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Human Development and the Spillover Effects of Investments in Telecoms: An Exploration of Transition Economies

Sergey Samoilenko
Virginia Union University, svsamoilenko@vuu.edu

Kweku-Muata Osei-Bryson
Virginia Commonwealth University

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Sergey Samoilenko (svsamoilenko@vuu.edu)
Department of CIS/CS, Virginia Union University, Richmond, VA23220, U.S.A.
&
Kweku-Muata Osei-Bryson
Department of IS, Virginia Commonwealth University, Richmond, VA 23284, U.S.A.

Abstract:

Previous investigations into macroeconomic impact of investments in ICT, while primarily focused on 'developed' economies, have yielded some important insights. For example, it was determined that the "investments to revenues" model works well only if a threshold level of ICT capital infrastructure has been developed, that it is not the quantity, but a quality of the full-time ICT workforce that plays an important role not only in converting a stream of investments in ICT into revenues, but also in achieving a spillover effect of investments that is captured by TFP, the 'something else' that contributes to macro-economic output. In this study we are concerned about the impact of human development, as measured by the human development index (HDI), on macro-economic outcomes and total factor productivity (TFP). The subject of the study is a group of transition economies (TEs), a set of highly related economies that has *Leaders* group that has some of the characteristics of developed economies & *Followers* group that has some of the characteristics of developing economies. Our results suggest that while for the *Leaders* group *HDI* has a statistically significant impact on *GDP* that this relationship does not hold for the *Followers* group. Similarly, our results suggest that while for the *Leaders* group *HDI* has a statistically significant impact on *TFP* that this relationship does not hold for the *Followers* group.

Keywords: Human Development, HDI, Investments in ICT, Telecoms, Economic Development, Total Factor Productivity, Transition Economies, Developing/Emerging Economies

INTRODUCTION

The macroeconomic impact of investments in ICT is a well-researched topic (OECD, 2005a, b, c; IMF, 2001; Samoilenko & Osei-Bryson, 2008a, b), within a relatively homogenous context of developed economies(Lam & Lam, 2005; Madden & Savage, 1999; Dunne *et al*., 2004; Siegel, 1997), but a notably under researched one in a more diverse context of developing, emerging, least developed, and Transition Economies (Roztocki & Weistroffer, 2008; Hoskisson et al., 2000). Because developed countries share a common set of important social, economic, and political characteristics (Ngwenyama & Morawczynski, 2009), the findings of the studies conducted in the settings of the developed economies can be easily generalized and the results of the investigations in the form of the easily adoptable best practices and lessons learned shared by the peer developed economies. However, the heterogeneity of other contexts (Roztocki & Weistroffer, 2008; Hoskisson et al., 2000) precludes straight forward transfer of practical insights and policy making knowledge between the rest of the economies that yet to obtain the spectacular results from investments in ICT (Arcelus & Arocena, 2000; Barro & Sala-i-Martin, 1995; Sala-i-Martin, 1996). Fortunately, the context of Transition Economies (TEs) offers an attractive research setting for investigators studying the impact of investments in ICT on the macroeconomic bottom line of the developing, emerging, and least developed countries (Samoilenko, 2008), for it has been noted that TEs share characteristics of developed and less developed economies of the world (OECD, 2004).

This study is part of our program of research (see Table 1) on the impact of investments in ICT on productivity, particularly within the context of TEs. Here we are concerned about the impact of human development, as measured by the human development index (HDI), on macro-economic outcomes and total factor productivity (TFP). Our study involves the following research questions:

1. RQ1: *There is no statistically significant relationship between HDI and GDP*
2. RQ2: *There is no statistically significant relationship between HDI and Revenues from Telecoms.*
3. RQ3: *There is no statistically significant relationship between HDI and TFP.*

These questions will be explored within the context of the efficient *Leaders* and the less efficient *Followers* subgroups of the TEs that were identified in our previous studies (see Table 2). It should be noted that while other researchers have inquired into the relationship between investments in ICT and various measures of social and economic development (Bollou, 2006; Ngwenyama et al., 2009), including HDI (Ngwenyama et al., 2006); however, no investigations to our knowledge have been conducted to inquire into the possible relationship between HDI and the macroeconomic impact of the investments in ICT.

Table 1. Previous results of Samoilenko & Osei-Bryson's research program on IT and productivity.

Study	**Findings**	**Follow-up Question**
Samoilenko (2008)	The study identified some of the general factors contributing to the differences in the levels of efficiency of utilization of investment in Telecoms between the more efficient group of TEs (the Leaders) and the less efficient group (the Followers).	Is the difference in the levels of efficiency of utilization of investment in Telecoms between the Leaders and the Followers due to the differences in the levels of investments, or is it due to the differences in the efficiency of the processes of conversion of investments into revenues?
Samoilenko & Osei-Bryson (2008a)	The results indicate that the Followers are able to obtain the higher levels of revenues from Telecoms not because of the higher levels of investments in Telecoms, but because of the Leaders' more efficient processes of conversion of investments into revenues.	Is there a significant complementarity effect between the levels of investments in Telecoms and full-time Telecom labor that is impacting the levels of revenues from Telecoms? Is there a similar discrepancy between the Leaders and the Followers in regard to the impact of investments in Telecoms on TFP?
Samoilenko & Osei-	The investigation identified the presence of a statistically significant complementarity effect of the levels of	Is there a similar complementarity effect of the levels of labor and investments on TFP?

Bryson (2008b)	investments and labor on the levels of revenues from Telecoms only in the case of the Leaders; for the Followers the effect was not statistically significant.	
Samoilenko & Osei-Bryson (2010)	The study proposed and tested a methodology allowing for relating "white box" components, such as investments in Telecoms and Telecom labor, to the "black box" component in the form of TFP. Results indicate the presence of the relationship between investments and labor and TFP for the Leaders only.	What are some of the factors impacting the presence of the relationship between investments in Telecoms and TFP?

Table 2: Groups sample of 18 TEs (Samoilenko & Osei-Bryson, 2010)

Subgroup	**Membership of the Group**
The Leaders	Czech Rep, Estonia, Hungary, Latvia, Lithuania, Poland, Slovenia, Slovakia
The Followers	Albania, Armenia, Azerbaijan, Bulgaria, Kazakhstan, Kyrgyzstan, Moldova, Romania, Ukraine

We base our inquiry on the framework of neoclassical growth accounting and utilize Data Envelopment Analysis (DEA) and Multivariate Regression (MR) to conduct the analysis of the data, which was provided by the previous inquiry of Samoilenko and Osei-Bryson (2008a) and the Human Development Report (UN, 2009). A major reason for using DEA in this study is to compute the TFP values based on the Malmquist Index (MI) which was originally suggested by Malmquist (1953). Caves et al. (1982) defined the Malmquist index of TFP growth. Later, Färe et al. (1994) demonstrated that the Malmquist index could be constructed based on the results of Data Envelopment Analysis (DEA). Since DEA relative efficiency scores are calculated for each point in time *t* (e.g., year 1993), for a given DMU it is possible to calculate the change in relative efficiency scores between any pair of consecutive points in time *t* and *t+1* (e.g., year 1993 and

year 1994). The calculated value of change in the scores will represent the Malmquist index and reflect TFP. We present our inquiry as follows. The next section of the paper provides an overview of the theoretical framework and states the research questions of the study. Then we present results of the data analysis are followed by the discussion of the findings. We conclude the paper with an overview of the contribution, directions for further inquiries, and limitations of the inquiry.

BACKGROUND

Theoretically, there is no obvious reason why developed economies can obtain outstanding macroeconomic benefits from investments in ICT, while less developed economies cannot (Madden & Savage, 1998; Eggleston et al., 2002). According to a well-established framework of neoclassical growth accounting, which is widely used in both contexts (Oliner &Sichel, 2000; Schreyer, 2000; Davery, 2000; Jorgenson & Stiroh, 2000; Whelan, 2000; Hernando & Nunez, 2002), macroeconomic benefit of investments could come from two sources. If the macroeconomic bottom line is represented by GDP, then the first source is represented by the stream of revenues that is generated from investments in ICT (UN ICT Task Force Report, 2005; WT/ICT Development Report, 2006), and the second source is represented by the outcome of the spillover effect of investments in ICT- a contribution to GDP that is not directly associated with investments (Samoilenko & Osei-Bryson, 2010). It is this investment-independence of the second source, commonly referred to as Total Factor Productivity (TFP) that makes it a highly attractive target in the quest of improving the macroeconomic impact of investments in ICT, for, within the neoclassical framework, TFP is free.

Inquiries into macroeconomic impact of investments in ICT along these two routes yielded some important insights. It was determined that the "investments to revenues" model works well only if a threshold level of ICT capital infrastructure has been developed (The Economist, 2004), and then, on top of the developed infrastructure, if the level of investments is high enough (Oliner & Sichel, 2000; Jorgenson, 2001; Jorgenson & Stiroh, 2000). Keeping in mind the resource intensive nature of ICT, investigators inquired into the complementary to investments in ICT factors (Kraemer & Dedrick 2001; Pohjola 2002) that could produce synergistic effect on the macroeconomic bottom line; the state of the full-time ICT workforce was determined to be one

of such complementary factors(Samoilenko & Osei-Bryson, 2007). Notably, researchers determined that it is not the quantity, but a quality of the full-time ICT workforce that plays an important role not only in converting a stream of investments in ICT into revenues (Samoilenko & Osei-Bryson, 2008a), but also in achieving a spillover effect of investments that is captured by TFP (Samoilenko & Osei-Bryson, 2010). Based on the results of the studies suggesting the importance of the effective and efficient ICT workforce to the macroeconomic bottom line, investigators proposed that workforce development programs may offer a new route allowing for better leveraging the impact of investment in ICT. Overall, taking into consideration the well-established insights regarding the significance of such factors as the level of investments in ICT, quality of the ICT workforce, and the presence of complementary investments for achieving the macroeconomic impact of investments in ICT, it appears that a basic "push" type model (see Figure 1 below) of the macroeconomic success of investments in ICT could be outlined. However, due to a consumer-oriented nature of ICT, at least portion of investments will be directed towards producing products and/or services for the customer consumption. Taking this into consideration, it is only reasonable to suggest that some efforts of the researchers should be directed toward the development of the "pull" type of the model of the macroeconomic success of investments in ICT, for it is a consumer demand for ICT products and services that, at least in part, is reflected in the stream of revenues and drives the level of investments.

Recent investigations of the impact of investments in Telecoms (a subset of investments in ICT) in the context of TEs identified that the better developed TEs (the *Leaders*) with a higher level of investments in Telecoms and a more productive workforce do demonstrate relationship between investments in Telecoms and macroeconomic growth, while the less developed TEs (the *Followers*) do not (Samoilenko & Osei-Bryson, 2010). This disparity can be easily explained by the mentioned above "push" model of investments in ICT, where the main reasons for the failure of the *Followers* to achieve the macroeconomic impact of investments in Telecoms could be traced to the insufficient level of investments in Telecoms and the inefficient Telecom workforce. The investigators also provided evidence that in the case of the Followers, the state of Telecom infrastructure and the utilization of Telecom infrastructure serve as factors affecting the level of investments in Telecoms (Samoilenko & Osei-Bryson, 2010). Meaning, in the case of the less developed TEs a rudimentary "pull" model (see Figure 1 below) of investments in ICT

may include such factors as insufficiently developed infrastructure and unsatisfied demand for services that rely on the utilization of that infrastructure.

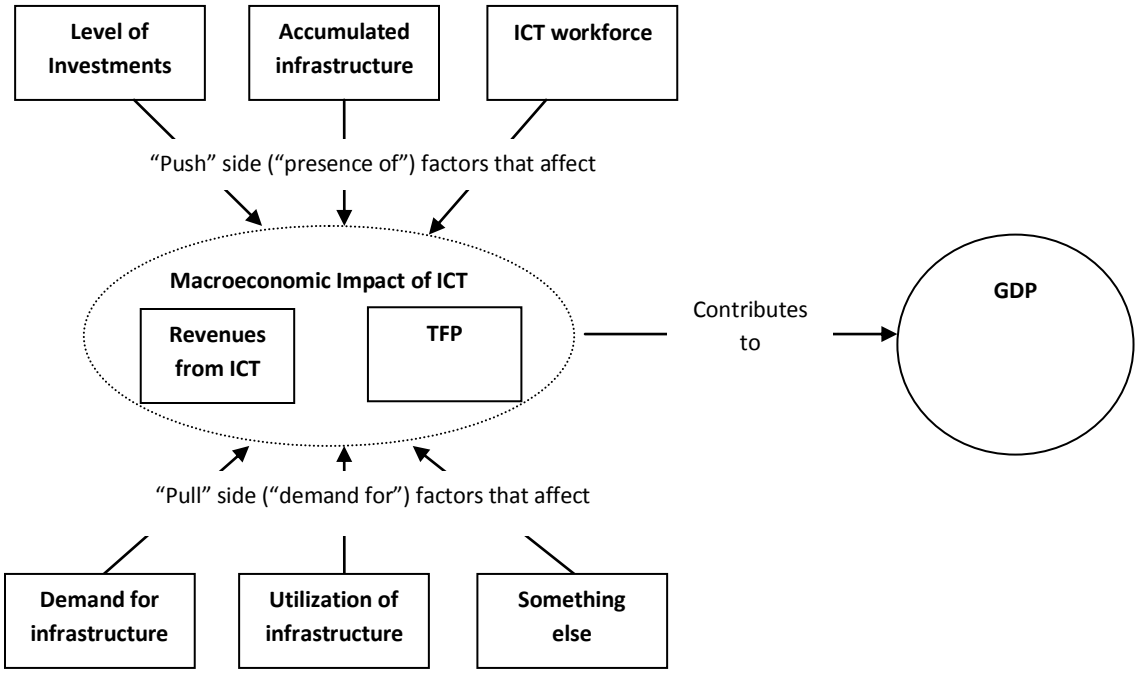

Figure 1 Macroeconomic Impact of Investments in ICT: Summary of the Current Insights

However, the same investigation found no evidence that in the case of the better-developed TEs (the *Leaders*) the level of investments in Telecoms was associated with the state of Telecom infrastructure or the utilization of Telecom infrastructure (Samoilenko & Osei-Bryson, 2010). The implication of this finding is interesting, for this tells us that in the case of the less developed TEs investments in Telecoms are probably driven by the structural and functional deficiencies of the Telecom infrastructure, but once the infrastructure is sufficiently developed, as in the case of the *Leaders*, something else drives the investments and, consequently, impacts the macroeconomic bottom line. The importance of knowing the answer to this question is intuitive, for regardless of the context, if a given economy is to progress then it is bound at some point to sufficiently develop its infrastructure and to satisfy a basic customer demand associated with the utilization of the infrastructure, thus ending up in the situation when "something else" is driving the investments and impacting the economic growth. It is only reasonable to assume the benefit of knowing what this "something else" is in advance.

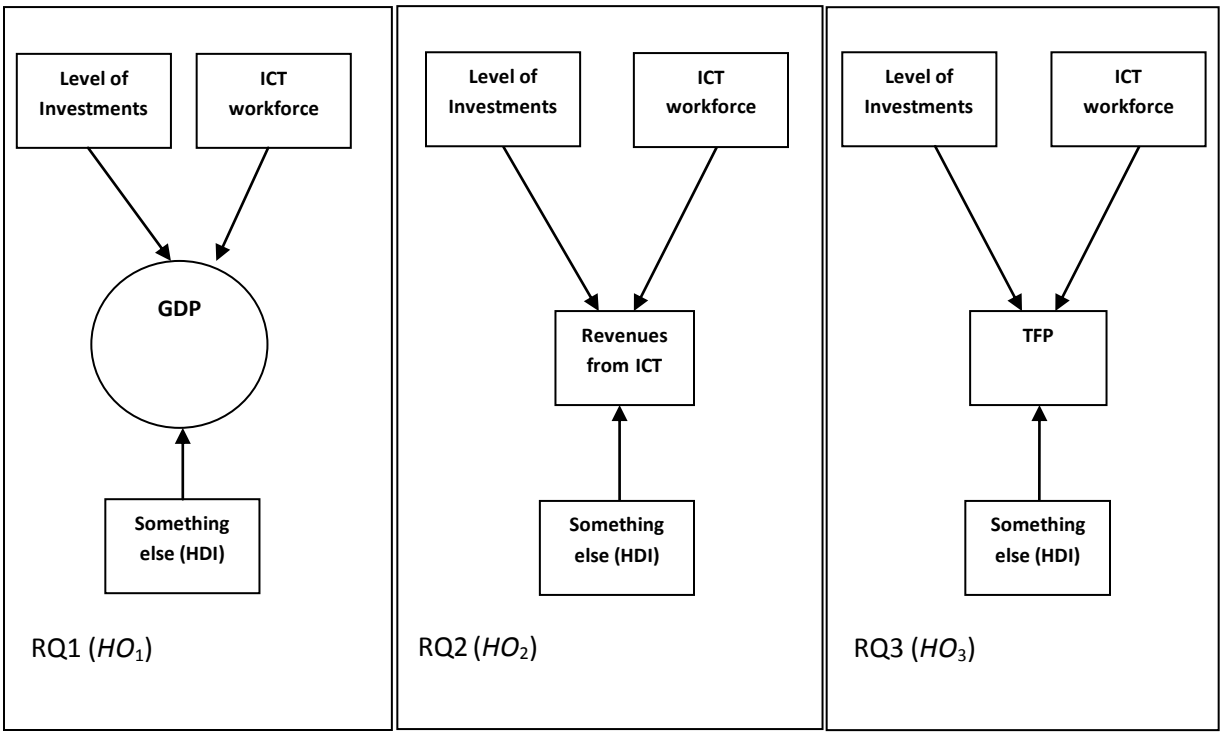

Figure 2: Domain of the investigation of the current study & corresponding null hypotheses

The purpose of the current investigation is to serve as a precursor to answering the outlined above research question, namely, *What are the factors that impact the macroeconomic bottom line by driving investments in ICT in the context of TEs with adequately developed and utilized ICT infrastructure?* In order to begin an inquiry into this undoubtedly multidimensional, complex problem, we propose investigating a role that an overall socio-economic development of economies, as it is represented and measured by the UN Human Development Index (UN, 1990), plays in impacting the macroeconomic outcomes of investments in ICT. The reasoning behind using Human Development Index (HDI) as a possible indicator of a macroeconomic impact of investments in ICT is an intuitive one: an increase in the value of HDI for a given economy indicates improvements in the areas of education and standards of living (Depotis, 2005; Neumayer, 2001; Sagar &Najam, 1998), and such increase may fuel the consumer demand for high-margin, less infrastructure-dependent products and services offered by ICT. We understand, however, that HDI is imperfect as a measure of socio-economic development (Paehlke, 2003; Cahill, 2005; Schimmack, 2008), and suggest that our inquiry serves as a springboard for other studies that may consider wider and more precise spectrum of variables representing the degree of socio-economic development.

THEORETICAL FRAMEWORK AND THE RESEARCH QUESTIONS OF THE STUDY

The neoclassical growth accounting model originated from the work of Solow (1957) and since then has been widely used by researchers to estimate contribution of ICT to the macroeconomic bottom line in the context of developed and developing countries (Oliner &Sichel, 2000; Schreyer, 2000; Davery, 2000; Jorgenson & Stiroh, 2000; Whelan, 2000; Hernando & Nunez, 2002). The objective of growth accounting is to decompose, using a neoclassical production function, the rate of growth of an economy into the contributions from the different inputs. A neoclassical production function relates output and inputs in the following manner:

(1) $Y = f(A, K, L)$

where Y = output (most often in the form of GDP); A = total factor productivity (TFP); K = capital stock, and L = quantity of labor/size of labor force.

In this study we expand the formulation (1) by including HDI as another independent variable and denote it as *HDI*. Consequently, the neoclassical production function allows us to relate HDI, *ICT Capital*, *ICT Labor*, and *Y* in the following fashion:

(2) $Y = f(TFP, ICT\ Capital, ICT\ Labor, HDI)$

We are going to use formulation (2) to generate three research models: the first two models are used to explore the relationship between HDI and the macro-economic output variables GDP, and *Revenues from ICT*, respectively; while our third model is used to explore whether HDI, the "something else", determines TFP, the presence of the spillover effect. Our three research models are expressed as follows:

(3) $GDP = \beta_0 + \beta_{1*}\ ICT\ Capital + \beta_{2*}\ ICT\ Labor + \beta_{H\to G} HDI + \xi_1$

(4) $Revenues\ from\ ICT = \beta_{10} + \beta_{11*}\ ICT\ Capital + \beta_{12*}\ ICT\ Labor + \beta_{H\to R} HDI + \xi_2$

(5) $TFP = \beta_{20} + \beta_{21*}\ ICT\ Capital + \beta_{22*}\ ICT\ Labor + \beta_{H\to T} HDI + \xi_3$

We will use the variable *Annual Investments in Telecoms* as a proxy for *ICT Capital*, and the variable *Full-time Telecom staff* as a proxy for *ICT Labor*.

Exploration of our research questions will involve testing the following hypotheses:

1. ***H_{O1}:*** *There is no statistically significant relationship between HDI and GDP (*$\beta_{H\to G} = 0$*).* Given our interest in exploring differences between the *Leaders* and *Followers* we will test this null hypothesis separately for both the *Leaders* and *Followers.*
2. ***H_{O2}:*** *There is no statistically significant relationship between HDI and Revenues from Telecoms (*$\beta_{H\to R} = 0$*).* Similarly to H_{O1}, hypothesis ***H_{O2}*** will be tested separately for both the *Leaders* and *Followers*.
3. ***H_{O3}:*** *There is no statistically significant relationship between HDI and TFP* ($\beta_{H\to T} = 0$). Similarly to H_{O1}, hypothesis ***H_{O3}*** will be tested separately for both the *Leaders* and *Followers*.

OVERVIEW OF THE DATA

In this investigation we utilize a data set on 18 TEs spanning the period from 1993 to 2002 that was used in previous study of Samoilenko & Osei-Bryson (2010). The original data were obtained from the *WDI* database (web.worldbank.org/WBSITE/EXTERNAL/DATASTATISTICS), and the Yearbook of Statistics (2004) (www.itu.int/ITU-D/ict/publications*) of International Telecommunication Union (ITU)(* www.itu.int*).* The values of HDI index were obtained from the Human Development Report (UN, 2009). Most of the studies inquiring into the macroeconomic impact of investments in ICT either analyze chronological time series (e.g., Ngwenyama et al., 2006), or point-in-time (UNDP, 2004) data.

Table 3: Mean Values of the Variables for Leaders & Followers Groups

Variable	***Leaders***	***Followers***
Annual Investments in Telecoms (current $US)	$529,724,490.19	$138,103,505.57
Annual Revenues from Telecoms (current $US)	$1,841,045,788.05	$365,197,999.15
GDP (current $US)	$44,653,918,142.86	$14,690,637,125.00
Number of Full-time Telecom Staff	18,647.43	34,168.88
HDI	0.85	0.76
MI	1.13	1.32

For the purposes of the study, we decided to concentrate on a single year, Year 2000. Table 3 below displays the mean values for relevant variables (e.g., GDP, MI, HDI, Full-time Telecom staff, Investments in Telecoms, Revenues from Telecoms) for the *Leaders* and *Followers* groups of our sample.

RESULTS OF THE DATA ANALYSIS

Our results suggest that while for the *Leaders* group *HDI* has a statistically significant impact on *GDP* that this relationship does not hold for the *Followers* group. Similarly, our results suggest that while for the *Leaders* group *HDI* has a statistically significant impact on *TFP* that this relationship does not hold for the *Followers* group. It should be noted that in a previous study (Samoilenko & Osei-Bryson, 2010) we found that while for the *Leaders* group *ICT Capitalization* has a statistically significant impact on *TFP* that this relationship does not hold for the *Followers* group. Interestingly, our current results also suggest that with regards to the impact of *HDI* on *Revenues from ICT*, that there is no difference between the *Leaders* and the *Followers* groups.

Table 3.1: Impact of HDI on GDP

H_{01}	*HDI* has no statistically significant impact on *GDP*					
Group	**Parameter**	**Estimate**	**t-value**	**Pr > |t|**	**Adj. R^2**	**Test of H_{O1}**
The Followers	Investments in Telecoms	43.8591	4.36	0.0121	0.8882	Accepted
	Full-time Telecom staff	137725	2.86	0.0461		
	HDI	5.543E10	1.22	**0.2902**		
The Leaders	Investments in Telecoms	-8.4288	-1.77	0.1741	0.9981	Rejected
	Full-time Telecom staff	2524472	25.62	0.0001		
	HDI	2.069E11	4.21	**0.0244**		

Table 3.2: Impact of HDI on Revenues from ICT

H_{02}	*HDI* has no statistically significant impact on *Revenues from ICT*					
Group	**Parameter**	**Estimate**	**t-value**	**Pr > |t|**	**Adj. R^2**	**Test of H_{02}**
The Followers	Investments in Telecoms	4.5696	4.61	0.0058	0.8563	Accepted
	Full-time Telecom staff	788.1	0.09	0.9313		
	HDI	2.7168E9	0.31	**0.7661**		
The Leaders	Investments in Telecoms	0.9064	0.88	0.4302	0.9330	Accepted
	Full-time Telecom staff	89071.7	4.00	0.0162		
	HDI	-3.747E9	-0.32	**0.7685**		

Table 3.3: Impact of HDI on TFP

H_{03}	*HDI* has no statistically significant impact on *TFP*					
Group	**Parameter**	**Estimate**	**t-value**	**Pr > |t|**	**Adj. R^2**	**Test of H_{O3}**
The Followers	Investments in Telecoms	5.56E-10	0.45	0.6763	0.2832	Accepted
	Full-time Telecom staff	-6.6E-6	-1.11	0.3279		
	HDI	-2.5284	-0.45	**0.6746**		
The Leaders	Investments in Telecoms	-611E-12	-5.33	0.0129	0.8523	Rejected
	Full-time Telecom staff	0.000010	4.26	0.0237		
	HDI	6.6821	5.64	**0.0110**		

DISCUSSION & CONCLUSION

The outcomes of the tests of H_{O1} offer evidence that in the case of the *Leaders* the levels of Telecom labor and HDI do serve as a predictors of GDP, while in the case of the *Followers* it is the levels of capital investment and the labor that impact GDP. It is somewhat not surprising that the level of Telecom labor is significant in this regard for both settings, for it is an ICT workforce that serves as a ”caretaker” of the capital investments. The significance of the level of capital investments in Telecoms for the *Followers* suggests that this group, unlike the *Leaders*, could increase its GDP by engaging in a straightforward ”white box” process of simply investing more in Telecoms and hiring more of Telecoms staff. At this point the level of socio-economic development of the *Followers* simply does not appear to be an important factor affecting their macroeconomic bottomline.

The results of the data analysis also suggest that HDI is not one of the determinants of the level of ICT-based revenues from Telecoms for either group of TEs. In the case of the *Leaders*, however, full-time Telecom staff does have an impact on the level of ICT-based revenues, while in the case of the *Followers* it is a level of investments in Telecoms that is a factor affecting the level of ICT-based revenues. This evidence provides support to the preliminary conclusion that the *Leaders* and the *Followers* are, indeed, at the different stages in regard to ther respective states of Telecom development, and if in the case of the *Followers* an increase in the level of revenues requires an increase in the level of investments (i.e., the *Followers* do not invest enough), in the case of the *Leaders* it is an efficient conversion of investments into revenues performed by Telecom staff (e.g., smaller number of workers handling greater quantity of investmtent inputs) that matter more than a simple increase in investment inputs.

The most interesting insight, however, is provided by the results of testing of H_{O3}; while in the case of the *Leaders* HDI, investments in Telecoms, and Telecom staff are all appear to determine TFP, none of the variables seem to impact TFP in the case of the *Followers*. This suggests that not only that the presence of the spillover effect is dependent on the multiple factors, but also that the *Followers* are simply not ready yet to demonstrate the macroeconomic impact of investments in Telecoms beyond the ”investments to revenues” model. Overall, the results of testing of the null hypotheses of this study provide some important insigths into the increasing complexity of the process of obtaining the macroeconomic impact from investments in ICT.

While obtaining the stream of revenues from investments in Telecoms seems to be while not a cheap, a fairly straightforward undertaking, achieving the spillover effect from investments in Telecoms appear to be uncomparably more complex process requiring many more variables working together.

Where do the findings of our study fit within the existing body of knowledge? Previously, it was reported that in the context of the least developed economies, investments in ICT and components of HDI (namely, education and healthcare) serve as predictors of GDP growth (Ngwenyama et al., 2007) , and acknowledged that, overall, there is high positive correlation between ICT indicators and HDI (UNDP, 2004). While this evidence is in line with the findings of our investigation, it is still not clear, even conceptually, what type of a mechanism exists that allows for macroeconomic growth to provide some sort of a feedback to the push and pull side factors of our model, specifically, HDI and investments in Telecoms. The importance of this follow-up question is fundamental, for the answer will allow to explain the sources of growth in the values of indicators that impact the macroeconomic bottom line, thus providing us with a model reminiscent of a close-loop second-order cybernetic system showing negative feedback-type mechanism, devoid of conceptual ”miracles” and ”black holes.”

We decided to take into consideration a possible effect of the political institutions on socio-economic outcomes of investments in Telecoms by comparing the *Leaders* and the *Followers* in regard to the values of POLKON index (ranges from 0 to 1), which is one of the commonly used conservative measures of political risks representing the degree of investor protection (Andonova & Diaz-Serrano, 2007). It is reasonable to assume that the countries with the higher values of the index (which represents a lower level of political risks) not only do better in terms of attracting the domestic private and foreign direct investment, but also in terms of fair distribution of the increased socio-economic wealth that would lead to the increase in the values of HDI. In our comparison we used averaged values of POLKON that was reported in the investigation of Andonova and Diaz-Serrano (2007) and determined (see Figure 3) that the *Leaders* differ favorably from the *Followers* in regard to political risks and investor protection (Andonova & Diaz-Serrano, 2007).This finding is in line with the conclusion of Baliamoune (2003) that if a liberal political environment is maintained, then ICT has a strong positive effect on the process of socio-economic development.

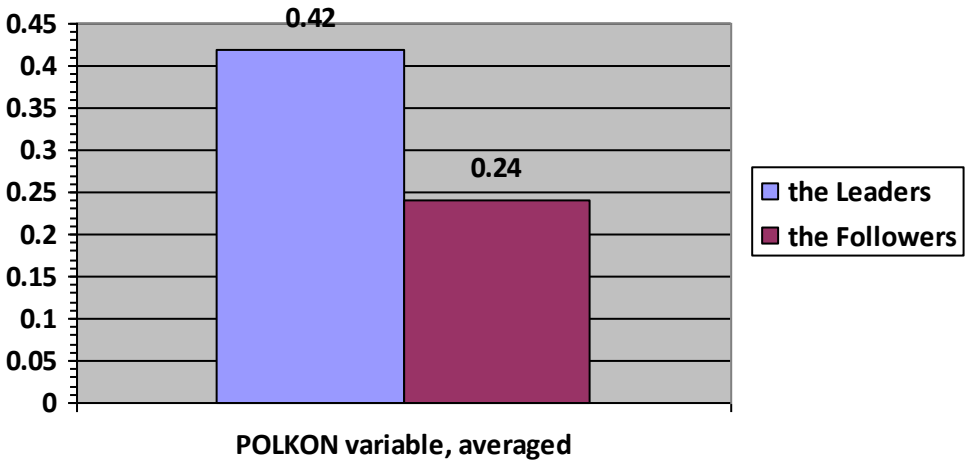

Figure 3 POLKON index: Comparison of the *Leaders* and the *Followers*

This allows us to propose a model depicted below in Figure 4 that we intend to address in a future study.

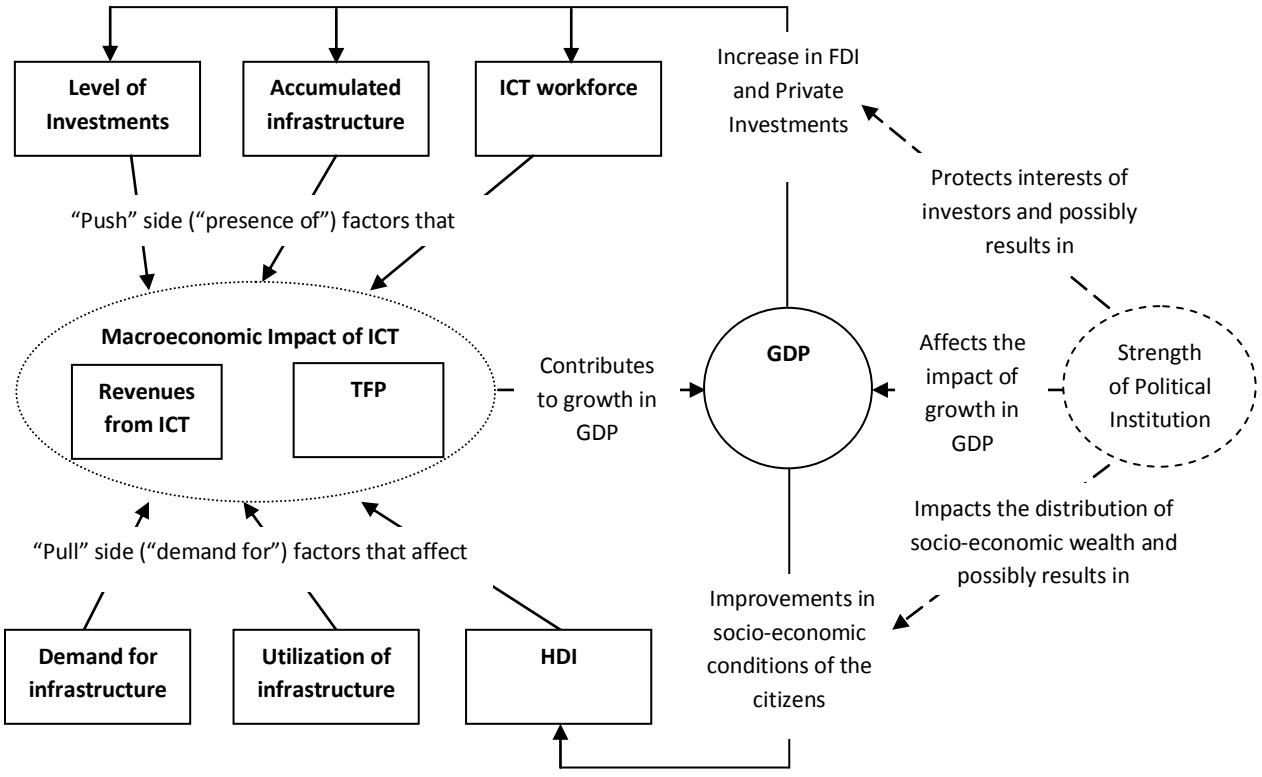

Figure 4 Macroeconomic Impact of Investments in ICT: Closed Loop Model

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