The Effect of Regional Income and Educational Differentials on Migration and Regional Convergence

Enkh-Amgalan Byambajav*

Terukazu Suruga**

Rokkodai, Nada-ku, Kobe 657-8501, Japan

Graduate School of International Cooperation Studies, Kobe University

Telephone: +81-80-5663-9714
Fax: +81-78-803-7147

* Kobe University & National University of Mongolia; e-mail: benkh25@live.com, enkhamgalan@ses.edu.mn

** Kobe University; e-mail: suruga@kobe-u.ac.jp

This paper is financially supported by the Japanese Society for the Promotion of Science under its Grand-in -Aid for Scientific Research No. 20･08314.

Abstract

In this paper we explore how interregional migration effects regional convergence, based on the costs and benefits of migration. Migrants can choose whether they get higher education for the future higher income or directly supply their labor to the market. Mongolian economic data is used for the calibration to show the numerical implications for convergence speeds.

The model predicts that migration has a direct effect on population convergence. The choice of study and the level of education tend to accelerate convergence speed, but the convergence speed is inversely related to the years of schooling.

This paper also investigates empirically the convergence of GDP per capita across Mongolia's twenty-two aimags[***].

Empirical results imply that if we include the net migration rate in the convergence equations, the estimated β coefficient shows that the GDP per capita converges more rapidly to the steady state position. This means that migration speeds up convergence as predicted in theoretical model.

Keywords: Convergence, GDP per capita, Education, Speed of Convergence, Migration

JEL classification codes: O15, O18, O47

[***] Aimags are same like U.S states, Canadian province, Swedish counties and Japanese prefectures.

1．Introduction

The effect of interregional migration on regional convergence has emerged as a central issue in the growth literature during the last few decades. In this study we explore how interregional migration effects regional convergence, based on the costs and benefits of migration. Here we assume that there are two main reasons to migrate from one region to another. First, regional income disparity-people move to urban areas to increase their income; second, education-people want to obtain higher education to access higher future income. Migrants can choose whether they get higher education for the future higher income or directly supply their labor to the market.

Mongolian economic data is used for the calibration to show the numerical implications for convergence speeds. The parameters measured in the convergence speed are set a benchmark values. In particular, the real interest rate, the growth rate of technological progress, the capital income share and the sensitivity of migration are considered to be benchmark values. The combination of the migrants choice, schooling years and level of education determines the convergence speed.

This paper also investigates empirically the convergence speed across Mongolian aimags in terms of per capita GDP.

According to international and domestic surveys, one third of the Mongolian population is living under the poverty line. Specifically, poverty is deeper in rural areas than in urban areas. Thus, one main objective of economic growth should be reducing the cross-regional income differences and maintaining real long-run per capita income growth. However, in Mongolia there is almost no research on regional economic development and regional income disparities.

Due to the transformation to the free market economy, the Government of Mongolia’s policy to reduce cross regional income differences has been almost lost and regional GDP per capita differences have increased. Widening differences in GDP by region caused migration which has made a dramatic influence on regional convergence. Although the period is short, the data set used in this study covers the 21 years of the transformation to the market economy since 1989.

The remainder of this paper is organized into four sections. The first section presents the theory and the methodology. The second section is about calibration. The third section is concerned about data issues. The fourth section discusses the empirical analysis of regional convergence. The concluding remarks are discussed in the final section.

2. Theory and Methodology

2.1 The Model

The model presented below largely follows the migration and convergence model proposed by Braun (1993) based on neoclassical growth theory. The therory states that the economy is composed of 2 different regions, one large and one small. The large economy is assumed to be at the steady state level and the small economy starts below the steady state level. Thus labor is assumed to migrate from the small economy to the large economy during transition.

We start our model with the elementary Ramsey growth model.

Consumer and firm behavior

Identical infinitely lived housholds choose consumption and savings to maximize instantaneous utility, subject to a budget constraint.

$$Max\int_0^\infty u(c(t))e^{-\rho t}dt$$

$$\dot{a} = (r-n)a + w - c$$

where, the instantaneous utility function $u(c)$ is strictly increasing, concave, and twice differentiable, the coefficient ρ captures the rate of time prefence, $\dot{a}$ is the law of motion of per capita assets.

If we use the first-order condition for a maximization of utility, we get the growth rate of consumption.

$$\frac{\dot{\hat{c}}}{\hat{c}} = r - \rho - g$$

On the production side, assuming that factor and product markets are competitive, the set of production possibilitites of the economy is represented by the Cobb-Douglas production function with labor augmenting technological progress.

$$Y = AK^{\alpha}(Le^{gt})^{1-\alpha}$$

Production function per unit of effecitve labor is given by

$$y = A\hat{k}^{\alpha}$$

At the macro level per capita assets equal capital stock per capita k and hence, the dynamic equation for capital stock per unit of effecitive labor can be written as

$$\dot{\hat{k}} = A\hat{k}^{\alpha} - \hat{c} - (n+g+\delta)\hat{k}$$

The wage is determined from the first order condition with respect to L.

$$\hat{w} = (1-\alpha)A\hat{k}^{\alpha}$$

In the presence of the standard neoclassical growth model, the equilibrium in each region is given as the growth rate of the capital stock per unit of effective labor and the growth rate of per-capita consumption. If during the transition the initial capital labor ratios are different, then the two regions will display convergence, which is the poorer region will grow faster than the richer one.

The main purpose of this study is to determine the impact of migration on the regional growth, population convergence and the link between population convergence and per capita GDP convergence, based on the above convergence framework.

Migration and Migration cost

The economy is composed of small and large regions. If there is wage difference between two regions, labor will move to the region with the higher wage rate.

As mentioned above, there are two main reasons to migrate: 1) People move to higher income regions to increase their income, and 2) People want to obtain higher education to access higher future income. Both of these reasons have an impact on the convergence speed through migration.

In this model we assume that capital mobility is perfect and labor mobility or migration is imperfect. Imperfect labor mobility means that migration from one region to another entails costs. Migration cost is measured as the cost of time during migration process.

Migrants have made one of two choices when they move to another region. First, migrants directly supply their raw labor to the labor market and therefore make the choice to move to obtain a higher wage than their origin. Second, migrants choose to move to obtain a higher education which will allow them to search for a job with a higher wage. In this model we will not consider educated labor mobility, it is out of our framework.

We can show the total benefit from migration as a weighted sum of the choice, illustrated by the following equation:

$$\pi = p \cdot \pi_1 + (1-p) \cdot \pi_2$$

π - The total benefit from migration

p - The choice between direct supply of labor to the labor market or to obtain higher education to access higher future income. In this case p shows that migrants directly supply their labor to the labor market.

$1-p$ migrants choose to obtain higher education.

π_1 - the benefit from migration if migrants choose direclty to work.

π_2 - the benefit from migration if migrants choose to be educated

The benefit from migrating can be written as follows:

$$\pi_1 = \int_t^{\infty} \left(w_1^u(v) - w_2(v) \right) e^{-r\cdot(v-t)} dv$$

$$\pi_2 = \int_t^{\infty} \left(w_1^e(v) - w_2(v) \right) e^{-r\cdot(v-t)} dv \qquad (1.1)$$

Where w_1^u is the wage of raw labor (uneducated wage), w_1^e is the wage of educated labor. The first equation shows the benefit from moving when migrants supply their labor to the labor market. The second one shows the benefit from moving when migrants obtained education.

The migrants who obtained a higher education are assumed to earn the following wage at time t.

$$w_1^e = [1 - s(t)][\varphi(t) + h(t)] w_1$$

where $s(t) \in [0,1]$ is the fraction of time that the individual spends for education and $1-s(t)$ is the fraction of time spent supplying labor to the market. $\varphi(t)$ is the raw labor that the migrant may be supplying to the market at time t, $h(t)$ is the level of education or human capital.

If we normalize $\varphi(t)$ to 1 the equation can be written as the following form

$$w_1^e = [1-s(t)][1+h(t)]w_1$$

Substituting this equation into equation (1.1) yields:

$$\pi_2 = \int_t^\infty \left([1-s(v)][1+h(v)]w_1(v) - w_2(v)\right)e^{-r\cdot(v-t)}dv$$

Finally we now can determine the total benefit from migration as follows

$$\pi = \int_t^\infty \left(b \cdot w_1(v) - w_2(v)\right)e^{-r\cdot(v-t)}dv \tag{1.2}$$

where $b = p + [1-p][1-s(t)][1+h(t)]$.

As mentioned above the costs of moving are measured as a time cost of the migration process, so it can be written as the function:

$$\phi = \zeta(m)\cdot(w_2 + s(t)w_2)$$

The time cost is evaluated at the current wage rate of the small region w_2 and schooling years $s(t)$. $m = M / L$ is defined as the migration flow from small regions to large regions.

Equilibrium

We will now analyze the behavior of the migration in equilibrium. All migrants are identical, thus in the equilibrium the cost of migration has to be exactly equal to the benefit for all t.

$$\pi = \zeta(m)\cdot(w_2 + s(t)w_2)$$

The migration rate m at each point in time can be computed as an inverse function of the above equation.

$$m = \xi\left(\frac{\pi}{(1+s(t))w_2}\right)$$

where $\zeta^{-1}(\cdot) = \xi(\cdot)$.

To get the time derivative of the benefit from moving, from (1.2) and differentiating with respect to t.

$$\dot{\pi} = -(bw_1 - w_2) + r\pi$$

In the presence of the labor augmenting technological progress above equations can be computed as follows:

$$m = \xi\left(\frac{\hat{\pi}}{(1+s(t))\hat{w}_2}\right)$$

$$\dot{\hat{\pi}} = -(b\hat{w}_1 - \hat{w}_2) + (r-g)\hat{\pi} \tag{1.3}$$

In the steady state all per capita variables grow at rate g and there is no migration between regions.

Transitional dynamics

To determine the labor transition dynamics we need to use a log-linear approximation of the system around the steady state for m. Note that π is linear.

The log-linear approximation of the system can be shown as follows

$$\begin{bmatrix} \dot{\hat{\pi}} \\ \dot{\ln L} \end{bmatrix} = \begin{bmatrix} r-g & b\cdot\alpha\cdot w^* \\ \dfrac{\xi'(0)}{(1+s)w^*} & 0 \end{bmatrix} \begin{bmatrix} \hat{\pi} \\ \ln L - \ln L^* \end{bmatrix}$$

The characteristic roots of the system are:

$$2\beta = (r-g) \pm \left((r-g)^2 + 4b\frac{\alpha\xi'(0)}{1+s} \right)^{\frac{1}{2}}$$

The negative characteristic root of the system is the coefficient of the convergence speed. Therefore the solution of the log-linearized system can be written as follows:

$$\ln L = e^{-\beta t}(\ln L(0) - \ln L^*) + \ln L^*$$

The model also predicts convergence speed for output, when we use the following Cobb-Douglas production function.

$$Y = \left(\frac{A}{L}\right) K^{\alpha} (Le^{gt})^{1-\alpha} \tag{1.4}$$

In this case, convergence speed for L is also the convergence speed for $\hat{y}$. The relation between growth rate of labor and growth rate of output can be computed as follows:

$$\frac{\dot{\hat{y}}}{\hat{y}} = -\frac{1}{1-\alpha}\cdot\frac{\dot{L}}{L} \quad \text{or} \quad \ln(L^*/L) = (1-\alpha)\ln(\hat{y}/\hat{y}^*) \tag{1.5}$$

2.2 Adjusment cost for capital and migration.

Adjustment cost for capital

Cobb-Douglas production function with labor autmenting technological progress.

$$Y_i = AK_i^{\alpha}(L_i e^{gt})^{1-\alpha} \tag{2.1}$$

by per capita terms:

$$\hat{y}_i = A\hat{k}_i^{\alpha} \tag{2.2}$$

The change of the capital stock is given by:

$$\dot{K} = I - \delta K \tag{2.3}$$

where I is gross investment, δ is depreciation rate. Hence we can change the capital stock in intensive form.

$$\dot{\hat{k}} = \hat{i} - (g + m + \delta)\hat{k} \tag{2.4}$$

where $\hat{i}$ is the investement per unit of effective labor and m is the change of labor force. In this case we assume that the natural growth rate of labor is equal to 0.

$$\text{Cost of Investment} = I \cdot \left[1 + \varphi\left(\frac{I}{K}\right)\right] \tag{2.5}$$

Where $\varphi(0) = 0$, $\varphi' > 0$, and $\varphi'' > 0$.

Firms choose their level of employment and gross investment to maximize the net present value of future cash flows

$$V(0) = \int_0^\infty \left(Y - wL - I \cdot \left[1 + \varphi\left(\frac{I}{K}\right)\right]\right) \cdot e^{-\int_0^t r(v))dv} dt \tag{2.6}$$

We can anaylyze this optimization problem by setting up the Hamiltonian

$$J = \left(Y - wL - I \cdot \left[1 + \varphi\left(\frac{I}{K}\right)\right] + q \cdot (I - \delta K)\right) \cdot e^{-\int_0^t r(v))dv} \tag{2.7}$$

The first order of conditions can be expressed as

$$\hat{w} = (1-\alpha)A\hat{k}^{\alpha} \tag{2.8}$$

$$q = 1 + \varphi\left(\frac{\hat{i}}{\hat{k}}\right) + \frac{\hat{i}}{\hat{k}}\varphi'\left(\frac{\hat{i}}{\hat{k}}\right) \tag{2.9}$$

$$\dot{q} = -\left[\alpha A\hat{k}^{\alpha-1} + \left(\frac{\hat{i}}{\hat{k}}\right)^2 \varphi'\left(\frac{\hat{i}}{\hat{k}}\right)\right] + (r+\delta)q \tag{2.10}$$

where q is the current-value shadow price of installed capital. The relation between q and $\hat{i}/\hat{k}$ is monotonically increasing, so we can ivert this relation to express $\hat{i}/\hat{k}$ as a monotonically increasing function of q:

$$\frac{\hat{i}}{\hat{k}} = \phi(q) \tag{2.11}$$

where $\phi'(q) > 0$. The transversality condition is:

$$\lim_{t\to\infty}[q\hat{k} \cdot e^{-(r(t)-m-g)\cdot t}] = 0 \tag{2.12}$$

The transversality condition says that the value of per unit of capital must approach 0 as time approaches infinity.

Migration

We assume that labor migration is costless in this model. Labor is assumed to migrate at a rate directly propotional to the benefit from moving.

$$\dot{L}/L = \eta[-(b\hat{w}_1 - \hat{w}_2) + (r-g)\hat{\pi}]$$

where η is the degree of labor mobility. The higher η is, the more rapidly labor responds to the benefit of moving and there is no labor mobility if $\eta = 0$.

Transitional dynamics and convergence

Now we have to determine the system of differential equations using the above equations. Substituting the equation (2.11) into the capital evolution equation, (2.4), and into the first-order condition with respect to the shadow value of capital yields

$$\frac{\dot{\hat{k}}}{k} = \phi(q) - (g + m + \delta)$$

$$\frac{\dot{q}}{q} = -\frac{1}{q}\cdot\left[\alpha A\hat{k}^{\alpha-1} + \phi(q)^2\varphi'(\phi(q))\right] + r + \delta \qquad (2.13)$$

$$m = \eta[-(b\hat{w}_1 - \hat{w}_2) + (r-g)\hat{\pi}]$$

If we substitute the migration equation into the capital evolution equation then the model reduces to two differential equations.

$$\begin{bmatrix} \dot{\ln k} \\ \dot{\ln q} \end{bmatrix} = \begin{bmatrix} \eta\cdot\alpha\cdot b\cdot w^* & \phi'(q)\cdot q \\ (1-\alpha)\left((r+\delta) - \dfrac{\phi(q)^2\varphi'(\phi(q))}{q}\right) & (r+\delta)-\phi(q) \end{bmatrix}\begin{bmatrix} \ln(\hat{k}/\hat{k}^*) \\ \ln(q/q^*) \end{bmatrix}$$

The equation of convergence speed is given as:

$$2\beta = z \pm \left(z^2 + 4\left\{(1-\alpha)\phi'(q)\left[(r+\delta)q - \phi(q)^2\varphi'\phi(q)\right] - \eta\alpha b w^*[(r+\delta)-\phi(q)]\right\}\right)^{\frac{1}{2}}$$

where $z = \eta\alpha b w^* - (r+\delta) - \phi(q)$

Normal convergence speed will apply if b or η equals 0.

3. Calibration

In this section we present the numerical results of the small economy transitions from an initial labor level below its steady state level, using a Mongolian economic data set. Due to the lack of the data I could not calibrate the second model-adjustment cost for capital and migration.

The parameters measured in the convergence speed are set at benchmark values. In particular, the real interest rate, the growth rate of technological progress, the capital income share and the sensitivity of migration are considered to be benchmark values. The combination of the migrants choice, schooling years and level of education determines the convergence speeds.

The average real interest rate is set to 14.7 percent. That is very high compared to other developed countries where the real interest rate varies around 3-5%. In Mongolia, the average nominal interest rate is 24.6 percent and the average inflation rate is 9.9 percent. Theorethically technological progress corresponds to the long-run growth of GDP. Thus the growth of the technological progress is relatively high at 7.28 percent. According to my previous study, the estimated coefficient of capital share, α , was approximately 0.74. To determine the sensitivity of migration, I have used Braun's theoretical model result and the data set of per capita GDP of Mongolia. Thus the sensitivity of migration is 0.0013.

The wage multiplicator has a direct effect on the convergence speed. So we can explain wage multiplicator instead of the convergence speed when we take into account the change of the parameters.

We are assuming that the parameter of the choice whether migrants obtain higher education or directly supply their labor to the market is 0.7. This means that 30 percent of the migrants would be able to study and 70 percent of the migrants would work in the labor market. But this choice is constrained with the entrance exam to proceed to higher education. Therefore every migrant would not be able to proceed to higher education. If we suppose that migrants can supply their labor to the market between the ages of 15 to 60, then our measurement of the schooling years is $s = 0.2$ - that is approximately 9 years spent for education. Next we assume that at the end of schooling, the migrant has a schooling level of h equal to 1. This means a migrant with education h is the productive equivalent of two migrants with $\varphi = 1$ each ($h = 1$ equal to 2 φ).

Table 1 shows the numerical results of the convergence coefficients in the benchmark case of Mongolian economic data set.

Table 1. Wage multiplicator and convergence
(benchmark case)

$r = 0.147$, $g = 0.073$, $\alpha = 0.74$, $\xi'(0) = 0.0013$				
P	s	h	b	betta
0.7	0.2	1	1.18	0.0111

According to the Benchmark case the wage multiplicator b is 1.18 and the coefficient of convergence speed to steady state level is 0.011.

If we use a kind of production function like equation (1.4), we can show convergence speed for labor as a convergence speed for per capita GDP. The releation between two convergence speeds is shown in equation (1.5). In this case, the coefficient of convergence speed per capita GDP is 0.0427. This result is almost suitable for the next empirical analysis section – I investigated convergence in real GDP per capita across twenty-two Mongolian aimags for the period 1989-2009 and estimated the speed of convergence with migration toward steady state position was 0.05.

Due to the enormously high real interest rate in Mongolia, the convergence speed tends to be lower. So if we reduce the real interest rate by policy, the convergence speed towards a steady state could rise. In particularly, if real interest rate decreases from 0.147 to 0.12, convergence speed rises from 0.0111 to 0.0152.

Table 2 shows the value of the convergence coefficient for some combinations of the parameters. The benchmark case is: $r = 0.147$, $g = 0.073$, $\alpha = 0.74$, $\xi'(0) = 0.0013$, and each line represents a modification of the parameters (bolded) shown while the rest of them are the same as in the benchmark case.

Table 2. Wage multiplicator and convergence

$r = 0.147$, $g = 0.073$, $\alpha = 0.74$, $\xi'(0) = 0.0013$					
	P	s	h	b	betta
1	**0.5**	0.2	1	1.30	0.0121
2	0.7	**0.3**	1	1.12	0.0099
3	0.7	0.2	**0.8**	1.13	0.0107
4	0.7	0.2	**0.1**	0.96	0.0093

The first row of table 2 refers to the possibilities of the choice between whether obtain to higher education or directly work. The speed of convergence depends positively on the wage multiplicator, represented by the value of p. As the possibility of the study becomes higher (0.5), the wage multiplicator can increase to 1.30, consequently the convergence speed will increase to 0.0121.

An increase of schooling years s leads to a decline in the wage multiplicator and the convergence speed. For example, the second row shows that as s rises to 0.3, the wage multiplicator decreases to 1.12 and the convergence speed decreases to 0.0099.

The value of convergence speed and wage multiplicator decreases to 1.13 and 0.0107 respectively if level of education decreases to 0.8. With low level of education, who spent for the education $s = 0.2$ years, migrants wage multiplicator becomes below 1. For example, 4rd row of the table 2 shows the level of education is 0.1 and wage multiplicator is 0.96. This means educated migrants wage rate is below small regions wage rate and migrants who obtained higher education are waste their valuable time. And also the convergence speed is at the lowest level.

4. Data sources

The data set for the empirical analysis of Mongolian economic growth was very difficult to collect. The basic data used here provided from National Statistical Office (NSO) of Mongolia. For the analysis of convergence speed, β, we calculated each aimag's GDP, because the data was not available from NSO of Mongolia and other sources.

(1). Data on GDP

I used here time series data for real GDP at constant 1995 price for the period 1989-2009. (Please see the real GDP in Appendix). Although there are some official data of GDP per aimag since 1999, the period is not sufficient to estimate convergence speed and also methodology has been changed for several times, so we calculated each aimag's GDP as follows

$$y_i = p \cdot x_i + (1 - p) \cdot [w \cdot z_i + (1 - w) \cdot q_i] \quad (4.1)$$

y_i : share of each aimag's GDP in GDP of Mongolia

p : share of industrial products in GDP of Mongolia

$1-p$: share of agricultural products in GDP of Mongolia

x_i : share of each aimag's indsutrial products in total industrial products

$[w \cdot z_i + (1-w) \cdot q_i]$: share of each aimag's agricultural products in total agricultural products

w : share of livestock products in agricultural products

$1-w$: share of field crop products in agricultural products

z_i : share of each aimag's livestock products in total live stock products

q_i : share of each aimag's field crop products in total harvest products

(2). Data on Population and Migration

The database of an aimag's population and migration pattern will be used for the study of regional convergence. To obtain per capita income, we used per aimag population data from the NSO of Mongolia. There is vast literatures concerned that migration contributes to convergence in per capita income. Thus the data on migration used for the study of regional convergence was obtained from the NSO of Mongolia (unpublished data) and Urban poverty and in-migration: Survey Report 2004.

5. Results of the Empirical Analysis

(1). β convergence

Due to the different methodology and the lack of data about aimags' GDP before 1999, each aimag's GDP per capita is calculated as in equation (4.1). As a calculation of each aimag's GDP per capita, mainly mining and field crops can be found in the developed aimags, border aimags and urban areas are richer than other aimags in per capita GDP.

As for Ulaanbaatar (capital city) per capita GDP is lower than before the transition level in 1989. It seems, the main reason of the lower per capita GDP is that the large amount of migration, relatively high informal sector and GDP is not perfectly reflected in an economy.

However, GDP per capita in Orkhon is the highest. The average growth rate of GDP per capita strongly depends on copper price in the world market. There are no big changes for other aimags. In case of natural disaster, due to the high propotion of agriculture to GDP, the average growth of GDP per capita tends to be lower.

Figure 1

As indicated in Figure 1, absolute convergence applies for the aimags of Mongolia. The relation between the aimags' average annual real GDP per capita growth rates from 1989 to 2009 is negatively related to the level of real GDP per capita in 1989 (the correlation coefficient is -0.51). It is clear that data on across Mongolian aimags presents absolute convergence in which relatively homogenous economies tend to converge to the same steady state. Figure 1 shows that most aimags grew faster than relatively developed aimags and urban areas in terms of GDP per capita since 1989.

Based upon absolute convergence hypothesis, I have estimated convergence coefficient β using a regression. The results of the regression divided into six periods can be characterized as follows.

1989-2009 years: Total period of analysis

1989-1993 years: Begining of the market economy with negative growth

1994-2004 years: The period, economic depression stopped and positive growth began

1995-1999 years: First 5 years of positive growth

2000-2004 years: Second 5 years of positive growth

2005-2009 years: Last 5 years of positive growth

The statistical model that is used for testing for β-convergence is given by equation (5.1). The average growth rate for economy i between two points in time, t_0 and $t_0 + T$, is given by,

$$(1/T)\cdot \ln(y_{i,t_0+T} / y_{i,t_0}) = c - [(1-e^{-\beta T})/T]\cdot \ln y_{i,t_0} + u_{i,t_0,t_0+T} \qquad (5.1)$$

where, y is the output, β is the rate of convergence, x is the exogenous rate of tehcnological progress, u_{i,t_0,t_0+T} is the error term and $c = x + [(1-e^{-\beta T})/T]\cdot[\ln \hat{y}^* + x\cdot t_0]$. The intercept is increasing in t due to technological progress. Controlled variables do not exist in equation (5.1), so it shows speed of absolute convergence.

Table 3

The high GDP per capita created by the copper mining of Orkhon aimag may cause distortion in the convergence coefficients and the dispersion. Therefore, I estimated two sapmles. In the first sample Orkhon aimag has been excluded from the sample, in the second sample Orkhon aimag has been included in the sample. According to the estimation results, there are no big differentials between coefficients. In order to involve all aimags in the study, I present the results with Orkhon aimag.

Table 3 presents the estimates of convergence speed β in the form of equation (5.1). The regression equation (5.1) is estimated using nonlinear least square for the entire sample period. The estimation of equation (5.1) for the 4 subperiods is a seemingly unrealted regression. Standard errors are given within parentheses. The estimated constant coefficient is not reported.

The full sample period 1989-2009, the positive growth period 1994-2004, and the first five years of positive growth period 1995-1999 show a positive and significant β coefficient. However, the begining of the market economy period 1989-1993, the second five years of positive growth period 2000-2004 and the last five years of positive growth period 2005-2009 shows an insignificant β coefficient and also a very low determination coefficients. To compare SUR with nonlinear least square methods with regard to 4 subperiods, the esimated β for the period 1995-1999, the estimation method SUR is higher than least square method and for the other periods vice versa.

For the longest sample period, 1989-2009, the estimation of β is 0.025 (0.017). As mentioned above, for the periods 1989-1993 and 2005-2009 the β coefficient is negative and statistically insignififcant. However, it is possible to explain a divergence in the periods 1989-1993 and 2005-2009, the gap between rich and poor aimags has tended to widen. This is closely related to the economic transition to a market economy and recent economic recession of world economy. As a consequence of the boom of the gold, copper and other minerals prices in 2004, the growth rate was high at 10.6 percent. It seems that due to this temporary high growth, β convergence is statistically insignificant for the period 2000-2004. In the case of Mongolia urban areas largely depends on industrial sector whereas rural areas largely depends on traditional agricultural sector. As consequently, due to high growth of industrial sector, the share of agriculture had been decreased. Thus real GDP per capita decreased in rural areas, for the period, 2005-2009, even the economy has the high growth.

If the four periods are restricted to have the same β but individual constants, then the joint estimate of β is 0.01(0.01). The Wald statistic is 9.71, with a p-value 0.02. The p-value comes from a χ^2 distribution with 3 degrees of freedom. The Wald statistic test does not reject the hypothesis that β is the same for the subperiods.

(2) Convergnce and migration

The neoclassical model views migration flows as an equilibrating tool to contract income differentials, given people tend to move from low income regions to high income regions in search for higher salaries. Income growth offers a significant incentive for net migration (Lowry, 1966; Richardson, 1973; Lande and Gordon, 1977). It could be also argued that income differentials are among major determinants of migration and the existence of regional differences in income is likely to be self-corrected through the migration effect (Dunlevy and Bellante, 1983). Therefore, migration is one of the main factors which highly affects the regional convergence.

In growth theory migration affects regional convergence. As shown in the section of Theory and Methodology, migration speeds up convergence in regional incomes transition toward their steady-state through per capita GDP (wage) and education (level of education). Based on this theoretical framework I present migration and its impact on convergence speed in the case of Mongolian aimags.

Figure 2

Figure 2 shows the relation between the net migration rate for 1989-2009 and the log of per capita GDP in 1989. The scatter plot depicts a positive relation between net migration and per capita GDP (correlation coefficient 0.54). The main point is that only Ulaanbaatar and Orkhon have the positive net migration (the average annual net migration is 1.9 percent and 1.5 percent, respectively). In general, all other aimags with lower per capita GDP in 1989 experienced a negative average annual net migration rate in the period 1989-2009. Therefore, it is clear from Figure 2 that the flows of migration are from other aimags to Ulaanbaatar and Orkhon. The Western region (five most western aimags) has a notably higher negative net migration rate. Specifically, Bayan-Oglii, Uvs, and Zavkhan aimags have higher negative net migration rates as seen in the lower left of Figure 2. Similar results applied in Figure 3. Figure 3 shows the relation between the net migration rate for 1989-2009 and the log education index in 1989. The scatter plot depicts a positive relation between net migration and education index (correlation coefficient 0.63).

Convergence speed towards a steady state position is higher in the model with migration. To get a value of sensitivity for net migration to per capita GDP and education index differentials across Mongolian aimags, the following statistical model is estimated,

$$m_{i,t_0,t_0+T} = c + d \ln y_{i,t_0} + z \ln \kappa_{i,t_0} + v_{i,t_0,t_0+T} \quad (5.2)$$

where m_{i,t_0,t_0+T} is the average annual net migration rate for aimag i between time t_0 and $t_0 + T$, y_{i,t_0} is the initial per capita GDP, κ_{i,t_0} is the initial education index for aimag i and v_{i,t_0,t_0+T} is the error term. The rate is calculated as the share of net migration to population. If $m_{i,t_0,t_0+t} > 0$, then immigration is larger than emigration.

Table 4 presents Non-linear least square and SUR estimation results in equation (5.2). The estimated constants, logarithm of per capita GDP, logarithm of education index (explanatory variable) and determination coefficients are displayd in table 4.

Table 4

Table 4 shows positive explanatory variable coefficients that is same for depicted in Figure 2 and Figure 3. The estimated explanatory variables are 0.005(0.003) and 0.127(0.077), respectively for the full sample period 1989-2009. This means that one percent increase in an aimag's per capita GDP (education index) raises net migration by 0.005 percentage points (by 0.127 percentage points), holding constant the effect of other variables.

The coefficient d is significant except for the periods 1989~1993 and 2000~2004. If the four subperiods are restricted to have the same net migration coefficient d and z, then the joint estimate is 0.008(0.002) and 0.072(0.027) respectively and both coefficients are signigicant at 1%. However, Wald statistic does not reject the hypothesis that d is the same for the four subperiods, whereas Wald statistic for z rejects the hypothesis. The p-value comes from a χ^2 distribution with 3 degrees of freedom.

The speed of convergence towards the steady state tends to be higher in the model with migration. In this case, I have predicted that migrant's education is lower than the domestic economy. Based on this prediction I estimated convergence coefficient β from the regression model augmented with the net migration as shown in equation (5.3). This form of regression is also argued in Braun's (1993) assumption with diminishing returns to scale. It is derived from the system with four differential equations during the transtion to the steady state.

$$(1/T) \cdot \ln(y_{i,t_0+T} / y_{i,t_0}) = c - [(1 - e^{-\beta T}) / T] \cdot \ln y_{i,t_0} + \xi \cdot m_{i,t_0,t_0+T} + u_{i,t_0,t_0+T} \quad (5.3)$$

Equation (5.3) is one of the system equations and should be estimated with the instrumental variable method. The logarithm of initial GDP per capita and logarithm of initial education index are considered as the instruments of the Instrumental variable estimation (IV). Here, the problem is initial GDP per capita included again in the convergence equation as a dependent variable in each time periods. Consequently, there is a possible simultaneous causality bias problem in the regression. To avoid this problem, I have used three kinds of estimation methods for the equation (5.3)-nonlinear least squares estimation method (NLS), seemingly unrelated regression method (SUR) and instrumental variable method (IV).

Table 5 shows estimation results of convergence coefficients augmented with the net migration rate as an explanatory variable in equation (5.3).

Table 5

As an estimation of NLS, for the full sample period, 1989-2009, estimated convergence coefficient β is 0.05(0.037) and migration coefficient is 1.3(0.92), both significant at level of 10%. This means for the long time period migration speeds up the convergence speed. For the periods of 1989-2003 and 2000-2004, I found same results. In the case of IV it could not show that migration speeds up convergence for the longest period, but for the 1994-2004 (convergence speed is 0.033 and significant at level of 5%) and 2000-2004 (convergence speed is 0.034 and not significant) periods are resulted as predicted in theoretical model.

For the periods which observed divergences, the values are exteremely high -21.9 percent and -19 percent per year, even though the speeds of convergence are significant at 5% and 1% respectively. Thus, by IV method the impact of net migration on the negative convergence speed is somewhat ambigous.

For the period 1995-1999 only one convergence coefficient is significant in both table 3 and table 5 by the SUR estimation method. To compare the value in table 3 (convergence coefficient without net migration is 0.049) is lower than table 5 (convergence coefficient with net migration is 0.037).

6. Concluding remarks

In this paper I tried to explore the interrelation between migration and population convergence. Due to the income (wage) difference labor tends to move from one region to another region. Migrants can choose whether they get higher education for the future higher income or directly supply their labor to the market. The model predicts that migration has a direct effect on population convergence. The choice of study and the level of education tend to accelerate convergence speed, but the convergence speed is inversely related to the years of schooling.

This paper also investigates convergence in real GDP per capita across twenty-two Mongolian aimags for the period 1989-2009 and estimates speed of convergence towards the steady state position with and without net migration rate.

As indicated in Figure 1, absolute convergence applies for the aimags of Mongolia and the speed of convergence is 2.5% per year, during last two decades. Two thirds of convergence is about 16 years. It indicates the number of years that would take to reduce by two thirds the gap between the logarithm of initial and the steady state GDPs.

Migration depends positively on the initial per capita GDP and initial education index as predicted on theory. The correlation coefficient between annual net migration rate and log of 1989 per capita GDP (log of 1989 education index) is 0.54 (0.63).

In growth theory migration affects regional convergence. Thus, I estimated convergence speed conditioning on migration using some estimation method. The convergence speed augmented with migration is 5 percent per year.

This results imply that if we include the net migration rate in the convergence equations, the estimated β coefficient shows that the GDP per capita converges more rapidly to the steady state position.

Appendix

Real GDP 1989~2009

(billion tugrug, at constant 1995 price)

Period	realGDP	Period	realGDP	Period	realGDP
1989	651.5	1996	563.2	2003	701.8
1990	635.1	1997	585.7	2004	776.1
1991	576.4	1998	606.4	2005	850.4
1992	521.6	1999	625.9	2006	924.7
1993	505.9	2000	632.5	2007	999
1994	517.6	2001	639.7	2008	1073.3
1995	550.3	2002	664.9	2009	1147.6

Source：National Statistical Office of Mongolia

REFERENCES

Barro, Robert J and Xavier Sala-i-Martin (2004) *Economic Growth* second edition, Cambridge: The MIT Press.

Braun, Juan (1993) “Essays on Economic Growth and Migration,” Ph.D dissertation, Harvard University.

Cheng, Kevin C. (2003) “Growth and Recovery in Mongolia During Transition,” IMF working paper (WP/03/217).

Dunlevy J.A. and Bellante D (1983) “Net Migration, Endogenous Income and the Speed of Adjustment to the North-South Differences,” *Review of Economics and Statistics* 65(1): 66-75

Jordan Rappaport. (2004) “How Does Labor Mobility Affect Income Convergence,” Seminar paper, Research Division, Federal Reserve Bank of Kansas City.

Lande, P.S. and Gordon.P (1977) “Regional Growth in the United States: A Re-examination of the Neoclassical Model,” *Journal of Regional Science* 17(1): 61-69

Mankiw N.Gregory, Romer David, Weil David N. 1992 “A Contribution to the Empirics of Economic Growth,” *Quarterly Journal of Economics* 107(2)：407-437.

Mathur, Somesh K. (2005) “Absolute Convergence, Its Speed and Economic Growth for Selected Countries for 1961-2001,” *Journal of the Korean Economy* 6(2) (Fall)：245-273.

National Statistical Office of Mongolia (2004) *Main Report of Labour Force Survey, 2004.* Ulaanbaatar

National Statistical Office of Mongolia (2004) *Mongolia in a Market system,2004.* Statistical Yearbook, Ulaanbaatar.

National Statistical Office of Mongolia(2005) *Mongolian Statistical yearbook 2004,* Ulaanbaatar.

National Statistical Office of Mongolia(2009) *Mongolian Statistical yearbook 2008,* Ulaanbaatar.

Ministry of Labor and Social Welfare, Population and Training Research Institute and United Nations Population Fund (2004) *Urban poverty and in-migration: Survey Report. 2004,* Ulaanbaatar.

Persson, Joakim (1994) “Convergence in per Capita Income and Migration Across The Swedish Counties 1906-1990,” Seminar paper, Institute for International Economic Studies, Stockholm University.

Wolrd Bank, UNDP, and National Statistical Office of Mongolia (2004) *Main Report of “Household Income and Expenditure survey/living standards Measurement Survey” 2002-2003,* Ulaanbaatar.

Figure 1

Convergence of per capita GDP across Mongolian aimags

(1989 per capita GDP and annual growth rate of GDP from 1989 too 2009)

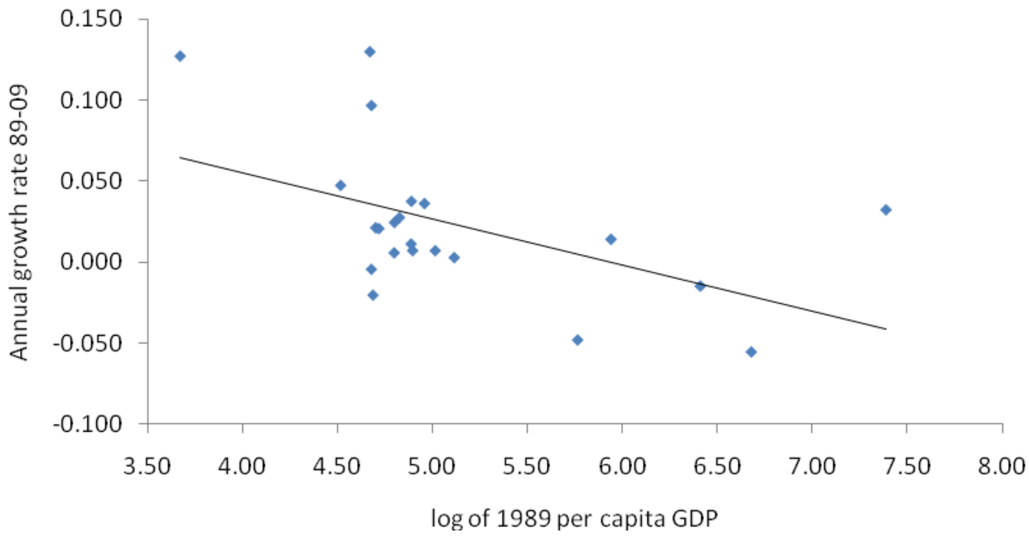

Figure 2

Relation between migration and aimags' per capita GDP (1989~2009)

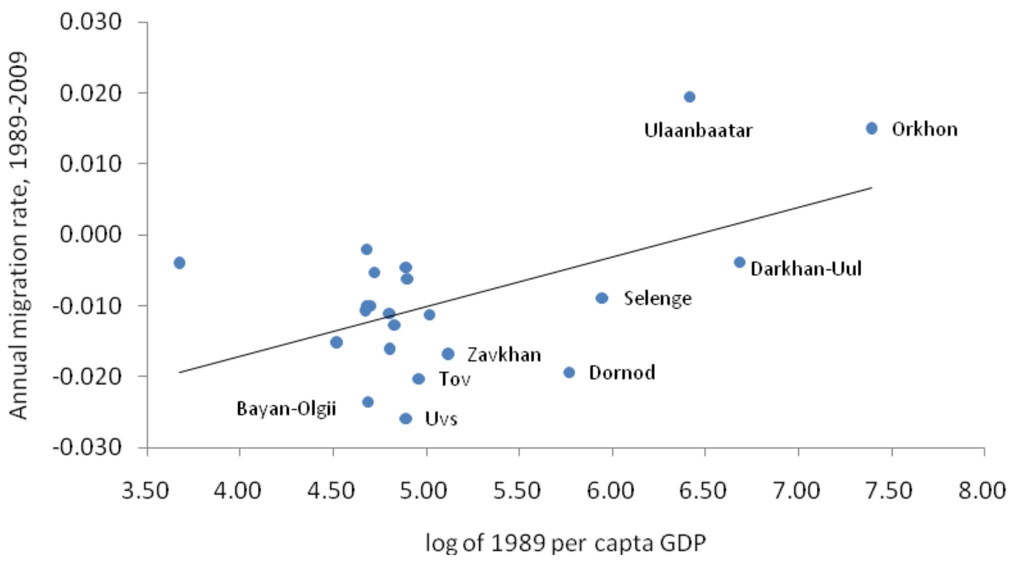

Figure 3

Relation between migration and aimags' education index (1989~2009)

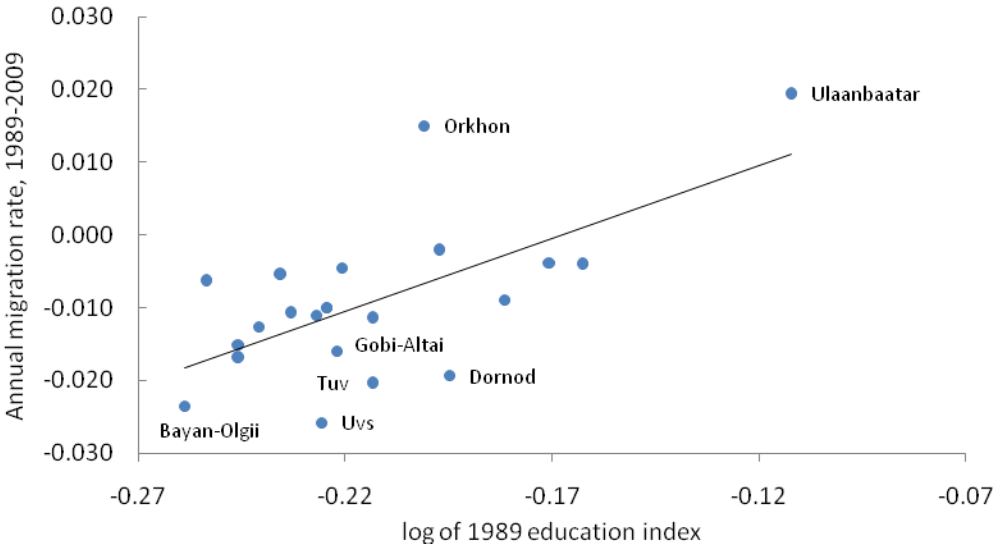

Table 3

Test for convergence speed β : Mongolian aimags

Period	LS		SUR	
	β	R^2	β	R^2
1989~2009	0.025* (0.017)	0.16	-	-
1989~1993	-0.007 (0.022)	0.05	-0.011 (0.020)	0.003
1994~2004	0.023** (0.011)	0.21	-	-
1995~1999	0.038** (0.018)	0.21	0.049*** (0.018)	0.19
2000~2004	0.020 (0.021)	0.04	0.012 (0.021)	0.03
2005~2009	-0.012 (0.019)	0.02	-0.01 (0.018)	0.017
Equality of coefficients [4 subperiods](note)	β restricted		0.01 (0.01)	-
	Wald statistics (p value)		9.71 (0.0212)	-

Note: 4 subperiods are 1989~1993, 1995~1999, 2000~2004, 2005~2009 years. Standard errors in parentheses.
*** significant at 1%, ** significant at 5%, * significant at 10%

Table 4

Cross-Aimags Net migration Regression (1989~2009)

Period	LS				SUR			
	Constant	logGDP	log(edu)	R^2	Constant	logGDP	log(edu)	R^2
1989~2004	-0.009 (0.03)	0.005* (0.003)	0.127* (0.077)	0.48	-	-	-	-
1989~1993	-0.044 (0.078)	0.009 (0.008)	0.02 (0.195)	0.12	-0.038 (0.07)	0.009 (0.007)	0.048 (0.173)	0.12
1994~2004	-0.007 (0.021)	0.006** (0.003)	0.168*** (0.044)	0.59	-	-	-	-
1995~1999	-0.036** (0.019)	0.011*** (0.003)	0.138*** (0.037)	0.62	-0.056*** (0.015)	0.012*** (0.003)	0.078*** (0.029)	0.57
2000~2004	0.028 (0.045)	-0.002 (0.006)	0.224** (0.106)	0.22	-0.003 (0.034)	0.001 (0.005)	0.136* (0.081)	0.19
2005~2009	-0.038* (0.024)	0.005* (0.019)	0.019 (0.087)	0.16	-0.024 (0.018)	0.003 (0.003)	0.051 (0.065)	0.14
Equality of coefficients [4 subperiods](note)	d restricted (for logGDP) z restricted (for log(edu))				-	0.008*** (0.002)	0.072*** (0.027)	-
	Wald statistics (p value)				-	9.91 (0.019)	1.12 (0.772)	-

Note: 4 subperiods are 1989~1993, 1995~1999, 2000~2004, 2005~2009 years. Standard errors are in parentheses.

*** significant at 1%, ** significant at 5%, * significant at 10%

Table 5

Convergence and Migration (1989~2009)

Period	LS				SUR			
	Constant	β	Migration	R^2	Constant	β	Migration	R^2
1989~2004	0.189*** (0.073)	0.05* (0.037)	1.298* (0.92)	0.24	-	-	-	-
1989~1993	-0.116 (0.129)	-0.002 (0.024)	0.56 (0.91)	0.03	-0.123 (0.116)	-0.003 (0.021)	0.49 (0.812)	0.03
1994~2004	0.126** (0.056)	0.019* (0.013)	-0.27 (0.515)	0.22	-	-	-	-
1995~1999	0.16* (0.104)	0.027 (0.021)	-0.720 (0.899)	0.23	0.203** (0.093)	0.037* (0.02)	-0.689 (0.801)	0.23
2000~2004	0.164* (0.118)	0.024 (0.024)	0.707 (0.785)	0.08	0.129 (0.109)	0.017 (0.021)	0.731 (0.723)	0.07
2005~2009	-0.082 (0.13)	-0.02 (0.02)	-1.38 (1.56)	0.05	-0.114 (0.118)	-0.024 (0.018)	-2.085* (1.413)	0.05
Equality of coefficients [4 subperiods][(note)]	d restricted				-	0.007 (0.01)	0.045 (0.43)	-
	Wald statistics (p value)				-	6.5 (0.0896)	3.54 (0.31)	-

Table 5 (continue)

Convergence and Migration (1989~2009)

Period	IV method			
	Constant	β	Migration	R^2
1989~2004	0.033 (0.159)	0.006 (0.030)	-1.495 (2.681)	0.17
1989~1993	-2.228 (1.881)	-0.219** (0.118)	-40.89 (36.851)	0.07
1994~2004	0.190*** (0.067)	0.033** (0.017)	0.701 (0.771)	0.24
1995~1999	0.164 (0.132)	0.029 (0.027)	-0.657 (1.408)	0.22
2000~2004	0.232* (0.135)	0.034 (0.027)	2.281 (1.773)	0.12
2005~2009	-2.334** (1.206)	-0.19*** (0.063)	-54.7** (28.486)	0.18

Note: 4 subperiods are 1989~1993, 1995~1999, 2000~2004, 2005~2009 years. Standard errors are in parentheses.

*** significant at 1%, ** significant at 5%, * significant at 10%