Master's Thesis of Economics

The Determinants of Economic Growth in Low Income Countries

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Abstract

Despite the consistent effort of the international community to eradicate poverty, extreme poverty still prevails in the world and fighting poverty remains the focus of international dialogue. The motivation of our study is identifying which sector should be supported with priority for effective poverty reduction. To this end, this paper examines the determinants of economic growth in low income countries using panel data across 150 countries.

Sanitation is known to be closely linked to general health conditions, especially in low income countries. Our findings show that improving sanitation in low income countries contributes to economic growth whereas it does not have a similar output on economic growth in middle and high income countries. This provides us with two implications: one is that improving basic health through improved sanitation contributes to primary human development and, in turn, leads to economic growth in low income countries. The other is that different kinds of human development drive economic growth at different stages of a country's economic development; therefore, the focus of human development should be adjusted as the economy grows.

Our study, combined with previous studies, contributes to illustrate two themes on human development and economic growth. Firstly, our study reinforces the assertion that human development should precede or at least accompany general economic growth initiatives. Our study is aligned with this assertion by demonstrating the relative importance of human development compared to economic infrastructure development. Secondly, we summarize the full picture of human development that is needed for economic growth at different development stages as follows: basic health like hygiene and nutrition is important at the bottom of the development stage. After escaping extreme poverty, basic education like secondary education becomes more important. After succeeding to jump to middle and high income stages, higher education like tertiary education and innovation become more crucial factor for economic growth.

In spite of its importance to economic growth in low income countries, the basic health sector is not easy to intrigue and attract private financial resources compared to that of economic infrastructure. Therefore, we suggest that the international community gives more attention to the basic health sector in low income countries and focus their support with priority in this sector for effective use and allocation of limited support resources in order to achieve our ultimate goal of reducing poverty.

Key words: Determinants of economic growth, Human development, Health, Sanitation, Poverty trap, Low income countries

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1. Introduction

Despite consistent efforts of the international community to eradicate poverty, extreme poverty still prevails in the world and fighting poverty remains a focus of international dialogue. Still, about 1.3 billion people worldwide live with less than US$1.25 a day whereas the other side of the world is enjoying stunning economic prosperity[1].

The engine of economic growth has been an on-going issue long debated by numerous scholars and policy makers. As to the growth analysis, Rodrik (2006) emphasized the importance for economists to detect significant binding constraints for economic growth through diagnostic analysis. Aligned with his assertion, there have been studies based on the idea that "binding constraints" or "driving engines" for economic growth would be different at different stages of development. The starting point of our study follows this idea. In other words, our purpose is to detect a particular hurdle or fundamental driver of economic growth in low income countries and we posit it will be different from that of middle and high income countries.

One of the major tools of the international community to promote economic development in low income countries has been financial assistance such as aid. During last 10 years (2002-2011), US$1.3 trillion of aid was donated to developing countries and 54% was for establishing social and economic infrastructure such as health, education, transportation, telecommunication and energy[2]. It is doubtless that the support in infrastructure lays the foundation for economic development in low income countries. However, in spite of the vast amount of support, it has been controversial whether the long history of foreign aid has been effective to buy the reduction of poverty. One of those criticisms is that the selection of sector to support might not have been appropriate. Chang H. J. (2010) criticizes about this in his book.

"… many donors have rushed into fancy programmes without carefully assessing the relative long-term costs and benefits of alternative uses of their money".

Therefore, it is meaningful to analyze which form of infrastructure impacts more fundamentally on economic growth of low income countries so that we can determine the priority of support for effective and sustainable outcome of poverty reduction, which is the motivation of our study.

[1] World Bank - World Development Indicator
[2] OECD statistics, http://stats.oecd.org

To narrow down our analysis, the first question we should ask ourselves is which is more basically necessary for reducing poverty between support of human development (represented by social infrastructure of health and education) or support of economic activity (represented by economic infrastructure of transportation, telecommunication and energy). The opinions to this question can vary across scholars but our answer to this question is that human development should take priority; in other words, precede other factors. Economic growth is a complex procedure combined with many factors but there is no doubt that it is carried out by humans. Without healthy and educated human capital, the provision of economic infrastructure cannot lead to economic growth. Ranis G., Stewart F., Ramirez A. (2000) emphasized the importance of human development as a prerequisite for sustainable economic growth. They emphasized that a focus on human development must be included from the beginning of any economic reform as economic growth itself will not be sustained unless preceded or accompanied by improvement in human development. Not surprisingly, Millennium Development Goals (MDGs)[3], the internationally agreed targets for poverty reduction by 2015, are also highly concentrated on human development like education, health and gender equality.

Our succeeding question to elaborate our study is what kind of human development contributes more crucially to economic growth in low income countries; in other words, what kind of social infrastructure between health and education should be supported with priority. Improvement on the quality of human capital through enhancing both health and education is an important contributor to economic growth but we hypothesize that improvement in basic health is more urgent for low income countries in order to take their first step forward in escaping poverty. In their dire situations like now, suffering from hunger and disease, it can be hardly expected for people to participate in the education system. When poor health works as a barrier, education cannot effectively play a determinative role in economic growth. Furthermore, considering that the industry of low income countries highly rely on manual works of labor, the health condition of labor can directly affect the economic performance of low income economies. Xavier Sala-I-Martin (2005) called this circumstance a health poverty trap, a tragic trap that poor

[3] Millennium Development Goals are adopted by all nations in the Millennium Declaration of the year 2000 to achieve the eight goals by 2015, which include (1) Eradicate extreme poverty and hunger; (2) Achieve universal primary education; (3) Promote gender equality and empower women; (4) Reduce child mortality; (5) Improve maternal health; (6) Combat HIV/AIDS, malaria, and other diseases; (7) Ensure environmental sustainability; (8) Develop a global partnership for development.

health tends to cause low income and low income, in turn, tends to cause poor health. Health and poverty form a vicious circle from which it can be difficult to escape.

Our study focuses on the relative importance among infrastructures for economic growth in low income countries hypothesizing that poor health conditions are one of the main constraints and, thus, improvement of health-related infrastructure contributes to economic growth. In section 2, we will review the previous literature demonstrating the link between health and economic growth. Then, we will indentify the major risk factors of poor health in low income countries, which can be represented by malnutrition and poor sanitation, and presenting basic facts suggesting the linkage between one of these factors (sanitation) and economic growth. In section 3, we will demonstrate the variables, data and methodologies used for empirical analysis and in section 4, we will explain the empirical results. In section 5, we summarize the conclusion.

2. Theoretical Consideration

2.1. Health and Economic Growth

Even though health is widely accepted as a significant component of explaining economic growth now, studies before the mid-1990s about the role of human capital on economic growth mainly focused on education. It is only around the mid-1990s when health started to receive serious academic attention as a major ingredient of economic growth and was incorporated in empirical studies about economic growth.

In empirical analysis for the impact of health on economic growth, life expectancy has been the most widely used proxy for measuring health, for example, by Barro R., Lee J. (1994), Barro R., Sala-I-Martin X. (1995), Caselli F., Esquivel G., Lefort F. (1996), Barro R. (1996), Sachs J., Warner A. (1997), Bloom D., Sachs J. (1998), Bloom D., Williamson J. G. (1998), Bloom D., Malaney P. (1998), Hamoudi A., Sachs J. (1999), Gallup J., Sachs J. (2000), Bloom D., Canning D. (2000), Ranis G., Steward F., Ramirez A. (2000)[4]. They generally find that life expectancy has a significant positive effect on the rate of economic growth[5]. Although these empirical analyses show that health has important effects on the aggregate rate of economic growth, it does not fully describe the mechanisms through which this effect operates[6].

[4] Bloom D., Canning D., Sevilla J. (2003)
[5] Bloom D., Canning D., Sevilla J. (2003)
[6] Sala-I-Martin (2005)

Health affects economic growth through various channels. Among these, the most direct relation between health and aggregate growth is through the effect of health on labor productivity[7]. Healthier workers are more productive due to increased vigor strength, attentiveness, stamina, creativity and reduced absenteeism at work[8].

The studies demonstrating the impact of health on productivity are usually focused on the link with nutrition. Malnutrition weakens the immune system, resulting in vulnerability to infectious disease which inevitably lowers productivity. Indicators of nutritional status can be nutrient intake as an input side and body size, body composition, body function as an outcome side. When it comes to productivity, it is not observable but productivity enhancement through health development can be observed by higher wages as higher wages will be rewarded if the employer can observe gains in either productivity or health of employees[9]. There is much evidence about the link between nutrition and productivity. Behrman J., Deolalikar A. (1988), Deolalikar A. (1988), Behrman J. (1989), Haddad L., H. Bouis (1991), Foster A., M. Rosenzweig (1993), Behrman J. (1993), Schultz T. P. (1996), Thomas D., Strauss J. (1997), Glick P., D. Sahn (1998), Strauss J., Thomas D. (1998) all find that lower adult height which is, in part, the consequence of poor nutrition in childhood is associated with reduced earnings as an adult[10]. Especially, Behrman J. (1993) showed that improved health has a direct effect on labor productivity, particularly among poorer individuals. Furthermore, considering the higher engagement of the manual labor force in low income countries than in higher income countries, the effect of labor productivity enhanced by improvements in health is especially strong and direct[11].

For this reason, there have been some studies emphasizing agriculture in low income countries, especially in Sub-Saharan African countries where poverty prevails most severely in the world. Juma C. (2011) emphasized the importance of agriculture as no country can acquire high economic growth without first solving the huger and food security challenge which Sub-Saharan African countries have been facing. He expects that smart investment in agriculture will reduce hunger and that advancing human capital in both health and education will bring multiplier effects on Sub-Saharan African economies. Another more recent study by Kim H. S., Nucube M. (2013) explains that developing agriculture enables a primitive economy to acquire the nutritional well-being and this generates a demographic dividend and savings that will be the base for take-off of low income economies.

[7] Sala-I-Martin (2005)
[8] Howitt P. (2005)
[9] Strauss J., Thomas D. (1998)
[10] Alderman H., Behrman J., Hoddinott J. (2003)
[11] Bloom D., Canning D., Sevilla J. (2003)

Another channel of impact for health on economic growth is through its effect on education. Sick children tend to miss school more often so they get less education[12]. Miguel E., Kremer M. (2001) experimented in Kenya to see how the health condition of children affects the children's school attendance and found that distributing deworming drugs reduces the children's absenteeism by one quarter. Also, poor health which can lead to the death of parents negatively affects the education of children through the loss of guidance, financial protection, and support, which are key in the process of educating children[13]. Case A. C., Paxson, J. Ableidinger (2002) surveyed 10 Sub-Saharan African countries between 1992 and 2002 and found that orphans are significantly less likely to be enrolled in school than non-orphans[14]. Also, Gertler P., D. Levine, M. Ames (2004) found that a parent death during the past twelve months leads to a doubling of the probability of a child dropping out of school that year by using Indonesia's National Socioeconomic Survey data[15].

Also, there are some explanations that the improvement of health will lead to demographic change which, as a result, is beneficial to economic growth in low income countries. Improvement in health leads to a decline in infant and child mortality which induces changes in the composition of working-age adults, in other words, demography[16]. Bloom D., Williamson J. G. (1998) suggest that the transition resulted in the working-age population growing at a much faster pace than the dependent population during 1965-1990 in East Asia contributed the occurrence of East-Asia's so-called "economic miracle".

Policy Brief of OECD (2003) provides us with a concise summary of the link between health and economic growth.

Good health contributes to development in a number of ways:

1. Higher labor productivity. Healthier workers are more productive, earn higher wages, and miss fewer days of work. This raises output, reduces turnover in the workforce, and increases enterprise profitability and agricultural production.

2. Improved human capital. Healthy children learn better. As health improves, absenteeism and early school drop-outs fall, leading to growth in the human-capital base.

3. Demographic changes. Improvements in both health and education contribute to lower rates of fertility and mortality. Ultimately, fertility falls faster than mortality,

[12] Sala-I-Martin (2005)
[13] Sala-I-Martin (2005)
[14] Miguel E. (2005)
[15] Miguel E. (2005)
[16] F. Morand (2005)

slowing population growth and reducing the "dependency ratio" (the ratio of active workers to dependents). This "demographic dividend" has been shown to be an important source of growth in per capita income for low-income countries.

4. Higher rates of national savings. Healthy people have more resources to devote to savings, and people who live longer save for retirement. These savings in turn provide funds for capital investment.

5. Higher rates of domestic and foreign investment. Increased labor productivity in turn creates incentives for investment. In addition, controlling endemic and epidemic disease, such as HIV/AIDS, is likely to encourage foreign investment, both by increasing growth opportunities for investors and by reducing health risks for their personnel.

2.2. Health in Low Income Countries

Two main factors that risk the health of people in low income countries are poor sanitation and malnutrition. Globally, about 1.7 million people die every day from diarrheal diseases[17] and 90% of them are children under 5 year old and mostly in developing countries[18]. 842 million people in the world do not have enough to eat and the majority (827 million) of them are in developing countries[19].

This becomes much clearer by scrutinizing the leading causes of death in low income countries. When we think about the diseases causing death, we might easily think of chronic diseases like cardiovascular diseases, cancers, dementia, chronic obstructive lung disease or diabetes. That is because they are the predominant diseases that cause the death in high income countries. In low income countries, however, people predominantly die of infectious diseases: lower respiratory infections, HIV/AIDS, diarrheal diseases, malaria and tuberculosis collectively account for almost one third of all deaths in these countries[20]. Figure 1 shows the 10 leading causes of death in low income countries.

Infectious diseases are highly related with sanitation (hygiene) and nutrition and are more fatal to the vulnerable like children and woman. This explains why nearly 4 in every 10 deaths in low income countries are among children under 15 years old.[21]

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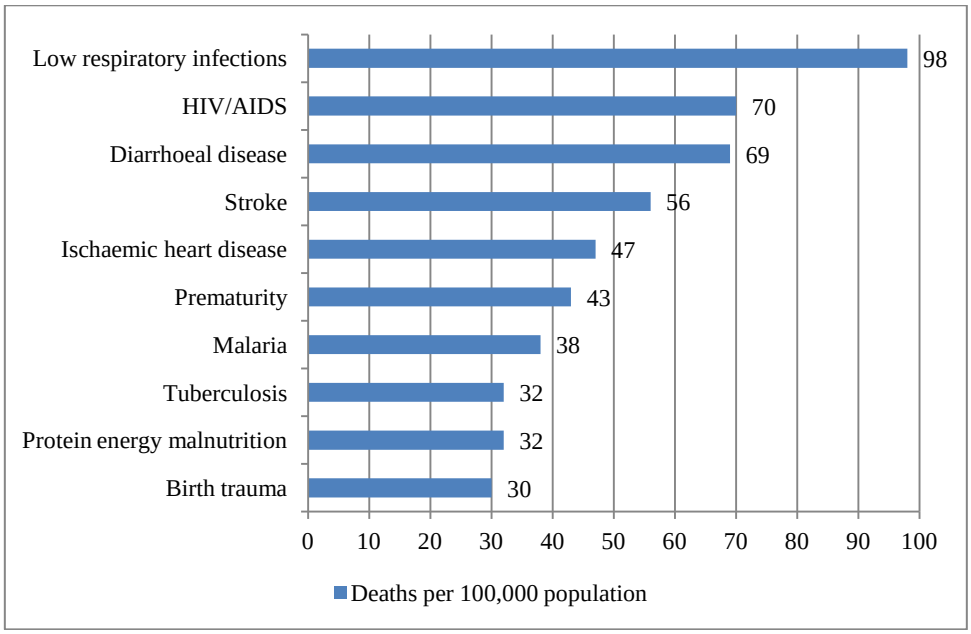
[17] Diarrheal diseases are one of the most sanitation-related disease.
[18] WHO homepage, Facts and figures: Water, sanitation and hygiene links to health, http://www.who.int/water_sanitation_health/publications/factsfigures04/en/
[19] The United Nations Food and Agriculture Organization homepage, Hunger statistics, http://www.wfp.org/hunger/stats
[20] WHO homepage, The 10 top causes of death, http://www.who.int/mediacentre/factsheets/fs310/en
[21] WHO homepage, The 10 top causes of death, http://www.who.int/mediacentre/factsheets/fs310/en

<Figure 1>The 10 Leading Causes of Death in Low Income Countries



Source: World Health Organization

2.3. Sanitation and Economic Growth

According to the World Health Organization[22], sanitation generally refers to the provision of facilities and services for the safe disposal of human urine and faeces[23] and our study focuses on sanitation under this definition. Inadequate sanitation is a major cause of disease world-wide and improving sanitation is known to have a significant beneficial impact on health both in households and across communities.[24] Therefore, improvement of sanitation conditions enhances health conditions and health conditions, in turn, boost economic growth as reviewed in section 2.2.

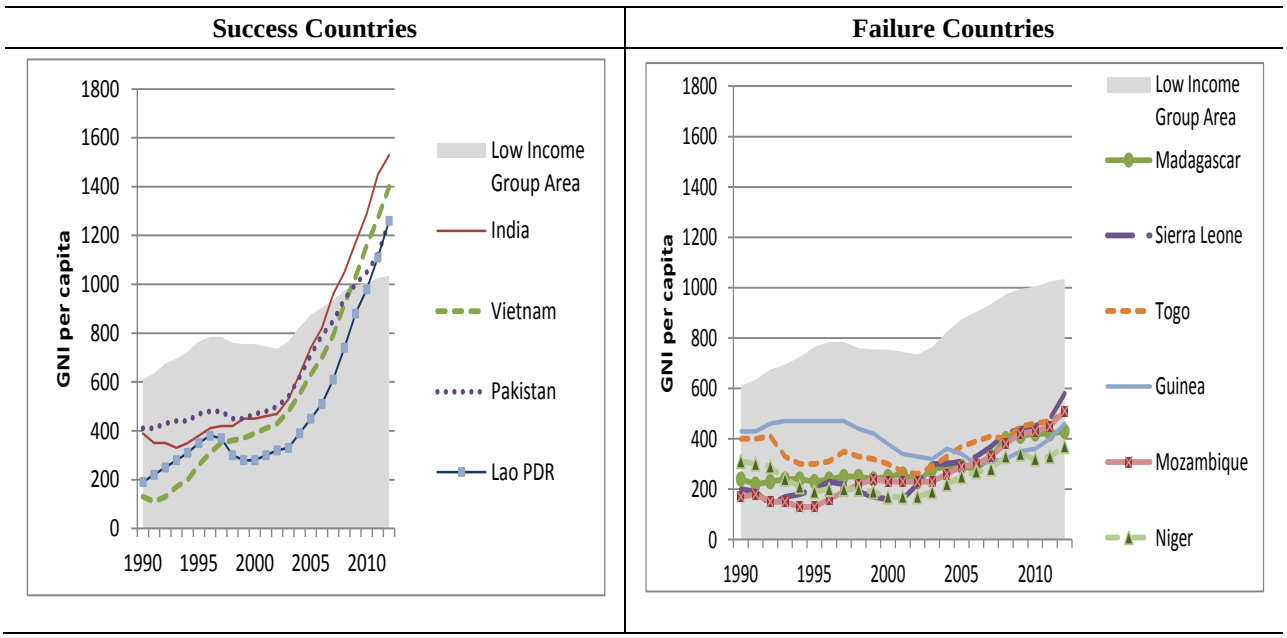
To detect the historic evidence of how sanitation conditions affected economic growth in low income countries, we searched countries that are succeeding to take off towards middle income status and those failing to escape poverty and remaining stuck in low income status. When classifying countries as low income or middle income, we used GNI per capita[25] and the country classification criteria of the World Bank[26] for the income threshold of each group. India, Vietnam, Pakistan and Lao PDR are example countries

[22] WHO homepage, Health topics, http://www.who.int/topics/sanitation/en/
[23] It also can refer to the maintenance of hygienic conditions, through services such as garbage collection a wastewater disposal, http://www.who.int/topics/sanitation/en/
[24] http://www.who.int/topics/sanitation/en/
[25] GNI per capita (Atlas method, US$)
[26] The World Bank's main criterion for classifying economies is GNI per capita (Atlas method US$). Based on this, countries are classified as low income, middle income (subdivided into lower middle and upper middle) or high income. The GNI per capita criteria is adjusted every year.

which succeeded to escape poverty. They were originally classified as low income countries during the 1990s but each country succeeded to be reclassified as middle income in 2000 (India), 2001 (Vietnam), 2000 (Pakistan) and 2005 (Lao PDR). We call these countries as success countries in our study for convenience.

On the other hand, countries like Sierra Leone, Togo, Guinea, Mozambique and Niger, have suffered extreme poverty for a long time. Their GDP per capita[27] never reached U$1,000 during two decades. We refer to those countries as failure countries in our study for convenience. Figure 2 shows how economies of succeeding and failure countries have performed during two decades.

<Figure 2> GNI per capita of Success and Failure Countries

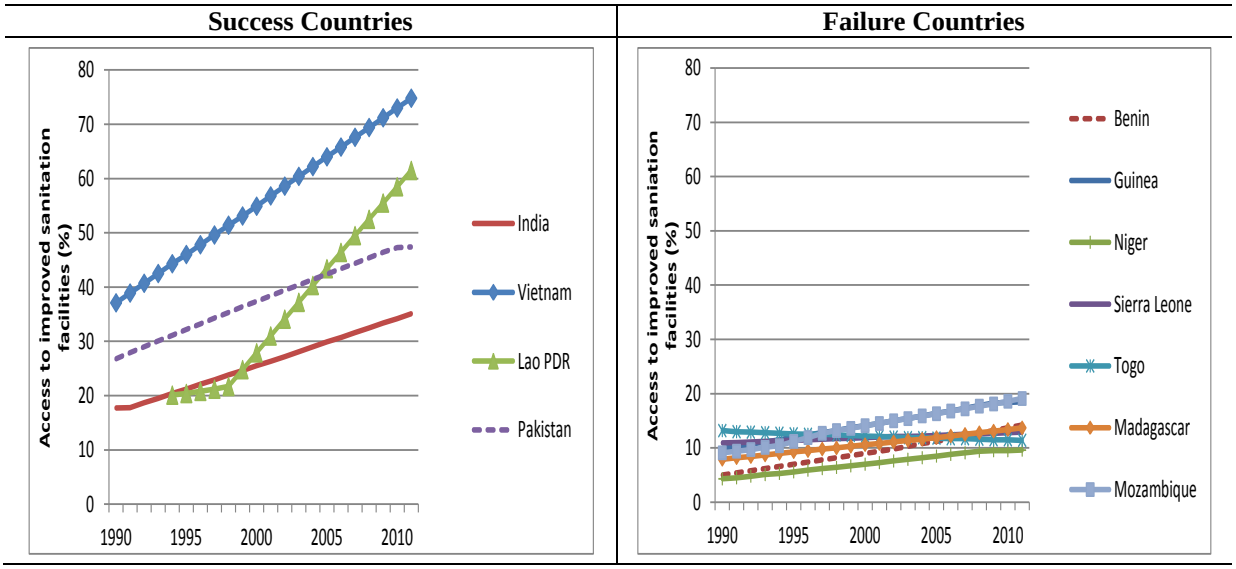


Source: World Bank - World development Indicator

To measure the sanitation conditions in each country, we use % of population with access to improved sanitation facilities sourced from the World Development Indicator of the World Bank. Figure 3 shows how the sanitation condition of success and failure countries has been changing and Table 1 compares the GDP per capita[28] and their sanitation condition from 1990 to 2010. The sanitation conditions in success countries have increased substantially during two decades whereas that of failure countries remained poor during two decades. Among success countries, Vietnam showed especially prominent improvement in sanitation from 37.1% in 1990 to 73% in 2010.

[27] GDP per capita, PPP (constant 2005 international $)
[28] GDP per capita, PPP (constant 2005 international $)

<Figure 3> Sanitation of Success and Failure Countries



Source: World Bank - World development Indicator

<Table 1> GDP per capita and Sanitation of Success and Failure Countries

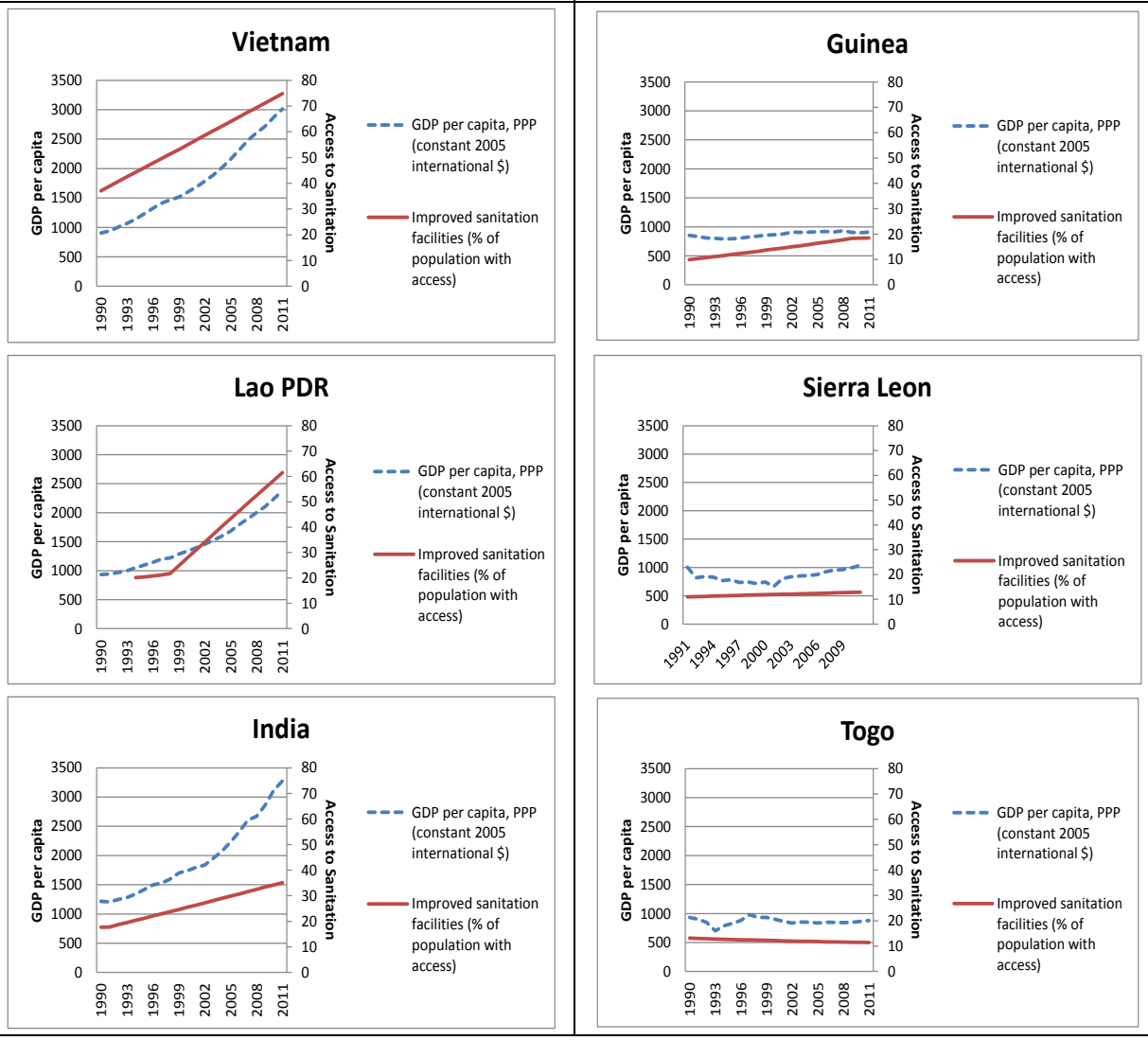
Country	GDP per capita					Sanitation				
	1990	1995	2000	2005	2010	1990	1995	2000	2005	2010
Success Countries										
Pakistan	1631.1	1793.3	1854.1	2153.9	2403.2	17.7	21.2	25.5	29.9	34.2
India	1216.6	1417.0	1741.3	2233.9	3121.6		20.4	27.9	43.4	58.5
Lao PDR	932.5	1096.8	1337.5	1684.4	2242.1	26.8	32.2	37.4	42.4	47.3
Vietnam	904.9	1230.7	1597.2	2161.3	2874.9	37.1	46	54.9	64	73
Failure Countries										
Madagascar	1012.7	855.1	881.8	849.5	849.1	7.9	9.3	10.6	11.9	13.4
Sierra Leone	984.7	768.4	742.9	855.3	996.5	10.9	11.4	11.9	12.3	12.8
Togo	933.9	828.8	902.7	837.7	862.0	13.2	12.6	12.2	11.8	11.5
Guinea	854.3	794.5	862.7	916.7	897.9	9.9	12	14.1	16.4	18.4
Niger	704.8	618.4	593.4	601.1	543.8	4.3	5.6	7	8.5	9.5
Mozambique	395.0	397.8	498.6	661.9	805.1	9.1	11.2	14.1	16.3	18.6

Source: World Bank - World development Indicator

We can compare some countries starting with similar GDP per capita in 1990 but having a huge gap after two decades, in 2010, and detect how sanitation has changed in those countries. In 1990, GDP per capita between some of the success countries (Vietnam and Lao PDR) and failure countries (Sierra Leone, Togo and Guinea) was similar, under but near US$1,000. However, their gap is now more than US$1,000. GDP per capita of Vietnam and Lao PDR more than doubled since 1990 whereas that of Sierra Leone, Togo and Guinea remained almost the same since 1990. Figure 4 shows that the trend of sanitation conditions has been similarly aligned with that of GDP per capita. While there were significant improvements in sanitation conditions in Vietnam and Lao PDR, that of Sierra Leone, Togo and Guinea remained almost the same.

<Figure 4> Country Comparison

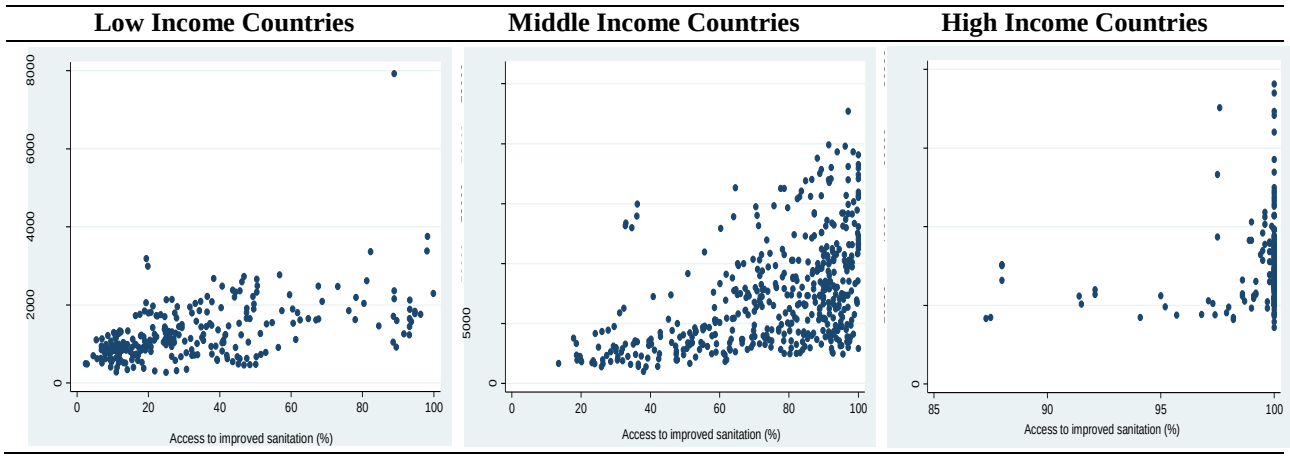
Success Countries	Failure Countries



Source: World Bank - World development Indicator

These historic facts, previously reviewed, provide us with an intuition of a possible relationship between sanitation and economic growth. To get a more visual and comprehensive sense of impact of sanitation on economic growth by income group as a benchmark, we draw a rough linear relationship between sanitation and GDP per capita shown in Figure 5. These graphs give us a sense that sanitation improvement might have the most impact on GDP per capita in low income countries. A rough positive linear correlation between sanitation and GDP per capita is also shown in middle income countries but as the level of sanitation increases, the linear relationship becomes vaguer.

<Figure 5> Correlation between GDP per capita and Sanitation



Source: World Bank - World development Indicator

Furthermore, the deviation of sanitation condition is the most in low income countries compared to other income groups, which provides us with the impression that poor sanitation could be a constraint to economic growth in low income countries. Table 2 shows sanitation by income groups. On average, only 33.9% of population could access improved sanitation facilities in low income countries whereas 74.4% of population in middle income countries and 99.1% in high income countries could access them. And the deviation is highest in low income countries as 24.5%.

<Table 2> Sanitation by Income Group (1990-2010)

Income group	Number of Observation	Average	Std. Deviation
Low Income Countries	1,033	33.9%	24.5%
Middle Income Countries	1,804	74.7%	21.9%
High Income Countries	810	99.1%	2.6%

Source: World Bank - World development Indicator

Our hypothesis, which we will prove with empirical evidence, is that health is a determinative contributor to economic growth in low income countries; therefore, sanitation, which is highly related to health in low income countries, would be significantly associated with economic growth in low income countries. In addition to this, we hypothesize that different human development modes are needed at different development stages; thus, even though basic health conditions like sanitation might be an important factor for economic growth in low income countries, it might not be in middle and high income countries.

3. Variables, Data and Methodologies[29]

3.1. Variables and Data

For our basic model, we divided the data into four-year sub-periods from 1983-1987 to 2007-2011 (7 periods in total). This division is for producing a sufficient number of sub-periods for panel estimation[30] without compromising too much on business cycle[31]. We discuss the empirical evidence for our hypothesis based on four-year growth analysis but we also try five-year growth analysis for sanitation for robustness-check purposes.

The dependent variable is the average growth rate of GDP per capita (constant 2005 PPP term). Our equation for estimation includes the basic control variables that are typically used in economic growth analysis, such as initial GDP per capita[32], investment ratio, population growth rate and school enrollment[33]. The main variables in our interest are basic infrastructure variables consisting of access to sanitation facilities (representing health), road density (representing transportation) and telephone lines per 100 people

[29] Referenced Lee K., Kim B.Y. (2007) and Lee K, Kim B.Y., Park Y.Y. and Sanidas E. (2012).

[30] This is due to the lack of road density data. The panel data for road density is available only from 2001 to 2010 and the data is not sufficient in this period. If we divide the data into five-year sub-periods, only two sub-periods are available for road density whereas three sub-periods are available when dividing into four-year sub-periods. Section 4 shows that road density data is still insufficient for system GMM analysis even with three sub-periods due to limited data available for each country. Instead, we rely more on other panel estimations, such as FE or RE, than those with two sub-period information.

[31] The duration of business cycle is between three and five years and typical cross-country regressions use growth rates measured over four or five year period to eliminate business cycles. Examples using four year period are Kmakova (2009) and Lee K., Kim B.Y., Park Y.Y., Sanidas E. (2012).

[32] We used the GDP per capita of 10 year before the starting year of each period due to the high correlation between GDP per capita and infrastructure variables *(Correlation of GDP per capita with sanitation : 0.61, with road : 0.42 and with telephone : 0.75.)*

[33] Secondary school enrollment is often used as control variable for economic growth analysis but due to the high correlation with infrastructure variables *(0.85 with sanitation, 0.74 with telephone),* we used primary school enrollment as an alternative. Sala-I-Martin, Doppelhofer G., Miller R. (2004) found the strong evidence that primary school enrollment is robustly related to economic growth through applying Bayesian Averaging of Classical Estimates (BACE) approach.

(representing telecommunication)[34]. The period of data available for our analysis is different among infrastructure variables: 1990-2011 for access to sanitation facilities, 2001-2010 for road density and 1983-2011 for telephone lines per 100 people. Due to the high correlation among infrastructure variables[35], we include each infrastructure variable to the equation one by one. The source of data for these variables is from the World Development Indicators of the World Bank. Appendix 1 and 2 show the detail of the source and description of data.

For robustness check, we included two additional variables of institution and economy openness. For the institution variable, we used the constraints on executives, sourced from Policy IV data set by Jaggers and Marshall's., which refers to the extent of institutionalized (as shown in laws) constraints on the decision-making power of chief executives, whether individuals or collectives. And for the economy openness variable, we used trade (% of GDP), which is the sum of exports and imports of goods and services measured as a share of gross domestic product, sourced from the World Development Indicators of the World Bank.

We include 150 countries and classify these countries into three groups by income as low income, middle income and high income countries. For the income threshold of the classification, we adopt the World Bank country classification criterion of GNI per capital (Atlas method US$). When applying this income threshold, we classify countries by two methods. One is to impose different income thresholds for each period and classify countries according to their income level at a specific period of time. Therefore, there are cases that classification of one country can vary over periods as the economy evolves. We call this the "time-varying country classification" method. The other way is to classify countries by their initial income[36]. Therefore, even though it is reclassified over periods, their income group does not change but is fixed depending on their initial income. This benefits us how countries starting with a different income group performed over time. We name this the "time-fixed country classification" method.

[34] We excluded the energy infrastructure as the data for access to electricity (% of population) is available only for 2009 and 2010 which is not enough for panel analysis. Many studies used electricity consumption as a proxy for energy infrastructure but we suspect endogeneity problem.
[35] Correlation between sanitation and telephone is 0.69.
[36] We classified countries according to their GNI per capita in 1987 where the World Bank country classification criterion starts. If data for GNI per capita in 1987 is not available but that within five years is available, countries are classified according to it (Appendix 3).

3.2. Methodologies

The empirical methods we used are pooled OLS, panel fixed-effect (FE), panel random-effect (RE) and system GMM. Pooled OLS pool all the observations in OLS regression regardless of country. In other words, it assumes that there is no heterogeneity across countries so the coefficients and intercepts are the same for all the countries. It is easy to run but is subject to have many types of errors. In order for the OLS estimates to be unbiased and consistent, explanatory variables should satisfy the exogeneity assumption. However, as it ignores the country-specific aspect of economic growth, those effects unique to each country are all included in the error term. In this circumstance, the explanatory variables will no longer be uncorrelated with the error term, which will make pooled OLS estimation biased and inconsistent.

The omitted variable bias can be reduced by applying FE estimation or RE estimation. Both estimations consider the heterogeneity among countries but the assumption on heterogeneity among countries is different. FE estimation assumes that this heterogeneity is constant over time and correlated with independent variables; therefore, this constant can be removed from the data by differencing. On the other hand, the rationale behind RE estimation is that the variation among countries is assumed to be random and uncorrelated with independent variable. To decide which to apply between FE or RE estimation, we run the Hausman test at 95% confidence level. Despite its advantage that both FE and RE estimation can control the country heterogeneity, there still remains unsolved problem in these approaches that endogeneity can exist.

Taking this problem into consideration, General Method of Moments (GMM) was applied by many economists, which usually mitigates unobserved country heterogeneity, omitted variable bias, measurement error, and potential endogeneity. Especially, system GMM developed by Arellano M., Bover O. (1995) and Blundell R., Bond S. (1998) and applied by Bond, S., A. Hoeffler, J. Temple (2001) to growth equation is advantageous as it reduces a small sample bias that characterizes the first-differenced GMM used by Caselli F., Esquivel G., and Lefort F. (1996).

In the system GMM estimation, the error term consists of two components of ω_i and u_{it}, where ω_i represents country-specific effect and u_{it} represents an idiosyncratic component. As discussed by Arellano M., Bover O. (1995), Blundell R., Bond S. (1998), and Lee K., Kim B. Y. (2007), the system GMM estimator technique combines the relevant regression in both first differences and in levels within one system. First

differencing allows us to deal with unobserved heterogeneity, the associated omitted variable bias, and the time-invariant component of measurement error. To correct the time-varying component of the same measurement error, explanatory variables are instrumented. If the measurement errors are serially uncorrelated, the values of the contemporary explanatory variables lagged at least twice and first-differences or values of the same variables lagged once can be used as instruments, respectively, in the equation in differences and the equation in levels. Instrumenting these variables as described above also allows us to correct for the endogeneity bias. Finally, estimating the two equations in a system reduces the potential bias and imprecision associated with a simple first-difference estimator (Arellano M., Bover O. (1995), Blundell R., Bond S. (1998)).

In order to evaluate whether our model for system GMM is correctly specified, we use two criteria, namely the Hansen and the AR2 test. The Hansen test is for over-identifying restrictions which, under the null of instrument validity, are asymptotically distributed as a chi-square with degrees of freedom equal to the number of instruments less the number of parameters. The AR2 test is for restrictions that are asymptotically distributed as a standard normal under the null of no second-order serial correlation of the differenced residuals, and provides a further check on the specification of the model and on the legitimacy of variables dated for t-2 as instruments in the differenced equation.

The basic equation we estimate is as follows:

$$y_{it} = \alpha_r + \alpha_1 Inigdp_{it_0} + \alpha_2 Popgrowth_{it} + \alpha_3 Inverate_{it} + \alpha_4 Eduenrol_{it} + \alpha_5 Infra_{it} + \mu_{it}$$

where i indexes countries, and t indexes time;

y_{it} is the average growth rate of GDP per capita in country i as measured in PPP-based U.S. dollars during t period[37];

$Inigdp_{it_0}$ is the initial level of GDP per capita in country i expressed in PPP-based U.S. dollars for which we used the 10 year before the starting year of t period;

$Popgrowth_{it}$ is the average of the population growth in country i during t period;

$Inverate_{it}$ is the average of the investment rate in country i during t period;

$Eduenrol_{it}$ is the average of the primary school enrollment rate[38] in country i during t period;

[37] For example, the average growth from 1983 to 1987 is calculated as ln(GDP per capita at 1987)-ln(GDP per capita at 1983)

[38] Secondary school enrollment is often used but due to high correlation with infrastructure variables *(0.85 with sanitation, 0.74 with telephone)*, we used primary school enrollment as an alternative.

$Infra_{it}$ is the infrastructure variable which is in our key interest of our study. The average of access rate to improved sanitation facilities, road density and telephone line per 100 people in country i at t period are individually included in the equation[39].

For one way of the robustness check, we also included two additional control variables together to our basic equation: institution variable ($Insti_{it}$) and economy openness ($Open_{it}$). $Insti_{it}$ is the average of the constraints on executives in country i during t period and $Open_{it}$ is the average of the trade in country i during t period. Finally, we run the basic model with five-year sub-periods too as another way of robustness check.

4. Results

4.1. Relative Importance of Infrastructure in Low Income Countries

We first run the regression to find out the relatively important infrastructure variable in low income countries. It is conducted by adding the selected infrastructure variables individually, such as sanitation, road and telephone, using pooled OLS, FE[40] and system GMM. When the result is not consistent among estimations, we rely the most on system GMM as it can mitigate the possible endogeneity of explanatory variables, as well as omitted variable biases. When it comes to country classification, we use two methods, time-varying country classification and time-fixed country classification, through adopting the World Bank country classification criterion for the income threshold of each income group.

Table 3-(1) presents the result with low income countries classified under time varying country classification. We run pooled OLS, FE and system GMM for sanitation and telephone. In the case of road, we use RE instead of FE as Hausman test rejects the FE[41] and we cannot rely on the result of system GMM for road as AR2 cannot be calculated due to the lack of data. Therefore, we compare the results by pooled OLS, FE and system GMM for sanitation and telephone and that by pooled OLS and RE for road. The results show that sanitation is significantly positive in all estimations (pooled OLS, FE and system GMM). In system GMM, Hansen and AR2 statistics show no evidence

[39] Due to the high correlation among infrastructure variables, we analyze each infrastructure variable separately. *(Correlation between sanitation and telephone = 0.69)*

[40] Depending on the result of Hausman test, RE was used instead of FE. The null hypothesis of Hausman test is that preferred model is RE. If null hypothesis is not rejected at 95% significance level, we used RE.

[41] Hausman test : Chi2 statistics= 1.33, probability of Chi2 statistics= 0.95

of poor instrument choice or bad specification of model at the 95% confidence level. Road and telephone, however, are not significantly associated with economic growth in all estimations[42].

[Table 3 : The Relative Importance of Infrastructure in Low Income Countries
(1) Results by Time-Varying Country Classification]

Next, we run the regression in low income countries classified under time-fixed country classification and Table 3-(2) shows its results. The results are similar overall under time-varying country classification but different in two points.

One is that the coefficient of sanitation is no longer significant in FE. However, in pooled OLS and system GMM, it is still positively significant and Hansen and AR2 statistics show no evidence of poor instrument choice or bad specification of model at the 95% confidence level. The other is that the coefficient of telephone is positively significant in pooled OLS and FE whereas it is not significant in any estimation under time-varying country classification. However, the coefficient of telephone is still not significant in system GMM even under time-fixed country classification.

[Table 3 : The Relative Importance of Infrastructure in Low Income Countries
(2) Results by Time-Fixed Country Classification]

In sum, the coefficient of sanitation is positively significant in low income countries in most of estimations whether country classification follows time-varying method or time-fixed method. The coefficient of telephone is positively significant in time-fixed country classification by pooled OLS and FE but still not by system GMM, the estimation we rely on the most. Only sanitation shows a positively significant relationship with economic growth by system GMM in both country classification methods. Therefore, the results show that sanitation is a relatively more important factor in low income countries.

[42] Road is significantly positive in system GMM but it is not reliable as we could not test AR2 which could not be calculated due to the lack of data.

4.2. Importance of Sanitation by Income Group

Now we turn to the basic idea underlying our study that different modes of human development are important at different development stages. Based on our finding at section 4.1 that sanitation is an important factor in economic growth of low income countries, we run the same regression for sanitation in middle income countries as well as high income countries. We classified the income group as low income, middle income and high income countries by two country classification methods likewise. As we already presented the results of low income countries, we discuss the results in middle and high income countries in this section.

Table 4-(1) presents the results by classifying the income groups with time-varying method. In middle income countries, the coefficient of sanitation is not significant in all estimations and in high income countries, the coefficient of sanitation is significant only in FE estimation but it is negatively significant. In system GMM for middle income countries, the Hansen and AR2 tests do not indicate problems with instrument selection or general specification of the model. Yet, there is some indication that the result pertaining to system GMM estimation using high income countries suffers from second-order autocorrelation. In summary, the impact of sanitation on economic growth is positively significant not in middle and high income countries but only in low income countries.

[Table 4 : Importance of Sanitation by Income Group
(1) Results by Time-Varying Country Classification]

Table 4-(2) shows the results by classifying the income groups with time-fixed method. The result is similar to that with time-varying country classification. In middle income countries, the coefficient of sanitation is not significant in all methods and, in high income countries, the coefficient of sanitation is significant only in FE but negatively. Therefore, we can confirm that sanitation is important factor for economic growth only in low income countries but not in middle and high income countries.

[Table 4 : Importance of Sanitation by Income Group
(2) Results by Time-Fixed Country Classification]

4.3. Robustness Check for Sanitation in Low Income Countries

To check the robustness for sanitation in low income countries, we run two kinds of regressions in both country classification methods. One is by adding two additional control variables and the other is by estimating the basic equation with five-year sub-periods.

The first robustness check is conducted by adding two control variables together to the equation. One of these variables is trade openness (% of GDP), which has been widely used in economic growth analysis. The other variable is the number of constraints on executives to represent institution of one country, which is used and turns out to be an important factor in lower income countries by Lee K., Kim B. Y. (2007). Table 5-(1) shows its result and it presents the same pattern with that of the basic model without additional control variables. In other words, in low income countries under time-varying country classification, the coefficient of sanitation remains positively significant in all estimations: pooled OLS, FE and system GMM and, in low income countries under time-fixed country classification, the coefficient of sanitation is positively significant in pooled OLS and system GMM. And Hansen and AR2 statistics by both country classification methods do not reject the null hypothesis of no serial correlation and instrument validity.

[Table 5 : Robustness Check for Sanitation in Low Income Countries

(1) Results with Additional Control Variables: Institution and Country Openness]

The second robustness check is by estimating the basic equation but with five-year sub-periods. We run regression in low income countries in both country classification methods likewise. These results presented in Table 5-(2) are generally aligned with those of four-year sub-period analysis except for one case. In the case of the result by time-varying country classification, the coefficient of sanitation is not positively significant in FE anymore. Except for this, the pattern of the result is similar with that of four-year sub-period analysis and Hansen and AR2 statistics do not reject the null hypothesis of no serial correlation and instrument validity this time too.

[Table 5 : Robustness Check for Sanitation in Low Income Countries

(2) Results with Five-year Sub-period Analysis]

We have also investigated the causality between sanitation and economic growth using the Granger Causality Test. We used the second and third lag of sanitation together with the first lag to take account of longer-term impact of sanitation. We test whether these two lags of sanitation are jointly significant in determining economic growth at 95% confidence level and vice versa. We conducted this test for the 10 example success and failure countries[43] in this study (Table 6). In Vietnam among success countries and Mozambique and Niger among failure countries, sanitation improvement turns out to cause economic growth and in Lao PDR among success countries, economic growth turns out to cause sanitation improvement. This means that substantial improvement of sanitation caused high economic growth in Vietnam and poor improvement of sanitation caused low economic growth in Mozambique and Niger.

[Table 6 : Granger Causality Test]

In summary, even though the results of FE vary across regressions, system GMM results, which we rely on the most, are consistent; in other words, the coefficient of sanitation is positively significant in low income countries at the 95% confidence level regardless of (i) whether low income countries are classified by time-varying method or time-fixed method, (ii) whether the model is with basic control variables or with basic plus additional control variables, or (iii) whether analysis is based on four-year or five-year sub-periods. These results suggest that sanitation is an important and robust contributor in economic growth in low income countries.

All in all, we summarize our findings as follows. First, the results show that the coefficient of sanitation is positively significant and robust whereas that of road and telephone is not: the estimation shows that a 1% increase in sanitation raises 4 year average growth of GDP per capita by 0.14%~0.86%. These results suggest that sanitation takes the most determinative role in economic growth of low income countries among infrastructure variables. This supports our hypothesis that basic health is the most crucial factor for human development leading to economic growth in low income countries. Secondly, sanitation is significantly associated with economic growth in low income countries but not in middle and high income countries. This implies that poor health conditions are impeding human development and working as a hurdle in

[43] Success Countries : India, Lao PDR Pakistan, Vietnam
Failure Countries : Guinea, Madagascar, Mozambique, Niger, Sierra Leone, Togo

low income countries to jump up to the next development stage whereas it is not in middle and high income countries. This reinforces our underlying idea that for countries in different stages of development, different phases of human development are needed to support economic growth, which suggests that the focus of human development should be adjusted as the economy grows.

<Table 3> Relative Importance of Infrastructure in Low Income Countries

(1) Results by Time-Varying Country Classification

Dependant Variable : 4 year GDP per capita Growth Rate	Sanitation			Road			Telephone		
	Pooled OLS	Fixed Effect	System GMM	Pooled OLS	Random Effect	System GMM	Pooled OLS	Fixed Effect	System GMM
Initial GDP per capita	-7.51e-05**	2.17e-05	-5.06e-05*	-3.39e-06	-1.80e-06	-1.94e-06	-5.60e-05*	1.00e-05	-9.15e-05**
	(-2.654)	(0.334)	(-1.926)	(-0.120)	(-0.0641)	(-0.0241)	(-1.952)	(0.197)	(-2.252)
School Enrollment	0.000665	0.00120**	0.000623	0.000334	0.000333	-0.000684	0.00107**	0.00196***	0.000721
	(1.525)	(2.153)	(0.718)	(0.428)	(0.433)	(-0.368)	(2.437)	(3.273)	(0.629)
Gross Capital Formation	0.00770**	-0.000509	0.00717**	0.00170	0.00159	0.00253	0.00765**	-0.000445	0.00505
	(2.650)	(-0.198)	(2.289)	(0.688)	(0.659)	(0.862)	(2.399)	(-0.174)	(1.068)
Population Growth	0.0252**	0.0157***	0.0188*	-0.0424	-0.0402	-0.0106	0.0132	0.0173***	0.00473
	(2.238)	(3.164)	(1.801)	(-1.548)	(-1.490)	(-0.162)	(1.086)	(2.762)	(0.218)
Sanitation	0.00219***	0.00869**	0.00166**						
	(3.376)	(2.415)	(2.012)						
Road				0.00107	0.00103	0.00502**			
				(0.963)	(0.937)	(2.577)			
Telephone							0.00111	0.0280	0.00146
							(0.170)	(1.177)	(0.156)
Constant	-0.202***	-0.387***	-0.184**	0.113	0.110	0.0505	-0.164*	-0.210**	-0.00800
	(-2.768)	(-2.939)	(-2.289)	(0.709)	(0.710)	(0.209)	(-1.980)	(-2.243)	(-0.0587)
Observations	180	180	180	56	56	56	182	182	182
R-squared	0.365	0.182		0.156			0.316	0.162	
Hansen test			[0.941]			[0.244]			[0.384]
AR2 test			[0.730]			[-]			[0.800]

*Note: T-value is in parentheses. / *** Significant at 99% ** Significant at 95% * Significant at 90%*

(2) Results by Time-Fixed Country Classification

Dependant Variable : 4 year GDP per capita Growth Rate	Sanitation			Road			Telephone		
	Pooled OLS	Fixed Effect	System GMM	Pooled OLS	Random Effect	System GMM	Pooled OLS	Fixed Effect	System GMM
Initial GDP per capita	-5.45e-05*	-4.45e-05	5.22e-06	5.10e-05	5.39e-05	9.05e-06	-3.11e-05	-8.59e-05**	-5.00e-05
	(-1.856)	(-1.392)	(0.205)	(1.427)	(1.592)	(0.0924)	(-1.232)	(-2.253)	(-0.963)
School Enrollment	0.000548	0.00116**	0.00126	0.000356	2.41e-05	0.000498	0.00112**	0.00181**	0.00126
	(1.361)	(2.296)	(1.268)	(0.346)	(0.0253)	(0.267)	(2.493)	(2.462)	(1.231)
Gross Capital Formation	0.00891***	0.00344	0.00758*	0.00849***	0.00791***	0.00922*	0.00853***	0.00389	0.00981**
	(3.419)	(0.941)	(1.976)	(3.040)	(2.679)	(1.964)	(2.810)	(1.048)	(2.306)
Population Growth	0.0252**	0.0153**	0.0176	-0.00184	0.000587	-0.00510	0.0233**	0.0158**	0.0252**
	(2.312)	(2.527)	(1.137)	(-0.0758)	(0.0242)	(-0.0780)	(2.409)	(2.241)	(2.072)
Sanitation	0.00245***	0.00459	0.00173**						
	(4.219)	(1.641)	(2.330)						
Road				0.000366	0.000501	0.000885			
				(0.717)	(0.842)	(0.456)			
Telephone							0.00683***	0.00733*	0.00544
							(3.065)	(1.751)	(1.627)
Constant	-0.242***	-0.245***	-0.308***	-0.170	-0.130	-0.161	-0.242***	-0.120	-0.262***
	(-3.445)	(-3.318)	(-3.458)	(-1.058)	(-0.866)	(-0.423)	(-3.436)	(-1.690)	(-2.932)
Observations	179	179	179	66	66	66	180	180	180
R-squared	0.411	0.156		0.390			0.362	0.214	
Hansen test			[0.492]			[0.340]			[0.761]
AR2 test			[0.997]			[-]			[0.585]

*Note: T-value is in parentheses. / *** Significant at 99% ** Significant at 95% * Significant at 90%*

<Table 4> Importance of Sanitation by Income Group

(1) Results by Time-Varying Country Classification

Dependant Variable : 4 year GDP per capita Growth Rate	Low Income Countries			Middle Income Countries			High Income Countries		
	Pooled OLS	Fixed Effect	System GMM	Pooled OLS	Random Effect	System GMM	Pooled OLS	Fixed Effect	System GMM
Initial GDP per capita	-7.51e-05**	2.17e-05	-5.06e-05*	-6.36e-06**	-6.12e-06*	3.80e-07	-1.96e-06**	-5.26e-06***	-2.07e-06
	(-2.654)	(0.334)	(-1.926)	(-2.427)	(-1.906)	(0.0468)	(-2.652)	(-2.784)	(-1.641)
School Enrollment	0.000665	0.00120**	0.000623	-0.000772	-0.000616	0.00421*	-0.00145	-0.00266*	-0.00296
	(1.525)	(2.153)	(0.718)	(-1.526)	(-1.119)	(1.965)	(-1.377)	(-1.766)	(-1.677)
Gross Capital Formation	0.00770**	-0.000509	0.00717**	0.00588***	0.00669***	0.0113***	0.00513***	0.0160***	0.0103**
	(2.650)	(-0.198)	(2.289)	(3.811)	(3.979)	(3.381)	(2.979)	(5.464)	(2.408)
Population Growth	0.0252**	0.0157***	0.0188*	-0.0265***	-0.0301***	-0.0192	-0.0104**	-0.0384***	-0.0115*
	(2.238)	(3.164)	(1.801)	(-2.955)	(-3.189)	(-0.939)	(-2.198)	(-5.602)	(-1.847)
Sanitation	0.00219***	0.00869**	0.00166**	6.36e-05	-4.17e-05	-4.41e-05	0.00404	-0.0118***	0.00312
	(3.376)	(2.415)	(2.012)	(0.185)	(-0.110)	(-0.0399)	(1.620)	(-7.785)	(0.879)
Constant	-0.202***	-0.387***	-0.184**	0.117	0.0952	-0.582**	-0.249	1.309***	-0.109
	(-2.768)	(-2.939)	(-2.289)	(1.520)	(1.153)	(-2.443)	(-0.872)	(7.077)	(-0.252)
Observations	180	180	180	320	320	320	152	152	152
R-squared	0.365	0.182		0.226			0.212	0.509	
Hansen test			[0.941]			[0.088]			[0.991]
AR2 test			[0.730]			[0.297]			[0.019]

*Note: T-value is in parentheses. / *** Significant at 99% ** Significant at 95% * Significant at 90%*

(2) Results by Time-Fixed Country Classification

Dependant variable : 4 year GDP per capita growth rate	Low Income Countries			Middle Income Countries			High Income Countries		
	Pooled OLS	Fixed Effect	System GMM	Pooled OLS	Fixed Effect	System GMM	Pooled OLS	Fixed Effect	System GMM
Initial GDP per capita	-5.45e-05*	-4.45e-05	5.22e-06	-4.86e-06***	-5.70e-06	-7.56e-06**	-2.38e-06***	-5.49e-06***	-2.17e-06*
	(-1.856)	(-1.392)	(0.205)	(-2.832)	(-1.357)	(-1.992)	(-3.270)	(-3.477)	(-1.873)
School Enrollment	0.000548	0.00116**	0.00126	-5.15e-05	0.00117	0.000235	-0.00361**	-0.000571	-0.00478*
	(1.361)	(2.296)	(1.268)	(-0.132)	(1.200)	(0.180)	(-2.646)	(-0.301)	(-2.034)
Gross Capital Formation	0.00891***	0.00344	0.00758*	0.00501***	0.0109***	0.00357**	0.00195	0.0104***	0.00417
	(3.419)	(0.941)	(1.976)	(3.572)	(3.051)	(2.204)	(0.840)	(3.088)	(1.031)
Population Growth	0.0252**	0.0153**	0.0176	-0.0233***	-0.0440***	-0.0126	-0.0125***	-0.0355***	-0.0136***
	(2.312)	(2.527)	(1.137)	(-2.954)	(-2.784)	(-0.993)	(-3.514)	(-9.853)	(-3.440)
Sanitation	0.00245***	0.00459	0.00173**	0.000244	-0.00125	0.00156	0.00211	-0.0140***	-0.00299
	(4.219)	(1.641)	(2.330)	(0.800)	(-0.683)	(1.198)	(1.537)	(-7.286)	(-0.322)
Constant	-0.242***	-0.245***	-0.308***	0.0224	-0.102	-0.0668	0.247	1.466***	0.827
	(-3.445)	(-3.318)	(-3.458)	(0.353)	(-0.731)	(-0.418)	(1.203)	(21.28)	(0.896)
Observations	179	179	179	340	340	340	116	116	116
R-squared	0.411	0.156		0.133	0.170		0.281	0.444	
Hansen test			[0.492]			[0.214]			[0.999]
AR2 test			[0.997]			[0.163]			[0.157]

*Note: T-value is in parentheses. / *** Significant at 99% ** significant at 95% * significant at 90%*

<Table 5> Robustness Check for Sanitation in Low Income Countries

(1) Results with Additional Control Variables: Institution and Economy Openness

Dependant Variable : 4 year GDP per capita Growth Rate	Time-Varying Country Classification			Time-Fixed Country Classification		
	Pooled OLS	Fixed Effect	System GMM	Pooled OLS	Fixed Effect	System GMM
Initial GDP per capita	-8.61e-05***	-3.02e-06	-5.24e-05*	-5.45e-05*	-6.57e-05*	-2.67e-05
	(-3.084)	(-0.0417)	(-1.678)	(-1.934)	(-1.697)	(-0.875)
School Enrollment	0.000560	0.000841*	0.000601	0.000554	0.000526	0.00135
	(1.421)	(1.751)	(0.937)	(1.463)	(0.816)	(1.397)
Gross Capital Formation	0.00553*	-0.00204	0.00241	0.00810***	0.000485	0.00598*
	(1.881)	(-0.721)	(0.960)	(2.963)	(0.160)	(1.710)
Population Growth	0.0233**	0.0221***	0.0287***	0.0216**	0.0242***	0.0275*
	(2.119)	(5.471)	(2.687)	(2.038)	(6.117)	(1.756)
Constraints of Executives	-0.0164**	-0.00489	-0.0180	-0.0146*	-0.00716	-0.0238
	(-2.213)	(-0.707)	(-1.506)	(-1.718)	(-0.807)	(-1.628)
Trade	0.000952	0.00205*	0.00186**	0.000228	0.00351**	0.000810
	(1.620)	(1.884)	(2.638)	(0.443)	(2.285)	(1.089)
Sanitation	0.00191***	0.00568**	0.00144**	0.00216***	0.00225	0.00197**
	(3.269)	(2.210)	(2.182)	(4.345)	(0.892)	(2.128)
Constant	-0.118*	-0.331**	-0.156*	-0.159**	-0.254***	-0.231*
	(-1.727)	(-2.301)	(-1.734)	(-2.339)	(-2.855)	(-1.853)
Observations	176	176	176	174	174	174
R-squared	0.404	0.215		0.413	0.269	
Hansen test			[0.999]			[0.991]
AR2 test			[0.743]			[0.585]

*Note: T-value is in parentheses. / *** Significant at 99% ** Significant at 95% * Significant at 90%*

(2) Results of Five-year Sub-period Analysis

Dependant Variable : 5 year GDP per capita Growth Rate	Time-Varying Country Classification			Time-Fixed Country Classification		
	Pooled OLS	Fixed Effect	System GMM	Pooled OLS	Fixed Effect	System GMM
Initial GDP per capita	-5.51e-05***	0.000236	-8.65e-05*	-6.93e-06	6.42e-05	1.45e-05
	(-2.714)	(1.606)	(-1.994)	(-0.130)	(0.994)	(0.252)
School Enrollment	0.00103	0.000936	-0.000903	0.000853	0.00146	-0.000229
	(1.465)	(0.860)	(-0.689)	(1.249)	(1.624)	(-0.170)
Gross Capital Formation	0.00609**	0.00792	0.00602	0.0111***	0.00519	0.0130***
	(2.155)	(1.624)	(1.463)	(3.359)	(1.074)	(3.325)
Population Growth	0.0521	0.0434	0.0515	0.0568	0.0461	0.0574
	(1.404)	(1.134)	(0.769)	(1.554)	(1.110)	(1.462)
Sanitation	0.00195**	0.00560	0.00294**	0.00257***	0.00240	0.00283**
	(2.303)	(1.103)	(2.102)	(3.018)	(0.621)	(2.130)
Constant	-0.271*	-0.758***	-0.0881	-0.419***	-0.400***	-0.391**
	(-2.000)	(-3.192)	(-0.501)	(-2.842)	(-3.516)	(-2.556)
Observations	141	141	141	148	148	148
R-squared	0.214	0.205		0.337	0.144	
Hansen test			[0.381]			[0.931]
AR2			[0.712]			[0.434]

*Note: T-value is in parentheses. / *** Significant at 99% ** Significant at 95% *Significant at 90%*

<Table 6> Granger Causality Test

Classification	Country	Null hypothesis	Prob. > F
Success Countries	India	Sanitation does not cause economic growth[44].	0.5014
		Economic growth does not cause sanitation.	0.3634
	Lao PDR	Sanitation does not cause economic growth.	0.1607
		Economic growth does not cause sanitation.	**0.0235**
	Pakistan	Sanitation does not cause economic growth.	0.0924
		Economic growth does not cause sanitation.	0.4847
	Vietnam	Sanitation does not cause economic growth.	**0.0021**
		Economic growth does not cause sanitation.	0.3314
Failure Countries	Guinea	Sanitation does not cause economic growth.	0.2235
		Economic growth does not cause sanitation.	0.2011
	Madagascar	Sanitation does not cause economic growth.	0.5997
		Economic growth does not cause sanitation.	0.1512
	Mozambique	Sanitation does not cause economic growth.	**0.0018**
		Economic growth does not cause sanitation.	0.8933
	Niger	Sanitation does not cause economic growth.	**0.0128**
		Economic growth does not cause sanitation.	0.2670
	Sierra Leone	Sanitation does not cause economic growth.	0.0664
		Economic growth does not cause sanitation.	0.0630
	Togo	Sanitation does not cause economic growth.	0.2948
		Economic growth does not cause sanitation.	0.3165

[44] ln (GDP per capita at *t*) – ln (GDP per capita at *t-1*)

5. Conclusion

This paper investigates the determinants of economic growth in low income countries. Our motivation is to ascertain what should be essentially founded for economic growth in low income countries and what should be supported with priority for effective poverty reduction. We hypothesize that human development is fundamental for economic growth and, especially in low income countries, improvement of health conditions by way of investing in basic health infrastructure like sanitation, should take priority. We detect that inadequate sanitation is one of the major health risk factors in low income countries. Based on this, we analyze the basic historic facts and empirical evidence related with the link between sanitation and economic growth.

Our findings provide us with two implications. Firstly, improvement of health conditions should take priority for economic growth in low income countries like we hypothesize. Our results show that sanitation is a more determinative and robust factor in economic growth of low income countries than roads and telephone access. This implies that poor health conditions work as a critical binding constraint for low income countries to move up to the next development stage. Therefore, supporting human development like improvement of health conditions should be preceded before focusing on the economic infrastructure.

Secondly, different phases of human development are needed at different development stages. Our results suggest that sanitation is significantly associated with economic growth in low income countries but not in middle and high income countries. Even though inadequate health infrastructure related with hygiene and nutrition appears to work as the main hurdle of economic growth in low income countries, it is not the main constraint for economic growth in middle and high income countries. This indicates that there are different kinds of human development driving the economic growth of middle and high income countries and policy should not remain constant but be adjusted as the economy evolves.

Our study contributes to two themes on human development and economic growth, combined with the previous studies.

Firstly, our study reinforces the assertion that human development should precede or at least accompany general economic growth initiatives. It is easy to assume that economic fundamentals can bring economic growth directly but neglect the more

fundamental element behind that. Ranis G., Stewart F., Ramirez A. (2000) criticized that economic and social policy tends to focus priority on economic fundamentals as a necessary precondition for economic growth. But economic growth itself will not be sustained if a focus on human development is not included from the beginning of any economic reform as prerequisite. Ranis G. (2004) criticized the view of "grow first and worry about human development later" and efforts for human development should have priority or at least move together with efforts for directly enhancing growth. Our study is aligned with this assertion by demonstrating the relative importance of human development compared to economic infrastructure development.

Secondly, we summarize the full picture of human development that is needed for economic growth at different development stages as follows: basic health like hygiene and nutrition is important at the bottom of the development stage. After escaping extreme poverty, basic education like secondary education becomes more important. After succeeding to jump to middle and high income stages, higher education like tertiary education and innovation become more crucial factor for economic growth. This summary is combined with the previous study by Lee K., Kim B.Y. (2007). They proved empirically that secondary education is an important factor of economic growth in low and lower middle income countries whereas tertiary education and technology are more conducive to the economic growth in upper middle and high income countries. Our study focuses especially on low income countries and shows that improvement of basic health through enhancing sanitation conditions is an important factor in economic growth of low income countries with additional evidence that it is not important in middle and high income countries.

Overall, we emphasized the importance of improvement in basic health for economic growth in low income countries. However, this does not mean denying the importance of other factors. Like Rodrik (2006) emphasized, it is important to diagnose the most significant constraints on economic growth as this is the starting point where the greatest return comes. We detect the main bottleneck that obstructs low income countries to jump to the next level is poor human development caused by poor health conditions. Poor health tends to lead to poverty and poverty tends to bring poor health[45]. In low income countries, this vicious circle is not easy to end merely with their own resources; however, the basic health sector is not easy to attract private financial

[45] Sala-I-Martin (2005)

resources compared to sectors in economic infrastructure. Therefore, what we emphasize in our study is to urge the international community to focus more attention on the basic health sector in low income countries and prioritize for effective use and allocation of limited support resources in order to achieve poverty reduction.

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Appendix 1: Variable definitions and sources

***GDP per capita**:* GDP *per capita* in purchasing-power-parity, constant year 2005 in international dollars. Source: World Bank, World Development Indicators, http://databank.worldbank.org

***GNI per capita**:* GNI *per capita* in Atlas method US$. Source: World Bank, World Development Indicators, http://databank.worldbank.org

***Capital formation (or Investment ratio)**:* Gross capital formation or investment as % of GDP. Source: World Bank, World Development Indicators, http://databank.worldbank.org.

***Primary school enrollment**:* School enrollment, primary (% of gross). The gross primary school enrollment ratio is the ratio of total enrollment (regardless of age) to the population of the age group that officially corresponds to the level of primary education. Source: World Bank, World Development Indicators, http://databank.worldbank.org

***Population**:* Population growth rate (annual %). Source: World Bank, World Development Indicators, http://databank.worldbank.org

***Access to improved sanitation facilities**:* Access to improved sanitation facilities (% of population). The improved sanitation facilities include flush/pour flush (to piped sewer system, septic tank, pit latrine), ventilated improved pit (VIP) latrine, pit latrine with slab, and composting toilet. Source: World Bank, World Development Indicators, http://databank.worldbank.org

***Road density**:* the ratio of the length of the country's total road network to the country's land area (km of road per 100 sq. km of land area). Source: World Bank, World Development Indicators, http://databank.worldbank.org

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***Telephone line**:* Telephone lines (per 100 people). Telephone lines are fixed telephone lines that connect a subscriber's terminal equipment to the public switched telephone network and that have a port on a telephone exchange. Source: World Bank, World Development Indicators, http://databank.worldbank.org

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***Constraints on executives**:* The constraints on the chief executive which refers to the extent of institutionalized (as shown in laws) constraints on the decision-making power of chief executives, whether individuals or collectives. Source: Polity IV Dataset, http://www.systemicpeace.org.

***Trade**:* Trade (% of GDP). Trade is the sum of exports and imports of goods and services measured as a share of gross domestic product. Source: World Bank, World Development Indicators, http://databank.worldbank.org

Appendix 2: Descriptive Statistics

Variable	All Countries		Low Income Countries		Middle Income Countries		High Income Countries	
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
GDP per capita growth rate (average of 4 year period)	0.07	0.17	0.04	0.20	0.09	0.15	0.07	0.10
GDP per capita (1973-2001)	9,321.44	11,548.62	1,299.39	1,001.24	5,862.65	3,831.92	24,656.13	10,411.46
Primary school enrollment (1983-2011)	99.33	19.45	87.78	27.19	104.69	13.78	102.60	6.11
Population growth rate (1983-2011)	1.58	1.62	2.32	1.29	1.30	1.16	1.26	1.77
Gross capital formation (1983-2011)	22.95	8.81	20.89	10.36	24.27	8.86	22.62	5.60
Access to sanitation (1990-2011)	69.79	30.97	33.92	24.55	74.74	21.88	99.10	2.59
Road density (2001-2010)	115.65	342.21	17.74	24.80	42.82	49.53	228.77	448.95
Telephone line (1983-2011)	18.53	20.03	1.74	3.07	13.27	10.51	45.38	15.49
Executive constraints (1983-2011)	4.66	2.19	3.53	1.83	4.92	2.02	6.29	1.67
Trade (1983-2011)	85.49	49.72	68.48	36.73	86.57	37.70	103.17	73.91

Appendix 3: Countries classified with GNI per capita within five year from 1987 for Time-Fixed Country Classification

Income Group	Country	The Year of which that GNI per capita is used for country classification
Low Income Countries	Guinea	1988
	Vietnam	1989
	Tanzania	1990
	Armenia	1992
	Kyrgyz Republic	1992
	Moldova	1992
	Tajikistan	1992
	Uzbekistan	1992
	Yemen, Rep.	1992
Middle Income Countries	Latvia	1989
	Romania	1989
	Ukraine	1989
	Lebanon	1990
	Russian Federation	1991
	Belarus	1992
	Djibouti	1992
	El Salvador	1992
	Georgia	1992
	Lithuania	1992
	Macedonia, FYR	1992
	Poland	1992
	Slovenia	1992
	Solomon Islands	1992
High Income Countries	Brunei Darussalam	1989
	Isle of Man	1997