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Measuring differences in regional cost of living index in Japan

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Abstract

In this study, we clarify the existence of regional disparities in the cost of living index in Japan. In order to measure this, we compare the differences in the cost of living among 47 prefectural government cities as well as nine regions, which allows us to determine whether regional differences occur in city or regional units. In addition, we reveal changes in the cost of living index resulting because of long-term price variations and temporary price fluctuations, due to, for example, frequent changes in raw material costs and the increase in consumption tax in April 2014.

Keywords: Regional cost of living index; Fisher index; Subindex; Contribution of each commodity

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1. Introduction

Japan is divided into 47 prefectural government cities that certainly differ by price, expenditure on commodities depending on each city. In analyzing by commodity such as demand system, the importance and weight of commodities should be different by city. For example, in Sapporo city the weight of fuel, light and water changes is higher than in other cities because of the cold climate. Further the price trend also varies from city to city. As a whole, we think that a regional difference in prices is occurring in Japan. The 47 prefectural government cities are allocated in nine regions, for which we assume the same condition of price changes.

One of the fundamental problems that the Japanese economy is having is the prolongation of price deflation. In 2013, the Japanese government highlighted the departure from deflation as fiscal objective, although it is not yet to be realized and inflation rate of prices remains low. In order to resolve the price deflation as a whole, it is necessary to increase the price of commodities by city or regional unit. If there really is a regional difference in prices in Japan, it will be possible to expect a rise in overall price by eliminating regional differences.

This study aims to clarify regional disparity in price changes for commodities by adopting a framework for the cost of living index and confirm whether the difference occurs in Japan's city units and/or regional units. More specially, we examine that if each city has varying or synchronized responses to certain temporary price changes, and if cities in the same region have similar. To achieve the inflation target by capturing this trend, we determine whether it is necessary to deal with each city or region. Ravallion and Walle (1991) showed that in the case of a developing country, the cost of living index in urban area is substantially higher than that in rural ones. These differences have also been studied in developed countries such as the United States (Kurre, 2003). Considering the degree of economic disparity, it is possible that Japan reports little disparity compared to these countries. However, the prices and income levels in Tokyo differ from those in other cities, and thus it is unnatural to assume the lack of disparity. Since this analysis incorporates the demand system framework, price changes or difference in individual commodities affect the cost of living index. Ravallion and Walle (1991), for example, employ housing and rice as commodities with spatial disparities in prices and show that in developing countries, housing prices exhibit spatial disparities between urban and rural areas. Araya and Rivera (2013) also measured the spatial cost of living index for housing goods and estimated the spatial substitution bias between a new price index and cost of living index in Chile.

Contrary to previous studies that adopt micro data, this study employs panel data from a household survey (Thomas, 1980; Kakwani and Hill, 2002), allowing us to capture changes in the cost of living index resulting from temporary price fluctuations. The majority of changes in the cost of living index are accounted for by those in price which may be caused by, for example, a frequent price rise owing to changing raw material costs and temporary fluctuations as a result of natural disasters or revisions in the consumption tax rate. In April 2014, Japan’s consumption tax rate was revised from 5% to 8% and this temporarily increased price. It is reasonable to assume that a price rise as a reaction to temporary factors differs by region. Further, the movement in the cost of living index for these incidents varies by region. Therefore, we also attempt to capture fluctuations caused by price changes in the cost of living index for each region.

The structure of this paper is as follows. In section 2 we introduce the almost ideal demand system (AIDS) model proposed by Deaton and Muellbauer (1980) as an estimation model. Section 3 gives the source of data used for this analysis; Section 4 estimates the cost of living index for 47 cities and for nine regions and compares differences between regions. Finally, section 5 discusses the conclusion of the paper.

2. Model specification

2.1 Model

We use the almost ideal demand system (AIDS) model developed by Deaton and Muellbauer (1980), in order to measure the regional cost of living index (RCLI). It is necessary to specify the exact functional form for the calculation of the RCLI. We have already specified the appropriate demand function for a Japanese household expenditure by using this model in the previous analysis (Ogura, 2015). First, to derive the AIDS model, we begin with a definition of the price independence generalized logarithmic (PIGLOG) cost function in region k as follows.

$$\ln C(u_k, \boldsymbol{p}_k) = \alpha(\boldsymbol{p}_k) + u_k\, \beta(\boldsymbol{p}_k), \tag{1}$$

where $C(u_k, \boldsymbol{p}_k)$ is the minimum cost achieving utility u_k with facing the price vector $\boldsymbol{p}_k$ in region k. We are interested in measuring the RCLI, so that different regions face different prices $\boldsymbol{p}_k$ by region. Therefore $\alpha(\boldsymbol{p}_k)$ and $\beta(\boldsymbol{p}_k)$ are defined as functions of prices in region k as follows.

$$\alpha(\boldsymbol{p}_k) = a_0 + \sum_{i=1}^{n} a_i \ln p_{ik} + \frac{1}{2}\sum_{i=1}^{n}\sum_{j=1}^{n} b_{ij}^{*} \ln p_{ik} \ln p_{jk}\ , \tag{2}$$

$$\beta(\boldsymbol{p}_k) = b_0 \prod_{i=1} p_{ik}^{b_i}, \tag{3}$$

where Eq. (2) is homogeneous in $\boldsymbol{p}_k$ and the translog cost function. Next, the budget share equations can be derived from $\partial \ln C / \partial\, \boldsymbol{p}_k = \boldsymbol{W_k}$ and the i-th budget share in region k can be expressed by

$$w_{ikt} = a_i + \sum_{j=1}^{n} b_{ij} \ln p_{jkt} + c_i \ln\left(\frac{x_{kt}}{P_{kt}}\right) + \sum_{m=1}^{M} d_{im} \ln Z_{mkt} + \varepsilon_{ikt}, \tag{4}$$

$$\text{for} \quad i, j = 1, \dots, n, \quad t = 1, \dots, T, \quad k = 1, \dots, K,$$

where n is the number of commodities in the system, w_{ikt} denotes the i th budget share in region k at period t, $\ln p_{jkt}$ is the log price of commodity j in region k at period t, $\ln\left(\frac{x_{kt}}{P_{kt}}\right)$ is the log real expenditure with $\ln P_{kt}$ of the aggregate price index in region k, and Z_{mkt} is the demographic variable in region k at period t. Further, $\ln P_{kt}$ is given by

$$\ln P_{kt} = a_0 + \sum_{i=1}^{n} a_i \ln p_{ikt} + \frac{1}{2}\sum_{j=1}^{n}\sum_{i=1}^{n} b_{ij} \ln p_{ikt} \ln p_{jkt}\ . \tag{5}$$

Naturally, this price index is nonlinear. In panel estimation, a linearly approximated price index is used to avoid complication of the estimation problem of a nonlinear price index. Therefore, we use $\ln P_{kt}^{S}$ linearly approximated by Stone's (1954) form in substitution for Eq. (5):

$$\ln P_{kt}^{S} = \sum_{i=1}^{n} w_{ikt} \ln p_{ikt}. \tag{6}$$

That is, we estimate the linearly approximated model in this study. Furthermore, in our panel model, the error term ε_{ikt} in Eq. (4) can be written as

$$\varepsilon_{ikt} = \theta_{ik} + \mu_{it} + e_{ikt}, \tag{7}$$

where θ_{ik} denotes an individual fixed effect in region k and μ_{it} denotes a time fixed effect in time. In addition, e_{ikt} is usually assumed to have strong exogeneity with $E(\boldsymbol{e} \mid \boldsymbol{\theta}, \boldsymbol{\mu}, \ln\boldsymbol{p}, \ln(\boldsymbol{x}/\boldsymbol{P}), \ln\boldsymbol{Z}) = 0$.

The AIDS model requires satisfying the conditions of adding-up, homogeneity, and symmetry in the parameters. The adding-up condition, which is automatically satisfied by the use of the $n-1$ equations in the estimation, is $\sum_{i=1}^{n} a_i = 1$ and $\sum_{i=1}^{n} b_{ij} = \sum_{i=1}^{n} c_i = \sum_{i=1}^{n} d_{im} = 0$.The homogeneity restriction for price parameters is $\sum_{j=1}^{n} b_{ij} = 0$, and the symmetry restriction is $b_{ij} = b_{ji}$. Both these restrictions are imposed on parameters in the estimation of Eq. (4).

2.2 Relative regional cost of living index

The cost of living index is determined by the ratio of the minimum cost needed to satisfy the utility and the price change for commodities. There are already many studies focusing on the cost of living index in the framework of demand system, such as those provided by Deaton and Muellbauer (1980), Fry and Parshardes (1989), Lewbel (1989), Pollak (1989), Diewert (2001), and Kakwani and Hill (2002). In particular, Kakwani and Hill (2002) have been developed an axiomatic approach for constructing bilateral and multilateral spatial cost of living indices. They compared with the cost of living indices in Thailand using the Laspeyres, Paasche, Fisher, and Tornqvist indices and showed that the performance of the Fisher and Tornqvist indices are preffered to the Laspeyres and Paasche indices. In this paper, we focus on the Fisher cost of living index, which is the geometric mean of the Laspeyres and Paasche cost of living indices. The Laspeyres index indicates the cost of maintaining reference region's utility level when faced with the prices of the comparison region. On the other hand, the Paasche index indicates the cost of maintaining comparison region's utility level when faced with the prices of the comparison region. Generally, the Laspeyres index tends to overestimate price increases and the Paasche index tends to underestimate it. Further, because these indices ignore substitution possibilities to use a fixed basket, the biased estimates may occur. On the other hand, because the Fisher index takes account of the consumption baskets of both regions, this problem can be avoided.

The cost function of Eq. (1) is estimated using the parameters of Eq. (4). Since $\alpha(\boldsymbol{p}_k)$ of (2) approximates the aggregate price index of Eq. (5), we set the initial value of a_0 so that the value of $\alpha(\boldsymbol{p}_k)$ does not deviate from the value of the aggregate price index in the estimation of the cost function.[1] Further, we assume that regional price differences do exist between the reference region and the comparison region. The Fisher cost of living index is defined as follows.

$$RCLI(\boldsymbol{p}_k, \boldsymbol{p}_s, u_k, u_s) = \frac{1}{2}\left[\frac{\ln C(u_k, \boldsymbol{p}_s)}{\ln C(u_k, \boldsymbol{p}_k)} + \frac{\ln C(u_s, \boldsymbol{p}_s)}{\ln C(u_s, \boldsymbol{p}_k)}\right], \tag{8}$$

[1] Because we assume the aggregate price index is approximated by the Stone index, $\ln P_{kt} \approx \ln P_{kt}^{S}$.

where $\boldsymbol{p}_k$ and $\boldsymbol{p}_s$ denote the price vector in the reference region k and the comparison region s. The first term in square brackets of Eq. (8) denotes the Laspeyres cost of living index and is expressed as a ratio of minimal cost function given utility level u_k incurred by the reference region with facing the comparison prices $\boldsymbol{p}_s$, relative to the cost incurred by a reference region with facing the reference prices $\boldsymbol{p}_k$. Similarly, the second term in square brackets denotes the Paasche cost of living index and is expressed as a ratio of minimal cost function given utility level u_s incurred by the comparison region with facing the comparison prices $\boldsymbol{p}_s$, relative to the cost incurred by a comparison region with facing the reference prices $\boldsymbol{p}_k$. The Fisher cost of living index we used is calculated from not only the price changes but utility levels of the reference and comparison regions.

3. Data

The household survey data employed in this study include monthly data for workers' households in 47 prefectural capitals. We source data on expenditures for each commodity and household demographics from the *Family Income and Expenditure Survey* (*Kakei Chosa* in Japanese) conducted between January 2000 and December 2016 by the Japanese Statistics Bureau. We classify data into 10 major groups: food; housing; fuel, light and water charges; furniture and household utensils; clothing and footwear; medical care; transportation and communication; education; culture and recreation; and other consumption expenditures. Demographic data indicate number of persons per household and age of the household heads. We also obtain price series data from the *Retail Price Survey* and since we measure price fluctuations in time, we divide price by the average value recorded in 2015 (base year) and multiply it by 100. Price data in Sendai City for March, however, are missing given the Great East Japan Earthquake in March 2011 and the considerable damage in this city.

Consumer price indices (CPI) are based on retail prices, which although not necessarily correspond with all CPI components.[2] For example, sauce (tare in Japanese) and soup base (tsuyu in Japanese) in foods are different items in CPI, but at *Retail Price Survey*, they are classified as the same item. A key difference is that the handling of imputed rent for housing not included in retail price; in other words, it only reflect the price of rent. Essentially, the weight of the housing price is second only to food, occupying nearly a quarter of the aggregate price. By excluding the item of imputed rent, the weight of housing will decrease greatly. We adjust the weights[3] for not included items and accordingly, create prices for major classifications.

Studies often use housing prices from various countries to calculate the cost of living index.

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[2] CPI comprises 585 items, that is, 584 items from the *Retail Price Survey* plus an item for imputed rent.

[3] We use CPI weights based on the 2015 standard published by the Japanese Statistics Bureau.

In particular, in developing countries, prices tend to differ by region and using such prices could introduce regional disparity in the cost of living index. Table 1 shows the regional average values for housing prices and other variables used in this analysis and that the housing price in Tokyo is not necessarily the highest. Because housing prices in Japan include rent as well as equipment repair and maintenance depending on regional climate, equipment cost is high. This increases the weight of cost to housing equipment, and subsequently, housing price itself—such a situation has been observed in Sapporo, Niigata, Toyama, Kanazawa, and Fukui. On the other hand, Aomori and Fukushima in the Tohoku region, Mito in the Kanto region, Wakayama in the Kinki region, Matsue in the Chugoku region, and Nagasaki in the Kyushu region show lower housing prices; this is possibly because these cities are located in rural areas that are somewhat far from the center.

Among the 47 countries, log expenditure is the highest in Toyama and Kanazawa and the lowest in Naha. Overall, while Tokyo's total expenditure is high, it is not the highest among the 47 cities. In the demand system, total expenditure is regarded as income and thus, Tokyo's income remains higher. Further, as shown in Eq. (2), the first term of the cost function comprises the approximated aggregate price index. In terms of the aggregate price index, Tokyo is the highest among the 47 cities, whereas Mito and Utsunomiya in the Kanto region are the lowest in Japan, indicating regional differences within the same Kanto region. However, overall, the difference in regional aggregate price index in Japan is smaller than those of other countries, which can be attributed to Japan's economic situation.

4. Measuring Japan's regional cost of living indices

4.1 Regional cost of living indices for 47 cities

In Eq. (4) with the aggregate price index (Eq. (6)), because the budget shares $\boldsymbol{W_k}$ appear on both sides of the model, the orthogonal conditions between the log real expenditure and error term are not satisfied. Therefore, we estimate the parameters of Eq. (4) using a generalized method of moments (GMM) with instruments. In addition, we use lagged log expenditure as instrumental variables. Table 2 presents the average of the estimated regional cost of living index (RCLI) and its standard error for 47 cities. In Eq. (8), we set Tokyo as reference region k with measured ratio divergences from comparative regions s. That is, we compare the number of times the RCLI in the comparison regions differ from that in Tokyo.[4] Figures 1.1–1.7 presents changes in the RCLI in the time series for 17 years. Since our data follows the 2015 standardization, it is possible to observe changes in the time series for the RCLI.

In Table 2, 4 out of 47 cities report a value higher than 100, with the remaining showing values less than 100. Kanazawa, and Osaka, Nara, and Yamaguchi have the highest RCLI value,

[4] In the estimation, we derive the index by multiplying the measured ratio by 100.

which is also higher than that of Tokyo. Akita and Toyama report values lower than but close to 100; however, both cities have higher housing price values compared to that of Tokyo. This suggests that high housing price could affect the RCLI results. Although Tokyo is the center of the Japanese economy and is higher at the level of the RCLI, it is not the highest of 47 cities. On the other hand, the lowest of the RCLI is Mito. In particular, although Mito belongs to the same Kanto region as Tokyo, there will be a difference of the RCLI. In the city with low housing price in Table 2, its RCLI shows low value in 47 cities, for example, Aomori, Fukushima, Mito, Wakayama, and Matsue. These cities are located in local areas even in Japan, indicating that the RCLI is low when compared with Tokyo. Table 3 shows the z test results for the average difference between Tokyo and other city. The null hypotheses are mostly rejected at 5% level except for Akita and Nara. This shows that there are the significant differences in the RCLI between Tokyo and other cities. On the other hand, Akita and Nara have no difference of the RCLI from the level of Tokyo. In addition, Table 4 indicates the test results for the average differences among cities within the same region. The null hypotheses are rejected at 5% level within all regions. It is also shown that there are the significant differences in the RCLI among cities within the region, for example, because Mito with the lowest RCLI belongs to the Kanto region, it shows that there are differences among cities.

The results by region in Figures 1.1–1.7 show that in the Shikoku and Kyushu regions, the RCLI movement in the time series is similar throughout the 17 years. Even in the case of other regions, the movements are similar after 2010, which is close to the base year, 2015. We observe a temporary increase in the RCLI for all regions in 2008. In particular, there has been remarkable growth in Sapporo, Akita, and Sendai as a result of considerable weight on fuel and light expenditures. This can be attributed to the rise in fuel and light expenditures because of increasing crude oil prices.[5] In Naha, the weight on food is high, and a temporary increase in 2008 will be affected by the rise of food prices.

Next, we examine for characteristics by region and to do so, we divide the 47 cities to 9 regions; Hokkaido, Tohoku, Kanto, Chubu, Kinki, Chugoku, Shikoku, Kyushu, and Okinawa. In Figure 1.1, the overall RCLI is often less than 100 in all cities in the Hokkaido and Tohoku regions. Akita maintained an RCLI of more than 100 until 2007, after which it has been less than 100. Further, Aomori reported a considerable deviation from 100 at the beginning of 2000, although it has gradually increased to a value close to 100. The Tohoku region suffered the East Japan Great Earthquake in March 2011. Since the values for March and April 2011 are missing for Sendai and Fukushima, we supplement them with the values for February 2011. Thus, it is

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[5] The price rise in fuel and light expenditures in 2008 due to increasing crude oil prices has been reported in the *retail price statistics*. In addition, the rise in food prices due to soaring raw material costs was also reported.

impossible to accurately measure the extent of damage to the RCLI as a result of the disaster. However, if considering the declines in Sendai and Fukushima, it is certain that some cities were economically damaged by the earthquake. We also see a downward stoppage from the beginning of 2012, a year after the earthquake, followed by a recovery trend until 2016. In the Kanto region (Figure 1.2), there are few instances in which the RCLI exceeds 100 in the time series. In many cities, the RCLI was sluggish from 2004 to 2014. Further, the increase in the RCLI of 2008 is smaller than that of other regions. In Mito, the movement in the RCLI is unique within the Kanto region with considerable divergence. Nevertheless, since 2009, the RCLI continues to increase and maintain pace with those of other countries. In addition, Chiba, Maebashi, and Utsunomiya have maintained the same RCLI level. The Chubu region (Figure 1.3) has a relatively high RCLI level. In particular, Kanazawa's RCLI has reported high levels across the country, often exceeding 100; however, since 2011, it has decreased to less than 100 with no difference compared to the level of other cities. On the other hand, Kofu and Shizuoka has remained sluggish with visible regional disparities until the late 2000, but since then they have increased to the same level as other cities by taking an upward trend. The Kinki region (Figure 1.4) also reports a relatively high level. That is, Osaka, Nara, and Otsu show high values, although since 2010, they have declined to the same level as those of other cities. On the other hand, Wakayama and Tsu initially recorded low values, although given an upward trend in time series over the recent years, their values have been rising to those of other cities. Similar to the Chubu regions, regional disparities have been eliminated close to the base year. A brief overview reveals similarities between the Chugoku region (Figure 1.5) and the Chubu and Kinki regions; however, differences appeared by the mid-2000s. In other words, while the RCLI decreased in other regions, many cities in the Chugoku region reported an increasing trend. In particular, Yamaguchi showed a strong trend with the highest value. The Chubu and Kinki districts recorded the highest values in the first half of the 2000s. Compared with the values in other regions, the rise in RCLI value was observed with a slight earlier. Overall, the RCLI level in the Chugoku region has been lower than those of other regions. Initially, Yamaguchi was the only city with an RCLI exceeding 100; this is no longer the case, although in recent years, it has maintained levels higher than those of all other cities along with a rise in time series. For 2008, we observe a rise in the RCLI for Yamaguchi and Matsue as a result of high weight on fuel and light expenditures, followed by Sapporo and Akita. The Shikoku (Figure 1.6) and Kyushu regions (Figure 1.7) show similar time series movements and RCLI levels. The RCLI level shows an upward trend throughout the country. Further, there is no notable disparity in the RCLI within the same region. The Shikoku and Kyushu regions are away from Honshu, the main island in Japan[6], and geographically close. Also, the trends of the RCLI are similar to each other.

[6] Honshu belongs to the Tohoku, Kanto, Chubu, Kinki, and Chugoku regions.

In addition, although Naha in the Okinawa region is located on a remote island, even in the Japanese archipelago, it is geographically close to the Kyushu region and shows no major difference in the RCLI. In 2008, we also observe a temporary rise as a result of high weight on food because of the soaring prices of wheat and feed, cocoa beans, and dairy products.

In this section, we clarify the differences of the RCLI between Tokyo and other cities and among cities within the region and identify cities with large regional differences by region. On the other hand, when we observe the RCLI among cities within the same region, the difference within each region seems to be getting smaller in recent year. We suppose that the reason for this is due to the influence of price deflation in recent years, in addition to the small price difference close to the base year, 2015.

4.2 Regional cost of living indices for nine regions with multiple comparisons

Following Kakwani and Hill (2002), we extend Eq. (8) to a multilateral comparison:

$$RCLI = \frac{1}{K}\sum_{k-1}^{K}(RCLI_{kr} - RCLI_{sr}), \tag{9}$$

where $K \geq 3$. However, we assume that the ratio of the cost of living in regions *k* and *s* will not depend on the *K* regions is used as the base region. We first re-estimate the $\alpha(\boldsymbol{p})$ and $\beta(\boldsymbol{p})$ values for nine regions using the estimation result for the parameter in Eq. (4). Then, we calculate the cost functions among multiple regions. Since Tokyo belongs to the Kanto region, we set the latter as the reference region, as in Section 4. Next, we set the national average as a reference. Table 5 shows the average RCLI relative to other regions.

The RCLIs in the Hokkaido, Chubu, and Kinki districts are higher than that of the Kanto region. In particular, the Chubu and Kinki districts have the highest values among the nine regions. The Kanto region has a lower RCLI because it includes Mito city, which has the lowest RCLI in Japan. The Chubu and Kinki districts have high RCLIs because they house Kanazawa and Osaka, where the RCLI is higher, and are able to maintain this level given the small standard errors in their other cities. On the other hand, the Okinawa region has the lowest level among all the regions and regional differences compared to the Chubu and the Kinki regions. A city-based observation reveals that Naha's RCLI does not considerably differ from those of cities in the Kyushu region. However, regional observations reveal differences with the Kyushu region. As a cause of this, the Okinawa region may be composed only of Naha. Naha has the lowest log expenditure in Table 1, and the estimated value to Eq. (3) becomes small. Therefore, the cost becomes smaller than in other regions. Even if other districts show lower values in city units, they are offset in regional units because they are made up of multiple cities.

Table 6 shows the results of the z test for the average differences between the Kanto and other regions, between the Chubu and Okinawa regions, between the Kinki and Okinawa regions and between the Kyushu and Okinawa regions. If we test the average differences in total periods, the null hypotheses are rejected at 5% level except for between the Kanto and Hokkaido regions. In addition, there are significant average differences in the RCLI among the regions. However, if we examine the RCLI values since 2010, the null hypotheses are not rejected at the 5% level for the Kanto and Chubu regions, the Kanto and Shikoku regions and the Kanto and Kyushu regions, indicating that the average regional differences have been recently resolved in several regions. But, the difference between the Kanto and Okinawa regions is not still improved, in addition to between the Kyushu and Okinawa regions. Table 7 also shows the results of the F test for differences among all regions. These results indicate that when comparing all the regions, there is a difference of the RCLI in both periods. When comparing only between two regions, the difference may be eliminated, but there still is a difference between all the regions.

Figure 2 presents the RCLI movements for the nine regions. Both figures show a remarkable rise in RCLI, particularly in those of the Hokkaido and Tohoku regions, in 2008. As described in section 4.1, this rise can be attributed to an increase in the price of fuel and light expenditures in the Hokkaido and Tohoku regions, where the weight on fuel and light expenditures is high given the rise in crude oil prices. We also observe an increased RCLI for the Okinawa region in 2008; this is possibly because of the soaring prices of wheat and feed, cocoa beans, and dairy products, as a result of which the weight of food also increased. At the beginning of 2000, the RCLI level was divergent among the nine regions. However, these divergences have gradually decreased and the regions are developing similar movements. According to Figure 2, Tokyo reports an RCLI value of 100 and this tendency has been considerably strong since 2010, which is close to the base year of 2015. Further, in recent years, the RCLI values in the Chugoku, Shikoku, Kyushu, and Okinawa regions have exceeded 100 and are higher than that of the Kanto region.

In this section, we clarify the differences among regions and identify regions with large regional differences. In recent year, it is statistically shown that the difference between some regions is resolved. However, the Okinawa region still cannot fill the difference with other regions, even with the geographically close to the Kyushu region. Improving the RCLI in the Okinawa region leads to the elimination of regional differences.

4.3. Changes in regional cost of living indices due to increased consumption tax rate

In April 2014, Japan’s consumption tax rate was revised from 5% to 8%. Furthermore, since Japan is refraining from changing the consumption tax rate from 8% to 10% in October 2019, we will discuss about the influence of price fluctuation on the RCLI in this subsection. As we can see from Figures 1.1 to 1.7 and Figure 2, the change in the RCLI due to the consumption tax increase is small compared to the change due to other factors such as that occurred in 2008. Changes in 2008 are largely attributable to the difference in weights by region for certain commodity, but in this case, it is different that we assume that prices of commodity will rise uniformly in all regions. Further, it may not be correct to judge that all movements in the RCLI occurred in April 2014 are due to the consumption tax increase, but in the case of our monthly data the price fluctuation in one month is very small and the price fluctuation due to other factors is insignificant. A total of 14 out of 47 cities report an increase in the RCLI along with a higher tax rate, although more than half the cities show a declining trend. In particular, five out of seven cities in the Kanto region have higher RCLIs, although the range of increase is not large. In 47 cities, the highest rate of increase was 1.10% for Akita, followed by Naha's 0.83%. On the other hand, the cities whose decrease in RCLI was more than 1% include Niigata (−1.67%), Kofu (−1.32%), Tsu (−1.95%), and Nagasaki (−1.69%).

Table 7 shows the contribution rate of 10 commodities to demonstrate the influence of each commodity on the RCLI movement. It is, therefore, necessary to define in advance the existence of a subindex. We suppose that commodities are divided into 10 categories such as food; housing; fuel, light and water charges; …; and other consumption expenditures and that the commodities are separable each other. Further we denote the partial cost function for category *i* in region *k* as $C(\boldsymbol{p}_k^i, u_k^i)$ where u_k^i is the category utility function. Then we define the partial RCLI of the Fisher type as follows.

$$RCLI^i(\boldsymbol{p}_k^i, \boldsymbol{p}_s^i, u_k^i, u_s^i) = \frac{1}{2}\left[\frac{\ln C(u_k^i, \boldsymbol{p}_s^i)}{\ln C(u_k^i, \boldsymbol{p}_k^i)} + \frac{\ln C(u_s^i, \boldsymbol{p}_s^i)}{\ln C(u_s^i, \boldsymbol{p}_k^i)}\right], \tag{10}$$

where the partial RCLI for category *i* is subindex. According to Pollak (1989), it is possible to define the subindex of the cost of living if commodity subsets in a system are separable from those of other commodities. The assumption that the commodities are separable from other is less restrictive than weak separability. On the basis of the subindex and commodity weight,[7] we calculate the contribution of each commodity in 47 cities as follows:

$$CR_s^i = \frac{(RCLI_{st}^i - RCLI_{st-1}^i) \times \frac{\omega_s^i}{\omega_s}}{RCLI_{st}} \times 100, \tag{11}$$

where $RCLI_{st}^i$ is the regional subindex of commodity *i* in region *s* in period *t*, ω_s^i is the weight of commodity *i* in region *s*, and ω_s is the total weight in all commodities. Table 7 shows that a rise in the subindex for transportation and communication contributes to an increase in Akita and Naha's RCLI. In particular, in Naha, when the price of transportation and communication changes, the RCLI changes at the rate of 0.37. On the other hand, a decline in the subindex for transportation and communication contributes to the RCLI decrease in Niigata, Kofu, Tsu, and Nagasaki. In other words, transportation and communication is a major factor contributing to

[7] We calculate the contribution degree by excluding the item of imputed rent from the weight of the aggregate price index.

RCLI. Education and culture and recreation following transportation and communication are also factors that increase or decrease RCLI. In particular, culture and recreation positively influence each city's RCLI. For example, education as well as culture and recreation considerably contribute to Nagoya, positively raising its RCLI.

In Figure 3.2, five out of nine regions report higher RCLIs as a result of increased consumption taxes. The RCLIs for the Hokkaido and Okinawa regions are higher than those of the nine regions. However, the fluctuations are lower than those observed for each city because the degree of fluctuation is offset within the region. That is, in the regional units, the influence of increased consumption tax is limited, even if negative. The Chubu and Kyushu regions including Niigata, Kofu, and Nagasaki report negative effects. Table 8 shows the contribution of 10 commodities in nine regions. The rise in the RCLI for transportation and communication has contributed greatly to the increase in the Hokkaido, Chugoku and Okinawa regions. Conversely, declines in the Chubu and Kyushu regions also contributed to the decline in transportation and communications. The RCLI of medical care and education is decreasing in all regions. On the other hand, food and furniture and household utensils are rising in most regions. This is due to the fact that food and furniture and household utensils contain many items related to products, and medical care and education contain many items related to services. In other words, in nine regions, the impact in the consumption tax increase positively works for commodities that contain many products.

In many cases, an increase in consumption tax tends to decrease each city's RCLI, although it has little or negative impact on regional units. This is because the degree of fluctuation is offset within the region. In the basket of 10 commodities, the contribution of transportation and communication is large in most regions. The RCLI is rising in the region where the subindex of this commodity is increasing, but it is also declining in the region where this is decreasing. In the Okinawa region, the increase rate is relatively high because the increase of subindex in transportation and communication is larger than in other regions. In other words, by turning this to an increasing direction, it will be possible to further increase the RCLI by the consumption tax increase.

5. Conclusions

In this study, we clarify the existence of regional disparities in the cost of living index in Japan. First, in the case of 47 cities, we calculate the RCLI based on Tokyo as a reference region. Our results show the one most highest is Kanazawa and the reverse is Mito. In particular, although Mito belongs to the same Kanto region as Tokyo, there is a regional difference within this region. This can be also shown from the test results for the average difference between cities within the Kanto region. In addition, regional differences occur not only within the Kanto region but also within other regions and between Tokyo and other cities. Second, in the case of nine regions, we calculate the RCLI based on the Kanto region as a reference region. The one most highest is the Chubu and Kinki regions and the reverse is the Okinawa region. When observing the RCLI by region, the difference in the RCLI among regions is smaller than observing by city because it is offset within region. Further our test results show that regional difference also occurs among most regions. In this study, we confirm that the regional differences are occurring both in city and regional units. Further we identify between regions with large regional differences. In particular, improving the Okinawa region with the low RCLI leads to the elimination of regional differences. Moreover, it will lead to raising the RCLI of Japan as a whole.

On the other hand, time series observations show that in recent years, regional disparities are being gradually resolved between some regions. For example, since January 2010 the null hypothesis for the difference in the RCLI between the Kanto and the Chubu regions, between the Kanto and the Shikoku regions and between the Kanto and the Kyushu regions is not rejected at 5% level, suggesting no difference between them. This can be attributed to minor price fluctuations in the recent years under deflation as well as the small deviation in price data close to the base year, 2015. However, the differences between the Okinawa region and other regions still remain. In other words, we cannot deny that eliminating this disparity is not a fundamental but a spurious.

Next, we also investigate the influence of a revision in the consumption tax rate. Depending on the characteristics of commodity, there are time lags to reflect the consumption tax on the price, and some are originally out of the consumption tax. However, price fluctuations due to this should occur for most commodities. A city-based observation shows negative influences on each city, whereas a regional study reports an increase in RCLI for a majority of the regions. This can be attributed to regional observations offsetting the negative influences on city units, which can be difficult to demonstrate in numerical values. We also decompose these changes by 10 commodities and measured which commodity affected the RCLI. Our results show that transportation and communication, education, and culture and recreation significantly contribute to RCLI. More specifically, in the future consumption tax increase, if the contribution degree of these commodities turns to positive in the city-based observation, it will lead to an increase in RCLI. That also leads to a rise in the region-based RCLI. These results become to a guide to changes in price and consumer surplus for the immediate consumption tax increase.

Finally, this analysis does not include imputed rent in housing price. However, the weight of imputed rent is high in Japan’s consumer price index and therefore, the cost itself is underestimated. Nevertheless, since the RCLI is estimated as a ratio of minimal costs, the impact of this exclusion is limited. Naturally, measurement at the original housing price including imputed rent will bring about a change in our results at RCLI. We will address this task in the future.

Reference

Araya, D. P. and Rivera, V. I. (2013) Substitution bias and the construction of a spatial cost of living index. Papers in Regional Science 92(1), 103-117.

Deaton, A. and Muellbauer, J. (1980) An almost ideal demand system. American Economic Review 70, 312-326.

Diewert, W.E. 2001. The consumer price index and index number purpose. Journal of Economic and Social Measurement 27, 167-248.

Fry, V. and Parshardes, P. (1989) Constructing the True Cost of Living Index From the Engel Curves of the PIGLOG Model. Journal of Applied Econometrics 4, 41-56.

Kakwani, N. and Hill, R.J. (2002) Economic theory of spatial cost of living indices with application to Thailand. Journal of Public Economics 86, 71-97.

Lewbel, A. (1989) Household Equivalence Scales and Welfare Comparisons. Journal of Public Economics 39, 377-391.

Ogura, M. (2015) The estimation of a panel cointegrated demand system in Japan: Results from a panel vector error correction model. International Journal of intelligent technologies and applied statistics 8(2), 117-132.

Pollak, R. A. (1989) The Theory of the Cost-of-living Index. Oxford University Press, New York Oxford.

Ravallion, M. and Walle, D.V. (1991) Urban-rural cost-of-living differentials in a developing economy. Journal of Urban Economics 29, 113-127.

Stone, J.R.N. (1954) The measurement of consumer expenditure and behavior in the United Kingdom, 1920-1938, vol.I. Cambridge University Press, Cambridge, UK.

Thomas, V. (1980) Spatial differences in the cost of living. Journal of Urban Economics 8, 108-122.

Table 1 Descriptive statistics of expenditure, prices, and demographics

Region	City	Expenditure	aggregate price	Housing price	number of household	age of the household heads
Hokkaido	Sapporo	17.202	4.569	4.629	1.197	3.840
Tohoku	Aomori	17.141	4.583	4.586	1.261	3.863
	Morioka	17.243	4.577	4.612	1.252	3.860
	Sendai	17.222	4.579	4.607	1.221	3.848
	Akita	17.230	4.578	4.639	1.205	3.845
	Yamagata	17.304	4.579	4.615	1.278	3.837
	Fukushima	17.300	4.573	4.595	1.256	3.864
Kanto	Mito	17.275	4.565	4.567	1.188	3.835
	Utsunomiya	17.305	4.565	4.632	1.208	3.832
	Maebashi	17.225	4.581	4.606	1.209	3.871
	Saitama	17.339	4.575	4.604	1.226	3.834
	Chiba	17.264	4.576	4.621	1.213	3.873
	Tokyo	17.366	4.588	4.629	1.189	3.854
	Yokohama	17.323	4.572	4.623	1.213	3.855
Chubu	Niigata	17.271	4.583	4.629	1.262	3.844
	Toyama	17.391	4.570	4.633	1.286	3.865
	Kanazawa	17.363	4.577	4.665	1.265	3.846
	Fukui	17.236	4.573	4.632	1.275	3.884
	Kofu	17.251	4.574	4.610	1.224	3.853
	Nagano	17.279	4.580	4.603	1.228	3.860
	Gifu	17.271	4.572	4.625	1.252	3.860
	Shizuoka	17.277	4.570	4.624	1.241	3.849
	Nagoya	17.234	4.577	4.613	1.226	3.879
Kinki	Tsu	17.255	4.565	4.609	1.228	3.879
	Otsu	17.241	4.567	4.626	1.261	3.862
	Kyoto	17.258	4.570	4.614	1.237	3.867
	Osaka	17.162	4.586	4.660	1.218	3.824
	Kobe	17.199	4.578	4.606	1.183	3.882
	Nara	17.317	4.581	4.630	1.247	3.856
	Wakayama	17.147	4.566	4.591	1.217	3.865
Chugoku	Tottori	17.139	4.580	4.644	1.264	3.852

	Matsue	17.236	4.580	4.582	1.217	3.826
	Okayama	17.244	4.579	4.601	1.240	3.807
	Hiroshima	17.291	4.577	4.612	1.201	3.847
	Yamaguchi	17.302	4.582	4.630	1.214	3.842
Shikoku	Tokushima	17.294	4.570	4.624	1.211	3.829
	Takamatsu	17.295	4.572	4.617	1.197	3.819
	Matsuyama	17.176	4.577	4.604	1.219	3.815
	Kochi	17.288	4.574	4.609	1.188	3.801
Kyushu	Fukuoka	17.267	4.579	4.619	1.233	3.822
	Saga	17.263	4.587	4.622	1.239	3.852
	Nagasaki	17.168	4.582	4.596	1.210	3.857
	Kumamoto	17.214	4.583	4.604	1.250	3.826
	Oita	17.237	4.570	4.600	1.197	3.838
	Miyazaki	17.166	4.578	4.610	1.201	3.825
	Kagoshima	17.260	4.574	4.606	1.226	3.826
Okinawa	Naha	17.021	4.577	4.609	1.279	3.803

Note: Descriptive statistics for 9588 observations. All values are logarithmic.

Table 2 The regional cost of living indices for 47 cities

Region	City	RCLI	Std.error	Region	City	RCLI	Std.error
Hokkaido	Sapporo	98.1	0.094	Kinki	Tsu	96.8	0.129
Tohoku	Aomori	96.2	0.244		Otsu	99.4	0.096
	Morioka	97.1	0.163		Kyoto	98.2	0.084
	Sendai	98.1	0.094		Osaka	100.6	0.141
	Akita	99.9	0.115		Kobe	97.4	0.128
	Yamagata	97.3	0.113		Nara	100.2	0.130
	Fukushima	96.9	0.146		Wakayama	96.6	0.162
Kanto	Mito	94.7	0.233	Chugoku	Tottori	97.6	0.090
	Utsunomiya	98.6	0.072		Matsue	95.5	0.191
	Maebashi	98.0	0.084		Okayama	96.8	0.164
	Saitama	97.5	0.112		Hiroshima	97.8	0.084
	Chiba	99.0	0.057		Yamaguchi	100.3	0.117
	Tokyo	100.0	-	Shikoku	Tokushima	97.9	0.133
	Yokohama	98.3	0.084		Takamatsu	97.9	0.105
Chubu	Niigata	98.3	0.066		Matsuyama	96.3	0.141
	Toyama	99.7	0.080		Kochi	97.7	0.110
	Kanazawa	100.9	0.112	Kyushu	Fukuoka	98.9	0.072
	Fukui	98.9	0.073		Saga	98.2	0.091
	Kofu	96.5	0.152		Nagasaki	97.3	0.120
	Nagano	97.2	0.117		Kumamoto	98.0	0.092
	Gifu	98.8	0.056		Oita	97.0	0.149
	Shizuoka	97.6	0.126		Miyazaki	97.1	0.116
	Nagoya	98.2	0.071		Kagoshima	98.2	0.092
				Okinawa	Naha	96.8	0.113

Table 3 The z test for regional difference between Tokyo and other city

Region	Comparison city s	Null hypothesis $\mathrm{H}_0: \overline{RCLI}_{\mathrm{Tokyo}} = \overline{RCLI}_s$	
		Test statistics	P-value
Hokkaido	Sapporo	20.290	0.000
Tohoku	Aomori	15.965	0.000
	Morioka	17.921	0.000
	Sendai	20.725	0.000
	Akita	0.743	0.458
	Yamagata	24.410	0.000
	Fukushima	21.685	0.000
Kanto	Mito	23.260	0.000
	Utsunomiya	20.636	0.000
	Maebashi	24.578	0.000
	Saitama	22.617	0.000
	Chiba	18.124	0.000
	Yokohama	20.299	0.000
Chubu	Niigata	25.888	0.000
	Toyama	4.292	0.000
	Kanazawa	-8.660	0.000
	Fukui	14.682	0.000
	Kofu	23.384	0.000
	Nagano	24.798	0.000
	Gifu	22.039	0.000
	Shizuoka	19.802	0.000
	Nagoya	25.747	0.000
Kinki	Tsu	25.287	0.000
	Otsu	5.836	0.000
	Kyoto	21.390	0.000
	Osaka	-4.231	0.000
	Kobe	20.682	0.000
	Nara	-1.202	0.230
	Wakayama	21.722	0.000
Chugoku	Tottori	26.960	0.000
	Matsue	24.273	0.000
	Okayama	19.801	0.000

	Hiroshima	26.811	0.000
	Yamaguchi	-2.955	0.000
Shikoku	Tokushima	16.239	0.000
	Takamatsu	20.268	0.000
	Matsuyama	26.443	0.000
	Kochi	21.714	0.000
Kyushu	Fukuoka	15.889	0.000
	Saga	20.167	0.000
	Nagasaki	22.641	0.000
	Kumamoto	21.834	0.000
	Oita	20.356	0.000
	Miyazaki	25.211	0.000
	Kagoshima	20.510	0.000
Okinawa	Naha	28.598	0.000

Table 4 F test for regional difference within region

Region	Null hypothesis	Test statistics	D.f	P-value
Tohoku	$H_0: \overline{RCLI}_{\text{Aomori}} = \overline{RCLI}_{\text{Morioka}} = \overline{RCLI}_{\text{Sendai}} = \overline{RCLI}_{\text{Akita}} = \overline{RCLI}_{\text{Yamagata}} = \overline{RCLI}_{\text{Fukushima}}$	73.914	5	0.000
Kanto	$H_0: \overline{RCLI}_{\text{Mito}} = \overline{RCLI}_{\text{Utsunomiya}} = \overline{RCLI}_{\text{Maebashi}} = \overline{RCLI}_{\text{Saitama}} = \overline{RCLI}_{\text{Chiba}} = \overline{RCLI}_{\text{Tokyo}} = \overline{RCLI}_{\text{Yokohama}}$	225.552	6	0.000
Chubu	$H_0: \overline{RCLI}_{\text{Niigata}} = \overline{RCLI}_{\text{Toyama}} = \overline{RCLI}_{\text{Kanazawa}} = \overline{RCLI}_{\text{Fukui}} = \overline{RCLI}_{\text{Kofu}} = \overline{RCLI}_{\text{Nagano}} = \overline{RCLI}_{\text{Gifu}} = \overline{RCLI}_{\text{Shizuoka}} = \overline{RCLI}_{\text{Nagoya}}$	187.280	8	0.000
Kinki	$H_0: \overline{RCLI}_{\text{Tsu}} = \overline{RCLI}_{\text{Otsu}} = \overline{RCLI}_{\text{Kyoto}} = \overline{RCLI}_{\text{Osaka}} = \overline{RCLI}_{\text{Kobe}} = \overline{RCLI}_{\text{Nara}} = \overline{RCLI}_{\text{Wakayama}}$	171.663	6	0.000
Chugoku	$H_0: \overline{RCLI}_{\text{Tottori}} = \overline{RCLI}_{\text{Matsue}} = \overline{RCLI}_{\text{Okayama}} = \overline{RCLI}_{\text{Hiroshima}} = \overline{RCLI}_{\text{Yamaguchi}}$	179.786	4	0.000
Shikoku	$H_0: \overline{RCLI}_{\text{Tokushima}} = \overline{RCLI}_{\text{Takamatsu}} = \overline{RCLI}_{\text{Matsuyama}} = \overline{RCLI}_{\text{Kochi}}$	38.216	3	0.000
Kyushu	$H_0: \overline{RCLI}_{\text{Fukuoka}} = \overline{RCLI}_{\text{Saga}} = \overline{RCLI}_{\text{Nagasaki}} = \overline{RCLI}_{\text{Kumamoto}} = \overline{RCLI}_{\text{Oita}} = \overline{RCLI}_{\text{Miyazaki}} = \overline{RCLI}_{\text{Kagoshima}}$	41.502	6	0.000

Table 5 Regional cost of living indices in multiple comparisons (Kanto region =100)

Regions	Hokkaido	Tohoku	Kanto	Chubu	Kinki
RCLI	100.2	99.6	100.0	100.5	100.5
Std.error	0.096	0.088	0.000	0.041	0.052
Regions	Chugoku	Shikoku	Kyushu	Okinawa	
RCLI	99.6	99.4	99.8	98.8	
Std.error	0.056	0.067	0.048	0.061	

Table 6 The tests for regional differences in multiple comparisons

Period	Null hypothesis	Test statistics	P-value
January 2000 to December 2016	z test:		
	$H_0: \overline{RCLI}_{\text{Kanto}} = \overline{RCLI}_{\text{Hokkaido}}$	-1.677	0.093
	$H_0: \overline{RCLI}_{\text{Kanto}} = \overline{RCLI}_{\text{Tohoku}}$	4.671	0.000
	$H_0: \overline{RCLI}_{\text{Kanto}} = \overline{RCLI}_{\text{Chubu}}$	-12.222	0.000
	$H_0: \overline{RCLI}_{\text{Kanto}} = \overline{RCLI}_{\text{Kinki}}$	-9.703	0.000
	$H_0: \overline{RCLI}_{\text{Kanto}} = \overline{RCLI}_{\text{Chugoku}}$	6.934	0.000
	$H_0: \overline{RCLI}_{\text{Kanto}} = \overline{RCLI}_{\text{Shikoku}}$	8.350	0.000
	$H_0: \overline{RCLI}_{\text{Kanto}} = \overline{RCLI}_{\text{Kyushu}}$	3.439	0.001
	$H_0: \overline{RCLI}_{\text{Kanto}} = \overline{RCLI}_{\text{Okinawa}}$	19.936	0.000
	$H_0: \overline{RCLI}_{\text{Chubu}} = \overline{RCLI}_{\text{Okinawa}}$	333.622	0.000
	$H_0: \overline{RCLI}_{\text{Kinki}} = \overline{RCLI}_{\text{Okinawa}}$	306.568	0.000
	$H_0: \overline{RCLI}_{\text{Kyushu}} = \overline{RCLI}_{\text{Okinawa}}$	193.133	0.000
	F test:		
	$H_0: \overline{RCLI}_{\text{Hokkaido}} = \overline{RCLI}_{\text{Tohoku}} = \overline{RCLI}_{\text{Kanto}} = \overline{RCLI}_{\text{Chubu}} = \overline{RCLI}_{\text{Kinki}} = \overline{RCLI}_{\text{Chugoku}} = \overline{RCLI}_{\text{Shikoku}} = \overline{RCLI}_{\text{Kyushu}} = \overline{RCLI}_{\text{Okinawa}}$	76.819	0.000
January 2010 to December 2016	z test:		
	$H_0: \overline{RCLI}_{\text{Kanto}} = \overline{RCLI}_{\text{Hokkaido}}$	4.250	0.000
	$H_0: \overline{RCLI}_{\text{Kanto}} = \overline{RCLI}_{\text{Tohoku}}$	6.207	0.000
	$H_0: \overline{RCLI}_{\text{Kanto}} = \overline{RCLI}_{\text{Chubu}}$	-0.474	0.604
	$H_0: \overline{RCLI}_{\text{Kanto}} = \overline{RCLI}_{\text{Kinki}}$	7.235	0.000
	$H_0: \overline{RCLI}_{\text{Kanto}} = \overline{RCLI}_{\text{Chugoku}}$	5.691	0.000
	$H_0: \overline{RCLI}_{\text{Kanto}} = \overline{RCLI}_{\text{Shikoku}}$	0.992	0.277
	$H_0: \overline{RCLI}_{\text{Kanto}} = \overline{RCLI}_{\text{Kyushu}}$	1.095	0.230
	$H_0: \overline{RCLI}_{\text{Kanto}} = \overline{RCLI}_{\text{Okinawa}}$	10.402	0.000
	$H_0: \overline{RCLI}_{\text{Chubu}} = \overline{RCLI}_{\text{Okinawa}}$	8.947	0.000
	$H_0: \overline{RCLI}_{\text{Kinki}} = \overline{RCLI}_{\text{Okinawa}}$	5.161	0.000
	$H_0: \overline{RCLI}_{\text{Kyushu}} = \overline{RCLI}_{\text{Okinawa}}$	6.069	0.000
	F test:		
	$H_0: \overline{RCLI}_{\text{Hokkaido}} = \overline{RCLI}_{\text{Tohoku}} = \overline{RCLI}_{\text{Kanto}} = \overline{RCLI}_{\text{Chubu}} = \overline{RCLI}_{\text{Kinki}} = \overline{RCLI}_{\text{Chugoku}} = \overline{RCLI}_{\text{Shikoku}} = \overline{RCLI}_{\text{Kyushu}} = \overline{RCLI}_{\text{Okinawa}}$	17.113	0.000

Table 7 The contribution in 10 commodities for 47 cities

City	Food	Housing	Fuel, light & water	Furniture & household utensils	Clothing & footwear	Medical care	Transport & communication	Education	Culture & recreation	Other
Sapporo	0.020	-0.014	-0.009	-0.025	0.029	-0.006	0.156	-0.233	0.043	0.002
Aomori	0.023	0.000	0.011	-0.058	0.063	-0.047	-0.065	-0.442	-0.062	0.036
Morioka	0.030	-0.005	0.002	-0.015	0.121	0.005	0.003	-0.108	0.149	0.001
Sendai	0.027	0.000	0.008	0.015	0.030	-0.001	-0.064	0.258	0.133	0.024
Akita	0.071	-0.016	-0.009	-0.092	0.010	-0.138	0.120	0.086	-0.071	-0.018
Yamagata	0.042	-0.010	0.030	-0.010	0.192	-0.003	0.027	-0.500	0.164	0.030
Fukushima	0.013	0.009	0.012	-0.137	-0.028	0.013	0.155	0.033	0.149	-0.012
Mito	-0.041	-0.001	0.010	-0.004	0.024	-0.008	-0.018	0.044	0.342	0.009
Utsunomiya	0.031	-0.004	0.007	-0.044	0.041	-0.013	-0.271	-0.108	0.198	-0.005
Maebashi	0.039	0.003	-0.003	-0.046	0.078	0.070	0.164	0.451	0.234	-0.016
Saitama	-0.004	-0.001	0.009	-0.061	0.022	0.055	0.037	-0.288	0.120	-0.020
Chiba	-0.013	-0.004	0.013	-0.075	0.005	-0.054	-0.033	0.493	0.030	-0.004
Tokyo	-	-	-	-	-	-	-	-	-	-
Yokohama	0.020	0.004	-0.012	-0.097	-0.001	0.132	-0.273	-0.588	0.065	0.013
Niigata	0.017	-0.007	0.009	0.026	0.077	-0.005	-0.555	0.140	0.329	0.021
Toyama	-0.012	-0.004	-0.016	-0.022	0.150	-0.027	-0.483	0.047	0.164	0.034
Kanazawa	0.038	-0.014	-0.005	-0.072	-0.012	0.058	0.060	-0.229	0.193	0.058
Fukui	0.014	-0.004	-0.001	-0.046	-0.003	0.039	0.069	0.171	0.292	0.009
Kofu	-0.007	0.025	0.010	-0.017	0.081	-0.089	-0.544	-0.076	0.246	-0.049
Nagano	0.010	-0.016	0.011	0.022	0.116	0.033	-0.262	-0.039	0.256	-0.009
Gifu	0.017	-0.001	0.002	0.008	-0.027	-0.105	-0.113	-0.086	0.121	-0.015
Shizuoka	0.072	0.000	-0.014	0.013	0.333	-0.023	-0.250	-0.256	0.240	-0.079
Nagoya	0.013	-0.018	0.013	-0.034	0.046	0.004	-0.012	0.463	0.414	0.016
Tsu	0.016	0.005	0.024	0.029	0.064	-0.037	-0.748	-0.558	0.062	0.016
Otsu	0.013	0.001	0.005	-0.063	0.086	-0.027	-0.084	0.218	0.229	0.008
Kyoto	0.011	-0.001	-0.003	-0.036	0.041	-0.004	-0.319	1.248	0.275	-0.016
Osaka	-0.051	-0.001	0.010	-0.062	0.093	-0.045	0.083	-0.064	0.226	-0.014
Kobe	-0.020	0.008	0.010	-0.002	0.015	0.022	0.217	-0.133	0.223	-0.012
Nara	0.019	0.011	0.004	0.012	0.070	0.010	0.105	-0.254	0.200	0.014
Wakayama	-0.003	-0.012	0.010	0.088	0.271	0.018	0.045	-0.157	0.288	-0.042
Tottori	-0.001	0.008	0.009	-0.032	-0.068	0.024	0.154	0.134	0.093	0.008

Matsue	0.014	0.009	0.002	-0.087	-0.069	0.082	0.768	0.267	0.124	0.045
Okayama	0.019	-0.002	-0.009	-0.033	0.033	-0.083	0.017	-0.070	0.099	-0.023
Hiroshima	0.027	0.003	0.008	-0.073	0.115	-0.017	-0.138	0.159	0.174	0.007
Yamaguchi	0.041	0.009	0.008	-0.069	-0.006	-0.048	-0.288	-0.025	-0.012	-0.023
Tokushima	0.014	-0.010	-0.001	0.007	0.094	-0.021	0.603	0.178	0.190	-0.029
Takamatsu	0.011	-0.005	0.022	-0.101	0.027	0.008	-0.366	-0.176	0.199	0.003
Matsuyama	0.060	-0.001	0.006	-0.022	0.102	-0.005	0.187	-0.251	0.273	0.005
Kochi	0.011	0.001	-0.002	-0.014	0.213	0.021	-0.248	0.001	0.220	-0.004
Fukuoka	0.019	0.000	-0.019	-0.042	0.038	0.073	0.070	-0.149	0.128	0.023
Saga	-0.008	0.001	-0.006	-0.017	0.002	0.011	-0.002	0.366	-0.071	-0.029
Nagasaki	-0.020	-0.005	-0.002	-0.120	0.053	-0.053	-0.779	0.096	0.185	0.009
Kumamoto	0.033	-0.015	0.000	-0.051	0.090	-0.056	0.057	-0.241	0.208	-0.009
Oita	0.013	-0.002	0.019	-0.027	-0.003	-0.051	-0.028	-0.183	0.192	0.017
Miyazaki	-0.003	0.014	0.003	-0.070	0.068	-0.004	-0.012	0.044	0.116	0.003
Kagoshima	0.019	-0.003	0.000	-0.007	0.125	-0.128	-0.153	-0.108	0.164	-0.010
Naha	0.025	-0.003	-0.006	-0.017	-0.007	0.004	0.370	-0.054	0.219	-0.013

Table 8 The contribution in 10 commodities for 9 regions

Region	Food	Housing	Fuel, light & water	Furniture & household utensils	Clothing & footwear	Medical care	Transport & communication	Education	Culture & recreation	Other
Hokkaido	0.016	-0.010	-0.013	0.018	0.004	-0.029	0.227	-0.184	-0.078	0.005
Tohoku	0.027	-0.002	0.004	0.002	0.041	-0.050	0.094	-0.081	-0.043	0.011
Kanto	-	-	-	-	-	-	-	-	-	-
Chubu	0.012	-0.002	-0.003	0.028	0.050	-0.032	-0.153	-0.050	0.097	0.002
Kinki	-0.001	0.002	0.008	0.055	0.089	-0.013	-0.016	-0.080	0.088	-0.002
Chugoku	0.015	0.005	0.000	-0.011	-0.023	-0.030	0.131	-0.033	-0.031	0.005
Shikoku	0.018	-0.002	0.003	0.012	0.081	-0.022	0.132	-0.083	0.069	-0.002
Kyushu	0.004	0.000	-0.004	0.000	0.028	-0.050	-0.069	-0.050	0.001	0.003
Okinawa	0.020	-0.002	-0.010	0.030	-0.022	-0.018	0.443	-0.075	0.085	-0.009

Figure 1.1 Regional cost of living indices in the Hokkaido and Tohoku regions

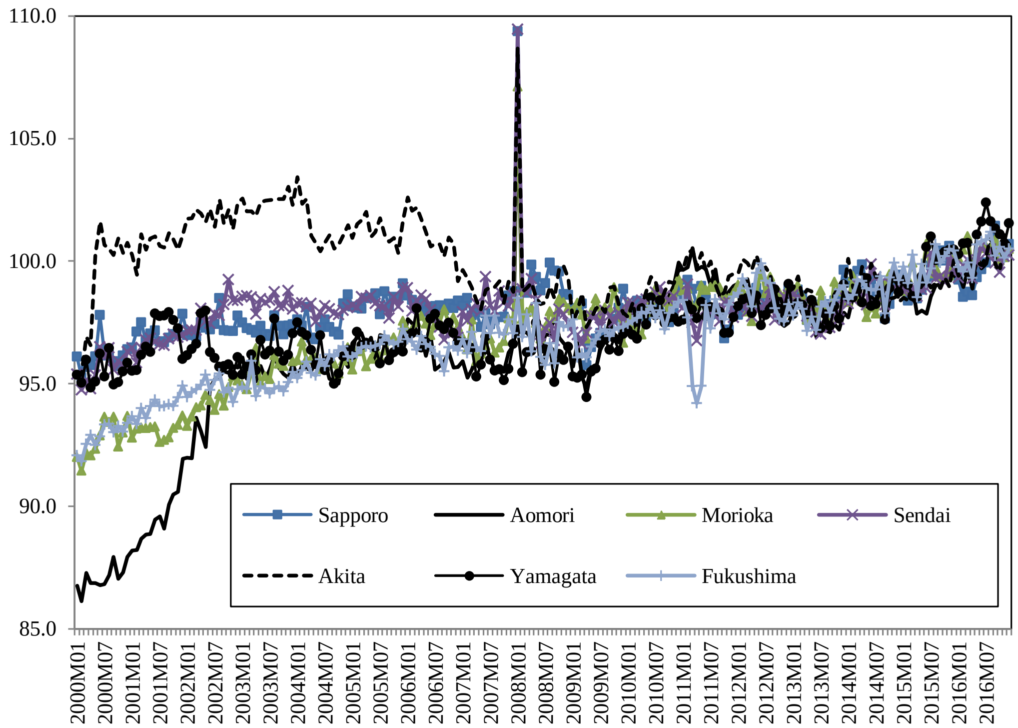

Figure 1.2 Regional cost of living indices in the Kanto region (Tokyo = 100)

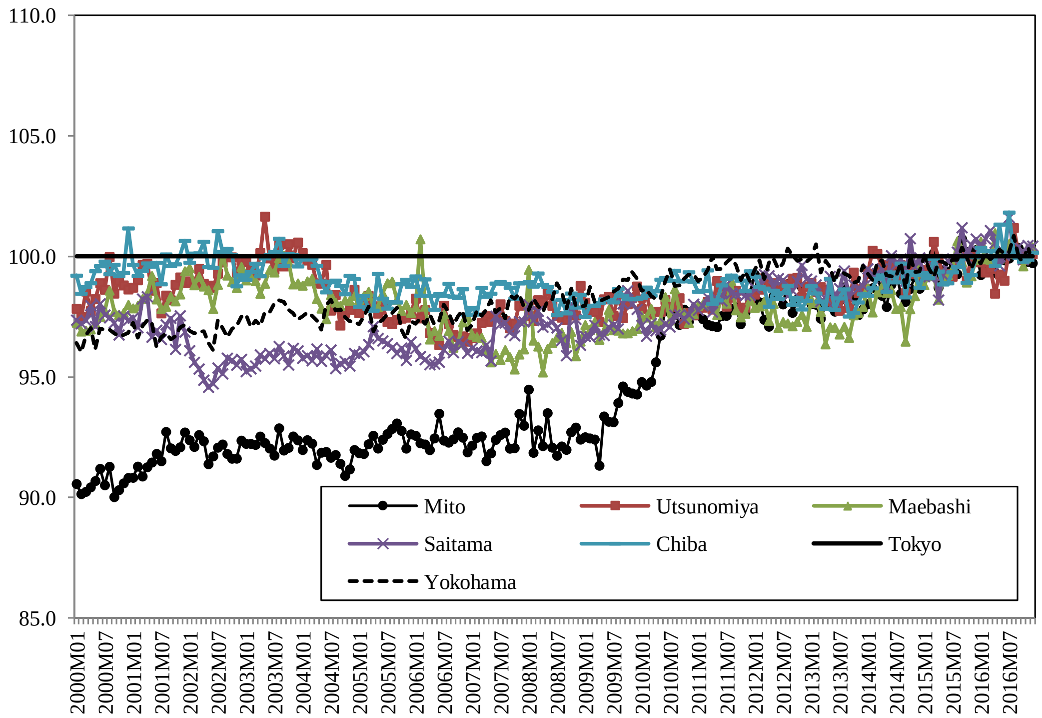

Figure 1.3 Regional cost of living indices in the Chubu region

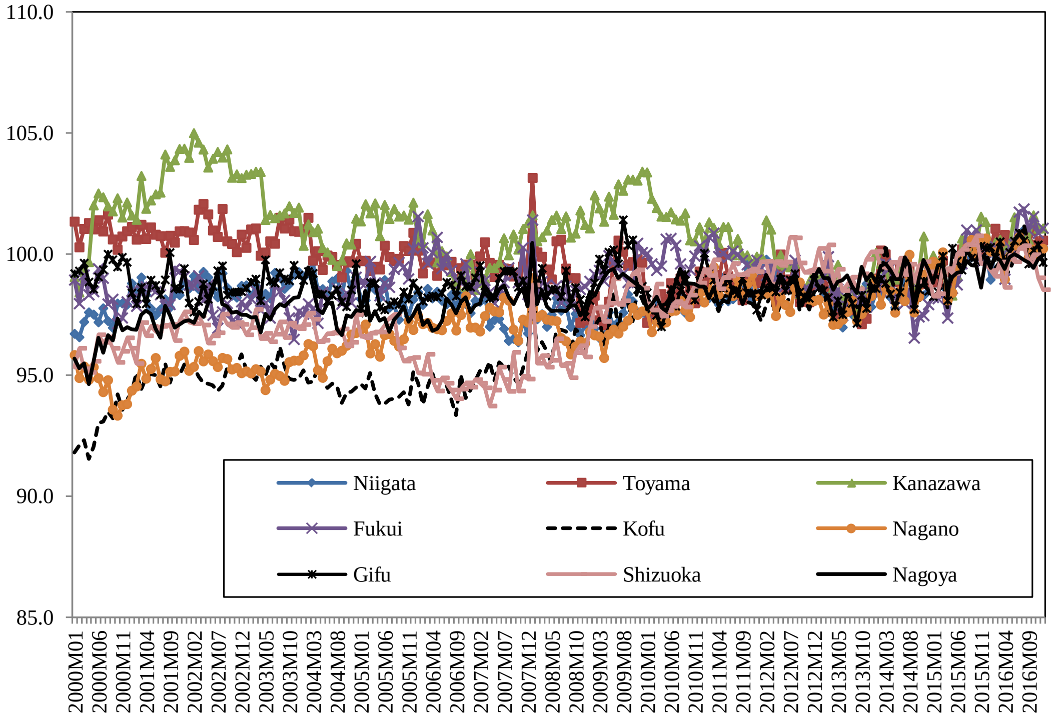

Figure 1.4 Regional cost of living indices in the Kinki district

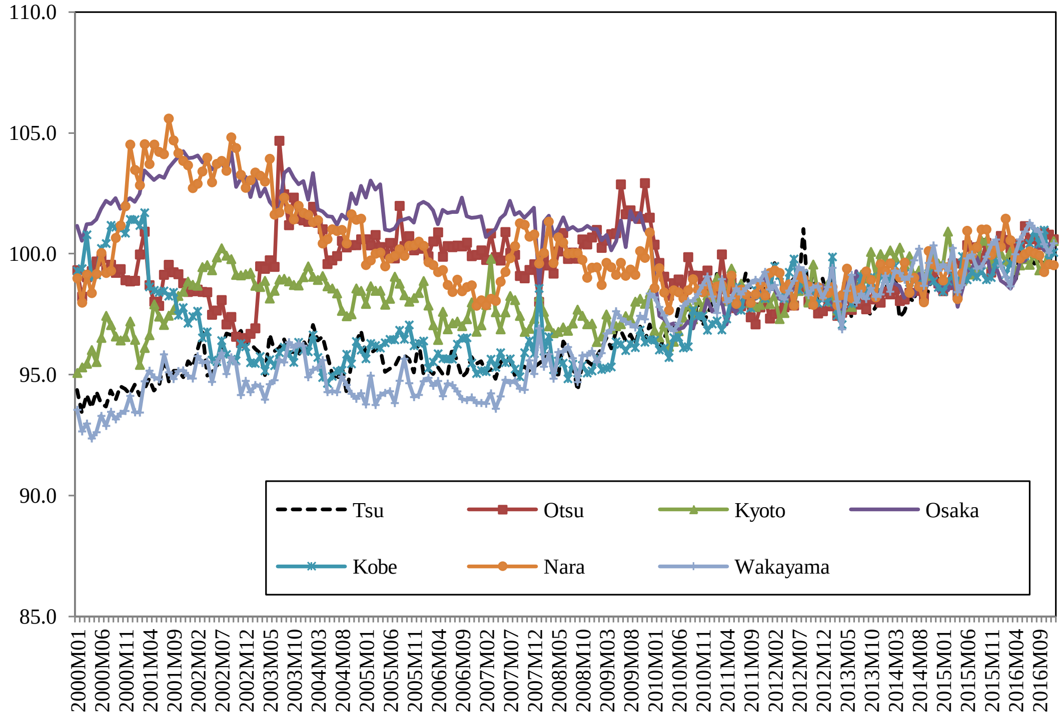

Figure 1.5 Regional cost of living indices in the Chugoku region

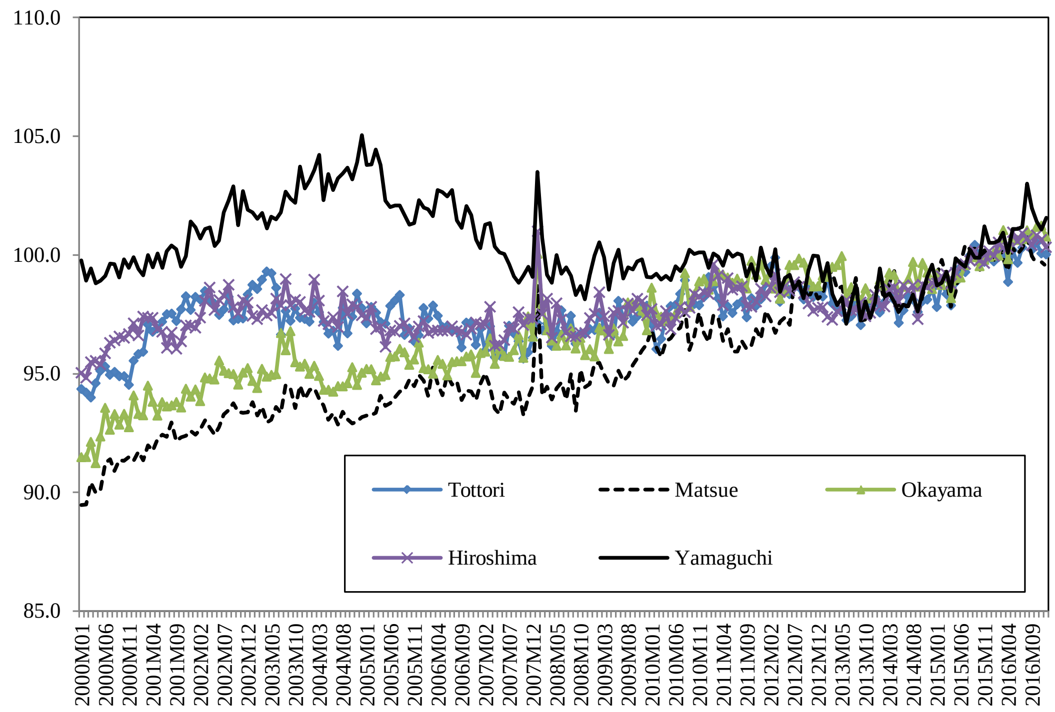

Figure 1.6 Regional cost of living indices in the Shikoku region

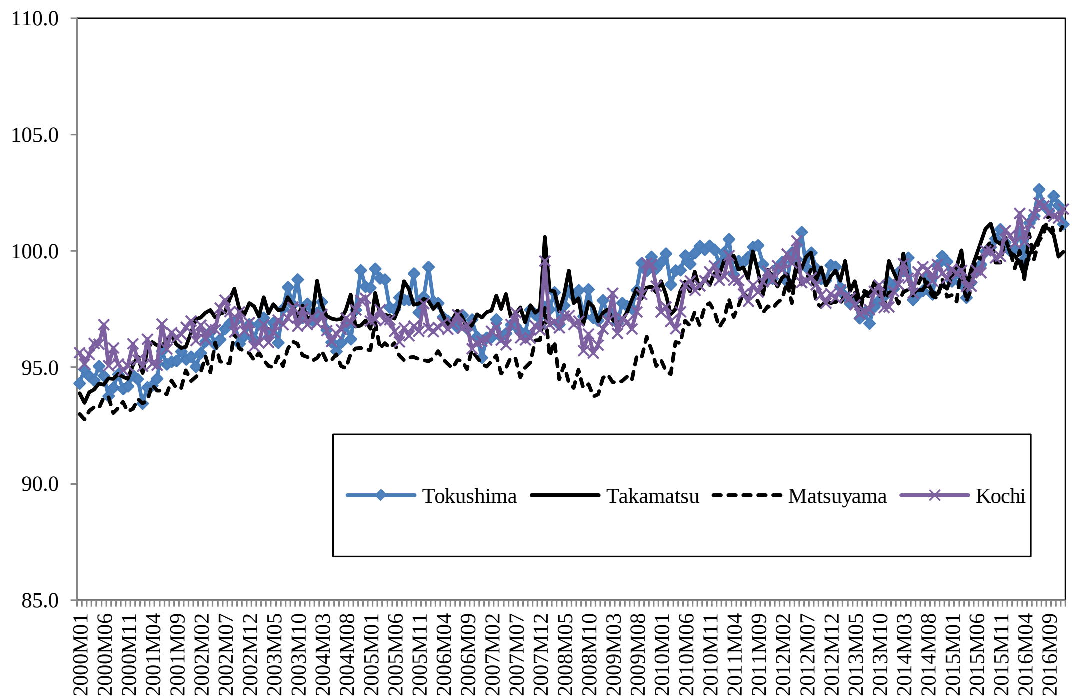

Figure 1.7 Regional cost of living indices in the Kyushu and Okinawa regions

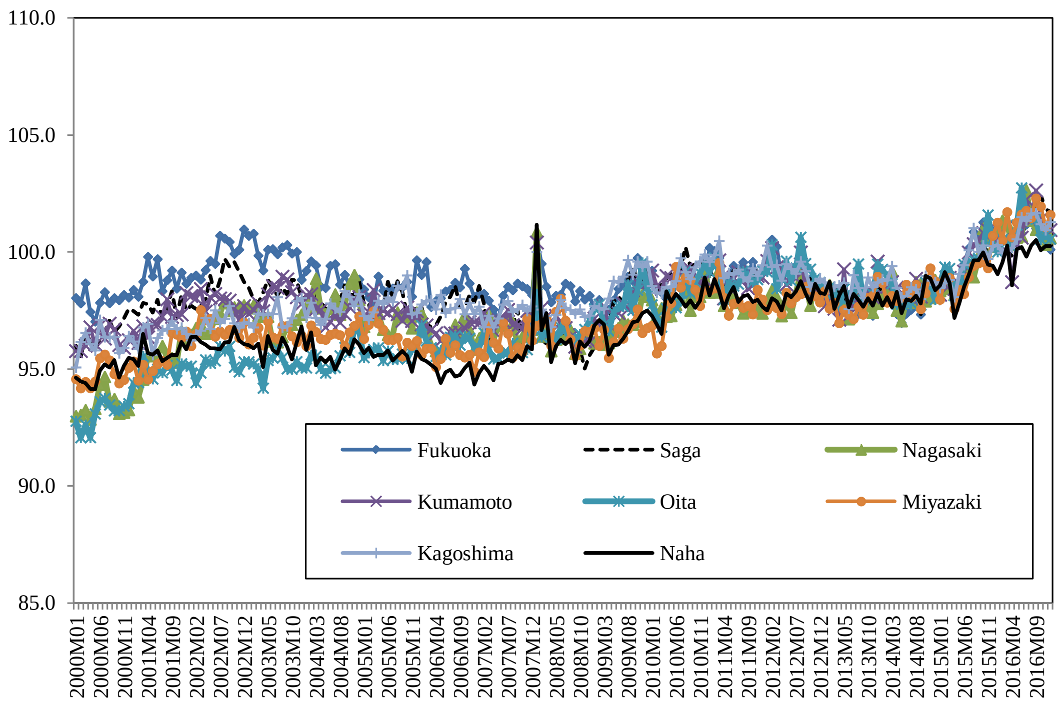

Figure 2 Regional cost of living indices for 9 regions as Kanto = 100.

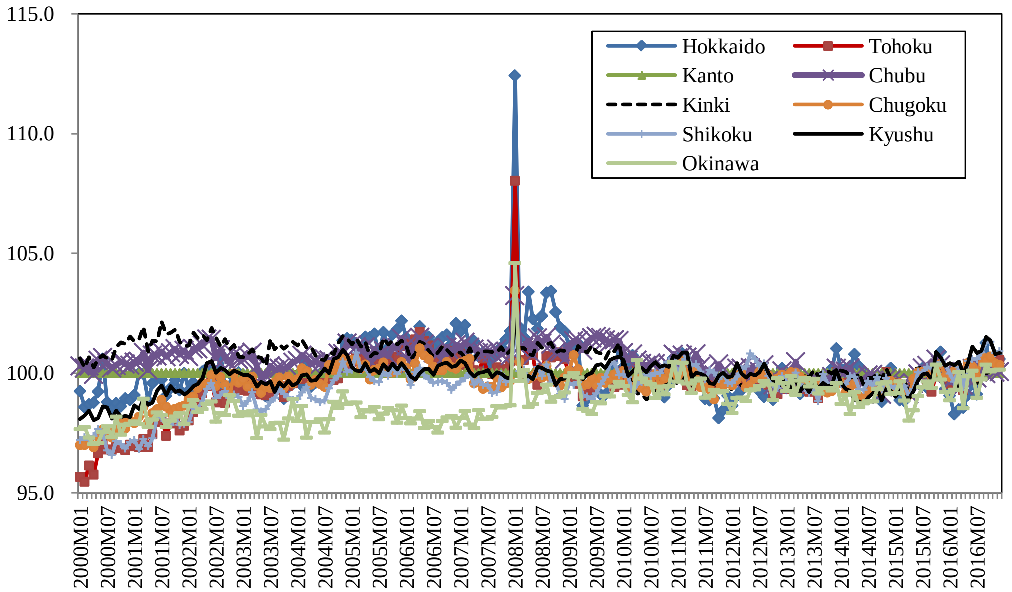

Figure 3.1 The increase rate of the RCLI in consumption tax increase for 47 cities

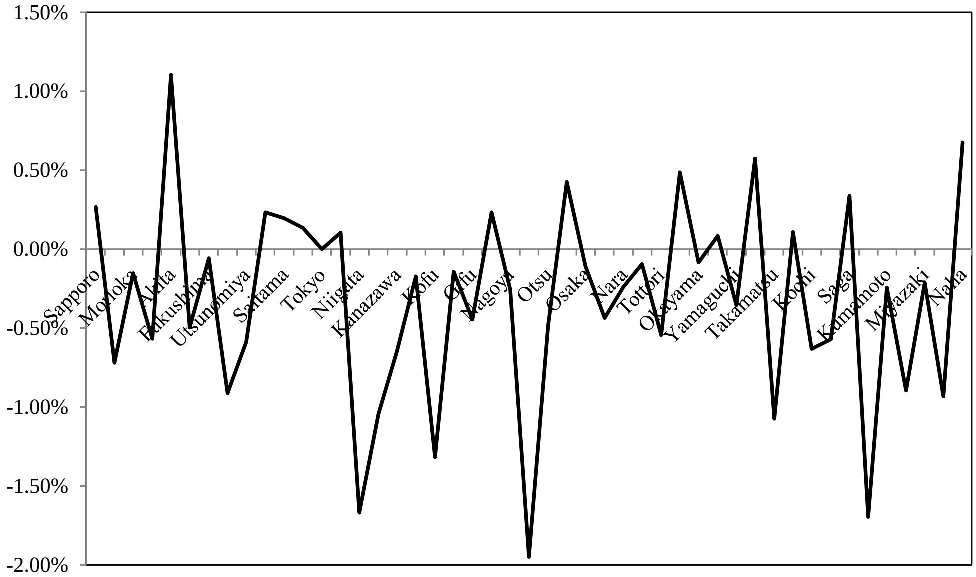

Figure 3.2 The increase rate of the RCLI in consumption tax increase for 9 regions