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Regional Integration and Economic Convergence in Northeast Asia: Evidence from the Greater Tumen Initiative

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Since the early 1990s, the Greater Tumen Initiative (GTI) has emerged as one of the major platforms for cross-border regional integration in Northeast Asia. Founded officially in 1995 with the support of UNDP, it was given a major boost in 2005 as China, South Korea, Russia, and Mongolia took ownership of the initiative. This paper assesses the effectiveness of GTI in terms of convergence in relative per-capita GDP across the 12 member regions over the period 1995-2013. The analysis is conducted using a combination of parametric and nonparametric methods and focuses on the shifts of the kernel density distribution of relative GDP and its intradistributional dynamics over time. The results indicate that in the first decade of the sample period intradistributional convergence was strong, while after 2005 improvements in living standards relative to a common benchmark dominated the process. Regression analysis reveals that on average cross-border convergence was annually 0.15% higher after 2005 than in the preceding decade. Moreover, the marginal rate of cross-border convergence was almost 40% of the rate of intranational convergence after 2005. Overall, the findings suggest that GTI has promoted regional convergence, especially over the past decade.

1. Introduction

Political changes in the early 1990s created great prospects for regional integration in Northeast Asia (NEA). After the breakdown of the Soviet Union, Russia opened up

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its Far Eastern region that had been isolated from neighboring countries for almost 70 years. At the same time, a new phase of market reforms in China set the stage for double-digit economic growth. As the relations between China and Russia normalized, skirmishes along the Sino-Soviet border gave way to tourists and traders. Similarly, South Korea established diplomatic relations with Russia and China, which offered new opportunities for Korean businesses, while North Korea expressed interest in attracting foreign capital by establishing a special economic zone. Political and economic liberalization produced favorable conditions for economic cooperation in the region.

A proposal made first at a conference in 1990 called for the creation of a cross-border economic hub along the Tumen River where China, Russia, and North Korea share a border drawing the attention of the United Nations Development Program (UNDP), which had sponsored the event. A year later, UNDP launched the Tumen River Area Development Program (TRADP) as a regional cooperation project between Russia, China, Mongolia, North and South Korea with Japan as observer. In 1995, the five member states signed an agreement establishing a consultative mechanism. Despite regular annual meetings, investment forums, and training workshops, progress was slow due to unrealistic goals, lack of funding, and the Asian Financial Crisis. Over the following decade, most initial objectives were not met and ultimately relatively few projects were implemented.[1]

In 2005, the program received a new breath of life as it was transformed into the Greater Tumen Initiative (GTI). Member countries agreed to assume ownership of the initiative and to provide financial support. The geographical area covered by GTI was expanded to include the three provinces of Eastern Mongolia, the three provinces of Northeast China, Russia's Primorsky region, and South Korea's four provinces on its eastern coast.[2] Moreover, a new strategic action plan was adopted for the period 2006-2015 focusing on five priority sectors, including energy, environment, investment, tourism, and transport.[3]

The goal of this paper is to evaluate the economic impact of TRADP/GTI since 1995 and to assess its effectiveness in fostering regional integration. In particular, the paper uses a combination of parametric and non-parametric methods to study the

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[1] An overview of the historical and institutional development of TRADP is provided in Marton et al. (1995), Pomfret (1998), Hughes (2000), Lee (2003), and Tsuji (2004).

[2] North Korea withdrew from GTI in 2009 and is no longer a member. The country is excluded from the analysis due to the lack of economic data.

[3] An overview of the historical and institutional developments of GTI since 2005 can be found in GTI (2011), Wang, 2014), Liu (2014), and Adhikari (2015).

convergence in living standards between the regions involved in the initiative. The first part of the analysis focuses on the distribution of regional per-capita GDP relative to a common benchmark and examines its shape and evolution over time. In addition, transition matrices are employed to explore intradistributional dynamics and to estimate the probabilities of relative convergence. The second part uses a linear regression model to identify the determinants of the convergence patterns detected earlier.

The existing literature on TRADP/GTI in English exhibits several shortcomings. The majority of studies were conducted in the 1990s and early 2000s and their findings are outdated. Given that the time frame of GTI's strategic action plan is coming to an end this year, it is an opportune time to take stock of the initiative's impact. Furthermore, previous works focused to a great extent on historical, political, and institutional aspects.[4] However, economic objectives are at the heart of this regional cooperation mechanism and deserve to be examined in greater detail. Last but not least, existing research has been almost exclusively descriptive with regards to economic data. Advances in statistical techniques and wider availability of regional-level data call for an empirical investigation of TRADP/GTI, which could provide important insights and help policymakers design more effective measures to achieve the objectives set in the strategic action plan.

Despite the relatively modest achievements of GTI to date, the project has economic potential as it brings together regional economies which exhibit complementarities. Russia's Primorsky region is rich in natural resources that are in high demand in China and South Korea, but suffers from labor shortage which can be alleviated by immigration from China and North Korea. In addition, its infrastructure, including ports and the Trans-Siberian Railway, provides an alternative trade route for goods from Northeast Asia to Europe. China's Northeast was the traditional industrial base of the country before market reforms led to a decline of the inefficient state-owned enterprises dominating the heavy industry in the region. Regional trade via GTI would boost growth and would offer access to sea ports that are particularly important to landlocked provinces such as Jilin. Similarly, landlocked Mongolia would benefit from access to the sea as it seeks to expand its trade with other countries besides China and Russia. South Korean businesses, on the other hand, are looking for investment opportunities and new trade routes through Eurasia, which could benefit Primorsky region as it struggles to fund the modernization of its infrastructure.

One of the main hurdles to regional integration via the TRADP/GTI has been the lack of a shared vision and political commitment from member states, especially at the

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[4] One of the few exceptions is Nobukuni (1996).

level of local authorities or the central government (GTI, 2011). As a result, the spontaneous initiatives at the micro level that promote cross-border economic cooperation have been hampered by a lack of support from national governments that often have different objectives. Hughes (2000) has conceptualized this as a conflict between regionalization and regionalism. The former describes the intensification of interregional cross-border trade and investment by businesses that want to exploit economic complementarities in the absence of a long-term vision or strategic blueprint. In contrast, regionalism entails the conscious efforts of government to deepen cross-border regional integration by creating an institutional framework and coordination mechanisms or, at the very least, by providing approval and support for local initiatives at the micro level.

The mismatch between these two processes in the case of TRADP/GTI is evident from a number of issues. A recent survey has identified trade barriers and transportation costs as the major hurdles for businesses in the GTI area (Adhikari, 2015). Member states have been slow at improving and expanding cross-border infrastructure and eliminating tariff and non-tariff barriers. For instance, despite labor shortages and a great potential for extraction of and trade in natural resources, Russian authorities in the Far East have been reluctant to facilitate cross-border flows of labor, goods, and capital from China because of fears that this process would eventually lead to a takeover of the region by its more populous neighbor. Accordingly, TRADP/GTI has failed to gain much political or popular support in Russia (Gulidov, 2012) despite the fact that the trade of Primorsky region with China and South Korea has been growing in the past few years. Another example of the divergence between regionalization and regionalism is the failure to engage Japan, one of the major economic powers in NEA, in TRADP/GTI. This, however, has not prevented trade flows between Primorsky region and Japan from increasing in recent times. Last but not least, a proposal for establishing a multilateral Northeast Asian Development Bank that would help fund cross-border projects has been discussed since the 1990s but has failed to win the support of national governments (Lee and Kim, 2014). These efforts have been further overshadowed by creation of the China-led Asian Infrastructure Investment Bank (AIIB) in 2015, which has similar objective but is not limited to NEA.

The rest of the paper proceeds as follows. Sections 2 and 3 explain the empirical methodology and data, respectively. Section 4 reports and discusses the results, and section 5 provides a summary of the findings and concluding remarks.

2. Methodology

The nonparametric part of the analysis relies on the methodology of Quah (1993, 1996a, b, 1997) and begins with the estimation of the probability density function of relative per-capita GDP using a kernel function. Let $X_1,...,X_n$ be a sample of n independent and identically distributed observations on a random variable X. The density value $f(x)$ at a given point x is estimated by the following kernel density estimator:

$$\hat{f}(x) = \frac{1}{nh}\sum_{i=1}^{n} K\left(\frac{x-X_i}{h}\right) \quad (1)$$

where h denotes the bandwidth of the interval around x and K is the kernel function.[5] The kernel estimator assigns a weight to each observation in the interval around x, with the weight being inversely proportional to the distance between the observation and x. The density estimate consists of the vertical sum of frequencies at each observation. The resulting smooth curve helps visualize the shape of the distribution of relative per-capita GDP and detect the presence of "convergence clubs" represented by modes.

Next, the dynamics of the relative income distribution and intradistributional mobility are investigated by estimating a transition probability matrix. Let Q_t denote the distribution of relative per-capita GDP across regions at time t. The distribution at time $t+1$ is then described by:

$$Q_{t+1} = M \times Q_t \quad (2)$$

where M is a finite discrete first-order Markov transition matrix that contains a complete description of the distributional dynamics as it maps Q_t into Q_{t+1}. The transition matrix is given by

$$M = \begin{pmatrix} p_{ij} & \cdots & p_{iN} \\ \vdots & \ddots & \vdots \\ p_{Nj} & \cdots & p_{NN} \end{pmatrix} \quad (3)$$

where p_{ij} with $i, j=1,..,N$ is the probability of a transition from an initial state i at time t to a state j at time $t+1$. The main diagonal of the matrix consists of the probabilities that an observation remains in the same state in t and $t+1$.

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[5] A data-driven bandwidth selection and a Gaussian kernel are used.

Assuming that the transition probabilities from t to $t+1$ are time-invariant and independent of any previous transitions, the evolution of intradistributional mobility can be studied by iterating Eq. (2) k times. As $k \rightarrow \infty$, the iteration yields

$$\lim_{k \rightarrow \infty} M_j^k = \delta_j > 0, \quad \sum \delta_j = 1 \tag{4}$$

The limiting probability distribution, δ_j, is the unconditional or ergodic distribution.[6] In other words, Eq.(4) describes the convergence to a steady-state distribution independent of the initial distribution. Accordingly, the ergodic distribution helps analyze the long-run tendencies of per-capita GDP of regions relative to the benchmark, assuming that the observed dynamics continue to hold.

The parametric part of the analysis seeks to identify the determinants of relative per-capita GDP growth via regression analysis. For this purpose, the following model is estimated:

$$\Delta ln\left(\frac{y_{it}}{y_t^{GTI}}\right) = \beta_0 + \beta_1 K_{it} + \beta_2 HK_{it} + \beta_3 R\&D_{it} + \beta_4 OPEN_{it} + \beta_5 FIN_{it} + \beta_6 GOV_{it} + \beta_7 INFR_{it} + \beta_8 CONV_{it} + \beta_9 GTI + \varepsilon_{it} \tag{5}$$

The dependent variable is the annual growth in real per-capita GDP of region i (i=1,...,11) in year t as a percentage of the GTI benchmark.[7] The regression includes dummies for each year and region to control for the effects of unobserved confounding variables that vary across time and across regions. All independent variables, with the exception of domestic convergence, enter the equation at their level from the previous year to minimize endogeneity issues.

One of the main variables of interest is domestic convergence (*CONV*), which is calculated in the same manner as the dependent variable except that the benchmark is replaced with the level of the wealthiest region within the country that the region is part of.[8] The coefficient explores the relationship between national and cross-border convergence and is thus a measure of the effectiveness of regional integration within and between countries participating in the TRADP/GTI. If the magnitude of the coefficient exceeds unity, this would signify that cross-border convergence is stronger than intranational convergence.

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6 The ergodic distribution is unique if there is only one eigenvalue of M with modulus one.

7 Korea's Ulsan region as the wealthiest in the sample was chosen to serve as the benchmark.

8 The national benchmarks are represented by Shanghai for China, Moscow for Russia, and Orkhon province for Mongolia.

The choice of the remaining regressors is largely guided by the availability of regional data and by the standard growth literature (Barro, 1991; Levine and Renelt, 1992; Sala-i-Martin, Doppelhofer, and Miller, 2004). Physical (*K*) and human capital (*HK*) accumulation increase labor productivity and promote economic growth, which could lead to convergence if the growth rate across regions is higher than for the benchmark. For similar reasons, innovation (*R&D*) is included in the model. External forces are represented by openness (*OPEN*), while the role of the government is accounted for by its level of spending (*GOV*). Financial deepening (*FIN*) and infrastructure (*INFR*) focus on the role of financial factors and transportation costs, respectively. Furthermore, a dummy variable (*GTI*) that takes the value of unity for the period starting with 2005 explores the effect of the transition from TRADP to GTI on regional convergence.

3. Data

The sample covers the 12 member regions of GTI over the period 1995-2013. These include China's four northeastern provinces (Heilongjiang, Jilin, Liaoning, and Inner Mongolia), Russia's Primorsky Krai, South Korea's two metropolitan areas (Ulsan and Busan) and two provinces (Gangwon and Gyeongsangbuk) , and Mongolia's three eastern provinces (Sukhbaatar, Dornod, and Khentii).[9] Regional per-capita GDP is measured according to purchasing power parity (PPP) in constant 2010 international dollars. Regional GDP data in current prices were collected from the national statistical offices of China, Russia, Korea, and Mongolia and the variable was deflated by the consumer price index (CPI).[10] Regional GDP data for Mongolia are not available prior to 2000. The missing observations for the three Mongolian regions for the years 1995-1999 were calculated from the national level by assuming that the share of each region in national GDP was constant and equaled the average share over the period 2000-2005. The PPP conversion factor was obtained from the World Bank's *World Development Indicators* database. Regional per-capita GDP in the analysis is expressed as a percentage of the wealthiest region's level, which is Ulsan.

Physical capital accumulation is measured as gross fixed capital formation. Innovation is represented by the expenditure on research and development (R&D),

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[9] Ulsan serves as the benchmark and is therefore excluded from the analysis. As a result, the final sample consists of 11 regions.

[10] Regional CPI was used for Korea, China, and Russia, whereas in the case of Mongolia regional GDP was deflated using the national CPI due to the lack of data.

while the role of the government is approximated by its spending at the regional level. Openness is calculated as the sum of exports and imports, whereas financial deepening is proxied by the amount of outstanding loans to the private sector. All of the above variables are measured at the regional level and are expressed as percentage of regional GDP. Human capital is represented by the number of students (per 10,000) enrolled in secondary schools.[11] The infrastructure is approximated by the rail freight in millions of tons.[12]

Table 1 *Descriptive statistics, 1995-2013*

	Korea	China	Russia	Mongolia
Real per-capita GDP (% of GTI benchmark)	42.35 (2.24)	11.01 (4.99)	11.24 (7.37)	5.92 (2.33)
Annual growth of relative p.c. GDP	-0.004 (0.059)	0.073 (0.073)	0.066 (0.149)	0.061 (0.181)
Fixed capital formation (% of GDP)	36.69 (5.79)	45.51 (17.99)	21.09 (13.59)	-
Government spending (% of GDP)	24.39 (9.89)	14.34 (2.72)	19.53 (1.76)	8.03 (7.45)
Openness(trade as % of GDP)	45.45 (36.63)	17.15 (10.91)	44.27 (9.19)	-
Infrastructure (freight in mil. tons)	-	162.79 (131.14)	13.16 (2.25)	0.11 (0.11)
Human capital (enrolled students per 10,000)	704.02 (26.45)	557.14 (63.81)	155.01 (17.18)	1058.38 (92.67)

11 The numbers of students enrolled in primary and secondary school are not reported separately at the regional level in Mongolia. The variable is calculated by using the national share of secondary school students in the total.

12 An attempt was made to include a variable that accounts for the freight throughput of the ports of Busan, Sokcho and Pohang (Korea), Dalian in China, and Vladivostok and Nahodka in Russia. However, no reliable results were produced due to the lack of data over longer periods of time.

Innovation(R&D as % of GDP)	1.53 (0.58)	0.88 (0.42)	1.01 (0.32)	-
Financial deepening (loans as % of GDP)	43.37 (24.78)	95.83 (21.31)	22.95 (11.62)	16.13 (10.98)
Domestic convergence (national benchmark)	-0.004 (0.059)	0.039 (0.057)	-0.031 (0.141)	0.029 (0.317)
Nr. of regions	3	4	1	3

Note: The reported numbers are averages across all years and regions within a country. Standard deviations are in parenthesis.

Most of the data were obtained from the CEIC database and from the national statistical offices of the four countries involved. For Korea, the data on loans and R&D spending at the regional level were collected from the Bank of Korea and from various issues of *The Survey of Research and Development in Korea* published by the Korea Institute for Science and Technology Evaluation, respectively. The Korea Customs Service provided the data on exports and imports by province.

The descriptive statistics for the variables in the regression analysis are shown in Table 1. The average relative per-capita GDP for Chinese and Russian regions was approximately 11% of the GTI benchmark, which was twice the level of Mongolian regions. Korean provinces were the wealthiest with 42% but they exhibited negative growth in relative GDP over the sample period. In contrast, relative GDP grew annually by 6-7% in all other regions. Furthermore, Korean and Russian regions diverged from their national benchmarks, while Chinese and Mongolian regions were able to catch up relative to the wealthiest regions in their respective countries. The physical capital accumulation in China at 45% of GDP is more than twice the Russian level. At the same time, R&D spending in Korean regions is almost twice as high as the Chinese level.

4. Result

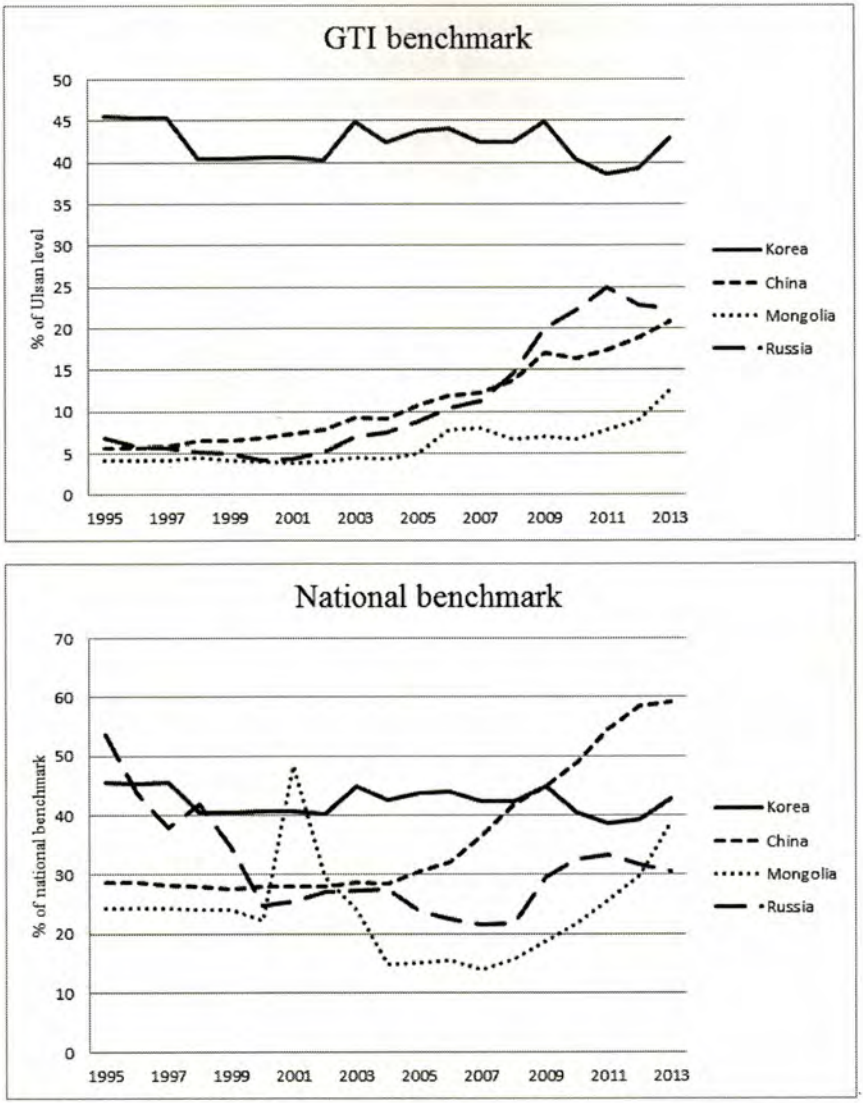
4.1 Preliminary observations

The first graph in Fig. 1 shows the regional per-capita GDP averaged by country relative to the GTI benchmark. The levels of the three Korean provinces do not display a clear trend and have comparatively minor variations over the sample period. Divergence seems to have occurred in the aftermath of the 1997 Asian Financial Crisis and the 2008 global financial crisis but even then the magnitude did not exceed 5%. In contrast, Chinese provinces exhibited consistent convergence tendencies as their relative per-capita GDP levels quadrupled. Primorsky region converged towards the benchmark in a similar fashion but only since 2003. For Mongolian provinces, the process of catching up began in 2006 but it leveled off after the start of the global financial crisis and picked up again in 2010. Accordingly, the convergence tendencies in Mongolia were much weaker than in other countries and their relative per-capita GDP barely managed to double in two decades.

The second panel in Fig. 2 displays the regional per-capita GDP relative to the corresponding national benchmark of each country. The Korean average remains unchanged from the previous graph, but the levels for the other three countries are much more volatile and exhibit differing patterns. The income level of Primorsky region was more than 50% of Moscow's in 1995 but then dropped to a low of 20% over the following decade. Mongolian regions also experienced a sharp divergence from their national benchmark but this trend reversed in 2009 allowing them to catch up again. The relative per-capita GDP of China's Northeast provinces remains almost constant until 2005 when sustained convergence allows them to double their levels within several years.

A comparison between the two graphs indicates that all regions (with the exception of the three Korean ones) exhibit consistent convergence towards the GTI benchmark, whereas their performance with respect to their national benchmarks is volatile and lacks common patterns over the sample period. This is an interesting result as it suggests that cross-border interregional convergence within the TRADP/GTI framework is a more stable and sustainable process than intranational shifts in relative regional GDP levels. This is a first sign that TRADP/GTI regions had a smoother integration with Korea between 1995 and 2013 than with the wealthiest region in their respective country.

Fig. 1 *Real per-capita GDP (PPP) of GTI member regions (% of Ulsan's level), 1995-2013*



Note: Regional per-capita GDP is averaged by country.

4.2. Kernel densities

Fig. 2 presents the kernel density distributions of relative per-capita GDP in 1995, 2005, and 2013. The first graph illustrating the shifts in the distribution relative to the GTI benchmark exhibits two patterns. There is a shift of the distribution to the right which indicates convergence towards the benchmark. In addition, the shape of the distribution changes as the height of the main mode increases over time. This signifies intradistributional convergence as most of the probability mass concentrates more tightly around the value of around 25% of the benchmark level. Another interesting observation is the fact that between 1995 and 2005 most of the change occurs in the height of the mode rather than its width. By comparison, the period between 2005 and 2013 is marked by strong convergence towards the benchmark as well as a significant decrease in intradistributional dispersion of relative per-capita GDP.

These patterns are confirmed by the density distributions for the two subperiods shown in Fig. 3. In the first graph, most of the evolution in the shape of the mode occurs between 1995 and 1998, whereas in the following period up to 2004 there is basically no change. It is worth mentioning that the latter period coincides with the aftermath of the Asian Financial Crisis. The second graph shows a continuous shift of the distribution towards the benchmark and the increasing height of the mode after 2005, which is in line with the earlier findings.

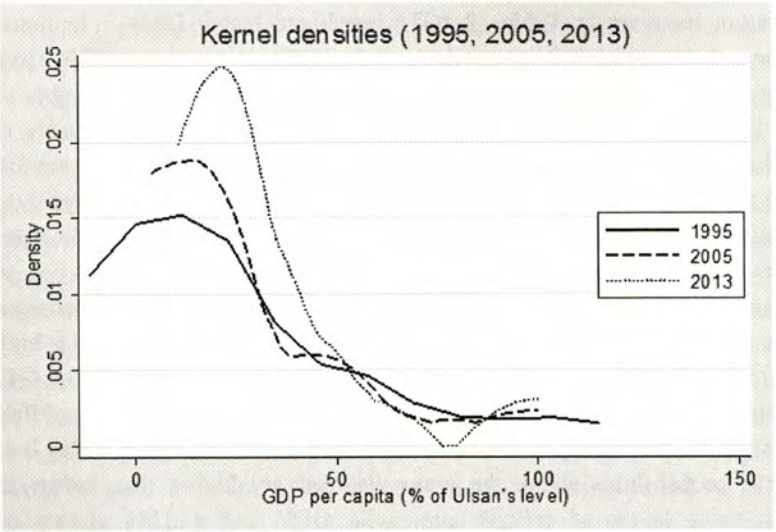
In the second graph of Fig. 2, the distributions using the national benchmarks present a very different picture. The shapes of the distributions in 1995 and 2013 are almost identical except that the latter has shifted further to the right. This means that there is convergence towards the national benchmarks but intradistributional dispersion in relative per-capita GDP has remained constant. However, the distribution for the midpoint of the sample period shows that this convergence patterns was not a linear process as was the case with the GTI benchmark. In 2005, the probability mass moved to the left and produced a peak that is notably higher than the ones in the first and last year of the sample period. This indicates strong divergence from national benchmarks between 1995 and 2005, coupled with intradistributional convergence. Accordingly, the period after 2005 is characterized by a widening mode and a significant shift towards national benchmarks. These interchanging divergence and convergence patterns contrast with the continuous convergence observed with the GTI benchmark.

4.3. Intradistributional dynamics

The transition matrices in Tables 2 (GTI benchmark) and Table 3 (national benchmarks) reveal the intradistributional dynamics of relative per-capita GDP. Each matrix consists of four states, with ranges chosen so as to contain the same number of observations. The initial states are displayed on the left, while the final states are in the top bar. The numbers in the matrix represent probabilities associated with moving from an initial to a final state. The diagonal embodies the persistence in the same state. Numbers below the diagonal indicate the likelihood of divergence, whereas the ones above measure the probability of convergence towards the benchmark.

The first matrix in Table 2 uses annual transitions relative to the GTI benchmark over the entire sample period. The persistence in the same initial state was very high (94%) for regions with an initial relative per-capita GDP of around 11% of the GTI benchmark. By comparison, regions with levels below 11% exhibit greater mobility with a probability of remaining in the same state of between 80% and 85%. It is evident that the probabilities above the main diagonal are higher than below it. Regions with lower levels of relative per-capita GDP had a 15% chance of convergence towards the benchmark. This was almost twice as high as the probability of diverging towards the left tail of the distribution. If sustained in the long run, these dynamics would have produced a unimodal ergodic distribution shown at the bottom of the matrix. Ten percent of the observations would have ended up in the left tail of the distribution, while more than half would have concentrated at levels between 11% and 36% of the GTI benchmark. Only about a third of the probability mass would be located at levels closer to the top of the distribution.

Fig. 2 *Kernel density distributions of per-capita GDP (% of GTI vs. national benchmarks)*



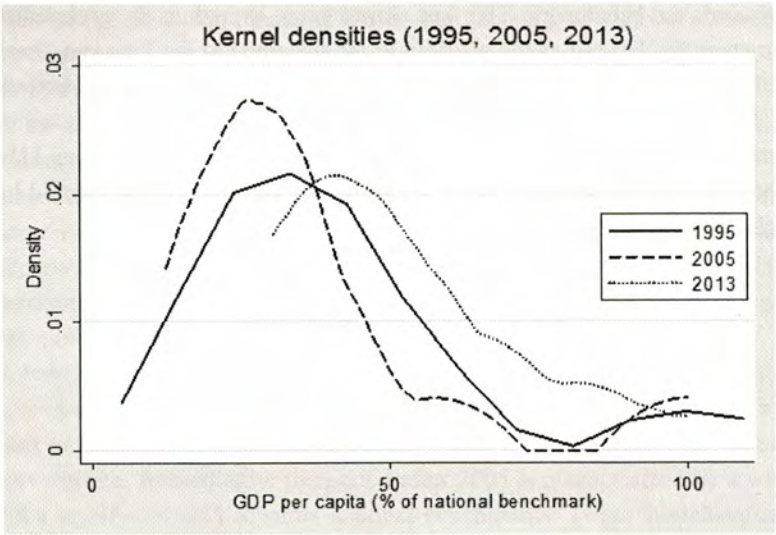
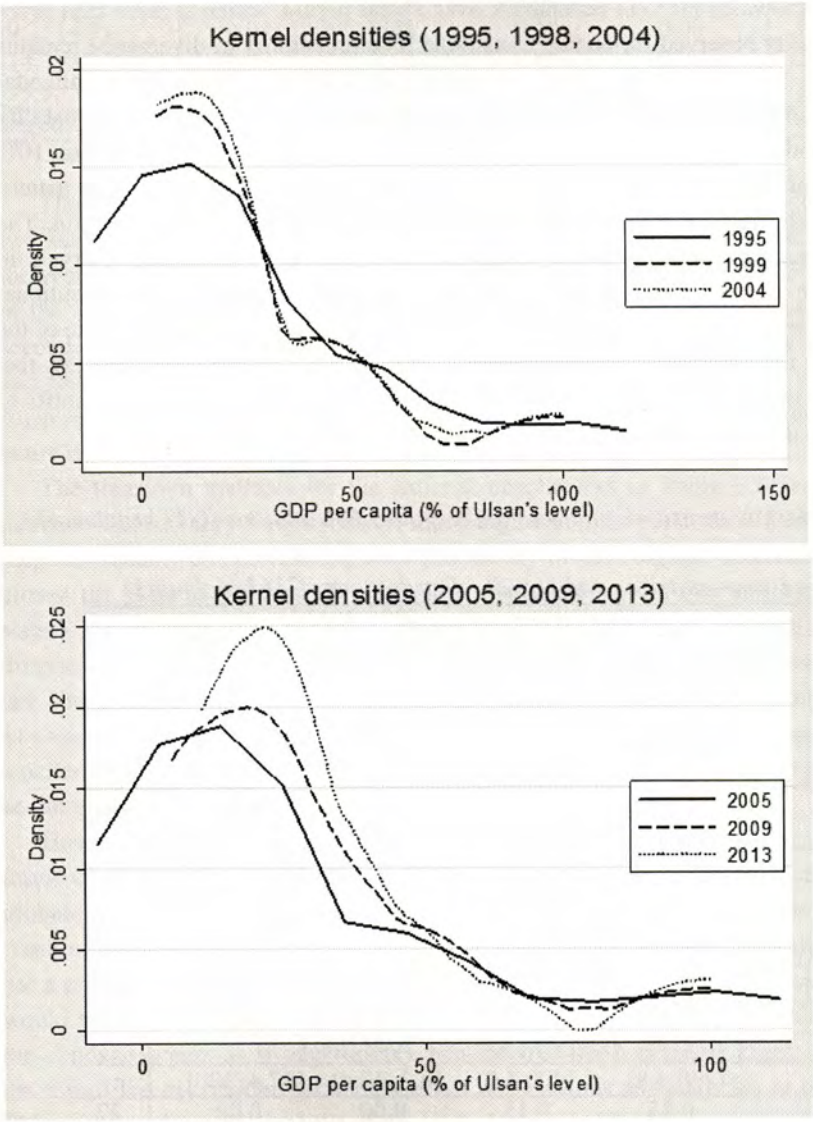


Fig. 3 *Kernel density distributions of relative per-capita GDP (1995-2004 vs. 2005-2013)*



The robustness of the results is tested by extending the transition period to 3 years in the second matrix. This causes the mobility across states to increase dramatically,

except at the top of the distribution, where it remains constant at above 90%. Countries with relative per-capita income below 10% have a 35% to 40% chance of converging towards the GTI benchmark over 3-year period, which is more than twice the probability observed for annual transitions. The probability of divergence remains unchanged. In the long run, these convergence tendencies yield the same unimodal ergodic distribution as before but with a much higher concentration of probability mass around the mode. Now 77% of observations end up in the range between 10% and 36% of the benchmark, while only 4% remain below this level. This pattern concurs with the findings of the kernel density analysis in the previous section. The higher concentration around the mode produces the growing peak observed in consecutive density distributions over time, which is a sign of intradistributional convergence. At the same time, the fact that the mode emerges in the third state of the matrix and that very few observations are located in the first two states suggests that there is an overall convergence towards the GTI benchmark revealed by the shifts of the density distribution to the right.

Table 2 *Markov transition matrices and ergodic distributions (GTI benchmark)*

Markov transition matrices and ergodic distributions (GTI benchmark)					
	Annual transitions, 1995-2013				
State	[2.9; 5.4)	[5.4; 10.8)	[10.8; 36.3)	[36.3; 100]	n
[2.9; 5.4)	0.85	0.15	0.00	0.00	54
[5.4; 10.8)	0.06	0.80	0.15	0.00	54
[10.8; 36.3)	0.00	0.02	0.94	0.04	54
[36.3; 100]	0.00	0.00	0.06	0.94	54
Ergodic	0.03	0.07	0.54	0.36	216
	3-year transitions, 1995-2013				
State	[2.9; 5.2)	[5.2; 10.1)	[10.1; 36.8)	[36.8; 100]	n
[2.9; 5.2)	0.63	0.35	0.02	0.00	48
[5.2; 10.1)	0.06	0.54	0.40	0.00	48
[10.1; 36.8)	0.00	0.02	0.96	0.02	48
[36.8; 100]	0.00	0.00	0.08	0.92	48
Ergodic	0.01	0.03	0.77	0.19	192
	Annual transitions, 1995-2004				
State	[2.9; 4.8)	[4.8; 6.7)	[6.7; 37.4)	[37.4; 100]	n
[2.9; 4.8)	0.85	0.15	0.00	0.00	27
[4.8; 6.7)	0.07	0.78	0.15	0.00	27
[6.7; 37.4)	0.00	0.04	0.96	0.00	27
[37.4; 100]	0.00	0.00	0.04	0.96	27
Ergodic	0.09	0.19	0.72	0.00	108

	Annual transitions, 2005-2013				
State	[3.6; 9.2)	[9.2; 14.7)	[14.7; 35.5)	[35.5; 100]	n
[3.6; 9.2)	0.70	0.26	0.04	0.00	27
[9.2; 14.7)	0.04	0.78	0.19	0.00	27
[14.7; 35.5)	0.00	0.07	0.85	0.07	27
[35.5; 100]	0.00	0.00	0.07	0.93	27
Ergodic	0.02	0.15	0.42	0.41	

The third and fourth matrices in Table 2 displaying the dynamics for each of the two subperiods are also in line with the previous results. The ergodic distribution for the years 1995-2005 exhibits mostly intradistributional convergence as the probability in the third state reaches a peak of 72%. In contrast, the long-run dynamics for the second decade of the sample period reveal an almost identical probability in the third and fourth states of the matrix (each at around 40%). This significantly wider mode suggests that most of the dynamics in that period were focused on convergence of the entire distribution to the GTI benchmark.

The transition matrices for the national benchmarks in Table 3 reveal different patterns. The mobility across states is much higher and the persistence along the main diagonal notably lower. Although the probability of convergence towards the top is almost the same as for the GTI benchmark (especially in the first and second initial states), the chances of divergence are stronger. These dynamics generate an ergodic distribution that has a wide mode across the third and fourth states and a very fat left tail. The difference between the bottom and the mode is merely 13 percentage points as compared to more than 50 in the case of the GTI benchmark. This means that such a pattern would lead to minimal convergence towards higher levels of per-capita GDP and to a lack of intradistributional convergence.

However, the second and third matrices in Table 3 reveal that this pattern is the result of two very different trends in the two subperiods. In the first decade, the probabilities below the main diagonal are significantly larger than above it. The resulting divergence from the benchmark is reflected in an ergodic distribution that has a prominent mode at the bottom of the distribution where 41% of the observations would be located (as opposed to only 11% at the top). In the years after 2005, exactly the opposite occurs as strong convergence towards the benchmark creates a peak at the top of the distribution with 74% of all observations and only 1% at the bottom. This again confirms the analysis of the second graph in Fig. 2.

Table 3 *Markov transition matrices and ergodic distributions (national benchmark)*

Markov transition matrices and ergodic distributions (national benchmark)					
	Annual transitions, 1995-2013				
State	[7.4; 25.9)	[25.9; 33.3)	[33.3; 45.5)	[45.5; 100]	n
[7.4; 25.9)	0.83	0.15	0.02	0.00	54
[25.9; 33.3)	0.09	0.74	0.15	0.02	54
[33.3; 45.5)	0.04	0.06	0.83	0.07	54
[45.5; 100]	0.00	0.04	0.04	0.92	54
Ergodic	0.18	0.22	0.29	0.31	216
	Annual transitions, 1995-2004				
State	[12.3; 25.2)	[25.2; 32.0)	[32.0; 41.9)	[41.9; 100]	n
[12.3; 25.2)	0.89	0.07	0.04	0.00	27
[25.2; 32.0)	0.11	0.81	0.04	0.04	27
[32.0; 41.9)	0.07	0.07	0.81	0.04	27
[41.9; 100]	0.00	0.04	0.15	0.81	27
Ergodic	0.41	0.26	0.22	0.11	108
	Annual transitions, 2005-2013				
State	[7.4; 26.5)	[26.5; 34.8)	[34.8; 50.5)	[50.5; 100]	n
[7.4; 26.5)	0.78	0.22	0.00	0.00	27
[26.5; 34.8)	0.07	0.63	0.30	0.00	27
[34.8; 50.5)	0.00	0.07	0.78	0.15	27
[50.5; 100]	0.00	0.00	0.04	0.96	27
Ergodic	0.01	0.05	0.20	0.74	108

4.4. Determinants of relative per-capita income growth

The factors that drive the distributional and intradistributional dynamics described in the previous two sections are explored via regression analysis. The results for several specifications are shown in Table 4, with the first two columns focusing on the entire sample period and the remaining ones on the two subperiods. The dependent variable is the growth of real per-capita GDP not in absolute terms but relative to the GTI benchmark. In other words, the dependent variable measures convergence between the regions and the GTI benchmark over time.

The positive and significant coefficient of the dummy variable accounting for the two subperiods suggests that the growth of relative GDP was higher after 2005 than over the preceding decade. This concurs with the earlier findings that convergence towards the GTI benchmark was stronger in the second subperiod. Furthermore, the convergence towards the national benchmark is the only variable that is positively and significantly related to GTI convergence across all periods. A one percentage point

increase in the growth of domestic relative per-capita GDP is associated with 0.37-0.44 percentage point growth relative to the GTI benchmark. Interestingly, in the first subperiod the magnitude of the coefficient is much stronger, even indicating in one of the specifications that GTI convergence rises by 1.15 percentage points in response to a one percentage point increase in domestic convergence. After 2005, the magnitude drops sharply to between 0.36 and 0.39. The distributional analysis in section 4.2. showed that relative GDP diverged from the national benchmark in the first decade and converged in the second. The regression results reveal that the initial divergence at the national level boosted regional convergence across borders. However, when national convergence accelerated after 2005, cross-border convergence did not keep up.

Relatively few of the control variables attain statistical significance and have robust coefficients across periods and specifications. Physical capital accumulation seems to have a negative effect on GTI convergence, which means that certain regions exhibited lower levels of fixed capital investment than others, causing divergence from the benchmark. In contrast, government spending at the regional levels is found to have had a positive effect on GTI convergence. Openness and financial deepening had a positive impact in the first decade but a negative one in the second subperiod.

Table 4 *Regression results for relative annual per-capita GDP growth*

	1995-2013		1995-2004		2005-2013	
	(1)	(2)	(3)	(4)	(5)	(6)
Fixed capital formation	-0.0014 (0.0012)	-0.0012 (0.0016)	-0.0019 (0.0019)	0.0033 (0.0024)	-0.0039** (0.0018)	-0.0016 (0.0016)
Government spending	0.0009 (0.0025)	-0.0001 (0.0028)	0.0081 (0.0058)	0.0188** (0.0073)	0.012* (0.0067)	
Openness	-0.0011 (0.0015)		0.0017 (0.0015)		-0.0044 (0.0031)	
Infrastructure	0.0000 (0.0000)	-0.0000 (0.0000)	0.0014 (0.001)	-0.0013 (0.0019)	-0.000 (0.000)	-0.0002 (0.0001)
Financial deepening	-0.001 (0.0065)	-0.0009 (0.0006)	0.0015* (0.0009)	0.0039** (0.0015)	-0.0019** (0.0007)	- 0.0014** (0.0005)
Human capital		0.0000 (0.0004)		-0.0005 (0.0005)		-0.0009* (0.0005)
Innovation		0.0301 (0.0439)		-0.0738 (0.0485)		0.0433 (0.066)

Domestic convergence	0.4424*** (0.1356)	0.3761*** (0.1399)	0.8277*** (0.2310)	1.1529** (0.5013)	0.3672*** (0.1300)	0.394** (0.1851)
GTI	0.1475*** (0.0222)	0.1533*** (0.0197)				
R^2	0.84	0.82	0.95	0.97	0.86	0.87
Nr. of observations	85	85	40	40	45	45

Note: All independent variables are measured at their initial levels at the beginning of each growth period. All specifications include dummies for each year and region. Robust standard errors are in parenthesis. *** p<.01; ** p<.05; * p<.10

5. Conclusions

Over the course of the 20th century, NEA was marred by various conflicts that have not allowed for peaceful economic cooperation between the countries in the region. Since the end of the Cold War, there has been a boom in bilateral agreements on trade and investment but TRADP/GTI has emerged as the only major multilateral initiative aimed at regional integration in NEA. Initial grand ideas of establishing a "Hong Kong of NEA" in the Tumen River area have given way to projects focused on facilitating cross-border trade, improving the infrastructure and creating new transportation links, protecting the environment, and boosting tourism across an area that encompasses 12 regions in four countries. The 20th anniversary of the initiative in 2015 is an ideal opportunity to evaluate its impact on the regions involved. In contrast to most existing studies, the current paper employs a rigorous empirical methodology to examine the economic convergence between GTI regions over the period 1995-2013. In particular, parametric and non-parametric techniques are used to examine the shape of the distribution of relative per-capita GDP and its evolution over time, to investigate intradistributional dynamics, and to identify potential determinants of the convergence tendencies.

The results show convergence among GTI regions as well as between them and a common benchmark. This means that between 1995 and 2013 most GTI regions managed to catch up with the wealthiest region in the sample in terms of per-capita GDP. However, this has not been a linear process. The years immediately following the creating of TRADP in 1995 were marked by strong intradistributional convergence that gradually slowed down after 1998 and by a lack of convergence towards the benchmark. After the emergence of GTI in 2005, intradistributional convergence continued but was now coupled with persistent shifts of the distribution towards higher levels of per-capita GDP.

This pattern is confirmed by the results of the transition matrices. If the convergence tendencies of the period 1995-2004 would hold over the long run, more than 70% of all observations would concentrate at levels between 6% and 37% of the benchmark level. By comparison, the ergodic distribution for the period after 2005 reveals that only 40% would remain at this level, while another 40% of observations would transition to per-capita GDP levels between 35% and 100%. The regression analysis does not produce very robust results but suggests that convergence towards the benchmark was impaired by physical capital accumulation, human capital, and financial deepening, especially after 2005. This could mean that lower levels of investment and education as well as less developed financial markets prevented some regions from catching up in per-capita income terms. Government spending at the regional level was found to be the only factor that consistently boosted convergence towards the GTI benchmark.

A major difficulty of the convergence analysis is to separate the effects of the spontaneous economic cooperation between regions from the conscious efforts of the TRADP/GTI. For instance, the convergence towards the benchmark after 2005 might be due to factors that are not related to GTI itself. Three strategies, namely an institutional, empirical, and comparative, are used to deal with this issue. First, economic analysis is combined with institutional development to detect common patterns. In its first decade of existence, the initiative was facing various problems with funding and the implementation of projects but one of its main achievements was to improve intergovernmental communication and trust building (Lee, 2003). This is in line with the increase in intradistributional convergence among member regions coupled with a lack of convergence towards the benchmark. The stronger engagement of member states, better funding and a more focused strategy within the GTI framework have produced better results which are reflected in the convergence tendencies detected after 2005.

A more rigorous strategy involves the inclusion of a dummy variable in the regression model. The resulting coefficient is positive and statistically significant indicating a structural break in 2005. Keeping all other factors constant, average annual growth in regional per-capita GDP relative to the benchmark was 0.15% higher after the creation of GTI in 2005 compared to the preceding decade.

A third approach consists of comparing convergence towards the GTI benchmark with convergence towards national benchmarks. The results of this investigation reveal that between 1995 and 2005 there has been a strong divergence from national benchmarks, while in the following decade this trend was completely reversed. Accordingly, marginal growth relative to the GTI benchmark was almost as high as or even higher than growth relative to the national benchmark in the first decade of the

sample period. As convergence within member states picked up after 2005, the marginal rate of cross-border convergence was reduced to about 40% of the national rate of convergence, which is still a relatively high level. The strong correlation between national and cross-border regional integration provides further evidence for the effectiveness of GTI.

In conclusion, the results of the empirical investigation indicate that both TRADP and GTI had a positive effect on different aspects of regional convergence in NEA. There is still potential for improvement given the large differences in per-capita income levels across regions, especially between Korea and the rest. The recent intensification of Sino-Russian economic cooperation, the 2015 free trade agreement between China and Korea, and Korea's Eurasia Initiative (Jeh, 2015) raise hopes that the process of regional integration in NEA is going to continue in the near future. Whether GTI continues to be a major part of this process or is overshadowed by bilateral or larger multilateral projects, such as the AIIB, will depend on the enthusiasm and initiative of national and regional governments across member states.

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