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A Primer on GDP and Economic Growth

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Abstract: This paper explores value concept and defines utility function with incorporation with value and price. From this value concept, the value added method is used for GDP measurement that is important in identifying driving factors of economic growth. This accounting identity approach does not rely on the restrictive assumptions in neoclassical growth models. The conceptual growth model is also proposed with three elements of capital accumulation, technological innovation, and institutional reform. The paper reveals that capital accumulation and technological innovation are two integrated elements in driving economic growth, institutional reforms play a key role in creating economic incentives that affect the steady state and growth in the real world economy.

Keywords: value concept, GDP measurement, economic growth, capital accumulation, technological innovation, institutional reform.

JEL Classification: D24; D46; O47

1. INTRODUCTION

The economic growth is always a central theme in economic literature. The neoclassical growth models are mainly used the technical form of Cobb - Douglas production with restrictive assumptions. The Solow - Swan growth model postulates a continuous production function linking output to the inputs of capital and labor which leads to the steady state equilibrium of the economy. The Harrod - Domargrowth models are based on the experience of advanced economies. They are primary addressed to an advanced capitalist economy and attempt to analyse the requirements of steady growth in such economy. These theoretical models provide basic principles on the steady state equilibrium and steady growth path, but they are hard to apply in growth analysis in the real economy.

The growth analysis requires to measure GDP of the economy, in which the GDP formula presents what are driving factors of economic growth. In theory, there are two primary approaches for measuring GDP, which should yield the same result even though they measure completely different factors. The expenditure approach measures the total expenditures on the final commodities produced by a country in a given year. The income approach measures the total incomes earned by householders and firms in a country in a given year. In practice, the expenditure approach measures GDP by using data on personal expenditure, capital investment, government expenditure and net export. The income approach measures GDP by using data on the firm profits and incomes that the firms pay householders for the resource they hire. The two approaches are based on different data sources that may give slightly different measures. Thus, both two approaches are used to check one approach against the other approach. The small statistical discrepancy between the approaches is used to adjust both approaches to make them equal. However, there is still no a common formula on the interrelationship between the expenditure approach and the income approach. This results in a limited explanation on how GDP is measured, and which are driving factors in economic growth model.

Since GDP is measured by valuating everything that is produced and adding all the value together, the value added method is used for GDP measurement that presents driving factors of the economy. This value added approach does not rely on the restrictive assumptions as in the neoclassical growth models. From this base, this paper also proposes the economic growth model with three elements of capital accumulation, technological innovation, and institutional reform. The paper provides a theoretical insight on economic growth that explains driving factors and economic incentives in the real world economy.

2. VALUE CONCEPT

The value concept has become a central theme in many disciplines. Most economists tried to make a clear distinction between value and price of a commodity. Baier (1971) offered a broader definition such as "value is the capacity of a good, service, or activity to satisfy a need or provide a benefit to a person or legal entity". Contemporary value concept is something which is perceived and evaluated at the time of consumption (Wikström, 1996; Woodruff and Gardial, 1996; Vargo and Lusch, 2004; Grçnroos, 2008). There is a common understanding that value is created in the users' processes as value-in-use (Grönroos, 2011).Since value is more appreciate guide to well-being than utility in the today's society and economy (Trinh, 2014a), the theory of value should be redefined the value concept and constructed upon a law of diminishing marginal value. Figure 1 presents the concepts of value, price, and utility.

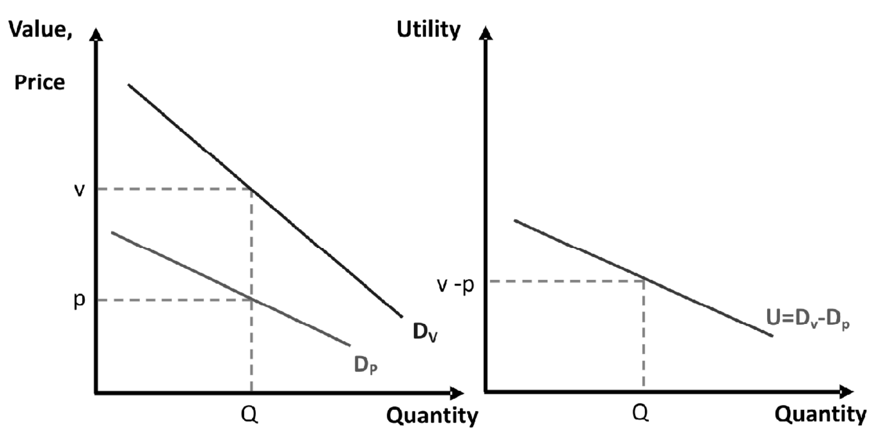

Figure 1: The value concept

From the value concept, the utility function is defined with incorporation of value and price (Trinh *et al.,* 2014a) as follows:

$$TU = u \times Q = (v - p) \times Q = TV - TR \quad (1)$$

Where, v, p, and u are unit value, unit price, and unit utility, respectively. TV, TR, and TU are total value, total revenue, and total utility, respectively.

Moreover, the foundation of value creation is shifting from firm-centric view to customer-centric view (Prahalad and Ramaswamy, 2004; Ojasalo, 2010; Trinh *et al.*, 2014b). Figure 2 shows the value creation system involving three processes of production, exchange, and consumption.

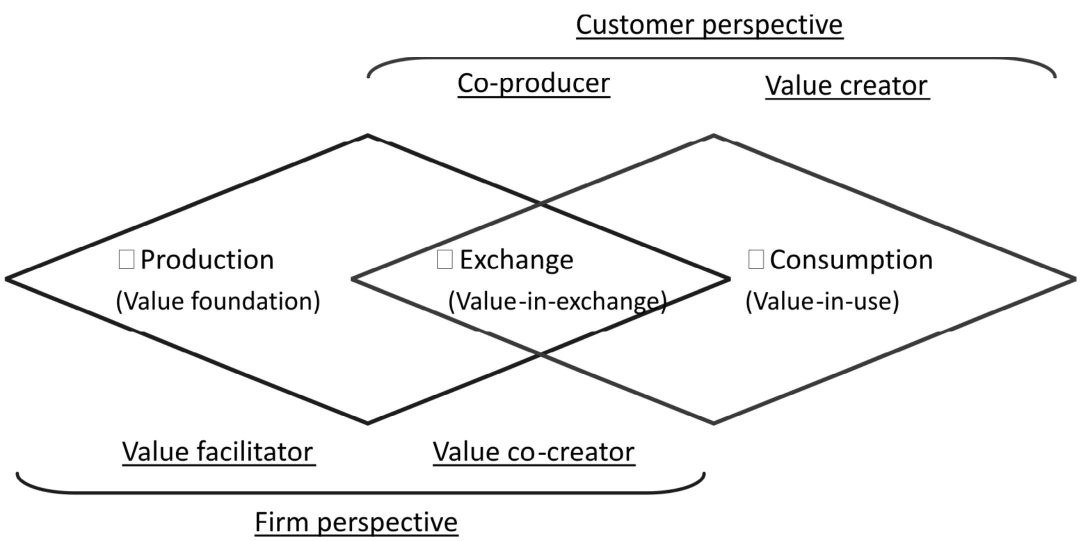

Figure 2: Value creation perspective

Source: Adapted from Grçnroos and Voima (2012), Trinh (2014b)

In firm perspective, the firm takes on the role of value facilitator in the production process, the firm could take part in the customer's experience of value-in-use and influence it as a value co-creator. Firm's production function is defined under the form of Cobb Douglas production function as follows:

$$Q = f(K_1, L_1) = A_1 \times K_1^{\alpha_1} \times L_1^{\beta_1} \quad (2)$$

Where, Q is total output of production. A_1 is firm's total factor productivity. K_1 and L_1 are firm capital and firm labor, respectively. α_1, β_1, are the output elasticities of input factors of production.

By using the least-cost combination of production inputs, firm's cost function (TC_1) can be determined as a function of output, depending on input prices and the parameters of the firm's production function as follows:

$$TC_1 = w_{K_1} \times K_1 + w_{L_1} \times L_1 \quad (3)$$

Where, TC_1 is firm's total cost, w_{K_1} and w_{L_1} are unit costs of firm capital and firm labor.

Firm's profit function is determined by the following formula.

$$\Pi = TR - TC_1 = p \times Q - w_{K_1} \times K_1 - w_{L_1} \times L_1 \tag{4}$$

Where, Π is firm profit and *TR* is total revenue ($TR = p \times Q$).

Profit maximizing firm will produce at the quantity where firm's marginal revenue (*MR*) equals firm's marginal cost (MC_1).

$$MR = MC_1 \tag{5}$$

In customer perspective, the customer is always a value creator and may take part in the firm's production process as a co-producer. Since the value is created in the consumption process, customer capital (K_2) and customer labor (L_2) are added in the consumption function as follows:

$$Q = f(K_2, L_2) = A_2 \times K_2^{\alpha_2} \times L_2^{\beta_2} \tag{6}$$

Where, *Q* is total output of consumption. A_2 is customer's total factor productivity. α_2, β_2, are the output elasticities of input factors of consumption.

By using the least-cost combination of consumption inputs, customer's cost function (TC_2) can be determined as a function of output, depending on input prices and the parameters of the customer's consumption function as follows:

$$TC_2 = w_{K_2} \times K_2 + w_{L_2} \times L_2 \tag{7}$$

Where, TC_2 is customer's total cost, w_{K_2} and w_{L_2} are unit costs of customer capital and customer labor.

Customer's utility function is determined by the following formula.

$$U = TU - TC_2 = (v - p) \times Q - w_{K_2} \times K_2 - w_{L_2} \times L_2 \tag{8}$$

Where, *U* is customer utility and TU is total utility ($TU = u \times Q = (v - p) \times Q$).

Utility maximizing customer will consume at the quantity where customer's marginal utility (*MU*) equals customer's marginal cost (MC_2).

$$MU = MC_2 \tag{9}$$

From the value creation perspective, the firm uses resources in the production process to create value foundation and facilitate the customer's value creation, and then the customers use firm resources and add their resources and skills in the consumption process to transform value foundation into value-in-use (value). The joint cost function and the joint value function are determined as follows:

$$TC = TC_1 + TC_2 = w_{K_1} \times K_1 + w_{L_1} \times L_1 + w_{K_2} \times K_2 + w_{L_2} \times L_2 \tag{10}$$

$$V = \Pi + U = v \times Q - (w_{K_1} \times K_1 + w_{L_1} \times L_1 + w_{K_2} \times K_2 + w_{L_2} \times L_2) = TV - TC \tag{11}$$

Where, V is joint value, TV is total value ($TV = v \times Q$) and TC is total joint cost. w_{K_1} and w_{L_1} are unit costs of firm capital and firm labor. w_{K_2} and w_{L_2} are unit costs of customer capital and customer labor.

In value creation system, value maximizing decision will make the quantity of production and consumption where marginal value ($MV = TV'(Q)$) equals marginal cost ($MC = MC_1 + MC_2$).

$$MV = MC \tag{12}$$

3. GDP MEASUREMENT

In economics, the value concept plays an important role in determining the relationship between demand and supply, and measuring total production value in the economy. GDP is measured by valuating everything that is produced and adding all the value together. The value added method determines production value of final commodity $(p_i Q_i)$ in the industry i through exchange processes between the firm and the customer as in Figure 3. GDP is measured by summing up final commodity's production value of industries in the economy.

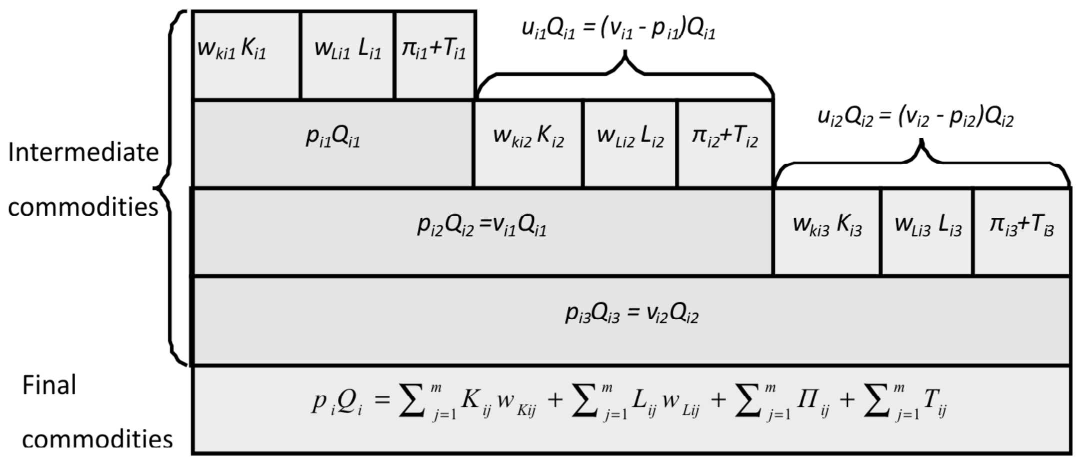

Figure 3: The GDP approach for industry *i*

For the intermediate exchanges, intermediate firms play dual roles of the firm and the customer. In the initial exchange, firms provide the commodities to customers. Firm profit (Π_{i1}) and customer utility (U_{i1}) are determined as follows:

$$\Pi_{i1} = p_{i1} \times Q_{i1} - K_{i1} \times w_{K_{i1}} - L_{i1} \times w_{L_{i1}} - T_{i1} \tag{13}$$

$$U_{i1} = (v_{i1} - p_{i1}) \times Q_{i1} - K_{i2} \times w_{K_{i2}} - L_{i2} \times w_{L_{i2}} - T_{i2} \tag{14}$$

Where T_{i1} is tax and subside of the firm and T_{i2} is tax and subside of the customer. Customer then plays a role of the firm in the next exchange process. The customer utility (U_{i1}) in the initial exchange is also the firm profit (Π_{i2}) in the next exchange.

$$\Pi_{i2} = (p_{i2} \times Q_{i2} - p_{i1} \times Q_{i1}) - K_{i2} \times w_{K_{i2}} - L_{i2} \times w_{L_{i2}} - T_{i2} \tag{15}$$

$$U_{i2} = (v_{i2} - p_{i2}) \times Q_{i2} - K_{i3} \times w_{K_{i3}} - L_{i3} \times w_{L_{i3}} - T_{i3} \tag{16}$$

Where, total value ($v_{i1} \times Q_{i1}$) equals total revenue ($p_{i2} \times Q_{i2}$) in the next exchange.

For the final exchange, customers are the final consumers that buy the final commodities from the last firms in the exchange processes. Firm profit (Π_{im}) is given as follows:

$$\Pi_{im} = \left(p_{im} \times Q_{im} - p_{im-1} \times Q_{im-1}\right) - K_{im} \times w_{K_{im}} - L_{im} \times w_{L_{im}} - T_{im} \tag{17}$$

Total profit of industry *i* is determined by the following formula.

$$\sum_{j=1}^{m} \Pi_{ij} = p_{im} \times Q_{im} - \sum_{j=1}^{m} K_{ij} \times w_{K_{ij}} - \sum_{j=1}^{m} L_{ij} \times w_{L_{ij}} - \sum_{j=1}^{m} T_{ij} \tag{18}$$

From above formula, total production value of industry *i* $\left(p_i \times Q_i + I_i = p_{im} \times Q_{im} + \sum_{j=1}^{m} I_{ij}\right)$ is defined as a sum of production value of intermediate firms, in which total expenditure $\left(p_{im} \times Q_{im} + \sum_{j=1}^{m} I_{ij}\right)$ is equal to total income $\left(\sum_{j=1}^{m} K_{ij} \times w_{K_{ij}} + \sum_{j=1}^{m} L_{ij} \times w_{L_{ij}} + \sum_{j=1}^{m} \Pi_{ij} + \sum_{j=1}^{m} T_{ij} + \sum_{j=1}^{m} I_{ij}\right)$, in which $\sum_{j=1}^{m} I_{ij}$ is capital investment of industry *i*. By setting $K_i \times w_{Ki} = \sum_{j=1}^{m} K_{ij} \times w_{K_{ij}}$, $L_i \times w_{Li} = \sum_{j=1}^{m} L_{ij} \times w_{L_{ij}}$, $\Pi_i = \sum_{j=1}^{m} \Pi_{ij}$, $T_i = \sum_{j=1}^{m} T_{ij}$, $I_i = \sum_{j=1}^{m} I_{ij}$, total production value of industry *i* can be expressed as follows:

$$p_i Q_i + I_i = K_i \times w_{K_i} + L_i \times w_{L_i} + \Pi_i + T_i + I_i \tag{19}$$

Total production value (GDP) of the economy with *n* industries is determined as follows:

$$GDP = \sum_{i=1}^{n} p_i \times Q_i + \sum_{i=1}^{n} I_i \tag{20}$$

$$GDP = \sum_{i=1}^{n} K_i \times w_{K_i} + \sum_{i=1}^{n} L_i \times w_{L_i} + \sum_{i=1}^{n} \Pi_i + \sum_{i=1}^{n} T_i + \sum_{i=1}^{n} I_i \tag{21}$$

By setting $\sum_{i=1}^{n} S_{Fi} = \sum_{i=1}^{n} \Pi_i + \sum_{i=1}^{n} I_i - \sum_{i=1}^{n} D_i$, in which $\sum_{i=1}^{n} S_{Fi}$ is firm savings and $\sum_{i=1}^{n} D_i$ is capital depreciation. Thus, GDP from Equation (21) can be rewritten as follows:

$$GDP = \sum_{i=1}^{n} K_i \times w_{K_i} + \sum_{i=1}^{n} L_i \times w_{L_i} + \sum_{i=1}^{n} S_{Fi} + \sum_{i=1}^{n} D_i + \sum_{i=1}^{n} T_i \tag{22}$$

From Equation (20), setting $PQ = \sum_{i=1}^{n} p_i \times Q_i$ and $I = \sum_{i=1}^{n} I_i$, in which total expenditure on final commodities (PQ) includes personal expenditure (C), government expenditure (G), and net export (NX). GDP measurement under the expenditure approach can be expressed as follows:

$$GDP = C + G + I + NX \tag{23}$$

From Equation (22), setting $KW_K = \sum_{i=1}^{n} K_i \times w_{Ki}$, $LW_L = \sum_{i=1}^{n} L_i \times w_{Li}$, $S_F = \sum_{i=1}^{n} S_{Fi}$, $D = \sum_{i=1}^{n} D_i$, and $T = \sum_{i=1}^{n} T_i$, GDP measurement under the income approach can be expressed as follows:

$$GDP = KW_K + LW_L + S_F + D + T \tag{24}$$

GDP is measured through total income that includes capital interest (KW_K), labor wage (LW_L), firm savings (S_F), capital depreciation (D), tax and subside (T).

4. ECONOMIC GROWTH

From the GDP formula, there are two ways of increasing GDP of the economy: capital accumulation and technological innovation. Capital accumulation increases the number of inputs with the old way that go into the production process. Technological innovation is the new ways that get more output from the same number of inputs. Capital accumulation and technological innovation are two integrated elements in driving economic growth. On the one hand, physical capital and human capital are essential forces in applying new technology and expanding market demand. On the other hand, technological innovation creates new economic opportunities for investment in physical capital and human capital. However, capital accumulation and technological innovation must be organized to produce valuable commodities in the economy. The key to producing and organizing the factors of production are institutions that create appropriate incentives for economic growth as illustrated in Figure 4.

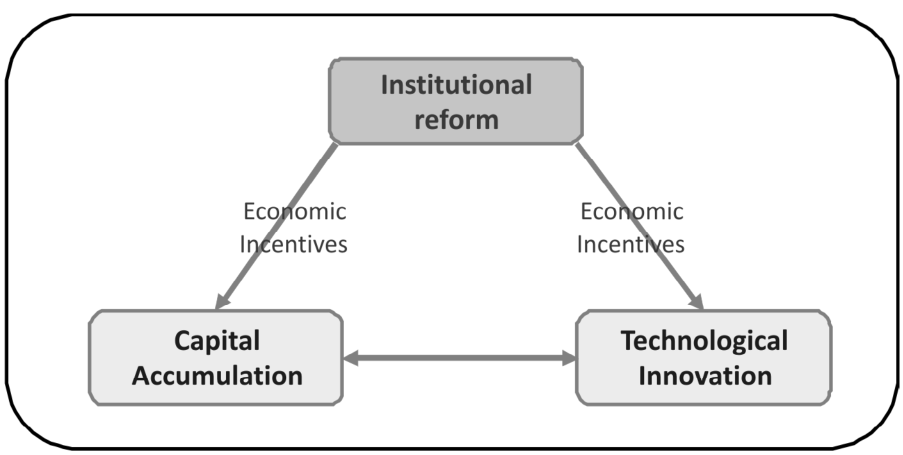

Figure 4: The conceptual growth model

Capital Accumulation

Exogenous growth theory attempts to explain economic growth by looking at capital accumulation (physical capital and human capital), technological innovation (technological change and market demand) is assumed exogenous. Therefore, the growth rate of the economy converges to the steady state that is determined by the rate of capital accumulation. The differences in GDP per capita depending on the paths of capital accumulation through saving rates (Solow, 1956), preference (Cass, 1965; Koopmans, 1965) or other exogenous parameters.

According to the exogenous growth model, if all economies have the same taste and technology parameters, and the same population growth rate, then they should have the same steady state level of GDP per capita. The rate of economic growth depends on the capital accumulation, the countries with the low capital accumulation grows more rapidly than those with higher capital accumulation. This "catch up" result implies a process of convergence among countries and regions. Comparing income across U.S. states is a good test of conditional convergence, in which U.S. states have similar unemployment rate and access to similar technology. The poorest states of Maine and Arkansas have grown faster than the richer states of Massachusetts and New York (Baro and Sala-I-Martin, 1995). In addition, countries with low GDP per capita grow more rapidly than those in which beginning GDP per capita are high. The gap in GDP per capita for four major European countries (France, Germany, Italy, U.K.) have been substantially reduced during 1870-1999 (Maddison, 1995). Although the model states "conditional convergence" with unrealistic assumptions of the same population growth and technology progress in various countries. The exogenous growth model provides a theoretical base for steady state equilibrium, the basis for much of today's economic theory (McCallum, 1996).

In response to the various failures of the exogenous model, Romer (1986) and Lucas (1988) have developed endogenous growth models in which steady state growth can be generated endogenously. Romer (1990), Grossman and Helpman (1991), and Aghion and Howitt (1992) stated that technological change is endogenous that is driven by R&D and innovations.

Technological Innovation

Endogenous growth theory holds that investment in human capital, innovation and knowledge are significant contributions to economic growth. The steady state is the point at which there is no growth through capital accumulation, growth at the steady state must be due to human capital, innovation and knowledge. Romer (1986) and Lucas (1988) emphasized on the importance of externalities in the accumulation of knowledge and human capital in offsetting the decreasing returns to scale in capital accumulation.

The rate of capital accumulation is one of the main factors determining the level of GDP per capita. Although its effects could be more or less permanent depending on the extent to which technological innovation is embodied in new capital investment. The rate of economic growth depends on two factors of capital accumulation (quantity of capital stock) and technological innovation (quality of capital stock) as in Figure 5. A country with the same capital stock but better technological innovation (a higher steady state rate) will grow faster than another country. This is due to the greater distance form steady state levels. Similarly, a country with a lower initial capital stock than another country, but the same technological innovation will grow faster because of the wider gap to be closed.

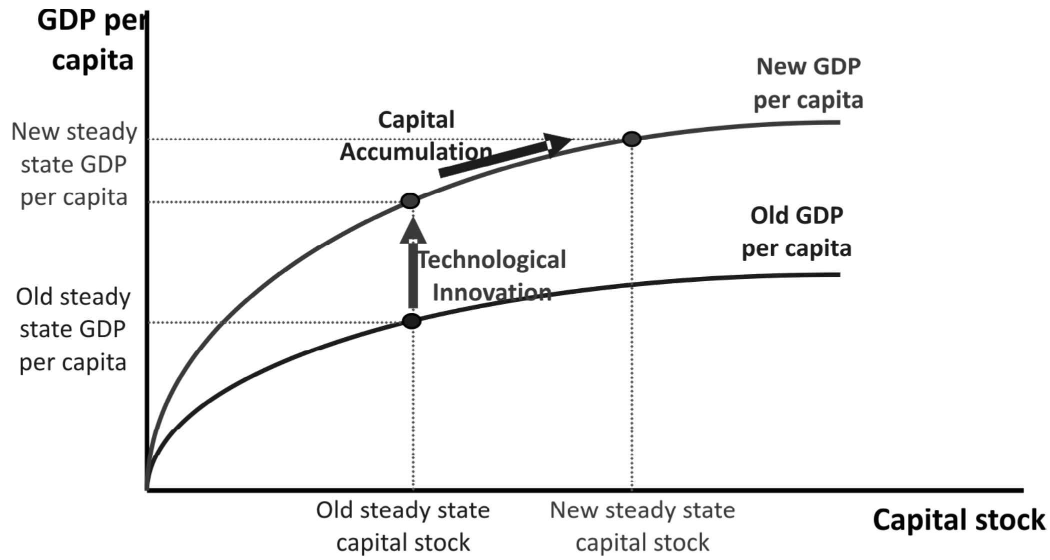

Figure 5: Neoclassical growth model

The East Asia countries with low level of capital stocks and high investment rates have further growth and catch up with the wealthier countries. However, the wealthier OECD countries still keep in high rates in GDP per capita due to technological innovation. Thus, steady state and steady growth are explained through capital accumulation and technological innovation. The way countries invest in capital accumulation and technological innovation results in GDP per capita over time. The fact is that GDP per capita today varies enormously among countries as in Figure 6 (Cowen and Tabarrok, 2011). It indicates that 80% of world's population lives in a country with an annual GDP per capita less than the world average. Today, GDP per capita is more than 50 times higher in richest countries than in the poorest countries.

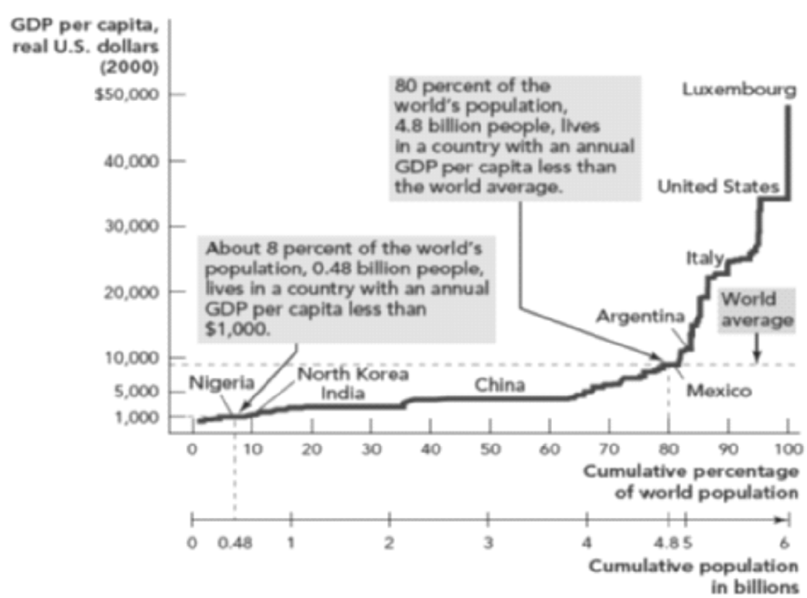

Figure 6: The distribution of world income (Summers and Heston, 2000)

Can countries catch up to rich countries is still the big question. Instead of answering this question, let's concern on what makes a country rich? Countries with a high GDP per capita have institutions that encourage investment in both capital stock and technological innovation.

Institutional Reform

In these models, the difference in GDP per capita and growth rate are not explained by variance in institutions that have influence on how a country invest in capital accumulation and technological innovation. A economic growth model that ignores the role of institutions may oversimplify the analysis and the important linkages in the dynamics of economic growth (Tebaldi and Elmslie, 2008).

The role of institutions has become one of the most popular research are a in development economics over the last twenty years (North, 1990; Huang and Xu, 1999; Rodrik et al., 2004; Acemoglu et al., 2005; Acemoglu and Robinson, 2010). What are institutions exactly? North (1990) defined institutions as the "rules of the game" that shape human interaction and structure economic incentives within a society. The key institutions are property rights, honest government, political stability, and dependable legal system, competitive and open markets that have been very positive for both innovation and economic growth (Cowen and Tabarrok, 2011).The institutional reform shapes the economic incentives of key actors in society that have influence on capital accumulation and technological innovation. The differences in economic institutions are the fundamental cause of different patterns of economic growth as in Figure 7.

Japan was one of the poorest countries in the world with GDP per capita less than that of Argentina, and South Korea was the poorest country with GDP per capita the same as that of Nigeria in 1950s. However Japan grew at an astonishing rate of 8.5 percent per year during 1950-1970, South Korea's growth miracle grew at a rate of 7.2 percent per year during 1970-1990. Japan and South Korea are two modern countries with a story of growth miracles. Growth miracles are possible but also are growth disasters, in which Argentina and Nigeria failed to grow much. As a result, Argentina's GDP per capita

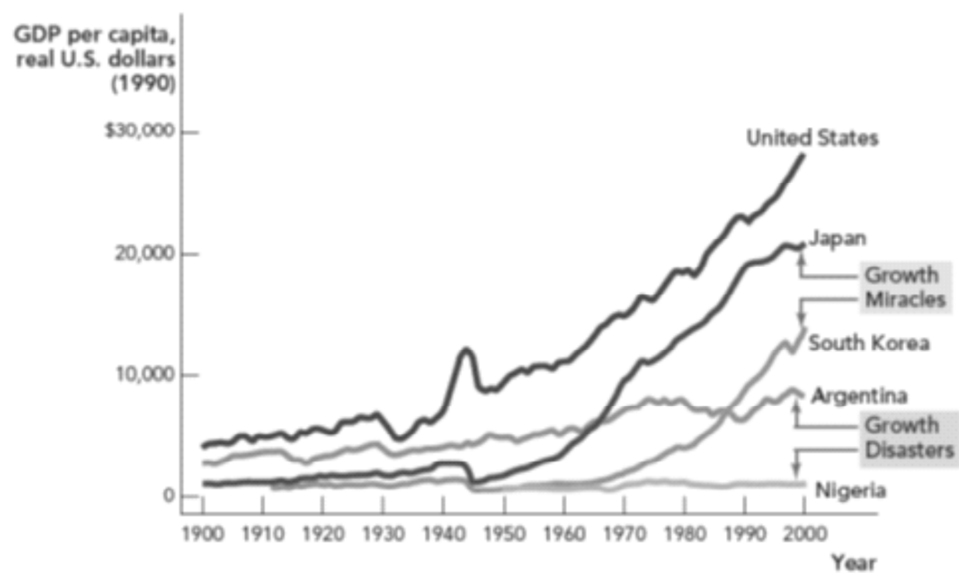

Figure 7: Growth Miracles and Growth Disasters *(Maddison, 2007)*

was less than a third of that of Japan and South Korea by the year 2000. Nigeria was even poorer in 2000 than in 1974. While Nigeria have stabled along the growth path, Argentina seem to have fallen off the growth path (Maddison, 2007).

5. CONCLUSIONS

The theory of value encompasses all the theories within economics that attempt to explain the difference between value and price. Since value is more appreciate in guide to well-being than utility, the theory of value needs to redefine the value concept, in which the utility function is defined with incorporation of value and price. From this theoretical base, the value added approach is used for the GDP measurement. The GDP formula presents driving factors that are important to economic growth analysis.

The neoclassical growth models are mainly used technical analysis for economic growth that states conditions of steady state and requirements of steady growth. However, technical analysis relies on many restrictive assumptions that are hard to apply with economic data. The economic analysis through accounting identity does not rely on neoclassical restrictive assumptions. In addition, the paper also proposes the conceptual growth model with three main elements of capital accumulation, technological innovation, and institutional reform. The growth model not only explains steady state and steady growth, but also identifies institutional reform in creating incentives for economic growth that leads to steady state equilibrium and steady growth rate in the real world economy.

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