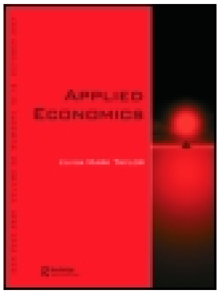

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Economic growth as a function of human capital, internet and work

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The World Bank has suggested the need to enhance Information and Communication Technology skills in all sectors because a 10% increase in internet connectivity was found to boost GDP growth by 1.38%. Simultaneously, the OECD argued that high internet access rates generate a 2% increase in GDP. Because the internet positively affects economic growth, we investigated the relationship between an economically active population, human capital and technology to evaluate these effects in Mexico. A data series from 1991 to 2010 was analysed in three stages according to the least-squares method. A Cobb–Douglas function under the Solow model was considered. Technology and internet access were found to positively affect top-level students and graduate students and thus contribute to the global innovation index.

Keywords: education; internet; economic growth; human capital

JEL Classification: O21; O38; O39

I. Introduction

The World Bank (2012) has suggested a need to promote Information and Communication Technology (ICT) potential in all sectors and transfer this potential to the market through national technology programmes, open cooperative platforms and innovation funds, all of which can promote the growth of technological skills and competencies in higher education institutions and research centres. The public sector can play an important collaborative role by creating digital content that establishes close collaborations with universities, the private sector and civil society. For this purpose, the World Bank performed an econometric analysis with a panel of 120 countries and found that a 10% increase in high-speed internet connectivity boosts the annual GDP growth in emerging countries by 1.38%.

Buttkereit *et al.* (2009) estimated that a 10% increase in home internet access resulted in a GDP boost that ranged between 0.1% and 1.4%. Likewise, in a study conducted by the OECD, authored by Friedrich *et al*. (2009) and cited by the World Bank (2012), high-income countries with high levels of broadband penetration had GDP growth rates of 2%.

Governments seek better connectivity to generate increased growth in electronic administration services and to improve high-speed internet access in governmental offices, local governments and universities. Governments invest in telecommunications and other infrastructure to establish real-time communications and minimize information security risks. The World Bank suggests that priority should be given to shared information centres (data centres) that are sustainable, profitable, energy efficient and applicable to all government institutions. Likewise, governments can promote the use of ICTs in the private sector, especially in SMEs, through the creation of incentives because ICTs help these companies to reduce corporate costs, improve internal management

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and broaden access to new technologies and market opportunity information (World Bank, 2012).

On one hand, the global innovation index (GII) reflects the importance of innovation as a driver of economic growth and prosperity; on the other hand, the GII indicates a need for the adoption of broad horizontal innovation perspectives that can be applied to both developed economies and emerging economies and that include more detailed indicators, compared to those that have traditionally measured innovation. The GII is a valuable tool for comparative analyses that facilitate dialogues between the public and private sectors and can be used by policymakers, corporate leaders and other stakeholders who are interested in assessing progress in real time. Mexico has a GII score of 32.9 on a scale of 0–100 (100 being the best score); thus, it is classified as a higher middle-income country (Soumitra, 2012).

The Economist Intelligence Unit (2012) indicates that food provisions cannot always reach their intended destinations due to physical, political, economic and market limitations. Food insecurity is costly, as it increases health costs and decreases labour productivity. Therefore, the global food security index (GFSI) was created to evaluate food security in three international dimensions: affordability, availability and use (quality and security). In this article, we will study *availability* as a parameter of agricultural innovation and technology to increase efficiency and access through the use of ICTs.

The purpose of this article is to generate recommendations that will promote an increased GII in Mexico through a higher level of ICTs in internet penetration, computers, human capital and educational expenditures, which affect schools, professors, hardware and software because these are the base indicators of the index.

This article studies the variables of internet and educational impacts, which contribute to both the GII and GFSI scores. The hypothesis of this article considers that human capital, technological capital and work have positive impacts on economic growth. This finding agrees with the World Bank, the OECD and Buttkereit *et al.* (2009), all of which suggest the promotion of ICT skills in all sectors, including education, and increased government involvement in telecommunications infrastructure growth because an increase in ICTs with regard to internet penetration generates GDP growth.

Pohjola (2000) studied the effects of information technology investment on economic growth in a transversal section of 39 countries during a period from 1980 to 1995 by applying an explicit economic growth model through an extended version of the neoclassical Solow growth model. The results indicated that physical capital is a key factor of economic growth for both developed and developing countries.

Neira (2007) performed a study of 19 OECD countries during a period from 1965 to 1990 and analysed the direct effects of education on the production function per capita via a Cobb–Douglas production function, which considered GDP per capita and the educational level of the population and found that human capital had a doubly positive effect on the GDP per capita and that education also affected labour productivity. Neira also suggested that human capital was an independent area of investigation and an important factor in economic growth theories. Neira concluded that the countries that achieved maximum educational levels in the twentieth century correlated with those that achieved the highest economic growth, even in the cases of countries with few natural resources.

Reynolds (2009; cited by West, 2011) analysed the role of communications infrastructure investments in the economic recoveries of OECD countries and found that nearly all of the technological developments were considered crucial to the economic stimulus packages. That study showed a strong relationship between investments and telecommunications economic growth, especially during recessions. Such investments promoted employment and laid the foundations of long-term economic growth.

West (2011) studied two representations of technology, the generation of innovation and the creation of economic prosperity. The author made recommendations for policies, based on the work of various researchers, with the aim of promoting innovation economy growth by adopting permanent research and development policies through a programme based on tax deductions, efficient knowledge generation at universities, improved worker training, reasonable migration reform and regional economic clusters. West concluded that an innovative economy can be created and long-term prosperity can be sustained.

Fong and Holland (2011) conducted a study in China and Hong Kong that involved 122 professors who offered their opinions on the ease and utility of using ICTs as support tools in education. The researchers concluded that professors with better understandings of ICTs had a positive impact on the use of ICT-based teaching and learning tools. Furthermore, Peeraer and Petegem (2011) analysed the use of ICTs in Vietnam as training tools for professors. The authors worked with 783 faculty members from five institutions and concluded that the most qualified professors tended to use more diverse ICTs and that these professors used ICTs more often than the professors with lower ICT skills. The study also found that ICT skills and confident computer use were the factors that determined the use of ICTs in teaching.

Nair *et al.* (2012) investigated the relationship between English teaching and ICTs used in classrooms in Malaysia because ICTs have been found to facilitate students' learning processes. The authors found that the teachers had positive attitudes towards ICTs, and the teachers' levels of proficiency with ICTs were also satisfactory.

Işık (2011) studied the relationship between technology and a knowledge-based economy as an objective of economic and productivity growth by using an autoregressive model with distributed lags to determine the evidence of causality between economic growth and technology as a short- and long-term investment. The results showed that in Turkey, ICTs positively affect short-term economic growth, but negatively affect long-term growth. Likewise, the author mentioned that economies that wish to create competitive advantages could increase prosperity and achieve their goals of becoming ICT-using societies.

Ahmed and Ridzuan (2012) studied the impact of ICTs on economic growth, according to the production function of capital and labour. Investment in telecommunications was used as a proxy with which to measure the contribution of ICTs, a new independent variable, to production growth in Malaysia, Thailand, Singapore, Indonesia, the Philippines, Japan, Korea and China. The results indicated that telecommunications labour, capital and investments correlate positively with GDP. The authors concluded that ICTs play an important role as a driver of sustainable growth and suggested broader cooperation with China, Japan and Korea through the exchange of knowledge, especially with regard to ICTs.

In Europe, Lucchetti and Sterlacchini (2004) performed an econometric analysis in 1999 on the use and effectiveness of ICTs; this analysis was performed on a sample of 514 SMEs in the Ancona province in Italy, which is considered a middle-income region. The results showed that the penetration of ICT use was associated with workers with higher educational degrees and, ultimately, with the presence of companies in foreign markets, while the adoption of ICTs depended on the size of the company relative to its peers, the use of advanced information technologies in production and the educational level of the workforce. The authors indicated the human capital improvement in SMEs as a key factor.

In Greece, Skordili (2008) studied the relationships between the indicators that affect technology, the internet and technological capacity. The study found that the internet is an important growth variable that can strongly influence people, places, societies and economies. The author also considered that this effect could grow in the foreseeable future.

Likewise, Antonopoulos and Sakellaris (2009) studied the relationship between ICT investments and economic growth with an applied neoclassical growth model. The authors found that for the period from 1996 to 2003, ICT service investments contributed 0.75% of the total growth rate. Additionally, the authors commented that ICT investments have been the driving force behind total factor productivity growth in the developed countries during recent years and that these investments are also a primary reason for increases in the total factor productivity growth rate.

Katz *et al.* (2010) studied the relationship between workplace broadband technology investments and German economic production. The authors analysed two sequential investment scenarios; the first scenario reflected the National Government's strategy for broadband internet, which extends to 2014, and the second scenario accounted for the evolution of ultra-broadband internet between 2015 and 2020. The authors concluded that the required investment of 36 billion Euros is justified due to the important benefits that would be generated in terms of employment and GDP growth.

Aoun (2012) studied the relationship between companies that do and do not use ICTs by applying a model based on dynamic capital structure. This study was performed on a sample of companies from the United Kingdom. The results indicated that the leverage indices of companies that use ICTs are more sensitive to income levels, singularity and virtual business crises than those of companies that do not use ICTs.

Edwards and Ford (2001) studied the role of internet information technology and the 'new' economy of Latin America and analysed the channels through which internet technology and information promote productivity growth and overall economic performance. Edwards and Ford argued that, to fully take advantage of this new technology, Latin American countries required large investments in complementary areas such as research, development, education and infrastructure. He also found that, if the countries in this region did not implement important institutional and economic reforms, information technology investments would only have a small effect on growth.

In the United States, Dedrick *et al.* (2003) demonstrated that labour productivity increased in industries that intensively used ICTs. Likewise, Venturini (2009) studied the impact of digital capital growth in the United States and 15 EU countries from a long-term perspective and estimated production elasticity with respect to ICTs within a production function framework through a cointegration analysis. The study results showed that ICT capital significantly boosted GDP growth.

Mayo and Wallsten (2011) analysed the relationship between internet externalities and economic growth that were associated with the implementation of broadband internet infrastructure in the United States. The authors found that theoretical and empirical models that adequately distribute broadband microtransmission routes could improve economic production, employment and productivity.

Baily *et al.* (2011) organized a meeting with public- and private-sector leaders to explore the reasons behind innovation-based economic growth in the United States. The authors brought together the most important industries, including information technology, communications, the communication media, manufacturing, resources, the defence industry and green technology. The authors proposed the design of innovative strategies to increase national economic production to its potential level through the promotion of all levels of innovation (basic science breakthroughs, technology, future industries, process efficiency and revolutionary business models). The authors further proposed investments in key factors of the future economy, including innovation, global markets, human capital, energy cost reductions and improvements to government innovation and performance.

In Mexico, Dieck-Assad and Peralta (2013) showed that energy is one of the pillars of productivity growth, irrespective of capital and new technology.

II. Descriptive and Methodological Section

A simultaneous equation model was formulated for reflecting economic theory to an analysis of education and technology through statistical methods, we submit an econometric model of simultaneous equations that can predict the performance of relevant variables. The endogenous variables that define the problem are the percentage of the population that uses the internet, the percentage of the population in college or postgraduate studies and the GDP. The predetermined values are mobile phone users, internet costs, computers, income per capita, educational expenditures, population agglomerations of more than one million inhabitants and the percentage of the population that is economically active.

The study was conducted in Mexico, with data from the Ministry of Public Education (SEP), the National Institute of Statistics and Geography (INEGI), the National Association of Universities and Higher Education Institutions (ANUIES), SELECT-IDC and Bank of Mexico; the economic data are reported in real pesos. A sample was chosen for a time period from 1991 to 2010.

The econometric model was estimated in three stages through the least-squares method (3SLS), which employed a simultaneous function adjustment with the SYSLIN procedure in SAS (Copyright (c) 2002 by SAS Institute Inc., Cary, NC, USA) version 9.0. This procedure estimated the parameters of an interdependent linear regression system because SYSLIN provides various techniques that produce consistent and asymptotically efficient estimates for regression equation systems. The 3SLS method estimated each of the model equations with the 2SLS method by calculating the residues to estimate the matrix of variances and covariances and to subsequently apply the feasible generalized least squares to the complete model. This method is more efficient than the two-stage least-squares model when there is a contemporary correlation between the variables. On the economic side, results were analysed by the sign of the expected estimators and by the magnitude of elasticity coefficients obtained by two manners: structural and reduced. Elasticity in the structural form shows the short-term effect in some variables and in the reduced form shows simultaneity effects in the model as well as linkage of predetermined endogenous variables.

We introduce a Solow model with the following characteristics. We assume that competitive firms produce a homogeneous good, Y, by combining physical capital (K), human capital (H) and labour (L) (Barro and Sala Martin, 2009), respectively, through the constant returns to scale Cobb–Douglas technology, the following equation results.

$$Y = AK^{\alpha}H^{\beta}L^{\chi} \tag{1}$$

We assume the marginal productivity of the factors to be positive, but decreasing; also, we assume the marginal productivity of the capital to approach zero when the capital tends to infinity and infinity when the capital tends to zero. The Inada conditions are satisfied thereby. The same applies to the labour factor.

Gujarati and Porter (2010) indicated that a special feature of simultaneous equation models is that the dependent variable of the equation might appear as an explanatory variable in another equation within the system. Therefore, this explanatory dependent variable becomes a stochastic variable and usually correlates with the error term of the equation in which it appears as an explanatory variable. The proposed model is made up of three equations, all of which are functional equations. The model also has three endogenous and seven exogenous variables, which are shown in Fig. 1 and described in Table 1.

We established the following instrumental variables: internet–computer elasticity, which measures the intensity with which internet users respond to a variation of computers in percentage terms; the percentage of professors per student; the number of computers lagged by one period; the number of computers lagged by two periods; the broadband subscriber index; internet demand price elasticity; the percentage of population agglomerations of more one million inhabitants compared to the Mexican population lagged by one period; the cost of internet lagged by one period; GDP per capita lagged by one period; the percentage growth of schools lagged by one period and mobile phone users lagged by one period. The simultaneous equation system is as follows:

$$X_3 = I_0 + I_1(X_4) + I_2(X_5) + I_3(X_6) + I_4(X_7) + U_1 \tag{2}$$

$$X_2 = A_0 + A_1(X_8) + A_2(X_9) + A_3(X_3) + U_2 \tag{3}$$

$$Y_1 = E_0 + E_1(X_1) + E_2(X_2) + E_3(X_3) + U_3 \tag{4}$$

The steps to the selection of the model were: (1) theoretical approach of the model – which was based on Solow Swan, (2) assumptions, (3) development of

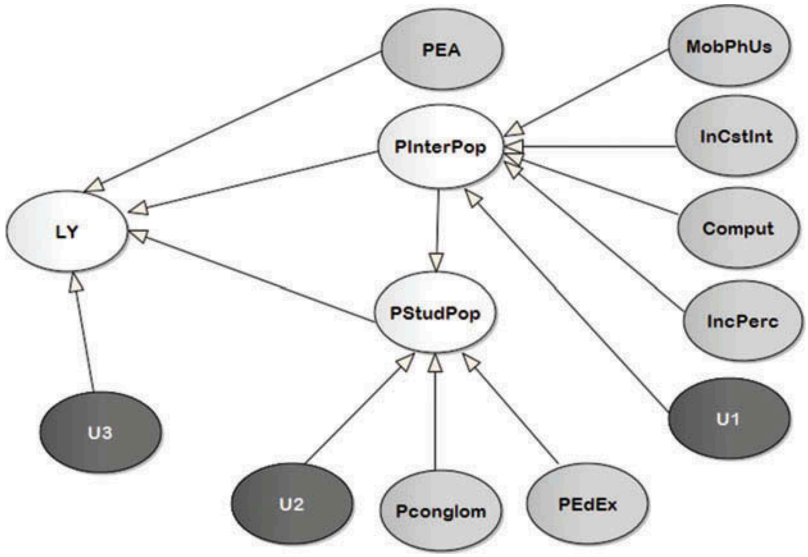

Fig. 1. Econometric model with endogenous and exogenous variables

Table 1. Study variables

Variable	Description	Type and relation
PInterPob (X_3)	Percentage of the population using the internet (in logs)	**Endogenous**, related to the PStudPop and LY variables in the entire model; it will also be considered physical capital and technology for the economic growth function
PStudPop (X_2)	Percentage of the population who are college or graduate students (in logs)	**Endogenous**, related to the LY variables as human capital for the economic growth function
LY (Y_1)	GDP in real pesos (in logs); the total value of all goods and final services produced by the economy in a concrete period which is usually a year (Krugman and Wells, 2007)	**Endogenous**, includes the variables PInterPop and PStudPop
MobPhUs (X_4)	Mobile phone users (in logs)	**Exogenous**, related to the PInterPop variable because mobile phones influence the internet
InCstInt (X_5)	Index created for the cost of internet (in logs)	**Exogenous**, related to the PInterPop variable because the cost of the internet influences its use
Comput (X_6)	Number of computers (in logs)	**Exogenous**, related to the PInterPop variable because computers are the basic equipment for internet use
IncPerc (X_7)	Income per capita (in logs); obtained by dividing the total income in Mexico by the number of inhabitants	**Exogenous**, related to the PInterPop variable because internet use depends on income
PEdEx (X_8)	Percentage of educational expenditure dedicated to the higher education and postgraduate levels in real pesos relative to GDP (in logs)	**Exogenous**, related to the PStudPop variable because the number of alumni depends on the educational expenditure on schools, professors, libraries and other infrastructure
Pconglom (X_9)	Population agglomerations with more than one million inhabitants (in logs)[a]	**Exogenous**, related to the LY variable because as population agglomerations grow, they require greater communication through web information systems
C_PEA (X_1)	Percentage change in the economically active population	**Exogenous**, related to the LY variable because labour is part of the economic growth function
U_1, U_2, U_3	Estimation errors	

Notes: [a]An urban agglomeration is a spatial concentration of economic activity in cities. One reason for which agglomeration takes place is increasing external returns, also known as economies of agglomeration. Theoretical research has identified various sources of economies of agglomeration, including labour market pooling, input exchange and knowledge diffusion. Empirical research has offered evidence for each of these sources.
Source: Strange (2008).

the mathematical form of the model and identification of the main variables and functional relationships of the same, (4) functional development of the econometric model, (5) data collection, (6) selection of variables with partial significant regression coefficients, (6) estimation of the coefficients of the econometric model and (7) validity of the model through the application of statistical tests.

III. Results and Discussion

The statistical results are shown in their structural forms in the model estimation (Table 2). Three functional relationships showed acceptable R^2 coefficients, between 0.96 and 0.99, along with their respective *t*-statistics and probability values; besides, the probability of finding a tabular *F* greater than the estimated is very low, less than 0.01%. Therefore, based on the *F* test, the model works adequately. The endogenous technological values, defined as the percentage of the population that uses the internet (PInterPop), positively affected the mobile phone users, computers and income per capita variables, which boost GDP, while the cost of internet index variable had a negative impact, which suggested that internet access price increases are harmful in terms of increased internet use.

The endogenous human capital variable, defined as the percentage of the population who are college or graduate students (PStudPop), positively affected all of its exogenous variables, which included the education expenditure as a percentage of GDP, percentage of population agglomerations with over one million inhabitants and the technology variable.

The most important endogenous variable in this study, GDP (LY), which includes the other two endogenous variables of PInterPop and PStudPop while also including the percentage of economically active population, also had a positive effect. Furthermore, the individual participations of the model variables were *t*-tested and should exceed a value of 1, which implies that the estimated parameter (statistic) is greater than the SE. With this criterion, the explanatory variables were shown to be significant. Table 3 shows the coefficients in reduced forms, wherein the effects of the predetermined variables on the endogenous variable can be observed.

In Table 3, we report the reduced-form coefficients of the endogenous model variables, allowing us to determine the effects of the dependent variables that appear as explanatory variables in the functional relations. From an economic point of view, the results were analysed both for the

Table 2. Mexico: coefficients of the structural form, estimated for human capital and technological capital, 1991–2010

Dependent variable	Intercept	Exogenous variables				R^2	Prob > *F*
PInterPop		**MobPhUs**	**InCstInt**	**Comput**	**IncPerc**	0.9949	0.0001
Coefficient	−45.2968	0.8954	−1.0711	0.3498	2.552	(0.9934)	
SE	14.2001	0.1794	0.4618	0.2056	1.3881		
t-Value	−3.19	4.99	−2.32	1.7	1.84		
p-Value	0.0066	0.0002	0.036	0.1109	0.0873		
PStudPop		**PEdEx**	**Pconglom**	**PInterPop**		0.9972	0.0001
Coefficient	−19.1394	0.0496	5.5812	0.0196		(0.9967)	
SE	1.3804	0.0209	0.3877	0.0039			
t-Value	−13.86	2.37	14.39	4.98			
p-Value	<0.0001	0.0317	<0.0001	0.0002			
LY		**C_PEA**	**PStudPop**	**PInterPop**		0.9689	0.0001
Coefficient	29.3387	0.0072	0.3328	0.0383		(0.9627)	
SE	0.1052	0.0025	0.1551	0.0125			
t-Value	278.85	2.89	2.15	3.05			
p-Value	<0.0001	0.0112	0.0487	0.0082			

Table 3. Coefficients in reduced form, estimated for human capital, technological capital and the production function

		Exogenous variables						
Dependent variable	Intercept	MobPhUs	InCstInt	Comput	IncPerc	PEdEx	Pconglom	C_PEA
PInterPop	−45.2968	0.8954	−1.0711	0.3499	2.5521	0	0	0
PStudPop	−20.0315	0.0176	−0.0211	0.0069	0.0503	0.0497	5.5812	0
LY	20.9369	0.0402	−0.0481	0.0157	0.1148	0.0165	1.8576	0.0073

signs of the estimators and for the magnitude of the reduced-form coefficients, according to the assumption of *ceteris paribus* and the mean values of the variables from 1991 to 2010.

The use of GDP, education as human capital (which included educational expenditure as an investment), the internet as technology and the economically active population as labour as the principal indicators yielded a 1% increase in mobile phone users and boosted GDP growth by 0.0402%. If the internet cost index increases by 1%, GDP will decrease by 0.0481%. If the quantity of new computers increases by 1%, GDP will increase by 0.0157%. If the income per capita increases by 1%, GDP will increase by 0.1148%. If the government increases public expenditures for higher and graduate education by 1%, GDP will increase by 0.0165%. For each 1% increase in population agglomerations of more than one million inhabitants, GDP will increase by 1.8576%. If the economically active population increases by 1%, GDP will increase by 0.0073%.

These results are consistent with those reported by Pohjola (2000), Dedrick *et al.* (2003), Neira (2007), Skordili (2008), Antonopoulos and Sakellaris (2009), Venturini (2009), Katz *et al.* (2010), Baily *et al.* (2011), Mayo and Wallsten (2011), Işık (2011), West (2011) and Ahmed and Ridzuan (2012).

The results from Table 3 show the existence of direct relationships between GDP and education as human capital, the internet as physical capital and technology because the coefficients (users of mobile phones, computers, income per capita, educational expenditure and population agglomerations) all have positive effects, except for the internet cost index. These findings agree with those of the World Bank, the OECD, Dedrick *et al.* (2003), Lucchetti and Sterlacchini (2004), Skordili (2008), Antonopoulos and Sakellaris (2009), Mayo and Wallsten (2011) and West (2011).

The coefficients of the structural form show the short-term effects of some of the variables, and the reduced-form coefficients are those in which we observed the simultaneous effects of the model and the links between the predetermined and endogenous variables.

IV. Conclusions

From the data shown in Table 3 with respect to human capital, we conclude that in Mexico, education, mobile phone access, computer and internet access, income per capita, educational expenditures (including faculty wages) and population agglomerations have positive impacts on economic growth. At the same time, the implementation of these factors results in a higher-quality education because students can develop new abilities in an educational system that can be supplemented with real-time multimedia content (internet). This coincides with the findings of Neira (2007), Venturini (2009), Işık (2011), Peeraer and Petegem (2011), Fong and Holland (2011), Baily *et al.* (2011) and Nair *et al.* (2012).

Public policies in Mexico should promote educational investments in human capital and technological parameters (in this case the internet and computing) that contribute to accelerated economic growth through innovation and increase the GFSI through food availability by implementing intelligent systems to control and send surplus food from Mexico to other countries. This would result in greater commercial opportunities through the electronic government that are capable of managing alert systems for climatological disaster warnings and communicating these through social networks and information systems as proposed by CEPAL *et al.* (2011). Therefore, it is important to increase public expenditures for educational research and development to generate qualified personnel who can create these systems and thus increase the GII score.

With regard to aspects of educational programmes, we report that this proposed model, which is based on the endogenous growth model, the AKLH model, capital and human capital externalities, and which assumes that all per capita growth is due to technological progress (ICTs in education), can be useful for improving the educational system.

The following points to be considered in educational public policy are put forth as recommendations:

(1) Increase public expenditure investments dedicated to education (schools, professors, computers and internet access).
(2) Support motivational programmes for faculty members to increase the use of ICTs through educational materials in order to promote a higher educational level through a system of incentives (economic and noneconomic); these will influence the use of multimedia educational materials on the internet by professors and their students, promote the use of ICTs and forge innovation. Thus, the GII score will increase and assure greater availability in the GFSI index.
(3) Promote the production of virtual online educational materials to increase quality education in a manner supported by technology in order to boost innovation and increase the GII and GFSI scores through information applications that are supportive of logistical commercial policy systems with regard to production and product sales and guarantee food availability and access through an adequate supply. This would promote better scores in Latin America and increase global position in the GFSI, decrease food insecurity-related health

costs and increase labour and academic productivity due to the availability of higher-quality protein, which in turn avoids current dietary imbalances between carbohydrates, fats and proteins.

(4) Increase and redistribute public expenditures for technological infrastructure that permit increased internet penetration and GII scores, while achieving a commercial opening based on government innovation policies that boosts the GFSI score in the public expenditure on research and development indicator. The GFSI score is an agricultural innovation and technology parameter that increases market efficiency and market access, which in turn is expected to increase food availability and access while simultaneously boosting GDP.

(5) Increase technological infrastructure with regard to hardware in order to create more public virtual workspaces that generate innovation.

(6) Promote technological initiatives in software and hardware to generate greater innovations in comprehensive information systems for all organizations that contribute to production and logistics.

(7) Generate new academic units to generate better human capital that will subsequently generate more innovation initiatives.

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