NEOCLASSICAL THEORY OF GROWTH IN TEN SELECTED ASIAN COUNTRIES USING PANEL DATA

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Abstract
Attention to the theories of economic growth has intensified when differences between output growth rates of industrialized countries on one hand and the amount and quality of economic growth of these countries with developing countries on the other hand emerged. Also, when the growth rate of industrial production in some countries declined, many economists considered the reasons and these two, led to design of numerous growth patterns. In this study we have tested the neoclassical growth theory in ten Asian countries using panel data over 2000-2009. At the end, relevant tests showed that in regard to the F obtained, models of panel data is more suitable for this series of data. Additionally, for final analysis and use of fixed or random effects, Hausman test showed that fixed effects are more valid. Finally, the results demonstrated that the degree of freedom had a negative effect and both labor and capital accumulation had a direct impact on economic growth in these countries; therefore planning on these fields will have great effect on economic growth.

Keywords: Economic Growth, Neoclassical Model, Panel Data, Capital Accumulation

JEL classification: C33, O11, C52

Introduction
During the second half of nineteenth century, the world witnessed dramatic developments in technology. Rapid technical developments and inventions in different fields, as well as continued high growth rates and increasing real wages of workers have guaranteed and stabilized interest rate trend. These conditions brought new different perspectives on economic development and welfare in the international community that is different and in some cases opposite with traditional classical approaches. Neoclassics considered short-term period’s in income distribution, theory of surplus value and theory of general equilibrium. So from this view framework, economic interactions between different parts in a certain period will be discussed and with economic development attitude, we focused on the optimal and efficient allocation of resources. From the neoclassical perspective, technology plays an important role in development and technological advances reduce costs and improve production methods that lead to rapid national income growth. Important feature of technological progress from neoclassical perspective is that it is capital intensive. This paper examines the factors affecting economic growth in ten selected Asian countries from neoclassical perspective. After appropriate tests, panel data model was selected for methodology of this study. Test results also indicate that neoclassical growth theory can explain economic growth better.

Problem statement
Most newly industrialized countries owe their high economic growth to the increased level of human education and capital accumulation. All developing countries are trying to increase education level of human resource. Capital accumulation accelerates industrial growth of young and modern economic. Workforce training promotes skills and capabilities and also productivity of labors. Also, these countries intend to access new and modern industries by huge investments in industry sector and the two factors, labor and capital leads to acceleration of economic growth. Therefore, decision makings on industrial development as well as workforce training are major factors to increase rapid and sustained economic growth. Another main criterion in the labor market is unemployment rate. It should be mentioned that unemployment is one of the major macroeconomic issues that directly affects individuals of a community. High population growth, low economic growth, saturation of absorbing workforce in public organizations, lack of sufficient flexibility in paying wages, low
mobility in the labor market and failure of perfect information are effective in raising unemployment rate. In this article, we measure labor contribution and capital influence on economic growth in ten Asian countries, using neoclassical growth model.

Methodology

According to the data, we use pool or panel methods. Results of the relevant tests showed that panel data is more efficient.

Neoclassical growth model

Neoclassical growth model involves a production function that is characterized by a variable set of capital-work and capital-output ratios. As a result, equilibrium growth rate is not fixed and growth rate can be equal to full employment growth rate. Production function used in the neoclassical growth model is a linear homogeneous production function with constant return to scale that has Cobb Douglas particular shape.

\[ y_t = A_t k_t^a L_t^{1-a} \]  

(1)

In addition to the above combining linear growth pattern, the growth model we investigate involves a review of conventional neoclassical assumptions. These assumptions include:

1 - Factor prices (factor ratios) are quite variable and full employment of labor and capital exists.

2 - Contribution of production factors is equal to the final output and therefore the output and factor markets are perfectly competitive.

Furthermore, in general neoclassical model it is assumed that final form of technology grows with compound interest rates of \( n \) and \( g \), namely:

\[ A_t = e^{nt} L_t = L_0 e^{nt} \]  

(2)

Where \( n \) is based on the exogenous growth rate of labor force and \( g \) is exogenous technology growth rate. Also it is assumed that the general investment patterns (rates of inventory investment change over time) are equal to savings and savings ratio is a constant coefficient of national production:

\[ I_t = \frac{dk_t}{dt} = sY_t \]  

(3)

Finally, by incorporating these assumptions and applying mathematical methods we have:

\[ Y_t = Y_0 e^{\left[ \frac{n - g}{1-a} \right] t} \]  

(4)

So in the long term national production grows, assuming that it is only a function of labor supply growth rate and technology. In fact in neoclassical growth equilibrium, growth occurs under the natural rate of growth. The concern is that the long-term growth rate is clearly independent of the proportion of national product or output that is allocated to savings and investment. Variability of guaranteed growth rate is due to the flexibility of capital-output ratio. This flexibility, in turn, originates from the classical assumption that says production takes place in situations where apart from flexible price factors, a continuous series of various production methods (with diminishing returns) exist. Primary growth model used by economists allows the substitution of labor and capital, diminishing capital return and flexibility in prices and wages. This evolution continues until the guaranteed investment growth rate coordinates with natural growth rate and provides full employment conditions. So we are in stable equilibrium conditions when per capita income - that is determined by the production function (which itself contains technology) as well as the savings rate - population growth and technology be exogenous. In recent years Solow and Swan growth theory (s-s) have been challenged by many theorists. Among them are those who especially asserted "endogenous growth" models and did not accept the assumption of stability of coefficients in different countries. Both endogenous and exogenous views raise useful theoretical and empirical work in this area over the following years. One of the main tasks in this area tends to bet on the convergence of per capita income for different countries. In 1992, a work is done by Mankiw, Romer and Weil (M-R-W) using cross-sectional data indicating that S-S model has compelling reasons for confirming empirical evidence. Nevertheless, they concluded that if human capital does not fall within the model, there exists a positive correlation between the effects of savings and population growths. Accordingly M-R-W model has tried to put human capital in growth models to Improve S-S model and find correlation effects and interactions among human capital, savings and population growth. They found a positive correlation between
human capital, savings and population growth. Based on their findings, in the improved S-S model, the effect of savings and population growth is smaller on the growth of national income. In this survey the main basis of work is on M-R-W model, with two different approaches. Firstly, using a panel method, the required information is described by Barrow-Solow-Martin model and this is mentioned in most previous interpretations of the neoclassical growth model. Then using the added information that is a feature of panel method, we can have proper economic analysis beyond conventional methods of econometrics estimation.

**Literature review**

Brennan and Moehler (2010) expressed the term *neoclassical economics* that delineates a distinct and relatively homogenous school of thought in economic theory and became prominent in the late nineteenth century. The term was originally introduced by Thorstein Veblen to describe developments in the discipline (of which Veblen did not entirely approve) associated with the work of such figures as William Jevons, Carl Menger, and Leon Walras. The ambition of these figures, the first neoclassicists, was to formalize and mathematize the subject in the aftermath of the so-called marginalist revolution.

Tavares (2004) presents a broad diagnostic of the level of institutional development in Portugal in the legal, corporate governance and financial systems. A comparative assessment suggests that Portuguese institutions are less developed than their European Union and East Asian counterparts are more developed than Greek institutions on a level similar to that of Spanish institutions. We use data for a wide cross-section of countries since 1960 and correlate indicators of institutional development with the long-term average growth rate, identifying issues where reform is likely to affect economic growth significantly. The results strongly suggest that in a large number of issues, institutional reform may translate into substantially higher rates of economic growth.

Mohammad Zadeh (2003) examines the neoclassical growth model using panel data in his article. He has done the neoclassical growth theory test with endogenous and exogenous factors emphasizing 52 selected countries during 1960 to 2000. Independent variables of the model were selected based on previous research results and according to the explaining power, they have been tested in three distinct section models in developed, developing and the whole countries. Results indicate that neoclassical growth model with endogenous variables can explain economic growth of the countries. This issue is particularly bolder in industrial developed countries. At the same time with fixed effects of panel method, we can see fundamental structural differences in the process of economic growth for different countries and show that how different economic conditions affect growth of them. Jalayee and Sabbagh Poor Fard (2009) reviewed the effect of foreign direct investment on economic growth in Iran. In the paper, the impact of foreign direct investment on economic growth of Iran will be determined, and then to determine the stability, control variables are used. Control variables showed the impact of foreign direct investment on economic growth. Results showed that this effect is positive and significant. Varady and King (2002) conducted a study on ten countries in Eastern Europe and CIS in the period 1996-1993. Results indicate that increased foreign direct investment and price liberalization enhance economic growth, so that a growing percentage of foreign direct investment of gross domestic product, increase economic growth for about one percent. Goldsmith (1969), McKinnon (1973) and Shaw (1973) were among the first who accepted this idea.

In a study Easterly and belt (1990-2001) showed that although most foreign direct investment depends on the capital that comes from outside, external consequences for the economy conclusively depends on the development of financial market. Ping Lin (2004) shows that potential foreign direct investment in creating the effects of vertical relations is strongly denied in the absence of developed financial markets. Vertical relationships may give firms the opportunity to achieve economy of scale that has not been available earlier and it can also encourage the creation of new enterprises. One should note that without external financing, these processes could not be achieved. Dollars (2001) examined the relationship between openness of economy and economic growth by introducing two indicators of exchange rate and exchange rate fluctuations on growth models and concluded that exchange rate fluctuations have a significant effect on economic growth. Of course for developing countries, he proposed instable economic variable and for regional economies such as Latin America, South Asia and sub-Saharan Africa, dummy variable was proposed and showed that geographical location is important.

Dollars (2001), in another study, has classified less global economies and more globalized with various indicators such as population, per capita GNP, inflation, rule of law index and the average years of primary education schools, intermediate and high school. Arma expressed trade liberalization and growth in developing countries using Granger causality test and co integration methods and studied the relationship between per capita national income and Exchange rate according to classification of per capita income of countries around the world. However, in his primary model, investment growth is also considered. The model studies developing countries based on panel data method evaluated the relationship between economy openness and growth in a
Theoretical Base of Model

According to the approach that developed by M-R-W, the model here is the neoclassical S-S model form. Thus the production function of Cobb-Douglas will be as follow:

\[ Y_t = k_t^\alpha H_t^\beta (A_t L_t)^{-\alpha - \beta} \quad (5) \]

Workforce development and improving the quality of the work force is based on the following statements:

\[ L_t = L_0 e^{nt} \quad (6) \]
\[ A_t = A_0 e^{st} F^\theta p^\vartheta P \quad (7) \]

In which, \( n \) is based on the exogenous growth rate of labor force (in fact conveys the population growth rate), \( g \) the exogenous technology growth rate, \( F \) economic openness (exports and imports of the country) and \( P \) is the level of educational facilities that shows amount of registered users in high schools. In this model we believe that according to the empirical studies, especially in developing countries, technology tend to grow more and imports capital goods while the level of development and expansion of education in economic growth is very effective. Thus the model can be used to apply econometric principles in:

\[ \ln y_{t0+T} - \ln y_t = (1 - e^{-\gamma T}) \left[ \frac{\alpha}{1 - \alpha - \beta} \ln a_k + (1 - e^{-\gamma T}) \left[ \frac{\beta}{1 - \alpha - \beta} \ln b_h \right] \right. + (1 - e^{-\gamma T}) \theta_f \ln f + \theta_p Lnp \left. - (1 - e^{-\gamma T}) \ln y_{t0} + \left[ (1 - e^{-\gamma T}) (\theta_0 + r) g + e^{-\gamma r} rg \right] + \right. \]

In this formula, the change in GDP is a function of savings, investment, economy openness, education and GDP in the previous period. Growth effects that will be discussed in general equilibrium have the growth rate of g. The first coefficient (\( \alpha \)) in model 12 depends on per capita growth rate and it is also dependent to the age of work force. The second and third coefficients (\( \beta \) and \( \sigma \)) depend on savings and investment in physical and human resources, respectively. And the fourth factor (\( g \)) will be positive if \( \theta_f \) is positive; meaning that the more we have economy openness, the higher economic growth will be. The same concept is also true for the fifth coefficient; the higher level of educational facilities results in increased growth rate. The sixth coefficient indicates that if an economy has potential economic growth, it can grow faster. This in fact is the condition of convergence in growth. The brackets in fact, express time-specific effects of growth. The last factor is related to \( A_0 \).

Panel data model

Since the estimation of panel data regression models depend on the discussed assumptions relating to intercept, slope coefficients and disturbance term, model specification in these patterns is important. Baltag (Baltag, 2001) introduced the panel data regression model considering one-tail and two-tail disturbance term models:

\[ Y_{IT} = \alpha + X_{IT} \beta + U_{IT} \quad (9) \]

In above, the term \( I \) indicate individuals, households, firms, countries or in another word it shows the cross-sectional dimension while \( T \) indicates time and \( \alpha \) is a scalar. \( \beta \) Vector dimension is \( k \times 1 \) and \( X_{IT} \) is observations of \( k \) explanatory variables. According to Baltag, regression models that are associated with panel data, often use one-tail error term model for disturbance terms.

\[ U_{IT} = \mu_I + v_{IT} \quad (10) \]

In the above equation \( u_i \) is fixed and does not change over time, while \( v_{IT} \) shows the residual error and is considered as disturbance term in regression. In fixed effects model, \( U_i \) are assumed constant parameters, which must be estimated. Disturbance terms \( (v_{IT}) \) are identically independently distributed \( \mathcal{N}(0, \sigma^2) \) and according to the assumption, for all \( I \) and \( T \), \( x \) is independent of \( v_{IT} \). If the investigation focuses on a particular set of firms, countries, states and generally on a set of sectional units, the fixed effects model is suitable. If data of the study is collected from \( N \) individual and these are selected randomly from a large population statistics, a random effects model is suitable.
Model used in the estimate represents as follows:

\[ \text{LOG (GCA?)} = B_0 + B_1 \text{LOG (TRA?) + B_2 LOG (LFT?) + B_3 LOG (GCF?) } \] (11)

**Model variables:**

**Dependent variable:**
In this model, the dependent variable is price fixed gross domestic product that is considered as economic growth. The Symbol LOG (GCA) expresses the variable; that is logarithm of GDP with fixed price. According to the 10-year averages, we have three independent variables in period 2000-2009.

**Independent variables:**
Independent variables were selected on the basis of neoclassical growth models and have been tested in three models with a symbol:
1. \( \text{LOG (TRA?),} \) logarithmic degree of economic freedom.
2. \( \text{LOG (LFT?),} \) logarithm of total labor force and in fact, the population of the workforce.
3. \( \text{LOG (GCF?),} \) logarithm of gross capital accumulation.

**Estimation methods and analysis:**
According to the use of statistical data, economic models are divided into three groups. Some models are estimated using time series data or in other words a relatively long period e.g. the estimation of total consumption during the time. Some others are estimated using cross sectional data meaning that data are considered in a given period e.g. a week, a month or a year from which Angel function can be mentioned. This is realized by estimation of a large number of households in a specific period. The second widely used method to estimate the model is based on panel data. In this method, a series of sectional units are considered over several years and the most usage of that, is in production functions of a firm or industry-related goods in which demand functions should be estimated simultaneously. With this method, optimal number of observations increases, thus the problem of lack of data in this study can be resolved. However, for estimating panel data models, different methods are presented according to the relevant case and study. In this study, data of 10-year period from 2000 to 2009 are collected from WDI Global site. Considering that the aim of this study is to get to elasticity of \( \alpha \) for individual countries, we apply a method for estimating the parameters that give the same amount for different countries. Accordingly, matrix of information is set through a simple huddle in balanced mode. For simplicity, the model can be summarized as follows:

\[ Y_0 = X_0 + U_0 \] (12)

Where \( Y \) is observations of the dependent variable for different countries and \( X \) is a collection of model explanatory variables. For estimation, different methods such as random effects method and fixed effects method exist. Fixed effects approach separates effects of different sectional units by inserting dummy variable. Random effects method also resolves heteroscedasticity among groups. In order to determine which method is more suitable, Hausman test is used. Null hypothesis in Hausman test is as follows.

\[ H_0 : \alpha = \alpha_i \]

\[ H_1 : \alpha \neq \alpha_i \]

The null hypothesis means that there is no relation between disturbance term of intercept and explanatory variables. The alternative hypothesis shows that there is a correlation between the disturbance term and explanatory variables. In case of accepting \( H_0 \), it is better to use fixed effects method. Under \( H_0 \) hypothesis, both fixed effects and random effects are consistent but fixed effects approach is inefficient. In other word in case of \( H_0 \) hypothesis rejection, fixed effects method is consistent and random effects method is inconsistent, hence we should use fixed effects method. If \( b \) estimates fixed effects method and \( \hat{\beta} \) estimates random effects one, Hausman proves that the above statistics has F distribution that is more suitable for testing.

\[ W = (b - \hat{\beta})' \sum_{i=1}^{-1} (b - \hat{\beta}) X_i X_i' \] (14)
The above formula is another test relevant to the significance of selected sample countries. If we are to work on effects of different groups and countries, we must consider the hypothesis test in which we estimate all the fixed terms that are equal to each other. Thus it is determined whether the panel data is more efficient to estimate the considered function or not. Therefore F statistic is used. The test, in which we use POOL or PANEL, is as follows.

\[
F(n - 1, nt - n - k) = \frac{(R^2_u - R^2_p)n(n - 1)}{(1 - R^2_p)(nt - n - k)}
\]  

(15)

In this function, \(n\) is the number of countries, \(t\) is the desired length, and \(k\) is the number of parameters. The term, \(u\) represents unrestricted model and \(p\) indicates Pooling model.

In this regard, the hypothesis is as follows:

\(H_0: \text{POOL}\)

\(H_{\alpha}: \text{PANEL}\)

With the relevant test, if the value of calculated \(F\) is more than that of the table (with degrees of freedom), then \(H_0\) hypothesis is not accepted, i.e. we must use the panel method.

**The first test: test of significance with POOL or PANEL:**

As it has been said, to ensure significance of group of sample countries, we use this test.

| \(SS_r\) | 565.4748 |
| \(SS_u\) | 437.2966 |
| \(1-n\) | 9 |
| \(Nt-n-k\) | 87 |

Value of the observed \(F\) is 516/229 and this is greater than that of the table. Hence, unlike group effects, \(H_0\) hypothesis is not accepted and different intercepts will be considered in the estimation using panel method

\[
F(n - 1, nt - n - k) = \frac{(SS_r - SS_u)(n - 1)}{(SS_u)(nt - n - k)} = 229.516
\]

Second Test: Selection of fixed or random effects

For this purpose, Hausman statistics is used that is 46/48 and as this value is more than chi square value of the table (for \(\alpha=0.5\), \(H_0\) hypothesis is not accepted). Therefore random effects are inconsistent and for estimation, we should use fixed effect method; i.e. the null hypothesis based on random effects is not accepted and the alternative hypothesis based on the fixed effects is approved.

<table>
<thead>
<tr>
<th>Test summary</th>
<th>Chi-sq statistic</th>
<th>Chi-sq.d.f</th>
<th>(\text{prob})</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cross section random</td>
<td>fixed</td>
<td>random</td>
<td>(\text{Var(diff)}</td>
</tr>
<tr>
<td>TRA) Log(2)</td>
<td>-0.4</td>
<td>-0.335</td>
<td>0.0001</td>
</tr>
<tr>
<td>LFT) Log(6)</td>
<td>2.447</td>
<td>1.292</td>
<td>0.0286</td>
</tr>
<tr>
<td>GCF) Log(2)</td>
<td>0.748</td>
<td>0.696</td>
<td>0.0001</td>
</tr>
</tbody>
</table>

Source: Researcher's findings.
As fixed effects are more valid, coefficients and test statistics are presented in this table.

<table>
<thead>
<tr>
<th>coefficients</th>
<th>Standard deviation</th>
<th>T statistic</th>
<th>probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>-17.220</td>
<td>4.0702</td>
<td>-4.23</td>
<td>0.0001</td>
</tr>
<tr>
<td>Log (TRA?)</td>
<td>-0.4</td>
<td>0.0758</td>
<td>-5.28</td>
</tr>
<tr>
<td>Log (LFT?)</td>
<td>2.447</td>
<td>0.2309</td>
<td>10.594</td>
</tr>
<tr>
<td>Log (GCF?)</td>
<td>0.748</td>
<td>0.1310</td>
<td>5.716</td>
</tr>
</tbody>
</table>

**Model estimate Function is as follows:**

\[ \text{LOG (GCA?)} = 17/220 -4 \text{ LOG (TRA?)}+2/447 \text{ LOG (LFT?)}+0/748 \text{ LOG (GCF?)} \]

**Conclusion:**

Factors such as degree of freedom of nations, total workforce in a country and capital accumulation have significant effects on growth in Iran, Japan, Malaysia, Thailand, Turkey, Korea, China, India, Indonesia and Australia. Coefficients obtained show that degree of freedom in these countries are negative that represents the reverse effect on economic growth. The analysis of this coefficient is that according to the poor economic situation of some of these countries, the negative coefficient is due to the imports of more consumer goods so that these imports causes a negative impact on sales and domestic goods and services. Therefore, we can control the import of consumer goods that contributes to economic growth. For work force coefficient, the positive sign of this factor represents a suitable work force status in the countries. As it can be observed, the main base of every economy is the labor force, particularly skilled work force, which leads to more economic growth. Therefore training workforce in all areas can significantly increase economic growth. The positive coefficient of capital accumulation shows a direct impact of the factor on economic growth and as this factor leads to useful and valuable investment in the country, it will elevate economic growth.
References


