NATIONAL ICT, ECONOMIC FREEDOM AND HUMAN DEVELOPMENT: A CROSS-COUNTRY DYNAMIC PANEL DATA ANALYSIS

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ABSTRACT

Human Development Level (HDL) is considered to be one of the most important factors in determining the dignity of citizens and attractiveness of a country. Nations, which are aware of the importance of Information and Communication Technologies (ICT) make policies to encourage investments both in public and private sectors, and to advance the adaptation of the population. Likewise, economic freedom level (EFL) is a factor displaying the attractiveness of a country in the eyes of global capital. Our objective in this study is to investigate the effects of ICT and EFL on nations' HDL, based on panel data of 118 countries covering the period of 2000-2011. We employ dynamic panel data analysis and find that ICT, EFL significantly increase HDL in positive direction. Based on our findings, HDL is a very significant aspect for any nation, and so it is recommended that governments who chase after increasing HDL should allocate more resources to progress ICT diffusion and establish more economically free environment.

Keywords: Human Development; Information and Communication Technologies; Economic Freedom; Information Asymmetry Theory; Neoliberal Economic Theory; Public Policy; Dynamic Panel Data Analysis.

INTRODUCTION:

Development levels of countries have gained gradual attention both from the scholars and public policy makers lately from almost all over the world. Ranking countries in terms of development levels provides insight on living standards and perceived prestige among the other nations. The concept of Human Development Level (HDL) is a composite phenomenon covering public health, wealth accumulation, safe environment, education and schooling that provides knowledge and a mix of rights and freedoms that are essential for human dignity (Alleyne, 2000). HDL is thought to be both an output and a process of widening a variety of individuals' choices to lead satisfactory lives. Though economic growth is somehow considered as an important source for human development and many people see Gross Domestic Product (GDP) as an easy way to measure and compare quality of life; human wellbeing, freedom, happiness, awareness and opportunity to live in a just and equitable environment cannot be reduced plainly to the scale and/or growth rate of GDP (Sen, 2013).

According to information asymmetry theory, information is regarded as the negative entropy against ignorance which represents entropy in social or industrial systems (Akerlof, 1970). Information and Communication Technologies (ICT) penetration and information culture has created new forms of discrimination between those who can be inhabitants of the infosphere and those who cannot, between insiders and outsiders, between information rich and information poor, entropic or non-entropic. Humanity in coverage area of infosphere generally has been progressed since information and knowledge has spilled into remote places in society (Floridi & Sanders, 2001). ICT capability is considered as a very significant phenomenon in terms of constructing a new and livable environment for future generations (Floridi & Sanders, 2005). Multiple studies confirm ICT has contributed significantly to growth on developed economies (e.g. Kraemer & Dedrick, 200 Colecchia and Schreyer, 2002). On the other hand, presence of this relationship in developing economies is of the concern especially if it is not supported with healthcare and education dimensions (Sunden & Wicander, 2002; Ngwenyama et al, 2006).

Neoliberal economic theory posits the concept of economic freedom as an important determinant of growth and probably key enabler for agents in an economy to accumulate wealth and develop higher living standards (Chauffour, 2009; Boas & Gans-Morse, 2009). In countries with greater Economic Freedom Level (EFL), human capital is considered relatively and significantly more valuable than others with lower EFL (Schultz, 1975). Although there are plenty of works which report positive relation between EFL and economic growth in developed countries (Scully and Slottje, 1991), ongoing debate still exists on the sensitivity of economic growth to EFL especially in developing and underdeveloped countries (De Haan & Sturm, 2000; Turen, Gokmen & Dilek, 2012). We cannot find any research directly scrutinizing longitudional causality relationship between EFL and HDL of countries in the literature.

Despite the importance of ICT and EFL to HDL, the literature has no research designed to quantify the magnitude of their combined impact based on global data. This research is therefore a first attempt to fill this gap by exploring the longitudinal impacts ICT and EFL on HDL using global panel data.

LITERATURE REVIEW:

Human Development Level:

Human development and sustainable development concepts namely have emerged and transformed the general approach to economic development in recent decades. The human development paradigm is a concept which is human centric and based on human well-being and emphasizes on how development can widen and straighten the social, economic and political choices of people by broadening freedoms, capabilities and opportunities (Kusharjanto & Kim, 2011).

Human Development Index (HDI) as proxy scale for HDL was first developed in 1990 by Pakistani economist Mahbub-ul-Haq and India-born American Nobel laureate Amartya Sen on behalf of the United Nations Development Program (UNDP). It is used to ascertain whether the country is a developed, a developing or an underdeveloped economy. It is a measure for comprehending and assessing the effect of the social and economic policies of a country on the life quality of its people. HDI has three dimensions namely longevity, knowledge and education and standard of living. Based on HDI scores, the countries of the world are basically divided into very high, high, medium and low human development groups.

ICT and Human Development Level:

Many scholars confirm that ICT capabilities are the initiator of economic growth. For almost all economic sectors, ICT capabilities have significant role to increase productivity and improve quality of services. For

example, Singapore is highlighted as an impressive example for newly industrialized countries which placed ICT capability at the core of their economic development strategies. Not only for the developed countries, but also for the developing or emerging economies, ICT is often seen as an enabler and catalyst for a successful shift in emphasis away from lower value added sectors to higher value added sectors. (Jorgenson, Ho & Stiroh, 2004; Timmer, Ypma & van Ark, 2003). When evaluated from the social perspective, it is asserted by Cecchini and Scott (2003) that the use of ICT applications can enhance poor people's access opportunities to markets, health, and education.

In the context of developing economies, ICT is considered as a communication and collaboration enabling tool that may counterbalance the dearth of other resources (Roztocki & Weistroffer, 2008). Qureshi (2005) proposed a model exploring the role of ICT in national development processes. Her model suggested ICT implementations contribute to development by way of providing "better access to information and expertise", "increased competitiveness and access to new markets including global markets", "administrative efficiencies from low transaction costs", "increase in labor productivity through learning" and "direct reduction in poverty". For the last three decades, impulsive role of ICT in several domains and scopes related with HDL in terms of economic growth and productivity in a number of developed, developing and transitional economies was emphasized on an immense volume of literature (Jorgenson & Vu, 2005). See Jorgenson, Ho, and Stiroh (2004) for macro- level; Sapprasert (2006) for industry level; OECD (2003, 2004) and Pilat (2004) for micro level. For positive impact of ICT in health care industry, see e.g. Kshetri (2013), Mahmud, Olander, Eriksén and Haglund (2013), Lluch and Abadie (2013). For ICT's role in struggle with poverty see e.g. Weber, Kulkarni and Riggins (2012), Diga, Nwaiwu, and Plantinga (2013). For ICT's contribution to education domain, see e.g. Vinluan (2011) and Al-Khasawneh, Khasawneh, Bsoul, Idwan and Turan (2013).

In line with the information asymmetry theory, new services, robotics, computer-aided design and new management techniques made possible by ICT are contributing to changes in the competitiveness of firms and nations. The implications of these technologies for the social and entertainment sectors and for governance are equally great. In an effort to clarify the key issues, United Nations Commission on Science and Technology for Development (UNCSTD) investigated the implications of ICTs for social and economic development. They concluded that, although the costs of building new information infrastructures are high, the costs of not doing so are likely to be much higher (Mansell, 1999). Consequently it is possible to assert that there is a consensus regarding that the transition to the 21st Century will witness a quantum leap in development and exploitation of ICTs, with corresponding ramifications for social and economic organization, the environment, culture and the development of a global information infrastructure (Mansell and Wehn 1998). In the light of above mentioned research and theoretical framework, we propose the hypothesis below.

H_1: *Increase in ICT capability increases HDL in a country*

Economic Freedom and Human Development Level:

Neo-liberal economic theory is a political philosophy which aims to "liberate" the processes of capital accumulation through advocating supported extensive economic liberalization policies such as privatization, fiscal austerity, deregulation, free trade and reductions in government spending in order to enhance the role of the private sector in the economy, briefly at the places where Economic Freedom (EF) at its heart (Luxton & Braedley, 2010: 3). Basically, EF means the absence of government intervention, constraint on the production, distribution or consumption of goods and services. In an economically free country, protection of private property and the provision of infrastructure are expected in exchange for fundamental functions of government (Keseljević, 2007; King, Montenegro, & Orazem, 2010). In such a country, government generally does not contribute in economic arena but creates an enabling environment and legal enforcement of possible private party breaches for a free economy to function perfectly. Gwartney, Lawson, and Hall (2009) defined economic freedom as phenomenon including policies and institutions promoting personal choice, voluntary exchange, freedom to compete, and security of privately owned property.

When the literature is investigated, many studies are encountered, dealing with EF and its impacts on other variables. Vega-Gordillo and Alvarez-Arce (2003) claim that economically free countries are more politically free and had higher levels of civil liberties than countries with less EFL. Some studies stated the positive and significant impact of EFL on economic growth or GDP per capita (e.g. Berggren, 2003; Prochniak, 2011). Kasper (2002) claim that free economic system generates relatively faster economic growth than centrally planned and controlled economic system which cause stagnation or decline in the long run. He emphasized the importance of open economy, competition, private property rights, non-discriminatory ground rules and citizen friendly institutions on entrepreneurship and economic growth. He also stated the enhancing role of

communication revolution in the process.

Esposto and Zaleski (1999) denotes that EFL improves the quality of life, in terms of literacy and life expectancy via two different analyses. First is based on a cross-sectional cross-national data; second consumes longitudinal one country data. Norton (1998a) reports that countries with stronger protection of private property have higher ranks on the United Nations Human Development Index. Goldsmith (1997) claims that developing countries, which protect economic rights better, have higher level of human well-being. Norton (1998b) reports that strong protection of private property rights have beneficial environmental consequences. Carlsson and Lundström (2001) concludes that EFL causes diminish in carbon dioxide emissions. Hoskisson, Eden, Lau and Wright (2000) states that EFL is considered as the main catalyst for economic growth in positive direction. Bengoa and Sanchez-Robles (2003) claim that countries with higher levels of EF have greater factor efficiency and higher rates of growth. Scully (2002) reports that EFL promotes both economic growth and equity, and that there is a positive but relatively small trade-off between growth and income inequality. Studies in the literature support the positive effect of free market system or economic freedom concept on the quality of human capital, and living standards and well-being of population. Thus, we postulate the hypothesis below.

H_2: *Progress in EFL increases HDL in a country*

DATA COLLECTION AND METHOD:

In this research, due to the lack of data about all countries, we see that the intersection set of three data sets has 118 countries' variables for the period of 2000–2011 and decide to use this complete three dimensioned intersection set in our further analyses.

Variables and Data:

In order to conduct a metric to measure nations' EFLs, we exploit Index of Economic Freedom (IEF) data collected from the formal website of the Heritage Foundation which evaluates economic freedom level of countries around the world together with the Wall Street Journal. Heritage Foundation and the Wall Street Journal has developed and published the Index of Economic Freedom (IEF) as proxy scale for EFL of countries since 1995 (Riley & Miler, 2012). The aim of IEF is to reveal the economic and entrepreneurial environment of countries in a balanced way in terms of freedom. IEF has 10 components of economic freedom that are equally weighted in order to make its overall score unbiased toward any one component or preferred policy direction. IEF basically focuses on ten aspects under four main dimensions of the economic environment which are prone to some policy control exercises of governments. These dimensions are namely Regulatory Efficiency (Business, Labor, and Monetary Freedom), Rule of Law (Freedom from Corruption, Property Rights), Government Size (Expenditures of Government, Fiscal Freedom), and Market Openness (Investment, Trade, and Financial Freedom) (Miller & Kim, 2014: 86).

We collected ICT connectivity data from ITU formal website as a proxy data for ICT capability. Practically, ICT domain includes radio, television, telephone, fax, computer and internet. Although newspaper and other print media do not fall under that definition, they are strongly influenced by electronic means (online news). International Telecommunication Union (ITU), established in 1947, is a specialized agency of the United Nations striving to improve international technical standards and efforts for enhancing access to ICTs. ITU has developed and published a composite index for measuring the ICT diffusion in countries since 2008. Due to the lack of ICT index data representing the period between the years 2000-2011, we cannot employ ICT index data. In order to set a proxy for ICT capability variable, we sought data and found that ITU has prepared and published some data concerning basically ICT connectivity of countries. As a result, we decided to exploit the mean of five core statistics [fixed (wired)-broadband subscriptions per 100 inhabitants, fixed-telephone subscriptions per 100 inhabitants, fixed (wired) Internet subscriptions per 100 inhabitants, percentage of individuals using the Internet and mobile-cellular telephone subscriptions per 100 inhabitants] as an indicator for national ICT capability.

For measuring HDL, we utilize Human Development Index (HDI) and gather them from official web site of United Nations Development Programme. HDI has three dimensions namely, longevity (life expectancy at birth, and index of population health and longevity), knowledge and education (average years of schooling and expected years of schooling) and standard of living (natural logarithm of Gross Domestic Product (GDP) per capita at Purchasing Power Parity (PPP) in US $). Based on HDI scores, the countries of the world are basically divided into very high, high, medium and low human development groups. For details, see Klugman, Rodríguez and Choi (2011). The details on variables in the model are shown in Table 1.

Table 1: Definitions and Sources of Variables

Variables	Proxy	Definitions	Sources	Official Web Site
HDL	HDI	Human Development Index	United Nations Development Programme	http://hdr.undp.org/en/reports/
ICT	ICT Connectivity	Information and Communication Technologies Index	International Telecommunication Union	http://www.itu.int/ITU-D/ict/statistics/
EFL	IEF	Index of Economic Freedom	The Heritage Foundation and The Wall Street Journal	http://www.heritage.org/index/explore?view=by-region-country-year

Econometric Model:

To assess the impacts of ICT and EFL on HDL, we employed the dynamic panel data model. By applying dynamic panel data model, the dynamic behaviors can be indicated by using lagged dependent variable(s) as regressors in the regression models presented in Equation 1 (Harris, Matyas & Sevestre, 2008, p.249). The underlying reasons of conducting dynamic panel data model are explained below:

a. The lagged dependent variable is included in the set of explanatory variables because human development indicators tend to change slowly over time and history dependent (Costa & Steckel, 1997: 73; Wawro, 2002; Kusharjanto & Kim, 2011; Sapkota, 2014).

b. The possibility of bi-directorial causality between dependent (HDL) and independent variables (Lagged HDL, ICT and EFL) may induce that regressors may be correlated with the error term refer to the existence of the endogeneity problem. The dynamic panel data model applied during the analysis is a useful model to deal with this problem.

After the information above and explanations under the 3rd and 4th headings, we see that HDL covers most of above mentioned variables associated with ICT and EFL capabilities of a country. So the following hypotheses were developed for the analysis:

H_1: *Increase in ICT capability increases HDL in a country.*

H_2: *Progress in EFL increases HDL in a country.*

Several statistical problems may be detected through dynamic panel data model. Applying dynamic panel data methods such as pooled OLS (Ordinary Least Square) regression the parameters in the model may induce to reveal biased and inconsistent estimates, due to the correlation between the error terms and the lagged dependent variables (Harris, Matyas & Sevestre, 2008, p.249, Baltagi, 2011, p.321, Lio, Liu & Ou, 2011). Ordinary Least Squares (OLS) is the most well-known method for estimating the unknown parameters in a linear regression model. This method is based on minimizing the sum of squared vertical distances between the observed values in the dataset and the values predicted from the linear equation. Pooled OLS is also a classic regression method, in which all observations are pooled in regression as expressed in below:

$$Y_{it} = \beta_0 + \beta_1 X_{1it} + \beta_k X_{kit} + \varepsilon_{it}; \qquad where\ i = 1,...,N;\ t = 1,...,T$$

In this model, all coefficients (including the intercepts) are supposed to be the same for all individuals. The most important assumption for the pooled OLS is the orthogonality between the error term and regressors. Due to not satisfying this assumption, the pooled OLS estimations are biased and inconsistent (Hayashi, 2000, p.186). Similarly, in both the fixed and random effects settings, one can encounter that the lagged dependent variable is correlated with the disturbance, even so it is supposed that u_{it} is not itself autocorrelated (Greene, 2003, p.307). Consequently, the statistical problems of the model can be categorized as below (Baltagi 2011, p.324; Roodman (2006); Lio et al., 2011):

a. The process may be dynamic, because the dependent variable is influenced by past ones.
b. The explanatory variables are supposed to be endogenous.
c. Time-invariant country characteristics (fixed effects) may be correlated with the explanatory variables
d. The lagged dependent variable (HDL_{t-1}), as a regressor, increases autocorrelation.
e. The panel has a short time dimension (T) and a large country dimension (N).

Therefore, alternative methods must be conducted to solve the above stated statistical problems. The most widely accepted approach is that of Generalized Method of Moments (GMM) based on a properly defined set of instrumental variables (Harris, Matyas & Sevestre, 2008, p.249). GMM estimation was developed by Hansen (1982) and unlike maximum likelihood estimation (MLE), GMM provide unbiased and consistent estimation for econometric models without satisfying such as specifying a particular distribution for the errors. Additionally, GMM estimation gains an evident way to test the specification of the suggested model. Consequently, we conduct a GMM estimator suggested by Arellano and Bond (1991) and Arellano and Bover (1995) for our dynamic panel model.

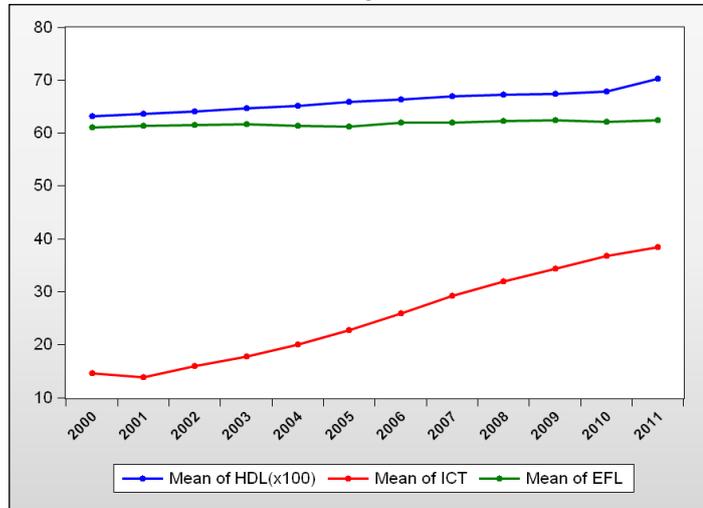The time based behavior of the variables is illustrated in Figure 1.

Figure 1: The graph of Variables

Table 2: Correlation Matrix of Variables

	HDL	ICT	EFL
HDL	1		
ICT	0.8559	1	
EFL	0.6421	0.5592	1

Since the variables in the model have different measurement units (e.g., EFL (0-100 point), ICT (0-100 point), HDL (0.000-1.000 point)), we suggest a dynamic logarithmic panel data (longitudinal data) regression model as indicated in Equation 1. Due to fact that the dependent variable in our model is likely to display considerable persistence from year to year and it is history dependent, we utilize lagged dependent variables as a regressor. Additionally, we have short time (T=12) and large country dimension (N=118) and we may encounter bi-directorial causality between dependent and independent variables. Thus, we specify a dynamic log-linear equation for our model including lagged dependent variable. To determine the optimal lag-length of dependent variable (HDL), the statistics of AIC and BIC are used and the equation is expressed below:

$$\ln HDL_{it} = \beta_0 + \beta_1 \ln HDL_{it-1} + \beta_2 \ln ICT_{it} + \beta_3 \ln EFL_{it} + u_{it} \qquad (1)$$

$lnHDL_{it}$: *The natural logarithm of HDI Score of ith country related to t^{th} term.*
$lnICT_{it}$: *The natural logarithm of ICT Score of ith country related to t^{th} term.*
$lnEFL_{it}$: *The natural logarithm of IEF value of ith country related to t^{th} term.*
u_{it} : *is the error (residual) term*

$u_{it} = \mu_i + \upsilon_{it}$ time-invariant country characteristics (fixed effects), may be correlated with the explanatory variables. The error term in Equation (1) has two parts: the unobserved country-specific effects (μ_i) and the observation-specific errors (υ_{it}).

ECONOMETRIC ANALYSIS AND RESULTS:

In this study, we employ dynamic panel analysis by using Generalized Method of Moments estimation in order to take into consideration of the statistical problems stated in the previous section. The dynamic relationships are

described by the presence of a lagged dependent variable as a regressor. The model is indicated in Equation 2.

$$y_{it} = \delta y_{i,t-1} + x'_{it}\beta + u_{it} \quad i = 1,...,N; \ t = 1,...,T \quad (2)$$

where δ is a scalar, x'_{it} is $1 \times K$ and β is $K \times 1$. It can be supposed that the u_{it} pursue a one-way error component model;

$$u_{it} = \mu_i + \upsilon_{it} \quad (3)$$

where they υ_{it} are assumed to be independent and identically distributed with mean zero and variance σ_v^2 ($\upsilon_{it} \sim IID(0, \sigma_v^2)$).While lagged dependent variables are integrated as regressors, both the within groups (WG) and the random effects estimators are biased and inconsistent (even if x_{it} is proposed strictly exogenous) unless the number of time periods is too large (Baltagi, 2005, p.135). This vanishes only if T tends to infinity. Alternatively, a GMM estimator (GMM-first-differences) is improved by Arellano and Bond (1991) which basically differences the model in order to avoid any endogeneity probably obtained from the correlation between time-invariant individual specific effects (fixed effects) and the right hand side variables (Baltagi 2011, p.324). Additionally, GMM estimator aids to ensure that all the regressors are stationary by differencing the model (Baltagi, Demetriades & Lawc, 2009). This method can deal with the problem (endogeneity) that the explanatory variables which are potentially correlated with the error terms, by using first differenced form with instrumental variables that are correlated with the explanatory variables but uncorrelated with the error terms. Although, Blundell and Bond (1998) express that the instruments used in the first-differenced GMM estimator return to less informative structure in two substantial cases: the value of α increases towards unity and the relative variance of the fixed effects increases.

Arellano-Bond estimator has a problem that lagged levels are weak instruments for an equation in first differences (Dimelis & Papaioannou, 2011). A further growth is improved by Arellano and Bover (1995) and Blundell and Bond (1998). It is indicated in their analysis that when the autoregressive parameter is partially large and the dimension of time is partially small, GMM-first-differences-IV estimator may behave poorly. Namely, they find that lagged levels of the series offer weak instruments for the first-differenced equation. It was supposed by the authors that a linear GMM estimator in a system of first-differenced and levels equations that provides significant enough gains in conditions where the GMM-first-differences estimator carries out poorly. In addition to lagged levels of the series as instruments for equations in first differences, it was exploited lagged differences of the series as instruments for the equations in levels (Andres, Betzer, Goergen & Renneboog, 2009). Briefly, the system GMM estimator uses as additional instruments the first differences of the instrumented variables. As mentioned by Arellano and Bover (1995) and Blundell and Bond (1998), it can be obtained more efficient estimators by allowing more instruments in this GMM estimation (Dimelis & Papaioannou, 2011).This method is named as GMM-in-systems.

Besides, dynamic estimators have some basic advantages (Marques & Fuinhas, 2011):

a. They can rule out countries' individual non-observable effects;
b. Due to variables' lagged values are used as instruments, they can cope with endogeneity among explanatory variables,
c. They can deal with the collinearity of variables.

To achieve our goal in this study, firstly, we employ granger causality test to the series in the model and we conduct dynamic panel data regression (GMM-in-first-differences [GMM-DIF]) and GMM-in-systems [GMM-SYS]) respectively.

Granger Causality Tests:

Although the presence of associations between variables does not prove causality or the direction of impact, the situation may change in time series and panel data regressions models, (Gujarati, 2004, p.697). Causality was defined by Granger (1969) and Sims (1972) as the past lagged values of a variable (x_t) having explanatory power in a regression of a variable (y_t) including lagged values of y_t and x_t (Greene, 2003, p.592). In general, since the future can not forecast the past, if variable x (Granger) induces variable y, then changes in x should precede changes in y. If we include lagged values of x in regression of y and it significantly develops the prediction of y, then it can be expressed that x (Granger) causes y. A similar definition can be stated, if y (Granger) causes x (Gujarati, 2004, p.697).

To execute panel Granger causality tests, we describe the following autoregressive models for country i and period t:

$$y_{i,t} = \alpha_i + \lambda_t + \sum_{j=1}^{q} \beta_j y_{i,t-q} + \sum_{j=1}^{q} \theta_j x_{i,t-q} + \sum_{j=1}^{q} \eta_j z_{i,t-q} + \varepsilon_{i,t} \qquad (4)$$

$$x_{i,t} = \alpha_i + \lambda_t + \sum_{j=1}^{q} \psi_j x_{i,t-q} + \sum_{j=1}^{q} \gamma_j y_{i,t-q} + \sum_{j=1}^{q} \eta_j z_{i,t-q} + \nu_{i,t} \qquad (5)$$

where i=1,2,3,…N and t=1,2,3,…T. In Equations (4-5), for example, x donates HDL and y donates is ICT. α_i and λ_t donate country fixed-effects, and period dummies namely. ε_{it} and υ_{it} are error (residual) terms. η is a matrix of common exogenous variables (eg. EFL). The base assumption of Granger test is that the future cannot cause the past or the present, whereas the past may cause the present or the future. However, if x occurs before y, it is not mean that x is cause of y. Thus, we need to examine the explanatory power of other variable on y. Thus, In Equations (4-5), the present value of y is specified as function of past values of itself and x (Justesen, 2008, p.696–703). The Granger causality test results are expressed in Table 3.

Table 3: Granger Causality Test Results

Dependent variable: lnHDL				Dependent variable: lnICT				Dependent variable: lnEFL			
Excluded	**Chi-sq**	**df**	**Prob.**	**Excluded**	**Chi-sq**	**df**	**Prob.**	**Excluded**	**Chi-sq**	**df**	**Prob.**
lnICT	114.067	2	0.0000**	lnHDL	33.289	2	0.0000**	lnHDL	39.948	2	0.0000**
lnEFL	22.574	2	0.0000**	lnEFL	9.936	2	0.0070**	lnICT	0.9181	2	0.6319
All***	134.15	4	0.0000**	All	35.334	4	0.0000**	All	46.504	4	0.0000**
Notes	(*) : The statistics of AIC and BIC are used to determine optimal lag-lengths. Null hypothesis: Variable X is not Granger cause of variable Y. (**) : Test results are significant at 0.01 significance level. (***) : The statistic in the last row (All) is the statistic for joint significance of all other lagged endogenous variables in the equation.										

Consequently, the results summarize that there is a bilateral Granger-causality between all variables except the direction from lnICT to lnEFL. To interpret, evolving over time ICT and EFL can cause HDL. EFL and HDL can cause ICT but ICT cannot cause EFL. Thus, the issue of bidirectional causality should be kept in mind for employing GMM estimators in order to examine the impacts of ICT and EFL on HDL.

FINDINGS and DISCUSSION:

In this research, in order to investigate the impacts of ICT and EFL on HDL, we conduct dynamic panel data model described in Equation 1, which consists of lagged depended variable and the others explanatory variables. We conduct three kinds of models: Pooled OLS, GMM-DIF and GMM-SYS.

Blundell and Bond (1998) suggested two alternative estimators that compel further restrictions on the initial conditions process, which are designed for developing the properties of the standard first-differenced GMM estimator. The restrictions not only provide valid results under stationarity but also under weaker assumptions. Indeed, one can exploit GMM-SYS model to solve the statistical problem of unit root (nonstationarity) or near unit root, by using lagged difference instead of the level as possible instruments (Huang, Hwang & Yang, 2008). Namely estimating the model in first differences can provide to avoid the spurious regression caused by unit root problem of variables (Siliverstovs, Kholodilin & Thiessen, 2011). Thus, we do not employ unit root test for our model.

As stated before, using pooled OLS to estimate model in Equation 1 may cause bias and inconsistent estimations. It is known that GGM-DIF method may induce large loss of information. Hence, we also conduct GGM-SYS method for estimation of our model. One rule of thumb suggests that one can tackle the problem of too many instruments, by describing the number of instruments as less than the number of groups. Thus, for determining the number of instruments; we take account of the basic rule in our study. The estimation results are expressed in Table 4.

Table 4: Dynamic Panel Model Summary[1]

Coefficients	Model		
	Pooled OLS [2]	GMM-DIF [3]	GMM-SYS [4]
Constant	-0.039** (0.0162)	-	-
lnHDI (lagged)	0.831* (0.0099)	0.574* (0.00327)	0.975* (0.00043)
lnICT	0.016* (0.0009)	0.010* (0.00007)	0.004* (0.00002)
lnEFL	0.019* (0.0044)	0.036* (0.00049)	0.002* (0.00005)
Sample Period	2000–2011	2000–2011	2000–2011
Number of time periods (T)	12	12	12
Number of countries (N)	118	118	118
Observations	1297	1180	1298
R^2	0.96519	-	-
Adjusted R^2	0.96511	-	-
F	11949.41*	-	-
Sargan Test♣ and [p-value]	-	$\chi^2(109)= 116.93$ [0.285]	$\chi^2(102)= 117.47$ [0.140]
AR(1)♣♣ and [p-value]	-	-3.594 [0.000]	-2.836 [0.004]
AR(2)♣♣♣ and [p-value]	-	1.448 [0.147]	0.803 [0.422]

Notes: (1) The estimation results of analysis are obtained from Stata 11.1 version with xtdpdsys command and xtabond2 command which was improved by Roodman (2006).

(2): Pooled Ordinary Least Square

(3): Generalized Method of Moments (in-first-differences).

(4): Generalized Method of Moments (in-system)

(*) and (**) indicate the statistical significance at the 1% and 5% levels, respectively.

(♣): Null Hypothesis: over-identifying restrictions are valid.

(♣♣): Null Hypothesis: no first order serial correlation.

(♣♣♣): Null Hypothesis: no second order serial correlation.

Figures in parentheses are standard errors.

While using the Arellano and Bond GMM procedure, two diagnostics must be examined: These are first order and second order serial correlation in the disturbances. The null hypothesis that assumes the absence of first order serial correlation should be rejected whereas the null hypothesis that proposes the absence of second order serial correlation should not be rejected (Baltagi, 2011, p.324). According to both GMM-DIF and GMM-SYS methods' results in Table 3, the null hypothesis that assumes no first order serial correlation is rejected at %1 significance level and the null hypothesis that assumes no second order serial correlation is not rejected at %1 significance level in both methods.

Additionally, a special feature of dynamic panel data GMM estimation is that the number of moment conditions increases with T. Therefore, the validity of the instruments based on special feature of dynamic panel data GMM estimation should be tested by using Sargan's (1958) statistic that tests the over-identifying restrictions. As scrutinizing Sargan Test statistics in Table 3, null hypothesis that assumes the over-identifying restrictions are valid is not rejected at %1 significance level in both methods (GMM-DIF and GMM-SYS).

Arellano and Bover (1995) indicate in their simulation results that if the coefficient of lagged dependent variable is closer to 1, it provides to increase the efficiency of the GMM-SYS estimator. According to results, the coefficient (0.975) of lagged dependent variable in GMM-SYS method is closer to 1. It means that GMM-SYS method provide more efficient results for our panel regression.

As stated before, we suppose that HDL has a persistent and history dependent structure. It can be obtained from results that the lagged coefficients of HDL (dependent variable) in three methods are positive and significant.

Namely, these results support our assumption. Examining the results, we can conclude that EFL and ICT have positive and significant impact on HDL in three methods. Additionally, the regression coefficients of lagged HDL are 0.831, 0.574 and 0.975 and all coefficients are statistically significant at %1 significance level. Further, the regression coefficients of HDL in Pooled OLS and GMM-SYS are closer to each other. It also supports our assumptions.

In Pooled OLS method, higher ICT and EFL cause a small increase in HDL. One percent changes in ICT induce 0.016 percent change in EFL and one percent changes in EFL induce 0.019 percent change in HDL in the same direction at %1 significance level under ceteris paribus conditions. Similarly, In GMM-DIF and GMM-SYS methods, higher ICT causes a small increase in HDL. Consequently, the sign of coefficients of variables indicated in Table 3 about the directions and significance of impacts of EFL and ICT on HDL meet our expectations.

As stated before, applying Pooled OLS method to estimate the parameters in the model may cause to reveal biased and inconsistent estimates, due to the correlation between the error terms and the lagged dependent variables. While scrutinizing the results, the two methods (GMM-DIF and GMM-SYS) can be accepted as proper estimators. Especially, the Sargan test does not reject the null hypothesis that assumes over-identifying restrictions are valid. Similarly, the absence of first order serial correlation is rejected and the absence of second order serial correlation is not rejected. Moreover, the lagged dependent variable in both methods is positive and significant. Therefore, we conclude that Dynamic GMM (GMM-DIF and GMM-SYS) can be appropriate estimators. It indicates that GMM-SYS is more efficient estimator, due to the coefficient of lagged dependent variable in GMM-SYS method is closer to 1 and we can evaluate GMM-SYS method as a more proper estimator for this study. Consequently, it can be relied on statistical inference carried out in our study related to the hypotheses explained previous sections. According to Dynamic GMM results, all three of the explanatory variables have significant and positive statistical effect on dependent variable.

CONCLUSION:

Given the need to address the scarcity of research on the longitudinal dynamic relationship between ICT, EFL and HDL, this study shed light on not only the effects of ICT and EFL on HDL but also mutual relationships between variables. As mentioned previously, the main assumption of the study is that HDL has history dependent and persistent nature. Dynamic panel data analysis shows that the lagged HDL as an independent variable has a significant and positive effect on HDL. Especially, results in GMM-SYS satisfy and verify our expectations related to lagged HDL. Indeed, the values of the components of HDL can not be changed or enhanced rapidly. Health, education, and standard of living issues can only be promoted by taking structural decisions and following the decisions made in the longer term. A developing country can hardly improve the level of literacy or schooling rates over night. This situation is almost the same for health or life expectancy. Likewise, because national income is considered to be an economic indicator which can be increased through well-established economic policies, a sustainable GDP per capita increase is considered history dependent. In line with our expectation, the composite structure of the HDL shows basically a gradual and self-improving behavior in our model.

In the literature, many researchers report that ICT has positive and significant impact on economic growth, human capital, productivity and HDL (e.g. Kraemer & Dedrick, 2001; Daveri, 2000; Colecchia & Schreyer, 2002; Campbell & Osei-Bryson, 2013). Our results based on three different methods (Table 3), show that ICT diffusion significantly improves HDL. In the theory, ICT increase information produced, stored, distributed and shared. Therefore, knowledge development and sharing also increase. The power of freely wandering knowledge can increase not only the efficiency of education and training processes but also increase the competitive edge, through efficiency and productivity, in micro and macro level leading GDP growth. Besides, ICT can also increase the quality of health industry, and can improve health quality in a country. In the long-run better education system, more qualified health industry and other much more effective and productive sectors may increase the interrelated HDL dimensions, which measure the throughputs of national health and education systems and average income.

As a result, we can say that governments, which are struggling to improve national HDL through improving ICT capability, should bear in mind the fact that ICT requires investments. The interaction between ICT and HDL may have a systematic delay, meaning that the HDL improvement, which is associated with ICT, comes after a delay of time. In this research, we use ICT connectivity data as a proxy for ICT capability of countries since data about other dimensions of ICT is not available for the time frame covered in tis study. Given this, ICT connectivity data may not cover all the aspects of ICT capability of countries. As a recommendation for

future studies, we advise that the impact of ICT on HDL should be investigated after compilation of data about all ICT aspects.

This study also reveals that EFL significantly improves HDL. This finding is consistent with our expectations and the other previous works (Kasper, 2002; Scully, 2002; Berggren, 2003; Prochniak, 2011; Bengoa & Sanchez-Robles, 2003). Here we can recommend governments to implement policies increasing EFL in order to increase national HDL bearing in mind that in literature there is no consensus about the impact of EFL on HDL (e.g. Bergh & Nilsson, 2010; Bennett & Vedder; 2012; Webster, 2013).

To conclude, we say that HDL is very important aspect for a nation, and based on our findings, we can recommend that governments who chase after increasing HDL should allocate more resources to progress ICT diffusion and establish more economically free environment.

The originality of this study lies in its dynamic panel data approach providing the association between variables based on longitudinal data from 118 countries. This approach gives us insights on probable causality relationships between variables at least in terms of probabilities claiming which variable can or cannot be one of the causes of another.

This research contains cross-sectional and longitudinal analysis, which is valid at a particular time interval and that is why the conclusions are probabilistic. Secondly, as a limitation of our research it should also be stated that, since the data related to the living standards dimension in HDI is calculated as a function of GDP per capita, it does not embrace the data of income inequality. This limitation should be considered before making generalizations.

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