Infrastructure Access and Human Development: Cross-Country Evidence and Post-2015 Development Strategies

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Abstract

Despite extensive policy discussion, there is limited empirical literature on the impacts of infrastructure on human development. Furthermore, major infrastructure services, such as transport and energy, are missing in the current MDGs framework; although there is a firm consensus that the infrastructure is the main vehicle in achieving the MDGs. Thus, this study assesses the impacts of several infrastructure variables (access to electricity, access to clean water sources, and road density) on human development index (HDI) and its three component indexes (i.e. health, education and income) using the panel data of 1995 to 2010 covering 91 developing countries. Dynamic panel estimation of General Methods of Moments (GMM) resulted that all the three infrastructure variables have significant positive impacts on HDI. However, access to electricity and access to water have positive and significant effect on education and health indexes only. On the other hand, road density is highly significant to increase the income index. These results clearly indicate the importance of infrastructure for human development process. However, current UN lead discussion on post-2015 development agenda failed to incorporate infrastructure comprehensively, although energy and water are included among the 11 themes for discussion. Therefore, it is argued that only integrated goals and targets with interlinked strategies and policies, which should be based on a comprehensive assessment of the whole infrastructure sector (not the isolation of its sub-sectors), can contribute poverty reduction and inclusive development efficiently. Because, without elimination of all types of infrastructure poverty (defined as "lack of access to infrastructure services"), it is almost impossible to eliminate human poverty, sustainably.

Keywords: human development, infrastructure poverty, post-2015 development strategies, panel data

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1. Introduction

There are well-established evidences of significant impacts of infrastructure on economic growth (for detailed survey of the literature see World Bank 1994 and Samli 2011). However, the general approach to development has changed dramatically from economic concentration to human focus in recent decades (Todaro and Smith 2012). There are quite extensive discussions on the impact and importance of infrastructure on human development because lack of access to basic infrastructure services undermines the inclusive development (Tanaka 2012, JICA 2004, Fujita, Tsuruga and Takeda 2013). Lack of access to basic infrastructure services itself can be defined as "infrastructure poverty," because, without such access, it is extremely difficult to fulfil basic human needs. Of course, there is a question of affordability and capability of utilizing the services (Hosono 2012); however, having access is a prime necessity (for details discussion on access and affordability, see Briceno-Garmendia et al. 2004). Despite extensive policy discussion, there is limited empirical literature on the subject matter, particularly on the impacts infrastructure variables on human development (Kusharjantoa and Kim 2011). To the authors' knowledge, there is no such empirical work in cross-country setting; therefore, it is the first attempt to narrow this gap by exploring the impacts of three main infrastructure variables, namely: access to electricity, water, and road networks on human development index (HDI) and its components in developing countries.

Such an exploration is urgently essential because despite being one of the main vehicles in meeting the Millennium Development Goals (MDGs) (Scout and Seth 2012); infrastructure particularly transportation and energy are missing from the MDGs framework. Some of the donor agencies, such as Japan International Cooperation Agency (JICA), highly emphasized the importance of infrastructure in achieving the MDGs inclusively, and took the infrastructure development as one of the key approaches to support the MDGs process (JICA 2010: 11).[1]

[1] In its policy document "JICA's Approach to the Millennium Development Goals: For inclusive and dynamic development", JICA put infrastructure as one of the three major approaches to support the MDGs. The other two approaches are human security approach and capacity development approach.

However, unilateral or independent efforts are not enough because global compacts only can harmonize the development process at the global level. Thus, it is arguably crucial to incorporate infrastructure with due priority within the post-2015 development framework as suggested by Scout and Seth (2012).

The main objectives of the paper are twofold. First, it tests the level of significance of the three key infrastructure variables; i.e. access to electricity, access to clean drinking water sources and the road density, on improving the overall HDI and its component indexes. It empirically shows how effective are the infrastructures for development. Second, it discusses how infrastructures can or should be addressed in the post-2015 new development strategies. In fact, one of the weaknesses of the current MDGs framework is that it fails to guide the means to achieve the end goals (Norren 2012: 830; Michiel and Wesenbeeck 2007). Of course, there are strong views that MDGs are the global targets for development ends; therefore, it is unreliable to seek means within it (Vandemoortele and Delamonica 2010). However, achievement of any goals relies on the proper means, and hence it is more effective if international development framework can address both development means and ends. Therefore, it is argued that post-2015 new development framework should also develop a proper framework of ways and strategies to achieve the development goals. Of course, many ideas and strategies should be unique to countries and cannot be generalized at the global level; however, there are also many areas and issues that are common to all developing countries, such as infrastructure poverty, and hence can be addressed at the global level.

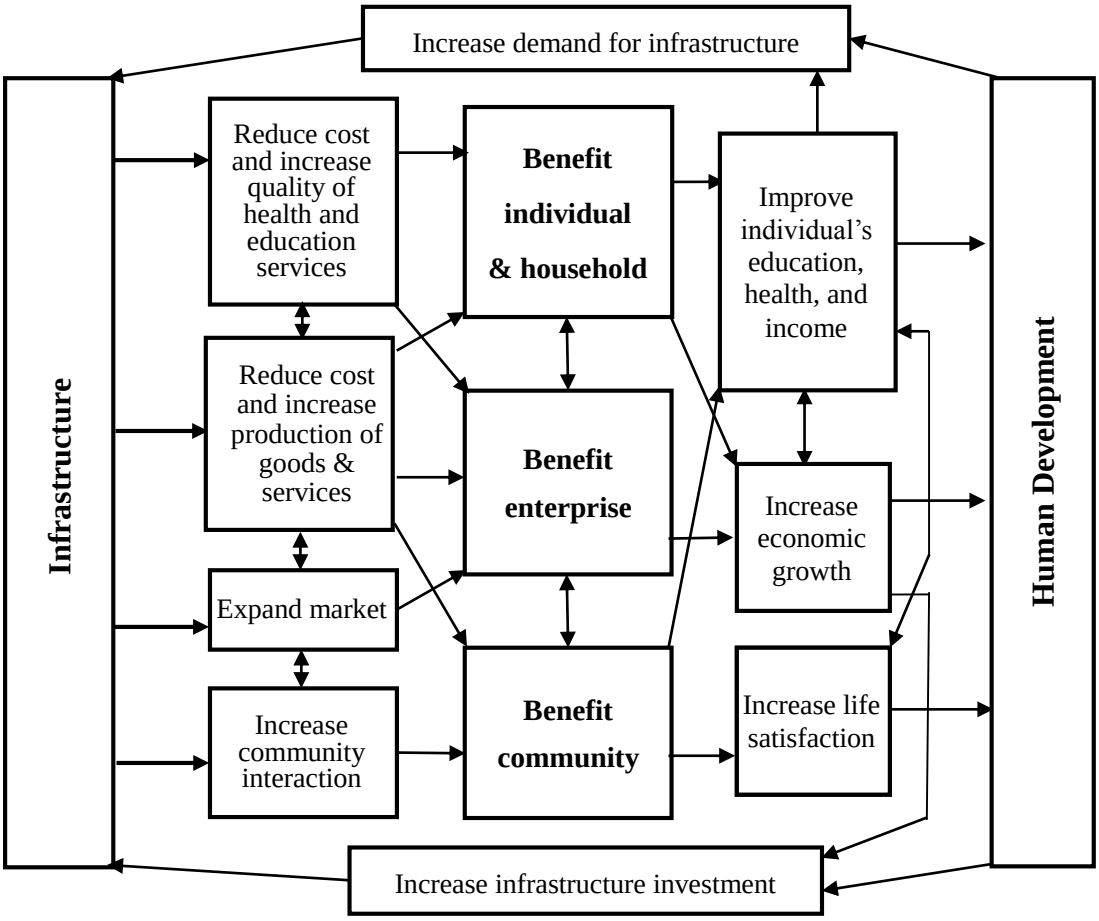
The paper is organized into six sections. Section 2 reviews the relevant literature and develops a dialectic model that shows the impact channels of infrastructure and human development. Section 3 describes the data and methodology, and section 4 presents the results showing the significant impacts of infrastructure on human development. In the light of the empirical results, section 5 proposes the ways to incorporate infrastructure in post-2015 development strategies. Section 6 concludes the paper with the argument that people-centered infrastructure would be the main vehicle to achieve the human development goals; hence

infrastructure should incorporate into the new international development strategies focusing on expanding the access.

2. Impacts channels of infrastructure and human development

Based on the existing literature, Figure 1 presents a dialectic model of infrastructure and human development. The arrow of the lines shows the direction of the flow of impact; thus, the lines with arrows at both ends indicate that the impacts flow both ways. The figure shows the multiple channels through which the links between infrastructure and human development operate. There is firm consensus that the increased access to infrastructure services like energy, water and transportation directly benefit individuals and households, communities, and firms (World Bank 1994). It benefits individuals and households through reducing cost and increasing quality of health and education services that further helps to improve education and health of an individual, which ultimately increase the level of human development at local and national level. For example, rural infrastructures increase the household and individual welfare through improving farm and non-farm productivity that raise the level of income and consumption, reduce the private cost and save time (WHO/UNICEF 2008; Ezcurra et al. 2005; Ali and Pernia 2003). Such effects clearly lead improved level of human development. Access to infrastructure not only provides direct benefits through reducing prices of manufacturing goods (Khandker et al. 2009) but also generates new opportunities indirectly; such as employment generation (Gachassin et al. 2010; Jacobs and Greaves 2003), market expansion and integration (Bhattacharyay 2009; World Bank 2004). A significant positive impact of infrastructure on health and education is also firmly established in the literature (Khandker et al. 2009; Bryceson and Howe 1993; Levy 1996). Interestingly, literatures suggest that the rural infrastructure improve education and health of women and girls more significantly than that of males (Levy 1996; Bryceson and Howe 1993).

Figure 1: A dialectic model of infrastructure and human development



Source: The author

Similarly, communities can be benefited through increased interactions with group members and also through increased size of the community (Hurlin 2006) that helps to increase the level of satisfaction, one of the psychological factors of human development. OECD (2002) claims that apart from generating employment and boosting efficiency, infrastructure supports social inclusion through increased social mobility and preserves environment through the efficient use of natural resources. Their arguments are supported with several case studies. For example, Kirubi et al. (2009) showed the significant contribution of community-based electric micro-grids on rural development through community development in Kenya. Interestingly, sectoral studies

focusing on the rural infrastructure by the World Bank (2004) revealed that infrastructure benefit is higher in less developed communities than more developed ones; because increased access to market and banking services, increased communication, and reduced cost of doing business are usually more in less developed communities.

Finally, increased infrastructure services directly benefits business enterprises through expanded market opportunities, reduced cost of production, and increased production quality and volume of goods and services (Jacoby 2002). Literature suggests that rural community-based infrastructure, such as rural roads, rural small-scale electrification, water and irrigation projects benefit small and medium scale enterprises significantly through increasing land and labor productivity, improving health and education level of the community, enhancing banking and communication services, and helping commercialization of agriculture (Kirubi et al. 2009; Khandker, Bakht and Koolwal 2009; Mu and van de Walle 2007, Lokshin and Yemtsov 2005; Jalan and Ravallion 2003; Reinikka and Svensson 2002). These all increase the rate of economic growth and ultimately contribute to human development (World Bank 1994).

On the other hand, while individuals' education, health and income level rose, it creates further demands for infrastructure services. Similarly, increased economic growth rate also helps to increase the quality and quantity of infrastructure services through increased investment in infrastructure development (Bhattacharya 2012). Therefore, infrastructure variables are not purely exogenous rather than endogenous to human development. This issue is addressed in the method of empirical assessment in the following section.

3. Data and methodology

3.1 The data

3.2.1 Dependent variables

Human development is the dependent variable. To measure the level of overall human development of a country, we use the human development index (HDI), which is developed by

the United Nations Development Program (UNDP) in 1990 aiming to provide a yardstick of human development of all member countries of the United Nations. The focus was on people, as the opening lines of the first HDI publication states:

> The real wealth of a nation is its people. And the purpose of development is to create an enabling environment for people to enjoy long, healthy and creative lives. This simple but powerful truth is too often forgotten in the pursuit of material and financial wealth. (UNDP, 1990: 1)

The UNDP has been publishing the Human Development Report (HDR) annually for the world and occasionally for regions and member states since 1990. The HDR's basic principle is that the essential components of quality of life are the combination of a long and healthy life, education, and a decent standard of living. As a result, the HDI has measured human development through the use of three factors; longevity, knowledge and GDP per capita measured in purchasing power parity (PPP).

Thus, we used HDI and its component indexes as dependent variable because the principles of the HDI are reflected in the MDGs framework as it also set health and education related goals together with income or poverty goals. See the technical notes of the HDR 2011 for details on how the HDI and its components are calculated.[2] In brief, the health aspect is measured through life expectancy at birth and converted into the Health (or life expectancy) Index (HI) using a minimum value of 20 years and observed maximum value over 1980-2010. Education Index (EI) is calculated using the population's mean years of schooling (of adults) and expected years of schooling (of children). The Income (or GNI) Index (II) is based upon the GNI per capita (2005 PPP International $, using the natural logarithm) expressed as an index using a minimum value of $100 and observed maximum value over 1980-2011. The data of these dependent variables are taken from the HDI database of the UNDP.[3] As the HDI trend data is available in five years interval until 2005, we used the panel data of 1995, 2000, 2005 and 2010. The analysis is limited to 91 developing countries due to the limited data availability for some independent variables.

[2] The technical notes can be accessed at: http://hdr.undp.org/en/media/HDR_2011_EN_TechNotes.pdf
[3] The HDI database can be accessed at: http://hdrstats.undp.org/en/tables/

The name of the countries covered in the analysis is listed in Appendix 1.

3.2.1 Explanatory variables

Infrastructure variables are the main explanatory variables of this study. According to ESCAP and AITD (2003), infrastructure is defined as the physical facilities; such as roads, airports, utility supply systems, communication systems, together with services generating from these facilities; such as water, sanitation, transportation and energy. Although a large number of the developing world's population is gaining access to infrastructure services in recent decades, large numbers of people remain without access to basic infrastructure services that hindering their overall development. For example, around 2 billion people gained access to electricity (GEA 2012) and safe drinking water (United Nations 2012) between 1990 and 2008, on the other hand if the current trend follows, at the end of the next 15-year period of international development goals, the numbers without access will be just as large as they are today. This continued lack of access will likely to retard achievement of any development goals agreed for the post-2015 period.

Therefore, the following three main infrastructure indicators are the main explanatory variables of this study. First, we use "access to electricity as the percentage of the population." Its data are taken from the World Bank's world development indicators (WDI) online database.[4] The literature suggests that increasing access to electricity improve human aspects of development through increased time for studying by girls and boys in a rural area, saving time for fuel wood collection, increasing household income and reducing poverty (Khandker et al. 2012) that ultimately uplift the level of human development. There is wide consensus among scholars that providing access to electricity, and other modern sources of energy substantially contribute in increasing household welfare (e.g., ADB 2010; World Bank 2008; Cockburn 2005; Martins 2005).

Second, we use "proportion of the population using improved drinking water sources." Its

[4] The World Bank's world development indicators (WDI) database is one of the most comprehensive and up to databases of development publicly available until now. The database can be access freely at: http://databank.worldbank.org/data/home.aspx

data are taken from the UN Stat's MDGs Indicators database.[5] It defines the improved water sources as a household connection, public standpipe, borehole, protected well or spring, and rainwater collection. Literature shows that the water is itself an economically productive asset, and sound water infrastructure is significant in improving human health and their livelihoods (Cleaver et al. 2005; Joshi 2004, Slaymaker et al. 2007). The human development impact of increasing access to drinking water also channels through time savings, which could reduce the burden on women and girls in rural areas that ultimately lead their productivity (Slaymaker et al. 2007).

Finally, we used access to road, which is proxy by the "road density in terms of km of road network per 100 sq. km of land area", and the data are taken from the WDI database. It defines road network as all roads in the country including motorways, highways, main or national roads, secondary or regional roads, and other urban and rural roads. Many scholars claimed that transport infrastructure has a higher impact than any other kind of infrastructure on economic growth, productivity, and even on poverty reduction (Sakamoto et al. 2010; Hook and Howe 2005; Ellis 1997). However, there are not many studies that analyze the contribution of transport to the MDGs achievement (Estache and Fay 2007; Hook and Howe 2005; Estache 2004), and there is no transport related issues within the MDGs framework.

We use four control variables that also potentially affect human development significantly. Firstly, consumer price index (2005=100) is taken as increasing price of daily consumption goods always hard hit to the low-income families that affect their health adversely (World Bank 2012). Secondly, we control for population growth (annual %) because there is a large body of literature on the linkages between population dynamics and development, and population growth is always considered as a negative factor of human development (Lee 2001; Egunjobi 1991).

There is also a vast body of literature on development impacts of globalization (for detail review of the literature see Sapkota 2011); hence we also control for the level of globalization

[5] The database can be accessed at: http://unstats.un.org/unsd/mdg/Data.aspx

of the countries. This study uses *Konjunkturforschungsstelle* (KOF) index of globalization, due to its comprehensiveness and data availability. Dreher (2006) introduced the KOF index of globalization. Following the explanations of Clark (2000), Norris (2000), and Keohane and Nye (2000:4), Dreher defined globalization comprehensively as follow:

> Globalization is meant to describe the process of creating networks of connections among actors at multi-continental distances, mediated through a variety of flows including people, information and ideas, capital and goods. Globalization is conceptualized as a process that erodes national boundaries, integrates national economies, cultures, technologies and governance and produces complex relations of mutual interdependence (Dreher 2006:1092).

Based on this comprehensive definition, Dreher systematically constructed the KOF index of globalization, which measures the economic, social and political dimension of globalization covering 24 variables over time. The data are updated annually, and it is available for 207 countries from 1970 to 2010 on an annual basis.[6]

Finally, a *democracy index* is used to control the effect of the level of freedom in the country on human development. Theoretical linkages of freedom and human development are well discussed in the literature after the Nobel Laureate Amartya Sen (1999) published his remarkable book "Freedom as Development", and democracy is considered one of the significant predictors of human development. For detail survey of the literature, see Gerring, Thacker, and Alfaro (2012). The data of a democracy index is taken from the Freedom House, which consists of two key rights.[7] Firstly, the political rights measure is a subjective indicator that annually ranks each country on a scale from one (the highest level of political rights) to seven (the lowest level of political rights). Secondly, the civil liberties measure is used to capture personal rights, such as free to express, organize or demonstrate; and is placed on the same scale from one to seven. These two measures of Freedom House are averaged as the overall democracy index.

All independent variables are taken as the last five years average unless specify otherwise.

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[6] The further details of the KOF index, its methodology and the data are available at: http://globalization.kof.ethz.ch/

[7] "Freedom House is an independent watchdog organization dedicated to the expansion of freedom around the world", and the data and the definition is available at: http://www.freedomhouse.org/

For example, data of year 2010 is the annual average of the data for 2006 to 2010. This let us use those variables that do not have data on a regular basis (in fact; most of the variables do not have data for the same year as well as the same interval). Average of the last five years also justifies the argument that the impact of infrastructure other independent variables on human development is less instantaneous and more gradual. The summary statistics and the correlation matrix of the variables are presented in Appendix 2 and Appendix 3.

3.2 Model specification

In order to assess the impacts of infrastructure on human development, we employ the dynamic panel data model implemented by Kusharjantoa and Kim (2011) with some improvement. As they used the regency level panel data of Java, Indonesia, Kusharjantoa and Kim simply regressed some infrastructure variables with the HDI and its component variables of the respective regencies within Java Island. However, we used HDI, and its component indexes to make the each regression consistent with each other. As the panel data is of cross-country, specification of each regression equation is desirable to change, and the data availability of the component variables are less consistent than the component indexes across countries. Furthermore, we need to control for some country-specific characteristics to minimize the biases that spur from country-specific characteristics. Therefore, we control for some country-specific characteristics introducing some control variables. We also control for the income group of countries through the income dummy. Thus, the regression model is specified as follows:

$$Y_{it} = \alpha + \beta_1 Y_{it-1} + \beta_2 INFRA_{it} + \beta_3 C_{it} + \eta_i + \eta_t + \varepsilon_{it}$$

Where; Y_{it} represents the dependent variables (i.e. HDI, EI, HI and II as explained in the Section 2.1) of country i at year t, Y_{it-1} is one-period lag of the dependent variable, $INFRA_{it}$ represents the infrastructure related variables, C_{it} represents the vector of control variables, η_i is the country fixed effect, η_t is the time-varying effect, and ε_{it} is an error term. Each variable and the respective hypothesis is explained in the previous Section 3.1. α is the constant term, and β_1,

β_2 and β_3 are the coefficients of each explanatory variable, which are the parameters of interest.

The lagged dependent variable is included in the set of explanatory variables because human development indicators tend to change slowly over time. This creates the dynamic structure of the model, which allows distinguishing between the short-run and long-run effects of the independent variables. The coefficient on the lagged dependent variable β1 represents the speed of adjustment. Static models assume that this parameter is equal to zero.[8] The long-run effects of the independent variable can be estimated by dividing the parameter of the independent variable by one minus the parameter of the lagged dependent variable (Greene 2008: 679).

Despite the above benefits, the dynamic structure of the model needs to control for possible biases arising from it (Kurita and Kurosaki, 2007). Because, given the inclusion of the lagged dependent variable and fixed country effects, the OLS estimator is biased and inconsistent in short panels (Nickell, 1981). Furthermore, if the infrastructure or other independent variables and the error term "ε_{it}" in the model are not independent, unobserved variables can affect both the outcome variable and independent variable, so the estimated coefficient β_2 and β_3 can be biased. Such problem of endogeneity can be partially solved by controlling fixed effects and time trend, but if some unobserved variable changes over time and across the countries, this problem will remain in the error term. To deal with this problem, a dynamic panel data method, particularly the system generalized method of moments (GMM) estimator, is used as suggested by Arellano and Bover (1995) and Blundell and Bond (1998). This method is not only appropriate for endogenous independent variables or correlated with past and possibly current realizations of the error term, but also with fixed individual effect (in our case, the country-specific effect) and heteroskedasticity and autocorrelation within individuals but not across them (Roodman 2009). Results are based on the two-step estimator implemented by Roodman (2005) with Windmeijer (2005) correction for finite-sample, which is explained in detail by Roodman (2009) in Stata.

[8] In a simple equation without lagged dependent variable, the independent variables capture the complete effects on dependent variable. However, when we include lagged dependent variable in the equation, its coefficient captured all the effects of the previous history, thus any impact of independent variable represents only the short-run effect. For further explanation, see Greene (2008: 469).

System GMM overcomes the problem of endogeneity by using a potentially large matrix of available instruments and weights them appropriately. However, the inclusion of extra instruments requires additional moment conditions; thus, the system GMM builds a system of two equations; the original equation as well as the transformed one. We assumed all the independent variables are endogenous[9] except the globalization index, and used as gmmstyle instruments in xtabond2 command in Stata as suggested by Roodman (2009). Similarly, globalization index and the dummies are used as ivstyle instruments. As the data structure is panels with gaps, we used orthogonal deviation to maximize the sample size. The Sargan/Hansen test supports the joint validity of the instruments.

We include dummy for fragile countries as per the "Harmonized List of Fragile Situations FY13," which is harmonized list of the World Bank, African Development Bank (AfDB) and the Asian Development Bank (ADB). According to the harmonized definition from the World Bank, AfDB and ADB, "Fragile Situations" are either: a) IDA-eligible countries with a harmonized average CPIA country rating of 3.2 or less (or no CPIA),[10] or b) the presence of a UN and/or regional peace-keeping or peace-building mission during the past three years."[11]

Dummies for time-periods are included to control time effect, and found jointly significant; however, it is excluded from the results table. Similarly, dummies for income groups of countries as specified by the World Bank are also included in the regression equations to observe the effects on different income groups of countries.

4. Results

First, we report the impacts of access to infrastructure on HDI and its component indexes in Table

[9] Which means, for example, better access to infrastructure can improve the level of human development and raised human development can in turn increase the infrastructure access.

[10] IDA is the International Development Association, the World Bank's fund for the poorest countries and CPIA is the Country Policy and Institutional Assessment, the World Bank's diagnostic tool (rating from 0 to 6) to assess the quality of a country's policies and institutions.

[11] For the list and detail definition of the fragile countries at: http://siteresources.worldbank.org/EXTLICUS/Resources/511777-1269623894864/FCSHarmonizedListFY13.pdf (retrieved: 26 February 2013).

1, which represents the short-run effects. Column 1 of the table shows the relationship between explanatory variables and HDI, and the columns 2, 3 and 4 show the relationships between explanatory variables and the component indexes of HDI, which includes, EI, HI and II. Then, we report the long-run effect of infrastructure and other independent variables in Table 2.

In Table 1, column 1 shows a positive and significant impacts of all infrastructure variables on HDI in developing countries. However, the levels of significance are varied at 1 percent for access to electricity, and 5 percent for access to water and road density. The result firmly reconfirms the general claim of JICA (2004, 2010) and other international organizations (e.g. World Bank 1994) as well as scholars (e.g. Kusharjantoa and Kim 2011), all argue that accesses to infrastructure facilities are among the key determinants of human development.

In fact, lack of access to infrastructure services, which is defined as "infrastructure poverty" in this study, hinder not only the living standards and economic growth but also limits the human development. It is obvious that the people and communities from the areas where the infrastructure poverty remains high find themselves lagging far behind the MDGs if we replicate these global goals at the local level. Indeed, prevalence of infrastructure poverty is extremely high in many parts of the world. For example, it is estimated that 780 million of the world's population still lack access to clean water (UNICEF and WHO 2012). Situation of access to electricity is more serious than the situation of access to water and road. For instance, the World Bank estimates that "nearly 75 percent of Sub-Saharan Africans, or 550 million people, do not have access to electricity. In South Asia, some 50 percent, or 700 million people, lack access. About 90 percent of those without access in South Asia lives in rural areas."[12] Such lack of access will continues if there are no new appropriate initiatives at global as well as local level, and such infrastructure poverty will significantly hinder the global and local development after 2015, as well (Scott and Seth 2012).

[12] http://go.worldbank.org/4UU59P0XM0 (retrieved: 6 March 2013)

Table 1: Human development impacts of infrastructure, 1990-2010

Dynamic panel-data estimation, two-step system GMM

	Dependent variables			
Independent variables	(1) Human Dev. Index (HDI)	(2) Education Index (EI)	(3) Health Index (HI)	(4) Income Index (II)
Lagged dependent variables	0.34912***	0.57478***	0.19633***	0.43883***
	(0.09351)	(0.09266)	(0.06848)	(0.12288)
Access to electricity (% of population)	0.03240***	0.03544**	0.05328***	0.00592
	(0.01181)	(0.01565)	(0.01853)	(0.01515)
Proportion of population using improved drinking water sources, total	0.11275**	0.13805***	0.10617*	0.05079
	(0.05353)	(0.04716)	(0.05939)	(0.04635)
Road density (km of road per 100 sq. km of land area)	0.05141**	0.04178	0.04260	0.13297***
	(0.02515)	(0.04398)	(0.05200)	(0.03628)
Consumer price index (2005 = 100)	-0.01500**	-0.00905	-0.02032*	-0.00654
	(0.00696)	(0.00915)	(0.01063)	(0.01186)
Population growth (annual %)	-0.00633	-0.00484	-0.01627*	-0.00686
	(0.00934)	(0.01291)	(0.00959)	(0.01765)
KOF index of overall globalization	0.10241**	0.01045	0.04040	0.20911***
	(0.04744)	(0.07020)	(0.04924)	(0.05919)
Democracy index	-0.01557	-0.04617	-0.02825	0.02541
	(0.02109)	(0.02467)	(0.03033)	(0.03485)
Dummy for fragile countries	-0.07019**	-0.08616**	-0.08324**	-0.10107**
	(0.03506)	(0.03458)	(0.03595)	(0.04270)
Dummy for low income countries (LIC)	-0.17442***	-0.20543***	-0.07751	-0.19201**
	(0.04562)	(0.06658)	(0.06029)	(0.08239)
Dummy for lower middle income countries (MIC)	-0.09049***	-0.06545***	-0.04590	-0.10996**
	(0.02972)	(0.02379)	(0.03157)	(0.04440)
Constant	-1.34578***	-0.62697	-1.04931***	-1.28960***
	(0.31975)	(0.41866)	(0.27421)	(0.36888)
Observations	237	237	237	237

Notes: Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1; Except HDI, EI, HI and II (which represents the annual data at 5 yrs. interval), all data are average of the last 5 years' annual data (e.g. data for 2010 represents the average annual data from 2006 to 2010. However, the data of 1995 represents the average of the annual data of 1990 to 1995). All variables are in natural logarithm.

Source: UNDP's HDR database for HDI, EI, HI, and II; Dreher (2006) for KOF globalization index; Freedom House for Democracy index; UN Stat's MDGs Indicators database, available at: http://unstats.un.org/unsd/mdg/Data.aspx, for access to improved water sources; and the World Bank's WDI online database, available at: http://databank.worldbank.org/Data/Databases.aspx, for the rest of the variables.

The results of the other dependent variables, EI, HI, and II in column 2, 3 and 4, respectively, are firmly consistent with the results of HDI. However, effects of access to electricity and access to clean water sources are more significant to increase education and health indexes, whereas the road density is highly significant to increase income index. It is intuitive that electricity and water are more sensitive towards education and health, and road is more sensitive towards income.

Regarding the control variables, the results are consistent with the existing literature. The results show the significant negative impacts of consumer price index on HDI and HI, and significant positive impacts of KOF index of globalization on HDI and II. Population growth rate is only significant at 10 percent to reduce health index. Democracy index is found insignificant to all human development indexes.

Interestingly, parameter of fragile countries dummy revealed that all the human development indexes of fragile countries are significantly lower than that of the non-fragile countries. The level of significance of such effects is 5 percent to all dependent variables. Thus, all aspects of human development and poverty reduction progress of fragile countries largely depends on the pace of resolving conflict and fragile situation the country.

To compare the level of human development across different income group of countries, we exclude the dummy for upper middle income countries (UMCs) from the regression equation, the parameters of the dummies for low-income countries (LICs) and lower middle-income countries (LMCs) compares the level of human development and its components of LICs and LMCs with UMC. The results revealed that the level human development is significantly lower in LMCs than UMCs, and LICs than UMCs. The results are natural.

As discussed above, dynamic panel data model can distinguishes between the short-run effect and long-run effect of independent variables. For example, if we can increase access to electricity by 1 percent in the country at time *t*, it will increase the HDI by 0.03 percent in the short-run because the magnitude of HDI can be estimated using the estimated parameter of access to the electricity variable. Similarly, if we increase access to water and road density by 1%, it leads to increasing the HDI by 0.11 percent and 0.05 percent, respectively.

At the same time, these parameters allow us to estimate the long-run effect, as well. According to Greene (2008: 679) inclusion of lagged dependent variable allows us to account the long-run effect, which is estimated by dividing the estimated parameters of independent variable by one minus the estimated parameter of the lagged dependent variable. In this case, the long-run effect of access to electricity on HDI can be obtained as 0.03 / (1-0.35) = 0.05. It means every one-percentage increase in access to electricity will increase the HDI by 0.05 percent in the long run, which is double than that of the short-run effect.

Table 2 shows the long-run effects of all the independent variables for each regression equation, and revealed that long-run effect of all the three types of infrastructure on human development and its component indexes are far greater than short-run effects. For example, the long-run effects of access to water and road density on HDI are 0.19 percent and 0.09 percent, whereas the short-run effects are 0.11 and 0.05 percent, respectively. Similarly, the long-run effects of access to electricity, access to clean water and road density on EI are 0.07, 0.27 and 0.08 percent, respectively. In fact, the results revealed that the parameters of lagged dependent variable in each regression are highly significant at 1 percent and positive, which means past events or information are more salient for progress on human development.

Table 2: The long-run impacts of infrastructure on human development, 1990-2010

	(1)	**(2)**	**(3)**	**(4)**
	Human Dev. Index (HDI)	Education Index (EI)	Health Index (HI)	Income Index (II)
Access to electricity (% of population)	0.05414	0.07057	0.06426	0.01012
Proportion of population using improved drinking water sources, total	0.18840	0.27487	0.12806	0.08680
Road density (km of road per 100 sq. km of land area)	0.08591	0.08319	0.05138	0.22723
Consumer price index (2005 = 100)	-0.02506	-0.01802	-0.02451	-0.01118
Population growth (annual %)	-0.01058	-0.00964	-0.01962	-0.01172
KOF index of overall globalization	0.17113	0.02081	0.04873	0.35735
Democracy index	-0.02602	-0.09193	-0.03407	0.04342
Dummy for fragile countries	-0.11729	-0.17155	-0.10040	-0.17272

Note: The numbers indicate the percentage change in dependent variable corresponding to 1% change in each independent variable.
Source: The author's calculation.

These results verify the key roles of infrastructure on human development of developing countries. However, how to provide access to infrastructure in the neediest areas is an immediate challenge, which needs to be addressed in the post-2015 development strategies. Although this study is not intended to answer this crucial question with empirical framework, the next section discusses some practical ways based on the existing literature and ongoing discussion on post-2015 development agenda.

5. Infrastructure poverty and post-2015 development strategies

Although empirical analysis in the previous section takes access to electricity, water and road as main infrastructure variables, this section considers infrastructure in a broader term. Based on the empirical evidence of this study, existing literature and current discussion on post-2015 development agenda, we focus on access aspect of infrastructure services, because we believe that without elimination of all types of infrastructure poverty (i.e. lack of access), it is almost impossible to eliminate human poverty sustainably. Indeed, access is a basic condition to start realizing the benefits, and then other aspects, such as affordability and quality, can be enhanced to increase the benefits from any infrastructure.

However, access to infrastructure is almost neglected in the current MDGs framework. Only water and sanitation infrastructure are included under the environmental goal 7 of the current MDGs. This inclusion is more due to the human right ground together with some other reasons (Scanlon, Cassar and Nemes 2004) rather than acknowledging its infrastructural roles on human development.[13] Despite such neglect in the current MDGs, some infrastructure services receive due attention in the ongoing discussion on post-2015 development agendas. In this section, we first highlight the proposals made so far for the infrastructure related post-2015 development goals, and then, it discusses the ways of incorporating infrastructure in the new international development framework.

[13] Several international human right conventions recognized water as human right. For details see: Scanlon, Cassar and Noemi (2004). Available at: http://data.iucn.org/dbtw-wpd/edocs/EPLP-051.pdf

5.1 Infrastructure related proposals so far for post-2015 development framework

Most of the proposals so far mainly come from the UN specialized agencies and some other international organizations. In the current form, these proposals are scattered and not organized. Even the report of the Report of the UN High-Level Panel of Eminent Persons on the Post-2015 Development Agenda failed to propose a consolidated and comprehensive proposal.[14] Some of the proposals are broad, which suggests guidelines and principles; however, some are very specific, which even suggest quantitative targets. Most proposals focused on energy and water, mainly because energy and water are included in the thematic consolations on post-2015 development agenda of the United Nations.[15] Still transportation, especially rural roads and communications have received quite significant attention. Brief discussions on the proposals made so far are presented below.

The Sustainable Energy for All (SE4All) initiative of the UN Secretary General proposes to gain universal access to modern energy services by 2030.[16] It is argued that universal energy access to be instrumental to rapid human development and poverty reduction. SE4All initiative also proposes to double the energy efficiency and the share of renewable energy by 2030, which would be supporting environmental sustainability.

The Joint Monitoring Program (JMP) for post-2015 of the World Health Organization (WHO) and the United Nations Children's Fund (UNICEF) proposes different water and sanitation goals and targets for different income groups with different dates for the different targets.[17] For instance, they also propose the universal access to safe and sustainable drinking

[14] This high level panel consist of 27 distinguished world leaders and scholars including Naoto Kan from Japan, which is co-chaired by President Susilo Bambang Yudhoyono of Indonesia, President Ellen Johnson Sirleaf of Liberia, and Prime Minister David Cameron of the United Kingdom.

[15] To design new global development policy after 2015, UN has already started the national and thematic consultations, and intensive dialogs and discussions are ongoing among donors, policymakers, civil society groups, and scholars as well. Among the 11 themes for thematic consultations of post-2015 UN Development Agenda, energy and water are selected as infrastructure components. The other themes are inequality, governance, growth and employment, health, education, environmental, sustainability, food security and nutrition, conflict and fragility, and population dynamics.

[16] http://www.sustainableenergyforall.org/images/content/FINAL%20ESG%20ALL.pdf

[17] http://www.wssinfo.org/fileadmin/user_upload/resources/A-proposal-for-consolidated-WASH-goal-targets-definitions-and-indicators_version7_Nov22_final.pdf

water by 2030. However, they proposed halving the population without access to safe and sustainable drinking water at home even in least developed countries (including disadvantaged group). In case of sanitation goals, JMP proposed that the poorest fifth of the population within a country uses an adequate sanitation facility by 2030. They also target the excreta of 50% of households is fully Managed (safely stored transported and adequately treated before use) by 2030. They also propose target to provide equitable access to basic water, sanitation and hygiene services in their schools and health facilities for everyone by 2030.

International Telecommunications Union (ITU) is reviewing the information communication technology (ICT) progress; however, they are not contributing to develop post-2015 framework for ICT development yet. However, the Centre for International Governance Innovation (CIGI) together with the Korea Development Institute (KDI) has highlighted the importance of connectivity, covering energy, transportation and communication. In their special report, candidate goal 8 specifies as "Quality Infrastructure for Access to Energy, Transportation and Communication" arguing that the unequal distribution of different types of connectivity is another form of inequality (Bates-eamer et. al. 2012: 22). The report also highlights the importance and necessity of universal access and affordable price to electricity, clean water, sanitation facilities, transportation and ICT and set overall goals, such as "good infrastructure for universal access." With a number of indicators for each category, the report set three targets; affordable and reliable energy system, accessible and safe transport network, and innovation-driven, secure and ubiquitous ICT system. However, the report just suggests the variables as indicators without specifying any exact measurable number to achieve by a certain time point.

Proposals and suggestions emerged from the UN System Task Team on the Post-2015 UN Development Agenda, and the report of the High-level Panel of Eminent Persons, established by the UN Secretary General, are the most significant for post-2015 development framework. It is not because their proposals are better than others; rather they are leading the process of formulating the post-2015 development strategies and UN bears the key responsibility in this process. With the renewed interest in infrastructure in international development policy,

energy and water infrastructures are selected among the 11 themes of the thematic consultations of post-2015 UN Development Agenda.[18] However, infrastructure could not become a standalone theme in the ongoing thematic consultations on post-2015 development agenda, in which transportation and communication infrastructure are missed even as separate themes. Therefore, it is unlikely to acknowledge the importance of infrastructure access for human poverty reduction in the new global development framework.

However, under the theme of "inequality", access to roads, land and energy are discussed widely as the necessary conditions to bring the people at the bottom layer to the mainstream society (United Nations 2013). Nayyar (2013) claims that a substantial investment from the public sector in infrastructure, particularly in rural areas, is essential to prevent or minimize the exclusion of poor people from development. The report of the High-level Panel of Eminent Persons on the Post-2015 Development Agenda clearly emphasized infrastructure under one of the "Five Transformative Shifts" that they have recommended for the new global development strategies. The first transformative shift is "Leave No One Behind", in which the report claims that:

> The new agenda must tackle the causes of poverty, exclusion and inequality. It must connect people in rural and urban areas to the modern economy through quality infrastructure – electricity, irrigation, roads, ports, and telecommunications (United Nations 2013: 7).

It clearly indicates that the high-level panel theoretically admit the key roles of infrastructure for reducing poverty and inequality, and avoiding exclusion. Despite such theoretical focus, the report, however, failed to recommend comprehensive and unified policy of providing infrastructure access to the poor and rural area. Rather they recommend infrastructure development with scattered manner under different goals. For example, the report proposes to provide "universal access to water and sanitation" and "secure sustainable energy" as goal number 6 and 7, respectively.[19] Similarly, one of the recommendations is to provide access to irrigation for smallholder to achieve its proposed goal number 5, ensure food security and good nutrition.

[18] http://www.worldwewant2015.org/sitemap

[19] The report of the High-level Panel of Eminent Persons on the Post-2015 Development Agenda recommended 12 goals and many strategies to achieve each goal. The report can be accessed at: http://www.post2015hlp.org/wp-content/uploads/2013/05/UN-Report.pdf (retrieved: 31 August 2013)

Furthermore, "providing universal access to infrastructure such as transportation and ICT" is recommended under the goal number 8, create jobs, sustainable livelihoods, and equitable growth. These recommendations are far ahead of the current MDGs framework in terms of incorporating infrastructure elements; however, it failed to provide a promising framework for reducing infrastructure poverty, which serves as one of the preconditions for poverty reduction and inclusive development. Thus, as Vandemoortele (2012: 10) cautioned, "the danger, then, is that a post-2015 framework will become another wish list–unfocused, unending and unattractive."

5.2 What are missing and how to get it?

First of all, the UN lead ongoing discussion on post-2015 development agenda failed to conceptualized infrastructure as a key input for human development and poverty reduction. Although they include energy and water among the 11 themes for national and global consultation on post-2015 development agenda, it cannot generate coordinated and consolidated policy for infrastructure development. However, we argue that only such comprehensive policy can effectively guide policymakers to develop inclusive, affordable and sustainable infrastructure services essential for poverty reduction. Thus, undermining close linkages among different kinds of infrastructures ultimately leaded to missing the transport and communication from the post-2015 discussion. Separating parts from the whole will create ineffective policies and inefficient investments across different infrastructure sectors, which prevents creating synergies in policy implementation. In fact, this is a crucial issue regarding infrastructure indicators in current MDGs, which put water and sanitation as two of the indicators of environment related goals and ICT as a global partnership goal. Due to such isolation, policies towards achieving these goals are not streamlined properly towards poverty reduction and other aspects of human development.

Thus, we urge to accept the fact that different infrastructure shares some commonalities and they are complements each other in many ways. For example, a hydropower project may be possible or facilitate by an access road to the power station. When there is a road, it helps to build irrigation canals and water supply and sanitation facilities. Availability of electricity through

hydropower generation provides power supply for ICT products. Thus, setting a goal and formulating strategies to achieve the goal for energy, transport, water and communication sectors independently lead terrific inefficiency. Therefore, we argue that only integrated goals and targets with interlinked strategies and policies, which should be based on a comprehensive assessment of the whole infrastructure sector (not the isolation of its sub-sectors), can achieve synergies in its implementation that ultimately contribute environmental sustainability (Bourguignon and Pleskovic 2007), community resilience, and inclusive development (Hosono 2012).

It would be immensely useful to recommend specific goals and targets with measurable indicators to contribute on the ongoing post-2015 development discussion, however, such detail analysis is not the purpose of this paper. Nonetheless, several broad suggestions are made based on the reviewed literature, empirical finding of this study and review of ongoing discussion on post-2015 development agenda.

First, we argue that the rural infrastructure should receive priority because poverty reduction and then elimination would be a priority of development at least for a couple of decades. The geographical focus is essential while building an infrastructure to reduce rural-urban inequality, as well. However, already developed areas attract infrastructure projects in the ground of higher economic rate of return of the project. However, there is always a tendency of either ignoring or poorly accounting of the social rate of return, which leads mistakes to show a lower rate of return of infrastructure projects in less developed area. This is widely accepted economic principle that the social marginal value of a dollar to poorer individual, household or community is greater than it is to a richer individual or household (Stiglitz 2000, p293). Hence, government should clearly be concerned about the impact of its projects or programs on the distribution of income across individuals, households and geographical regions. However, there are rare practices on the consideration of the distributional impact of any policy, program and project, although scholars suggest several tools to account this impact (Little and Mirless 1969, Weisbrod 1968, et al.). Even the World Bank, IMF and other international organization do not consider this aspect on their policy, programs and project evaluation (Yitzhaki 2003). Thus, Post-2015 development policy

should develop such a framework that can guide accounting social return of any development projects accurately, which ultimately encourage streamlining the resources toward the most needed areas and community.

Secondly, post-2015 development policy should emphasize “inclusive infrastructure” which means the benefits from future infrastructure should go to the bottom layer of society most. It is crucial because many scholars argue that the most of the benefits from infrastructure usually goes to the wealthier or capable groups of the community. They argue that poor and weak people benefits far less than richer people. Thus, the new development framework should properly guide how to develop “inclusive infrastructure." Idea of inclusion should follow from the design to construction, and use to maintenance or development phase.

Thirdly, we recommend setting a global target in terms of access to basic infrastructure services, which make sure that no country fall from this global standard. Of course, each country can set their own national targets for each development goals, which will be the case for many countries, which are already in the upper bound of the global average. Setting such global targets, however, helps to streamline the global efforts and resources towards the needy countries and areas, such as fragile countries, least developed countries and backwards regions or rural areas within a country.

Finally, we suggest defining the role of both developed and developing countries to achieve each of these global goals and targets. As infrastructure development much more depends on financial as well as technical resources, global partnerships are much more crucial to eliminate infrastructure poverty. There is a firm consensus among donors, policymakers and scholars that it is almost impossible to overcome the global development challenge as well as to take the benefits from the global development prospects without the genuine efforts from both the developed and developing countries alike.

6. Conclusion

Human poverty is mainly driven by lack of access to infrastructure. However, there is limited empirical literature on the impacts of infrastructure on human development, even though extensive policy discussion is ongoing. This study aimed to reduce this gap empirically assessing the impacts of infrastructure variables on human development index (HDI) and its components. The study used system GMM as the main method to estimate the impacts. The results show that, as expected, all the three infrastructure variables have significant positive impacts on HDI. In the case to HDI component indexes as dependent variables, access to electricity and access to water have positive and significant effect on education and health indexes only. On the other hand, road density is highly significant to increase the income index. These results clearly indicate the key importance of water and energy access to health and education, and transport infrastructure on income aspect of human development.

However, current MDGs framework does not include the infrastructure except the access to clean water and sanitation facility. Similarly, current UN lead discussion on post-2015 development agenda and recently published "The Report of the High-level Panel of Eminent Persons on the Post-2015 Development Agenda" failed to address the infrastructure poverty comprehensively, although access to modern energy and clean water received clear attention. It is a good signal that the report of the High-level panel accepted the key roles of infrastructure on poverty and inequality reduction as well as inclusive development theoretically. This creates demands genuinely for a comprehensive framework to eliminate infrastructure poverty, which can essentially ensure meeting other goals of reducing human poverty and inequality and accelerating inclusive development effectively.

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[Appendices follow]

Appendix 1. List of the countries included in the data analysis

1	Albania	32	Guinea	63	Pakistan
2	Argentina	33	Guinea-Bissau	64	Panama
3	Armenia	34	Guyana	65	Paraguay
4	Azerbaijan	35	Honduras	66	Peru
5	Bangladesh	36	India	67	Philippines
6	Belarus	37	Indonesia	68	Romania
7	Belize	38	Iran, Islamic Rep.	69	Russian Federation
8	Bhutan	39	Jamaica	70	Rwanda
9	Bolivia	40	Jordan	71	Senegal
10	Brazil	41	Kazakhstan	72	Serbia
11	Bulgaria	42	Kenya	73	Seychelles
12	Burkina Faso	43	Kyrgyz Republic	74	Sierra Leone
13	Burundi	44	Lao PDR	75	South Africa
14	Cambodia	45	Latvia	76	Sri Lanka
15	Cameroon	46	Lesotho	77	Sudan
16	Central African Republic	47	Lithuania	78	Swaziland
17	Chile	48	Macedonia, FYR	79	Syrian Arab Republic
18	China	49	Madagascar	80	Tajikistan
19	Colombia	50	Malawi	81	Tanzania
20	Costa Rica	51	Malaysia	82	Thailand
21	Cote d'Ivoire	52	Mali	83	Tunisia
22	Dominican Republic	53	Mauritania	84	Turkey
23	Ecuador	54	Mexico	85	Uganda
24	Egypt, Arab Rep.	55	Moldova	86	Ukraine
25	El Salvador	56	Morocco	87	Uruguay
26	Ethiopia	57	Mozambique	88	Venezuela, RB
27	Fiji	58	Namibia	89	Vietnam
28	Gambia, The	59	Nepal	90	Yemen, Rep.
29	Georgia	60	Nicaragua	91	Zambia
30	Ghana	61	Niger		
31	Guatemala	62	Nigeria		

Appendix 2. Summary Statistics

Variables	Obs.	Mean	Std. Dev.	Min	Max
Human Development Index (HDI)	364	0.555	0.152	0.206	0.805
Education Index (EI)	364	0.523	0.190	0.092	0.883
Health Index (HI)	364	0.694	0.157	0.165	0.934
Income Index (II)	364	0.482	0.137	0.171	0.738
Access to electricity (% of population)	364	61.282	36.920	1.5	100
Proportion of population using improved drinking water sources, total	364	78.108	18.415	16.7	100
Road density (km of road per 100 sq. km of land area)	364	30.321	35.724	0.5	201
Consumer price index (2005 = 100)	364	77.821	37.940	0.004	172.664
Population growth (annual %)	364	1.610	1.183	-1.575	5.294
KOF index of overall globalization	364	46.558	12.453	14.983	77.438
Democracy index	361	3.987	1.331	1	7

Appendix 3. Correlation Matrix

Variables	HDI	ele	water	road	CPI	pop	gobl	demo
Human Development Index (HDI)	1							
Access to electricity (% of population) [ele]	0.90	1						
Proportion of population using improved drinking water sources, total [water]	0.81	0.78	1					
Road density (km of road per 100 sq. km of land area) [road]	0.28	0.24	0.30	1				
Consumer price index (2005 = 100) [CPI]	0.20	0.15	0.16	0.07	1			
Population growth (annual %) [pop]	-0.03	-0.04	0.02	-0.07	-0.04	1		
KOF index of overall globalization [gobl]	0.71	0.62	0.62	0.14	0.42	-0.17	1	
Democracy index [demo]	-0.45	-0.29	-0.36	-0.23	-0.20	-0.09	-0.57	1