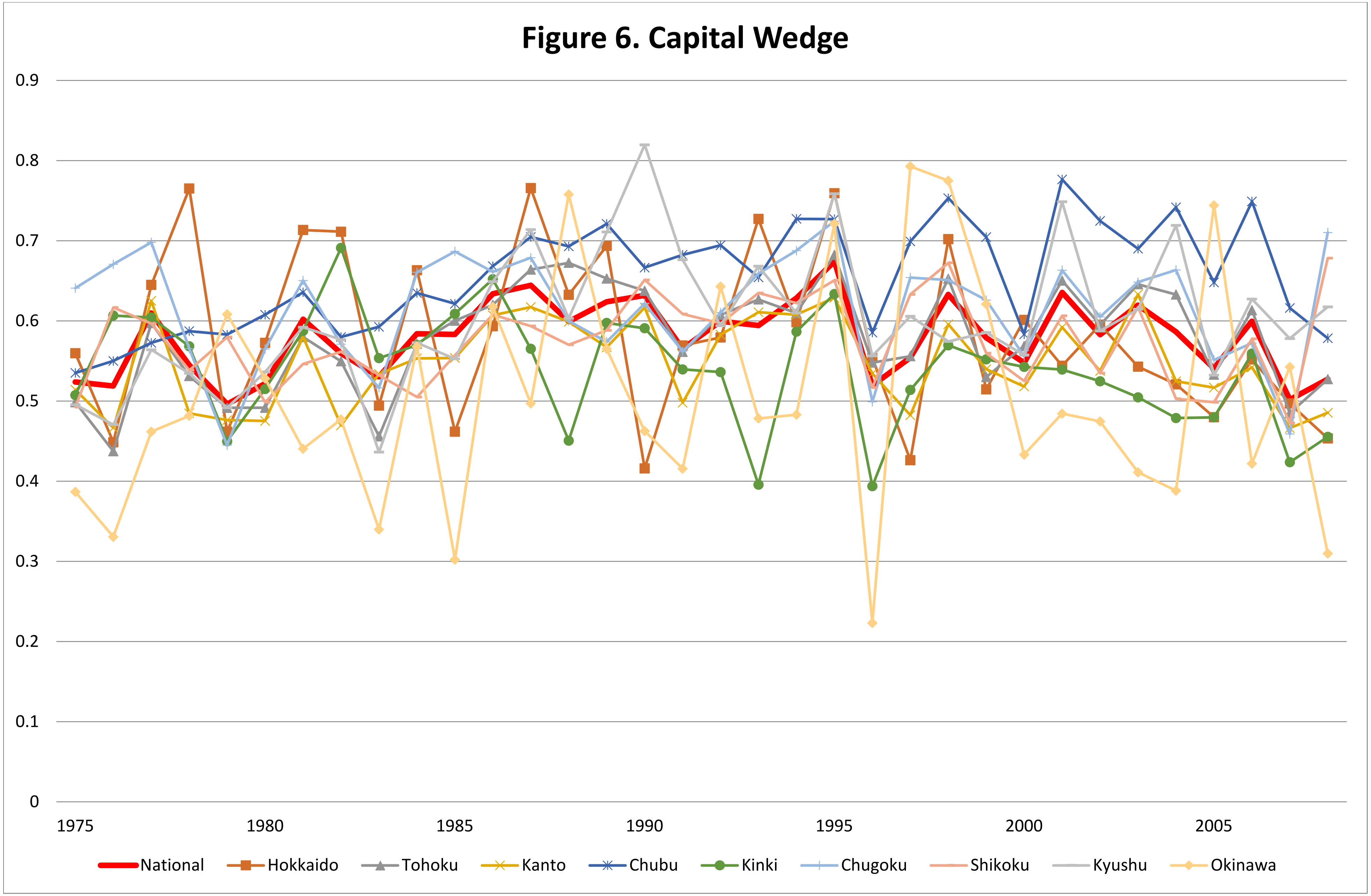


Figure 6. Capital Wedge
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
1975
1980
1985
1990
1995
2000
2005
National
Hokkaido
Tohoku
Kanto
Chubu
Kinki
Chugoku
Shikoku
Kyushu
Okinawa