DISCUSSION PAPER SERIES

Human Capital Agglomeration Effect and Regional Inequality in China

Zhiwei Cen　Junko Doi　Yoshimasa AOKI

No.2019-01

京都産業大学大学院経済学研究科
〒603-8555　京都市北区上賀茂本山

Graduate School of Economics
Kyoto Sangyo University
Motoyama-Kamigamo, Kita-ku, Kyoto,
603-8555, Japan

2019/3/31

Human Capital Agglomeration Effect and Regional Inequality in China*

Zhiwei Cen† Junko Doi‡ Yoshimasa AOKI§

31 March 2019 (first draft)

Abstract

In this paper, using Barro Regression, we tested the hypothesis that the human capital agglomeration effect is a factor behind expansion of income inequality and reached the following empirical conclusions. First, there was no significant absolute β-convergence in any of the time periods included. Second, when the human capital agglomeration effect was taken into account, there was significant conditional β-convergence, and a significant coefficient estimate value was obtained in terms of the impact of the foreign direct investment effect and the overseas trade effect on regional economic development. These empirical results have the following significance. If human capital agglomeration occurs, workers with a high level of human capital accumulate in the coastal regions, encouraging trade and production activity by overseas-owned companies in those regions, leading to an even higher rate of economic growth. However, regions where this is not the case lose workers with a high level of human capital and so benefit little from overseas capital and so on which in turn lowers the level of economic growth. This effect causes expansion in income inequality between regions in the period in question. Issues to be tackled in the future include clarification of the factors behind income inequality between regions in China over a longer period. As a result, further research must be conducted using panel analysis and other methods.

1 Introduction

The aim of this paper is to clarify the factors behind the income inequality between regions in China since the 1990s, using Barro Regression based on Chinese regional microdata and Chinese population census data from the year 2000.

Since the 1990s, China has made serious efforts to introduce a market economy with the intention of stimulating the economy. As part of this process, restrictions on internal movement of labor were eased so that, in the ten years from 1990 to 2000, the fluid population of China rose 4.3-fold from 33.840 million to 144.39 million (see Table 1). However, despite the easing of restrictions on movement of labor, income inequality between the Chinese coastal regions and inland regions has expanded since the 1990s. This could well be attributable to the effect of human capital agglomeration caused by China's internal migration strategy of household registration. To obtain urban registration under the

*This research was supported by the GPG Center of Kyoto Sangyo University . we would like to express our thanks.
†Kyoto Sangyo University; Corresponding author: cen25@cc.kyoto-su.ac.jp.
‡Kansai University
§Ritsumeikan University

Chinese household registration system, long-term employment in the region in question must be secured. Naturally, workers with high human capital find it easier to obtain such jobs. We think that, therefore, after restrictions on labor movement were eased, workers with high human capital accumulated in the coastal regions where wages were high, moving away from inland regions. As a result of this kind of labor movement, average income per capita rose in the coastal regions, while, in contrast, economic development lagged in the inland regions. This caused income inequality between the coastal and inland regions. It can thus be surmised that inequality in human capital agglomeration caused by the Chinese household registration system has contributed to the expansion in income inequality between regions in China since the 1990s. Therefore, in this paper, we use Barro Regression to test the hypothesis that the human capital agglomeration effect is a factor behind expansion in income inequality.

The structure of the paper is as follows. In Section 2, we discuss the characteristics of the income inequality between regions in China since the 1990s, the factors behind it, and the reasoning underlying the hypothesis that the human capital agglomeration effect explains those factors. In Section 3, we describe how Barro Regression pertains to the human capital agglomeration effect hypothesis and how we tested the hypothesis. In Section 4 we describe the verification data used and summarize our empirical results. In Section 5, we summarize our conclusions and outline future challenges.

2 Income inequality between regions in China since the 1990s and relevant factors

In Figure 1, we show trends in four statistical indicators of inequality in real per-capita Gross Regional Product (GRP) from 1970 to 2008, namely Gini coefficient, standard deviation of logarithmic value (σ convergence),[1] coefficient of variation, and Theilindex. This figure indicates that, after having contracted consistently since 1978, income inequality between regions in China began to expand again in 1990.[2] This can be explained by a "hypothesis relating to the ratio of wealthy & middle-income families to those in poverty" (Chen, 2002a) and a hypothesis of "club convergence" between the eastern and the central western regions.

(Figure1)

The hypothesis relating to the ratio of wealthy and middle-income families to those in poverty explains income inequality between regions in China from the viewpoint of economic convergence. This hypothesis focuses on income level in China and suggests that, in the early stages of economic development, there was polarization between the large number of people in poverty and the small number of wealthy people.Then, along with economic growth, middle income households emerge and income inequality is reduced, that is economic convergence occurs.[3]However, it has been shown that further eco-

[1]The standard deviation of logarithmic value of per-capita GRP is a statistical indicator that measures economic convergence between regions, and it is thought that there is economic convergence (income inequality contraction), if it declines over time. Barro and Sala-i-Martin (2004) called it σ convergence.

[2]This fact is also confirmed by Jian (1996), the World Bank (1997), Chen (2002a, 2002b), and Lin and Liu (2003).

[3]Please see Barro *et.al.* (1992, 1994) for more information on economic convergence.

nomic development causes the expansion of the income inequality between thehigh , the middle-income households, and the poor. This implies that the economic convergence is disappeared. Meanwhile, Cai, and Du (2000), who emphasize a hypothesis of club convergence between the eastern and central western regions, used the average Theil contribution of each region during the period of 1978-1998toexplain the income inequality between regions. They conclude that there are two distinct clubs, the eastern regions club and the central western regions club, [4] and even if there is economic convergence within a club, there will be no economic convergence between clubs.[5]Similarly, by breaking down Chinese economic convergence into that within the coastal regions (which have enjoyed economic development) and that between the coastal regions and inland regions (where economic development has been delayed), Chen (2002b) suggests that while income inequality has contracted within the coastal areas, income inequality between the coastal regions and inland regions has expanded continuously. This implies that the decrease of income inequality between regions in the 1980s due to economic convergence within the coastal regions.On the other hand, the following expansion in overall income inequality due to expansion in the inequality between the coastal and the inner regions.

However, both hypotheses seems to fail to touch on an important fact in the consideration of income inequality between Chinese regions, the labor migration within China, which began in earnest in 1990. Table 1 gives an overview of the labor migration, using Chinese population census data for 1982-2012. The table shows that labor migration within China has been increasing sharply since 1990.

(Table1)

According to Yan (2004), inter-regional labor migration in China, which was swelled from 10.81 million in the latter half of the 1980s to 34 million from the latter half of the 1990s. A notable trend in labor migration is the flow of the working population from economically developing regions to developed regions. This signifies that the trend for people to work away from home in other Chinese regions took off in earnest from the 1990s. According to Harris and Todaro's model, when this kind of labor migration occurs, wages will be declined in developed regions by labor inflow. Meanwhile, in developing regions, wages will be advanced because labor markets are tightened. The advance in wages in developing regions improves the income inequality between regions. However, as shown in Figure 1, the income inequality between regions has been expanding since the 1990s. We consider that the factors behind this are as follows.

Historically, the Chinese government adopts a policy that makes it impossible for workers to easily move between regions, namely the "hukou" household registration scheme. The purpose of this policy is make a clear distinction between urban and farming households and stipulates that households cannot access public services such as social security and children's education in a region if they are not registered in the region. Households can join the another region's register if they have long-term employment in that region. Hence, the higher human capital households (i.e., if they have a degree, or at least a

[4]Please see Quah (1996) for more information on "club convergence" within economic convergence.

[5]While the tile contribution in the period for "within the eastern region" fell from 63.71% to 41.52%, the contribution for "between the eastern and central western regions" rose from 30.95% to 56.29% (Cai and Du, 2000, Table 1).

high school diploma) , the more likely to obtain long-term employment in developed regions, and so the more likely they can obtain the registration in that regions. Meanwhile, because the majority of workers who have moved from an inland (developing) region to the coastal (developed) region as unskilled labor do not have high human capital, they are unlikely to obtain long-term employment and have to work in that region temporarily. So, many migrant workers have to move back to their home regions (Wang, 2006).[6]Thus, because of the household registration system, it is easy for workers with a high level of human capital to move to another region, but there are restrictions on workers with a low level of human capital moving to another region. Therefore, households with high human capital accumulate in the developed coastal regions because they obtain high wages in such regions. Such human capital agglomeration might affect the difference of the economic development between developed coastal regions and developing inland regions).That is, while households with a high level of human capital who have accumulated in the coastal regions promote further economic development of the region, in inland regions that suffer from an outflow of workers with high human capital, the economic development will be stagnated (Figure 2).

(Figure 2)

This human capital agglomeration effect could explain why income inequality between Chinese regions continued to expand even after 1990 when the movement of labor was liberalized. In this paper, we test whether this hypothesis is correct or not by using the analysis framework of Barro *et al.* (1992, 1994). The results of our analysis show that it is likely that the economic convergence between Chinese regions since the 1990s is not absolute but conditional, that is, it appears after taking account of the above possibilities.

3 Empirical model

3.1 Basic model

In Barro *et al.* (1992, 1994), the economic convergence is defined as follows. If some economic groups, which are in different economic circumstances (for example, with different per-capita GDP), approach the same long-term equilibrium (the same long-term level of per-capita GDP), the economy converges. In other words, economy converges when groups with a low income level (or production level) experience faster growth than groups with a high income level and, as a result, the level of per-capita income of the low income group approaches that of the high income group. By applying this thought process to the problem of income inequality and inequality between regions, it can be said that when "economic convergence" (shortened to "convergence" below) happens, income inequality and inequality between regions contract. Similarly, when there is no convergence, income inequality and inequality between regions expand.

Such convergence can be tested by using tests for β convergence and σ convergence. To test our hypothesis, we use a method that measures β convergence. β convergence measures the existence of

[6]The recent phenomenon of "mingonghuang" (the shortage, in China, of rural migrant workers (mingong) to work in regions with economic development, despite the country's abundant labor resources])could be attributable to these factors.

the process of approach to the long-term equilibrium from a certain economic state (initial state).[7] To measure β convergence, we used Barro Regression (Barro *et al.* (1992, 1994)). The measure of β convergence is the measure of β, which is called the convergence coefficient in the next equation.

$$\begin{aligned}\bar{G}\left(t_0, t_0+T\right)_k &= const. + b \times \ln y\left(t_0\right)_k + B\left(\ln y^*\left(\Phi\right)\right) + u\left(t_0, t_0+T\right)_k \\ &= const. + b \times \ln y\left(t_0\right)_k + \textstyle\sum_l^L c_{k,j}x_{k,j} + u\left(t_0, t_0+T\right)_k\end{aligned} \tag{1}$$

Here, y_k is the real per-capita GDP of region k and $\bar{G} \equiv \ln\left(y\left(t_0, t_0+T\right)/y\left(t_0\right)\right)/T$ expresses the average growth rate in period t_0 and in period t_0+T , $b = -\left(1-\exp\left(\beta T\right)/T\right)$ [8].$B\left(\ln y^*\left(\Phi\right)\right)$ is a factor that includes real per-capita GDP at long-term equilibrium (y^*) and the various choice variables and environmental variables which will influencing y^*.[9] $\sum_l^L c_{k,j}x_{k,j}$ in the second row of equation(1) expresses the series of state variables, choice variables, and environmental variables thought to influence$B\left(\ln y^*\left(\Phi\right)\right)$.

Moreover, there are two types of β convergence, namely, "absolute convergence" and "conditional convergence." If some groups converge to the same long-term equilibrium, it is called "absolute convergence." However, when the long-term equilibrium of each group differs and economy converges when we have to take account of (control for) certain conditions, it is "conditional convergence."[10]

In actual measurement, the two types of convergences are confirmed as follows. If, $\beta > 0$ (which indicates convergence) is at a significant level without taking account $B\left(\ln y^*\left(\Phi\right)\right)$ inequation (1), that convergence is "absolute convergence."[11] In contrast, when $B\left(\ln y^*\left(\Phi\right)\right)$ differs there will be no convergence between the groups (we cannot obtain the positive value of β significantly). However, if there is convergence as a result of controlling certain conditions , in other words, if we take into account some variables which determine$B\left(\ln y^*\left(\Phi\right)\right)$ and affect the convergence, then that convergence is considered to be "conditional convergence" (Barro, 1997; Barro and Sala-i-Martin, 2004).

3.2 Barro Regression with "human capital agglomeration effect"

Next, Let us consider the measurement of the "human capital agglomeration effect" in Barro Regression.

In Barro Regression, if we take into account some variables which determine$B\left(\ln y^*\left(\Phi\right)\right)$,we should use some quantification methods such as the instrumental variable method (IV), the two-stage least square (2SLS) method, and the generalized method of moments (GMM). The instrumental variable method is used when problems arise such as simultaneous equation bias or endogeneity (simultaneity). When endogeneity occurs, the estimated values do not have the desirable property of consistency and lack of bias. However, if we find the appropriate control variables by using the instrumental variable method, ,then we obtain estimated values that hold consistency.

[7] In other words, it quantitatively measures whether there is a process of approach to (convergence on) the long-term equilibrium (steady state) from an initial state, by solving a differential equation obtained from a Solow model or an optimal growth model.

[8] β is found from$b = 1-\exp\left(\beta T\right)/T$ in such a way that $\beta = -\left(1+bT\right)/T$.

[9] See Barro (1997) for choice variables, environmental variables, and state variables in Barro Regression.

[10] See Barro and Sala-i-Martin (2004), chapter 1.2.10

[11] See Nakazato (1999) and Etsuro (2000).

When we use the instrumental variable method in Barro Regression with the conditional convergence, we have to add some choice variables which are thought to be factors that give rise to differing long-term equilibrium as additional explanatory variables. Moreover, we have to control the endogeneity of those variables. If the estimated value of β is not significant when these are not controlled for, but is found to be significant when they are controlled for, then these choice variables can be considered to be factors that generate the conditional convergence.

Now, we apply the above method to factor analysis of the income inequality between Chinese regions since 1990. First, we find the choice variables relating to the "human capital agglomeration effect," which is thought to be a factor that prevents β convergence between Chinese regions since 1990. Second, we add the finding choice variables and control their endogeneity by instrumental variables. If, as a result of such process, convergence appears, these choice variables and instrumental variables can be considered to be among the factors that caused expansion of inequality between regions from 1990. In this paper, we test the "human capital agglomeration effect" within the expansion of inequality between Chinese regions since 1990 by using the above process.

Let us consider the choice variables relating to the "human capital agglomeration effect" and the instrument variables that control for them. First, let us examine the statistical indicators (Tables 2a and 2b) relating to the "human capital agglomeration effect."[12]These tables show, for central western and coastal regions: (1) "average growth rate" for per-capita Gross Regional Product; (2) the "graduate ratio" which means the proportion of the university graduates in the region to all nationwide university graduates; (3) the "graduate employee ratio" which is the proportion of university graduates in the region to all employed people in the region; (4) "net immigration rate" [(labor inflow − labor outflow) (those residing in the region for five years or more + labor outflow)]; and (5) "per-capita Gross Regional Product."[13] Table 2a lists the group consisting of five central western regions (Sichuan, Hubei, Henan, Hunan, and Shanxi Provinces) in order of "graduate ratio," and Table 2b lists the group consisting of six coastal regions (Zhejiang Province, Jiangsu Province, Tianjin Municipality, Beijing Municipality, Guangdong Province, and Shanghai Municipality) in order of "average growth rate."

(Table 2*a*)

First, when looking at the central western region group, while the "graduate ratio" in Sichuan, Hubei, and Henan is among the highest in the nation (in the top 10, with deviation from the nationwide average for the three provinces of 2.06 %), [14] their "graduate employee ratio" is among the lowest (lower than 12, with deviation from the nationwide average for the three provinces of 2.18%). If we take the "graduate ratio" as a surrogate variable for the level of a region's education and the "graduate employee ratio" as a surrogate variable for the level of the human capital of workers in a region, it can be said that the

[12]The data in the data set used in the analysis in this paper that relate to Qinghai Province and Tibet are inadequate and so these two regions have been omitted.

[13]Yan (2005, Chapter 3) defines mobility (net immigration) as "net immigration rate = those moving out less those moving in the permanent population (at the time of the population census)"

[14]While the "graduate ratios" of the four regions other than Shaanxi Province (namely, Sichuan, Hubei, Henan, and Hunan Provinces) were among the highest in 2000 (within the top 10, deviation from the nationwide average of 1.63% for the four regions), their "graduate employee ratios" were among the lowest (within the bottom 12, deviation from the nationwide average for the four regions of -6.79%).

level of workers' human capital in these regions is very low in spite of the level of education is very high. Since regions with a high level of education, like Japan and the US, also have a high level of workers' human capital, it seems paradoxical that the negative relationship between level of education and level of workers' human capital in the central western regions of China, shown in Table 2a. However, if we take account of the migration of labor between regionsor "net immigration rate," the reason of these points could be explained.

For example, Sichuan and Hubei Provinces rank third and fourth nationwide in terms of "graduate ratio", but their net immigration rates, which show the situation of the migration of labor, are -56.81% (ranked 27th) and -19.04% (ranked 22nd), respectively. These facts show that in these provinces more people move out than move in.[15]It is natural to suppose that the labors who move out from these regions involve many university graduates who received a high level of education in Sichuan and Hubei Provinces (workers with a high level of human capital). If so, we should consider that the paradoxical relationship in Sichuan and Hubei Provinces between a high level of education (a high "graduate ratio") and a low level of human capital among workers ("graduate employee ratio" ranking 22nd and 12th) shown in Table 2a is due to the fact that many workers with high human capital move away. These factors give rise to the low average economic growth rate in Sichuan and Hubei Provinces (they rank 18th and 22nd, respectively, among the 29 provinces, municipalities, and autonomous zones) and, as a result, they both also rank low in the country in terms of per-capita Gross Regional Product (nationwide rankings of 26th and 17th, respectively). We find similar results in other central western regions.

(Table 2*b*)

Conversely Sichuan and Hubei Provinces, Tianjin and Shanghai have typical high human capital workers inflows. The "graduate ratio" in Tianjin City is at a very low level (the 20th) in the country, although the "graduate employee ratio" is the 3rd in the country (the deviation from the nationwide average is 4.34%). This is because the high net immigration rate of Tianjin City (the fifth highest, with a deviation from the national average of 27.60%). From these facts and the fact that "graduate employee ratio" ranks third, it is natural for us to suppose that the high average growth rate and high GRP per capita (third in the country) in Tianjin city results from workers with many high human capital levels migrating to Tianjin and contributing to the economic growth of Tianjin.

Within the coastal regions, the situation in Zhejiang Province is slightly different. Although both Zhejiang's "net immigration rate" (14th place) and "economic growth rate" (1st place) are among the highest in nation, "graduate employee ratio" is extremely low (18th place, deviation from the national average is -1.63%). we consider the reason of this fact that there are many privately-owned small and medium enterprises (manufacturing) in Zhejiang province, and these companies need low skilled workers rather than high skilled workers.

Beijing and Shanghai stand in contrast to Zhejiang. The "graduate ratio" (9th) in Shanghai City is lower than that of both Sichuan (3rd) and Hubei (4th), but the "graduate employee ratio" (2nd) The level of) is much higher than the two provinces. The factor of this fact is also considered to be the high

[15]The figures of -56.81% and -19.04% for net immigration rate mean that "those within the permanent population who had moved in minus those who had moved out" has a negative value and that more people moved out than moved in.

"net immigration rate" (fourth place). Therefore, it can be said that Shanghai City has also achieved high average growth rate (12th, deviation from national average is 0.46%) and high GRP (1st national) per capita due to these factors.

Beijing, on the other hand, has a high "graduate ratio" (sixth), as well as a very high "net immigration rate"(second) and "graduate employee ratio" (first). The economic growth rate (9th) is also relatively high. So, we presume that, in Shanghai and Beijing, the agglomeration of high human capital workers promotes the higher economic growth, and regions such as Sichuan Province and Hubei Province experiences the outflow of high human capital workers deteriorates the economic growth rate in inland regions (mid-western regions).

Thus, it can be considered that many workers with a high level of human capital gather in coastal regions (regions with relatively high economic growth rates), as shown by the cases of Shanghai and Beijing Municipalities, while many workers with high human capital move out of central western regions (regions with relatively low economic growth), as shown by the cases of Sichuan and Hubei Provinces. These data support our hypothesis that is the "human capital agglomeration effect".

Hereafter , to test our "human capital agglomeration effect" hypothesis, we take statistical indicators relating to human capital agglomeration and associated statistical indicators shown in Tables 2a and 2b as surrogate variables. We consider two types of the surrogate variables: Type 1, which are indicators of the level of human capital in the regions and do not take labor migration into account and Type 2, which are indicators of the human capital agglomeration effect that take into account the effects from migration of labor .[16] In particular, we take the level of education (graduate ratio) in the region and the level of workers' human capital (graduate employee ratio) in the regionas type 1 surrogate variables (for example, "ln_*Averedu*, *Percen_unv_empl_year*, and *unv.s_year*"). Type 2 surrogate variables are defined by following equation.

$$hca_k \equiv \frac{\sum_{j=1}^{I} M_{k,j} - \sum_{j}^{I} T_{k,j}}{\sum_{q=1}^{Q} S_{k,q}} \times \Lambda_k \tag{2}$$

Here, Λ_k shows the level of human capital (for example, the average number of years in education or "graduate ratio") and the level of workers' (employees') human capital (for example "graduate employee ratio") in region k, while $\sum_{j=1}^{I} M_{k,j}$ shows the gross number of the labor inflow into the region,$\sum_{j=1}^{I} T_{k,j}$, the gross numberout of the labor outflow of the region, and $\sum_{q=1}^{Q} S_{k,q}$, the permanent population of at least five years' duration. Accordingly, $\sum_{j=1}^{I} M_{k,j} - \sum_{j=1k,j}^{I} / \sum_{q=1}^{Q} S_{k,q}$ expresses the level of net immigration. The stronger a region's "human capital agglomeration effect," the higher the value of hca_k, and it will have a positive effect on the economic growth rate. Hence, by taking account of the human capital agglomeration effect, we modify the Barro Regression equation as follows.

$$\bar{G}_k = const. + +b \times \ln y\left(t_0\right)_k + \sum_{\mu=1}^{Z} z_\mu \times hca_{k,\mu} + \sum_{l}^{L} c_{k,j} x_{k,j}\left(\Theta\right) + u\left(t_0, t_0 + T\right)_k \tag{3}$$

[16] For example, indicators that show the synergy of labor migration (net immigration rate) and the level of workers' human capital (graduate employee ratio) in the region in question. It can be considered that their value for a region will rise in line with the strength of human capital agglomeration (as a large number of people move in, the level of human capital of employees in that region will also rise).

Here, the term $\sum_{\mu=1}^{Z} z_{\mu} \times hca_{k,\mu}$ is the "human capital agglomeration effect". $\sum_{l}^{L} c_{k,j} x_{k,j} (\Theta)$is the new choice variables which could affect the real per-capita Gross Regional Product in long-term equilibrium , such as surrogate variables of the level of the human capital (namely, rate of investment in physical capital, dependence on foreign trade (foreign trade effect), the proportion of foreign direct investment in gross regional product (FDI effect), birth rate, average number of years in education, and government spending). The $x_{k,j} (\Theta)$ expresses the relationship of the endogenous variable and the instrumental variables that affect it.

In this paper, we consider endogeneity between the average number of years in education, which is extremely important in generating the "human capital agglomeration effect" and the average growth rate of per capita GRP , for the following reasons. It goes without saying that the average number of years in education (the level of human capital) at any given period is a stock variable. [17] If the accumulation of human capital does not depend on the quality of the education in the region in question, but instead, as suggested in this paper, is produced by the human capital agglomeration mechanism, then high economic growth and high per-capita GRP in a region could be an incentives for workers with a high level of human capital to gather in that region. We detect the endogeneity between the average number of years in education and the average growth rate of per capita GRP which is shown in Tables 5b, 6b, 7b, and 8.

4 Data and Estimation results

4.1 Data

In this paper, we use data, 1) regional macro data in "China Compendium of Statistics 1949-2008", published by the National Bureau of Statistics of China in 2010 (below China Compendium 60), 2) "Tabulation on the 2010 population census of the People's Republic of China by county" (1995 and 2000), by Population Census Office under the State Council, and other related data. Taking reform from 1978 and actively beginning to flow into FDI from 1986 into account, we divide our estimated periods into (a) 1979-2007 (to verify post-reform convergence); (b) 1987-2007 (to verify convergence considering the FDI effect); (c) 1991-2004 (the period needed to verify the hypothesis in this paper); and (d) 1991-2007 (extension of the period (c)). Below, we list the variables used for tests in this paper and the data utilized for these variables.

(1) Dependent variable $\bar{G}_k$: Average growth in real per-capita Gross Regional Product in the period $\equiv$ Per-capita Gross Regional Product adjusted using the nationwide consumer price index (Data: China Compendium)

(2) $\ln y\left(t_0\right)_k \equiv \ln GRP_t$: Real per-capita Gross Regional Product in the initial term of the calculation period$\equiv$ Initial term of calculation period (logarithmic value) (Data: China Compendium)

(3) $x_{k,1} \equiv G.cons\_Y_t$ Government spending as a proportion of expenditure-based Gross Regional Product (average value for each calculation period(Data: China Compendium)

[17] Given data limitations in this paper, we use the average number of years in education in each region for the year 2000.

(4) $x_{k,2} \equiv I\_Y_t$: Fixed capital formation as a proportion of expenditure-based Gross Regional Product (average value for each calculation period) (Data: China Compendium)

(5) $x_{k,3} \equiv trad\_Y_t$: Total overseas trade value as a proportion of Gross Regional Product (average value for each calculation period) (Data: China Compendium)

(6) $x_{k,4} \equiv fdi\_Y_t$: Foreign direct investment as a proportion of Gross Regional Product (average value for each calculation period) (Data: China Compendium)

(7) $x_{k,5} \equiv \ln\_fer_t$: Birth rate in the calculation period (initial term, logarithmic value) (Data: China Compendium)

(8) $Nmig_t$: Net immigration rate ≡ net immigration rate in the calculation period(Data: National Population Census, (1995-2000))

(9) *Human capital level* : (a) $\ln\_Averedu$ ≡ Logarithmic value of average education (overall, men, women) (2000); (b) *Perc.unv_empl_year*≡ Ratio of university graduates within employees (average for each calculation period); (c) *unv.s_year* ≡ Proportion of the region's university graduates within all graduates nationwide (average for each calculation period) (Data: Fifth National Population Census (each province), *China Statistical Yearbook* (for each year))

(10) *Human capital agglomeration effect* : (a) *hca_ln_Averedu* ≡ Logarithmic value of average education x net immigration rate; (b) *hac_Percen.unv_empl_year* ≡ Proportion of university graduates within all employees × net immigration rate; (c) *hca_unv.s_year* ≡ Proportion of all students nationwide × net immigration rate.

Table 3 shows the basic statistics for each of the variables above.

(Table 3)

4.2 Estimation results

Table 4 contains data analysis relating to convergence using the ordinary least squares method.

(Table 4)

Tables 5 to 8 summarize the results of calculations using Barro Regression. Tables 5 and 6 are the results of calculation for periods 1979-2007 and 1987-2007. The former tests convergence between regions after reform, and the latter convergence between regions after the beginning of full-fledged inflow of foreign direct investment. Tables 7 and 8 show whether or not the "human capital agglomeration effect" can be shown. Following Tables 5a and 5b present whether or not convergence between regions can be seen.

(Table $5a$)

Columns (1) − (4) in Table 5a reports the results of calculation using the ordinary least squares method . We do not take account of human capital agglomeration in (1) − (3). In Column (1), we do not consider the differences in the levels of human capital between regions or regionality. Column (1) shows that absolute convergence in the period from 1979 to 2007 was very weak. We think that this reflects the fact that income inequality between regions in China reduced continuously from 1978, but then started expanding again from 1990, as shown in Figure 1.

In contrast, in the calculation results in (2) and (3) that take account of regionality (region dummy) and the level of human capital (level of average education) between regions, $\ln\_GRP_t$ coefficient calculation value, showing convergence, is at a significant level.

Column (4) shows the results re-estimated to evaluate the human agglomeration effect, but we do not consider the endogeneity of average education level. When we consider the "human capital agglomeration effect" ($hca\_\ln\_Averedu\_2000$), as shown in Column (4), the foreign trade effect (dependence on foreign trade) becomes also significant. This result shows conditional convergence since the reform and suggests that the human capital agglomeration effect ($hca\_\ln\_Averedu\_2000$) was in existence from the time of the reform until 2007, not just during the verification period (1991-2004).

In the ordinary least square calculations after Table 5, we test the potential for variable omission and multi-collinearity for the explanatory variables. The Ramsey Regression Equation Specification Error Test (RESET) and the Variance Inflation Factor (VIF) value are test-use specification tools for this context. For the results in columns (2) – (4), we concluded, using these tools, that there was no potential for variable omission or multi-collinearity.[18]

Table 5b summarizes the results of test for endogeneity about "average number of years in education" and using the instrumental variable method utilized in endogeneity tests.

(Table 5*b*)

Column (5) shows the results of endogeneity tests using instrumental variables. The Wu-Hausman F and Durbin-Wu-Hausman chi-sq tests test the null hypothesis that the average number of years in education is a exogenous variable in this paper. If this hypothesis is rejected (that is, if the exogeneity of the average number of years in education is rejected), then the number will be judged as a variable with endogeneity. Both tests show the null hypothesis is rejected at a significance level of 1% in column (5). Thus, we have to treat the average number of years in education in each region as a variable with endogeneity. Columns (6) and (7) summarize the results using the instrumental variable method for controlling the endogeneity. Unlike in (4), in columns (5) – (7), we take account of "$Percen\_unv\_empl\_99$" and of "$hac\_Percen\_unv\_empl\_9699$" which is its "human capital agglomeration effect." Columns (6) and (7) display the results of controlling the average number of years in education, and treating "$hca\_\ln\_Averedu\_2000$" and others as instrumental variables. These show the same results as in column (4) and a significant value for the "$hca\_Percen\_unv\_empl\_9699$" [19]is also obtained. The above calculation results can be summarized as follows. If the human capital agglomeration effect exsists, a large number of workers with high human capital will accumulate in the coastal regions (values in the "$hca\_\ln\_Averedu\_2000$" and "$\ln\_Averedu\_2000$" rows). This raises the level of workers' human capital

[18]The Ramsey RESET test is a null hypothesis test to check that a model has no omitted variables. For all calculation results in Table 5a Columns (2) - (4), the null hypothesis was not rejected. However, VIF value is a specification tool for testing multi-collinearity and, generally, if its value is 10 or lower, there is judged to be no multi-collinearity.

[19]"$hac\_Percenu\_nve\_mpl\_9699$" variable is taken to represent the synergy effect of the level of the human capital of the workers in each region and labor migration (net immigration rate).

in those regions ("*hca_Percen_unv_empl_9699*" calculation results), promotes trade in those regions, and gives rise to high economic growth. However, in other reagions where loose high skilled workers, their foreign trade effect becomes low and, accordingly, their economic growth is depressed. This result is also confirmed by the calculations for 1987-2007 and 1991-2007.

On the other hand, unlike Barro(1997), investment rates shown in columns (2) – (7) are not statistically significant, but the (positive) calculation results for government spending as a proportion of Gross Regional Product are significant in all cases. These results make sense since the effectiveness of investment in most Chinese regions was low[20] and infrastructure investment to promote economic growth was included in Chinese regional government consumption. [21]

Table 6 also summarizes results verifying convergence between Chinese regions, considering the foreign direct investment effect.

(Table 6a)

(Table 6b)

The results in Table 6 are very similar to those in Table 5. However, the FDI effect (*fdi_Y_9104*) is not significant in all cases. Unlike in Table 5, in Table 6b, all (positive) values obtained for *hac_Percen_unv_empl_9699* (the agglomeration effect for the level of workers' human capital) are significant.

(Table 7a)

(Table 7b)

(Table 8)

Table 7 shows the results for the main hypothesis of this paper. The results resemble those in Tables 5 and 6, apart from the lack of significance in the results of the human capital agglomeration effect ("*Percen_unv_empl_9699*" and "*hac_Percen_unv_empl_9699* "). However, when we extend the hypothesis period to 2007, as shown in Figure 8, the "human capital agglomeration effect" becomes significant.

5 Conclusions and Remarks

In this paper, using Barro Regression, we test the hypothesis that the human capital agglomeration effect can explain income inequality between coastal and internal regions in China. First, there was no

[20]The average investment rate for Chinese regions in that period was 42.98% and the average growth rate was 8.96%, giving a high (average) marginal capital coefficient of 4.9 (Qinghai Province 13.2, Jiangxi Province, 9.9, and Gansu Province 7.9). This shows that the effectiveness of investment was poor. Incidentally, the correlation coefficient of the investment rate and growth rate for this period is 0.0883, implying almost no correlation.

[21]It is thought that government consumption expenditure spending within Chinese expenditure-based Gross Regional Product also includes government public investment.

significant absolute β-convergence in any of the estimated periods. Second, when the human capital agglomeration effect was taken into account, conditional convergence was seen, and the foreign trade effect, which develops regional economy, is also significant. These empirical results show that if human capital agglomeration exsists, workers with a high human capital accumulate in the coastal regions, encouraging trade and production activity at overseas-owned companies in those regions. This can promote economic growth. However, regions which lose workers with a high human capital and benefit little from foreign direct investment, in turn depress the economic growth. This effect can explain income inequality between regions during the period.

We need to test our hypothesis over a longer time, to show the reason why income inequality between regions in China. Thus, further research must be conducted using panel analysis and other methods

References

[1] Barro,Robert J., and Xavier Sala-iMartin(992),"Convergence,"*Journal of Political Economy*, 100, April, 223-251.

[2] Barro,Robert J.,and Jong-Wha Lee(1994), "Sources of Economic Growth," *Carnegie-Rochester Conference Series on Public Policy.*

[3] Barro, Robert J. (1997), *Determinants of Economic Growth: A Cross-Country Empirical Study* (Lionel Robbins Lectures),The MIT Press.

[4] Barro,Robert, Xavier Sala-iMartin(2004), *Economic Growth* (Second Edition),New York: MacGraw-Hill.

[5] Cai Fang and Du Yang(2000) "Convergence and Differences in the Growth of China's Regions-Enlightenment from the development strategy of the western region,"*Economic Research Journal*,No. 10.

[6] Chen Guanghui (2000a), "Long-term analysis of income inequality between provinces in China,",*International research journal,* Takushoku University international development research center 2(3),33-41. (Japanese)

[7] Chen Guanghui(2000b),"'Analysis of incomes between provinces in China after the onset of reform and convergence hypotheses,"*Journal of Economics and Business Administration*, Kobe University, Research Institute for Economics and Business Administration, 181, (6) 89-100. (Japanese)

[8] Department of Comprehensive Statistics of National Bureau of Statistics(2010), *China Compendium of Statistics 1949-2008.*

[9] Etsuro, Shioji (2000),"Japanese regional income convergence and social capital,", *Macroeconomics of cycles and growth*, Chapter 8, University of Tokyo Press.(Japanese)

[10] Jian,Tianlun, Jeffery D.Sacks, and Andrew M, Warner(1999),"Trends in Regional Inequality in China," *NBER working paper*,No.5412.

[11] Lin Yifu and Liu Mingxing(2003),"China's Growth Convergence and Income Distribution," *World economy*, January(Chinese)

[12] Mizuho Research Institute(2004), "Economic and industrial characteristics and investment environment of Zhejiang Province, China," Mizuho Asia Insight (Feb 20) (http://www.mizuho-ri.co.jp/publication/research/pdf/asia-insight/asia-insight040220.pdf)(Japanese)

[13] Nakazato, Touro(1999),'"Public investment and regional economic growth," *Japan Economic Research Institute,* No.39. 8.(Japanese)

[14] Population Censun Office Under The State Council Department of Populaton and Employment Statistics National Bureau of Statistics(2010),T*abulation on the 2010 population census of the People's Republic of China by county.*

[15] Quah, Danny T(996), "Twin Peaks: Growth and Convergence in Models of Distribution Dynamics," *Economic Journal*, Royal Economic Society, vol. 106(437),1045-55.

[16] World Bank(1997), "Sharing Rising Incomes: disparities in China", *China 2020 series*. Washington D.C.

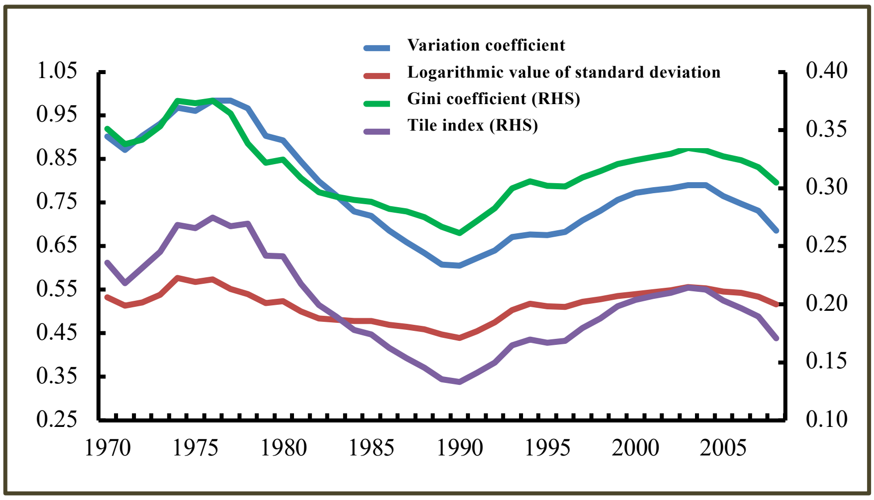
[17] Wang, Zhen(2006)" Changes for farmers in the Chinese industrialization process – comparison using local surveys in Shanghai Municipality and Anhui Province"', *Globalization and marketization of the Chinese economy*, Chapter 4, Koyo Shobo (Japanese)

[18] Yan Shanping(2004), '"Ppopulation mobility between provinces in China and their determining factors – quantitative analysis using population census collected data," *Asian Economy*. (Japanese)

[19] Yan Shanping(2005), *Chuugoku no jinkouidou to minkou*, Keiso Shobo. (Japanese)

[20] Zhang,Junkuo(2007),"New trends in Chinese regional economic development,"(Translated by Feng, Xi), *The 22nd Economic Research Center and KITAN International Symposium. (Japanese)*

Figure 1: Trends in income inequality between regions in China（1970－2008）



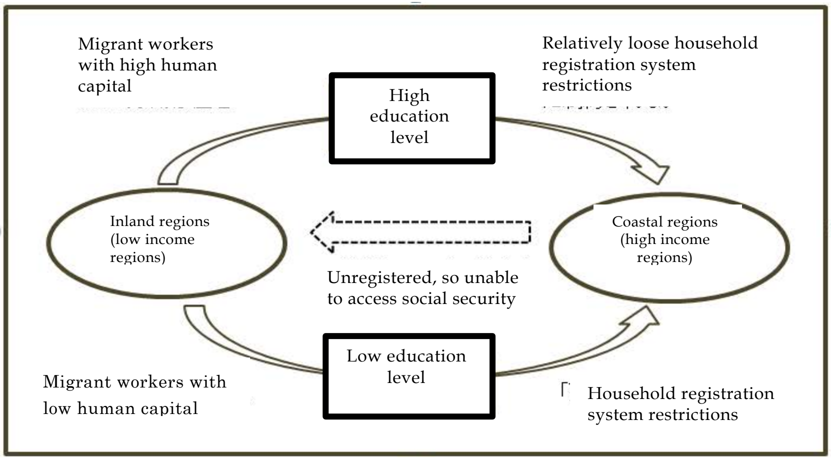
Source: Compiled from *China Compendium of Statistics 1949-2008* (National Bureau of Statistics of China)

Table 1: Trends in China's fluid population (1982－2010)

Financial term	Fluid population (mn people)	Increase (mn people)	Increase (times)	Average growth rate （%）	Source
1982	6.57				Third nationwide population census [a]
1990	33.84	27.27	5.2	22.7	Fourth nationwide population census
1995	60.17	26.33	1.8	7.5	Nationwide 1% population census
2000	144.39	84.22	2.4	11.6	Fifth nationwide population census
2005	147.35	2.96	1.0	0.3	Nationwide 1% population census
2010	261.39	114.04	1.8	7.4	Fifth nationwide population census

Source: Compiled from Cao, 2004 (1982), Gen 2005, (1990, 1995), and official nationwide population census papers by the Chinese government (2000 and later). Cao, Xin (2004), *Gendai chuugoku ryuudou jinkou kenkyuu (Current Chinese fluid population research),* Beijing Municipality website, social science planning （http://www.bjpopss.gov.cn/bjpssweb/n10513c48.aspx）

Figure 2: Human capital agglomeration effect hypothesis



Source: compiled by the authors

Table 2a: Statistical indicators related to "human capital agglomeration effect" (central western regions)

	①Ave. growth rate (%)	Nationwide ranking	② Graduate ratio (%)	Nationwide ranking	③Graduate employee ratio (%)	Nationwide ranking	④Net immigration rate (%)	Nationwide ranking	⑤Per-capita GRP (RMB)	Nationwide ranking
Sichuan Province	8.51	18	6.17	3	2.33	22	-56.81	27	7,895	26
	-0.55		2.73		-2.24		-49.84		-6,169	
Hubei Province	8.23	22	5.57	4	3.84	12	-19.04	22	9,898	17
	-0.83		2.13		-0.73		-12.07		-4,166	
Henan Province	10.19	8	4.74	8	2.20	24	-44.30	25	9,201	19
	1.13		1.30		-2.37		-37.33		-4,863	
Hunan Province	9.22	13	4.54	11	2.63	19	-59.33	28	9,165	21
	0.16		1.10		-1.94		-52.36		-4,899	
Shaanxi Province	8.47	20	4.25	12	3.69	15	-7.57	18	8,587	23
	-0.59		0.82		-0.87		-0.60		-5,477	
Nationwide average	9.06		3.44		4.57		-6.97		14,064	

Note: **Bold** font shows each indicator's deviation (deviation from the average). ① Average growth rate: 1991-2004; source: *China Compendium of Statistics 1949-2008*; ② Proportion of region's graduates within all graduates nationwide (graduate ratio): 1995-2000; source: *China Statistical Yearbook* (for each year); ③ Graduates as a proportion of all employees in the region (graduate employee ratio): 1996-1999; source: *China Labour Statistical Yearbook* (for each year) and *China Statistical Yearbook* (for each year); ④ Net immigration rate: 1995-2000; source: official Chinese government population census paper (1995 and 2000); ⑤ Per-capita Gross Regional Product: 2004; source: *China Compendium of Statistics 1949-2008.*

Table 2b: Statistical indicators related to "human capital agglomeration effect" (Coastal regions)

	①Ave. growth rate (%)	Nationwide ranking	② Graduate ratio (%)	Nationwide ranking	③Graduate employee ratio (%)	Nationwide ranking	④Net immigration rate (%)	Nationwide ranking	⑤Per-capita GRP (RMB)	Nationwide ranking
Zhejiang Province	11.86	1	3.10	16	2.93	18	1.19	14	24,352	4
	2.80		-0.33		-1.63		8.16		10,288	
Jiangsu Province	11.08	2	7.67	1	3.74	13	10.14	11	20,223	6
	2.02		4.24		-0.83		17.11		6,159	
Tianjin Province	10.61	3	2.31	20	8.91	3	27.60	5	30,575	3
	1.56		-1.12		4.34		34.57		16,511	
Beijing Municipality	10.01	9	5.53	6	19.81	1	46.74	2	41,099	2
	0.95		2.10		15.25		53.71		27,035	
Guangdong Province	9.60	11	4.87	7	4.27	11	49.50	1	20,870	5
	0.54		1.43		-0.29		56.47		6,806	
Shanghai Municipality	9.52	12	4.61	9	13.15	2	37.40	4	46,755	1
	0.46		1.17		8.58		44.37		32,691	
Nationwide average	9.06		3.44		4.57		-6.97		14,064	

Note: **Bold** font shows each indicator's deviation (deviation from the average). ① Average growth rate: 1991-2004; source: *China Compendium of Statistics 1949-2008*; ② Proportion of region's graduates within all graduates nationwide (graduate ratio): 1995-2000; source: *China Statistical Yearbook* (for each year); ③ Graduates as a proportion of all employees in the region (graduate employee ratio): 1996-1999; source: *China Lab our Statistical Yearbook* (for each year) and *China Statistical Yearbook* (for each year); ④ Net immigration rate: 1995-2000; source: official Chinese government population census paper (1995 and 2000); ⑤ Per-capita Gross Regional Product: 2004; source: *China Compendium of Statistics 1949-2008.*

Table 3: Basic statistics for each var iable

	Obs	Mean	Std. Dev.	Min	Max
$\mathit{G\_}_{9107}$	29	0.102	0.014	0.077	0.129
$\mathit{ln\_GRP\_}_{91}$	29	6.347	0.469	5.622	7.628
$\mathit{G.cons.\_Y\_}_{9107}$	29	0.154	0.085	0.102	0.574
$\mathit{I\_Y\_}_{9107}$	29	0.447	0.077	0.266	0.635
$\mathit{trade\_Y\_}_{9107}$	29	0.034	0.050	0.000	0.175
$\mathit{fdi\_Y\_}_{9107}$	29	0.002	0.005	0.000	0.024
$\mathit{ln\_fer\_}_{91}$	29	-1.770	0.310	-2.551	-1.409
Dummy_Region	29	0.345	0.484	0.000	1.000
Nmig_{9500}	29	-0.072	0.353	-0.837	0.495
$\mathit{ln\_Averedu\_}_{2000}$	29	2.039	0.103	1.816	2.301
$\mathit{unv.s}_{9506}$	29	0.034	0.019	0.003	0.077
$\mathit{Percen.unv\_empl}_{9699}$	29	0.046	0.039	0.010	0.198

Table 5a: Measurement of convergence in 1979-2007

(Dependent variable: average growth rate of per-capita GRP in the period; Independent variable: level of each variable)

	(1)	(2)	(3)	(4)
const.	0.130***	0.168***	0.066**	0.083***
	0.000	**0.000**	**0.018**	**0.003**
ln_GRP_79	-0.009*	-0.017***	-0.030***	-0.034***
	0.079	**0.006**	**0.000**	**0.000**
G.cons._Y_7907		0.040**	0.036***	0.031***
		0.011	**0.001**	**0.002**
I_Y_7907		-0.017	-0.003	-0.015
		0.499	**0.827**	**0.315**
trade_Y_7907		0.037	0.074	0.080*
		0.585	**0.107**	**0.052**
ln_fer_79		-0.0003	0.001	-0.003
		0.982	**0.850**	**0.611**
Dummy_Region		0.020 ***	0.018***	0.014***
		0.000	**0.000**	**0.000**
ln_Averedu_2000			0.086***	0.087***
			0.000	**0.000**
hca_ ln_Averedu_2000				0.005**
				0.028
R^2	0.133	0.743	0.899	0.928
Adj.R^2	0.094	0.653	0.855	0.889
Ramsey RESET test		F(3, 14) =1.15 Prob > F =0.363	F(3, 13) =0.29 Prob > F =0.829	F(3, 12) =0.38 Prob > F =0.766
VIF (Mean,Max)		2.1, 3.3	2.5, 5.4	2.8, 6.1
Observations	24	24	24	24

Note: **Bold** type where P（>|t|), *** and ** show significance levels of 1% and 5%, respectively

Table 5b: Measurement of convergence in 1979-2007

(Dependent variable: average growth rate of per-capita GRP in the period; Independent variable: level of each variable)

	(5) IV	(6) 2SLS	(7) GMM
const.	0.065	0.053*	0.025
	0.138	**0.082**	**0.492**
ln_GRP_79	-0.029***	-0.028***	-0.027***
	0.001	**0.000**	**0.000**
G.cons._Y_7907	0.038***	0.037***	0.033**
	0.004	**0.000**	**0.000**
I_Y_7907	-0.003	-0.005	-0.002
	0.897	**0.690**	**0.898**
trade_Y_7907	0.069	0.059*	0.075***
	0.181	**0.095**	**0.002**
ln_fer_79	0.003	-0.0004	0.001
	0.761	**0.949**	**0.786**
Dummy_Region	0.018***	0.016***	0.014***
	0.000	**0.000**	**0.000**
ln_Averedu_2000	0.084***	0.087***	0.104***
	0.002	**0.000**	**0.000**
Percen.unv_empl_99	-0.004	-0.120	-0.219**
	0.965	**0.171**	**0.028**
hac_Percen.unv_empl_9699		0.241*	0.339***
		0.062	**0.008**
unv.s_2005	0.027	0.039	0.007
	0.781	**0.565**	**0.908**
Instrumented:	ln_Averedu_2000	ln_Averedu_2000	ln_Averedu_2000
Instruments:	hca_ Averedu Nmig_t and others	hca_ Averedu Nmig_t and others	hca_ Averedu Nmig_t and others
R^2	0.900	0.913	0.902
Wu-Hausman F test:	8.68 F(1,13) P-value = 0.011		
Durbin-Wu-Hausman chi-sq test:	9.61 Chi-sq(1) P-value =0.002		
Tests of overidentifying restrictions:		Basmann chi2(2)= 3.90(p = 0.14)	Hansen's J chi2(2) = 3.70 (p = 0.16)
Observations	24	24	24

Note: (a) **Bold** type where P (>|t|) , *** and ** show significance levels of 1% and 5%, respectively

Table 6a: Measurement of convergence in 1987-2007

(Dependent variable: average growth rate of per-capita GRP in the period; Independent variable: level of each variable)

	(1)	(2)	(3)	(4)
const.	0.082***	0.154***	0.097***	0.102**
	0.004	**0.000**	**0.007**	**0.010**
ln_GRP_87	0.0006	-0.010*	-0.023***	-0.024***
	0.896	**0.080**	**0.002**	**0.004**
G.cons._Y_8707		0.053***	0.055***	0.053***
		0.006	**0.002**	**0.003**
I_Y_8707		-0.024	-0.025	-0.030
		0.268	**0.179**	**0.180**
trade_Y_8707		0.055	0.057	0.059
		0.273	**0.193**	**0.188**
fdi_Y_8707		0.464	0.511	0.467
		0.226	**0.129**	**0.192**
ln_fer_87		0.007	0.007	0.007
		0.483	**0.461**	**0.480**
Dummy_Region		0.014***	0.015**	0.014***
		0.006	**0.001**	**0.004**
ln_Averedu_2000			0.066***	0.069**
			0.010	**0.011**
hca_ ln_Averedu_2000				0.001
				0.680
R^2	0.0006	0.591	0.709	0.712
Adj.R^2	-0.0364	0.455	0.593	0.575
Ramsey RESET test		F(3, 18) = 1.53 Prob > F = 0.240	F(3, 17) = 0.26 Prob > F = 0.855	F(3, 16) = 0.16 Prob > F = 0.924
VIF(Mean,Max)		2.0, 3.3	2.5, 6.2	2.8, 6.1
Observations	29	29	29	29

Note: **Bold** type where P (>|t|), *** and ** show significance levels of 1% and 5%, respectively

Table 6b: Measurement of convergence in 1987-2007

(Dependent variable: average growth rate of per-capita GRP in the period; Independent variable: level of each variable)

	(5) IV	(6) 2SLS	(7) GMM
const.	-0.032	-0.032	-0.028
	0.462	**0.340**	**0.490**
ln_GRP_87	-0.011*	-0.011**	-0.012**
	0.086	**0.021**	**0.018**
G.cons._Y_8707	0.052***	0.052***	0.049***
	0.000	**0.000**	**0.000**
I_Y_8707	-0.003	-0.003	0.003
	0.877	**0.842**	**0.819**
trade_Y_8707	0.104**	0.104***	0.103***
	0.016	**0.001**	**0.000**
fdi_Y_8707	0.143	0.143	0.194
	0.631	**0.259**	**0.249**
ln_fer_87	0.007	0.007	0.006
	0.385	**0.259**	**0.438**
Dummy_Region	0.007*	0.007**	0.007*
	0.073	**0.016**	**0.075**
ln_Averedu_2000	0.100***	0.100***	0.098***
	0.000	**0.000**	**0.000**
Percen.unv_empl_9699	-0.448***	-0.448***	-0.437***
	0.003	**0.000**	**0.000**
hac_Percen.unv_empl_9699	0.369*	0.369***	0.364**
	0.051	**0.008**	**0.010**
Instrumented:	ln_Averedu	ln_Averedu	ln_Averedu
Instruments:	hca_ Averedu Nmig_t and others	hca_ Averedu Nmig_t and others	hca_ Averedu Nmig_t and others
R^2	0.828	0.828	0.826
Wu-Hausman F test:	6.63 F(1,17) P-value =0.0197		
Durbin-Wu-Hausman chi-sq test:	8.13 Chi-sq(1) P-value = 0.0043		
Tests of overidentifying restrictions:		Sargan (score) chi2(3)=1.98 (p = 0.58)	Hansen's J chi2(3) = 1.96 (p = 0.58)
Observations	29	29	29

Note: **Bold** type where P (>|t|), *** and ** show significance levels of 1% and 5%, respectively

Table 7a: Measurement of convergence in 1991-2004

(Dependent variable: average growth rate of per-capita GRP in the period; Independent variable: level of each variable)

	(1)	(2)	(3)	(4)
const.	0.030	0.152***	0.098*	0.081
	0.368	**0.003**	**0.051**	**0.206**
ln_GRP_91	0.0095*	-0.014	-0.030**	-0.025
	0.076	**0.155**	**0.013**	**0.111**
G.cons._Y_9104		0.047*	0.048**	0.050**
		0.054	**0.033**	**0.035**
I_Y_9104		-0.026	-0.027	-0.020
		0.358	**0.288**	**0.515**
trade_Y_9104		0.073	0.091	0.081
		0.353	**0.207**	**0.289**
fdi_Y_9104		0.310	0.411	0.449
		0.535	**0.369**	**0.347**
ln_fer_91		-0.012	-0.009	-0.009
		0.319	**0.413**	**0.457**
Dummy_Region		0.019***	0.021***	0.021***
		0.010	**0.003**	**0.003**
ln_Averedu_2000			0.078**	0.071*
			0.029	**0.072**
hca_ ln_Averedu_2000				-0.003
				0.669
R^2	0.112	0.539	0.639	0.642
$Adj.R^2$	0.080	0.386	0.494	0.473
Ramsey RESET test		F(3, 18) = 0.84 Prob > F = 0.488	F(3, 17) = 0.32 Prob > F = 0.809	F(3, 16) = 0.31 Prob > F = 0.819
VIF (Mean,Max)		2.7, 5.1	3.2, 8.2	4.4, 15.0
Observations	29	29	29	29

Note: **Bold** type where P (>|t|), *** and ** show significance levels of 1% and 5%, respectively

Table 7b: Measurement of convergence in 1991-2004

(Dependent variable: average growth rate of per-capita GRP in the period; Independent variable: level of each variable)

	(5) IV	(6) 2SLS	(7) GMM
const.	0.006	0.0004	-0.014
	0.943	**0.994**	**0.819**
ln_GRP_91	-0.023*	-0.023**	-0.025***
	0.093	**0.025**	**0.002**
G.cons._Y_9104	0.044*	0.043**	0.036***
	0.062	**0.011**	**0.000**
I_Y_9104	-0.005	-0.007	0.009
	0.867	**0.759**	**0.723**
trade_Y_9104	0.156	0.146**	0.113**
	0.100	**0.043**	**0.040**
fdi_Y_9104	0.442	0.340	0.228
	0.412	**0.452**	**0.476**
ln_fer_91	-0.010	-0.011	-0.012*
	0.349	**0.195**	**0.067**
Dummy_Region	0.015**	0.015***	0.020***
	0.045	**0.009**	**0.010**
ln_Averedu_2000	0.102**	0.105***	0.117***
	0.015	**0.001**	**0.000**
Percen.unv_empl_9699	-0.194	-0.262*	-0.252
	0.144	**0.098**	**0.126**
hac_Percen.unv_empl_9699	-0.102	0.126	0.082
	0.521	**0.581**	**0.686**
unv.s_9500	-0.102	-0.081	-0.130
	0.521	**0.524**	**0.217**
Instrumented:	ln_Averedu	ln_Averedu	ln_Averedu
Instruments:	hca_ Averedu Nmig_t and others	hca_ Averedu Nmig_t and others	hca_ Averedu Nmig_t and others
R^2	0.680	0.684	0.646
Wu-Hausman F test:	14.65 F(1,17) P-value = 0.001		
Durbin-Wu-Hausman chi-sq test:	13.42 Chi-sq(1) P-value =0.000		
Tests of overidentifying restrictions:		Sargan (score) chi2(4) = 4.41 (p = 0.35)	Hansen's J chi2(4) =4.27 (p = 0.37)
Observations	29	29	29

Note: **Bold** type where P (>|t|), *** and ** show significance levels of 1% and 5%, respectively

Table 8: Measurement of convergence 1991-2007

(Dependent variable: average growth rate of per-capita GRP in the period; Independent variable: level of each variable)

	(5) IV	(6) 2SLS	(7) GMM
const.	-0.054	-0.054	-0.082*
	0.540	**0.400**	**0.081**
ln_GRP_91	-0.021	-0.021**	-0.027***
	0.138	**0.036**	**0.000**
G.cons._Y_9107	0.080***	0.080***	0.066***
	0.003	**0.000**	**0.000**
I_Y_9107	0.022	0.022	0.056**
	0.502	**0.355**	**0.019**
trade_Y_9107	0.169*	0.169***	0.155***
	0.055	**0.005**	**0.000**
fdi_Y_9107	0.940	0.940*	1.061***
	0.179	**0.058**	**0.000**
ln_fer_91	-0.014	-0.014*	-0.014***
	0.184	**0.062**	**0.001**
Dummy_Region	0.011	0.011**	0.009**
	0.169	**0.052**	**0.018**
ln_Averedu_2000	0.120***	0.123***	0.150***
	0.005	**0.000**	**0.000**
Percen.unv_empl_9699	-0.357	-0.357**	-0.386***
	0.144	**0.039**	**0.000**
hac_Percen.unv_empl_9699	0.291	0.291	0.352*
	0.489	**0.340**	**0.051**
unv.s_9006	-0.098	-0.098	-0.119
	0.576	**0.442**	**0.203**
Hca_unv.s_9006	-0.380	-0.380*	-0390***
	0.216	**0.083**	**0.000**
Instrumented:	ln_Averedu	ln_Averedu	ln_Averedu
Instruments:	hca_ Averedu Nmig_t and others	hca_ Averedu Nmig_t and others	hca_ Averedu Nmig_t and others
R^2	0.748	0.748	0.697
Wu-Hausman F test:	8.679 F(1,15) P-value = 0.01		
Durbin-Wu-Hausman chi-sq test:	10.63 Chi-sq(1) P-value = 0.00		
Tests of overidentifying restrictions:		Sargan (score) chi2(5) = 8.35 (p = 0.14)	Hansen's J chi2(5) = 5.19 (p = 0.39)
Observations	29	29	29

Note: **Bold** type where P (>|t|), *** and ** show significance levels of 1% and 5%, respectively