Investigating The Convergence of Growth: A Comparative Study

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Abstract. We conduct empirical investigation on the convergence of output growth in two groups of economies, i.e. European versus Asian economies. Two notions of convergence are included in our analysis, namely absolute beta convergence and conditional beta convergence. Single equation and panel data analysis techniques are applied. The results show evidences of absolute convergence using Theil approach. However, these two groups of economies fail to catch up to the growth level of U.K. either conditional or not conditional to a list of control factors.

Keywords: Catch-Up Effects; Convergence of Growth; Panel Data Analysis

1. Introduction

The rapid growth of Asia in the last three decades was an economic myth or miracle as documented by many researchers and economists. However, a regional financial crisis has changed the course of Asia's emergence. Nevertheless, the region remains dynamic and still features many of the policies that were responsible for this high growth in the past after the recovering. Not unexpectedly, Asia's strong growth performance unleashed a major debate about the factor inputs that were responsible for this high growth. The general point was that factor inputs of labor and capital. In this research, several questions emerged: does the economic growth in East–Asia can catch up with the growth level in the leading Asia country like U.K.? Are the growth supported by human investment and higher productivity? As a result, in this study, we would like to investigate the conditional and absolute convergence of growth in Europe and Asian countries.

A number of studies in the previous literature of development economics indicate that exports play an important role in economic growth in East Asian countries, [1]. Many studies also report that human capital and productivity are the main contributor to growth. According to [2], investment in human and technological capital is an important role in a growth process. Applying panel data analysis, [3] reports that human capital investment and education can have significant impact on growth in East Asian countries. He suggests that education can be a long-run policy tool used to achieve sustainable growths in a country. As concluded by [4], advanced Asian countries have the ability to reduce the income gap with US faster. Higher educated countries tend to learn and adapt new technology faster and easier compare to those lower educated countries However according to [14], the interaction effects between schooling and R&D were not significant determinants of country labor productivity growth. Apart from this, some studies report that capital and productivity are important determinant of growth, e.g. [5] and [6].

In this paper, we focus our study on investigating the convergence of growth in Europe and Asian economies. The main purposes of this study are to investigate the three types of convergence in growth of these two groups of countries, i.e. absolute β convergence and conditional β convergence. With two different models applied (Theil's inequality and Panel data analysis) we obtain results showing that absolute convergence exists for both the Europe and Asian regions, but this convergence does not hold in the selected Europe and Asian countries when panel data analysis is being used.

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The rest of the paper is organized as follow: section two is about the related works and background regarding the convergence of growth, section three discusses the statistical data used and the methodologies apply, and section four explains the result obtain in this study. Last but not least, section five concluding the results and make some suggestions for future enhancement.

2. Concepts – Types of convergence

The literature of growth defines the condition where the poorer countries growth rates increase faster than the rich one we as convergence of growth. The idea of convergence sometimes refers as catch–up effect. There are three types of convergence, namely the σ convergence, absolute (unconditional) β convergence and conditional β convergence. σ convergence occurs if the dispersion of income per capita across countries declines overtime (see [7]). On the other hand, β–convergence occurs if the countries converging to their own steady state of growth rate in long run. The details of explanation are as follows.

σ convergence refers to a reduction in the cross–sectional variance of income per capita among a group of countries (see [4]). According to [3], σ convergence exists whenever dispersion of real per capita income across groups of economies is decreased over time. σ convergence can also refer as the catch up effect between richer and poorer countries. β convergence is a necessary condition for sustained σ convergence such as a negative value of the slope coefficient of correlation between growth and initial income (positive value of β).

Conditional β convergence converge to the same steady state growth rate but not necessarily converge to the same level of initial per capita income, [8]. According to [9], conditional convergence will occur only when per capita incomes of countries that have a similar structure and converge to a common steady state level in the long run, regardless of the countries' initial conditions.

Absolute β convergence suggests a tendency towards the equalization of per capita incomes. It has an inverse relationship between the income growth rate and its initial level, [4]. Absolute β convergence considers the assumption of the high growth rates of the poor countries against the rich countries, regardless of the determinant of growth of the sample countries, [10]. Unlike conditional β convergence, poor countries will grow faster than rich ones in order to catch up with the rich countries but this does not mean that inequality will disappear since different territories will have random shocks with uneven effects, [2]. According to [8], absolute β convergence means that both poor and rich countries will converge to the same level of per capita income in the steady state, but somehow poor countries will grow faster than the rich countries.

3. Data and Methodologies

In this study, we mainly focus analysis on economies of Europe and Asian in determining the convergence in those economies. The selected Europe countries include Austria, Belgium, Finland, France, Iceland, Ireland, Italy, Norway, Switzerland and Turkey. Asian countries include in this study consist of Malaysia, India, Indonesia, Philippine and Thailand. The sample periods in this study is from 1960 to 2009. Variables used in this study consist of gross domestic product, inflation, trade openness, government consumption expenditure, foreign direct investment net inflow and total population. We conduct analysis to investigate the convergence of growth in two groups of countries (Europe versus Asian).

3.1. Theil approach – Testing for Absolute Convergence

In this study, Theil inequality indices from Theil approach are used as absolute convergence testing approach for Europe and Asian economies. Theil inequality indices, so called Theil entropy index, T^* and Theil's second measure, L^*. The first index assumes a minimum value of 0 whenever there is an equality in inter–country GDP and a maximum value of ln(n) whenever there is an inequality. The equation for Theil entropy index is expressed as $T^* = \sum_{i=1}^{n} y_t^* \ln\left(y_t^* / p_t^*\right)$ where y_t^* is the ratio of GDP of country i to the total GDP of all countries for relative regions in the sample and p_t^* is the ratio of total population of country i to the total population of all countries for relative regions in the sample. n is the total countries in relative regions (see [11]). The value of Theil's second measure, L^* is same as Theil entropy index, ranges from minimum 0 and maximum ln(n). The equation of L^* is same as the T^* but the ratio of GDP to population are

reversed, it is expressed as $L* = \sum_{i=1}^{n} p_t^* \ln\left(p_t^* / y_t^*\right)$. Absolute convergence can be tested with Theil approach by running the regression over the linear time trend:

$$T_t^* = \alpha + \beta t + \varepsilon_t \tag{1}$$

$$L_t^* = \alpha + \beta t + \varepsilon_t \tag{2}$$

where t indicates times and ε_t is the error term. A significant positive value of β implies non absolute convergence (see [11]).

3.2. Panel Data Analysis – Testing for Conditional Convergence

In this study, we apply panel estimation approach with fixed effects model to test the presence of conditional convergence among selected Europe and Asian economies because it is not necessary to assume the independent of explanatory variables on individual specific effects when we condition on the individual specific effects. The fixed effects model controls for all time-invariant differences between the individuals. It produces unbiased estimated coefficients since the time-invariant characteristic is omitted from this model. In fixed effects model, we assume that those time-invariant characteristics are unique and uncorrelated with others individual characteristic, [12]. In general, the equation for the fixed effects model can be expressed as follows:

$$y_{i,t} = \alpha_i + \beta x_{i,t} + \varepsilon_{i,t} \tag{3}$$

where α_i is the intercept for each entity, β is the coefficient (or within groups estimator) for independent variable x and $\varepsilon_{i,t}$ is the error term. $y_{i,t}$ is the dependent variable where i is the entity and t represent time, [12]. $E(\varepsilon_{it}) = 0$ and $Var(\varepsilon_{it}) = \sigma_y$. In this study, we use a common panel data regression model of GDP represented by dependent variable y and independent variable x to formulate the conditional convergence equation:

$$\Delta \log y_{i,t} - \log y_{uk,t} = \alpha + \beta \log y_{uk,t} + \gamma x_{i,t}^j + \varepsilon_{i,t} \tag{4}$$

where α and β are coefficients, ε is the error term with mean zero and variance σ_ε^2, i is the indices for individual country and j is the factors or control variables included in this study. y_i and y_{uk} are the GDP of country i and GDP of United Kingdom respectively. United Kingdom is used as a benchmark of advanced economy. In this case, we seek to investigate if the country i will converge or catch up to the income level of United Kingdom. The vector of x_i^j contains all the control variables set in this study, include trade, general government consumption expenditure (GCE), inflation, population and foreign direct investment net inflow (FDI). In order to have conditional convergence to be hold, a negative and significant value of β should be obtained from this test ([13]; [11]).

Besides Theil's inequality approach mentioned before, absolute convergence test can also be carried out from panel data analysis by excluding all the control variables. This test can be carried out by applying a formula as follows:

$$\Delta \log y_{i,t} - \log y_{uk,t} = \alpha + \beta \log y_{uk,t} + \varepsilon_{i,t} \tag{5}$$

A negative and significant value of β implies an existence of absolute convergence for the region. Equation (4) enables us to investigate the conditional catching up effect conditional at factors x_i while (5) is the absolute convergence catching up model.

4. Results and Discussions

All the results of estimation are summarized in Table I – VI. The notations are applied to all tables, i.e.: *** indicates the result is significant at 1% level, ** as the significance at 5% level and * denotes the significance at 10% level.

Table I and II summarize the results of absolute convergence using the Theil approach. From both tables, we observe the evidences of absolute convergence in both Europe and Asian regions. However, the coefficient of convergence for Europe region is higher compare to the coefficient of convergence for Asian region. This implies that Europe economies have faster growth rate than Asian economies.

Table III summarize the results of absolute convergence using U.K. as benchmark economy for comparison. The result shows that absolute convergence does not hold in these selected countries over the

sample period. Obviously, this result does not coincide to the result obtained by using Theil Inequality approach. The different outcome is due to different approach and concept of analysis. In the Theil's indices, convergence is based on the relative size of population of the region However, in the second case, the testing of GDP convergence is based on the GDP level of U.K. economy.

Next, Table IV summarizes the results of conditional convergence, i.e. a list of control variables are added into the convergence equation and U.K. is the benchmark economy for comparison. Again, we fail to detect convergence of these two groups of economies to the growth level of U.K. conditional on a list of factors. Among these factors, inflation and foreign direct investment have significant impacts on the relative growth of Europe – U.K. while trade is the only significant factor on the relative growth of Asian – U.K.

Table. 1 Absolute Convergence – T Index

Theil–T index	Coefficient (Standard Error) α	β	S.E. of Regression	Durbin Watson Statistic
Europe	6.066048*** (0.076110)	0.077117*** (0.002677)	0.273135	0.129251
Asian	0.046049* (0.024620)	0.003827*** (0.000804)	0.065415	0.209681

Table. 2 Absolute Convergence – L Index

Theil–L index	Coefficient (Standard Error) α	β	S.E. of Regression	Durbin Watson Statistic
Europe	-0.012484*** (0.000695)	0.000306*** (2.44E-05)	0.002494	0.035353
Asian	0.041641** (0.019921)	0.002736*** (0.000650)	0.052930	0.228598

Table. 3 Absolute Convergence – Panel Data Analysis

Theil–L index	Coefficient (Standard Error) α	β	S.E. of Regression	Durbin Watson Statistic
Europe	-2.03184*** (0.040617)	7.07E-14 (4.84E-14)	0.218332	0.190924
Asian	-2.36289*** (0.071872)	7.80E-14 (8.34E-14)	0.286305	0.270941

Table. 4 Conditional Convergence – Panel Data Analysis

	Coefficient	Standard Error
Europe		
α	-1.70551***	0.206918
β	-3.91E-14	3.74E-14
Inflation	-0.003870***	0.001350
Trade	0.001041	0.004170
Foreign Direct Investment Net Inflow	-0.003950*	0.002323
Government Consumption Expenditure	-0.013330	0.013274
Total Population	4.95E-09	3.48E-09
S.E. of Regression	0.177092	–
Durbin Watson Statistic	0.259323	–
Asian		
α	-1.963300***	0.131458
β	-1.97E-14	3.70E-14
Inflation	-0.006070	0.005535
Trade	0.000901*	0.000477
Foreign Direct Investment Net Inflow	0.013249	0.020869
Government Consumption Expenditure	-0.026150	0.016528
Total Population	-2.48E-10	1.82E-10
S.E. of Regression	0.227024	–
Durbin Watson Statistic	0.411362	–

5. Conclusion

We conduct empirical analysis to investigate two notions of convergence, i.e. absolute and conditional convergences in several European and Asian countries. Theil approach and panel data analysis are applied. We also compare the results relative to the economy of U.K. The results show evidences of absolute convergence in Europe and Asian economies using Theil approach. However, if the absolute convergence uses U.K. as benchmark economy for comparison, we fail to detect evidence of convergence in these two groups of economies. we also fail to detect evidence of convergence using U.K. as benchmark economy if some control variables are included in the model. The different outcome is due to different approach and concept of analysis. In the Theil's indices, convergence is based on the relative size of population of the region However, in the second case, the testing of GDP convergence is based on the GDP level of U.K. economy.

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