

# “Economic and environmental convergence of transformation economy: the case of China”

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# ECONOMIC AND ENVIRONMENTAL CONVERGENCE OF TRANSFORMATION ECONOMY: THE CASE OF CHINA

## Abstract

Rapid economic reforms and proper GDP growth in China has affected the regional development of Chinese provinces. This study aims to estimate the degree of economic and environmental disparities within Chinese provinces for developing policy recommendations of regional transformation. The reduced log-linear specification of endogenous growth model is used for the estimation of convergence rates within Chinese provinces. The empirical results prove that an increase of 1% in GDP per capita basic year reduces the economic growth rate by 0.1% in the reference year. Thus, the ratio of the average per capita income in the wealthiest group to poorest provinces accounted for the factor 9.6 in 1995 and factor 4.1 in the year 2015, which means a reduction of disproportionate development. Environmental convergence trends were also found and less polluted provinces eventually increase emissions at higher rates than the initially polluted ones. With the pass of time, all provinces do move to the same steady state in environmental parameters. The speed of the economic and environmental convergence in China provinces is rather slow, and the economic growth was achieved by great sacrifices of an environment, since all provinces are striving to the same steady state in terms of pollution increase. The industrialized regions due to the presence of significant financial resources should pay more attention to the protection of the environment using all the available economic potential. At the same time, both initially poor provinces and rich have to develop more profoundly agriculture, tourism, recreation, and other environmentally friendly industries to improve economic performance.

## Keywords

economic and environmental convergence, economic growth, regional development, China

## JEL Classification

C23, R11, R12

## INTRODUCTION

Since the last forty years, the macroeconomy of China has proved good operating activities, however, significant differences of growth rates and income inequality among different provinces could influence the economic performance and social stability of China itself. Regional development in China has recently attracted the attention of many economists both in China and outside the country. Researchers are discussing how economic reforms have affected regional development and decreased disparities of Chinese provinces.

During the 25 years of reforms, the real GDP of China has increased in 6 times, with average annual growth 9.4%. The labor productivity has been three times increased. China has put an economic goal of four times increase of GDP till 2050 compared to 2000. This is a challenging goal, the realization of which will make China the powerful economy as the US and the EU today. According to Dervis (2012), by 2025–2030 many emerging market economies will be much closer to those of the advanced economies and the Chinese economy will be-

come the largest in the world. The accelerated pace of China's development over the past 20 years has been the result of excessive use of natural resources and environmental violations. For example, in 2008, the contribution of China in the world economy was about 5-6%, while consumption of steel, cement, and other materials amounted to one-third of the world total, and the use of coal, copper, and iron were the highest in the world. Concerning oil consumption and electricity, China is the second economy, the first in the U.S. Before the start of economic reforms in 1978, the Chinese economy was ninth in the world by nominal GDP. Currently, in 2017, the Chinese economy is the second largest in the world with 14.9% of world GDP. The first place is taken by US economy with USD 19.4 trillion or 25% of the world GDP. It should be noted that the start of Chinese reform has targeted the economic growth and little attention was paid to the disequilibrium in regional development. The history of Chinese reforms is usually divided into three big periods. The first period 1978–1991 was marked by starting rural reform, the origination of private businesses, deregulation of state-owned enterprises, the creation of special economic zones. The second period 1992–2006 promoted the social market economy creation. The motto of the period was “to create on the base of state-owned enterprises the system of competitive businesses”. However, after that, the situation relating to regional disparities has been changed. The third period started with the beginning of eleventh five-year plan in 2006, with the main idea of leveling regional development, decreasing the per capita income difference, decreasing economic differences between city and village, solving social, ecological problems, promoting energy saving.

This paper reviews the relevant literature on economic and ecological convergence debate in China and provides new evidence of empirical regional disparity/convergence issues in China. This study aims to determine the degree of economic convergence and environmental development within one country and develop practical recommendations to transformation changes of the Chinese economy.

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## 1. ANALYSIS OF RECENT PUBLICATIONS

A significant contribution to research on regional economic growth and convergence was made by such scholars as Chen and Fleisher (1996), Barro and Sala-i-Martin (2004), Miller and Gench (2005), Manasan and Mercado (1999), Morrison (2012). The scientists have analyzed the methodology of the research process of economic convergence and the fundamental problems of regional development. The paper by Perotti (1996) analyzes several channels linking income distribution, institutional factors, and economic growth. The first two channels are related to social/political stability and to educational attainment in a country. The third is related to the borrowing obstacles and investments in human capital.

The concept of economic convergence is mainly developed on the international level, when a domestic country is compared to the group (club) of selected economies. In this regard, the paper by Jong-Wha Lee (2017) describes the essential milestones of China's economic system on its convergence way to the group of developed econ-

omies. Among the critical factors are a high share of investments, improvements in human capital, high international openness and institutional factors improvements. Li et al. (2018) uses the log t convergence test combined with a probit model to figure out the convergence clubs in China over the period 1992–2010. The results proved the existence of six convergence clubs for 2,286 counties. The key important factors responsible for convergence clubs are per capita fixed assets, population density, and industrialization levels.

The concept of environmental convergence was broadly discussed for the carbon dioxide (CO<sub>2</sub>) emissions including such papers as Westerlund and Basher (2008), Lee and Chang (2008), Jobert, Karanfil, and Tykhonenko (2010) with per capita emissions as a main indicator of convergence. According to the research of Camarero, Castillo, Picazo-Tadeo, and Tamarit (2013), it was found that for a panel of 22 OECD countries over the period 1980–2008, there exist a carbon dioxide (CO<sub>2</sub>), and sulfur oxides (SOX) emissions convergence. While it was proved that there was no nitrogen oxides (NOX) convergence within the sample. There was found more progress in the

OECD countries convergence for carbon dioxide indicators due to more strict environmental regulations. The OECD countries tend to form clubs in eco-efficiency with different steady states. Thus, most environmentally efficient states are forming the clubs by themselves, while the other states are building their eco-efficiency clubs by themselves. Strazicich and List (2003) performed similar research with panel data for 21 developed countries over the period 1960–1997, and conditional carbon dioxide convergence was found. Lee and Chang (2008), using panel of seemingly unrelated regressions and implementing augmented Dickey-Fuller tests to identify unit roots in the sample of 21 OECD countries over the period 1960–2000, have found divergence within 14 OECD member states. Also, using the long-run data between 1870 and 1985, it was proved by Pritchett (1997) that the ratio between the rich and the emerging countries has six times increased.

Jakob, Haller, and Marschinski (2012) using difference-in-differences estimations for the panel of 51 developed/developing countries over the period 1971–2005 have found that developing countries are moving towards the global average in economic and environmental indicators. The empirical model estimates the influence of per capita primary energy consumption growth rates on per capita incomes. The research proved that for average developing country movement to certain economic steady states implies the similar change in energy use convergence pattern. As for the developed economies, there were found no interrelations between rates of economic development and energy consumption rates, which proved the idea of decoupling between growth and the environment. That is the most advanced and rich economies can support their development without a significant increase in energy consumption, while the developing economies are converging to better income levels by more energy intensive paths.

There are the papers (Schäfer, 2005; Sotnyk, 2016), which link the structural changes in the economic system and shift in energy consumption (decrease of energy consumption and carbon dioxide emission in the residential sector and increase of energy consumption in the transportation sector). As for the industry, it was found an

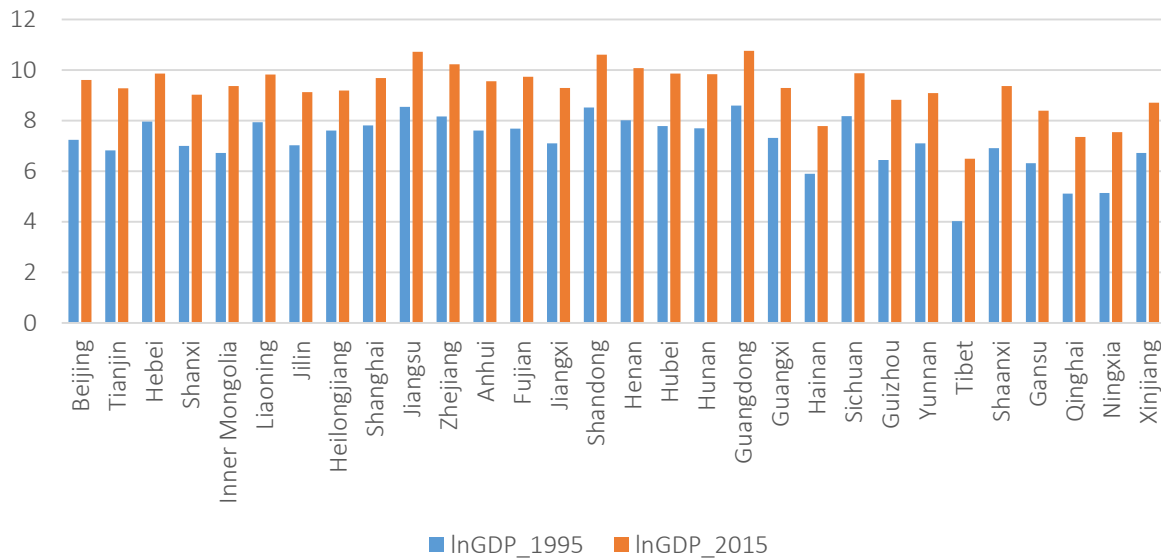
inverted U-shape form of income rise and industrial sector development. Thus, the papers mentioned above create an expectation of economic and ecological convergence within a single domestic economic system.

According to Wu (1999), there is an ongoing interest in the efficiency of China's economic reforms concerning regional disparities, and between 1953 and 1997, it was found that regional differences were most extensive in the end of the 1960s. Later on, with a start of economic reforms, the Chinese regional economies were converging to some steady state in terms of economic development. The convergence was higher in the 1970s and early 1980s. According to Shen, Ruiqiang, and Nan Yi (2018), there is a significant difference in Beijing counties from 1994 to 2004. The key recommendation of research stated that lagging counties of Beijing have to develop their economies intensively based on regional advantages and resource availability. The proper economic instruments for such policies are tax reduction steps and changes in the tax system to harmonize the economic growth within Beijing counties. Among the viable steps for undeveloped Beijing, counties are servicing industry promotion, including tourism, banking, insurance, and community serving.

There two directions that link economic performance and economic convergence. The first direction according to Galor and Zeira (1993) states that economic convergence in terms of income distribution leveling does not necessarily lead to improved economic achievements. The second path moves from the better financial result to more equal levels of incomes (individual or regional).

## 2. METHODS

There is a repeated interaction between economic reforms and economic convergence in developing economy. Thus, according to Wang (2015), economic convergence is moving on until the bottleneck is achieved, then some institutional reforms are required to start another wave of convergence. Having analyzed China, Russia, and India from 1993 to 2003, Badunenko and Tochkov (2010) have proved that wealthy regions in each country are



**Figure 1.** The logarithmic GDP of Chinese regions in 1995 and 2015 (real prices of 1995)

responsible for the economic growth of the whole country. Moreover, the technological improvements are the basis for the economic prosperity of rich regions rather than poor ones. Consequently, the divergence in technological progress in different regions leads to income divergence in all three counties. The logarithmic values of GDP at Chinese provinces are presented at Figure 1.

Nevertheless, even if the considered economic goals will be achieved, it is still necessary to solve many challenging problems. Among the most urgent are employment, ecological issues (Pimonenko et al., 2018), scarcity of many natural resources (first of all arable lands, pure water, etc.), educational system and health care system (Shkarupa & Kharchenko, 2017; Sotnyk & Kulyk, 2014). This and many other factors not only stimulate the growth of economic potential, but also harm to achieving new challenges. Currently, China spends most of the resources on the program of technological development, and regions with the well-developed infrastructure can strengthen their position on the global market.

The OECD paper “Going for Growth” (Economic policy, 2012) directly suits the current China priorities both in an economy and natural environment, promoting long-run growth and a number of them would also boost Green Growth and contribute to environmental sustainability. Recently the responsiveness to “Going for Growth” priorities in China becomes a pro-Green Growth in many sectors.

We consider the need to integrate the processes of environmental and economic convergence of regional development in order to develop effective measures and mechanisms for the implementation of a balanced regional economic policy. In general, ecological and economic convergence means leveling the economic and environmental potentials in different areas through the reallocation of financial resources.

For China, the question of convergence within the country’s economic and environmental performance is an important factor in reducing disequilibrium between individual regions and equalization the quality of life in different areas. Also, it should be noted that the difference between eastern and western provinces of China in terms of GDP per capita in 2000 was about three times.

To analyze the convergence path of some region within time series, the coefficients are most often used, among them *unweighted/weighted* coefficient of variation, *Gini index*, and *Theil index*. The abovementioned indexes are calculated as follows:

$$\text{Weighted coefficient of variation} = \sqrt{\frac{\sum (Y_i - \bar{Y})^2 / n}{\bar{Y}}}$$

$$\text{Theil index} = \sum \frac{Y_i \log\left(\frac{Y_i}{\bar{Y}}\right)}{n\bar{Y}}$$

$$\text{Gini index} = \frac{\sum \sum \sqrt{\frac{(Y_i - \bar{Y})^2}{2n^2\bar{Y}}}}$$



The positive side of such indexes is easiness of interpretation and calculation, while the negative side is that they don't enable the dynamic analysis, which would encompass several decades within the single empirical model.

In empirical researches, there are three main approaches to estimate convergence: sigma-convergence, absolute beta-convergence, and conditional beta-convergence. Historically, according to Sala-i-Martin (1994), first appeared sigma convergence approach, which deals with variances for the different indicators across time for specific groups of countries (regions). Absolute convergence means a common steady state in economic indicators.

Conditional beta-convergence means that it is not possible to achieve unique steady state by all regions due to the differences in natural resource availability and historic achievements. Conditional convergence means separate steady states for different territories.

A theoretical concept of economic convergence in GDP per capita parameters was developed at neo-classical macroeconomics by Solow (1956) and Koopmans (1965). Practically most widely used was the linearized form for estimation convergence, which was discussed in Sala-i-Martin (1994), Manasan (1999), Miller (2005), Melnyk et al. (2016) and presented as:

$$\ln\left(\frac{y_{i,T}}{y_{i,0}}\right) = \beta_0 + \beta_1 \ln(y_{i,0}) + u_i, \quad (1)$$

where  $y_{i,0}$  and  $y_{i,T}$  are the initial income and income at the end of the period considered,  $T$  is the length (years) of the period,  $\beta_1$  is the convergence rate per annum,  $\beta_0$  is the intercept and  $u_i$  is the error term. Subscript  $T$  means last/end period, while 0 means an initial/zero period.

This linearized version (1) considers the impact of most important indicators while depressing the less economically significant. On the other hand, the advantage of this specification is a possibility to evaluate the rate of convergence between provinces. In formula (1), if  $\beta_1 < 0$ , this means that more prosperous provinces grow at

a lower speed, and economic convergence is clearly observed. Otherwise, if  $\beta_1$  is more than zero, it implies that richer provinces are developing at higher rates. Additionally, it is needed to mention that the results of the logarithmic model are elasticities, and this means that 1% change in the independent variable contributes to  $\beta_1\%$  change in the dependent variable.

We believe that economic divergence of regions can cause significant migration within the country due to the economic potential difference between per capita incomes in different regions of the country. Similar situation is observed considering the absence of ecological convergence – regions with less assimilative capacity and accordingly more specific indicators of pollution perform nature destructive economic activity much faster than regions with significant assimilative capacity and respectively lower specific indicators of pollution areas. As the lack of economic convergence, the lack of environmental convergence does not meet the conditions of sustainable development concept of the country.

Mishenin et al. (2018) prove the necessity of industrial ecology and logistics for regional sustainable development fostering. In addition, in their paper, Kyrychenko et al. (2018) proved the impact of social factor on economic growth. Also, Kuroyanagy et al. (1996) point out that macroeconomic stability is the reason for the fast and stable economic growth of Eastern Asia countries.

The additional empiric model, which we use to analyze the macroeconomic stability impact on convergent processes in the country, may be represented in the following way:

$$\ln\left(\frac{y_{i,T}}{y_{i,0}}\right) = \beta_0 + \beta_1 \ln(y_{i,0}) + \beta_2 X + u_i, \quad (2)$$

where  $X$  is a matrix of the variables, which point to the country's peculiarities and enable to keep features of the economic system stationary state at the constant level.

Imbalances Index (*IMB*), proposed by Butzer, Jordan, and Stracca (2013), is used as macroeco-

conomic stability indicator of the national economy. The *IMB* is based on the calculation of three standardized macroeconomic indicators: the fiscal balance (*GovLend*), the inflation rate (*Inf*), the current account balance (*CurrAcc*) as follows:

$$IMB = -GovLend + Inf - CurrAcc. \quad (3)$$

An additional variable of model (2) is country's involvement level parameter in the globalization processes (KOF globalization index), which is calculated from SWISS Economic University surveys (KOF, 2018). This indicator measures economic, political and social globalization of the country and is from 0 to 100.

### 3. RESULTS

Model (1) is constructed in a way that the coefficients at the determined factors are interpreted as elasticities, and the base growth in per capita income by 1% leads to an increase in the rate of income growth, respectively, by 1%. Using a database of statistical data collected by the authors for the study period 1995–2015 in 31 provinces of China, the following results were obtained:

$$\ln\left(\frac{y_{2015}}{y_{1995}}\right) = 2.84 - 0.10 \ln(y_{1995}) + \varepsilon_i. \quad (4)$$

Statistical properties of econometric relationships (4) for China show that only 20% of the variation in regional GDP could be explained by the convergence model. Besides that, the parameter responsible for the presence of convergence was statistically significant at 99% significance level. Thus, an increase in base year economic indicators by 1% reduces the income growth rate by 0.1%. In 1995, the ratio of the average per capita income in the wealthiest group to poorest regions accounted for 9.6. However, in 2015, the difference between the richest and the poorest regions in China accounted for 4.1 times. Thus, our empirical results based on the reduced model prove the existence of economic convergence in China. Our results are comparable with Andersson (2012) who based on provincial data from 1978 to 2009; found that over the

long-term period provinces do converge in two growth clubs. Also, our results are comparable with the paper of Maasoumi and Wang (2007) who use the metric entropy concept to estimate the economic convergence in Chinese provinces. The entropy concept enabled to measure differences in economic growth rates across separate regions (provinces) in China. The main results proved no general economic convergence during the pre- and post-reform periods. While there was found several economic convergence clubs, which are more visible in the post-reform period.

The application of convergence methods are commonly used only for evaluation of economic processes; however, this approach can be used to assess environmental leveling as well. To assess the environmental convergence, we use such indicators as emissions into the atmosphere. Using the economic convergence methodology for ecological processes, the following results were achieved:

$$\ln\left(\frac{p_{2015}}{p_{1995}}\right) = 1.03 - 0.26 \ln(p_{1995}) + \gamma_i. \quad (5)$$

China has clear tendencies of ecological convergence of territorial development and the base level emissions increase in 1995 by 1% do reduce annual growth rates 0.26%. Thus, provinces with high emissions do decrease their emissions or grow with smaller rates. It can be found that economic growth in China is basically guaranteed by great sacrifices of an environment. Specifically, in China from 1990 to 2010, the desertification areas were increasing to 2,460 km<sup>2</sup> annually. The available agricultural land per capita decreased from 1,300 m<sup>2</sup> in 1990 to 952 m<sup>2</sup> in 2008. However, the Administrative Centre for China's Agenda 21 facilitates the implementation of sustainable development (Swanson, 2004), and hopefully the ecological situation will start to improve in China.

The results of calculation regarding macroeconomic stability impact and country's globalization level on the economic development convergence and its environmental leveling are presented in Table 1

**Table 1.** The results of macroeconomic instability impact and globalization level on the economic and environmental convergence

Indicators	Economic convergence (GDP)	Environmental convergence (emissions into the atmosphere)
$\ln(y_{1995})$	-0.074 (0.010)	-
$\ln(p_{1995})$	-	-0.0153 (0.000)
IMB	-0.0021 (0.048)	0.033 (0.105)
KOF	0.0297 (0.008)	0.932 (0.000)
$R^2$	0.53	0.92

According to the given results (Table 1), the explanation ability of the model makes 53.9% (economic convergence) and 92.4% (environmental convergence), proper coefficients with GDP initial level logarithm  $\ln(y_{1995})$  and level emissions  $\ln(p_{1995})$  are significant with 99% significance level and demonstrate the proper convergence processes (coefficient  $\beta_1$  negative is significant). Reduction of *IMB* indicators misbalance and increase of globalization level do assist Chinese economic convergence.

In fact, the macroeconomic policy of a country has to be aimed at the elimination of large economic differences among various Chinese provinces, since continuous economic diver-

gence may harm the efficiency of resource allocation and would have the negative impact on economic development in general. The institutional factors are the dominant ones in sustaining Chinese economy high rates of economic growth, and Jong-Wha Lee (2017) claims that sustainable economic development in China requires no severe policy mistakes in response to external fluctuations.

The disparity in economic development between the eastern, central and western regions of the country, which at the beginning of the reform period may increase, could gradually reduced with the development of the central and western regions. The transformation of egalitarian distribution trend of increasing differences could continue for a relatively long time. Only after the improvement of market economy institutions and regulatory policies, the problem of excessive income inequality can be gradually solved.

Within the achieved results, the high economic growth would inevitably lead to increased pressure on the environment. It is expected that by 2030, the economic growth will be accompanied by the continued expansion of the volume of traditional production and hence pollution, since it is not possible to immediately change the structure of energy consumption, which uses much of coal.

## CONCLUSION AND DISCUSSIONS

The analysis of current regional situation in China proved the presence of economic and environmental convergence among different provinces. This means reduction of disproportionate development in provinces. Also, with regard to China, there are distinct ecological convergence trends and less polluted provinces eventually increase emissions at higher rates than the initially polluted ones. That is economic growth in China was supported by great sacrifices of an environment, since all provinces in China are strive to some steady state in terms of pollution increase. Based on the results of the study, it is advised for each province to use its competitive advantage in order to achieve the best performance in the economic and environmental areas. The industrialized regions due to the presence of significant financial resources should pay more attention to the protection of the environment, using all the available potential. While, provinces with relatively low levels of pollution and significant assimilative capacity should benefit from it. At the same time, both initially poor regions and rich have to develop more profoundly agriculture.



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