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Abstract

This paper examines regional income disparity in Indonesia for the 28 years to 2005. It first shows that the inter-provincial distribution of income differs greatly depending on whether oil and gas income is included or not. It then investigates inter-provincial income disparity in Indonesian provinces using the distribution approach, which employs the Markov transition matrix to capture transition dynamics and produce corresponding ergodic distributions. This analysis suggests that if oil and gas income is included and the distribution approach is used, there is some evidence of increasing regional disparity. If oil and gas income is excluded, the distribution become bimodal, which also suggests increasing regional disparity. Furthermore, if population growth in rich regions is relatively slow and past dynamics hold, inter-regional disparities could increase in the future.

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1. Introduction

This paper investigates disparity among Indonesia's provinces. By population, Indonesia is the world's fourth largest country and Southeast Asia's largest, with more than 200 million residents. Indonesia is a country rich in oil, gas, minerals, forests, and fish among other natural resources, but these resources are not evenly distributed across the country. In addition, because Indonesia is a vast island country, traffic and trade among provinces can be quite costly. In addition, industrialization has been heavily concentrated in the Greater Jakarta area and in the export processing zones of the Riau Islands. All of these factors contribute to regional disparity.

Many previous studies suggest that inter-regional distribution has not changed much, in marked contrast to the larger changes observed in other developing economies such as China or Thailand.[1] In contrast this paper uses a distribution approach to analyzing inter-provincial disparities and the results suggest a trend toward increased disparities since the 1990s. One reason for the difference between the result of this study and others is that many previous studies of convergence have focused on analysis of β-convergence or σ-convergence.[2] However, both of these indicators provide only summary information about the distribution. For example, β provides information regarding the conditional mean, while σ provides information regarding the dispersion. However, these summary statistics cannot reveal what is happening to the shape of the distribution. In contrast, the distribution approach used in this paper focuses on the change of the structure of the income distribution. More specifically this approach analyzes whether the distribution converges toward the average level over time; if so, absolute convergence exists. Two techniques are used in this approach. First, the structure of income distribution structure is clarified by estimating the density function. Second the ergodic characteristics of the income distribution structure are examined by using the Markov chain.[3]

The paper begins with a literature review in Section 2. Section 3 then reviews recent time-series evidence from the provincial data and section 4 presents cross sectional evidence for 1977, 2005, and several interim years. The cross sectional distributions are obtained from actual data using approximations based on the Gaussian normal kernel. Next, section 5 presents a brief description of the Markov transition matrix methodology for modeling distribution dynamics. Finally, the main empirical analysis and results are presented in section 6 and section 7 offers some concluding remarks.

2. Some Related Literature

[1] For example, see Bhalla, Yao and Zhang (2003), Pedroni and Yao (2006), Sakamoto and Islam (2007) in China's case and Ikemoto and Uehara (2000), Motonishi (2006) in Thailand's case.

[2] For detail, see Barro and Sala-i-Martin (2004).

[3] Both techniques were suggested by Quah (1993, 1996a, 1996b, 1996c, 1997).

Many studies suggest that income inequality in Indonesia has not changed much over the last 30 years. For example, Thee (2001) suggests that the Gini coefficient has hardly changed over this period, while data from Booth (2000) show it increased slightly from 0.35 on the middle of the 1960's to 0.38 in 1978, then decreased to 0.32 in 1990 before rising to 0.36 in 1996. In its famous report '*The East Asian Miracle*', the World Bank (1993) also concluded that Indonesia had been succeeded in achieving relatively rapid economic growth with a lower inequality degree of the income distribution than Thailand and Malaysia, for example. Timmer (2004) also examines the relationship between economic growth and income inequality for 8 Asian countries over the last four decades and concludes that Indonesia enjoyed moderate economic growth with low income inequality.[4] However, there are a lot of people who question the trends suggested by the Gini coefficient data. For example, a lot of young people in large cities like Jakarta have enough income to enjoy themselves over meals costing several 50,000 rupiah or more but migrant workers from rural areas often make no more than this in a single day and have to send much of their earnings home to support their families.

There are also several studies of regional disparity following Esmara's (1975) pioneer research. For example, Akita and Lukman (1995) examine interregional income inequalities in Indonesia from 1975-1992. Williamson's weighted coefficient of variation is used to measure interregional income inequality. They also perform a sectoral decomposition analysis to investigate the extent to which industrial sectors contribute to the overall weighted coefficient of variation. Their major finding is that, although interregional income inequality remained fairly stable when mining GDP is excluded, it has undergone a significant structural change. Specifically, the contribution of the tertiary sector to inequality, though still large, has gradually declined. Meanwhile, the contribution of the secondary sector increased, reflecting its growing share of GDP. In addition, they also conclude that inequality is much smaller in consumption expenditure than in non-mining GDP and point out that fixed capital formation has been unevenly distributed, especially during the rapid growth toward the end of the period studied.

Garcia and Soelistianingsih (1998) also point out that despite 20 years of sustained economic growth which resulted in rising GDP levels in all provinces and convergence of per capita GDP across provinces, inter-provincial disparities in per capita incomes persist. They present evidence that poor provinces have tended to catch up with middle- and high-income provinces, but that regions at the top and bottom of the distribution in 1975 finished in similar positions in 1993. They also suggest that investments in human capital seem to be the most effective way of increasing provincial incomes and reducing the inter-provincial disparities in

[4] Because Statistics Bureau in Indonesia is making the survey data concerning the household income, the research of income inequality based on these data, especially National Socio Economic Survey (SUSENAS) is active. For example, see Akita and Lukman (1999), Asra (1989), Bidani and Ravallion (1993), Hughes and Islam (1981), Islam and Khan (1986), Sigit (1985), Skoufias, Suryahadi and Sumarto (2000), Sundrum (1979) and so on.

GDP per capita. Poorer provinces and rural areas can grow faster than the richer ones because they can gain the most from better health and education, because they have the highest rates of illiteracy, fertility, and infant, child and maternal mortality.

Akita and Alisjahbana (2002) estimate regional income inequality from 1993 to 1998, using a Theil index based upon district-level GDP and population data. They point out that regional income inequality rose significantly between 1993 and 1997. Their two-stage nested inequality decomposition analysis, which is an extension of the ordinary one-stage Theil decomposition method, indicates this was due mainly to an increase in within-province inequality, especially in Riau, Jakarta, West Java, and East Java. Especially, in 1997, the within-province component represented about 50% of regional income inequality. Akita (2003) also applies the two-stage nested Theil decomposition method to district-level income and population data in Indonesia and China and explores factors determining regional income inequality in Indonesia and China.

Resosudarmo and Vidyatamma (2006) estimated a model of per capita income growth in a panel of Indonesian provinces for 1993-2002 period and investigated the determinants of the country's inter-provincial income disparity. Their results suggest that, despite the existence of substantial disparities, conditional convergence of regional incomes occurred as growth proceeded during this period. Moreover, the investment-output ratio, openness to international trade, and the contribution of the gas and oil sectors were found to be important determinants of the variation of growth across provinces.

Handa (2005) thought that differences in the endowments of physical and human capital gave rise to regional disparities. Accordingly, he first estimated regional factor endowments for 1993-1996 and then estimated a production function in which human capital was distinguished. He used the second Theil decomposition method (so-called mean logarithmic deviation), finding that variation in human capital endowments explained most of the observed regional disparities. He also conducted simulations indicating that improving human capital formation through elementary education could reduce regional disparities markedly.

Handa (2007) used the Markov transition matrix in an approach similar to that used in this study. This matrix is derived from the shape of distribution between initial point and convergence point which called ergodic distribution. He concluded that the regional disparity is decreasing when oil and gas GDP is included in the definition of income for 1986-1997. However, regional disparity changed very little when oil and gas related incomes are excluded. In the period after the Asian monetary crisis (1997-2003), convergence occurred when oil and gas GDP is included, but the regional distribution is bimodal when oil and gas incomes are excluded.

Both this paper and Handa's (2007) research emphasize the advantages of using the distribution approach. Many other studies of convergence have examined either β-convergence or σ-convergence. This approach is based on regressions of growth on the initial income level and other controls. In this framework, β is the coefficient on the initial income variable and a significant negative value is taken as the evidence of convergence, a significant positive value as evidence of divergence, and an insignificant value suggesting neither convergence nor divergence. However, there are two fundamental criticisms of this approach. One of these relates to Galton's Fallacy. A negative value of β does not necessarily imply a reduction in the dispersion of the distribution of per capita income across regions. Hence when researchers make such a conclusion, they risk falling into Galton's Fallacy. The second line of criticism of studies based on β-convergence or σ-convergence is that both β and σ provide only summary statistics of the distribution of interest and hence are not adequate for understanding what is happening to the entire distribution. The distribution approach has been developed to address these criticisms and it focuses on the shape of the entire distribution and the changes in its shape.[5] Two technologies are necessary to implement the distribution approach. First of all, the income distribution structure is estimated by using the density function. Second, elgord characteristic of the income distribution structure is examined by using the Markov chain. This approach has been widely used in a variety of studies.[6]

In short, inequality can be discussed at the household level (e.g., calculations of Gini coeffiecients for the entire country) or at regional level using either household survey data or national accounts data. This study will focus on the latter, analysis of regional disparities as revealed in the national accounts data. The paper focuses on inter-provincial distribution because changes in provincial boundries have been relatively few, whereas changes in more narrowly defined regions (e.g, the prefecture or *kabupaten* level) have changed much more.[7] It also analyzes a much longer time period and more subperiods than previous studies using the distribution approach. This can help to isolate important changes over time that may have been missed by previous studies.

3. Time Series Evidence

The analysis of this paper focuses on the period from 1977 to 2005.[8] The regional (provincial) time series data on per capita GDP are compiled from BPS (various years) and are brought to constant 2000 prices. Indonesia is classified into east and west and/or 5 states by a regional classification of BPS. For detail, Sumatra (Aceh, North Sumatra, West Sumatra, Riau, Jambi, South Sumatra, Bengkulu, Lampung, Bangka Belitung Islands, and Riau

[5] For more detail discussion, see Sakamoto and Islam (2007).

[6] See for example studies of inter-country distribution (Quah 1993, 1996a, 1996b) and studies of inter-regional distribution in the United States (Quah 1996a), Japan (Kakamu and Fukushige 2006, Kawagoe 1999, Togo 2002), and China (Bhalla, Yao and Zhang 2003, Sakamoto and Islam 2007).

[7] For example, see Fitrani, Hofman and Kaiser (2005).

[8] The deregulation of trade starts in 1985, and the economic circumstance has changed into Indonesia greatly. This continues until about 1995, however, due to economic crisis in 1997, the economic growth rate of next year exceeds the minus 13%, and economy suddenly fails. Indonesian economy recovers gradually after that, and the economic growth rate of 5% is maintained at last few years. Moreover, decentralization has accelerated in 2000.

Islands), Java and Bali (Jakarta, West Java, Central Java, Yogyakarta, East Java, Banten and Bali) are belonging to west Indonesia. Kalimantan (West Kalimantan, Central Kalimantan, South Kalimantan, and East Kalimantan), Sulawesi (North Sulawesi, Central Sulawesi, South Sulawesi, South East Sulawesi, West Sulawesi, and Gorontalo), and Lainnya (West Nusa Tenggara, East Nusa Tenggara, Maluku, North Maluku, Irian Jaya (Papua), and West Irian Jaya) are belonging to east Indonesia. East Timor is excluded for our data set.

Next, although this is a feature of Indonesia, two kinds of GDP, which the 'including oil/gas' is contained oil and gas income and 'excluding oil/gas' is not contained them, are calculated. Akita and Lukman (1995) pointed out that much of the value added generated by a resource-rich region through extracting activities does not trickle down to the people living there, but goes instead to other regions or abroad. They continued for instance, the bulk of income derived from oil and gas in Indonesia accrues to the central government, with only a small portion going to the governments and people of the producing provinces. For this reason, like previous studies on regional disparities in Indonesia, this paper treats the including oil/gas and excluding oil/gas separately.

In this section, the trend of the regional disparity by the time series is shown. This analysis is necessary before the distribution approach is actually discussed. Because by comparing with this result and the distribution approach, the robustness of results is kept. Figure 1 shows two categories (including oil/gas: OG and excluding oil/gas: NOG) of disparity in whole Indonesia by the two measurements of the coefficient of variation and the logarithm standard deviation. It is clearly understood that the disparity is remarkably downtrend until 1990 in the case of including oil/gas, but it turns uptrend after that. The disparity in the case of excluding oil/gas is gradually uptrend through the period. It suggests that the little expansion of the disparity as long as the trend after 1990 is seen though Indonesia has been said to be a country that has developed without the regional disparity has expanded so much up to now.

Figure 2 shows the disparity divided from whole country to east and west. On the whole, the disparity of east is absolutely larger than west in both of the case. And it shows interesting evidence that the trend of the disparity before 1990 is different in the case of excluding oil/gas between east and west. However, the disparity is uptrend after 1990.

Figure 3 shows the trend of the disparity of each state in the case of including oil/gas. The state in which it greatly contributed to the disparity reduction is Sumatra in east and is Kalimantan in west. There is expanding tendency of disparity in Java and Sulawesi, but the degree of disparity in Sulawesi is quite small. The change of disparity in Lainnya is quite large.

Figure 4 shows the same in the case of excluding oil/gas. The disparity is reducing greatly until 1985, and having become an expansion tendency afterwards are Kalimantan and Lainnya in the east. Although Sumatra did not have great fluctuations of the disparity, Java and Sulawesi are expanding tendency some. The degree of disparity in Sulawesi is also quite small. Therefore, it is thought the state that can become the factor of the disparity expansion is Java, which is including Jakarta city.

4. Approximation of Income Distribution in Selected Years Using the Gauss Kernel

In this section, approximation of the income distribution in Indonesia will be examined. We are interested in the change of the structure of the income distribution. If the income distribution becomes concentrated around the average level, it can be interpreted that absolute convergence exists. Of course, if not, income convergence does not exist and income divergence exists in some cases. Therefore, approximating the income distribution and understanding corresponding distribution dynamics is the first step to apply the distribution approach. For example, Quah (1996c, 1997) investigates distribution dynamics across more than 100 countries over 15-year horizons using the gauss kernel estimation and he shows two income peaks over the period.

We only have discrete income data for each economy. Estimating the density function means transformation from the discrete data to a continuous curve. As a method of expressing the discrete income distribution as a continuous curve according to the stage, the kernel density estimation is broadly adopted. If the width of the discrete income distribution becomes fine enough, the distribution could be expressed by a continuous curve.

Let y_i denote per capita GDP of province i in 2000 prices, and $\bar{y}$ be the cross-section population weighted average of y_i. We first want to abstract from the shift in the mean of the distribution as reflected in the secular movement in $\bar{y}$. We therefore normalize the data from different years by their respective cross-section means, and take the log of the ratio of y_i to $\bar{y}$ as the variable to analyze. We denote this variable by x_i, so that

$$x_i = \ln\left({y_i}/{\bar{y}} \right) = \ln y_i - \ln \bar{y} . \quad (1)$$

We begin by approximating the actual distribution of x_i for selected years using the Gaussian normal kernel.[9] The density function used for the approximation is as follows:

$$\tilde{f}(X) = \frac{1}{h} \sum_{i=1} \frac{w_i}{\sqrt{2\pi}} \exp\left(-\frac{1}{2} \cdot \left(\frac{X - x_i}{h} \right)^2 \right), \quad (2)$$

where x_i is an observed value of the variable, w_i is the population share, and h is the window width (assumed to be 0.2).

Figure 5 presents the approximated distribution in the case of including oil/gas for 1977, 1980, 1985, 1990, 1995, 2000, and 2005. As we can see, the shape of the distribution has not

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9 For details, see Silverman (1986).

changed remarkably over time. However, these figures display from a single-model characteristic with a bigger low-income peak to a bi-modal characteristic with a bigger low-income peak and a smaller high-income peak. Comparing the distributions for 1977 and 2005, we find that the income level at the lower peak moved to more higher, which located at around -0.5 (relative income x_i) in 1977 to around -0.2 in 2005. Moreover, instead of lost of a higher small peak, which located at around 2.2 in 1977 and 1980, the income level at the next higher peak moved to more higher, which located at around 0.7 in 1980, 1.0 in 1990, 1.2 in 1995, and 1.3 in 2005. We imply that the width of distribution has been narrowed at least.

Corresponding years' distributions in the case of excluding oil/gas are shown in Figure 6. They also display the similar bi-modal characteristic, but distribution range is narrower than that of including oil/gas. Interestingly, despite the income level of at the lower peak have not been moved so much, which located at around -0.2 during sample period, the height of the density at the lower peak is smaller, which shared 7 percent at the income level of around -0.2 in 1985 decreased to 5.5 percent in 2000. However, the change of the higher peak is similar with that of including oil/gas, which located at around 1.1 in 1985 and 1990 to around 1.5 after 1995. The change of the disparity between the case of including oil/gas and excluding oil/gas are different as well as time series analysis by Figure 1.

Figure 7 to Figure 14 show the component of income distribution for selected years of 1977, 1985, 1995 and 2005. The figures of the odd number are the case of including oil/gas and the figures of the even number are the case of excluding oil/gas. Because of using the population weighted average for approximation, the height of the density is different in each state. Therefore, the height of the density of the west is greater than that of the east. The weight of Java and Bali is especially high in the west. We find that the peak of income between the west and the east is almost same in 1977. In the west side, the peak of Sumatra is higher than that of Java and Bali, but there is more higher density exists in Java and Bali. In the east side, the peak of Kalimantan is the highest, Sulawesi is the second and Lainnya is the lowest. However, there is large difference between the case of including oil/gas and the case of excluding oil/gas in the peak of Kalimantan (see Figure 7 and Figure 8).

A big difference between 1977 and 1985 is that the disparity between the east and the west became clear in 1985. The income has risen in the west for each case. Similarly, we can find the higher income peak clearly. On the other hand, the peak of density in Kalimantan and Sumatra greatly moves to the left, and the income decreases relatively (see Figure 9 and Figure 10). Comparing 1985 with 1995, it is clear that the difference between the higher income peak level and the lower income peak level has been extended. However, we find that there is no big change in the income distribution structure between 1995 and 2005. These characteristics exist when including oil/gas or when excluding oil/gas (see from Figure 11 to Figure 14).

It seems that the change of such an income distribution structure is related to the convergence analysis using Markov chain that will explain in the next. Having thus obtained an overview of the distributions and the changes in them, we now turn to modeling the dynamics of distribution using Markov transition matrices and producing corresponding ergodic distributions.

5. Markov Transition Matrix Methodology

Next, the ergodic characteristics of the income distribution structure by using the Markov chain will be examined. Quah (1993, 1996a, 1996b) has developed the methodology for implementation of this approach. The methodology is based on the use of Markov transition matrix to model the change in distribution from one period to the next.[10] In the following we present the essentials of this methodology before turning to its implementation for the Indonesian case.

Let $n \times 1$ vector F_t gives the distribution at time t, with n being the number of states distinguished to represent the distribution. In case of income distribution, as is in this paper, each state represents an income interval. Let M be the (n by n) Markov transition matrix governing the transformation of F_t into F_{t+1}, the distribution for t+1, so that we have

$$F_{t+1} = M^t \cdot F_t . \quad (3)$$

The Markov matrix assumes the following form.

$$M = \begin{pmatrix} a_{11} & \cdots & a_{1k} \\ \vdots & \ddots & \vdots \\ a_{j1} & \cdots & a_{jk} \end{pmatrix}, \quad (4)$$

with each element of the matrix, a_{jk}, giving the probability of transition from state j during the initial period to state k during the next. These elements are therefore referred to as Markov transition probabilities.

Assuming that the Markov transition matrix remains unchanged, the distribution after several periods can be obtained by repeating equation (3)'s number of times. And if repeating times go to infinity, the distribution converges to an ergodic distribution, sometimes also referred to as the steady state distribution, $\bar{F}$ .The ergodic or steady state distribution does not change, so that

$$\overline{F} = M^t \cdot \overline{F} . \quad (6)$$

Equation (6) shows that for a particular transition matrix M, it is possible to obtain a

10 For more details, see Durlauf and Quah (1999), Islam (2003), Magrini (2004), Sakamoto and Islam (2007).

corresponding steady state or ergodic distribution. Technically, the ergodic distribution is computed as the left eigenvector corresponding to the unit eigenvalue. The ergodic distribution shows what the long run distribution is going to be like if the observed dynamics continue to hold.

Thus the Markov transition matrix methodology can be helpful in answering many unanswered questions regarding regional convergence in Indonesia. It may be used to find out what the recent dynamics are in the form of computed transition probabilities and what kind of distribution will evolve if these dynamics continue to hold. It is then possible to compare and see how the ergodic distribution differs from the initial and final period distributions. Such a comparison can provide a fuller picture of what is happening with regard to the regional convergence process.

6. Distribution Dynamics and Ergodic Distributions

An important issue in modeling distribution dynamics using Markov transition matrix concerns discretization. It involves determining the number of states and the grid values to demarcate these states. In this paper we provide two alternatives. One is based on five states, and the other is based on seven states. Table 1 and Table 3 presents the results from five-grid (five states) analysis in the case of including oil/gas and excluding oil/gas, while Table 2 and Table 4 does the same for the seven-grid analysis in the case of including oil/gas and excluding oil/gas, respectively.

With regard to the grid values to demarcate the states, there are several possibilities. This paper chooses grid values in a way so that overall the distribution of the actual values prove to be close to being uniform.[11] On the other hand, in Indonesia due to decentralization advances, the number of provinces increases after 2000. Concretely, 26 provinces are available for the 1977-2005 period and newly 4 provinces are available for the 1999-2005 period. Moreover, 3 provinces are separated and available for the 2004-05 period. For calculating transition of separated province, we assume to calculate two income state transitions which are separated province and remaining province from original province. Therefore, all together there are 755 observations on annual transition. A uniform distribution with five (seven) states would therefore have about 151 (108) observations in each state.

The first panel of Table 1 shows the Markov transition matrix based on annual transition data from 1977 to 2005. As can be seen, the grid values of x_i prove to be -0.5962, -0.4431,

[11] Choosing gridlines to make the distribution uniform is a popular option. For example, Quah (1996a) too uses this option in his analysis of the US states. Another option is to choose the gridlines by fixed length, say by number of standard deviation or some other chosen interval. In his analysis of 119 countries, Quah (1993, 1996a, 1996b) opts for such arbitrarily chosen gridlines. One consideration guiding the choice of gridlines is the total number of transition episodes available in the data. If this number is large, the option of arbitrary gridlines becomes feasible, because all the states are likely to have enough number of transition episodes to make the analysis successful. The problem arises when the cross-section dimension is small, so that arbitrary gridlines may result in states with no or very few corresponding transition episodes, making the analysis infeasible or problematic (Sakamoto and Islam, 2007).

-0.1951, and 0.1139. The numbers in parentheses in the first column show the number of observations in the entire sample whose initial state belongs to the state represented by the respective row. Comparing these numbers across the rows we see that the chosen grid points indeed result in a fairly uniform distribution in the entire sample. As already explained, the numbers in the cell represent Markov transition probabilities, so that a_{jk} gives the probability of transition from state j during the initial period to state k during the next period. The diagonal elements, a_{jj}, show the probability of a state remaining unchanged. The numbers in the last row of the panel show the ergodic distribution that would result from the Markov transition matrix shown in the panel. We can see that the probability at the fourth column is the highest (28.16 percent). As a result, because the fourth column is a column including average income level (valued 0) of distribution, the tendency that the income distribution converges to the average is thought.

The second panel of Table 1 shows the Markov transition matrix based on annual transition data from 1980 to 2005. In this study, whenever the sample period changes, the grid values is recalculated. Therefore, note that the grid values are different at each measurement period. For example, the grid values prove to be -0.5951, -0.4369, -0.1865, and 0.1010 in 1980-2005 period. According to all panels of Table 1, we can see that the ergodic distribution at the fourth column (income state), which including average income is the most until the third panel (1977-2005, 1980-2005, and 1985-2005). However, the distribution share of the lowest income state rises little by little, and the share of the lowest income state is the most for the period since 1990-2005. In a word, it is understood to tend an increase of the relatively poor income region.

It seems that this is different form bi-modal characteristics shown in Figure 5. However, the state of the highest rank is more than 0.11 (relative income x_i) as shown in the setting of the grid line in 1977-2005 period. The peak in the higher income in Figure 5 is at around 1.0. Moreover, the proportion of the higher income region is extremely low. Therefore, the regions where the income is high are including the highest income state, and it seems that this invents the difference of the result in this analysis.

Table 2 shows analogous results with a finer grid division. We now have seven states, corresponding to the grid values -0.6450, -0.5331, -0.4111, -0.2241, -0.0810, and 0.4887 in 1977-2005. The number of observations in the first column of the table shows that these grid values do produce a distribution that is close to being uniform. We can see that the distribution has concentrated on the fifth and the sixth columns of the last row of the first three panels. The sixth column is including the average. And the distribution has concentrated on the first (lowest) column of the last row of the last three panels. Therefore, we can conclude that the result of Table 1 and Table 2 is similar.

Table 3 shows the results from five-grid analysis in the case of excluding oil/gas. Under our assumption, the grid values are also different from the case of including oil/gas, prove to be -0.4323, -0.2704, -0.1038 and 0.0573 in the 1977-2005 period. We can see that the probability at the first column of the last row of each panel is the highest. This means the distribution concentrates to the lowest income states. In a word, it is thought that the region where the income worsened relatively came out one after another.

However, the case of 1995-2005 is somewhat difference. There is a direction that the region where the income worsens is decreasing, and the probability of the highest income state is increasing. In the other words, the bi-modal distribution is observed in 1995-2005. Interestingly, we can find that these results are corresponding to the result of Figure 6.

We can see the similar result from seven-grid analysis in Table 4. The grid values prove to be -0.5138, -0.3534, -0.2387, -0.1332, -0.0186 and 0.1732 in 1977-2005 period. This table also shows the concentration to the lowest income states except the bi-modal distribution pattern of 1995-2005.

For readers' reference, according to the result of Table 1 to Table 4, we provide Figure 15 to Figure 18 which shows the ergodic distribution of each sample period. These may be helpful to understand convergence future income distribution under assuming several economic growth patterns.

By using the model of the Markov chain, we show that the regional disparity of Indonesia is increasing tendency in the case of excluding oil/gas, while it is decreasing tendency in the case of including oil/gas. The most important thing is not up to change the transition probability matrix during the period greatly when the model of the Markov chain is assumed. However, it becomes difficult to hold this assumption if the observation period is longer. Various changes are thought for the period, for instance, it seems that Asian financial crisis for 1997 hits this. This might correspond to the structural change if it says by the time series data. The structural change of the transition probability matrix can be examined by the Chi-square test. However, it doesn't touch this problem in this paper. It is because it is not a purpose to examine the structural change of Indonesian economy.

7. Concluding Remarks

After showing that the inter-provincial distribution differs greatly when oil and gas income is included and when it is not, this paper investigates inter-provincial income disparity in Indonesian provinces using the distribution approach. This approach uses the Markov transition matrix is used to capture transition dynamics and produce corresponding ergodic distributions. This helps to forecast future changes in the distribution if the current dynamics hold. The distribution approach also facilitates analysis of the entire distribution, not just its mean and/or dispersion. The results of approximating the income distribution in this way reveal several regions were incomes have tended to be relatively high (Jakarta, Riau, East Kalimantan, and other mineral rich provinces). However, except for Jakarta, the population in these provinces is generally small and has not grown very rapidly. Jakarta is the largest rich region with a large population and a diverse economy, but other richer regions have smaller populations and specialize in specific activities (e.g., export processing in Riau and oil, gas, and other minerals in East Kalimantan. This is one reason why standard statistical analysis of convergence based on the mean or dispersion of income does not reveal a trend toward increased inequality. However, if oil and gas income is included and the distribution approach is used, there is some evidence of increasing regional disparity. If oil and gas income is excluded, the distribution become bimodal, which suggests increasing regional disparity. Furthermore, if population growth in rich regions is relatively slow, inter-regional disparities could increase.

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Figure 1: Coefficient of variation and log standard deviation across Indonesian provinces

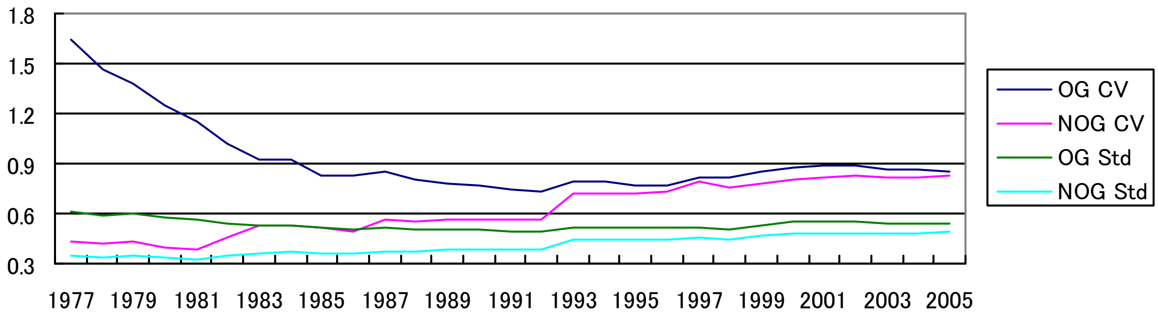

Figure 2: Standard deviation between east and west

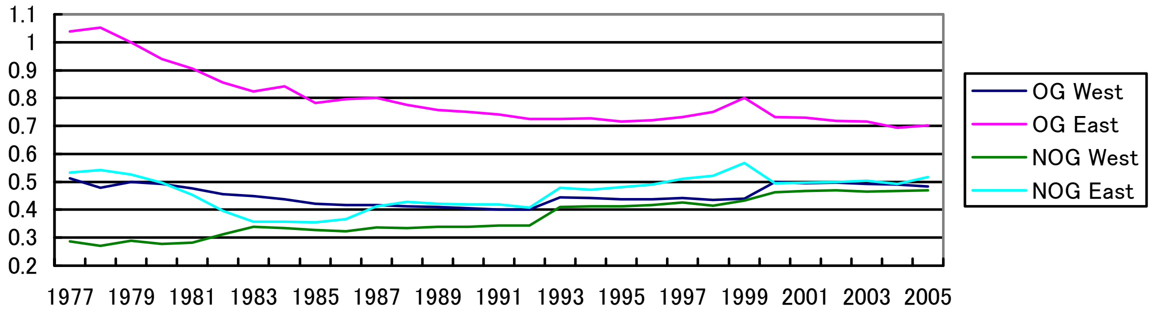

Figure 3: Standard deviation of each state (including oil/gas)

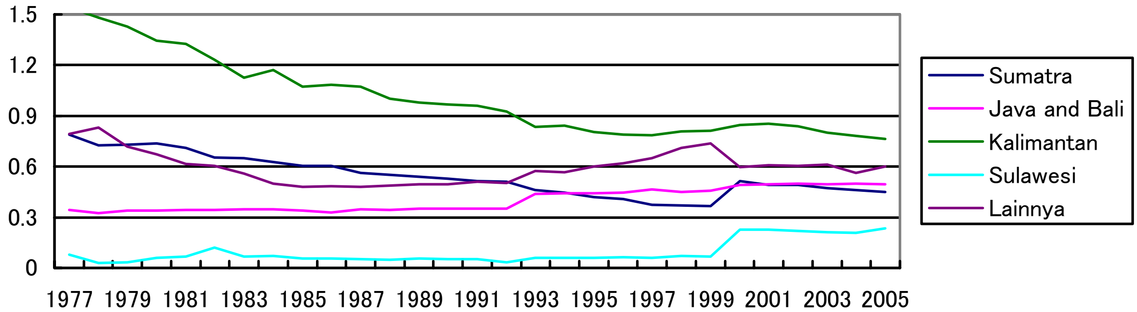

Figure 4: Standard deviation of each state (excluding oil/gas)

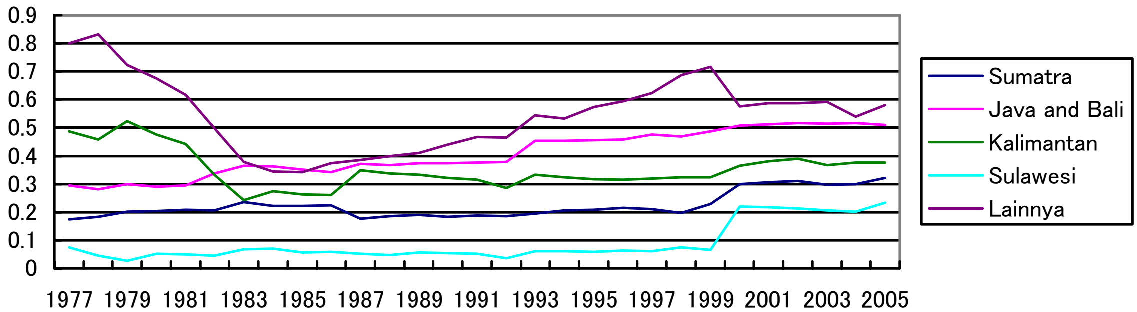

Figure 5: Approximation of Income Distribution (selected years, including oil/gas)

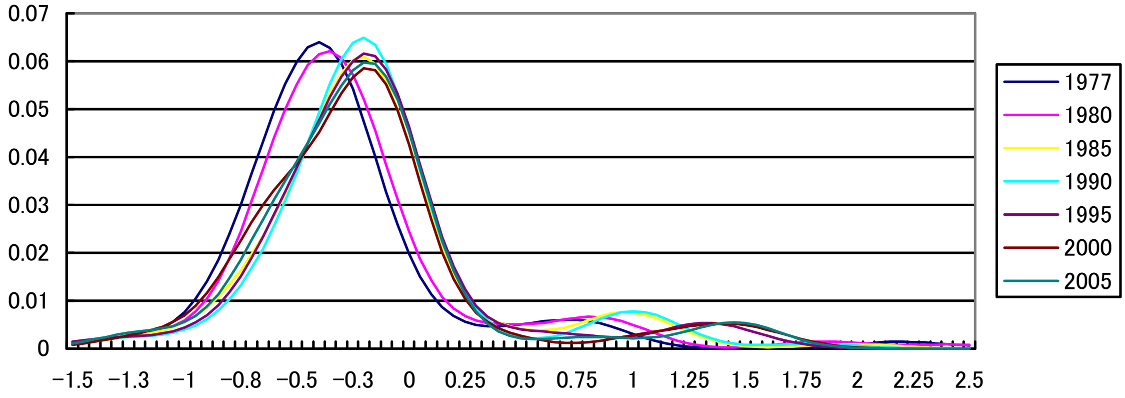

Figure 6: Approximation of Income Distribution (selected years, excluding oil/gas)

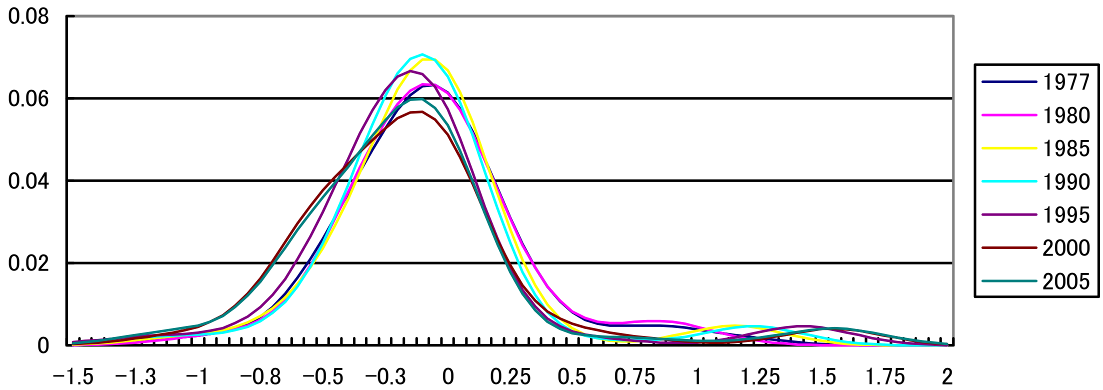

Figure 7: Approximation of Income Distribution and its Components (1977, including oil/gas)

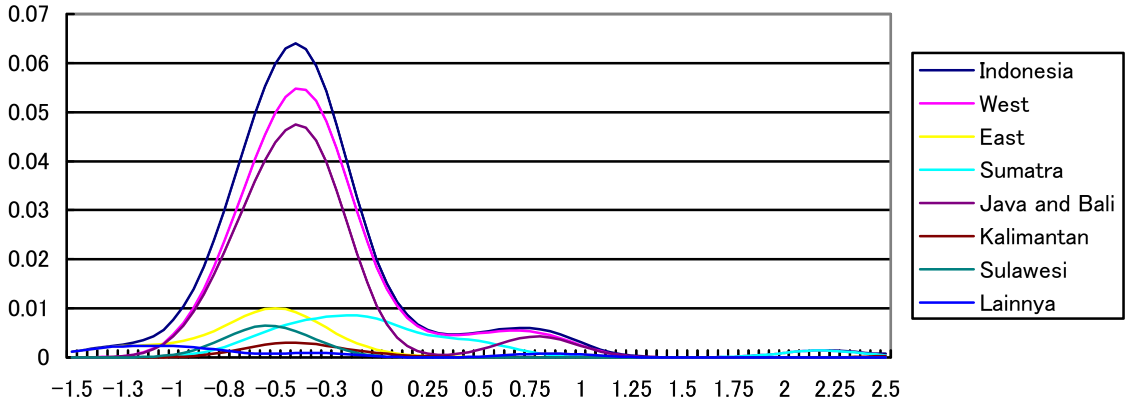

Figure 8: Approximation of Income Distribution and its Components (1977, excluding oil/gas)

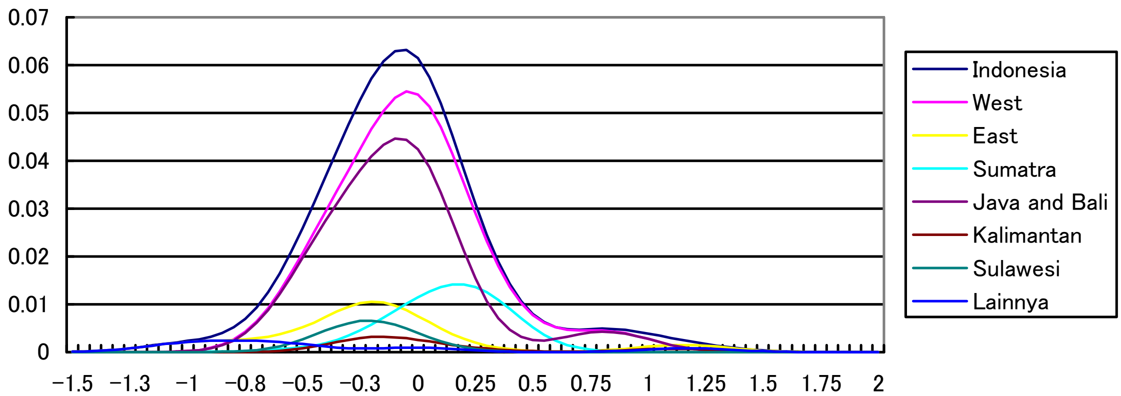

Figure 9: Approximation of Income Distribution and its Components (1985, including oil/gas)

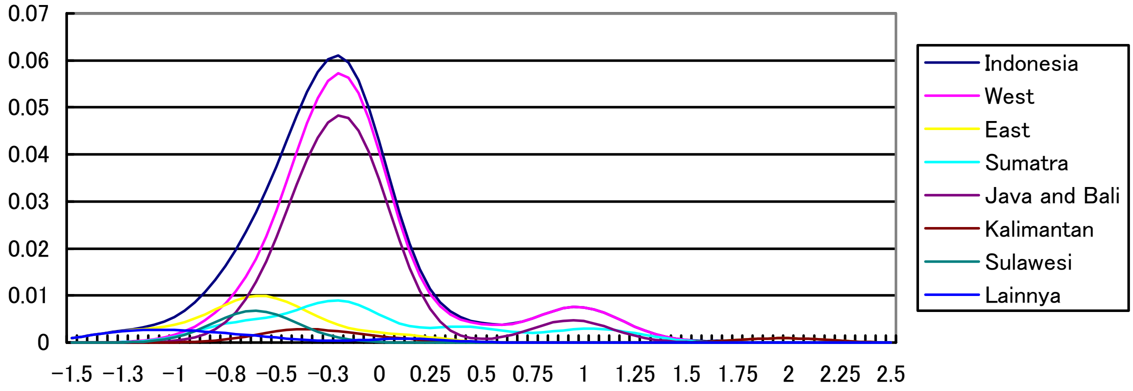

Figure 10: Approximation of Income Distribution and its Components (1985, excluding oil/gas)

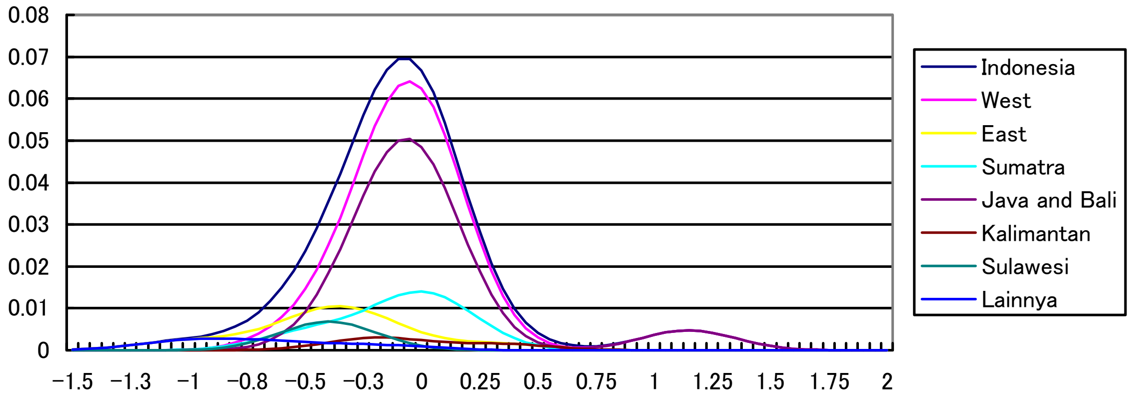

Figure 11: Approximation of Income Distribution and its Components (1995, including oil/gas)

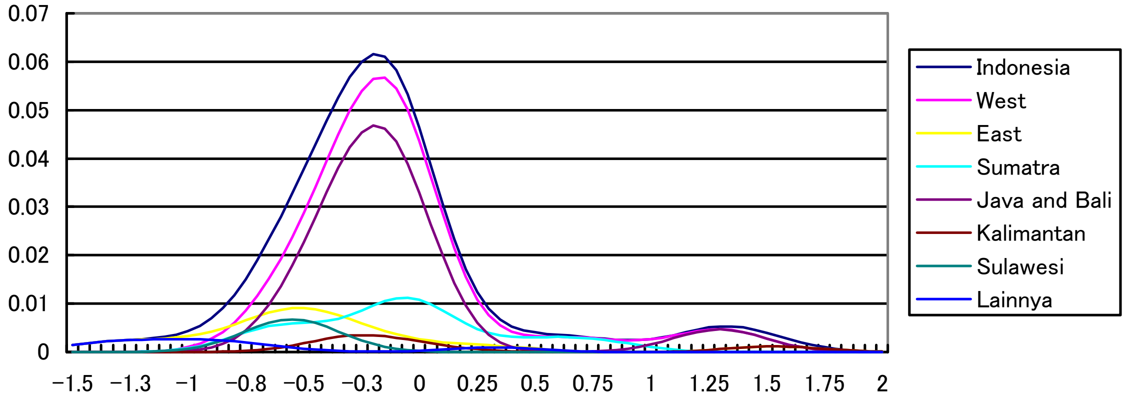

Figure 12: Approximation of Income Distribution and its Components (1995, excluding oil/gas)

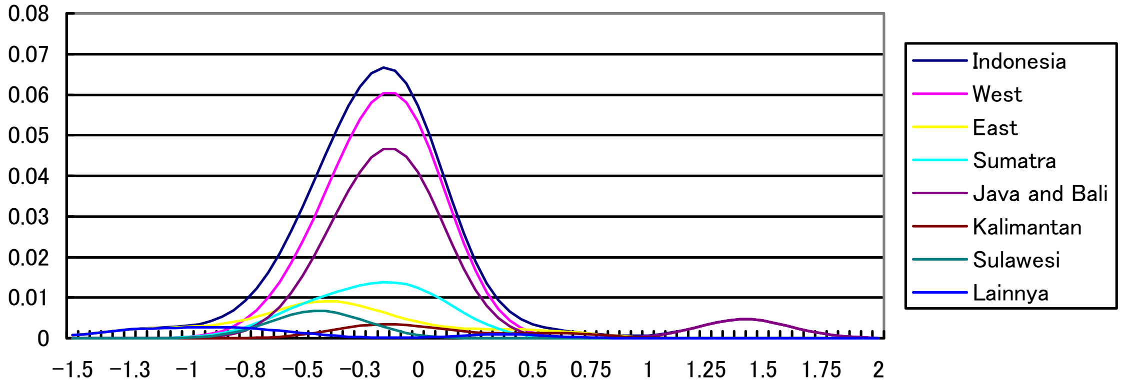

Figure 13: Approximation of Income Distribution and its Components (2005, including oil/gas)

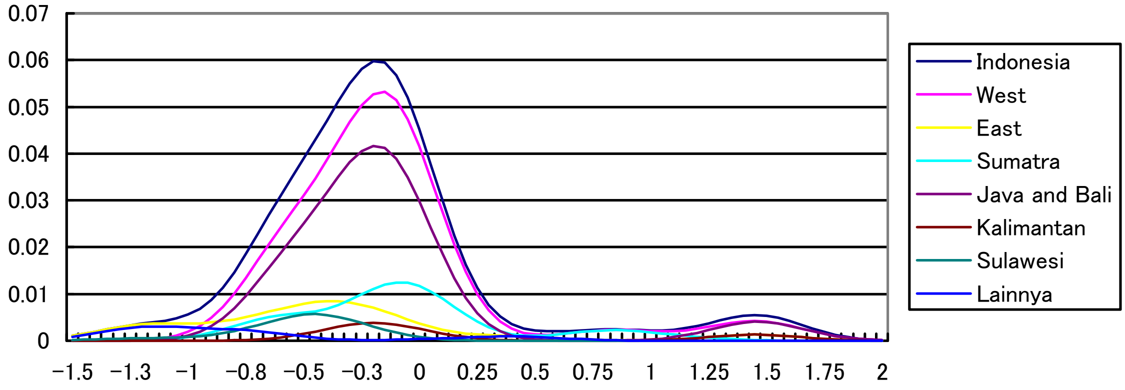

Figure 14: Approximation of Income Distribution and its Components (2005, excluding oil/gas)

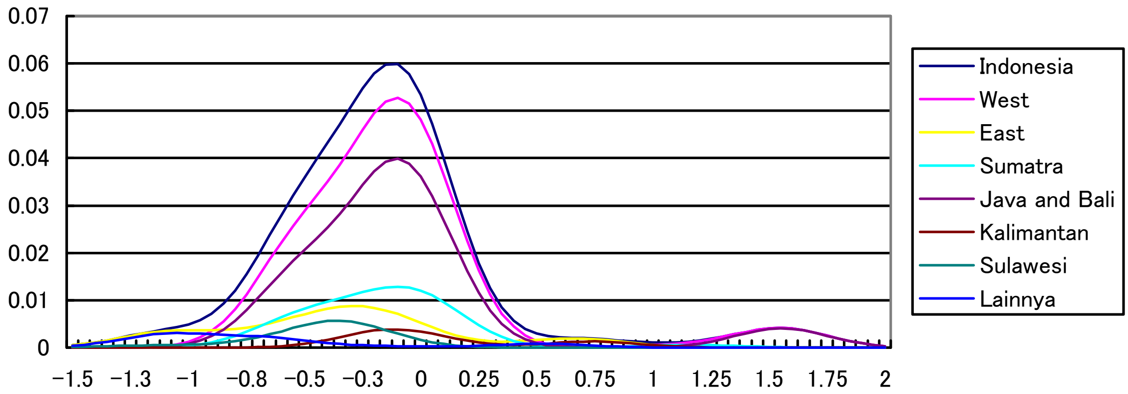

Figure 15 Ergodic Distribution (5 grids, including oil/gas)

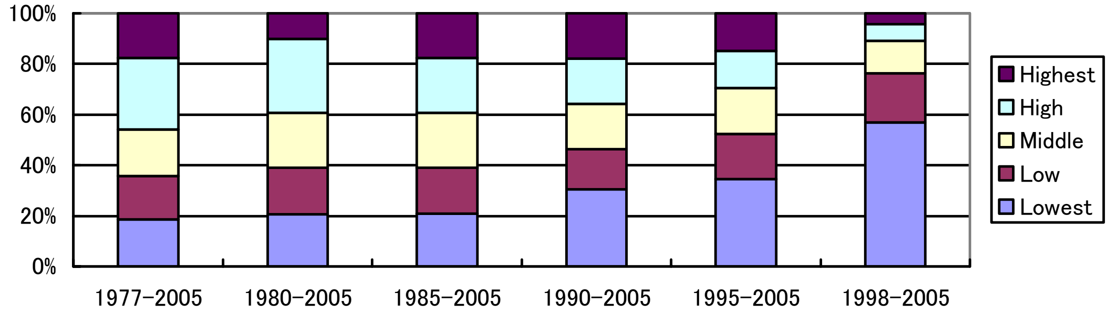

Figure 16 Ergodic Distribution (7 grids, including oil/gas)

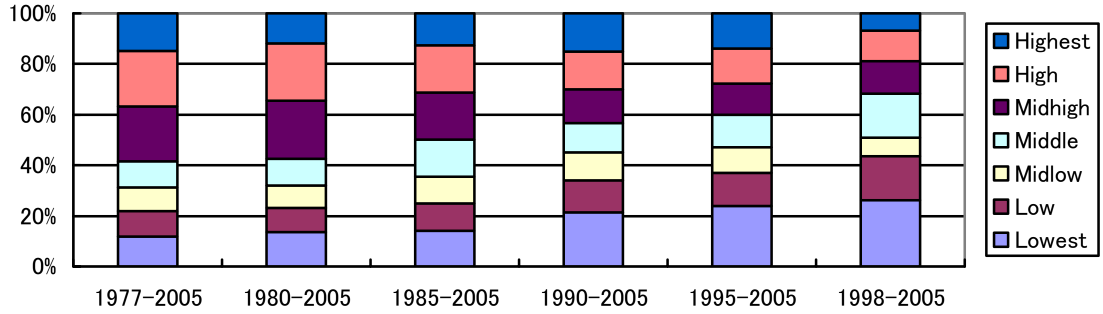

Figure 17 Ergodic Distribution (5 grids, excluding oil/gas)

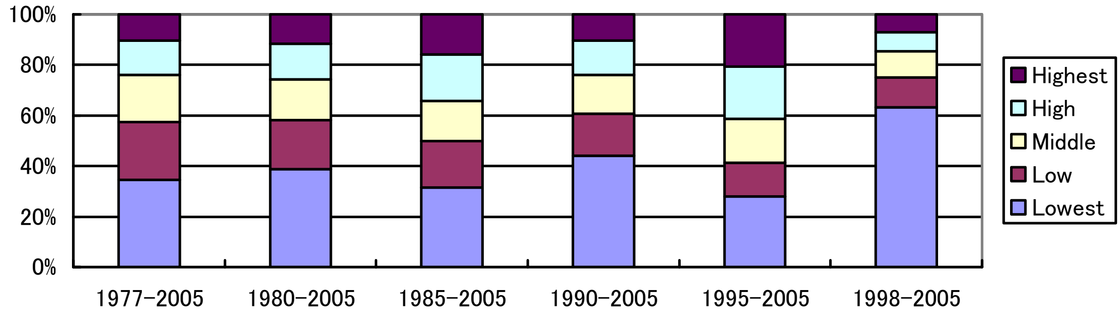

Figure 18 Ergodic Distribution (7 grids, excluding oil/gas)

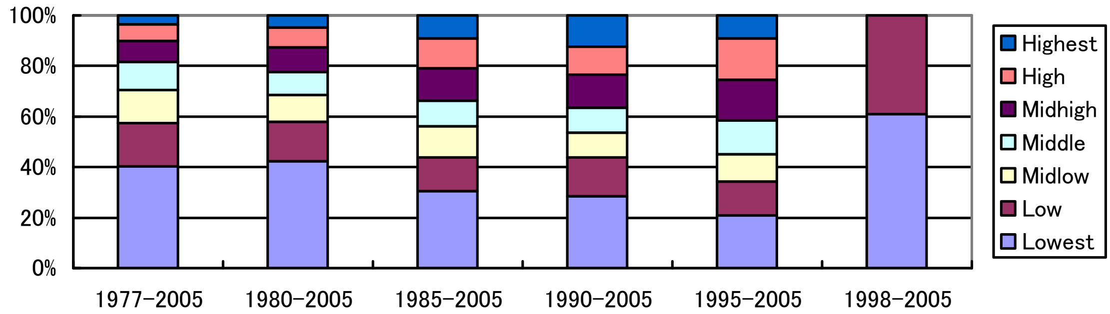

Table 1: Markov Transition Matrix and Ergodic Distribution (5 grids, including oil/gas)

		Grid line (highest point)				
1977-2005		-0.5962	-0.4431	-0.1951	0.1139	Inf
Samples	148	0.9122	0.0878	0.0000	0.0000	0.0000
	155	0.0968	0.7742	0.1290	0.0000	0.0000
	151	0.0000	0.1192	0.8079	0.0728	0.0000
	147	0.0000	0.0000	0.0476	0.9320	0.0204
	154	0.0000	0.0000	0.0000	0.0325	0.9675
	Ergodic	0.1873	0.1700	0.1841	0.2816	0.1770
1980-2005		-0.5951	-0.4369	-0.1865	0.1010	Inf
Samples	133	0.9098	0.0902	0.0000	0.0000	0.0000
	139	0.1007	0.7770	0.1223	0.0000	0.0000
	135	0.0000	0.1037	0.8148	0.0815	0.0000
	132	0.0000	0.0000	0.0606	0.9242	0.0152
	138	0.0000	0.0000	0.0000	0.0435	0.9565
	Ergodic	0.2054	0.1840	0.2170	0.2918	0.1017
1985-2005		-0.5951	-0.4224	-0.1696	0.0571	Inf
Samples	107	0.9159	0.0841	0.0000	0.0000	0.0000
	113	0.0973	0.8142	0.0885	0.0000	0.0000
	108	0.0000	0.0741	0.8704	0.0556	0.0000
	109	0.0000	0.0000	0.0550	0.9083	0.0367
	110	0.0000	0.0000	0.0000	0.0455	0.9545
	Ergodic	0.2092	0.1808	0.2160	0.2180	0.1760
1990-2005		-0.6041	-0.4196	-0.1632	0.0449	Inf
Samples	81	0.9383	0.0617	0.0000	0.0000	0.0000
	86	0.1163	0.7907	0.0930	0.0000	0.0000
	83	0.0000	0.0843	0.8434	0.0723	0.0000
	83	0.0000	0.0000	0.0723	0.8916	0.0361
	84	0.0000	0.0000	0.0000	0.0357	0.9643
	Ergodic	0.3035	0.1611	0.1777	0.1777	0.1799
1995-2005		-0.6287	-0.4071	-0.1632	0.0336	Inf
Samples	56	0.9464	0.0536	0.0000	0.0000	0.0000
	58	0.1034	0.7931	0.1034	0.0000	0.0000
	58	0.0000	0.1034	0.8103	0.0862	0.0000
	57	0.0000	0.0000	0.1053	0.8421	0.0526
	58	0.0000	0.0000	0.0000	0.0517	0.9483
	Ergodic	0.3459	0.1791	0.1791	0.1467	0.1493
1998-2005		-0.6432	-0.4003	-0.1758	0.0113	Inf
Samples	41	0.9512	0.0488	0.0000	0.0000	0.0000
	42	0.1429	0.7619	0.0952	0.0000	0.0000
	42	0.0000	0.1429	0.8095	0.0476	0.0000
	43	0.0000	0.0000	0.0930	0.8605	0.0465
	41	0.0000	0.0000	0.0000	0.0732	0.9268
	Ergodic	0.5683	0.1940	0.1294	0.0662	0.0421

Table 2: Markov Transition Matrix and Ergodic Distribution (7 grids, including oil/gas)

		Grid line (highest point)						
1977-2005		-0.6450	-0.5331	-0.4111	-0.2241	-0.0810	0.4887	Inf
Samples	106	0.9057	0.0943	0.0000	0.0000	0.0000	0.0000	0.0000
	109	0.0917	0.7615	0.1193	0.0183	0.0092	0.0000	0.0000
	109	0.0183	0.0917	0.7706	0.1193	0.0000	0.0000	0.0000
	110	0.0000	0.0455	0.0909	0.7727	0.0909	0.0000	0.0000
	106	0.0000	0.0000	0.0000	0.0472	0.8679	0.0849	0.0000
	106	0.0000	0.0000	0.0000	0.0000	0.0849	0.8962	0.0189
	109	0.0000	0.0000	0.0000	0.0000	0.0000	0.0275	0.9725
	Ergodic	0.1175	0.1021	0.0937	0.1026	0.2175	0.2175	0.1491
		Grid line (highest point)						
1980-2005		-0.6456	-0.5293	-0.4064	-0.2103	-0.0836	0.4577	Inf
Samples	95	0.9158	0.0842	0.0000	0.0000	0.0000	0.0000	0.0000
	98	0.1020	0.7653	0.1020	0.0306	0.0000	0.0000	0.0000
	97	0.0206	0.0722	0.7835	0.1237	0.0000	0.0000	0.0000
	99	0.0000	0.0404	0.0909	0.7778	0.0909	0.0000	0.0000
	95	0.0000	0.0000	0.0000	0.0421	0.8632	0.0947	0.0000
	95	0.0000	0.0000	0.0000	0.0000	0.0947	0.8842	0.0211
	98	0.0000	0.0000	0.0000	0.0000	0.0000	0.0408	0.9592
	Ergodic	0.1362	0.0944	0.0889	0.1058	0.2284	0.2284	0.1178
		Grid line (highest point)						
1985-2005		-0.6607	-0.5292	-0.3743	-0.1976	-0.0848	0.4173	Inf
Samples	77	0.9221	0.0779	0.0000	0.0000	0.0000	0.0000	0.0000
	79	0.0886	0.8101	0.0759	0.0253	0.0000	0.0000	0.0000
	79	0.0127	0.0759	0.8481	0.0633	0.0000	0.0000	0.0000
	78	0.0000	0.0128	0.0513	0.8205	0.1154	0.0000	0.0000
	78	0.0000	0.0000	0.0000	0.0769	0.8077	0.1154	0.0000
	78	0.0000	0.0000	0.0000	0.0128	0.1026	0.8590	0.0256
	78	0.0000	0.0000	0.0000	0.0000	0.0000	0.0385	0.9615
	Ergodic	0.1412	0.1094	0.1039	0.1458	0.1874	0.1874	0.1249

Table 2: Continued

		Grid line (highest point)						
1990-2005		-0.6660	-0.5291	-0.3563	-0.1881	-0.0816	0.4093	Inf
Samples	59	0.9322	0.0678	0.0000	0.0000	0.0000	0.0000	0.0000
	60	0.1000	0.7833	0.0833	0.0333	0.0000	0.0000	0.0000
	60	0.0167	0.1167	0.8333	0.0333	0.0000	0.0000	0.0000
	59	0.0000	0.0000	0.0678	0.7966	0.1356	0.0000	0.0000
	60	0.0000	0.0000	0.0000	0.1000	0.7667	0.1333	0.0000
	59	0.0000	0.0000	0.0000	0.0169	0.1017	0.8305	0.0508
	60	0.0000	0.0000	0.0000	0.0000	0.0000	0.0500	0.9500
	Ergodic	0.2135	0.1263	0.1105	0.1164	0.1326	0.1490	0.1516
		Grid line (highest point)						
1995-2005		-0.7318	-0.5301	-0.3432	-0.1858	-0.0878	0.3906	Inf
Samples	40	0.9250	0.0750	0.0000	0.0000	0.0000	0.0000	0.0000
	42	0.1190	0.7857	0.0714	0.0238	0.0000	0.0000	0.0000
	41	0.0244	0.0976	0.8780	0.0000	0.0000	0.0000	0.0000
	41	0.0000	0.0000	0.0244	0.8049	0.1707	0.0000	0.0000
	42	0.0000	0.0000	0.0000	0.1190	0.6905	0.1905	0.0000
	40	0.0000	0.0000	0.0000	0.0500	0.1250	0.7500	0.0750
	41	0.0000	0.0000	0.0000	0.0000	0.0000	0.0732	0.9268
	Ergodic	0.2399	0.1303	0.1017	0.1272	0.1252	0.1362	0.1396
		Grid line (highest point)						
1998-2005		-0.7542	-0.5357	-0.3422	-0.1867	-0.0889	0.3662	Inf
Samples	30	0.9000	0.1000	0.0000	0.0000	0.0000	0.0000	0.0000
	29	0.1379	0.7931	0.0345	0.0345	0.0000	0.0000	0.0000
	31	0.0323	0.1290	0.8387	0.0000	0.0000	0.0000	0.0000
	29	0.0000	0.0000	0.0345	0.8276	0.1379	0.0000	0.0000
	33	0.0000	0.0000	0.0000	0.1515	0.6364	0.2121	0.0000
	27	0.0000	0.0000	0.0000	0.0370	0.1852	0.7407	0.0370
	30	0.0000	0.0000	0.0000	0.0000	0.0000	0.0667	0.9333
	Ergodic	0.2626	0.1730	0.0740	0.1730	0.1277	0.1219	0.0677

Table 3: Markov Transition Matrix and Ergodic Distribution (5 grids, excluding oil/gas)

		Grid line (highest point)				
1977-2005		-0.4323	-0.2704	-0.1038	0.0573	Inf
Samples	146	0.9315	0.0685	0.0000	0.0000	0.0000
	155	0.1032	0.7806	0.1032	0.0065	0.0065
	151	0.0000	0.1325	0.8079	0.0596	0.0000
	149	0.0000	0.0134	0.0805	0.8322	0.0738
	154	0.0000	0.0000	0.0130	0.0974	0.8896
	Ergodic	0.3448	0.2288	0.1869	0.1356	0.1040
1980-2005		-0.4424	-0.2823	-0.1150	0.0460	Inf
Samples	131	0.9466	0.0534	0.0000	0.0000	0.0000
	140	0.1071	0.7643	0.1143	0.0143	0.0000
	135	0.0000	0.1481	0.7926	0.0519	0.0074
	133	0.0000	0.0075	0.0677	0.8271	0.0977
	138	0.0000	0.0000	0.0145	0.1159	0.8696
	Ergodic	0.3886	0.1938	0.1610	0.1415	0.1152
1985-2005		-0.4712	-0.3113	-0.1217	0.0378	Inf
Samples	105	0.9238	0.0762	0.0000	0.0000	0.0000
	114	0.1316	0.7719	0.0877	0.0088	0.0000
	110	0.0000	0.1000	0.8364	0.0545	0.0091
	107	0.0000	0.0093	0.0467	0.8505	0.0935
	111	0.0000	0.0000	0.0090	0.1081	0.8829
	Ergodic	0.3156	0.1827	0.1592	0.1837	0.1589
1990-2005		-0.5094	-0.3241	-0.1203	0.0378	Inf
Samples	79	0.9494	0.0506	0.0000	0.0000	0.0000
	89	0.1236	0.7528	0.1124	0.0112	0.0000
	82	0.0122	0.1220	0.8049	0.0488	0.0122
	82	0.0000	0.0000	0.0732	0.8415	0.0854
	85	0.0000	0.0000	0.0118	0.1176	0.8706
	Ergodic	0.4414	0.1658	0.1527	0.1360	0.1041
1995-2005		-0.5296	-0.3319	-0.1323	0.0324	Inf
Samples	55	0.9455	0.0545	0.0000	0.0000	0.0000
	62	0.1129	0.7258	0.1452	0.0161	0.0000
	56	0.0000	0.1250	0.8036	0.0536	0.0179
	56	0.0000	0.0000	0.0536	0.8571	0.0893
	58	0.0000	0.0000	0.0172	0.0862	0.8966
	Ergodic	0.2787	0.1347	0.1738	0.2055	0.2074
1998-2005		-0.5416	-0.3203	-0.1201	0.0343	Inf
Samples	40	0.9750	0.0250	0.0000	0.0000	0.0000
	45	0.1333	0.7333	0.1111	0.0222	0.0000
	40	0.0000	0.1500	0.8250	0.0000	0.0250
	42	0.0000	0.0000	0.0476	0.8333	0.1190
	42	0.0000	0.0000	0.0238	0.1429	0.8333
	Ergodic	0.6311	0.1183	0.1052	0.0756	0.0698

Table 4: Markov Transition Matrix and Ergodic Distribution (7 grids, excluding oil/gas)

		Grid line (highest point)						
1977-2005		-0.5138	-0.3534	-0.2387	-0.1332	-0.0186	0.1732	Inf
Samples	102	0.9510	0.0490	0.0000	0.0000	0.0000	0.0000	0.0000
	112	0.1161	0.7589	0.1071	0.0179	0.0000	0.0000	0.0000
	110	0.0000	0.1545	0.7182	0.1000	0.0182	0.0091	0.0000
	107	0.0000	0.0093	0.1402	0.7664	0.0841	0.0000	0.0000
	108	0.0000	0.0000	0.0370	0.1019	0.7593	0.0926	0.0093
	106	0.0000	0.0000	0.0000	0.0189	0.1226	0.8208	0.0377
	110	0.0000	0.0000	0.0000	0.0091	0.0000	0.0818	0.9091
	Ergodic	0.4037	0.1705	0.1312	0.1116	0.0822	0.0653	0.0355
		Grid line (highest point)						
1980-2005		-0.5206	-0.3580	-0.2530	-0.1467	-0.0231	0.1372	Inf
Samples	93	0.9677	0.0323	0.0000	0.0000	0.0000	0.0000	0.0000
	99	0.0808	0.7980	0.0909	0.0202	0.0101	0.0000	0.0000
	98	0.0102	0.1531	0.7143	0.0918	0.0204	0.0102	0.0000
	99	0.0000	0.0202	0.1515	0.7475	0.0808	0.0000	0.0000
	94	0.0000	0.0000	0.0213	0.0851	0.7979	0.0851	0.0106
	95	0.0000	0.0000	0.0000	0.0211	0.1053	0.8316	0.0421
	99	0.0000	0.0000	0.0000	0.0000	0.0101	0.0808	0.9091
	Ergodic	0.4243	0.1562	0.1048	0.0901	0.0979	0.0788	0.0479
		Grid line (highest point)						
1985-2005		-0.5344	-0.3872	-0.2782	-0.1544	-0.0414	0.1206	Inf
Samples	74	0.9459	0.0541	0.0000	0.0000	0.0000	0.0000	0.0000
	82	0.1098	0.7439	0.1098	0.0244	0.0122	0.0000	0.0000
	79	0.0127	0.1392	0.7595	0.0633	0.0127	0.0127	0.0000
	79	0.0000	0.0127	0.1266	0.7595	0.0886	0.0127	0.0000
	76	0.0000	0.0000	0.0132	0.0789	0.7895	0.1053	0.0132
	77	0.0000	0.0000	0.0000	0.0260	0.1169	0.8052	0.0519
	80	0.0000	0.0000	0.0000	0.0000	0.0125	0.0750	0.9125
	Ergodic	0.3036	0.1354	0.1221	0.1011	0.1291	0.1189	0.0900

Table 4: Continued

		Grid line (highest point)						
1990-2005		-0.5547	-0.4021	-0.2855	-0.1571	-0.0466	0.1081	Inf
Samples	58	0.9310	0.0690	0.0000	0.0000	0.0000	0.0000	0.0000
	60	0.1167	0.7500	0.1167	0.0000	0.0167	0.0000	0.0000
	62	0.0161	0.1774	0.6774	0.1129	0.0000	0.0161	0.0000
	60	0.0000	0.0167	0.1167	0.7500	0.1000	0.0167	0.0000
	57	0.0000	0.0000	0.0175	0.0702	0.8070	0.0877	0.0175
	58	0.0000	0.0000	0.0000	0.0345	0.1034	0.7931	0.0690
	62	0.0000	0.0000	0.0000	0.0000	0.0161	0.0645	0.9194
	Ergodic	0.2844	0.1546	0.0981	0.0968	0.1329	0.1102	0.1231
		Grid line (highest point)						
1995-2005		-0.6090	-0.4594	-0.2882	-0.1587	-0.0389	0.1381	Inf
Samples	40	0.9000	0.1000	0.0000	0.0000	0.0000	0.0000	0.0000
	40	0.1000	0.7750	0.1250	0.0000	0.0000	0.0000	0.0000
	44	0.0682	0.0909	0.6591	0.1364	0.0227	0.0227	0.0000
	42	0.0000	0.0000	0.1429	0.7381	0.0952	0.0238	0.0000
	38	0.0000	0.0000	0.0000	0.1053	0.7368	0.1316	0.0263
	40	0.0000	0.0000	0.0000	0.0250	0.1500	0.8000	0.0250
	43	0.0000	0.0000	0.0000	0.0000	0.0233	0.0698	0.9070
	Ergodic	0.2081	0.1355	0.1065	0.1355	0.1601	0.1648	0.0896
		Grid line (highest point)						
1998-2005		-0.6356	-0.4552	-0.2803	-0.1511	-0.0318	0.1265	Inf
Samples	29	0.9310	0.0690	0.0000	0.0000	0.0000	0.0000	0.0000
	28	0.1071	0.8929	0.0000	0.0000	0.0000	0.0000	0.0000
	33	0.0606	0.1515	0.6061	0.1212	0.0606	0.0000	0.0000
	31	0.0000	0.0000	0.2581	0.6774	0.0323	0.0323	0.0000
	28	0.0000	0.0000	0.0000	0.0714	0.8214	0.0714	0.0357
	28	0.0000	0.0000	0.0000	0.0357	0.1071	0.7857	0.0714
	32	0.0000	0.0000	0.0000	0.0000	0.0313	0.1250	0.8438
	Ergodic	0.6084	0.3916	0.0000	0.0000	0.0000	0.0000	0.0000

All Figures and Tables are author’s calculation.