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Output Convergence among Provinces in Thailand

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Abstract

This paper investigates per capita output convergence among provinces in Thailand. We find that in the aggregate level, per capita output of provinces in Thailand diverges. However, there is convergence among groups of rich provinces. We then investigate factors that contribute to convergence. We find that factors that positively affect convergence are average output and diversity of production structure. We find that the output of provinces that close to each other tends to diverge faster than that of provinces that are far apart.

บทคัดย่อ

บทความนี้ศึกษาการลู่เข้าของระดับผลผลิตต่อหัวของจังหวัดในประเทศไทย ผลการศึกษาพบว่าในภาพรวมระดับผลผลิตของจังหวัดในประเทศไทยมีลักษณะลู่ออกจากกัน แต่เมื่อพิจารณาในกลุ่มจังหวัดที่มีระดับผลผลิตสูงจะพบว่าผลผลิตของจังหวัดในกลุ่มนี้มีลักษณะลู่เข้าหากัน นอกจากนี้ผู้วิจัยยังได้ศึกษาถึงปัจจัยที่ส่งผลให้ผลผลิตของกลุ่มจังหวัดลู่เข้าหากัน ผลการศึกษาพบว่าปัจจัยที่ส่งผลทางบวกต่อการลู่เข้าหากันของผลผลิตของกลุ่มจังหวัด ได้แก่ ผลผลิตเฉลี่ยของกลุ่มจังหวัดและความแตกต่างของโครงสร้างการผลิตในกลุ่ม นอกจากนี้ยังพบว่าผลผลิตของจังหวัดที่อยู่ใกล้กันมีแนวโน้มที่จะลู่ออกจากกันมากกว่าจังหวัดที่อยู่ไกลกัน

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1. Introduction

A big question in economics is whether the income of rich and poor economies converges or diverges in the long run. If it converges, the poor will catch up the rich and inequalities among nations would eventually disappear. On the contrary, if it diverges, the gap between the poor and the rich would increase indefinitely.

For Thailand, the convergence question is also important to Thai policy makers. Since the implementation of 7^{th} National Economic and Social Development Plan in 1987, the government has focused on policies to promote economic development in rural areas and alleviate disparities among urban and rural economies.

In this paper, we will test whether per capita output of Thai provinces converges or not using annual data during 1981-2005. Moreover, we also search for the potential determinants of convergence/divergence. The paper is organized as follows. Related literature is reviewed in Section 2. Empirical models are discussed in Section 3. Then the estimation results are presented in Section 4-5. Section 6 concludes.

2. Related Literature

2.1 Theory

Neoclassical Models

Theoretical research on convergence has started since Solow's seminal paper in 1956. Under the neoclassical growth models with constant-returns production functions, initially with small amount of capital, an economy grows very fast. As capital gets accumulated and its productivity is diminished, the economy then grows at a slower rate and eventually reaches its steady state with a zero growth rate. The phenomenon implies that (i) poor economies grow faster than riches economies (often called β convergence) and (ii) income inequality among economies would decrease overtimes (often called σ convergence). Figures 1 and 2 depict β convergence. Figure 3 depicts σ convergence.

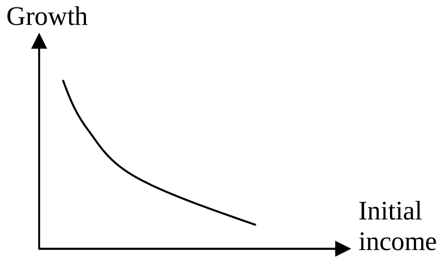

Figure 1

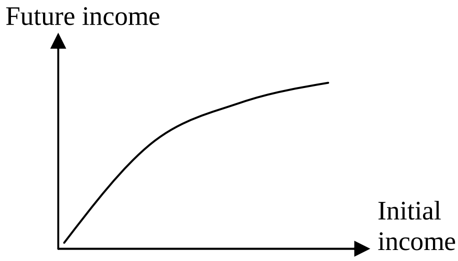

Figure 2

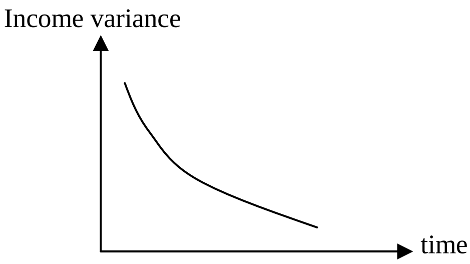

Figure 3

Increasing-Returns Models

The convergence results in neoclassical growth models are driven by constant-returns-to-scale production functions. Although empirical evidences using country-level data are consistent with constant returns production functions, evidences using city-level data seem to support increasing returns.[2]

Models with increasing-returns production functions tend to produce income divergence across regions. Classic examples of these models are Krugman (1991) and Krugman and Venables (1995). Recently, Rossi-Hansberg and Wright (2007) propose a tractable general equilibrium model that reconciles increasing returns in local level and constant returns in the aggregate level.

[2] For example Basu and Fernald (1997) and Gabaix (1999).

2.2 Empirical

Empirical research on convergence was launched in 1980s. Baumol (1986) is the first to empirically test the convergence hypothesis. Baumol uses simple regressions to test whether there is negative correlation between the growth rate of each country and its initial income level, using cross country data during 1870-1979. He found that there was remarkably convergence among the groups of market industrialized economies and planned economies. However, no evidence of convergence was found in the group of developing economies. DeLong (1988) comments that there is a biased in the sample selected in Baumol and the result might be spurious. Mankiw, Romer and Weil (1992) use a cleaner international data during 1960-1985 to perform a direct estimate of the Solow growth model. They show that the augmented Solow model with human capital well fit the data. They find that there is evidence on unconditional convergence only for the OECD countries. However, the data supports convergence only when controlling investment rates and population growth. Similar results on conditional convergence are found in Sala-i-Marin (1995). Up to now, it is a consensus that there is no absolute convergence among large samples of countries. However, there exists convergence in groups of rich countries.

While the studied mentioned above employs cross-country data, Barro and Sala-i-Martin (2004) uses data of U.S. states during 1983-1996 and Japanese prefecture during 1930 to 1990. They find a strong support for convergence.

The studies discussed above mainly focus on the question whether poor countries grow faster than rich countries. Another approach is to focus on σ convergence and to test whether the variance of cross-country income decreases overtime or not. As one will see in subsequent sections, an advantage of this approach is that it is possible to control for group characteristics and investigate the characteristics that might determine convergence in each group. Ben-David (1994) is the first who implements this approach. He estimates and compares the rate of convergence of European Economic Community (ECC) during 1900-1933 and 1951-1985. The period 1951-1985 is considered a trade liberalization period of ECC. He finds that the convergence rate of ECC during 1951-1985 is much higher than that during 1900-1933. This result hints that there is a causal link between trade and convergence in EEC. Using panel data of 25 richest countries for the period 1960 to 1988, Ben-David (1996) estimates and compares convergence rates among trade groups and random groups with various sizes. According to his criteria, if country *i* exported or imported more than 4 percent of its total exports or imports in the last year of the sample to country *j*, country *j* will be part of country *i*'s trade group. The estimates show that a trade group tends to converge faster than a random matched group of the same size. This evidence indicates a positive trade-convergence relationship. However the result from this paper is not sufficient to show either that trade causes convergence, or that countries trade with one another as their income gaps decrease.

3. Empirical Models and Data

In this section, we present the empirical models. Sections 3.1 and 3.2 discuss the models for β convergence and σ convergence, respectively. Section 3.3 discuss data sources for estimation.

3.1 β *convergence*

To test the β convergence hypothesis, the following equation will be estimated

$$\ln(y_{i,T}) = \beta_1 + \beta_2 \ln(y_{i,0}) + \varepsilon_i \qquad (1)$$

where $y_{i,t}$ is the log of per capita output of province *i* in period *t*. Subscripts 0 and *T*, respectively, denotes the first year and the last year in the data set. This equation was first estimated in Mankiw, Romer and Weil (1992). β's are constant coefficients. ε_i is a disturbance term. Note that (1) is equivalent with the following equation:

$$\ln(\frac{y_{i,T}}{y_{i,0}}) = \alpha_1 + \alpha_2 \ln(y_{i,0}) + \varepsilon_i .$$

where $\alpha_1 = \beta_1$ and $\alpha_2 + 1 = \beta_2$. Convergence is implied if $-1 < \alpha_2 < 0$ or $0 < \beta_2 < 1$. Although (1) is intuitive and widely used in literature, its shortcoming is that it is not appropriate for investigating what factor contributes to convergence or divergence. To resolve this problem, the test for σ *convergence* is proposed.

3.2 σ convergence and its determinants

As mentioned earlier, σ *convergence* implies that the variance of output of provinces decreases over time. The following equation:

$$\sigma_{i,T}^2 = \alpha_1 \sigma_{i,0}^2 + \varepsilon_i \qquad (2)$$

is used to test σ convergence, where $\sigma_{i,t}^2$ is the variance of log per capita output of provinces in group *i* in period *t*.[3] Subscripts 0 and *T* denote the first period and the last period in the data set, respectively. As shown in Barro and Sala-i-Martin (1992), this equation can be derived from the Solow model with stochastic technology shocks. In order to test for determinants of convergence, we modify Equation (2) as follows:

$$\sigma_{i,T}^2 = (\alpha_1 + \alpha_2 X_{2i} + \alpha_3 X_{3i} + \ldots + \alpha_k X_{ki})\sigma_{i,0}^2 + \varepsilon_i \qquad (3)$$

where X_{ji}, $j \in \{2,3,..,k\}$, is a potential determinant for output convergence in group *i* suggested by economic theories such as average distance of provinces in the group. If X_{ji} causes output *convergence* (resp. divergence), the sign α_j will be significantly *negative* (resp. *positive*).

3.3 Data Sources

Annual data on gross provincial product (GPP) and its sectoral components, and population during 1980-2005 are from National Statistics Office of Thailand (NSO).[4] Throughout this paper, we use GPP as a proxy for provincial output. Data on output and population is in logs.

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[3] Note that the value of the variance of *log*(*x*) is independent of the unit of *x*.

[4] In principle, to test convergence, it would be more appropriate to use data of actual economic regions such as cities or urban areas rather than provinces which are government administrative divisions. However, data on output of cities in Thailand is not available. We therefore use provinces as a proxy for cities.

Data on migration among Thai provinces during 1996-2000 is also collected from National Statistical Office. Data on distances in kilometer between Thai provinces is from the Department of Land Transportation.

3.4 Measurement Errors

As pointed out in Barro and Sala-i-Martin (2003), using the national deflator as the deflator for each province might cause measurement errors in the level of real output. Barro and Sala-i-Martin (2003, table 11.1) try to correct these errors by using instrumental variables. However, their estimates using instrumental variables are not significantly different from those using simple OLS. They conclude that the measurement errors do not play an important role in the estimation results. Given such result, we assume that measurement errors are negligible and the OLS estimator is reliable.

4. Empirical Results

4.1 Preliminary Plots

Before reporting formal estimation results, we show few data plots. Figure 4 shows the plot of the output of each province in 1981 with that in 2005. The figure shows some positive correlation between output of each province in 1981 and that in 2005. In the Solow model, convergence implies that the future output of each province is increasing and concave in its initial output. However, Figure 5 does not support this relationship.

Figure 4: Output in 1981 and 2005[5]

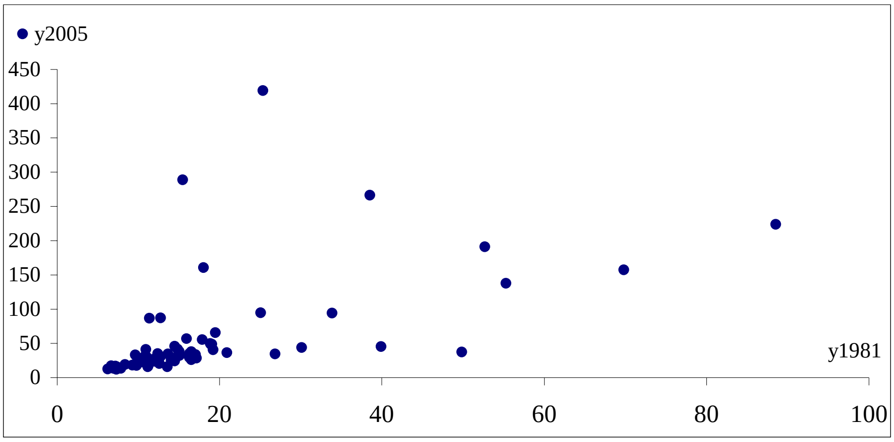
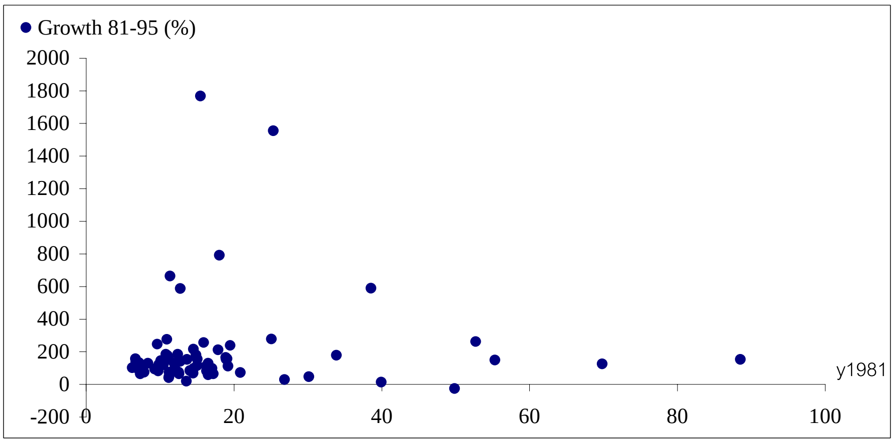


Figure 5: Growth Rates and Initial Output



The plot of the growth rate of each province during 1981-2005 with its initial output is shown in Figure 5. The scattered plot exhibits some weak positive relationship between initial output and growth rates. Provinces with high initial output tend to grow faster than those with low initial output. Obviously, the plot contradicts with the convergence hypothesis.

[5] Output in Figures 4 and 5 are in unit of 10,000 baht in 1985.

The variances of gross provincial product of provinces of Thailand in 1981-2005 are shown in Figure 6. They fluctuate considerably with a positive trend. Figure 7 shows the variances of log of provincial population during 1981-2005. In contrast to the output variances, the population variances are pretty smooth and exhibit a negative trend. The negative trend in the population variances indicates that in terms of population, big provinces or cities grow slower than small provinces. As one can see, the population variances have a sharp drop in 1997 because people migrate from big cites back to rural areas as a consequence of the Asian economic crisis. Figure 8 shows the variances of log of per capita output of Thai provinces in 1980-2005. The figure shows that the variances have been increasing.

Figure 6: Variance of Log GPP

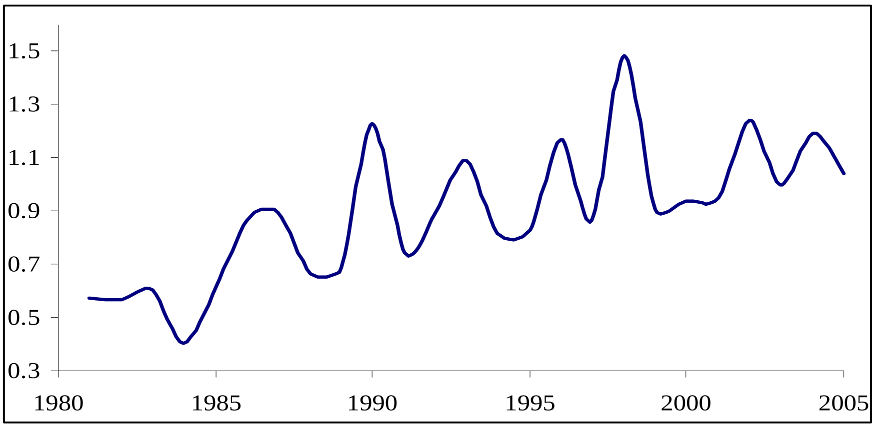


Figure 7: Variance of Log Population

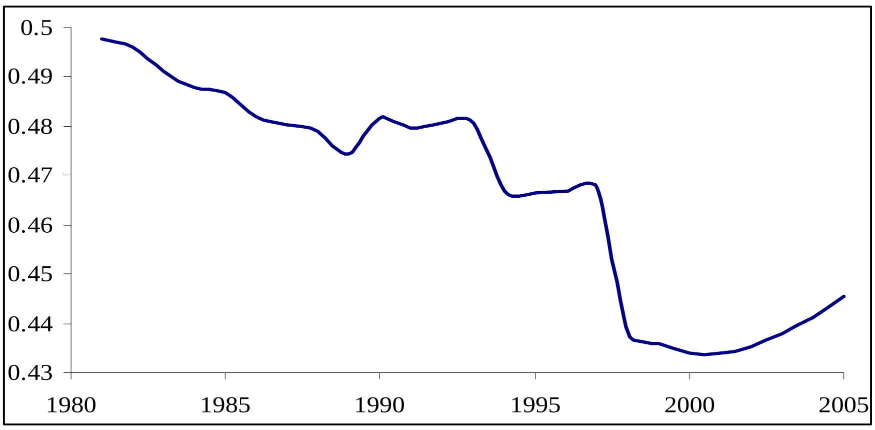
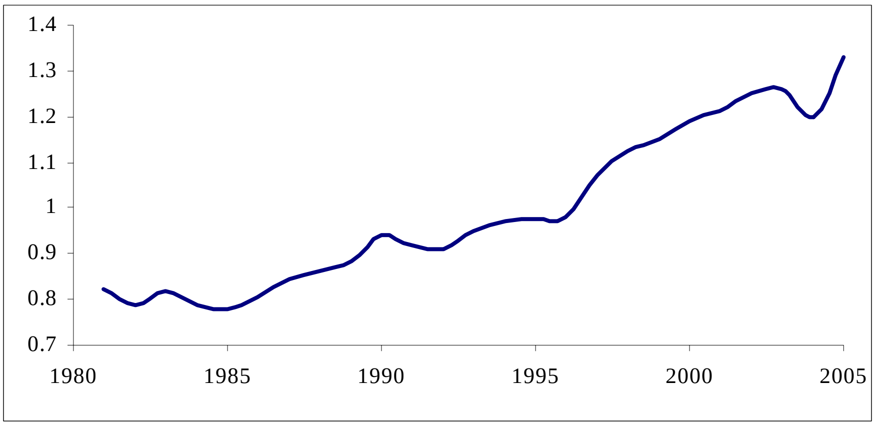


Figure 8: Variance of Log Per Capita Output



In summary, Figures 4-8 show that output of Thai provinces is not converging but diverging.

5. Estimation Results: β convergence

The least-squared estimates of Equation (1) are shown in Table 1. The estimates for the samples during 1981-2005 are shown in rows 2-4. The second row shows the estimates using all the data of all provinces. The third and fourth rows show the estimates using the data of the 30 poorest and the 30 richest provinces, respectively.[6] For all 72 provinces, the value of the estimated coefficient is 1.09 which is greater than 1. This estimation result indicates that there was no convergence among the 72 provinces during 1981-2005. The third row reports a similar result showing that there is a large divergence among the poorest 30 provinces. However, the estimate in column 4 shows that the coefficient is less than 1 and suggests convergence among richest provinces in this period. This result is similar to that found in the existing literature that there exists convergence only among rich countries.

The estimation results for samples in periods 1981-2005, 1981-1990, 1991-2000 and 2001-2005 are shown in Table 1. As one can see from the last column, the numbers of

[6] The 30 poorest (resp. richest) provinces are categorized using 1980 per-capita output.

observations of all provinces in these 4 periods are not the same. These numbers correspond to the fact that the number of provinces increased from 72 to 73 in 1982 and again increased to 75 in 1994. Qualitatively, the estimation results are the same as those for samples in period 1981-2005. The results suggest no convergence among all 72 provinces and the 30 poorest provinces. However, there exists convergence among the 30 richest provinces. However during 2001-2005, there is no evidence of convergence among all 3 groups of provinces.

Table 1: β convergence [a]

Period/Explanatory Variables	Constant	Initial Output	R^2	# of Observations
1981-2005 (All 72 provinces)	0.71 (0.02)	1.09 (0.00)	0.58	72
1981-2005 (30 poorest provinces)	.239 (0.68)	1.261 (0.00)	0.46	30
1981-2005 (30 richest provinces)	1.55 (0.06)	.823 (0.00)	0.47	30
1981-1990 (All 72 provinces)	-0.45 (0.25)	1.28 (0.00)	0.55	72
1981-1990 (30 poorest provinces)	-2.11 (0.25)	2.02 (0.02)	0.27	30
1981-1990 (30 richest provinces)	0.20 (0.49)	1.07 (0.00)	0.82	30
1991-2000 (All 72 provinces)	-0.14 (0.94)	1.08 (0.00)	0.82	73
1991-2000 (30 poorest provinces)	-.855 (0.06)	1.38 (0.00)	0.71	30
1991-2000 (30 poorest provinces)	.453 (0.34)	.962 (0.00)	0.71	30
2001-2005 (All 72 provinces)	-0.02 (0.80)	1.05 (0.00)	0.97	76
2001-2005 (30 poorest)	-.068 (0.64)	1.09 (0.00)	0.66	30
2001-2005 (30 richest)	-.229 (0.10)	1.09 (0.00)	0.94	30

[a] Number in parentheses are p-values. The RHS variable is the last period output.

6. Estimation Results: σ convergence and its determinants

In this section, we investigate σ convergence and its potential determinants. These potential determinants are distances, migration, average output and similarities and diversity of production structures.

Table 2 reports the estimate of Equation (2) using data of 72 provinces during 1980-2005 to test σ convergence. Convergence (resp. divergence) is implied if $\alpha_1 < 1$ (resp. $\alpha_1 > 1$). As mentioned in Section (3.2), to control the effect of group sizes on the estimates, we perform each estimation using samples with a same group size. For example, row 2 shows the estimation of Equation (2) using samples of 2-province groups. Given that the number of provinces is 72, the number of all groups with 2 provinces is therefore $\frac{72!}{(72-2)!2!} = 2556$. In this case, all possible 2-province groups are generated and their data are used for the estimation. For group sizes greater than 2, it is too costly to generate all possible groups. In such cases, we randomly generate 5000 groups for each estimation.

Table 2: σ convergence [a]

Group Size	Initial Variance of Output	R^2	# of Observations
2	1.14 (0.00)	0.33	2556
3	1.35 (0.00)	0.28	5000
5	1.47 (0.00)	0.24	5000
7	1.53 (0.00)	0.23	5000
9	1.58 (0.00)	0.20	5000
LHS variable: the end period variance. Period: 1980-2005.			

[a] Numbers in parenthesis are p-values.

In order to check for the robustness of the estimation results with various group sizes, we estimate Equation (2) using various group sizes. The initial variance is calculated using the variance of log of average of annual output of provinces in group *i* during 1985-1989. The end period variance is calculated in a similar fashion using 2001-2005 data. All estimated coefficients for the initial variance are greater than one.

Thus, both estimation results in Tables 1 and 2 are consistent. The results suggest that for the group of all provinces, there is no evidence of convergence of Thai provincial output during 1981-2005. A shortcoming of the estimation in Tables 1-2 is that they could not explain what factors contribute to such convergence/divergence.

In the next section, we will investigate various factors that might potentially affect convergence. The factors that we will consider in the subsequent sections are proximity, migration, average output and diversity in production structure.

6.1 Common Borders and Distances

The first potential determinant of convergence that we will investigate is proximity between provinces. Under classical models with diminishing returns to scale, provinces that are close to each other converge faster than provinces those which are far apart. The closer the provinces in a group, the faster the factor movement and technology transfer, and output However, under models with increasing returns to scale, for example Krugman (1991), proximity and decreasing transportation costs between regions can accelerate agglomeration and promote divergence.

To test the relationship between common borders and convergence, we first estimate equation (3) in which $k = 2$ and X_{2i} is a common-border variable and is defined as:

$$X_{2i} = \frac{\sum_{j,k \in i} A(j,k)}{N_i (N_i - 1)/2}$$

where *j* and *k* are provinces in group *i*. $A(j,k)$ is 1 if *j* and *k* share a common border and is 0, otherwise. N_i is the number of provinces in group *i*. It follows that $X_i \in [0,1]$; X_i is 1 if each province in group *i* is adjacent to all the other provinces in the group and X_i is 0 if no two adjacent provinces are in the group.

The second row in Table 3 shows the estimation result for groups with 2 provinces. For groups with 2 provinces, the common border variable of each group is 0 or 1. Its value is one if the two provinces are adjacent and its value is zero otherwise. The coefficient for the common border variable is negative and significantly different from 0 at 90 percent confidence level. The negative coefficient implies that adjacent provinces, their output variance grows slower than that of non-adjacent provinces. In other words, adjacent provinces diverge slower or converge faster than non-adjacent provinces.

Table 3: Common Border and Convergence [a]

Group Size	Initial Variance of Output	Common Border Variable	R^2	# of Obs.
2	1.27 (0.00)	-0.44 0.08	0.33	2486
3	1.35 (0.00)	0.00 0.99	0.28	5000
5	1.45 (0.00)	0.20 0.28	0.24	5000
7	1.52 (0.00)	0.11 0.44	0.23	5000
9	1.60 (0.00)	-0.28 0.31	0.32	5000
LHS variable: the end period variance. Period: 1980-2005.				

[a] Numbers in parentheses are p-values.

However, as reported in rows 3-6 of Table 3, for groups with sizes greater than 2, this common-border coefficient is not significant. Therefore, the relationship between common borders and convergence is ambiguous.

Now, we test how distances between provinces affect their convergence. We estimate equation (3) in which X_{2i} is the average of log distances of all pairs of provinces in group *i*. The results are shown in Table 4. The estimated coefficients for distances are negative and significantly different from zero for all group sizes. Surprisingly, they show that proximity has a *negative* contribution on convergence; output of provinces that close to each other tends to diverge more than that of provinces that are far apart. This result suggests that the production function of each province might exhibit increasing returns.

Table 4: Distance and Convergence [a]

Group Size	Initial Variance of Output	Distance	R^2	# of Obs.
2	1.79 (0.00)	-0.08 (0.06)	0.34	2485
3	2.17 (0.00)	-0.13 (0.00)	0.29	5000
5	2.45 (0.00)	-0.15 (0.00)	0.25	5000
7	3.27 (0.00)	-0.27 (0.00)	0.21	5000
9	2.41 (0.00)	-0.13 (0.00)	0.20	5000
LHS variable: the end period variance. Period: 1980-2005.				

[a] Numbers in parentheses are p-values.

6.2 Migration

In classical economic theory, factor movement equalizes factors' returns across regions and speeds up output convergence. On the other hand, in the new economic geography models, factor movement might accelerate economic agglomeration and exacerbate convergence. In this section we empirically test the impact of migration between provinces and convergence. We estimates Equation (3) using $k = 2$ and $X_{2i} = MR_i$, the migration ratio (*MR*) of group *i*, where

$$MR_i \equiv \sum_{j \neq k \in i} \frac{M(j,k)}{N_j + N_k}$$

where j and k are provinces in group i

$M(j,k)$ is the total migration for j to k during 1996-2000[7]

N_k is the average population of province k during 1996-2000.

[7] Note that this is the only migration data available from NSO.

To match the period of output data used for estimation with the migration data during 1996-2000, for this regression, the initial variance of output is calculated using data 1991-1995 and the final variance of output is calculated using data in 2001-2005. The estimation results are shown in Table 5. All the coefficients for initial variance of output are positive. The migration coefficient is significantly negative and positive for groups with 2 and 3 provinces, respectively. For groups with more than 3 provinces, the coefficients are positive but not significant. Therefore, the relationship between migration and convergence is ambiguous.

Table 5: Migration and Convergence [a]

Group Size	Initial Variance of Output	Migration	R^2	# of Obs.
2	1.27 (0.00)	-0.05 (0.02)	0.60	2485
3	1.32 (0.00)	0.06 (0.00)	0.01	5000
5	1.47 (0.00)	0.00 (1.00)	0.25	5000
7	1.51 (0.00)	0.01 (0.94)	0.22	5000
9	1.55 (0.00)	0.04 (0.44)	0.23	5000
LHS variable: the end period variance. Period: 1991-2005.				

[a] Numbers in parentheses are p-values

6.3 Average Output

In this section, we investigate how a group's initial output level might affect its convergence. Similar to what we did before, we estimate Equation (3) in which $k = 2$ and X_{2i} is average output level of group i. The results in Table 6 show that there is a significant positive relationship between convergence and average output levels. This result is consistent with that in Table 1 in which there exists convergence only among the 30 richest provinces.

Table 6: Average Output and Convergence [a]

Group Size	Initial Variance of Output	Average Output	R^2	# of Obs.
2	3.23 (0.00)	-0.63 (0.00)	0.35	2485
3	2.95 (0.00)	-0.53 (0.00)	0.28	5000
5	2.70 (0.00)	-0.42 (0.00)	0.24	5000
7	2.99 (0.00)	-0.512 (0.00)	0.23	5000
9	3.26 (0.00)	-0.60 (0.00)	0.23	5000
LHS variable: the end period variance. Period: 1980-2005.				

[a] Numbers in parentheses are p-values.

6.4. Diversity in Production Structure

A standard economic development theory suggests that the production structure of an economy moves from agriculture based to industry based as it develops. The theory suggests that we should be able to observe catching up between non-industrialized provinces and industrialized provinces. To investigate this hypothesis, we use the standard deviation of initial manufacturing shares to output of each province in each group in 1980 as the explanatory variable X_{2i} in equation (3). The estimated coefficients for the standard deviation of manufacturing shares are shown in Table 7. All of them are negative and significantly different from zero. These coefficients indicate that groups with more diverse production structure tend to diverge slower or converge faster than groups with similar production structure. This result is consistent with the standard economic development theory mentioned above.

Table 7: Diversity of Production Structure and Convergence [a]

Group Size	Initial Variance of Output	Initial Standard Deviation of Manufacturing Share	R^2	# of Obs.
2	2.06 (0.00)	-0.04 (0.00)	0.38	2485
3	2.32 (0.00)	-0.06 (0.00)	0.35	5000
5	2.63 (0.00)	-0.07 (0.00)	0.32	5000
7	2.76 (0.00)	-0.08 (0.00)	0.33	5000
9	2.92 (0.00)	-0.09 (0.00)	0.30	5000
LHS variable: the end period variance. Period: 1980-2005.				

[a] Numbers in parentheses are p-values.

6.5 Distances, Initial Output and Diversity of Production Structure

As the final part of this section, to test the robustness of the results above, we now use all factors that previously found significantly affecting convergence as explanatory variables. Equation (3) in which X_{2i}, X_{3i} and X_{4i} are, respectively, distance, average output and the standard deviation of manufacturing shares are estimated. The results are reported in Table 8. Qualitatively, the estimation results do not change much. The signs of the coefficients for average output and the standard deviation of manufacturing shares are all significantly negative. The coefficients for average output are significantly negative for group sizes less than 6. However, for groups with more than 6 provinces, the coefficients are not significantly different from zero.

Table 8: Distances, Initial Output, Diversity of Production Structure and Convergence

Group Size	Initial Variance of Output	Distance	Average Output	Initial Standard Deviation of Manufacturing Share	R^2	# of Obs.
2	4.12 (0.00)	-0.19 (0.00)	-0.28 (0.00)	-0.03 (0.00)	0.38	2485
3	4.50 (0.00)	-0.22 (0.00)	-0.29 (0.00)	-0.05 (0.00)	0.36	5000
5	4.97 (0.00)	-0.29 (0.00)	-0.20 (0.00)	-0.07 (0.00)	0.32	5000
7	4.46 (0.00)	-0.27 (0.00)	-0.00 (0.91)	-0.09 (0.00)	0.33	5000
9	5.03 (0.00)	-0.33 (0.00)	0.021 (0.77)	-0.10 (0.00)	0.33	5000
LHS variable: the end period variance. Period: 1980-2005.						

[a] Numbers in parentheses are p-values.

7. Conclusion

In this paper, we investigate the two following questions: (i) whether output of Thai provinces converge or diverge and (ii) what are the factors that contribute to convergence among provinces. On the aggregate level, we find that during 1981-2005, output of Thai provinces diverged. However, there was convergence among the 30 richest provinces.

We then search for factors that might affect this convergence/divergence. It is found that groups of rich provinces and groups of provinces with diverse production structure tend to converge. However, migration between provinces plays no significant role on convergence. Moreover, we find that the provinces that are far apart tend to converge more than provinces that are close to each other. This evidence suggests increasing returns to scale production functions on province levels. Similar evidences on increasing returns of Thai provinces' production function are also found in Preechametta (2007 and 2008).

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