EAST ASIAN DEVELOPMENT NETWORK

EADN WORKING PAPER No. 102 (2017)

Regional Income Divergence in Vietnam since the Economic Reforms

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2013 EADN INDIVIDUAL RESEARCH GRANT

Final Draft

REGIONAL INCOME DIVERGENCE IN VIETNAM SINCE THE ECONOMIC REFORMS

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Hanoi, December 2013

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Abstract

This research paper was designed to analyze the patterns of economic and per capita income growth in Vietnam since the implementation of economic reforms in 1986. Using that as a basis, the study tried to test whether the per capita income in the country was regionally divergent or convergent using econometric models. This study was also designed to explore the possible role of space in the patterns of growth of the economy and of per capita income. It also provided suggestions for policy recommendations on tackling regional income inequality in Vietnam. The findings confirm that there is no sign of convergent patterns in per capita gross domestic product (GDP) among the provinces in Vietnam, both globally and locally (or groupings). Since 1990, per capita incomes in the majority of provinces appear to have diverged or moved away from one another. This finding points to the idea that these specific features in Vietnam's experiences may be important in explaining the systematic and persistent regional income divergence in other developing economies in their initial stage of development and growth. In testing for the spatial dependence (i.e., the role of space) among provinces in order to explain the growth pattern of one province in relation to that of other provinces, Moran's I and both the LM statistics did not support our prior assumption of spatial dependence among provinces in growth or progress. Thus, space does not have a significant role in the growth patterns of the economy and of per capita income in Vietnam.

1. Introduction

1.1 Problem Formulation

Vietnam's picture of economic growth has changed significantly following the implementation of the *Doi Moi* (economic reform policy) in 1986, which introduced economic incentives in all sectors and opened the economy to foreign trade and investment. Before the Doi Moi, real per capita income grew at around 2.2 percent per annum on average for 10 years starting from the unification of the country in 1975 up to the time that the Doi Moi was implemented. Growth during this period was quite erratic. The economy was in recession in the first half of the 1980s with failures in agriculture and industry caused by economic mismanagement. The Doi Moi brought about dramatic economic growth with a large influx of foreign direct investment (FDI) and an increase the country's two-way trade with other countries worldwide. With these positive changes, the economy experienced a period of unprecedented rapid and steady growth of more than 7 percent from 1990 to 2006 although this growth has slowed down in recent years, especially after the 2008--09 global economic crisis.

The rapid economic growth over the past 25 years since the start of the reforms significantly boosted the standard of living in Vietnam. However, practical evidence and findings from many studies reveal that over this period of time, various regions/provinces attained different growth rates. Some provinces, such as Vung Tau, Vinh Phúc, Ho Chi Minh City, and Hanoi, recorded high economic growth rates while other provinces had low growth rates. As a result, income inequality increased across regions. However, the increase in Vietnam's regional income inequality has not yet been fully explored. Thus, in this project, we attempted to examine if regional incomes diverged or converged across the different provinces of the country. The literature on development economics bear out that in many studies conducted in developing countries, regional incomes tended to diverge during the initial period of economic growth. Studies on China's economy done by Pedroni and Yao (2005) and Zhang et al. (2001), among others, provide evidence for this. A common argument is that the regional divergence in incomes may be due largely to geographic factors or to the varying degrees in which provinces promote open-door policies. In this study we focused more on the fundamental causes of the convergence/divergence in regional incomes resulting from geographic factors that, in turn, were considered to be linked to rapid growth. We did not consider cases related to the different degrees to which provinces promoted or practiced an open-door policy due to the lack of information on progrowth and open-door policies.

1.2. Research objectives

Based on the points discussed in the preceding section, this study set the following objectives:

(i) To examine if the regional income in Vietnam diverged in the 25 years since the Doi Moi and to analyze its trends

(ii) To explore the spatial effects (i.e., the role of space) on regional income divergence in Vietnam

(iii) To provide policy recommendations aimed at tackling income inequality across regions in Vietnam

1.3. Research questions

As discussed in the problem statement and research objectives, this study will focus mainly on regional income divergence and spatial effects. In other words, it will explore and analyze the divergence in income across regions in Vietnam and examine the spatial effects that impact regional income inequality in the country. To meet these objectives, this study sought to address several questions as follows:

1. Has regional income diverged across provinces since the implementation of the Doi Moi? How can the trend in regional income be described?

2. What spatial factors play a role in regional income convergence/divergence in Vietnam and how do these spatial factors play this role?

3. What are the policy implications for reducing regional income inequality in the country?

1.4. Research significance and policy relevance

This research project will have academic and practical significance.

Academically, it would add to the body of literature on regional income divergence/convergence in developing countries in particular as well as in other countries around the world. Furthermore, by exploring spatial effects, the study will also contribute to the existing literature on the role of space in regional income inequality in Vietnam. If successfully completed, it can become a reference for academicians and students in the fields of development economics and development studies.

In practical terms, the study would provide knowledge on, and raise awareness about, income divergence and its patterns across the different provinces in Vietnam. In addition, by examining spatial effects and analyzing the role of space in regional income divergence, the study will also provide basic understanding on how space affects regional income inequality across provinces in Vietnam.

The study is especially significant for sustainable development (including policymaking in this field) and poverty reduction for the following reasons:

i. The findings would provide a proper understanding of income divergence across provinces in Vietnam. These could also be used as a basis for, and provide background information on, intervention policies aimed at mitigating regional income inequality, policies that would fit in with Vietnam's sustainable development strategies of equitable development and poverty reduction.

ii. The spatial patterns in the divergence of regional incomes would help policymakers find ways of addressing the problem of regional disparities in order to reduce the development gaps among regions/provinces.

iii. By examining the role of space and spatial effects, the findings could also be used to identify geographic determinants and their impacts on regional income inequality across regions/provinces in Vietnam to help in the policymaking process.

The findings from this study can be used as building blocks for various policies in Vietnam and similar countries, particularly developing countries in Asia.

2. Brief Literature Review

Internationally, there is voluminous research on regional income inequality. Neoclassical growth theory assumes that poorer regions display higher marginal productivity of capital and, therefore, should grow faster than rich ones. Barro and Sala-I-Martin (1988) referred to this process as beta-convergence and stated that beta-convergence is more likely to occur in regions within a country due to similarity in technology, preferences, and institutions rather than in a cross-country sample. Another aspect to consider would be the potentially higher mobility of factors across regions than across countries.[1] There is extensive literature discussing the economic convergence of Chinese and Russian regions, with most of these studies arguing in favor of the convergence of two steady states. Using neoclassical growth models, Solanko (2003), Ahrend (2002), Chen and Fleisher (1996), Cai et al. (2002), Demurger et al. (2002), and Weeks and Yao (2003) found clear evidence of conditional beta-convergence across Russian and Chinese regions. At the same time, Solanko (2003) and Bradshaw and Vartapetov (2003) noted a growing dispersion in per capita income among regions in Russia. Ducan and Tian (1999), Cai et al. (2002), and Weeks and Yao (2003) also reported the same results in Chinese regions. In the same study, Weeks and Yao (2003) found evidence to reject the hypothesis that interior and coastal Chinese provinces displayed the same rate of technical progress and, subsequently, the hypothesis that both groups are converging to distinct steady

[1] Several papers mention the existence of factor mobility-limiting institutions: Berkowits and Dejong (2001) discussed trade barriers between Russian regions while Zhai et al. (2003) described the labor mobility-limiting effect of the Chinese household registration system and land policy.

states.[2]

In addition, theoretically, many studies found both a negative and a positive relationship between income inequality and economic growth (Perotti 1996; Li and Zou 1998; Forbes 2000; and Barro 2000). However, there has been no systematically empirical work using econometric models conducted on the issue in the case of Vietnam until now. Thus, this research can be considered a pioneering work in studying regional income inequality and its link to regional economic growth at the provincial level in Vietnam using Theils' indices. The study will go further and analyze the correlation between growth and income inequality at the regional level. It will also test the role played by space or several geographical factors and variables that might exert an impact on the relationship between regional income inequality and regional economic growth.

The study of the convergence/divergence process at the regional and international levels has drawn a great deal of attention from researchers worldwide. The regions extensively studied are the United States (Rey and Montouri 1999; Miller and Genk 2005) and the European regions, especially EU-15 (López-Bazo et al. 1999; Le Gallo and Ertur 2003; Arbia and Piras 2004). Income convergence/divergence in provinces/states in developing countries, such as China (Zhang et al. 2001; Pedroni and Yao 2005) and Brazil (Azzoni et al. 2000) have also been studied. The study on European convergence has revealed two features. First, it is widely accepted that the rate of convergence in these regions is quite low.[3] The second feature refers to the geographical distribution of economic activities. Some

[2] For further analyses exploring the potential determinant of regional inequality, see Tian (1999), Zhang and Kanbur (2001), Fedorov (2002), and Dolinskaya (2002). The literature dealing with Chinese regions is more extensive than that for Russia. Therefore, only selected studies are mentioned in this chapter. For a more detailed discussion, see Demurger et al. (2002).
[3] This rate of convergence (<1% per year) is considered low compared with the rate generally agreed upon in literature which is 2 percent per year (see, among others, Barro and Sala-I-Martin 1991, 1995; Armstrong 1995; Ertur et al. 2006).

studies (by, among others, López-Bazo et al. 1999; Le Gallo and Ertur 2003; Magrini 2004) have noted that European regions were divided into two groups: rich groups in the north and poor regions in the south. This observation can be linked to several characteristics of New Economic Geography, including agglomeration and the cumulative processes that spatially determine the location of economic activities (Krugman 1991). For example, it is thought that a region that borders rich regions is more likely to have high economic growth than another region surrounded by poor regions. This point refers to spatial interactions (or spatial/spillover effects) among neighboring regions, which is especially relevant at the regional level.

In Vietnam, most empirical studies on the issue of regional income inequality have been conducted by the World Bank and the General Statistical Office (GSO) of Vietnam over the years, based on the various rounds of the Vietnam Living Standards Survey. These studies found an increase in regional income inequality as well as inequality between the rural and coastal regions as the Gini index increased from 0.345 in 1990 to 0.432 in 2011. However, there is still a lack of systematic studies focusing on regional income inequality and its linkage to regional economic growth in the country. In his PhD thesis, Nguyen Huy Hoang (2009) reported evidence of increased regional income inequality and spatial effects in Vietnam from 1990 to 2006. In another study, Nguyen Huy Hoang (2010a, 2010b) found some relationship between regional income inequality and regional economic growth. However, these studies lack an analysis of the pattern of regional income in Vietnam and a discussion of whether regional income has diverged or converged since the economic reforms. This study aims to bridge this gap.

According to a 2006 World Bank report, inequity of welfare in general and regional welfare inequality in Vietnam in particular has grown significantly since the implementation of the economic reform called Doi Moi started in 1986. In the same report, the World Bank discussed the evolution of regional inequality in health and education and found that per capita income shows disparities in the health and education sectors among provinces and regions in Vietnam. As the statistics on provincial growth rate reveal, regional income in Vietnam has been diverging as the rich provinces recorded a faster rate of economic growth than the poor ones. This is in direct contrast with the inequality trend found in most developed countries like the United States and the European Union where the poor regions had a higher rate of growth than the rich ones (Barro 1991 and Fingleton 2003). In Vietnam, rich provinces still enjoy a faster rate of economic growth than poor provinces, something that is in line with the findings of Kuznets (1955) in his well-known work on the link between inequality and growth.

Vietnam is currently in the initial stage of its economic development. Since its implementation of the comprehensive Doi Moi program, its economy has shifted from a centrally planned to a market-oriented one. Various explanatory studies conducted by the World Bank and the GSO over the years make it clear that regional income in the country has been diverging over time as the rate of economic growth sped up. The statistics provided in the yearbooks published by the GSO reveal that the rate of economic growth in wealthier regions is higher than that in poorer regions. In addition, data from studies done by the World Bank (2005) on provincial income reveal the trend of regional differences in per capita income in Vietnam and it implicitly reflects the potential causal correlation between disparities in regional per capita income and the regional rate of economic growth.

3. Methodology

The study uses two different frameworks to find answers to the research questions. These two frameworks are presented as follows:

3.1. The concept of convergence/divergence and a model to test for

convergence/divergence:

To more accurately investigate whether the data are consistent with convergence or divergence, we begin with a formal definition of what we mean by the concept of convergence since there are two concepts regularly mentioned in the literature on economic growth: beta-convergence (β-convergence) and sigma-convergence (σ-convergence). In addition, we would also mention a definition of income convergence in keeping with the study by Evans (1998) for an international panel of country-level data. This notion of convergence asks whether or not the long-run forecasts for output differences converge as the forecasting horizon increases, which implies that the long-run income gap between any two nations must be stationary.

We start with an elaboration of β-convergence and σ-convergence. The first form, β-convergence, has been the primary focus of macroeconomics. It occurs when the growth of poor regions is faster than that of the rich ones, resulting in the former eventually catching up to the latter in per capita income levels. The second form, σ-convergence, refers to the decline in the cross-sectional dispersion of per capita incomes. In the literature on economic growth, several different measures have been used to examine σ-convergence, including unweighted standard deviation and the coefficient of variation of the log of per capita income (see Carlino and Mills 1996b and Bernard and Jones 1996, among others). This form, σ-convergence, has attracted much attention from researchers (among others, Kuznets 1955; Easterlin 1960a, 1960b; Williamson 1965; Amos 1988). In other words, σ-convergence is the process when country-level inequality tends to reduce over time. Generally, β-convergence tends to generate σ-convergence: when the poor regions grow faster than the rich ones, the result is the reduction in the differences in per capita income across individual regions.

Vietnam is in its initial stage of development. The regional GDP per capita is still diverging since the poor regions are still lagging behind the rich regions in terms of growth rate. To be more precise, the gross regional product (GRP) per capita is in the divergent process. For this reason, we will not look at σ-convergence because inequality is still increasing in the country. For β-convergence, there are two distinct convergence notions to be considered: absolute (unconditional) β-convergence and conditional convergence.[4] The concept of β-convergence directly comes from neoclassical theory. This theory stipulates that in the long run, per capita GDP growth depends only on exogenous technical progress. When applied to several economies, there are different situations that need to be distinguished. If the economies share the same structural characteristics (e.g., in terms of human capital, savings rate, production function, etc.), the convergence in GDP per capita and growth rate is present (Debarsy and Ertur 2006). However, if the structural characteristics differ among economies, only a convergence in growth rate is observed. In this case, we talk of absolute (unconditional) β-convergence because the long-run equilibrium is the same for all economies. The concept used is thus conditional β-convergence. To test the absolute (or unconditional) convergence process, we use the specification developed by Barro and Sala-I-Martin (1995) for cross-sectional data as follows:

$$y_T = \alpha + \beta y_0 + \varepsilon \qquad (1)$$

where y_T is the *(N,1)* vector of log average annual growth rate of per capita GDP, N is number of observations, T is the number of periods under study, and y_0 is the log per capita GDP in the initial period. We assume that ε is a vector of normally distributed random error terms with means 0 and homoskedastic variance σ^2. Convergence is observed if β is negative and significant. In fact, the growth rate is then negatively correlated with the level of per capita GDP.

[4] The literature makes a distinction between conditional and unconditional (absolute) convergence, with the former pertaining to the partial correlation of the growth rate and initial level after controlling for a number of additional variables reflecting differences in equilibrium wages and technologies (Barro and Sala-I-Martin 1992).

To test for the conditional β-convergence hypothesis, we need to include conditioning variables. The equation for the test is as follows:

$$y_T = \alpha + \beta y_0 + \gamma S + \varepsilon \qquad (2)$$

with all the variables and notions defined as above and S is a matrix of log conditioning variables. This matrix consists of state variables such as human capital stock (employment rate), public spending on GDP, fertility rate, and school enrolment. Conditional convergence is present if β is negative and significant when X is kept constant.

Two more parameters can be computed based on equations (1) and (2). The first refers to the speed of convergence while the second refers to the time necessary to reach the steady state, which is known in the literature as the *half-life*. The equations to compute the speed of convergence and the *half-life* are as follows:

$$\xi = -\log(1 + T\beta) / T \qquad (3)$$

and

$$\tau = -\log(2) / \log(1 + \beta) \qquad (4)$$

where ξ is the speed of convergence, τ is the half-life, T is the number of periods under study, and β is the convergence coefficient estimated from equations (1) and (2).

However, conventional β-convergence treats regions as "isolated islands" (Quah 1996). It does not capture the fact that the economic performance of a region depends upon those of other regions. In fact, the development of each region is closely correlated with the development of, at the very least, neighboring regions. In this context of spatial dependence, the distribution of regional per capita income is unlikely to be spatially independent. When models are estimated for cross-sectional data, the lack of independence across these units may cause critical problems of model misspecification and biased estimators when ignored (Anselin 1988). In addition, as discussed in the explanatory analysis of the data, we used spatial panel data for this study. One of the advantages of this is that it allowed the use of the spatial econometric method because each observation is geographically located. In fact, until recently, countries and regions were treated as independent economies without any interaction in many studies. Quah (1996) has raised concerns about the neglected spatial dimension in β-convergence. However, on the regional level, spatial spillovers are of interest since each region is likely to interact with neighboring regions. We, therefore, took space into consideration. The explanation of how to take spatial effects into an econometric regression is considered in the next section.

Next, another notion of the convergence test discussed by Evans (1998) was employed. This approach asked whether or not the long-run forecasts for output differences converge as the forecasting horizon increases, which implies that the long-run income gap between any two provinces must be stationary. There has to be an important implicit distinction between this empirical formalization and the informal graphical analysis in the previous section in order for us to conclude in favor of convergence. We also require that the properties of the data must be consistent with the fact that the differences are eventually eliminated and not necessarily that the differences gradually become smaller at some point in time (Evans 1998). To formalize this idea empirically, we can characterize convergence as follows. If we denote y_{it} as the logarithm of per capita output for province i at time t while keeping the difference stationary, and thus exhibit unit root behavior individually. Then any pair of province i and j are said to converge pairwise if the difference ($y_{it} - y_{jt}$) is stationary so that y_{it} and y_{jt} are cointegrated. Analogously, convergence among members of a larger group of provinces is then defined by requiring that every pair within the set exhibit convergence. It should further be noted that if the stationary differences between provinces have nonzero means, then this corresponds to the notion of conditional convergence because convergence is conditional on the province-specific effects. One obvious advantage to this method of focusing on the properties of long-run income gaps as the criteria for convergence is that it directly allows us to infer from long-run forecasts the absence or presence of income disparities between provinces.

For the group of provinces in the empirical study of the Vietnam case, we might test this condition pairwise for all provinces within the sample and then require that the condition hold for each possible pair of provinces. One disadvantage of this approach is that conventional tests for cointegration tend to have low power for such a relatively short sample, so the probability of failing to reject the null of no cointegration for at least some pairs would be quite high regardless of the true relationship. Fortunately, Evans (1998) shows that it is possible to translate these criteria into a single criterion that should apply to the group as a whole when interpreted as a panel. Particularly, Evans demonstrates that the criterion of pairwise convergence for all members of the panel is equivalent to the condition that the difference between the individual series, y_{it}, and the mean value for the series across all members at each point in time, $\bar{y}_t = \frac{1}{N}\sum_{i=1}^{N} y_{it}$, is stationary. Thus, the condition states that all members converge pairwise if $y_{it} - \bar{y}_t$ is stationary for each member $i = 1,2,...,N$ of the panel. Consequently, Evans argues that the null of convergence can be interpreted as the unit root null in the panel unit root test.

As discussed above, in this context, the occurrence of convergence can be determined and evaluated by asking whether or not the autoregressive parameter β_i is zero for the panel data regression given by:

$$\Delta\left(y_{it} - \bar{y}_t\right) = \mu_i + \beta_i\left(y_{i,t-1} - \bar{y}_{t-1}\right) + \sum_{k=1}^{K_i} \phi_{i,k} \Delta\left(y_{i,t-k} - \bar{y}_{t-k}\right) + \varepsilon_{it} \quad (5)$$

where $i = 1,2,3,....,N$ (number of observations - number of provinces in our sample),

$t = 1,2,3,....,T$ (defined as the number of periods under study),

μ_i fixed effects represent the individual province's average sample difference from the group mean ($y_{it} - \bar{y}_t$),

$k = 1,2,3,...,K_i$ is the number of lags in our study, and

ε_{it} is the error terms of province *i* in time *t*.

According to Evans, this specification is an augmented Dickey-Fuller (ADF) regression applied to the panel of income differentials between the individual provinces and the mean income value of the provinces as a group. In this case, the μ_i fixed effects represent the individual province's average sample difference from the group mean ($y_{it} - \bar{y}_t$), which is permitted to vary by province. The autoregressive parameter for the income differentials, β_i, becomes the key coefficient for determining the presence or absence of convergence. The lagged difference terms are intended to capture higher-order serial correlation in the time-series process for income differentials and the number of lags, *Ki*, are chosen in a manner to ensure that the remaining error terms ε_{it} are serially uncorrelated. Under this specification, the null hypothesis of the panel unit root is stated as

$$H_0 : \beta_i = 0 \text{ for all } i \quad (6)$$

against the alternative hypothesis

$$H_1 : \beta_i < 0 \text{ for some } i \quad (7)$$

In case the null hypothesis is rejected, it means that at least some subsets of the members of the panel are converging toward one another. In contrast, if we are not able to reject the null hypothesis, it means that no subset of the members of the panel is converging toward one another.

To test this hypothesis, we employed the panel unit root tests (IPS tests) used by Im, Pesaran, and Shin (2003), which allow the value for the autoregressive coefficient, β_i, under the alternative hypothesis to vary across provinces. In contrast, the panel unit root tests by Levin et al. (2002) employed in the first generation of panel unit root convergence tests, such as Evans (1998) and Evans and Karras (1996), require the autoregressive coefficient to be homogeneous under the alternative hypothesis so that $\beta_i = \beta < 0$. Thus, more recent tests provide us with the additional flexibility of allowing the convergence dynamics to differ across provinces under the alternative hypothesis. Practically, the Im, Pesaran, and Shin tests are constructed on the basis of averaging the unit root tests for the individuals to produce a group mean test statistic. In one such test, Im, Pesaran, and Shin recommend constructing a *t*-bar statistic, which is based on averaging the individual ADF unit root *t*-tests.

In the context of this study, the procedure of the test is as follows. To compute the statistics, we first need to estimate the ADF regression presented in equation (5) individually for each of the i ($i = 1, 2, \ldots, 61$) provinces of the panel and then construct the 61 corresponding ADF *t*-statistics, t_i. These individual statistics are averaged to obtain the *t*-bar statistic ($\bar{t} = \frac{1}{N}\sum_{i=1}^{N} t_i$). Finally, because the distribution of the individual ADF *t*-statistics are not centered around zero under the unit root null hypothesis, it becomes necessary to adjust for this feature to ensure that the distribution of the *t*-bar statistic does not diverge under the null hypothesis as the number of individual members of the panel, N, gets large. Luckily, under the null hypothesis, the mean of the individual t_i is a known constant as the sample size T

gets large (being the standard deviation of the individual t_i). Consequently, the *t*-bar statistic is adjusted by subtracting off the mean and dividing by the standard deviation so that the statistic becomes

$$\bar{z} = \sqrt{N}\left(\bar{t} - u\right) / s \qquad (8)$$

where *u* is the mean of the individual ADF *t*-statistic distribution, and *s* is the standard deviation of the individual ADF *t*-statistic distribution. As Im, Pesaran, and Shin demonstrate, as long as the individual statistics are independent, this statistic will be distributed as the standard normal under the null hypothesis. Thus, it will diverge to negative infinity under the alternative hypothesis so that large negative values can be taken to reject the null hypothesis.

3.2. Role of space and spatial effects on regional income divergence

In case the Moran's I test and the LM test fail to reject spatial dependence among provinces, we go on to explore spatial effects or the role of space or spatial effects on the patterns of growth in Vietnam's economy. The exploration will be carried on the basis of the right specifications of the spatial models (i.e., whether it is a spatial lag or a spatial error depending on the tests taken based on the coefficient of Moran's I and both Lagrange Multipliers).

Because our data is collected locally, these are associated with spatial units. Thus, the data used for analysis is the spatial data. When a value observed in one location depends on the values observed in neighboring locations, there is spatial dependence. Spatial data may show spatial dependence in the variables and error terms. To consider this, we introduced the spatial effect--namely, spatial autocorrelation, in this section. Spatial autocorrelation refers to the fact that an observation associated with a location depends on other observations in other locations. The analysis of spatial autocorrelation is aimed at detecting spatial dependence among observations in the analysis of β-convergence.

Anselin and Bera (1998) define spatial autocorrelation as “the coincidence of value similarity with location similarity.” In other words, the observation of a random variable in a given location is partly determined by the observation of this variable in neighboring locations (neighborhood being defined by the spatial weight matrix). The absence of spatial autocorrelation is defined by the random spatial distribution of the variable of interest.

The presence of spatial autocorrelation provides further information with respect to traditional statistics like mean or standard errors because it gives us an idea of the geographical distribution of the values of the variable under study. Furthermore, modeling spatial autocorrelation allows taking the existence, influence, and size of geographic spillover effects into consideration. Before discussing the spatial econometric models for spatial interaction, it is important to specify the modeling of interactions among regions. As we use N observations, it is necessary to impose a structure to spatial interactions, which is given by the spatial weight matrix W. The objective of structuring this matrix is to consider a neighborhood relationship for each region. There are some approaches used to construct a weight matrix such as transport time between regions, distance between regions, or binary concept. In this study, we use binary weight matrix which is defined as “1” if two regions share a border and “0” otherwise (Le Sage 2001). We therefore have constructed a binary weight matrix where the connection relation between two regions is defined as either 1 or 0. If the two regions border each other, the element of the weight matrix carries the value of 1; otherwise, its value is 0.

Now we discuss the specifications that capture spatial dependence. There are three types of spatial autocorrelation and sometimes these are jointly present in the same regression. These types are endogenous spatial lag (SAR[5]), spatially auto-correlated errors (SEM[6]), and the spatial cross-regressive model (Anselin 1988; Anselin and Bera 1998). Spatial lag is present when the dependent variable is in a place affected by the independent variables in that place and in the adjacent place while spatial error occurs when the error terms across different units are correlated.

The model from which spatial models can be derived is the classical linear regression model of the form:

$$y = \beta X + \varepsilon \qquad (9)$$

with *y* as the *(N,1)* vector of observation of the dependent variable; *X* as the *(N,K)* matrix of observations of the *K* explanatory variables; *β* as the *(K,1)* vector of the unknown parameters to be estimated; and *ε* as the *(N,1)* vector of the error, ε being *iid* $(0,\sigma^2)$.

The SAR model consists of inserting the endogenous spatial lag, *Wy*, in the set of explanatory variables. Formally, the linear model in (9) is transformed into SAR as follows:

$$y = \beta X + \varphi Wy + \varepsilon \qquad (10)$$

where *Wy* is the endogenous spatial lag and *φ* is the autoregressive spatial parameter expressing the interaction intensity between the observations of the dependent variables. When spatial weight matrix *W* is standardized, $(Wy)_i$ is a weighted average of observations of regions in the neighborhood of region *i*.

The introduction of the endogenous spatial lag in the regression allows for the assessment of the degree of spatial dependence if the effect of other variables is controlled for. In order to see the two effects induced by this specification, write (10)

[5] SAR stands for Spatial Autoregressive model.
[6] SEM denotes Spatial Error model.

in its reduced form:

$$y = (1-\varphi W)^{-1}\beta X + (1-\varphi W)^{-1}\varepsilon \qquad (11)$$

From the reduced form in (11), note that the matrix $(1\text{-}\varphi W)^{-1}$ must be nonsingular.[7] From equation (11), note that the spatially lagged variable *Wy* is correlated with the error term ε. Thus, the ordinary least squares (OLS) estimators would be biased and inconsistent. The simultaneity embedded in the *Wy* term must be explicitly accounted for in a maximum likelihood estimation framework (see Ord 1975).[8]

The reduced form in equation (11) can be written in the inverse spatial transformation under the geometric expansion form as follows:

$$y = (1+\varphi W+\varphi^2 W^2+\varphi^3 W^3+.....)\beta X + ((1+\varphi W+\varphi^2 W^2+\varphi^3 W^3+.....)\varepsilon \quad (12)$$

The first term in the right hand side of the equation (12) presents the spatial multiplier effect, which means that the expected value of *y* in region *i* does not only depend on the value of explanatory variables in this region but also on the value of those variables in all regions under consideration. From equation (12) we observe that this multiplier effect decreases over distance. The second effect is the spatial diffusion effect, which is described by the second term in the right-hand side of (12). This effect, which also decreases over distance, indicates that a random shock hitting a given region will gradually affect all regions under consideration.

Another way to deal with spatial dependence effects is to introduce an exogenous spatial lag variable (Rey and Montouri 1999). In this model, spatial dependence in the process of regional convergence can be incorporated by a spatially lagged explanatory variable *Wx*:

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[7] This condition is satisfied if the absolute *value of* $\varphi \neq 0$ and when $1/\varphi$ is not an eigenvalue of *W*.
[8] For more details, please refer to Anselin (1988), Anselin and Bera (1998), and Anselin (2001).

$$y = \beta X + \eta W x + \varepsilon \qquad (13)$$

For this specification, because the spatially lagged explanatory variable is exogenous, estimation of the spatial cross-regressive model can be based on the OLS method.

In addition to spatial lag, spatial autocorrelation may be present under another form; namely, spatially autocorrelated errors (SEM). This type of autocorrelation is preferred when autocorrelation is viewed more as a nuisance than a substantial parameter (see Florax and Nijkamp 2004). Formally, the SEM model is as follows:

$$\begin{aligned} y &= \beta X + \varepsilon \\ \varepsilon &= \varphi W \varepsilon + u \end{aligned} \qquad (14)$$

where φ is the spatial autoregressive coefficient and u is the vector of errors with the usual characteristics. The error u is independent and identically distributed with mean zero and variance σ^2. The parameter φ reflects the intensity of the interdependence between residuals. According to Anselin (2001), due to nonspherical errors, OLS estimators are inefficient and the maximum likelihood method or the generalized method of moments is preferred.

By substituting the second equation for the first one in equation (14), we get the reduced form of the SEM model:

$$y = \beta X + (1 - \varphi W)^{-1} u \qquad (15)$$

Similar to the previously discussed SAR model, the matrix $(1\text{-}\varphi W)^{-1}$ must be nonsingular. From equation (15), we can see that the SEM model includes only a spatial diffusion effect as the term βX is not premultiplied by the inverse spatial transformation.

The process of estimation is as follows. First, we will estimate β using the OLS regression of both the unconditional and conditional models presented in equations (1) and (2), respectively. Based on the results, the speed of convergence and *half-life* presented respectively in equations (3) and (4) will be computed. Based on the diagnostics for spatial effects, the spatial dependence models will be implemented using the maximum likelihood method.

3.3. Data sources and types

The study used time series data and panel data collected from various sources (e.g., provincial-level data from the GSO and provincial statistical offices or PSO). Income was measured using real gross regional product (GRP) per capita adjusted to 1994 prices. The per capita growth rate was gathered from the statistical yearbook published yearly by the GSO and the PSO. The rate is based on the differences between two subsequent years.

This study focuses on growth from 1990 to 2011 due to the availability of data for this period. Vietnam's Doi Moi program, in fact, started before 1986, but the lack of statistical data from the years before 1990 and the lack of reliable sources for such data constrained us to focus our analysis for the period covering 1990 to 2011. Since the study deals with the regional level, the present work will mostly be based on regional data at the provincial level and will be a cross-section of the data on per capita income and GDP growth.

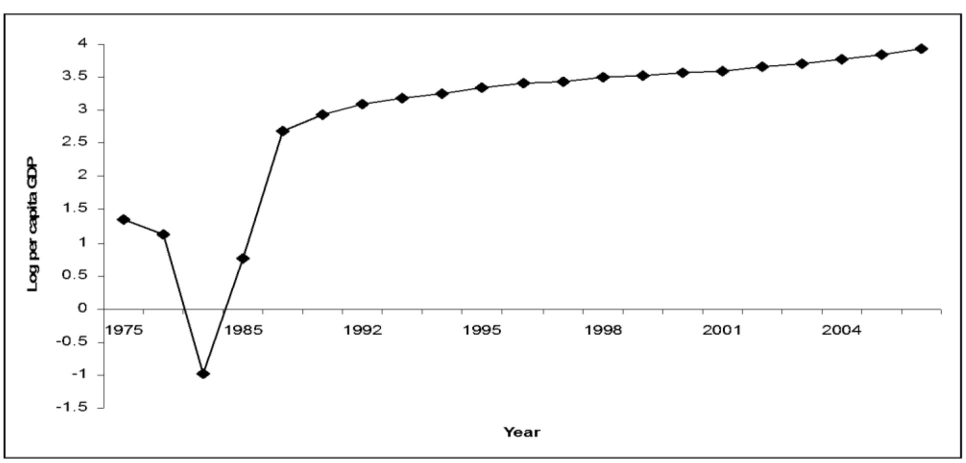
4. Informal data analysis of income convergence/divergence in Vietnam

This section is primarily an informal examination of the raw data. The data used spans a 17-year period (1990 to 2006) and consists of the provincial GDP for 61 provinces. The provincial GDP was obtained from Vietnam's GSO and is based on yearly statistics. In order to study income convergence, we used total population in combination with GDP and deflated by provincial GDP deflators to generate real per capita GDP by province. The GDP deflator takes the price of 1994 as 100 percent.

As has been previously mentioned, spillover effects play an important role in fostering the economic growth of neighboring regions. From this point, we need to think about borderless regions characterized by the lack of restrictions on the movement of commodities and technologies. The free flow of commodities and technologies is underpinned by the belief that the growth of any region is affected by its neighbors' performance. Despite its relative importance to regional studies, this issue has been ignored thus far by most researchers in this field because of the problems inherent in capturing the spatial effects in regression. However, the spatial econometric tools developed by Anselin (1988) and other econometricians might be a workaround for this difficulty. These tools allow one to capture spatial dimension in an econometric regression. Problems caused by taking space into consideration in econometric regression have two dimensions, that is, space interferes in two different ways on estimators. These are called spatial effects. When we worked on data from Vietnam's provincial regions, we, of course, thought of correlation among observation units. In other words, the observation of a variable in a location is partly affected by the observation of the same variable in adjacent locations. This effect is called spatial autocorrelation and refers to the existence of dependence among regions. In addition, if we think of the fact that economic relationships and behaviors differ across regions (e.g., rural versus urban behavior and economic performance) we would talk of the second spatial effect called spatial heterogeneity. In Vietnam, there is still a lack of studies on this topic. This particular study, therefore, can be considered pioneering in exploring regional income divergence in Vietnam and the role of space in its course.

Vietnam's picture of economic growth changed significantly following the implementation of the Doi Moi in 1986. The program attracted incentives in all economic sectors and opened up the economy to foreign trade and investment. Real per capita income grew at around 2.2 percent per annum on average for almost 10 years after the unification of the country in 1975 up to the time that the Doi Moi was implemented. Growth during this period was quite erratic. The economy was in recession in the first half of the 1980s with failures in agriculture and industry caused by the mismanagement of the economy. When the Doi Moi was implemented in 1986, the large influx of foreign direct investment and the increase in two-way trade between Vietnam and other countries around the world resulted in dramatic economic growth. With these positive changes, the economy experienced a period of unprecedented rapid and steady growth of more than 7 percent from 1990 to 2006, but this growth rate has slowed down in recent years. The contrast in economic growth before and after the Doi Moi can be seen in figure 1, which depicts the average real log per capita income for the 61 provinces for which data is available as far back as 1975. It should be noted that the data for the real per capita GDP growth from 1975 to 1990 was the national average; it was not available for each individual province. As the picture shows, the period covering the time before the implementation of the Doi Moi and the starting year of the Doi Moi was characterized by the unsteady growth with relatively wide fluctuations in per capita income. Since the Doi Moi, and particularly since 1990, the growth of per capita GDP was steady (fig. 1).

Figure 1. Average provincial per capita GDP at constant 1994



The most important achievement of the Doi Moi is the outstanding economic growth that resulted from its implementation. Over the last 10 years, Vietnam's economy has been growing at an impressive rate, enabling per capita income to almost quintuple. Vietnam is currently one of the fastest-growing economies in the world. Table 1 shows the average annual growth rate of the real per capita GDP of all the provinces from 1990 to 2006. It is evident that this high growth rate was sustained over the last 15 years. For the country as a whole, the average growth rate of per capita GDP during this period (1990—2006) was 7.8 percent while the average growth rate of per capita GDP before the Doi Moi (1975--90) was very low, somewhere at 3.5 percent annually, according to data from various statistical yearbooks. Because of the lack of statistics on economic performance for the pre-Doi Moi period, we are unable to provide illustrations of the per capita GDP growth rates of the provinces covered in this study during that time. However, as has already been discussed, Vietnam's economy was in deep recession in the years before the Doi Moi was implemented.

The acceleration of economic growth in provinces across Vietnam has been very broad-based. The average annual growth rates in all provinces during the Doi Moi were quite high at 7.8 percent, much higher than the growth rate before the Doi Moi (1976--90), which stood at around 2.2 percent. In particular, many of the metropolitan cities and provinces that attracted several FDI projects (e.g., Hanoi, Hai Phong, Vinh Phuc, Bac Ninh, Da Nang, Binh Duong, and Ho Chi Minh City) enjoyed high growth rates in per capita GDP compared with the rates recorded by other provinces that did not attract the same number of FDI projects (see table 1). However, the annual growth rates of per capita GDP over time during the Doi Moi period vary significantly across provinces. As reported in table 1, the standard deviation of the growth rate between the province with lowest rate and the one with highest rate is more than 300 percent. The slowest-growing province, Dak Lak, posted an average annual growth of only 4.02 percent while the fastest-growing province, Vinh Phuc, grew an average of 13.93 percent from 1990 to 2011. Many provinces recorded high growth rates of between 5 percent and 10 percent but there were six that managed to grow at double-digit rates.[9] Five of these six provinces were located either in the northern part or in the southern part of the country which were considered as the richer regions in Vietnam. Only one of the six, Da Nang, is in the south central coast, which is considered as the economic center of the country's central coastal region. Interestingly, however, in geographical terms, not all the provinces in the north or in the south have been enjoying faster growth than the provinces in the other regions of the country. For example, looking at the statistics provided in table 1, the rates of growth average from around 7 percent to 9 percent in most provinces in all the regions, not only in the north, in the south, or in the coastal area but also in the central highlands as well. Thus, there is no indication of which region appears to possess the conditions necessary to bring about the highest growth rates or enhance the current growth rate.

Table 1. Growth performance of the provinces in Vietnam during Doi Moi

Average annual growth rate of per capita GDP during Doi Moi (1990--2011)			
Province	Rates	Province	Rates
Hanoi	10.31	Da Nang	10.35
Hai Phong	7.24	Quang Nam	9.16
Vinh Phuc	13.93	Quang Ngai	7.98
Ha Tay	7.53	Binh Dinh	7.37
Bac Ninh	9.79	Phu Yen	9.24
Hai Duong	7.61	Khanh Hoa	8.96
Hung Yen	8.87	Kon Tum	8.69
Ha Nam	7.03	Gia Lai	6.45

[9] These provinces are Hanoi, Vinh Phuc, Ha Giang, Da Nang, Binh Duong, and Ba Ria-Vung Tau whose average annual growth rate in per capita GDP over the 1990--2006 period were 10.31 percent, 13.93 percent, 10.68 percent, 10.35 percent, 10.68 percent, and 10.41 percent, respectively.

Nam Dinh	6.04	Dak Lak	4.02
Thai Binh	6.27	Lam Dong	6.69
Ninh Binh	7.69	Ho Chi Minh City	7.87
Ha Giang	10.68	Ninh Thuan	5.13
Cao Bang	9.50	Binh Phuoc	6.24
Lao Cai	5.98	Tay Ninh	9.45
Bac Kan	7.20	Binh Duong	10.68
Lang Son	7.84	Dong Nai	9.26
Tuyen Quang	7.10	Binh Thuan	8.39
Yen Bai	7.95	B. Ria - V. Tau	10.41
Thai Nguyen	6.56	Long An	6.42
Phu Tho	6.83	Dong Thap	6.55
Bac Giang	6.20	An Giang	8.05
Quang Ninh	8.82	Tien Giang	7.04
Lai Chau	5.70	Vinh Long	7.25
Son La	7.27	Ben Tre	7.76
Hoa Binh	6.72	Kien Giang	6.92
Thanh Hoa	6.10	Can Tho	7.49
Nghe An	6.70	Tra Vinh	7.76
Ha Tinh	5.99	Soc Trang	7.02
Quang Binh	7.53	Bac Lieu	8.75
Quang Tri	7.43	Ca Mau	6.45
Thua Thien - Hue	7.59		

Source: GSO, Vietnam (Statistical Yearbook).

We now illustrate by graphical analysis some of the key features of the provincial growth process during the Doi Moi period based on the available data. These illustrations help us gain a broad sense of the tendencies toward income convergence or divergence (since the start of the Doi Moi) among the 61 provinces covered in this study before we carry out more formal tests for convergence using econometric tools.

To illustrate the provincial growth pattern, we examined Ba Ria-Vung Tau, the richest province among the 61 studied. Ba Ria-Vung Tau is rich in natural resources, especially crude oil, and thus is home to many companies in the crude-oil extraction field. Contrast this with those provinces that are catching up to Ba Ria-Vung Tau but are falling behind in terms of per capita GDP such as Hanoi, Ho Chi Minh City, Hai Phong, and Binh Duong. Figure 2 shows the extent to which the average per capita income of these provinces is approaching that of Ba Ria-Vung Tau. The figure shows that the provincial average incomes of all provinces in this group, excluding Ba Ria-Vung Tau, seem to converge or approach one another while that of Ba Ria-Vung Tau slightly diverges. Figure 3 shows the average per capita income of Ba Ria-Vung Tau in comparison with the mean income of the richest group (excluding Ba Ria-Vung Tau) and the mean incomes of the falling-behind groups such as those in the north central coast. The northeast excludes relatively higher-income provinces as Thai Nguyen, Phu Tho, Quang Ninh, and the entire northwest. We observe from figure 3 that the per capita incomes within the considered clusters seem to be diverging. The richest province, Ba Ria-Vung Tau, and the high-income group consisting of Hanoi, Ho Chi Minh City, Hai Phong, Da Nang, and Binh Duong, are diverging from the falling-behind groups such as the north central coast, the northeast, and the northwest. The only sign of convergence was within the low-income group.

Many studies of the Vietnamese economy tend to categorize provinces simply into mountainous provinces versus lowland provinces since, historically, there has been a significant difference in their relative growth rates. However, this trend seems to be shifting as provincial growth rate is currently different among provinces with many FDI projects and those without, or fewer, FDI projects. In fact, FDI projects usually went to lowland provinces due to their advantages in terms of the available labor force, transportation, and infrastructure. Thus, in general, lowland provinces throughout Vietnam still seem to enjoy higher growth rates except in several cases where provinces in the central highlands and some provinces in the mountainous northern part of the country enjoyed advantages in sectors such as industrial crop production, mining, or tourism.

If we refer to convergence as the narrowing of interprovincial income differences, it seems that there is relatively little overall convergence among clusters of all provinces when we examined the income pattern over the entire sample period. Furthermore, figure 3 shows that regional clusters, including rich and poor provinces, fail to converge toward one other. This means that interregional income disparities are likely to continue to diverge.

The informal analysis based on the growth rate presented in table 1 and on the graphical presentation in figures 2 and 3 can help in developing a sense of the extent of the convergence or divergence present in the data used for the analysis. In order to determine if the data is, in fact, consistent with long-run convergence or divergence in a formal sense, we turn to the next section where a more systematic empirical analysis and test are conducted.

Figure 2. Average provincial per capita incomes of the high-income provinces relative to the richest province Ba Ria-Vung Tau

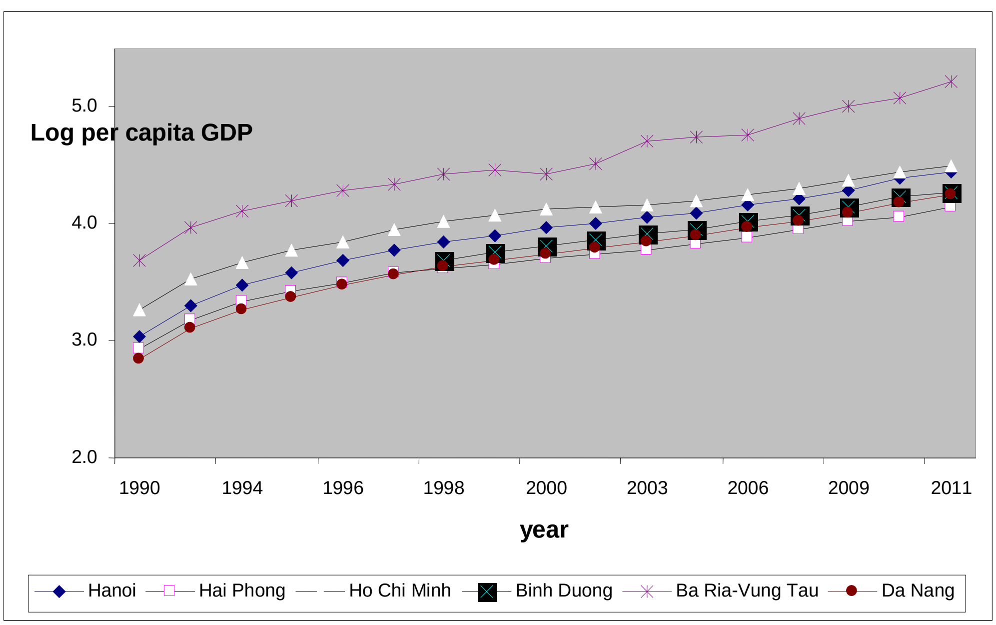
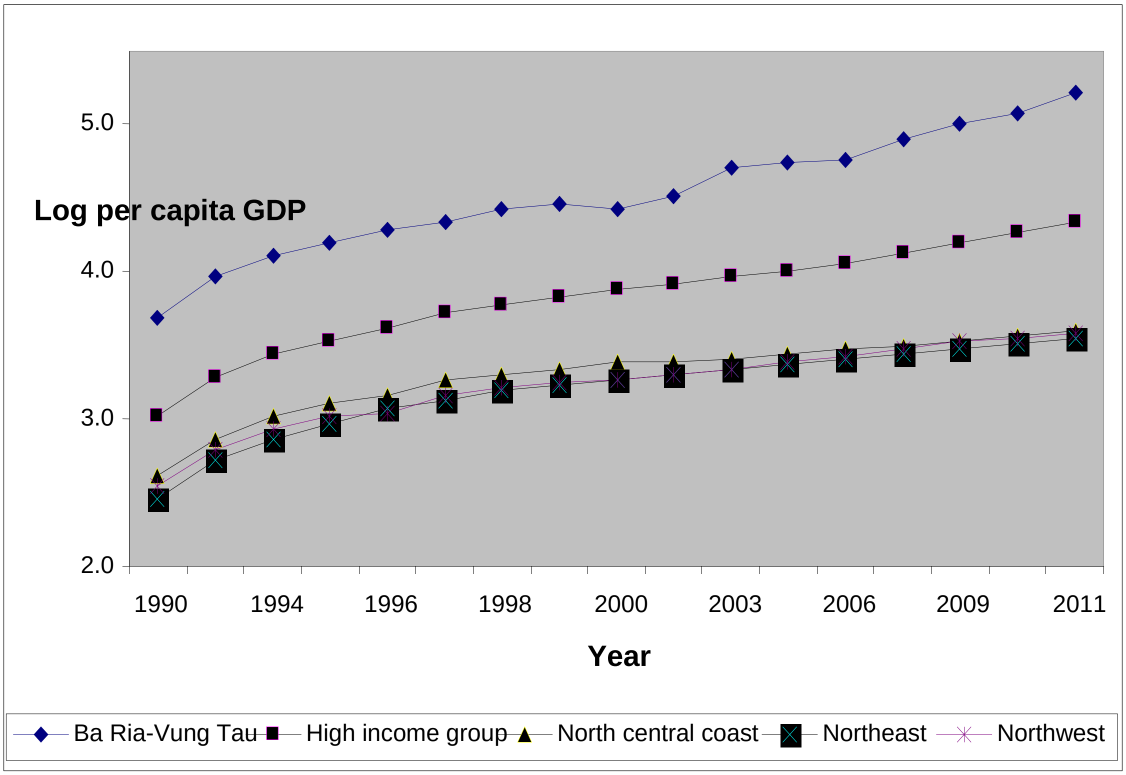


Figure 3. Richest province and high-income group versus poor and falling-behind clusters



5. Empirical Results

This section reports the empirical results and the test for convergence that was developed theoretically and empirically. It also explores the role of space in the patterns of economic growth based on the models given in section III.

5.1. Absolute β-convergence

For the absolute β-convergence, we will apply the tools of spatial econometrics developed by, among others, Cliff and Ord (1973), Anselin (1988), and Anselin and Florax (1995) to test for unconditional β-convergence (absolute β-convergence*)* expressed in equation (7.1). This exercise covers the provinces of Vietnam for the period 1990--2006. We worked on unconditional β-convergence due to the lack of information on potential control variables presented in equation (7.2) for the case of conditional β-convergence.

First, we estimated model (7.1) for the analysis of unconditional β-convergence using the OLS technique. Taking variables of interest into account, the model to be estimated becomes:

$$y_T = \alpha + \beta y_{1990} + \varepsilon$$

with y_T as the vector of the average annual rate of per capita GDP growth in logarithms for each province between 1990 and 2011, T=21, y_{1990} as the vector containing the observations of the per capita GDP in logarithms in 1990, α and β as the unknown parameters to be estimated, and ε as the vector term with the usual properties. The estimation results are summarized in table 7.2.

Table 7.2. OLS results of the absolute β-convergence and diagnostic tests for spatial autocorrelation

Dependent variable: y_T		**Tests for spatial dependence**	
R^2 adjusted	0.5074	*Moran's I (error)*	0.382
			(0.702)
s^2	0.2611	LM_{ERR}	0.487
			(0.485)
α	-2.1956	LM_{LAG}	0.000
	(0.000)		(0.987)
β	1.7965	RLM_{ERR}	0.492
	(0.000)		(0.483)
Convergence speed	-	RLM_{LAG}	0.005
Half-life	-		(0.942)

Note: Numbers in parentheses are the p-values; Moran's *I* is the Moran test for spatial autocorrelation. LM_{EER} and LM_{LAG} are the Lagrange Multiplier statistics which test for the presence of spatial autocorrelation in the errors and an endogenous spatial lag, respectively. RLM_{EER} and RLM_{LAG} are their robust counterparts.

Results from the estimation of the model (7.1) presented in table 7.2 show that the estimated β parameter is positive (1.7965) and highly significant with a high overall fit (adjusted R^2 is above 0.50), which means that an absolute convergence process is not present in this studied sample. We, therefore, will not compute the convergence speed[10] and the half-life.[11]

Given the economic intuition that provinces are correlated by factors like international trade or knowledge spillovers, we have checked for the presence of spatial autocorrelation. The most commonly applied statistic to test for the presence of spatial dependence is Moran's I. If significant, the sample is not randomly distributed and spatial autocorrelation is present among observations. However, this test does not specify the nature of dependence. If it is significant, we first have to try to include more exogenous variables. If not possible because of the lack of these exogenous variables in this study, we must perform specification tests that will help us determine the nature of spatial dependence.

The right-hand side of table 7.2 reports the results of a number of diagnostics for spatial dependence. Three different tests for spatial dependence are included: a Moran's I test, two Lagrange Multiplier tests (*LM – error and lag*), and two Robust Lagrange Multiplier tests (*RLM – error and lag*). According to a study by Anselin and Rey (1991), the first test is very powerful against both forms of spatial dependence: spatial lag and spatial error autocorrelation. Unfortunately, it does not allow for the separation between these two forms of misspecification. In contrast, the robust tests have displayed good power against a specific alternative in an extensive set of Monte Carlo experiments (Anselin et al. 1996). In our sample, all tests included Moran's I, and the two types of Lagrange Multiplier tests were

[10] The convergence speed, ζ, is computed using equation (7.3).
[11] Half-life τ is calculated from the expression in equation (7.4).

allowed to enable us to reject any presence of spatial dependence because all the tests are not significant with very high p-values. We, therefore, ruled out any spatial effects among the observations in our sample.

5.2. ADF (IPS) test for unit root

The ADF (IPS) test for unit root further confirmed our suggestion in Section II: informal data analysis of income convergence indicates that there was no convergence in per capita income among the provinces in Vietnam as all the tests provided in table 7.2 rejected the null hypothesis of the per capita GDP convergence in our sample. To further consolidate this conclusion, we used Evans' approach (as discussed in Section 3.1) to further test for per capita income convergence among the regions in Vietnam using the ADF test. To do this, we applied the IPS *t*-bar test for the entire sample for the period 1990 to 2011. The results of the test are in table 7.3. In this exercise, the lag truncation for the individual ADF unit root regressions was allowed to vary by individual province for both the individual tests as well as the panel-based test. In each case, the length of the lag was selected by a standard data-dependent step-down procedure, which is typically implemented for the ADF unit root test in time series regressions. The step-down procedure involves starting with a sufficiently large number of lags and then sequentially eliminating the highest-order lags one at a time until one of the tests is significant. In our study, we allowed this procedure to choose a different lag truncation for each province. For the arbitrary initial starting value, we rounded off to the nearest integer of 1/5 of the sample length. This means that in our sample with T=22, we started with the highest lag of 3 and then allowed the automated data-dependent procedure to choose the actual number of fitted lags, which then varied between 0 and 3. Because the test with different lags was not significant, we reported only the results for the case with a maximum truncation of 3.

Consider first the results of the tests for individual provinces reported in table 7.3. The first column to the right of the province name gives the value for the individual ADF *t*-statistic for a particular province computed using equation (7.8). The next column reports the associated marginal significant level known as "p-value" for the given ADF *t*-statistic. Based on the p-values, we see that only three provinces (Ha Giang, Cao Bang, and Bac Kan) are able to reject the unit root null at 5 percent significance level or better while the remaining provinces are unable to reject (and indeed did not even come close to rejecting) the null hypothesis of the unit root as the provided statistics are far from rejecting the null hypothesis. This points to the likelihood that, on balance and as discussed earlier (refer to the discussion in subsection 3.1 of the methodology), the majority of the provinces are not converging towards one another since we cannot reject the panel unit root null hypothesis for the differences ($y_{it} - \bar{y}_t$). On the other hand, the fact that a small subset of provinces provides rejections leads us to consider the possibility that there may be small subgroups with income convergence. In addition, even the combined evidence does not reject the null hypothesis of the unit root as the *t*-bar statistic for the panel test reflects this; the ADF test is not significant (last row of table 7.3 gives the panel IPS *t*-bar statistics of –0.548 with a p-value of 0.981). Thus, again we state, based on both the absolute β-convergence, Moran's I test, and the unit root test for cointegrated, that there is no sign of global convergence in per capita GDP in Vietnam.

Table 7.3. Individual provincial ADF tests for unit root

Province	ADF	p-value	Province	ADF	p-value
Hanoi	-1.056	0.936	Da Nang	-1.335	0.879
Hai Phong	-0.460	0.985	Quang Nam	-0.859	0.960
Vinh Phuc	-0.728	0.971	Quang Ngai	-1.530	0.819
Ha Tay	-0.674	0.975	Binh Dinh	-1.196	0.911

Bac Ninh	-0.989	0.946	Phu Yen	-1.258	0.898
Hai Duong	-1.445	0.847	Khanh Hoa	-1.653	0.771
Hung Yen	-2.138	0.525	Kon Tum	-2.384	0.388
Ha Nam	-1.191	0.912	Gia Lai	-1.533	0.817
Nam Dinh	-0.201	0.991	Dak Lak	-0.548	0.984
Thai Binh	-1.598	0.793	Lam Dong	-1.517	0.823
Ninh Binh	-0.454	0.985	Ho Chi Minh City	-2.398	0.381
Ha Giang	-8.244	0.000	Ninh Thuan	-0.797	0.966
Cao Bang	-3.487	0.041	Binh Phuoc	-0.409	0.987
Lao Cai	-0.694	0.974	Tay Ninh	-1.496	0.831
Bac Kan	-3.911	0.017	Binh Duong	-2.289	0.440
Lang Son	-1.769	0.719	Dong Nai	-2.282	0.441
Tuyen Quang	-1.075	0.933	Binh Thuan	-0.172	0.992
Yen Bai	-0.990	0.945	Ba Ria-Vung Tau	-1.080	0.932
Thai Nguyen	-1.126	0.925	Long An	-0.824	0.964
Phu Tho	-1.288	0.891	Dong Thap	-1.565	0.806
Bac Giang	-0.948	0.951	An Giang	-2.063	0.567
Quang Ninh	-1.242	0.901	Tien Giang	-1.690	0.755
Lai Chau	-2.044	0.577	Vinh Long	-0.871	0.959
Son La	-1.567	0.805	Ben Tre	-2.477	0.339
Hoa Binh	0.785	1.000	Kien Giang	-1.876	0.667
Thanh Hoa	-0.510	0.983	Can Tho	-1.424	0.854
Nghe An	-1.061	0.935	Tra Vinh	-2.175	0.504
Ha Tinh	-1.888	0.661	Soc Trang	-2.504	0.326
Quang Binh	-1.193	0.912	Bac Lieu	-1.809	0.701
Quang Tri	-0.436	0.986	Ca Mau	-1.933	0.637
Thua Thien-Hue	-1.287	0.891		**ADF**	**p-value**
Panel IPS-tbar				***-0.548***	***0.981***

Consequently, we next considered the possibility that the apparent absence of convergence nationally can be attributed to the possibility that at least some subsets of provinces are converging to separate regional clubs or that there is local convergence or any convergence club in the country. We are aware that the results for the full sample of provinces already indicate the unlikelihood of global convergence since we cannot reject the possibility that there is no sizeable subset of provinces that converge pairwise within the sample. Given the presence of sampling variation and the fact that we cannot say *a priori* what constitutes a sufficiently sizeable subset on the basis of the full sample results, the convergence properties of the candidate subsets of provinces is worth further investigating. For example, we may propose that differences in geography or differences in preferential open-door policies at the provincial level might generate a convergence club among the provinces of Vietnam. Some possible clubs might be the high-income group versus the coastal and the geographically interior groups.

We now examine various regional subgroupings for the possibility of geographically based convergence clubs. We designed the high-income group versus the central coastal group, the north interior group, and the south interior group. The last two groups are for the interior groupings. As has already been described earlier, our sample of a high-income subgroup consists of six provinces with high per capita GDP. The central coastal subgroup consists of six coastal provinces, excluding the relatively high-income provinces such as Da Nang, Khanh Hoa, and Phu Yen. The north interior subgroup consists of five low-income provinces in the mountainous northern region while the south interior subgroup consists of seven low-income provinces in the southeast and the Mekong River Delta, excluding the coastal and high-income provinces in these regions. Table 7.4 shows the group results of the ADF test for these groupings for both the individual provinces and for the subgroups as a whole (i.e., the panel test) in the last row. Notice that, statistically, the individual test values for the same province tend to differ depending on the grouping in which it is included (in table 7.4) compared to the whole country as a sole group (in table 7.3). This difference is because when we test ($y_{it} - \bar{y}_t$), the values for $\bar{y}_t$ differ between groups compared to the whole country. Look at the results of the ADF test for each province individually. In all the groups, we were able to reject the null hypothesis that all of the ($y_{it} - \bar{y}_t$) are nonstationary for one province in each group. In the group of high-income provinces, the ADF test for unit root was able to reject the null hypothesis for the case of Da Nang at 0.1 significance level with a p-value of 0.006. In the central coastal group, the IPS test was able to reject the null of unit root for the case of Quang Nam province at almost all significance levels (p-value of 0.000). The IPS test was also able to reject the null hypothesis of unit root for the case of Son La province in the northern interior group and Dong Thap province in the southern interior group (p-values of 0.004 and 0.000, respectively). We, therefore, state that there is no convergence club in the country. This finding strongly contradicts the presumed presence of a separate, high-income convergence club or a central coastal convergence club or a northern interior convergence club discussed above. The last row of table 7.4 provides the panel IPS *t*-bar for the ADF test for convergence clubs (convergence subgroups). The panel IPS test failed to reject the null hypothesis of unit root for any groupings. The panel IPS *t*-bar tests for the group of high-income provinces have a high p-value of 0.258. Meanwhile, the high p-value for the group of central coastal provinces is 1.000; for the northern interior provinces, 0.808; and for the southern interior provinces, 0.189. Thus, we can see that there is no sign of per capita GDP converging in any groupings of the provinces.

Table 7.4. ADF test for geographic subgroupings

Province	High-income subgroup		Central coast group minus high income		Northern interior		Southern interior	
	ADF	p-value	ADF	p-value	ADF	p-value	ADF	p-value
Hanoi	-	0.159	-	-	-	-	-	-

	2.909							
Hai Phong	-1.040	0.938	-	-	-	-	-	-
Da Nang	-4.102	0.006	-	-	-	-	-	-
Ho Chi Minh	-1.695	0.753	-	-	-	-	-	-
Vung Tau	-1.209	0.908	-	-	-	-	-	-
Binh Duong	-1.780	0.714	-	-	-	-	-	-
Thanh Hoa	-	-	-1.583	0.798	-	-	-	-
Ha Tinh	-	-	-2.932	0.152	-	-	-	-
Quang Binh	-	-	-1.956	0.625	-	-	-	-
Quang Tri	-	-	-1.879	0.665	-	-	-	-
Quang Nam	-	-	-5.012	0.000	-	-	-	-
Quang Ngai	-	-	-1.761	0.723	-	-	-	-
Ha Giang	-	-	-	-	-2.320	0.423	-	-
Cao Bang	-	-	-	-	-0.267	0.990	-	-
Bac Kan	-	-	-	-	0.335	0.988	-	-
Lai Chau	-	-	-	-	-0.134	0.992	-	-
Son La	-	-	-	-	-4.258	0.004	-	-
Ninh Thuan	-	-	-	-	-	-	-2.185	0.498
Binh Phuoc	-	-	-	-	-	-	2.127	1.000
Binh Thuan	-	-	-	-	-	-	0.087	0.995
Dong Thap	-	-	-	-	-	-	-9.886	0.000
An Giang	-	-	-	-	-	-	0.253	0.996
Tien Giang	-	-	-	-	-	-	0.693	0.997
Vinh Long	-	-	-	-	-	-	-0.910	0.955

Panel IPS-tbar	***-2.649***	***0.258***	***1.234***	***1.000***	***-1.558***	***0.808***	***-2.822***	***0.189***

The results of the absolute *β*-convergence tests for convergence in per capita income and ADF tests (IPS tests) for unit root (evidence for convergence in per capita income) reveal an interesting picture of growth pattern among the provinces during the Doi Moi period. While it is a general phenomenon that usually happens in developing economies, per capita GDP among the provinces in Vietnam does not appear to have converged. Instead, it is more likely to have diverged over the time period covered in our sample during the Doi Moi. This case cannot be explained by the presence of a simple, dual-convergence club that distinguishes between high-income and low-income provinces or between central coastal provinces and interior provinces. As the tests indicated, in all cases, per capita incomes did not appear to be converging toward one another regardless of which groupings we consider.

6. Conclusions and policy recommendations

6.1. Conclusions

In this paper, we have developed the theoretical framework of, and carried out the two different kinds of empirical tests (absolute *β*-convergence test and ADF panel IPS *t*-bar test) for, the convergence in per capita GDP and Moran's I and both the LM tests for spatial dependence among the provinces of Vietnam during the Doi Moi period. We used data covering a 17-year period of high/relatively high economic growth rate from 1990 to 2006 provided by Vietnam's GSO. This exercise presents an important case study for examining regional income differences that accompany rapid economic growth. By using recent econometric developments that account for the time series properties of the data for the IPS *t*-bar test, our primary results confirmed that there is no sign of converging patterns in per capita GDP among the provinces of Vietnam both globally and locally (groupings). Since 1990, per capita incomes in majority of the provinces appear to be diverging away from one another. These findings underscore the idea that these features of Vietnam's experiences may be important in explaining the systematic and persistent regional income divergence that other developing economies experience in their initial stage of development and growth.

In parallel with the test for per capita GDP convergence, the paper also attempted to test for spatial dependence among the provinces in order to explain the growth pattern of one province in relation to that of others. However, Moran's I and both the LM statistics given in table 7.2 did not support our prior assumption of spatial dependence among the provinces in growth progress. This is one of the reasons why we did not go on to examine the spatial effects or role of space in the growth patterns as we initially set out to do.

Historically, experience elsewhere in the world suggests that few countries have succeeded in maintaining political stability under conditions of severe disparity. Despite this fact, Vietnam has never gone through such a circumstance. However, the existence of regional income disparities is of considerable interest as it bears directly on the sustainability of economic reform (Doi Moi) and the open-door policy. The findings from this exercise add to the growing body of literature that further confirms a serious potential risk (if this disparity is not addressed) that growing regional income inequality might harm the stability of Vietnam's economic reform process and slow down future growth. The findings also have important implications for countries in the Southeast Asian region and elsewhere that share similarities with Vietnam in their growth path. There are also good implications here for countries in other regions that are contemplating prospects for greater economic integration. Finally, these findings might help other regional economic groups in developing regions, such as Africa and Latin America, to understand the fact that more rapid growth associated with greater openness to trade in goods and services may also be associated with larger regional income differences.

6.2. Policy Recommendations

The rising regional income disparity in Vietnam is a source of concern for the government because it causes widespread discontent and social unrest. The following are policy options that the government can choose from. This list is not intended to be exhaustive; other options may exist that will provide equally good, or even better, solutions to the problem.

Income Transfer

If market mechanisms do not lead to more equality, the state could intervene through income-transfer programs to help protect poor regions against the risk of fluctuations or shocks. The basic idea is fiscal federalism in which the central government takes responsibility for regional macroeconomic stabilization. Action can be taken through two channels. First, there can be a passive channel of interregional risk sharing with automatic fiscal stabilizers. In this case, an asymmetric shock induces automatic transfers between regions. Second, there can be an active channel of risk sharing in which the central government provides subsidies to regional governments to compensate for the negative effects of a crisis. However, an ill-designed transfer payment scheme, even if well intended, could worsen rather than improve inequality in the long run. For example, an aggressive transfer payment scheme could tax the modern urban sector and then make a transfer payment to rural peasants.

Regional Development Strategy

To reduce regional income inequality and its possible effects on growth and political stability, Vietnam might adopt a clear regional development strategy that favors the disadvantaged areas. Recent efforts to strengthen economic development in the northwestern and central regions show that the government has been aware of the inequality problem and is now moving to tackle this issue.

Nonstate Enterprises

As Vietnam further integrates with global markets, state-owned enterprises (SOEs) face increasing pressure to adjust their production structures to Vietnam's comparative advantage, which may lead to more layoffs. The government could design policies to promote the development of private businesses in disadvantaged regions to reduce the unemployment rate. Because the majority of the poor are located in the lagging northern and central regions where state-owned industries remain the major providers of jobs, the need to speed up the development of nonstate enterprises to compensate for the jobs shed by SOEs is even more urgent.

Social Security

Establishing an effective social security system for the potentially vulnerable population in urban and rural areas is another policy option deserving attention. Since Vietnam established and improved its socialist market economy system in the mid-1980s, it has reformed the social security system practiced under the planned economy. A basic framework for a social security system has been set up corresponding to the market economy system, with the central and local governments sharing specific responsibilities. The reformed social security system has helped to equalize the distribution of unemployed and retired household members' income in urban areas.

Infrastructure

The abolition of the old welfare system has caused a rapid decrease in in-kind subsidies and a corresponding increase in out-of-pocket expenditures on education, health care, and housing for urban residents. This change makes the urban poor more vulnerable to sudden shocks and crises and less likely to develop human capital, reducing their ability to catch up with the rich. In the long run, the government should improve the access of poor people in disadvantaged, usually rural, regions to basic education and health care by increasing infrastructure investments so that all can share the opportunities offered by the economic expansion. Improving rural infrastructure and promoting rural off-farm activities may raise the incomes of the people living in these areas and increase domestic demand which, in turn, could provide a needed vent if the extraordinary growth led by foreign demand were to fall in the future.

Labor Mobility

Labor mobility between regions is instrumental in alleviating spatial disparity and should therefore be encouraged. The institution most frequently blamed for blocking mobility is the household registration system, which denies rural residents the right to migrate to urban areas.

Urbanization

Because the major cause of regional income disparity in Vietnam is the urban-rural income gap, the most effective effort the government can make might be to accelerate urbanization. The ultimate cure for the urban-rural income gap is absorbing all rural surplus labor in the urban sector, which is closely linked to the reform of the household registration system. Achieving this objective will require that the government promote and maintain rapid growth in the urban sector. As this sector expands relative to the rural sector, the urban-rural gap may continue to widen for a period of time. Therefore, to reduce income disparity in the long run, Vietnam will have to live with rising regional income disparity in the short run.

Acknowledgements

I am grateful for, and indebted on so many levels to, many people who have inspired me to create and think through this work. Those people I would like to thank.

First and foremost, I would like to thank the East Asia Development Network-Global Development Network (EADN-GDN) for the financial support. Without this support, this research project could not have been conducted. I would also like to give special thanks the director of the Philippine Institute for Development Studies (PIDS) for their valuable support during the project.

Special thanks to Dr. Joseph Anthony Lim who has encouraged this work with meaningful contributions and conversations. He has given me his invaluable support, advice, and encouragement. He kindly and patiently read my paper and offered detailed advice for completion of the project.

I would also like to thank all the staff of PIDS, especially Ms. Maureen Ane Rosellon and Ms. Christine Ma. Grace R. Salinas, for their administrative assistance during the time I conducted this research project.

Last but not least, my gratitude abounds to my family, friends, and colleagues who provide advice and support. The product of this research project would not be possible without their help.

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