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The Impact of Information and Communication Technologies on Informal Economy Growth: A National-Level Study

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ABSTRACT

Informal economy (IE) is second only to the US economy in size; however, the role of ICT in IE remains largely unexplored. In this study, we conduct an empirical analysis of the role of ICT in IE growth. With PLS analysis involving more than 100 nations, we show that ICT products and software piracy may play important roles in IE growth, that impact of ICT and other determinants on IE growth remains largely unchanged over years; however the impact of ICT- and other determinants on IE growth for developing and developed nations may not be the same.

Keywords

Informal economy, determinants, national-level modeling, ICT, PLS.

INTRODUCTION

The size of Informal Economy or shadow economy (henceforth IE) is huge and varies greatly across countries. IE ($ ten trillion in estimated size and growing) is second only to the US economy and more than half of all employed people worldwide work in IE according to Neuwirth (2011). IE has been defined in many ways. For the present article we define IE as per Schneider (2002) as "all market-based legal production of goods and services that are deliberately concealed from public authorities". IE may include avoiding payment of income or other taxes, avoiding payment of social security contributions, avoiding meeting labor requirements such as minimum wages, avoiding administrative procedures such as filling up administrative forms etc. However, for reasons of accurate measurements, activities such as drug dealing etc. are not included in this definition of IE. Schneider estimated that IE as a percentage of GDP ranged from 8.7 (in the US) to 67.1 in Bolivia in 1999/2000. This difference persists among nations in estimates around 2006/2007, according to a World Bank report (Schneider, Buehn and Montenegro, 2010). For example, for Zimbabwe IE is 62.7% of GDP and for Austria IE was calculated as 9.5% of GDP. Although IE is considered to mostly have a negative impact, there are studies that also outline positive or uncertain impacts of IE on formal economy and development (Garcia-Boliver, 2006). The important questions are i) what causes the developments of IE globally, ii) do these causes change over time? and iii) how do these relationships among determinants and IE differ in context of developing and developed nations, given that a large percentage of a developing nation's output may be accounted for by informal economy activities, whereas for developed economies, informal activities account for far less of a nation's output.

Many antecedents to estimate the size of the IE have been proposed in the models developed by researchers in the past. See (Schneider et al., 2010) for a review of such causes. Economic factors such as GDP per capita, GDP growth rate, tax rate (Giles and Tedds, 2002), labor force participation rate (Schneider et al., 2010), unemployment rate (Hussmanns, 2004), currency, inflation rate, social security contribution, social context (Beneria and Roldon, 1987) etc., have been suggested. Economic factors alone may not explain the variations. A number of non-economic causes at various levels have also been conjectured to impact IE. These include the regulatory/ public sector services factors such as intensity of regulation and

regulatory quality (Tomei, 2000; Chen 2007; Kus, 2010; Fitzmaurice, 2004), size of government, fiscal and business freedom, openness, etc.(Schneider et al., 2011). The role of many of these antecedents has been conjectured to be opposite. Kus (2010), for example, points out that IE is related to degree of regulations but contrary to some earlier research, decreasing regulations may not reduce IE.   However, empirical investigation of causes such as the level of education, corruption and most importantly information and communication technology (ICT) products or ICT-related phenomenon such as software piracy on IE growth is missing in research literature so far.

In this paper, we empirically investigate the impact of ICT on IE estimates. In particular, we investigate how adoption of ICT products (e.g., Telephones, Internet) and ICT phenomenon such as Software Piracy influence (if at all) IE growth in various nations. The dependent variable data was gathered from the World Bank estimates of IE for 162 nations from 1999 to 2006/2007, which used MIMIC (multiple indicators, multiple causes) method that allows comparison of IE across various nations. Because IE has decreased, or eroded, in recent years (Schneider et al., 2010) we also examine the effect of independent variables that impact IE changes over the years. Since it has been observed that IE can be influenced by a number of non-technological factors as described above and used in previous research, for our analyses we design a structured equation model (SEM) that contains mainly ICT and other variables not used in the previous research as causes and investigate how these may impact the validated MIMIC estimates of IE (which was obtained using those well-established non-ICT determinants).

We begin by discussing some theoretical constructs associated with IE growth, with various types of ICT, and the ways ICT can impact IE growths in different nations. We next review some of the background literature associated with IE growth.

A Brief Review of IE

IE literature is vast. Even the terminologies vary widely. More common, popular and somewhat interchangeable terms are underground economy, black economy, shadow economy and informal economy and as such IE can be defined and measured in many ways. See Chen (2005), Gërxhani (2004), Kazemier (2005) for a review. However, according to FitzMaurice (2004), "Regardless of the definition one uses, one thing is certain; whoever is participating in the informal economy is trying to evade detection. This makes achieving factual estimates almost impossible". Chen (2007) notes, IE is comprised of both self-employment in informal enterprises (i.e., small and/or unregistered) and wage employment in informal jobs (i.e., without secure contracts, worker benefits or social protection).IE has been measured in many ways using direct, indirect and model approach. Direct method uses government surveys or tax audits. Indirect methods use discrepancy (based on differences between aggregate income and expenditure), monetary (based on quantity of money in circulation) or physical input techniques (based on say discrepancy in electricity consumption and GDP). The model approach is based on a structural model such as MIMIC (which is the estimate technique used by Schneider et al., 2011).

HYPOTHESES AND MODEL DEVELOPMENT

We do not frame hypotheses on the relationships between IE and economy as these are obvious and the dependent variable IE has been created using economic variables exhaustively (Schneider et al., 2011). Instead we focus on possible ICT-related causal variables that have not been considered empirically or otherwise in the existing research.

Software Piracy and IE

The BSA/IDC Global Software Piracy (SP) study definition of software piracy is used in the present study which includes piracy of packaged software that runs on personal computers (PC), including desktops, laptops, and ultra-portables. This definition of software includes operating systems, systems software such as database and security packages, business applications, and consumer applications such as games, personal finance, and reference software (Software Piracy Report, 2010). Global Piracy rate has been shown to be associated with cultural norms, regulatory and economic factors of a nation, among other causes (Moores 2005). Piracy rate of a country thus indicates the general environment in a country to conduct business that allows or prohibits illegal business activities and can depict the environment of illegal or IE of that nation. Economic benefits accruing from controlling SP can be substantive, particularly for developing nations (http://www.bsa.org/upload/idc-findings_summary.pdf).The IDC study found that a 10-point reduction in SP can generate an estimated $130 million in additional tax revenue for Greece (for example) which had a 61% piracy rate in 2006. Thus IE and SP may affect the formal economy in a similar fashion.

> *H1:   Nations with high rate of SP will have high rate of IE.*

ICT Products and IE

Technology has become a part of daily activities of individuals of many nations where ICT infrastructure is well developed. ICT infrastructure may thus help or reduce the activities related to IE. As Hiralal (2010) notes, many "new home workers" do assemble electronic parts and process technological data which contribute to IE. ICT can help as people may use this comparatively new medium to foster IE activities. With the advent of the Web/Internet plethora of other opportunities have opened up that may also contribute to IE. Using Internet/Web, people can more easily do transactions with banks in nations considered as tax-heavens. Regulatory checks and balances are not yet fully operative as far as Web/Internet is concerned. Home-based workers who contribute to IE also use public phones/internet and IE-related home businesses require use of telephones and other ICTs such as the Web/Internet (Hiralal, 2010). As Neuwirth (2011) discusses in his book "Africans head to China each year to buy cell phones, auto parts, and other products that they import to their home countries through a clandestine global back channel, Paraguayan merchants smuggle computers, electronics, and clothing across the border to Brazil, laid-off San Franciscans, working without any licenses, use Twitter to sell home-cooked foods.....". ICT sale and use in IE is growing ubiquitously. We have used internet penetration/100(IU) and telephone/100(TU) as the two components of ICT products adoption. Preventive schemes based on ICT can also impede the development of IE.

>   *H2:   Nations with low levels of ICT adoption will have high rate of IE.*

Regulation and IE

Although various aspects of regulation have been used in defining IE, two regulatory issues have not been directly considered. These are Voice and Accountability (VOA) and Rule of Law (ROL). Accountability is important because it can impede IE activities as people, firms and government in a nation with high accountability are held accountable for their deeds by the society at large and transparency in activities result which in turn results in lesser IE activities. For example, good accountability of a government ensures firms are usually informed clearly and transparently by the Government on changes in policies affecting their industry, when deciding upon policies and contracts, Government officials do not favor well-connected firms, effectiveness of national Parliament/Congress as a law making and oversight institution. (Kaufmann et al., 2009). Similarly rule of law (ROL) obviously may provide obstacles to IE activities.

We also consider level of corruption as a part of regulation. Tanzi (1998) defines corruption as abuse of public power for private benefits. When policies are liberalized to reduce entry-level barriers, corruption is reduced and that enables firms engaged in IE to move into formal economy (Schneider et al., 2000). Thus one can conclude that more the corruption level of a nation, the higher the rate of IE will be.

>   *H3:   Nations with high level of Regulation will have low rate of IE.*

Demography and IE

The demography consists of three parts: percent of rural population, education-level and gender.

Rural Population and IE.

According to Blunch, Canagarajah and Raju (2001), the informal sector is more relevant in the rural areas than urban ones. According to Edgcomb and Thetford (2004), there are reasons that contribute to IE in a rural setting. Some of these are, lack of good employment opportunities, small-scale returns of many rural jobs and inability to manage when scale increases. Urban population contributes less to IE than rural population (Sethuraman, 1978; Chen, 2007).

Education and IE.

McGrath,and King (1994) in a report noted that lack of education and training is a major concern for the development of informal sector in economy. Becker (2004) cites that IE predominantly provides employment opportunities for primary school leavers or totally uneducated people. Cunningham and Gomez (2000) also noted the low level of education among contracted and self-employed workers who contribute to IE.

Gender and IE.

Blunch et al. (2001) observed that there is a majority of women in the informal sector. Many reasons have been provided for this. Some scholars think that women are not in formal sector as formal sector has failed in properly recognizing household activities; others feel more women are in IE because of its ability to mingle with the household work easily. (Beneria and Roldan, 1987)

> *H4:   Nations with a high level of rural population, low level of education or high percentage of females will have a high rate of IE.*

Other Hypotheses

It is also postulated that regulation will be associated with (negatively) software piracy and (positively) ICT product adoption. ICT brings in new issues such as privacy, security, protection rights in the internet which require better regulations for proper functioning.

> H_{5a}:   *Nations with a high rate of ICT product adoption will have a better regulation*
>
> H_{5b}:   *Nations with a high rate of ICT product adoption will have a low rate of software piracy.*
>
> H_{5c}:   *Nations with better regulation will have a low rate of software piracy.*

In this article we also consider the changes in national IE values between 1999 and 2007 (the period chosen is dictated by data availability) and see if these changes were caused by same set of antecedents. Although changes are not substantive in many nations, for some nations such as Brazil, India, China and UK, IE has reduced by 10.29%, 10.78%, 9.85% and 34.38% respectively, during these years.

Changes in IE Over time

Since IE develops differently in various nations, countries are not in the same stage of development and since over the years nations exhibit different economic, regulatory and technological developments, it is likely that all antecedents will not be equally relevant over the years in contributing to IE growth.

> *H6 . Significance of Impact of Causes of IE will not be same over time (for example, in 2000 and 2006).*

Developing and Developed Nations

We also want to investigate whether the role of ICT products and phenomenon and other determinants on IE as described in this paper has been different in developing and developed nations. In developing and developed nations, IE may not have progressed in a similar rate. According to Becker (2004), the nonagricultural employment share of the informal workforce is 78% in Africa, 57% in Latin America and the Caribbean, and 45–85% in Asia. New opportunities and negative impacts due to trade and industry liberalization have both affected developing and developed nations. Increased globalization generated by ICT products has resulted in restructuring of production and distribution resulting in larger growth of IE. Large companies/multinationals moved their jobs to developing nations (which has low labor costs) and sometimes used informal employment arrangements (Carr and Chen, 2001). Since for developing nations, ICT product adoption is low compared to developed nations and since IE-related activities are much higher in developing nations, it can be expected that the effect of ICT products on IE will be lower in developing nations. Since SP is typically higher in developing nations, the influence of it may be stronger on IE in developing nations.

> *H7 . ICT products and phenomenon will have different influences on IE in developing nations compared to developed nations.*

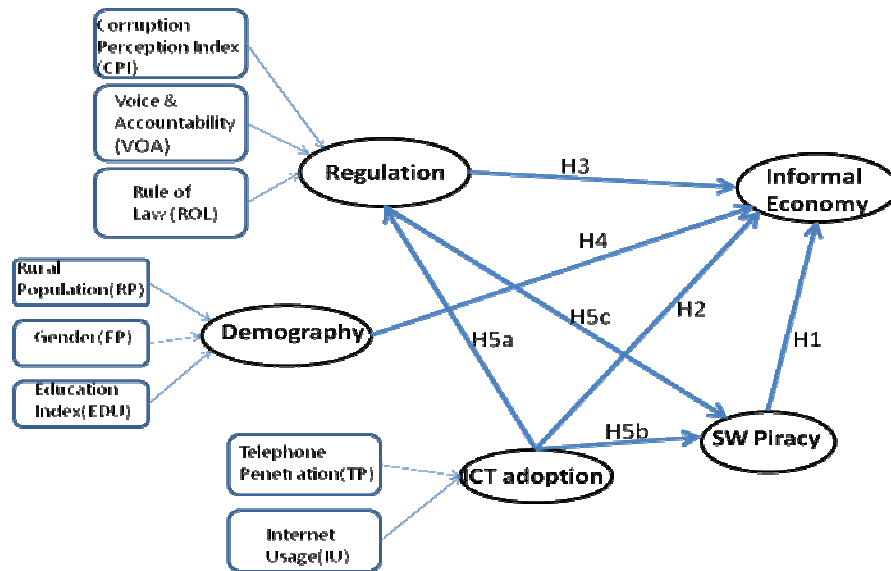The basic research model is given in Figure 1.

Figure 1. The Model. IE and Possible Causes

DATA AND METHODOLGY

Data

We tested our research hypotheses on a cross-section of nations. The measures, data sources, and explanation of each of the factors are summarized in Table 1. The World Bank study report (Schneider et al., 2010) provided data on IE as a percentage of GDP (for the years 1999 – 2007), which is used as a main dependent variable of interest. Our other variables are ICT product (such as the Internet and telephone) adoption data from World Bank database, primary/secondary education level per 100 population of each nation from UNDP, SP rate data from BSA/IDS database, rural population, gender ratio data from World Bank, Corruption Perceptions Index (CPI) is obtained from Transparency International. Finally, VOA and ROL data are from Kaufmann's data on regulations, as available through World Economic Forum database. For testing hypotheses H1-H6 we used two years of data, 1999 and 2006. For testing hypothesis H7, we divided the sets into total number of nations (developed and developing) and developing nations only with the presumption that any difference in result between the two sets would be due to the sets of developed nations. The total number of data for year 2006 was 107 nations. This set represents all the major nations in world in terms of population. Missing data existed for 2000 data set which was replaced with appropriate group means of nations. Correlations were conducted for 2000 data set with other year datasets (2004-2010) for variables with missing data after replacement. The weakest correlation resulted for SP data of 2000 and later years which varied within 0.5-0.6 range.

Causes	Source	Average Value Meaning
Variables		
IE	The World Bank Study Report (Schneider et al., 2010)	Represents Informal economy as a percentage of "official" gross domestic product for 2000 and 2006
ICT Variables		
IT index	The World Bank Database	Average of Adoption of Telephone and Internet (per 1,00 population) 2000, 2006
Software Piracy Rate	BSA/SPA Global Software Piracy Study 2002, 2007	Piracy rate(software pirated/total amount of software installed) 2000, 2006
Regulatory Variables		
Corruption Perception Index	Transparency International site	CPI ranges between 10 (highly uncorrupt) and 0 (highly corrupt) for years 2000, 2006
Voice and Accountability(VOA)	World Economic Forum	Ranges between 2.5(high VOA) and -2.5(low VOA) for years 2000, 2006
Rule of Law (ROL)	World Economic Forum	Ranges between 2.5(high ROL) and -2.5(low ROL) for years 2000, 2006
Demographic Variables		
Education	UNDP, Human Development Report 2002, 2007	Education Index ranges between 1(high) and 0(low) for years 2000, 2006
Gender	World Bank	Female population as % of total population for 2000, 2006
Rural Population	World Bank	Rural population as % of total population for 2000, 2006

Table1. Study Variables

Methodology

We analyzed the data using structural equation modeling (SEM) approach with WarpPLS 2.0 software that applies the partial least squares (PLS) technique (Kock, 2011; http://www.scriptwarp.com/warppls). SEM is superior to simple regression in that it allows simultaneous assessment of multiple dependent and independent variables (Gefen, Straub and Boudreau, 2000). PLS is an advanced statistical technique that allows empirical assessment of a structural model along with its measurement model. It is a component-based SEM, in comparison to LISREL or AMOS which are covariance-based. The structural model develops a causal relationship between the various dependent and independent constructs whereas the measurement model links each construct with a set of indicators or components measuring the construct (Keil, Tan, Wei, Saarinen, Virpi and Wassenaar, 2000). PLS is known for being used in studies where the sample size is small. We use PLS in our model because it is suitable for exploratory research and theory development as is the case in our study. We tested the research model in two steps (Anderson & Gerbing 1988).

Step1: The quality of the measurement model was assessed from its overall fit and factorial validity using convergent and discriminant validity (Gefen & Straub, 2005).

Step 2: The hypotheses of our study were tested by examining path effects and significance levels in our hypothesized structural model.
Additionally, in order to test H7 and H8, we used multi-model comparison using a WarpPLS macro, based on Chin's P-test (Kock, 2011, Eberl, 2010).

RESULTS AND DISCUSSION

We tested our model on three datasets.

(i)   The entire dataset for 107 nations for the year 2000 is represented by Model1 (M1).

(ii) The entire dataset for 107 nations for the year 2006 is represented by Model2 (M2).

(iii) The dataset of 82 developing nations for the year 2006 is represented by Model3 (M3).

Measurement Model

The Average Path Coefficient (APC) and Average R-Squared (ARS) both have p-values less than .001 for all three models. This is less than the recommended maximum limit of 0.05 required for the model to fit with the data. Also the Average Variance Inflation Factor(AVIF) for all the three models is lower than the recommended maximum limit of 5 (Kock, 2009). Thus the results show that the three models have adequate predictive and explanatory power as all the three criteria are satisfied.

Our research model has three latent variables, two having three components each and one having two components. We conduct convergent and discriminant validity in order to assess the factorial validity of such reflective latent variables. Convergent validity is the extent to which items are thought to reflect one particular construct (Straub, Boudreau, & Gefen 2004). We tested convergent validity by examining the structure loadings of the components on the reflective latent variable and found acceptable results in Table 2a:

(i)   The structure loadings of the components on the respective latent variables are greater than the recommended threshold of 0.5 and significance-levels of p<0.001 for all the three models (Hair, Anderson, & Tatham 1987).

(ii) The cross-loadings on other factors were lower than the corresponding structure loadings.

	Regulation			Demography			ICT			SP			IE		
	M1	M2	M3	M1	M2	M3	M1	M2	M3	M1	M2	M3	M1	M2	M3
CPI	.913	0.946	0.929	-.469	-.593	-0.511	0.829	0.877	0.768	-0.714	-.883	-0.807	-.653	-.668	-0.499
VOA	.950	0.958	0.939	-.281	-.332	-0.176	0.653	0.681	0.474	-0.615	-.745	-0.633	-.593	-0.56	-0.361
ROL	.962	0.961	0.96	-.278	-.397	-0.286	0.711	0.723	0.6	-0.709	-.756	-0.672	-.622	-.659	-0.511
RP	-.351	-.458	-.379	.890	0.888	0.878	-.624	-0.641	-0.622	0.332	0.618	0.554	0.379	0.398	0.308
FP	.033	-.065	-.151	-.277	-.256	-0.184	0.067	0.113	0.07	0.022	0.052	0.147	0.097	0.112	0.177
EDU	.326	0.428	0.281	-.923	-.921	-0.909	0.597	0.72	0.699	-0.213	-.608	-0.499	-0.338	-.432	-0.292
IU	.788	0.719	0.697	-.550	-.732	-0.682	0.969	0.966	0.957	-0.674	-.793	-0.82	-0.63	-.649	-0.494
TP	.713	0.817	0.547	-.716	-.699	-0.72	0.969	0.966	0.957	-0.602	-.884	-0.666	-0.643	-0.66	-0.501
SP	-.721	-.831	-.746	.283	0.643	0.56	-.658	-0.868	-0.776	1.000	1	1	0.46	0.68	0.524
IE	-.660	-.658	-.485	.362	0.425	0.305	-.657	-0.677	-0.519	0.460	0.68	0.524	1.000	1	1
R²	.65	.70	.51							.57	.81	.70	.52	.52	.33

Table 2a. Structure loadings and cross-loadings

(iii)   The Cronbach's alpha and AVE of the Regulation, Demography and ICT adoption were above the recommended conservative threshold of 0.5 for the three models (Fornell & Larcker 1981) as shown in Table 2b.

	Regulation			Demography			ICT		
	M1	M2	M3	M1	M2	M3	M1	M2	M3
Cronbach alpha	0.936	0.952	0.937	-0.793	-.747	-0.560	0.934	0.928	0.909
Average Variance Extracted(AVE)	0.887	0.912	0.888	0.573	0.568	0.544	0.938	0.933	0.917

Table 2b. Cronbach alpha and AVE

Based on these results we can conclude that the components show sufficient convergence towards the three reflective latent variables, Regulation, Demography and ICT.

Discriminant validity is the extent to which items reflect their suggested construct differently from the relation with all other items in the measurement model (Straub et al. 2004). The square root of the average variance extracted (AVE) is much larger than any correlation among the latent variables for all three models. Therefore, we can conclude that the components of all the three latent variables reflect the respective latent variables better than any other measurement items in all three models.

Structural Model

Bivariate correlation coefficients show preliminary support for most hypotheses. Estimated path diagrams are next summarized in Tables 3a-3b.The R square-values of IE in all models varied from 0.33 to 0.52 as shown in Table 2a. The role of SP is evident in all models, so H1 is supported. H2 is weakly supported thus implying the possibility that ICT index may play a weak but still significant role in IE. H3 is also supported. Thus regulation is relevant in IE. H4 is not supported. This shows that demographics does not play a significant role in IE. H5 (a)-(c) are supported. H6 is not supported whereas H7 is supported thus enabling us to conclude that determinants of IE as shown in Figure 1 are equally relevant over time and developing and developed nation models do vary in determinants of IE. Corruption did not come out as significant as a regulation item as many consider IE as an incubator of formal economy and so its role to them is a positive one.

	Yr2000	YR2006	Chin's P-test (p-value of difference)	Significant?(Y/N)
Regulation → SP	-0.427***	-0.373***	0.3650	No
Regulation → IE	-0.250**	-0.221**	0.4376	No
Demography → IE	-0.145	-0.120	.4525	No
ICT → Regulation	0.806***	0.835***	.2760	No
ICT → SP	-0.359***	-0.565***	.0925	Weakly significant
ICT → IE	-0.431***	-0.344*	.3518	No
SP → IE	0.209*	0.281**	.3636	No

*p <0.10, ** p< 0.05 , *** p < 0.01

Table. 3a. Path Coefficients and p-values of difference (Chin's P-test) between years 2000 and 2006

	Yr2006 (total sample)	YR2006 (developing nations)	Chin's P-test (p-value of difference)	Significant?(Y/N)
Regulation → SP	-0.373***	-0.398***	.4359	No
Regulation → IE	-0.221**	-0.152	.3471	No
Demography → IE	-0.120	-0.100	.4555	No
ICT → Regulation	0.835***	0.714***	.0908	Weakly significant
ICT → SP	-0.565***	-0.506***	.3623	No
ICT → IE	-0.344*	-0.289	.4225	No
SP → IE	0.281**	0.257**	.4599	No

*p <0.10, ** p < 0.05 , *** p < 0.01

Table. 3b. Path Coefficients and p-values of difference (Chin's P-test) between total sample and developing nations for year 2006

CONCLUSION

The role of ICT-products and ICT phenomena such as software piracy in IE has been preliminarily investigated in this paper which was lacking in previous research. Like all works, there are several drawbacks of this work. Thus secondary data sets as used in the study render results susceptible and should be interpreted with caution. Impacts of various other variables on IE were not considered. In spite of these drawbacks, the study contributes in several ways. First, the study found evidence that that ICT products and Software piracy (an ICT-related phenomenon) impact IE growth significantly. Second, the study also found that the impact of the set of variables remains unchanged over the years. Regarding the developing and developed nations, we found that incorporation of developed nations does change impact of ICT variables on IE.

Some scholars like de Soto (2000) think that the formalization of property rights for the informal workforce which will help them convert their informally-held assets into real and thus alleviate IE. The results show that use of ICT (products and phenomenon) is related to IE development and growth and these should be taken into serious consideration (such as including them in designing an IE index) in IE studies. Proper actions on ICT-related products and issues can also alleviate IE to some extent. Future research could focus on this aspect.

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