

How do Agglomeration Economies and Migration explain the Change of Interregional Income Disparities?

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This paper investigates the causes of changing income disparities across regions by the extension of β convergence model. Increasing returns to scale in presence of agglomeration economies and of interregional population migration are included in the model. Agglomeration economies induce population in-migration due to higher productivity. The region experiencing population in-migration will decrease its productivity in a sense of neoclassical economic theory, i.e., the existence of decreasing returns to scale. At the same time, however, population in-migration has a possibility of enhancing agglomeration economies. If marginal effect of agglomeration economies is greater than decreasing marginal productivity of labour, then regional disparities may expand. This suggests a kind of the Verdoorn effect. Of course the differences of industrial composition across regions are another important cause of disparities. In this paper I present a consistent model which explains changing regional disparities and try to estimate the magnitudes of IRS by considering the existence of human capital. The model is a kind of the integration of Kaldorian model and endogenous growth model. The estimations are carried out by using Japanese regional data.

Keywords: agglomeration economies, migration, income transfer, convergence/divergence, regional income disparity

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1. Introduction

Convergence or divergence of per-capita income in an inter-regional economic system is an essential topic to policy maker as well as scholars. In the long run, which implies more than thirty years, interregional income disparities tend to show marked convergence. This is confirmed in several countries including Japan by Barro and Sala-i-Martin (2004), and others. However, the rate of decline in regional per-capita income disparities is not constant over the period. Furthermore, in the course of economic progress we have often experienced divergence of per-capita income across regions.

There are two competing theories which explain convergence/divergence of regional disparities. The one is neoclassical growth theory including endogenous growth theory which states convergence to the steady state solution. The other is cumulative growth theory which suggests differential growth among regions. This is initially advocated by Kalor and subsequently integrated to Verdoorn Law by Dixon and Thirlwall (1975).¹

A number of papers have applied convergence model by Barro and Sala-i-Martin and also structural convergence model proposed by Mankiw, Romer and Weil (1992) to regional disparities in many countries.² Although some earlier studies found regional convergence in the long-run by applying β -convergence model, recent research is directed to explain non-convergence trend or even divergence trend in regional disparities and to extend the conditional convergence model. This is because of recent detection of increasing regional disparities shown in several countries. For examples, Funke and Strulik (1999) found increasing disparities of per-capita income since 1990 for *Länder* (states) in West Germany, and Terrasi (1999) also verified divergence across Italian regions since 1975, and more recently Longhi and Musolesi (2007) found the convergence process of the national economies of the EU coexists with divergence process between regions in EU countries.

In order to overcome a shortcoming of the cross-sectional approach which neglects the dynamic effects of growth and incorporate divergence effect into conditional convergence model, several efforts have been done. Funke and Strulik propose an estimation model

¹ Targetti and Foti (1999) estimated convergence equation and cumulative growth equation simultaneously for cross-country pooled data.

² Cribfield and Pangabeau (1995), Cribfield et al. (1995), Lall and Yilmaz (2001), Miller and Genc (2004) for US regions (states or metropolitan areas); Terrasi (1999) for Italian regions; de la Fuente (2002) for Spanish regions; Badinger et al (2004) for NUT 2 regions; Christopoulos and Tsionas (2004) for Greece; Carlier and Gaulier (2005) for French regions; Armstrong (1995) for EU regions; and Henley (2003) for regions in the UK.

allowing for different convergence rate as well as different steady-states across regions and estimate by panel data.³ Hammond (2006) suggests divergence of regional disparities due to the existence agglomeration economies created by knowledge spillovers and resulting increasing returns to scale regional production function. Time variant model with a data generating process is estimated by using time series of the US metropolitan data and shows divergence between metropolitan and non-metropolitan incomes.

In a historical view the period when the nation is experiencing high economic growth, income disparities across regions tend to increase, and then the relatively higher income regions often accomplish higher growth rate of per-capita income than lower income regions in such a period. The large metropolitan regions, which often exhibit relatively higher income, are likely to generate endogenous growth and attract human capitals due to their agglomeration economies. This cumulative causation implies the tradeoff between aggregate efficiency and interregional equality.

When we observe decreasing regional disparities, economic disparities across regions converge to a steady state level. On the contrary, in case of increasing or expanding regional disparities, the economy is in transition to another steady state due to changing industrial structure.

There are many sources which could change inter-regional income disparities. In a dynamic context, migration is an important factor which can be the cause and/or result of regional disparities as well as regional difference of technological progress. Many empirical studies find agglomeration economies arising from population and industrial concentration will raise regional productivity.

A regional income transfer by the national government is another important factor affecting income disparities. Income transfer usually is implemented to poor regions in order to adjust differences in local public finance. The total amount of transfer, in case of Japan, is determined by the national tax revenue and political judgement.

In this paper I will focus on three main factors, which have been neglected in the convergence model but important for changing regional income disparities, i.e., agglomeration, migration, and income transfers. Starting by the findings the contributions of those factors to income disparities graphically, I provide the base of specification of the

³ Wang and Ge (2004) applied their model to Chinese provinces.

model. This is presented in the following section. The trends of regional per-capita income disparities measured by the CV (Coefficient of Variation) are depicted with/without income transfers and with excluding Tokyo. The graphical relationships between per-capita income growth and agglomeration, income transfers, migration are also exhibited. Section 3 provide neoclassical convergence model including agglomeration and regional migration. Specification of the model presented in Section 3 is estimated and results are interpreted in Section 4 by using Japanese regional data. Concluding remarks are given in Section 5.

2. Fact Findings on Regional Convergence/Divergence

In this section we will focus on the trend of regional disparities and examine some factors which are seemed to be related to the change in regional income disparities. The candidates for factors are agglomeration and migration, and income transfers. After graphically examining such factors, I proceed to construct the model explaining regional convergence/divergence.

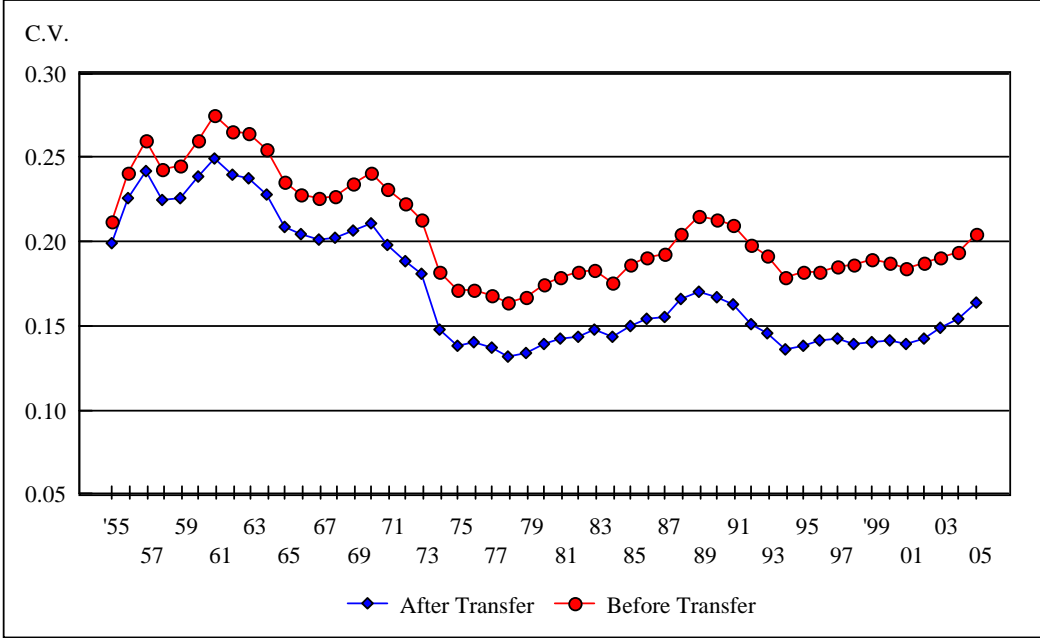
2.1 Trend of Coefficient of Variation

Figure 1 displays the time trend of per-capita income disparities across 47 prefectural regions measured by the CV (Coefficient of Variation). There are two lines; the lower blue line means the CV calculated by usual per-capita income of each region, and the upper red line is the CV in which the amount of governmental income transfers to each region is subtracted from regional income. The interpretation of this measure is presented in the following subsection.

By taking a look at Figure 1 we can notice there were at least three periods when Japanese economies have experienced the expansion of interregional per-capita income disparities. The first one is the period of 1955-1961; this period, ten years after the WWII, the modern industrialisation in Japanese economy had started by accompanying locally weighted public investment. This might cause the expansion of disparities as well as the high economic growth as a nation. The second increasing period is the 1980s. In particular, the late in 1980s, Japanese economy experienced sharp increase in land price in large metropolitan areas as well as in stock prices. Later we call it ‘bubble economy’. After ‘the bubble economy’ Japan had been suffering from its negative heritage. The third is the most recent trend of the CV from

2000 to 2005.

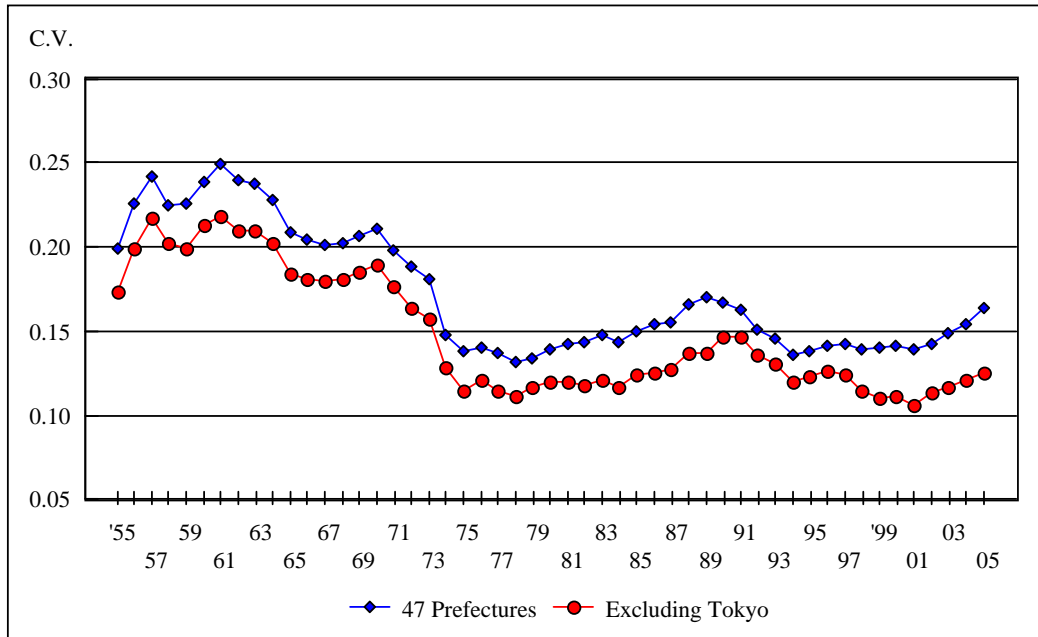
Figure 1 Trend of per-capita income disparities measure by the CV: per-capita income with and without the governmental income transfer



It is likely said that the behavior of regions with large economic size will dominate the change of the CV. Particularly, Tokyo which is the capital region in Japan, would have a significant role on the level and change of the CV as Tokyo occupies approximately 16 % of total income of 47 prefectural regions.

In order to capture the effect of Tokyo on the regional disparities, two lines of the CV are depicted in Figure 2; the one is the line of the CV calculated by 47 prefectural regions, the other is the line calculated without Tokyo. In Figure 2 the trend of the CV excluding Tokyo shifts downward, however it does not substantially change the general behavior of the CV trend except for the late 90s. It also shows that in the period of increasing CV the effect of Tokyo is greater than other decreasing periods of regional disparities. From these findings we can conjecture that in the increasing period of regional disparities Tokyo relatively grew higher than other less rich regions and this will be due to some specific factors which are internal or external to income producing activities in Tokyo. The representative factor in which Tokyo dominates over is agglomeration economies.

Figure 2 Trend of per-capita income disparities measure by the CV:
47 regions and 46 regions excluding Tokyo



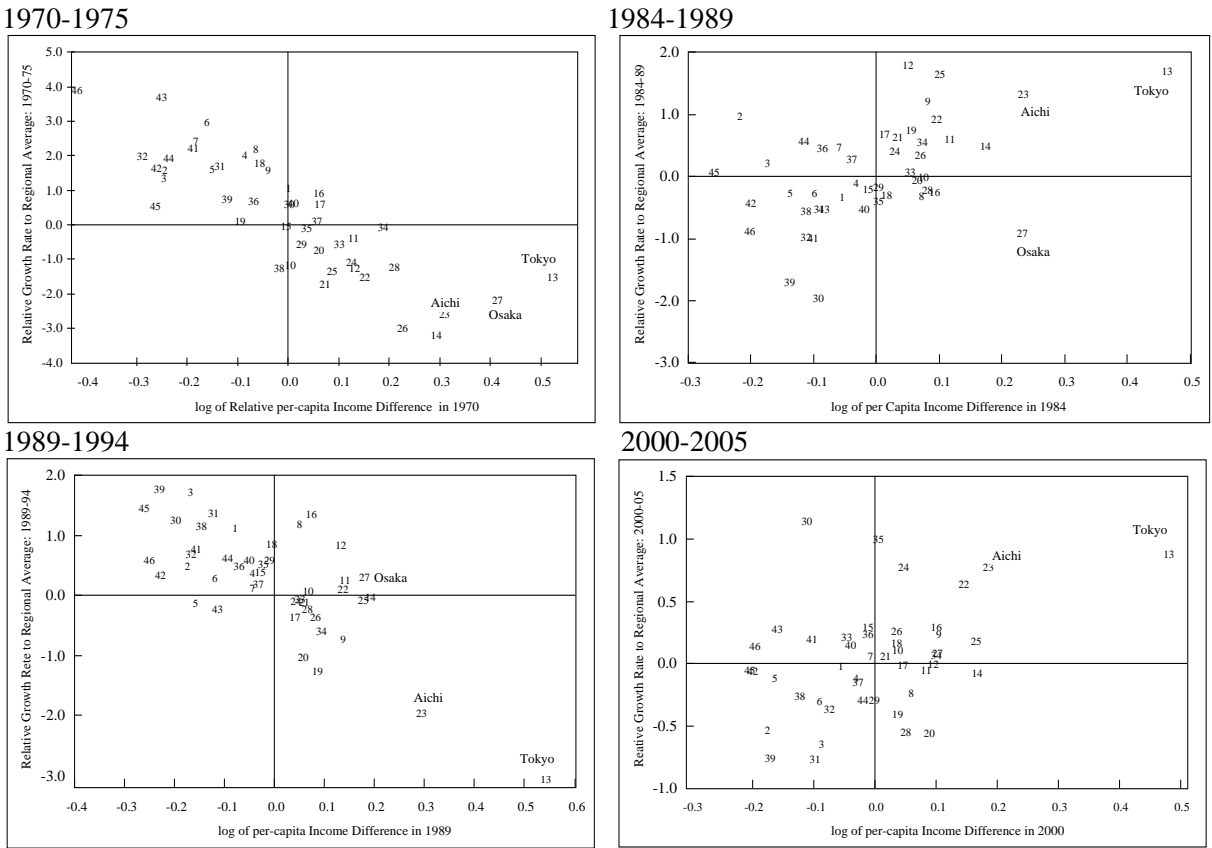
2.2 Convergence/Divergence

The following four figures in Figure 4 are typical examples for the periods in growing regional disparities and shrinking regional disparities, respectively. In the early 70s the graph shows a clear convergence, and simple correlation coefficient between per-capita income of initial year 1970 and its growth rate to 1975 is -0.861 . Relatively higher income regions like Tokyo, Osaka, and Aichi were damaged by the oil-crisis occurred in 1974. In the late 80s, we can find that the relatively higher income regions, particularly Tokyo, have pulled the national economic growth. The correlation coefficient between initial income level 1984 and growth rate to 1989 is 0.490 , this is a quite contrasting the figure of 1970-1975. After 1990, the Japanese economy had been suffering from the after-effects of remarkable increase in asset prices by the excessive speculation and has experienced a low economic growth, and even a deflationary recession in the late 1990s. This is one of the reasons for the decrease in regional disparities. In recent years, 2000-2005, regional disparities have a tendency to increase due to the effect of an economic recovery which has been led by the Tokyo metropolitan region.

From four representative graphs we can also imagine that agglomeration economies would substantial to divergence of regional per-capita income and some policy instrument might be effective during convergence period. According to previous empirical studies on

convergence of regional disparities, the main reasons for decreasing income disparities across Japanese regions after 1955 are regional income redistribution through governmental transfer and direct public investment which attracts factory firms with industrial dispersion policy for local (non metropolitan) regions.

Figure 3 Typical Examples of Coverage/Divergence in per-capita Income



2.3 Agglomeration Economies

Agglomeration is an important factor to explain dynamic change in regional disparities as well as cross sectional viewpoint of interregional disparities. The most popular measurement of agglomeration is population, in particular population at workplace. Thus, I choose top three largest regions in terms of daytime population, which are Tokyo, Aichi, and Osaka. These prefectural regions have been also top three highest per-capita income levels.

Figure 4 shows the trend of regional share of population at workplace for those three regions. In the periods when regional disparities are expanding (1955-60, 1980-90, 2000-05) Tokyo’s share is also increasing while the share of Osaka is declining after 1975 and that of Aichi is constantly increasing. As a result per-capita income of Osaka is lower than that of

Aichi in recent years.

Figure 4 Regional Share of Population at Workplace

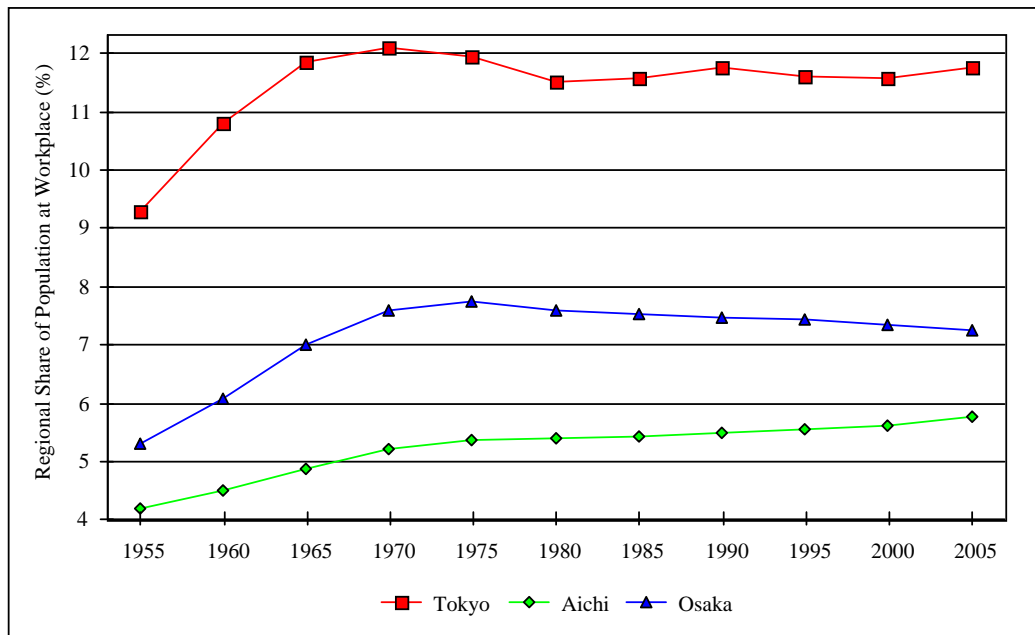
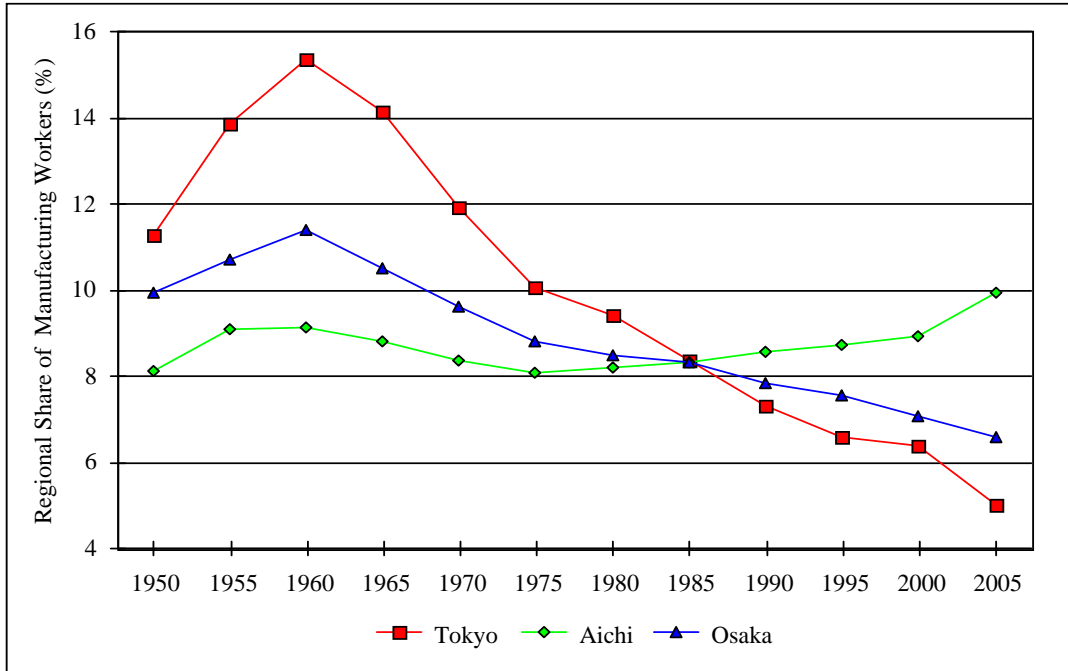


Figure 5 shows another measure of agglomeration counted by regional share of the number of manufacturing workers. It is often said that in the industrialising period agglomeration of manufacturing activity could become the driving force of regional economic growth. In the early expanding period of regional disparities rapid concentration of manufacturing works in Tokyo was found from this figure. This feature coincides with the trend of CV in Figure 1. After 1965, the share of manufacturing workers in Tokyo is continuing to decrease. The trend of Osaka is similar to that of Tokyo. On the contrary, for Aichi region manufacturing share is increasing since 1975 and in recent years its increase comes from the growing export of car of Toyota because the headquarter and main factories of Toyota are located in Aichi Prefecture. Interestingly, as a result, the share of manufacturing workers in each region became equal in 1985. Therefore, we can imagine that agglomeration of manufacturing industries which would be reflected in regional scale economies in production was effective in the early stage of regional development.⁴

⁴ This will be true for other developed countries as well as currently developing countries.

Figure 5 Regional Shares of Manufacturing Workers



In order to understand the role of agglomeration effects on income divergence, I check for the existence of scale economies (increasing returns to scale) in large regions. A simple relationship is assumed between the population (P) and income (Y), which is expressed as

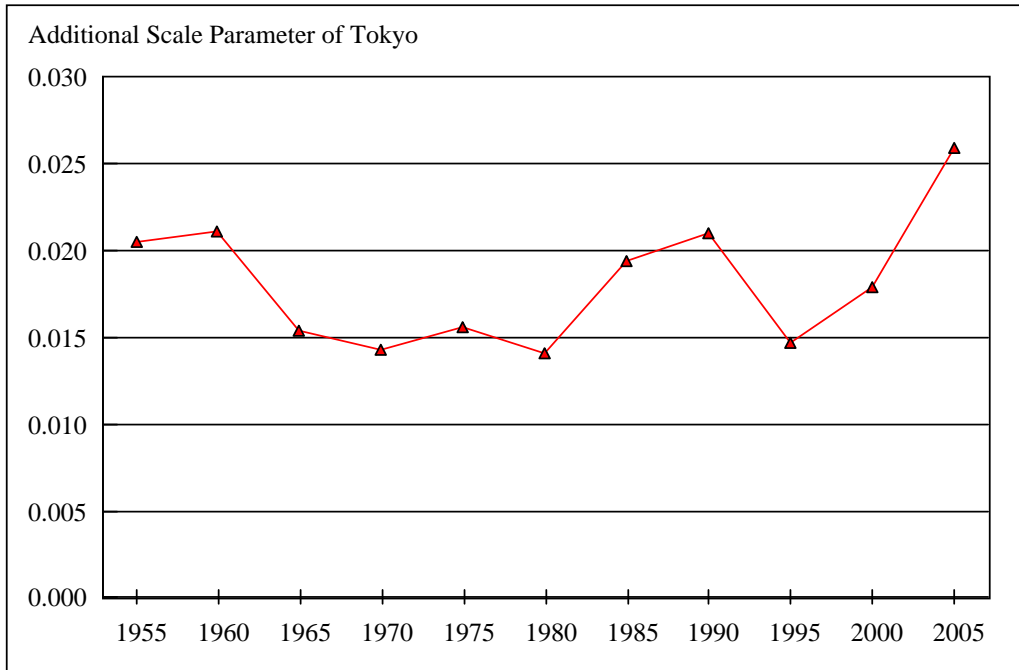
$$\ln Y_i = \beta_0 + (\beta_1 + \beta_{TD}Tokyo + \beta_{AD}Aichi + \beta_{OD}Osaka) \ln P_i, \quad (1)$$

where β_{TD} , β_{AD} , and β_{OD} are, respectively, *Tokyo*, *Aichi*, and *Osaka* regional dummies, and β_0 and β_1 are parameters to be estimated. Equation (1) also interpreted as a regional aggregate production function with one factor of production (population). In a regional level, agglomeration economies are internalised and appeared in the parameters of $\beta_1 + \beta_{TD}Tokyo + \beta_{AD}Aichi + \beta_{OD}Osaka$. The regression equation is rewritten in the form of per-capita income:

$$\ln \left(\frac{Y_i}{P_i} \right) = \beta_0 + (\beta_1 + \beta_{TD}Tokyo + \beta_{AD}Aichi + \beta_{OD}Osaka - 1) \ln P_i. \quad (2)$$

In Figure 6, the line shows estimated values of β_{DT} 's. At first consideration, there seems to be a positive correlation between the trend of CV and that of β_{DT} ; in the 80s scale parameter of Tokyo was increasing and also in 2000s it is increasing.

Figure 6 Trend of Scale Parameter of Tokyo



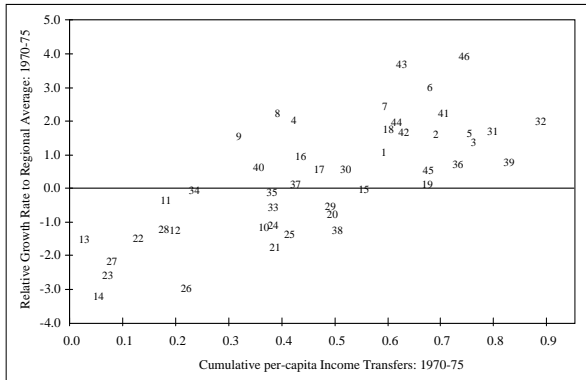
2.4 Income Transfers

In general, factor mobility is not free between regions and also there certainly exist agglomeration economies both in production and consumption. These are opposite factors to convergence in the neoclassical growth theory. If it is not easy for some factor in production to move among regions, then regional disparities will be sustained. If agglomeration economies are substantial, then regional disparities may be expand. Therefore, in order to converge disparities across regions, income transfers by the national government are implemented as a policy tool, so that the growth rates of poorer regions can catch up to the richer regions.

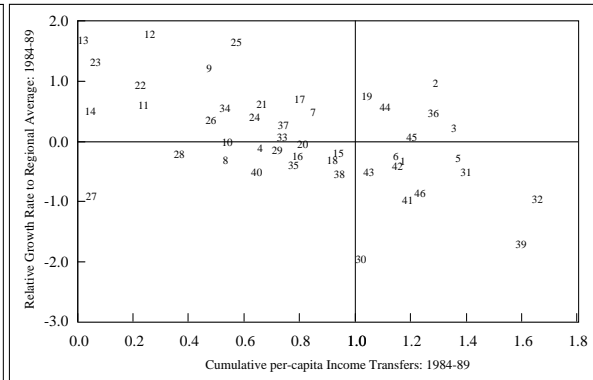
Concerning the above four periods we examine how governmental transfers contribute to reduce per-capita income disparities across regions. In each figure horizontal line indicates total amount of per-capita transfers during the period, measured as million yen per capita. It is obvious that in the period of contracting disparities the amount of (per-capita) income transfers by the central government exhibit high correlation with per-capita income growth. In the period of expanding regional disparities (1984-89, 2000-05), transfers of lower per-capita income regions are not effective to increase income level.

Figure 7 The relation between Income Transfers and Regional Growth Rate

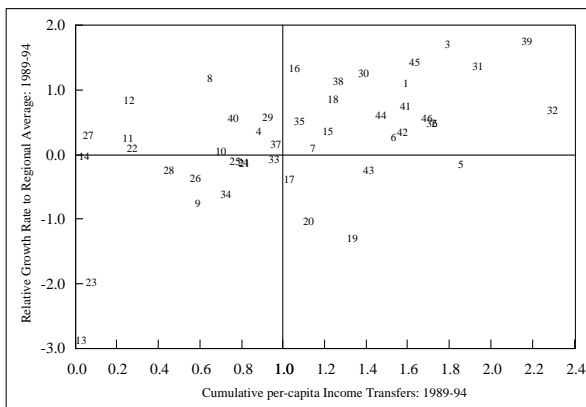
1970-75



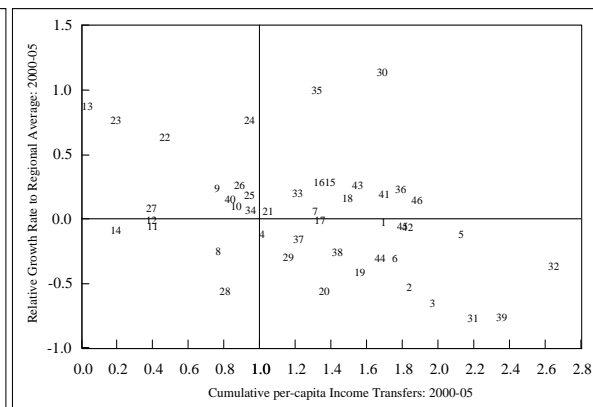
1984-89



1989-94



2000-05



2.5 Migration

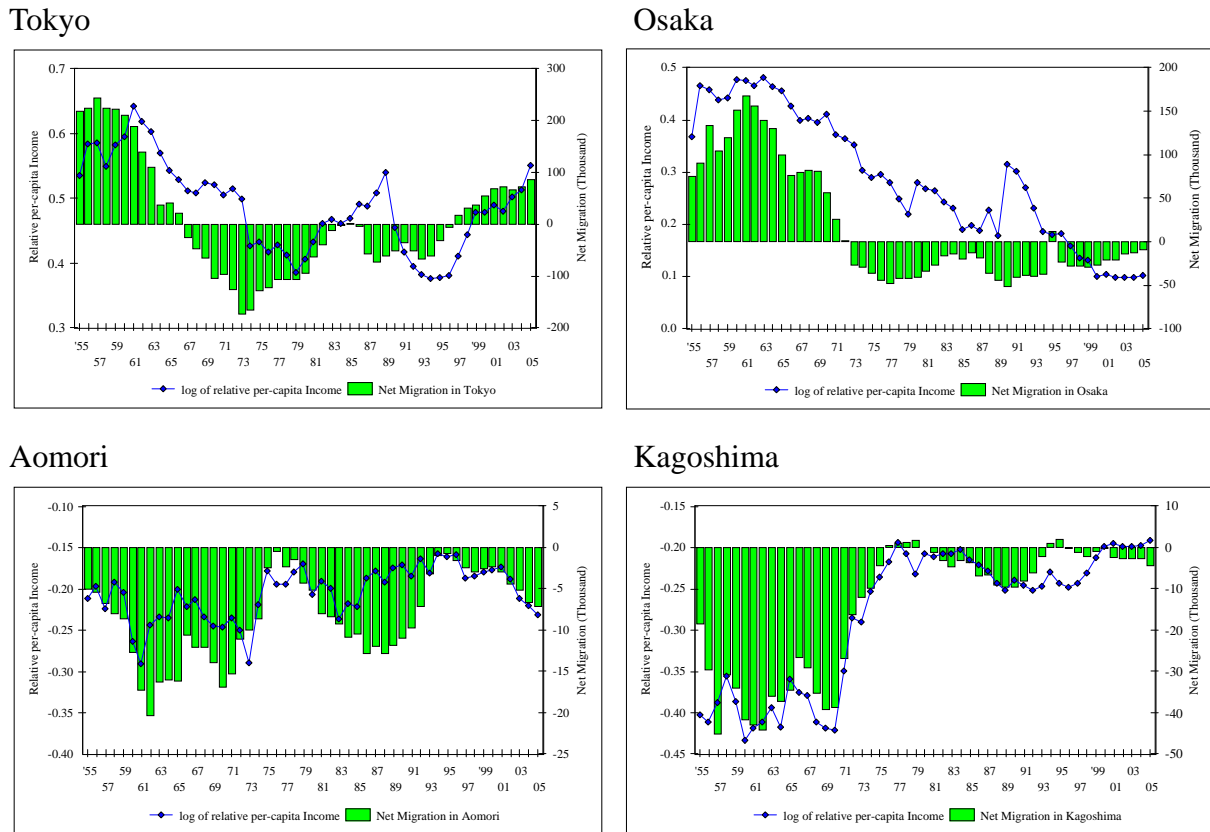
Migration causes a change of inter-regional income disparities whereas inter-regional income disparity is also a reason of migration. In a neoclassical regional growth model interregional population migration is assumed to respond to regional differences in factor prices, so that regions with relatively higher labour productivity attracts population and then marginal productivity will decrease due to diminishing returns. In this case regional income disparities will converge.

However, migration followed by human capital such as high skilled labour may raise the average income in in-migration region. This is another type of agglomeration in terms of human capital. In this case regional income disparities could diverge.

The causality between migration and income differential are still now ambiguous. Figure 5 depicts line exhibiting per-capita income level relative to the average over 47 prefectural regions and draws bar showing net migration. By taking a glance at figures, we can realize

that there exist strong correlation between net migration in a region and relative per-capita income difference. Regarding to Tokyo, migration seems to lead relative change of per-capita income in most of the period. Migration causes in the late 50s Tokyo has accepted much migration and followed by decreasing relative pre-capita income. In a neoclassical theory out-migration induces to raise marginal productivity of labour, so that per-capita regional income will increase. This is well traced in the figure of Kagoshima in Figure 8.

Figure 8 Migration and Relative per-capita Income



3. Convergence Model in presence of Agglomeration Economies and Migration

In this section I try to formulate convergence model in presence of agglomeration and migration. First, we define per capita income producing function as

$$y_{it} = A_i(P_{it})f(k_{it}; Y_{it}), \tag{1}$$

where y_{it} and k_{it} are respectively per-capita income and per-capita capital stock in region i at time t . These variables are defined as $y_{it} = Y_{it} / P_{it}$ and $k_{it} = K_{it} / P_{it}$, in which Y_{it} , K_{it} , and P_{it} are total income, capital stock, and population in region i , respectively. The existence of Y_{it} as

an argument in function f implies the possibility of increasing returns to scale due to internalised agglomeration economies in a regional aggregated level. $A_i(P_i)$ denotes Hicks neutral shift factor of production.

The change in capital stock, \dot{K}_{it} , is given by

$$\dot{K}_{it} = I_{it} - d \cdot K_{it}, \quad (2)$$

where I_{it} is investment in region i and d is depreciation rate which is assumed to be constant over the period and region. By dividing both side of equation (2) by P_{it} the change in per capita capital, \dot{k}_{it} , is derived as

$$\dot{k}_{it} = I_{it} - \left(d + \frac{\dot{P}_{it}}{P_{it}} \right) k_{it} = s_{K,it} y_{it} - \left(d + \frac{\dot{P}_{it}}{P_{it}} \right) k_{it}, \quad (3)$$

where $s_{K,it}$ is the proportion of investment in regional income.

In equation (3), unlike standard convergence model, population growth rate is variable over the period. The reason for this is that there is high frequency of interregional migration compared to international migration due to regional openness.⁵ Population change is divided into natural change and social one. The separation of two factors is written as

$$\dot{P}_{it} = n_{it} P_{it} + M_{it}. \quad (4)$$

The migration rate is defined by

$$m_{it} = \frac{M_{it}}{P_{it}}, \quad (5)$$

which is also dependent of regional characteristics such as relative per-capita income level.

Thus, m_i is rewritten as

$$m_{it} = m(y_{it} / \bar{y}_t), \quad (6)$$

where \bar{y}_t is the average value of y_{it} over regions, and equation (6) is $dm_i / d(y_{it} / \bar{y}_t) > 0$.

At this point the causality between migration and per-capita income level is ambiguous. In a neoclassical world, for regions experiencing positive net migration per-capita income will decrease due to diminishing returns to scale with respect to labor. On the other hand, for regions receiving in-migration of skilled-labor may increase per-capita income.

⁵ In their perspectives on regional economic growth, Niikamp and Poot (1998) formulate the endogenous growth model by considering labour migration.

Thus steady-state of capital intensity level is given by the equation:

$$\frac{d \ln k_{it}}{dt} = \frac{\dot{k}_{it}}{k_{it}} = \frac{s_{K,it} A_i(P_{it}) f(k_{it}, Y_{it})}{k_{it}} - (n_{it} + d + m_{it}) = 0. \quad (7)$$

Let denote

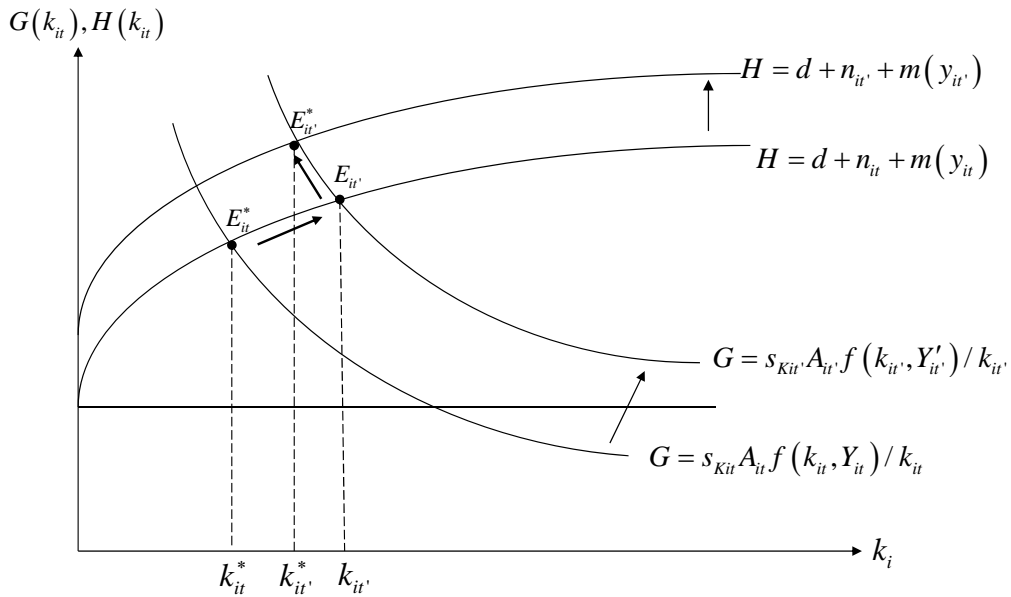
$$G(k_{it}) = s_{K,it} A_i(P_{it}) f(k_{it}, Y_{it}) / k_{it} \quad (8a)$$

and

$$H(k_{it}) = d + n_{it} + m(k_{it}), \quad (8b)$$

where time subscript is added, and $y_{it} \propto k_{it}$ is assumed. In equations (8a) and (8b), $H(k_{it})$ is increasing function of k_{it} while $G(k_{it})$ is decreasing function of k_{it} . The per-capita capital at steady state k_{it}^* is given by the solution of $G(k_{it}) = H(k_{it})$. This steady state at time t is characterized by E_{it}^* in Figure 9. Now that we suppose the function $G(k_{it})$ shifts upward due to agglomeration effect such as $Y_{it} < Y_{it}'$. If this occurs in regions which are relatively higher per-capita income, then income disparities will diverge. Then a temporary steady state point is given by E_{it}' in the figure. Although regions move to new steady state point, region i will experience population in-migration because of higher capital/labour ratio. This will shift $H(k_{it})$ curve upward. This in turn generates convergence process of interregional disparities.

Figure 9 Shift of Steady-state Point



Even if region i is not on the steady state path at time t , per-capita income of region i approaches to the steady state E_{it}^* under the conditions that G exhibits negative slope and H does positive slope, with respect to k_i , respectively. Since there is no reason that at time t region i is on the steady-state path, the approaching to steady-state in terms of per-capita income of region i is usually described by the partial adjustment equation as

$$\ln \frac{y_{it'}}{\bar{y}_t} - \ln \frac{y_{it}}{\bar{y}_t} = b \left(\ln \frac{y_{it}}{\bar{y}_t} - \ln \frac{y_{it}^*}{\bar{y}_t} \right), \quad (9)$$

where y_{it} is per-capita income at period t in region i and y_{it}^* is its equilibrium solution at t . The convergence equation which has been tested in many regions and countries is derived from this equation and the coefficient which is derived from solving difference-equation (9), as a function of b , denotes a speed of convergence. The right hand side of equation is approximately equal to the growth rate of per-capita income in region i measured by the deviation from the regional average. The convergence equation is

$$\ln \frac{y_{it'}}{y_{it}} = a + \beta \ln \frac{y_{it}}{\bar{y}_t}. \quad (10)$$

In convergence model β is assumed to be constant over the period. If β takes the negative value, then regions deviating from the steady state in terms of per-capita income would converge. However, regions with relatively higher per-capita income may grow faster than the regions with relatively lower per-capita income due to agglomeration effects, and furthermore higher income level will attract human capital from lower regions, which in turn induces in-migration. Therefore, we cannot deny the non-negativity of β as well as its constancy over the period.⁶

As shown in Figure 9, the transition of steady-state may occur during $[t, t']$. In this case parameter β will depend upon the difference of two equilibrium levels of per-capita income, $\ln y_{it'}^e - \ln y_{it}^*$ (superscript 'e' means expectation of equilibrium value at current period), and migration rate explaining the shift of equation (8b). Therefore, constant parameter β can be

⁶ There are some papers which try to specify and estimate the changing convergence parameters in order to capture regional divergence.

written by the functional form like

$$\beta = \beta \left(\ln \frac{y_{it}^e}{y_{it}^*}, m_{i,(t,t')} \right). \quad (11)$$

In equation (11), it is expected that the effect of migration on β will be positive because migration promotes to converge inter-regional per-capita income disparities by diminishing returns to labour in neoclassical model. On the other hand, the speed of convergence to new steady-state will decline due to the additional change of steady-state or high expectation of new steady-state may causes divergence.

4. Specification of the Model

First, I will define the Cobb-Douglas production function for firms with agglomeration economies. In a specification of a firm-level production function agglomeration economies are external to individual firms, and then the production function is expressed as

$$\tilde{y}_{ij} = \alpha_0 P_i^\eta Y_i^\gamma \tilde{k}_i^\alpha \tilde{l}_i^{1-\alpha}, \quad (12)$$

and

$$\tilde{y}_i = \frac{Y_i}{E_i}, \tilde{k}_i = \frac{K_i}{E_i}, \tilde{l}_i = \frac{L_i}{E_i},$$

where E_i is the number of firms, \tilde{y}_{ij} is produced income per firm, \tilde{k}_{ij} is capital stock per firm, and \tilde{l}_{ij} is labour which is measured as employees per firm. Y_i is the total produced income in region i, and external to individual firms.

In aggregating into a regional level the production function is rewritten as

$$\begin{aligned} Y_i &= A_i P_i^\eta K_i^\alpha L_i^{1-\alpha} Y_i^\gamma \\ &= A_i P_i^\eta K_i^\alpha (\kappa_i P_i)^{1-\alpha} Y_i^\gamma, \end{aligned} \quad (13)$$

where labour is assumed to be the constant ratio of population, κ_i .

Rewriting Equation (13) in terms of per-capita income gives the estimation form as

$$Y_i = A_i^{1/(1-\gamma)} \kappa_i^{(1-\alpha)/(1-\gamma)} P_i^{(1-\alpha+\eta)/(1-\gamma)} K_i^{\alpha/(1-\gamma)}, \quad (14)$$

where $L_i = \kappa_i P_i$. Thus per-capita income is expressed as

$$y_i = A_i^{1/(1-\gamma)} \kappa_i^{(1-\alpha)/(1-\gamma)} P_i^{(\eta+\gamma)/(1-\gamma)} k_i^{\alpha/(1-\gamma)} \quad (15a)$$

or

$$y_i = A_i \kappa_i^{1-\alpha} k_i^\alpha Y_i^\gamma P_i^\eta, \quad (15b)$$

where $k_i = K_i / P_i$, and $y_i = Y_i / P_i$.

Equation (15a) indicates the industry-level production function in which agglomeration economies presented by regional aggregate income are internalised. Thus, the regional aggregate production function exhibits increasing to returns to scale when γ is positive, even given constant returns to scale at the firm level.

Substituting equation (15a) into (8a) gives

$$G(k_{it}) = s_{K,it} A_{it}^{1/(1-\gamma)} \kappa_{it}^{(1-\alpha)/(1-\gamma)} P_{it}^{(\gamma+\eta)/(1-\gamma)} k_{it}^{(\alpha+\gamma-1)/(1-\gamma)} \quad (16)$$

The solution of steady state, k_i^* , is obtained by equating (16) and (8b):

$$k_{it}^* = A_{it}^{1/(1-\alpha-\gamma)} \kappa_{it}^{(1-\alpha)/(1-\alpha-\gamma)} \left(\frac{s_{K,it}}{\delta + n_{it} + m_{it}} \right)^{(1-\gamma)/(1-\alpha-\gamma)} P_{it}^{(\gamma+\eta)/(1-\alpha-\gamma)} \quad (17a)$$

Therefore, per-capita income at the steady-state is expressed as

$$y_{it}^* = A_{it}^{1/(1-\alpha-\gamma)} \kappa_{it}^{(1-\alpha)/(1-\alpha-\gamma)} \left(\frac{s_{K,it}}{\delta + n_{it} + m_{it}} \right)^{\alpha/(1-\alpha-\gamma)} P_{it}^{(\gamma+\eta)/(1-\alpha-\gamma)}. \quad (18a)$$

This equation implies that regional population has a role of shifting per-capita income upward if agglomeration parameter γ is positive.

By applying equation (15b) to equation (8a) instead of (15a), we can drive another specification of steady-state like

$$k_{it}^* = A_{it}^{1/(1-\alpha)} \kappa_{it} \left(\frac{s_{K,it}}{\delta + n_{it} + m_{it}} \right)^{1/(1-\alpha)} Y_{it}^{\gamma/(1-\alpha)} P_{it}^{\eta/(1-\alpha)} \quad (17b)$$

and

$$y_{it}^* = A_{it}^{1/(1-\alpha)} \kappa_{it} \left(\frac{s_{K,it}}{\delta + n_{it} + m_{it}} \right)^{\alpha/(1-\alpha)} Y_{it}^{\gamma/(1-\alpha)} P_{it}^{\eta/(1-\alpha)}. \quad (18b)$$

This specification explicitly presents agglomeration sources by aggregate income and regional population size and shows positive effect of agglomeration on per-capita income while migrations is negative effect on per-capita income. By combining equations (9) to (11) and (18a)/(18b), we can construct the estimation model.

5. Estimation of the Model

5.1 Data

With regard to regional classification, the most relevant Japanese regional counterpart of NUTS 2 regions is ‘prefectures’ in Japan. There are 47 prefectures including the Tokyo Metropolis, which has 23 special wards, similar to inner London. Each prefecture is a local government and has its own governor. The average area over the 47 prefectural regions is approximately 7,930 km², which is slightly larger than the average of 36 NUTS 2 regions in the UK, which is 6,773 km².

The data on income are from the Cabinet Office in Japan, ‘Annual Report on Prefectural Income’ (various issues) and data on population and job occupation by region are from Census of Population which is issued by each five year. In terms of statistical availability we can use data on the Regional System of Accounts (Annual Report on Prefectural Income) as far back as 1955.

The data on income transfers by the national government are also available since 1955. Income transfer is called grant-in-aid from tax revenue; it is redistributed to local municipalities (cities, towns, villages, and prefectures) for which the amount of local financial demand exceeds local tax revenue.

5.2 Estimation Model

In specifying convergence parameter function β we add two variables which will be significant to explain per-capita income level by the investigation of graphs in section 2. The one is the income transfers conducted by the national government, which would help to converge income disparities across regions, denoted by S_{it} . The other is the number of skilled workers which acts as human capital in a regional economy. Migration brings skilled labour force which will be affect positively per-capita income growth. Hence, the varying parameter model of convergence parameter β is written as

$$\beta = b_{\beta} + b_P \ln \frac{P_{it}^e}{P_{it}} + \left(b_{H0} + b_{H1} \ln \frac{H_{it'}}{H_{it}} \right) \sum_t \frac{M_{it}}{P_{it}} + b_S \sum_t \frac{S_{it}}{P_{it}}. \quad (19)$$

The estimation equation is obtained by substituting equation (19) into equation (10) as

$$\ln \frac{y_{it'}}{y_{it}} = a + \left(b_{\beta} + b_p \ln \frac{P_{it'}}{P_{it}} + \left(b_{H0} + b_{H1} \ln \frac{H_{it'}}{H_{it}} \right) \sum_t \frac{M_{it}}{P_{it}} + b_s \sum_t \frac{S_{it}}{P_{it}} \right) \ln \frac{y_{it}}{\bar{y}_t}, \quad (20)$$

where the expected signs of parameters are $b_{\beta} < 0$, $b_p > 0$, $b_{H0} < 0$, $b_{H1} > 0$, and $b_s > 0$.

The positive sign of parameter b_p means agglomeration economies have negative impact on convergence. Migration in general tends to converge regional disparities, i.e., $b_{H0} < 0$ because of diminishing returns to labour, while parameter b_{H1} may be positive as human capital represented by skilled labour can be brought with population in-migration and it contributes to increase regional per-capita income. Finally, the sign of income transfers is expected to be positive since the role of transfers is contract to regional disparities

5.3 Estimation Results

In the estimation some variables have endogenous characteristics which means a correlation to the error term, so that we use the two-stage least squares method with instrumental variables in order to deal this endogeneity problem. The candidates of instruments are lagged dependent variables.

By considering figures 1 to 5 I select five typical sub-periods which shows increasing in terms of the CV; 1955-1960, 1984-1989, 2000-2005, and decreasing in the CV; 1970-1975, 1989-1994. The reason I do not use the whole period is that the purpose of this paper is to investigate how agglomeration and migration economies affect change in regional disparities. If we try to estimate agglomeration effect on regional disparities in the long-run, it will be failed to capture it correctly.

The estimations are carried out by two types of specification of agglomeration economies in addition to simple β -convergence model. The one is equation (19) in which the parameter of regional population change reflect agglomeration effect, and the other is regional aggregate income is adopted as the agglomeration variable instead of regional population, in which the parameter of change in regional aggregate income, $\ln(Y_{it'}/Y_{it})$, implies so-called Verdoorn coefficient in Kaldorian cumulative growth model.

In Table 1 the first row in each period shows estimates of absolute convergence model. In the early 70s and 90s simple regression model well capture convergence, particularly for the period 1970-75 the adjusted R^2 is quite high. On the contrary, the late 50s in which Japanese economy started high growth and the late 80's in which Japan experienced an excessive economy in real estate market, show non-convergence estimated values.

Table 1 Estimated Parameters

	1955-1960			1970-75			1984-89		
	Divergence			Convergence			Divergence		
	OLS	2SLS	2SLS	OLS	2SLS	2SLS	OLS	2SLS	2SLS
b_β	0.127 (2.45)	-0.008 (-0.08)	0.042 (3.08)	-0.419 (-11.70)	-0.315 (-3.69)	-0.268 (-2.15)	0.141 (3.69)	0.181 (2.98)	0.016 (0.62)
α_P		-0.041 (-0.96)			0.212 (2.88)			0.320 (2.31)	
α_Y			1.062 (16.88)			0.907 (11.93)			0.950 (12.19)
α_M		0.086 (2.06)	0.064 (1.94)		-0.382 (-2.77)	-0.429 (-2.87)		0.447 (1.82)	0.577 (2.23)
α_H		-	-		0.559 (2.25)	0.604 (2.48)		0.713 (2.57)	0.545 (1.83)
α_S		-0.091 (-1.65)	0.022 (2.71)		0.038 (2.52)	0.028 (2.18)		0.015 (2.92)	0.019 (3.25)
\bar{R}^2	0.116	0.219	0.972	0.752	0.796	0.833	0.232	0.381	0.904

Table 1 (Continued)

	1989-1994			2000-2005		
	Convergence			Divergence		
	OLS	2SLS	2SLS	OLS	2SLS	2SLS
b_β	-0.186 (6.78)	-0.202 (-2.64)	-0.158 (-3.94)	0.099 (2.46)	0.023 (2.47)	0.023 (1.96)
α_P		-0.061 (-0.86)			-0.087 (-0.92)	
α_Y			0.923 (13.32)			0.944 (14.62)
α_M		-0.469 (-2.60)	-0.514 (-2.55)		0.375 (2.05)	0.652 (4.83)
α_H		0.137 (1.81)	0.253 (2.19)		-0.118 (-1.23)	0.076 (1.40)
α_S		0.024 (3.19)	0.035 (3.63)		0.018 (2.03)	0.022 (3.98)
\bar{R}^2	0.494	0.547	0.964	0.119	0.349	0.971

Estimated parameters of population change, α_P , which is a proxy of agglomeration effect are found to be insignificant and even negative in most of the periods. The reason of this is

that population change and net migration rate are often highly correlated. Concerning the estimated parameters α_y 's show significant contribution to the positive change of per-capita income rather in the period of increasing disparities than decreasing disparities across regions. The parameter also indicates Verdoorn effect implying the elasticity of per-capita income growth, and it seems to be stronger in the earlier period such as the beginning age of industrial development in Japan.

Migration effects on the convergence provide positive sign for the periods, 1970-1975 and 1989-1994, which are decreasing in disparities of regional per-capita income. However, the periods for the increasing disparities show positive sign which imply population net migration may induce divergence. Although the causality between migration and income disparity has been ambiguous, it can be said from our estimation results that population migration could support convergence for the period of decreasing disparities while it contributes to divergence due to transition to the new steady-state for the period in increasing disparities. In recent years, after 2000, Japanese regional economies are experiencing increase in interregional income disparities, in particular compared to Tokyo metropolitan region. The estimated results for 2000-2005 imply that population migration into fairly higher income regions represented by Tokyo would increase regional disparities accompanied by agglomeration economies.

We also add a variable for human capital to account for migration parameter estimates. Human capital is represented by the number of skilled labour which comes from Census of Population by occupation. It well controls the parameter of migration because of its positive sign in most of the cases.

From Figure 1 it is likely said that income transfers by the national government have a role of decreasing income disparities across regions.⁷ Figure 7 also shows transfers to lower income regions help catch up higher income regions in the period of decreasing regional disparities. The parameter of income transfers, α_s , would reflect the magnitude of convergence in case of positive sign. Table 1 shows positive estimates and t-values are greater than 2.0 in most of the periods. Income transfers are effective for lower income regions in order to catch up higher per-capita income regions.

⁷ Barro and Sala-i-Martin (1996) states that interstate transfers are not responsible for the long-run decline in income in spite of admitting transfers help reduce per-capita income dispersion.

6. Concluding Remarks

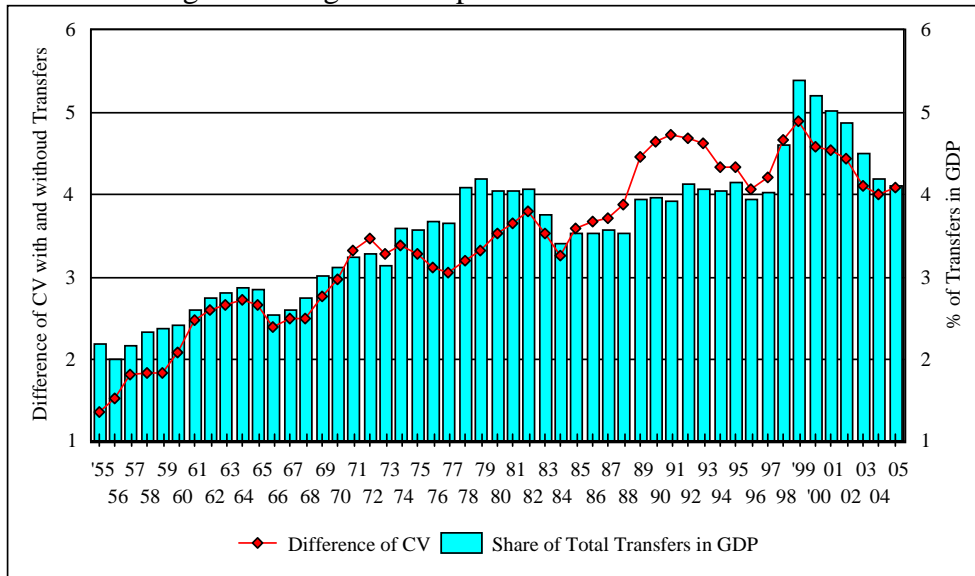
In this paper I have focused on the role of agglomeration and migration in regional convergence/divergence in terms of per-capita income. Although numerous studies are conducted about regional convergence as well as international comparison, there are few studies shedding light on the role of agglomeration and migration in framework of neoclassical (new) growth theory. I extended the beta-convergence model into varying parameter version which allows divergence feature due to agglomeration as well as sources of convergence such as income transfers. Migration effect also is incorporated into the extended model with human capital variable.

The empirical implementation was conducted with Japanese regional data which cover from 1955 to 2005. While it is available to estimate long-run convergence, I have chosen typical periods which respectively show increasing and decreasing disparities. For the developed countries like this case it will be natural to converge in the long-run.

The summary of the results are as follows. Agglomeration economies measured by regional aggregate income have significant impact on regional disparities in divergence while income transfers contribute to regional convergence. This indicates the existence of so-called Verdoorn effect in divergence of regional disparities. Concerning another agglomeration variable, regional population, which is alternately used to aggregate income, estimated parameters also indicate divergence though the degree of divergence is decreasing. Migration in general contribute regional convergence, but in the period of increasing disparities it is attracted to higher income regions due to agglomeration economies.

These estimated results report important implications for regional policy. In the medium term (not long-run) agglomeration economies raise per-capita income. It may be effective for convergence, particularly in low growth years of GDP, to redistribute tax revenues to relatively poorer regions by means of income transfer. However, it does not mean regional sustainability. As shown in Figure 9 the share of income transfers in GDP is declining in recent years and thus this may generate non-convergence. In order to get out of dependency on transfers regional policy should be headed for fostering industrial clusters which most likely exhibit agglomeration economies.

Figure 10 Regional Disparities and Income Transfers



In this analysis I dropped important feature, which is a spatial interdependency between neighboring regions. Recent papers incorporate spatial correlations into regional convergence models and confirm the importance of spatial effects. For examples, Lall and Yilmaz (2001), Badinger et al. (2004), Henley (2005), and Battisi and Vaio (2008) etc..

Although spatial interdependency affects the change of regional per-capita income, most important problem of estimating convergence equation is to know how convergence or divergence occurs. This paper provided some light on it.

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