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A Perspective on Frugality in Growing Economies: Triggering a Virtuous Cycle between Consumption Propensity and Growth

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Abstract

Growing economies have recovered from the global financial crisis faster than many developed economies and increased the consumption significantly over the past years. In light of the role of their consumption growth in global sustainability, this paper analyzes the decisive factors leading to a virtuous cycle between consumption propensity and investment in growing economies. An empirical analysis was conducted to identify the contributing factors to such a cycle in 40 countries. They could be divided into three economic groups by the marginal propensity to consume. The results suggest that growing economies suffer from an autarky cycle between consumption and GDP due to insufficient investment elasticity against consumption elasticity while advancing and advanced economies allow GDP growth to induce investment efficiently. A possible trigger for inducement of investment by growth in growing economies can be 'frugality'.

Keywords: *Consumption; growth; frugal innovation; consumption propensity; growing economies.*

INTRODUCTION

Growing economies have recovered from the global financial crisis faster than many developed economies. The pace of the recovery in advanced economies has been hampered by high unemployment rates, weak household balance sheets, and anemic bank credit, and it remains heavily dependent on macroeconomic policy support. By contrast, many emerging economies have continued to rebound swiftly over the course of 2009 and the first quarter of 2010. Contribution of Asian countries to a global recovery after the crisis has been outstanding. While Asia's recovery was generally driven by exports in the past recessions, it has also been reinforced by resilient domestic demand, particularly household consumption this time (IMF, 2010).

Growing economies are expected to continue to increase consumption steadily even after the global financial crisis in 2009. The reasons to believe this include high population growth and emergence of the new middle class. Rapid shift toward the new middle class could be found in growing economies corresponding to their rapid growth. Consumption growth by the new middle class will play a critical role for global sustainability. Raballion (2009) pointed out that while growth rates in growing economies are expected to slow down during the spillover effects of the global financial crisis, maintaining their growth, particularly in Asia, will be especially important for preventing a slowdown in overall progress. Kharas (2010) discussed a scenario which does not depend on a

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rebound in US consumer demand but on a sharp upsurge in demand from a new Asian middle class. This new Asian middle class is huge and is growing rapidly. It is sufficient enough to provide the impetus for demand growth corresponding to the world demand. However, there remain not a few uncertainties on this optimistic scenario. New perspectives ensuring the economic structural shifts towards growing economies leading to global sustainability are thus required.

Structure of consumption effects on economic growth differs depending on levels of economic development, and can be classified into three economic groups as demonstrated in Figure 1;

- Group A: Growing Economies consisting of eight countries, Brazil, China, India, Indonesia, Malaysia, Philippine, Russia and Thailand;
- Group B: Advancing Economies consisting of seven countries, Czech Republic, Korea, Mexico, Poland, Slovak Republic, Taiwan and Turkey; and
- Group C: Advanced Economies consisting of 22 countries, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Japan, Luxembourg, Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, United Kingdom and United States.
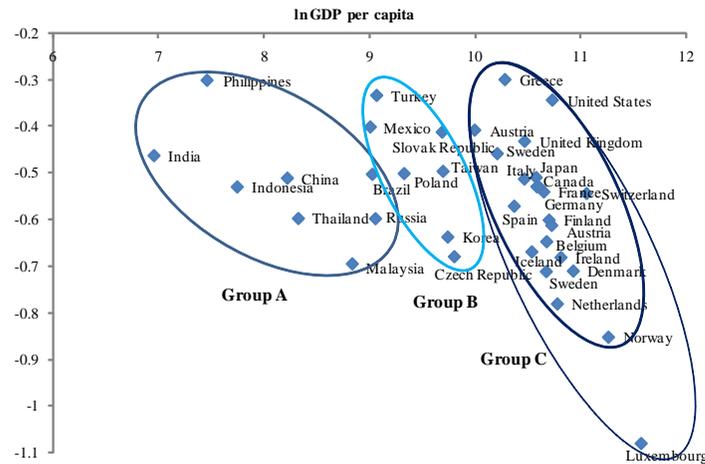

Figure 1: Correlation between Household Final Consumption Expenditure per GDP and GDP per capita in 37 Countries[a, b] (2009).

[a] 37 countries can be classified into three groups by their HFCE per GDP – GDP per capita correlation structure as depicted as follows:

$$\ln HFCE\ per\ GDP = 1.161 - (0.207D_1 + 0.175D_2 + 0.165D_3)\ln GDP\ per\ capita$$

$$(2.74) \quad (-15.31) \quad (-18.38) \quad (-21.04)$$

$$adj.R^2 = 0.986, DW = 1.62$$

where D_1, D_2 and D_3 are dummy variables corresponding to Group A, B and C (see Table 1).

[b] The data on HFCE per GDP for China was reevaluated in correspond to its GDP size.

Looking at Figure 1 carefully, we note that contrary to the noting difference

of the economic level, extent of the level of average propensity to consume (Household Final Consumption Expenditure (HFCE) per GDP) of growing economies is not necessary below the level of countries in advancing and advanced economies (except Luxemburg). This observation suggests that there should be certain structural impediments hampering the co-evolution between consumption and GDP increases, in the growing economies.

Studies on inducing dynamism between consumption, investment and growth (e.g. Solow, 1975) suggest that the foregoing structural impediments can be attributed to the disability of consumption structure in growing economies in inducing their investment. In light of the significant role of economic development of growing economies, induced by their consumption increase, this paper attempts to demonstrate the above hypothetical view. An empirical analysis is attempted to reveal the structural impediments hampering co-evolutionary dynamism in growing economies. Section 2 introduces the analytical framework. Section 3 describes the results of the analysis. Section 4 provides the interpretation of the results of the analysis. Section 5 briefly summarizes new findings and policy implications.

ANALYTICAL FRAMEWORK

Numerical Analysis

An empirical analysis consists of three parts. First, the consumption effects on economic growth in major countries in growing, advancing and advanced economies are examined to identify the differences among them. Second, the optimal trigger that maximizes the consumption effects on economic growth is identified. Finally, the structural differences in maximizing the consumption effects are analyzed with a focus on the role of investment.

Correlation between Consumption and Economic Growth

The first analysis focuses on the marginal propensity to consume. This evaluates the consumption effects on economic growth depending on the development stage. In order to compare structural differences of such effects among countries with significant difference of population and size, marginal propensity to consume in per capita terms (MPC) was focused upon. Given the governing factors of MPC, V (GDP), C (consumption) and N (population), general equation of MPC can be depicted as follows:

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$$MPC = F(V, C, N) \tag{1}$$

where V: GDP; C: Household Final Consumption Expenditure (HFCE); and N: population size.

MPC can be expanded by the following equation:

$$MPC = \frac{\partial C/N}{\partial V/N} = \frac{\partial \ln C/N}{\partial \ln V/N} \cdot \frac{C}{V} \tag{2}$$

While MPC can be expanded to equation (2) by C/N and V/N, consumption is linked to disposal income, correlation between them can be depicted by equation (3) by which MPC can be measured as a product of coefficient b and average propensity to consume as $MPC = b\,C/V$.

$$\ln C/N = a + b \ln V/N \tag{3}$$

where a, b: coefficients.

Institutional structure of MPC can be identified by equation (4) which can be obtained by means of Taylor expansion to the secondary terms:

$$\ln MPC = d + e \ln V + f \ln C + g \ln N + h \ln V \ln C + j \ln V \ln N + k \ln C \ln N \tag{4}$$

where d: constant; and e, f, g, h, j, k: coefficients.

VIRTUOUS CYCLE BETWEEN MARGINAL PRODUCTIVITY OF INVESTMENT AND GDP GROWTH

Furthermore, the analysis attempted to identify the optimal trigger for the consumption effects on economic growth with emphasis on the role of investment. According to the Solow Growth Model (Solow, 1957), the consumer saves fraction s of income in an economy where consumers receive all the production:

$$S = sV \text{ and } C = (1-s)V \text{ hence } V = C + S$$

where S: Savings.

Since consumers receive the production in all sectors, savings is simply investment. Given real income is assumed to be equal to GDP, the following equation can be obtained:

$$V = C + I$$

where I: investment in all sectors including government and foreign investments. The equation can be expressed in per capita terms:

$$v = c + i \tag{5}$$

where v: GDP per capita (V/N); c: HFCE per capita (C/N); and i: investment per capita (I/N).

Given that the size of investment per capita (Y) is decisive to nation's GDP (V), and considering a state of the size of investment per capita dependent economy, Y can be depicted by the following epidemic function with the level of GDP per capita (X):

$$\frac{dY}{dX} = \frac{\partial Y}{\partial X} = \alpha Y \left(1 - \frac{Y}{\overline{Y}} \right) \tag{6}$$

where Y: the size of investment per capita in logarithmic scale ($\ln i$); X: the level of GDP per capita in logarithmic scale ($\ln v$); α: velocity of diffusion of investment per capita; and $\overline{Y}$: carrying capacity of investment per capita (also in logarithmic scale).

Equation (6) can be developed by the following logistic growth function:

$$Y = \frac{\overline{Y}}{1 + \beta e^{-\alpha X}} \tag{7}$$

where β: initial state of the diffusion.

Equation (7) leads to the following equations:

$$1 - \frac{Y}{\overline{Y}} = \frac{1}{1 + \beta^{-1} e^{\alpha X}}$$

$$\frac{\partial Y}{\partial X} = \alpha Y \left(1 - \frac{Y}{\overline{Y}} \right) = \frac{\alpha}{1 + \beta^{-1} e^{\alpha X}} \cdot \frac{\overline{Y}}{1 + \beta e^{-\alpha X}} = \frac{\alpha \overline{Y}}{2 + \beta^{-1} e^{\alpha X} + \beta e^{-\alpha X}}$$

$$\frac{\alpha \overline{Y}}{\partial Y / \partial X} = 2 + \beta^{-1} e^{\alpha X} + \beta e^{-\alpha X} = \alpha \overline{Y} \cdot \frac{\partial X}{\partial Y} \equiv \alpha' \cdot MPi \tag{8}$$

where $\alpha' \equiv \alpha \overline{Y}$; and MPi: marginal productivity of investment with intensity $= d \ln v / d \ln i$ [2].

Given that $y \equiv \alpha' \cdot MPi$ and $x \equiv \beta e^{-\alpha X}$, equation (8) can be expressed as

$y = 2 + \dfrac{1}{x} + x$. Thus, bi-polarization diffusion trajectory can be traced as illustrated in Figure 2.
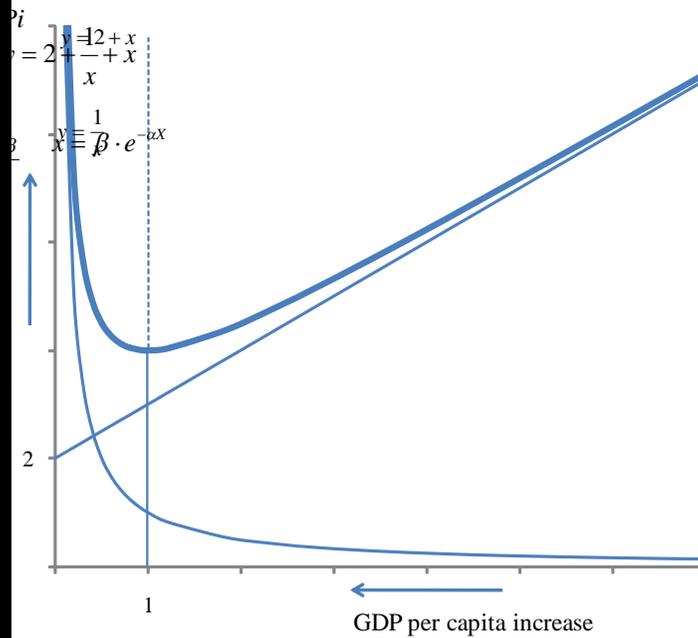
Figure 2: Bi-polarization Diffusion Trajectory

rginal productivity of investment with intensity) reaches

el when $X = \dfrac{\ln \beta}{\alpha}$ where $x = 1$ leads to $dy/dx = 0$. Therefore,

ose $X \geq \dfrac{\ln \beta}{\alpha}$,can enjoy a virtuous cycle between *MPi* increase

capita increase. Contrary to such a nation, the nation whose

pita level is higher than $\dfrac{\ln \beta}{\alpha}$, suffers the paradox of

based development resulting in a vicious cycle between *MPi*

GDP per capita increase.

ity between Consumption and Investment

tability between consumption and investment based on

e can be measured by the elasticity of substitution σ, depicted

ing equation:

$$\dfrac{\overline{\partial c}}{\partial i} \tag{9}$$

Integration of equation (9) leads to the following equations:

$$\ln \frac{i}{c} = \gamma + \sigma \ln \frac{\partial v/\partial c}{\partial v/\partial i}$$

$$= \gamma + \sigma \ln \frac{\partial \ln v/\partial \ln c}{\partial \ln v/\partial \ln i} \cdot \frac{v/c}{v/i} = \gamma + \sigma \ln \frac{\partial \ln v/\partial \ln c}{\partial \ln v/\partial \ln i} + \sigma \ln \frac{i}{c} \qquad (9)'$$

$$\sigma \ln \frac{\partial \ln v/\partial \ln i}{\partial \ln v/\partial \ln c} = \gamma + (\sigma - 1)\ln \frac{i}{c}$$

where γ: coefficient.

Partial differentiation by $\ln \dfrac{i}{c}$ leads to the following equation:

$$\varepsilon = d \ln \frac{\partial \ln v/\partial \ln i}{\partial \ln v/\partial \ln c} \bigg/ d \ln \frac{i}{c} = \frac{\sigma - 1}{\sigma} = 1 - \frac{1}{\sigma} \qquad (10)$$

Here, ε can be considered the i/c elasticity to the ratio of i elasticity to v and c elasticity to v.

Equation (10) indicates that a higher σ increases ε, which leads to higher i elasticity to v corresponding to i/c increase.

DATA CONSTRUCTION

The empirical analysis focused on 40 countries in three economic groups including 30 countries out of 34 OECD member countries, 5 countries out of 10 ASEAN member countries (original members), Taiwan and BRIC. Data on GDP and GDP per capita data for each country are obtained from the IMF's World Economic Outlook Database released in April 2011. Household Final Consumption Expenditure (HFCE) data are sourced from the World Bank national accounts data and OECD National Accounts data files[3]. Data are all in US dollars in 2009, the latest available year. Population and HFCE per capita data for each country is calculated from the above data.

RESULTS

Consumption Effects on Economic Growth

First the regression analysis was conducted based on equation (3) to classify the clusters of 37 countries by examining their marginal propensity to consumption structure. The result is summarized in Table 1.

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$$\ln C/N = a + (b_1 D_1 + b_2 D_2 + b_3 D_3)\ln V/N$$

where D_1, D_2 and D_3: dummy variables; $D_1 = 1$ in eight countries (Brazil, China, India, Indonesia, Malaysia, Philippine, Russia and Thailand), others $= 0$; $D_2 = 1$ in seven countries (Czech Republic, Korea, Mexico, Poland, Slovak Republic, Taiwan and Turkey), others $= 0$; and $D_3 = 1$ in 22 countries (Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Japan, Luxembourg, Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, United Kingdom and United States), others $= 0$.

Table 1: Correlation between Home Final Consumption Expenditure (HFCE) per capita and GDP per capita in 37 Countries *(2009)*

a	b_1	b_2	b_3	adj. R^2	DW
1.161	0.793	0.825	0.835	0.986	1.62
(2.74)	(15.31)	(18.38)	(21.04)		

Looking at Table 1, we note that 37 countries examined can be divided into three clusters by marginal propensity to consume (MPC) corresponding to growing economies (Group A), advancing economies (Group B) and advanced economies (Group C) as $MPC_{Group\,A} = 0.793 \cdot C/V$,

$MPC_{Group\,B} = 0.825 \cdot C/V$ and $MPC_{Group\,C} = 0.835 \cdot C/V$.

Next, utilizing MPC measured by equation (2), aiming at analyzing its structure in 37 countries, the regression analysis was conducted based on equation (4). Table 2 summarizes the result of the analysis using the backward elimination method with 10% significant level criteria.

Table 2: Correlation between the Marginal Propensity to Consume, GDP, HFCE and Population in 37 Countries *(2009)*

$$\ln MPC = d + e\ln V + f\ln C + g\ln N + h\ln V \ln C + j\ln V \ln N$$

d	e	f	g	h	j	adj. R^2	DW
-1.005	-1.001	1.108	-0.080	-2.376×10^{-3}	2.252×10^{-3}	0.998	2.46
(-2.17)	(-62.17)	(25.48)	(-2.28)	(-1.75)	(1.76)		

Prompted by the hypothetical view postulated in section 1 that there should be certain structural impediments hampering co-evolution between consumption and GDP increases in countries in growing economies, co-evolutionary dynamism between consumption and MPC increases leading to GPD growth was analyzed by computing the elasticity of consumption

to MPC ($\partial \ln MPC / \partial \ln C$) in 37 countries (see details in Appendix). Figure 3 illustrates the result of the analysis which clearly classifies three economic groups. Countries in growing economies (Group A) demonstrate extremely higher elasticity than countries in advancing and advanced economies (Group B and C, respectively).
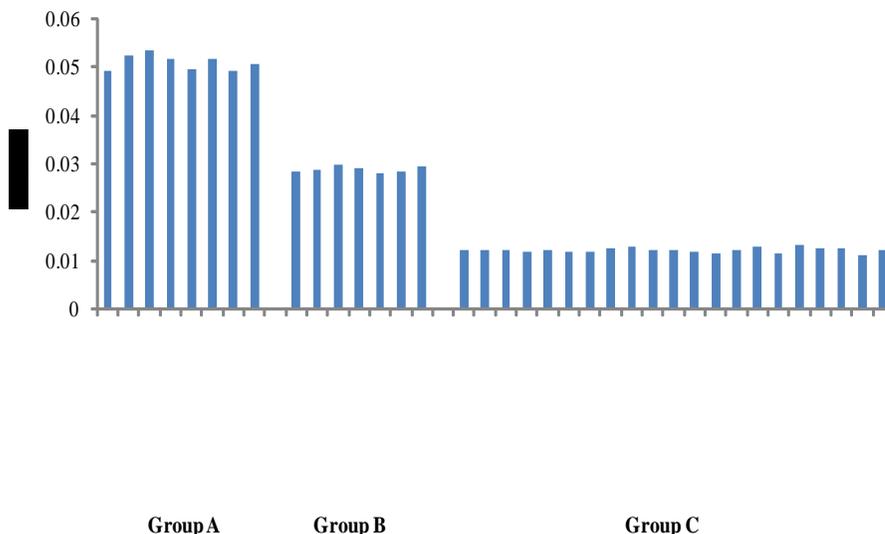
Group A   Group B   Group C

Figure 3: Elasticities of Marginal Propensity of Consumption to Consumption in 37 Countries *(2009)*.

Lowest GDP level in countries of growing economies, despite such a higher elasticity, suggests that these countries remain an autarky cycle between consumption and GDP increases, not inducing investment while countries of advancing and advanced economies have constructed a co-evolutionary dynamism between investment, GDP and consumption increases

Optimal Trigger for Consumption Effects on Economic Growth

Stimulated by the foregoing analyses, the empirical analysis was conducted to identify the role of investment leading to distinct differences of the consumption elasticity to MPC between three economic groups demonstrated in Figure 3.

Utilizing equation (7), diffusion trajectory of investment driven by GDP growth was thus analyzed. Table 3 tabulates the result of the analysis.

Table 3: Fit of Logistic Growth Function in 37 Countries *(2009)*[a,b]-.

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$$Y = \frac{\overline{Y}}{1 + \beta e^{-\alpha X}}$$

$\overline{Y}$	α	β	adj. R^2
15.920	0.277	12.422	0.977
	(38.20)	(34.78)	

[a] Based on equation (6), the level of Y corresponding to $dY/dX = 0$ is first identified which is equivalent to $\overline{Y}$. Utilizing identified $\overline{Y}$, coefficients α and β were identified by means of the following regression:

$$\ln\left(\frac{\overline{Y}}{Y} - 1\right) = \ln \beta - \alpha X$$

[b] 3-unit moving average.

On the basis of this result, utilizing equation (8), development trajectory of marginal productivity of investment per capita (*MPi*) induced by GPD per capita increase in 37 countries was analyzed as illustrated in Figure 4. This figure suggests that growing economies of eight countries in Group A have been confronting a vicious cycle between per capita GDP growth and investment driven growth. On the other hand, advancing economies of seven countries in Group B and advanced economies of 22 countries in Group C have been maintaining a virtuous cycle.
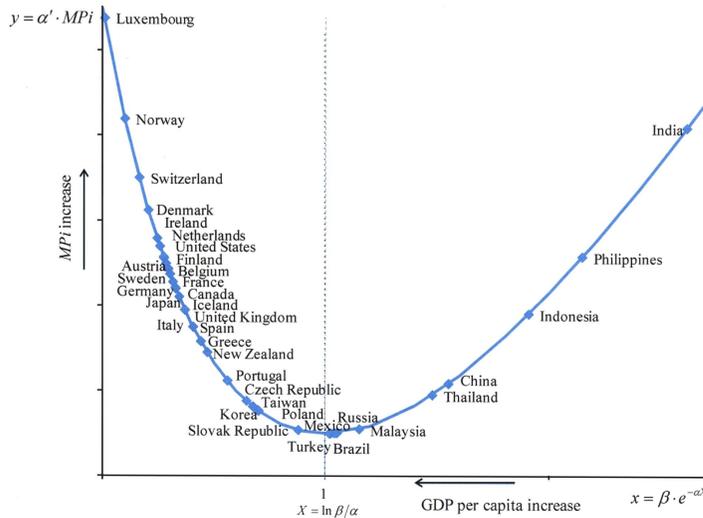

Figure 4: Investment Driven Development Trajectory of 37 Countries (2009)

These three economic groups show the different correlations between

investment per capita and HFCE per capita as demonstrated in Figure 5. Group A demonstrates the lower consumption elasticity to investment than those of Group B and C.
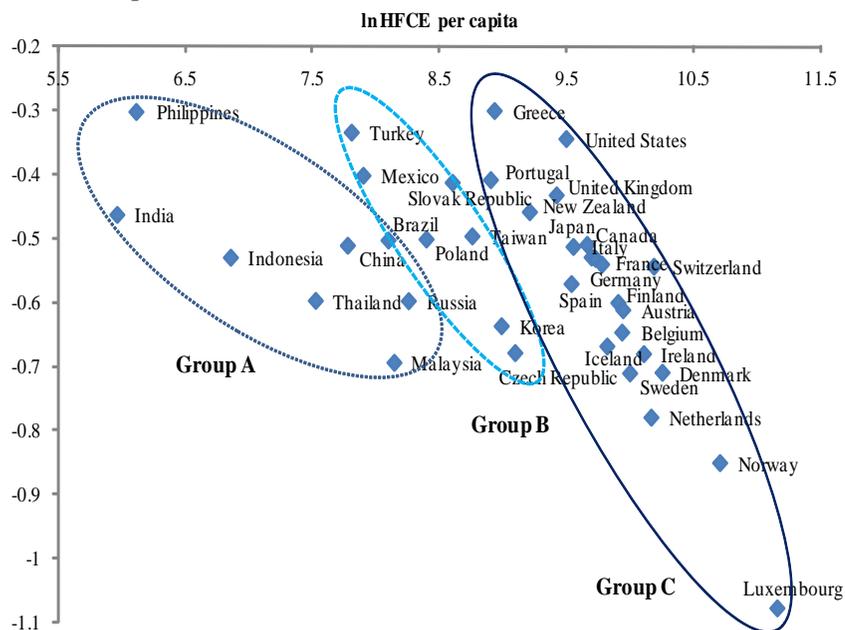

Figure 5: Correlations between Investment per capita and HFCE per capita in 37 Countries (2009).

Structure of Investment Driven Development

The elasticity of substitution between investment and consumption σ can be obtained from the regression analysis based on equation (9)′. Table 4 summarizes the result. Here, the value of $\dfrac{\partial v/\partial c}{\partial v/\partial i}$ of each countries are computed using the equations $\partial v/\partial c = 1/MPC$ and $\partial v/\partial i = 1/1 - MPC$, which can be obtained from equation (2).

$$\partial \ln \frac{i}{c} = \gamma_1 + \gamma_2 D + (\sigma_1 D_1 + \sigma_2 D_2 + \sigma_3 D_3) \ln \frac{\partial v/\partial c}{\partial v/\partial i}$$

where D, D_1, D_2 and D_3: dummy variables; $D = 1$ in two countries (Luxemburg and Norway), others $= 0$; $D_1 = 1$ in eight countries (Brazil, China, India, Indonesia, Malaysia, Philippine, Russia and Thailand), others $= 0$; $D_2 = 1$ in eight countries (Czech Republic, Korea, Mexico, Poland, Slovak Republic, Taiwan and Turkey), others $= 0$; and $D_3 = 1$ in 22 countries (Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Japan, Luxembourg, Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, United Kingdom and United States), others $= 0$.

Table 4 Correlation between the Ratio of Investment and Consumption and the Ratio of Consumption and the Ratio of Marginal Productivity of Consumption and Investment of GDP per capita in 37 Countries *(2009)*

γ_1	γ_2	σ_1	σ_2	σ_3	*adj. R^2*	*DW*
-0.441	-0.964	1.128	1.278	1.280	0.981	2.24
(-46.03)	(-0.96)	(23.38)	(14.83)	(27.12)		

The result demonstrates a consistency with the bi-polarization of the investment driven development trajectory shown in Figure 4. The countries examined are bi-polarized according to the elasticity of substitution σ; growing economies in Group A (with the value 1.13) and advancing and advanced economies in Group B and C (with the value 1.28). Based on the result, the i/c elasticity to the ratio of i elasticity to v and c elasticity to v, ε, depicted by equation (10) of three economic groups can be computed as illustrated in Figure 6. The figure shows that the value of the elasticity ε of Group B and C is about twice as large as that of Group A. This distinct difference indicates that as the ratio of investment and consumption (i/c) increases, investment *(i)* elasticity to GDP *(v)* increases significantly in advancing and advanced economies while the elasticity ε of Group A is not sufficient enough to induce v in contrast to those of Group B and C.
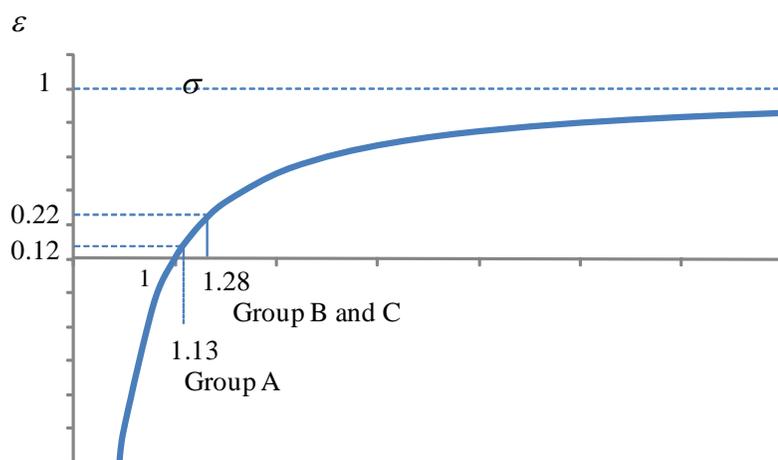
ε

Figure 6: Correlation between Two Elasticities of Three Groups (2009)

DISCUSSION

The results from the first analysis indicate that growing economies in Group A have the highest potential among three economic groups to boost their consumption. However, economic growth in growing economies largely depends on consumption growth whereas advancing and advanced economies in Group B and C leverage investment for their growth. The second analysis finds out the role of investment in the relationship between consumption and economic growth. It is revealed that growing economies in Group A and advancing and advanced economies in Group B and C take contrasting approaches to investment driven development as demonstrated in Figure 7. Growing economies have encountered an autarky cycle of consumption driven development due to the relatively small multiplier effect of investment. Although they have increased GDP by consumption growth strongly, they simultaneously suffered from the drop of the marginal productivity of investment with intensity (*MPi*) along with GDP growth, with the result that they cling to an autarky cycle where consumption leads to life improvement and then brings GDP growth. On the other hand, advancing and advanced economies benefit from a virtuous cycle induced by investment. Here, GDP growth induces consumption increase, which in turn increases GDP. Increased GDP induces investment. Investment stimulates further GDP growth, which increases consumption demand for more attractive goods and services. The new demand contributes to a better quality of life and then leads to GDP growth.
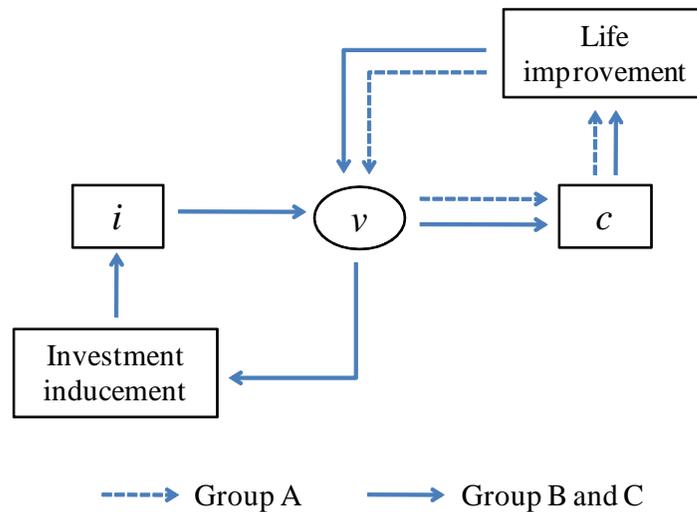
Figure 7: Consumption/Investment Driven Growth Trajectory options in Developed, Advancing and Advanced Economies

Growing economies should shift from an autarky cycle to the investment driven cycle to increase their consumption in a more sustainable way. One option is to increase the ratio of i elasticity to v and c elasticity to v. Growing economies suffer from insufficient investment elasticity against consumption elasticity while advancing and advanced economies allow GDP growth to induce investment efficiently.

A possible trigger for the inducement of investment by growth in growing economies can be frugality. Frugality does not just mean second-rate or low cost (Economist, 2010), but satisfies three elements of new demand of people in growing economies; accessibility, accountability and affordability (Gupta, 2010b). Their new demand is from their own unique cultural, environmental and economic situations which are completely different from those in advanced economies, and implies the necessity of new functionality. This new functionality should improve their life. Banerjee and Duflo (2008) found that the emerging new middle class have fewer children and they spend much more on the education and health of these children as well as on their own health. In addition, they pointed out that although there are many entrepreneurs in the middle class, the businesses owned by them still seem to operate with very little, in terms of assets. The new middle class contribute to the development of democracy, entrepreneurship, human capital and saving, and consumption (Banerjee

and Duflo, 2008; Kharas, 2010). Frugality could lead a way to exploring the new functionality leading to investment driven development for their life improvement and further contribution to global sustainability.

The co-evolution between advanced and growing economies is necessary to devise new functionality development for new demand in growing economies (Fukuda et al., 2010). ICT is an effective tool for new functionality development, and significantly contributes to their economic growth in growing economies. However, in contrast, it leads to negative impact on growth in advanced economies. This suggests that the co-evolution between these economies has a high potential to create frugality to meet new demand of people in growing economies. While advancing economies in Group B shows the same pattern of investment driven development as advanced economies in Group C, as shown in Figure 7, bi-polarization in investment driven trajectory in Figure 4 implies that their position is less stable than advanced economies. The co-evolution between advancing economies and other two economies would also stabilize their investment driven development.

Advanced economies as well as advancing economies have tried to increase innovation for growing economies. They have viewed the new middle class in growing economies as a growth opportunity and as a source of innovation (Prahalad, 2004; Landrum, 2007). However, it is open to question whether their innovation strategy will simultaneously stimulate growth of the new middle class in growing economies. Many firms still get a supply of consumer goods from growing economies and products sold there by some transnational firms. But this offers no guarantee that they will contribute to either improving the welfare or reducing poverty (Jenkins, 2005; Karnani, 2006, 2007; Landrum, 2007).

Against these criticisms, some firms are taking new approaches to growing economies (Byron, 2010; Immelt et al., 2009; Jana, 2009). One approach is to start with observation on targeted consumers. P&G spent thousands of hours with men in India to better understand their shaving needs to design a new affordable shaving blade. Nokia researched how young people in Africa share handsets to release a new phone enabling owners to share music and videos with others in the US as well as a more practical phone in Africa. Other firms are creating formal process of observation. Xerox hired two researchers who will hunt for inventions and products from Indian startups which might adapt for North America. Hewlett-Packard uses its research lab in India to see how to migrate application for mobile phone in growing economies in Asia and Africa to advanced economies. Another approach is to find new markets for products in growing economies. Nestlé

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repositioned popular low-fat dried noodle created for rural Asian consumers in Australia and New Zealand. P&G expanded the customer base of its cold-remedy syrup beyond Mexico to Western Europe and the US. GE pioneered new users in advanced economies for the medical devices originally developed for markets in growing economies.

Growing economies are promoting innovation by them for their own perspective. India has accumulated its efforts to establish a social network for grass root innovations since the 1990s (Gupta et al, 2003, Gupta 2010a). The network, named as the Honey Bee Network, has documented grass root innovations and traditional knowledge examples in rural and small towns in India. The network also tries to spread the knowledge through online database, and helps the inventors get a fair economic reward for their creativity. These activities in collaboration with government and NGOs have helped provide a platform to aggregate the social and the ethical capital of society to solve local problems. In order to promote further growth based on innovation in society, India has declared that the ten years from 2010 is designated as the decade of innovation and has established the National Innovation Council (National Innovation Council, 2010).

These current efforts in advancing, advanced and growing economies suggest a fundamental shift in global innovation from 'think global, act local' to 'act global, think local' (Sheth, 2010). Growing economies will necessitate more in-market, low-cost innovations that make emerging products more accessible, accountable and affordable for their sustainable development. This necessity urges firms to change their business strategy in growing economies. Historically, they have relied on local adaptation strategy to deliver their products and make a few adaptations for local markets. However, it is shifting to in-market development starting with local innovation to create new global products. Advancing and advanced economies need to have a greater focus not on activities oriented toward their own perspectives but on demand of growing economies from their own perspective (Jose, 2008; Landrum, 2007). Frugality is the requirement to satisfy new demand of growing economies from their own perspective for more attractive goods and services, which would trigger a shift from the closed cycle to the investment driven cycle. The co-evolution between three economies is crucial for creating frugality for sustainable development in growing economies and in the world as well.

CONCLUSION

Frugality plays a decisive role for the optimal trigger of investment driven development leading to a virtuous cycle between the marginal propensity

to consume and GDP growth in growing economies. The co-evolution between advancing, advanced and growing economies leads to frugality oriented new functionality development, which contributes to sustainable growth in growing economies as well as stable growth in advancing economies and global sustainability accordingly.

Frugality is a key to new functionality satisfying local demand of people in growing economies. Most of people in growing economies are emerging as the new middle class. They contribute to sustainable development of growing economies, which affects global sustainability amidst the economic structural shift to growing economies. The new middle class's contribution to global sustainability comes through its consumption growth for life improvement and its investment inducement to further the economic growth, leading consumption demand for more attractive goods and services. Frugality would trigger the shift from an autarky cycle between the consumption and GDP increases, to investment driven development.

The co-evolution between advancing, advanced and growing economies would generate frugality oriented new functionality development trajectory. Advanced economies as well as advancing economies have accumulated their efforts to serve demands in growing economies. Growing economies have leveraged ICT for economic growth and promoted innovation to solve local problems. Fusing these efforts would realize the co-evolution between them leading to sustainable development in growing economies and global sustainability.

Firms require a new approach to growing economies. They should view people in growing economies as innovators or producers rather than consumers. This view is required for in-market development starting with local innovation to create new global products. Innovation policies should support the view and promote activities to uncover local knowledge, stimulate social and ethical capital, and design solutions for local problems. These policies are indispensable for growing economies and they must induce investment for further their growth.

Further works should focus on the elucidation of transition dynamism from consumption oriented autarky cycle to investment driven development. In depth observation of growing economies depending on each respective institutional systems would help identify the role of frugality as a trigger for a shift to investment driven development. Elucidation of the co-evolution dynamism to frugality-oriented new functionality development trajectory would be another important subject to focus.

FOOTNOTE

1. $Y = F(X)$ thus $\dfrac{dY}{dX} = \dfrac{\partial Y}{\partial X} \cdot \dfrac{dX}{dX} = \dfrac{\partial Y}{\partial X}$

2. *MPi* can be defined as marginal productivity of investment in per capita term in logarithmic scale and depicted by $d\ln v / d\ln i = (dv/di)(i/v)$ implying a product of marginal productivity of investment in per capita terms and investment intensity which can be called "*marginal productivity of investment with intensity.*"

3. HFCE data is available in 37 countries except Australia, Hungary and Singapore. The data for Taiwan is supplemented with data from the National Statistics of Taiwan and the US Federal Reserve Board of Governors.

4. Because of the availability of reliable HFCE data in 2009, the regression analysis was conducted in 37 countries. The data on HFCE per capita for China was re-evaluated in correspond to its GDP size.

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APPENDIX

The elasticity of the marginal propensity to consume (MPC) ($\partial \ln \sigma / \partial \ln C$) of each country was estimated by the following steps.

Equation (5) can be developed using the regression results tabulated in Table 3 as follows:

$$\partial \ln MPC / \partial \ln C = -1.001 \cdot \partial \ln V / \partial \ln C + 1.108 - 0.080 \cdot \partial \ln N / \partial \ln C$$
$$- 2.376 \cdot 10^{-3} \cdot \left(\partial \ln V / \partial \ln C \cdot \ln C + \ln V \right)$$
$$+ 2.252 \cdot 10^{-3} \cdot \left(\partial \ln V / \partial \ln C \cdot \ln N + \ln V \cdot \partial \ln N / \partial \ln C \right)$$

GDP per capita can be represented by the following equation given its size is related to population size:

$$\ln V / N = a' + b' \ln N \qquad \qquad \text{(a)}$$

where a', b': coefficients.

Table A illustrates the result of the regression analysis in 40 countries based on equation (a).

Table A Correlation between GDP per capita and Population in 40 Countries *(2009)*

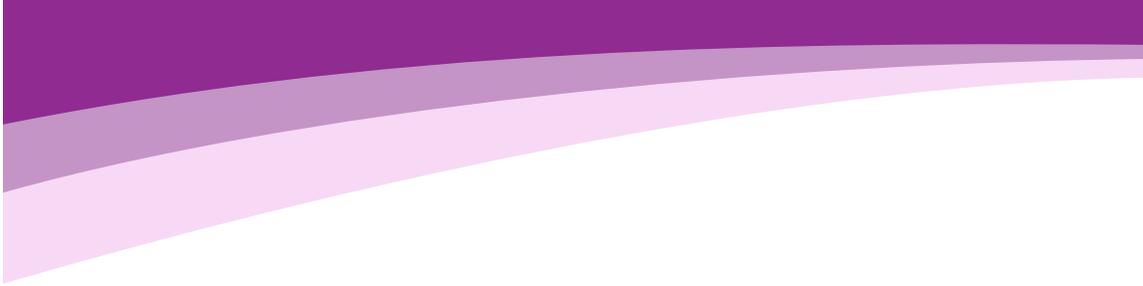$$\ln V / N = a' + \left(b'_1 D_1 + b'_2 D_2 + b'_3 D_3 \right) \ln N$$

where D_1, D_2 and D_3: dummy variables; $D_1 = 1$ in eight countries (Brazil, China, India, Indonesia, Malaysia, Philippine, Russia and Thailand), others = 0; $D_2 = 1$ in eight countries (Czech Republic, Hungary, Korea, Mexico, Poland, Slovak Republic, Taiwan and Turkey), others = 0; and $D_3 = 1$ in 24 countries (Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Japan, Luxembourg, Netherlands, New Zealand, Norway, Portugal, Singapore, Spain, Sweden, Switzerland, United Kingdom and United States), others = 0.

a'	b'_1	b'_2	b'_3	adj. R^2	DW
12.073	-0.203	-0.152	-0.086	0.860	2.34
(15.84)	(-5.01)	(-3.36)	(-1.85)		

The regression results based on equations (1) and (a) lead to two values of elasticity of growth and population size to consumption as tabulated in Table B. Using these values and the statistic data, the elasticity in each country were computed.

Table B Values of Elasticities of Growth and Population Size to Consumption of Three Economic Groups of 37 Countries

Group	$\partial \ln V / \partial \ln C$	$\partial \ln N / \partial \ln C$
A	0.950	1.192
B	0.970	1.144
C	0.985	1.077