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The Impact of Information and Communication Technologies on Economic Growth in Mexico

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ABSTRACT

The World Bank has stated that mobile communications are important for economic growth. The objective of this research is to perform an analysis the impact of the use of Information and Communication Technologies (ICT), in terms of mobile phones, computers, the internet, fiber optics and the price of the internet, as well as gross capital formation fixed and the economically active population, to see their relationship in the Gross Domestic Product (GDP) or economic growth in Mexico and generate recommendations based on ICT. The three-stage least squares method was used to examine a 1990 – 2014 data set. A Cobb-Douglas function was considered with the Solow model. The results show that a positive impact was found for mobile phones, computers, the Internet and fibre optics that favours GDP levels, but the Internet price variable was found to have a negative impact. The principal contribution is that in Mexico the population should be Motivated mobile telephony investment, however the government should provide training on its use, because in some countries like Uganda, China, 22 countries of the Middle East and North Africa and others have presented economic growth with the use of mobile phones.

Keywords: Impact of ICT on growth, mobile phone, economic growth, ICT, Internet, economic growth with ICT, economic growth with cell phones.

JEL Classification: O4, O47, O33.

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1. Introduction

The World Bank has identified six billion mobile subscriptions in use worldwide and has shown that roughly three quarters of the global population now has access to a mobile phone. Thus, more people now have access to a mobile phone than to a bank account, to electricity, or even to drinking water (World Bank Information, Communication Technologies & infoDev 2012). Mobile communications now offer strong opportunities for growth in human development, for delivering basic access to education and health information, for cash payment delivery through mobile funds, for business facilitation, and for stimulating citizen participation in democratic processes. Thus, mobile applications enrich the lifestyles of populations by now being considered necessary for numerous activities and by

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growing the economy as a whole. Therefore, it is critically important to study the role of mobile phone use in economic growth.

The World Bank indicates that with the arrival of personal computers, broadband Internet, and mobile phones, ICTs have become an important driver of innovation promotion, increasing company productivity and economic growth. Thus, ICT innovation is being recognised as a source of economic competitiveness (World Bank, 2012). According to the World Bank initiative, will it be possible for ICTs to help generate economic growth? In this research in Mexico, it is possible that it is possible.

The Global Innovation Index (GII) presents: 1) the relevance of innovation as a source of economic growth and wealth 2) the need to adopt a broad perspective on innovation that can be useful to developed and emerging economies 3) indicators used to measure innovation. This index serves as a valuable comparative analysis instrument that facilitates dialogue among sectors like public and private and that can be used by legislators, business leaders in evaluating on-going progress. Mexico's GII is currently ranked 66th out of 143 countries, and it is classified as an upper middle-income country (Dutta, Lanvin & Wunsch-Vincent. 2014). Still, developing and emerging countries are not gaining more from investments in ICT than developed economies, calling into question the argument that these countries are 'leapfrogging' through ICT (Niebel 2018).

The 2013-2018 National Development Plan indicates that mobile phone incursion in Mexico currently matches 86 lines to every 100 inhabitants, unlike 112 lines to the same number of inhabitants in countries such as Spain. Additionally, Mexico occupies last place (78th place) for broadband incursion among all OECD countries: this type of band has an incursion rate of 11.4% in fixed telephony and a rate of 9.6% in mobile telephony. Consequently, according to the World Economic Forum's 2013 Global Information Technology Report, Mexico is ranked 63 out of 144 countries according to the Networked Readiness Index. The Telecommunication Reform, introduced for this reason, seeks to provide incentives for effective competition in all telecommunication sectors to ensure universal television, radio, telephone and data service access for the whole country (de la Federación 2013).

The objective of this work is to perform an analysis the impact of the use of Information and Communication Technologies (ICT), in terms of mobile phones, computers, the internet, fiber optics and the price of the internet, as well as gross capital formation fixed and the economically active population, to see their relationship in the Gross Domestic Product (GDP) or economic growth in Mexico and generate recommendations based on ICT.

For this research, a Cobb-Douglas function was considered with the Solow model, and the three-stage least squares method was used to examine a data set for the period 1990-1914.The results of this investigation include variables that have not been studied jointly by the mentioned authors. The main contribution is that in Mexico the population should be a motivated investment in mobile telephony, however, the government should provide training on its use, since in some countries such as Uganda, China, 22 countries in the Middle East and North Africa and others have presented economic growth. With the use of mobile phones.

2. Literature review

This work examines impact variables of mobile phone usage, which in turn influence economic growth. We hypothesise that physical capital (gross fixed capital formation), technologies (mobile phones) and human capital (economically active population) positively affect economic growth. Therefore, in this section, investigations of different authors are presented that justify this hypothesis

ICT use is necessary to examine economic sciences, as technological progress promotes economic growth and technological innovation serves as a growth driver (Solow 1956; Romer 1990; Rincón 1990; Freeman & Soete 1997). Likewise, ICT are technological tools to facilitate the digital communication by electronic means; this include telephone mobile, computers and Internet (Chetley et al., 2006). It can also include all mobile devices such as tablets, smart phones and laptops.

Analyses of economic growth are based on Solow (1956) and Swan (1956). These are based on a production function with constant to scale returns and diminishing returns for each production factor. A perfectly competitive market is assumed to guide the economy towards long-term sustained balance with full employment while introducing technological progress as the exogenous factor that determines long-term positive growth rates of per capita income (Solow 1957).

The Solow model makes the following predictions. 1) In the long-term, the economy reaches a steady state that is independent of initial conditions. 2) The income level corresponding to the steady state depends on the savings and growth rates of the population. 3) The growth rate of per capita income steady state depends on the technological growth rate. 4) Per capita income of the steady state grows at the same rate as the income level. 5) In the steady state, the marginal product of capital is constant, while the marginal product of work grows in accordance with the technological progress rate. 6) Convergence among homogeneous countries is derived through the model's transition towards the steady state. A country with less initial capital stock per capita and that shares the same steady state as another that is initially farther ahead will show a higher degree of marginal capital productivity (due to decreasing returns of this factor) and thus higher returns, investment stimuli and economic growth.

The ICT revolution fueled by the exponential progress of the technology has become an important driver of economic growth across nations, so every organization can improve its performance with more effective use of ICT (Jorgenson & Vu 2016). Also, the mobile services contribute much more to growth economic, but the effect diminishes as the provincial economy develops more (Ward & Zheng 2016). Furthermore, ICT has the potential to affect many aspects of economic and societal activities such as GDP growth, employment, productivity, poverty alleviation, quality of life, education, and healthcare (Palvia, Baqir & Nemati 2017).

Focusing on the United States, Dedrick, Gurbaxani & Kraemer (2003) found that ICT investments positively affect economic growth. The authors also demonstrated that work productivity levels have increased in industries that intensively use ICTs. Likewise, Venturini (2009) studied the effect of digital growth in the United States and in 15 European Union countries using a long-term approach. The author estimated the production elasticity of ICTs based on a production function framework via cointegration analysis; and they found that ICT capital notably boosts GDP growth. In the United States Internet externalities and economic growth are associated with the implementation of broadband Internet infrastructures (Mayo & Wallsten 2011), so this relationship is very important, and should be implement in the countries. Furthermore, there is interaction between ICT growth and Population growth that is a significant mediator of the relationship between ICT growth and GDP growth; with this interaction variable as a mediator, be predicts that if population stays the same, GDP growth will rise by 0.596% for ever percentage increase in ICT growth (Qureshi & Najjar 2017).

West (2011) studied the role of communications infrastructure investments in economic recoveries among OECD countries and found that nearly all technological development is considered important for economics. The study showed that a solid relationship exists between telecommunication investment and economic growth. These forms of investment help countries create jobs and lay the foundations for long-term economic development. Moreover, the countries should actively engage in both the development of telecommunications infrastructure to levels that include not only computers and internet affordability, but also television, telephones and online newspapers, to economic growth (Pradhan, Arvin & Hall, 2016). Moreover, 3G/4G services improve mobile broadband penetration; the magnitude of the latter being nearly three-times that of the former; besides, it be a positive effect of broadband penetration on economic growth, primarily working through a reduction in broadband prices and well as greater innovation (Ghosh, 2017). Also, the broadband diffusion is both statistically significant and positively correlated with the growth of real GDP per capita (Castaldo, Fiorini & Maggi 2018).

The technology and the knowledge-based economy work together a driver of economic growth and productivity labour (Işık 2013). Ahmed & Ridzuan (2013) studied ICT effects on economic growth based on a standard production function of capital and labour. The authors used Communications infrastructure investments as an indicator to measure ICT contributions; and found that labour, capital and Communications infrastructure investments positively relate to GDP.

Internet is a relevant variable of economic growth and can have a strong effect on general economic (Skordili 2008), also concluded that this effect may grow more prominent in the future. furthermore, Antonopoulos & Plutarchos (2009) investigated the interconnection with ICT investment and economic growth using a neoclassical growth model and concluded that investment in ICT services promoted 0.75 to the overall growth rate; so ICT investment serves as a source to behind total productivity increases in advanced countries. Katz Vaterlaus, Zenhäusern & Suter (2010) investigated

investment effects on labour between broadband telecommunications and economic production in Germany and concluded that investments are justified by essential benefits in conditions of employment and GDP growth. In the same way. Aoun (2012) studied the relationship between companies in the United Kingdom that use ICTs and those that do not by means of a model based on a dynamic capital structure. The results indicate that the leverage ratio of a company that uses ICTs is primarily affected by income variability and virtual business crises, thus differing from companies that do not use ICT.

Farhadi, Ismail & Fooladi. (2012) confirmed the positive impact of ICT use (Internet users, broadband Internet users and mobile Internet users per 100 inhabitants) on economic growth by estimating the generalized method of moments (GMM) for 159 countries. Najarzadeh, Rahimzadeh & Reed (2014) also showed that the Internet has statistically significant positive effects on work productivity. The internet and information technologies help to increase productivity growth and economics in general; also, large investments are necessary in ICT to complement some areas, such as research, development, education and infrastructure, likewise economic growth in a country may exist when Internet users increase and the cost of Internet use decreases; this in order to make the internet more accessible to users (Choi & Yi 2018).

Likewise, Quiroga-Parra & Torrent-Sellens (2015) consider ICTs as the basis of processes of productive transformation that work with other factors (e.g., knowledge and institutions). Evangelista, Guerrieri & Meliciani (2014) indicate that ICT use and digital empowerment directly influence economic effects, especially employment and the inclusion of disadvantaged groups in the labour market. Special emphasis must also be placed on the effect of ICT and non-ICT resource use on economic growth, as Hanclova, Doucek, Fischer & Vltavska (2015) found that a drop in GDP growth in the European Union from 1994 – 2008 was due to slow non-ICT capital growth, overall factor productivity levels and stagnant growth of low elasticity ICT capital.

Vodafone (2005) showed that in Africa, mobile telephony has significantly boosted economic growth, as such technologies have twice the impact in developing countries (an increase of 10 mobile phones increases GDP levels by 0.6% points (Waverman, Meschi & Fuss. 2005). Similarly, for Qiang, Rossotto & Kimura (2009), a 10% increase in mobile incursion in developed countries results in a 0.8% increase in economic growth. Mobile broadband has a greater impact on GDP than fixed broadband (Thompson & Garbacz 2011).

The spread of ICT, through Internet and cellular mobile telephony, have a positive influence in the Australian economic growth (Shahiduzzaman & Alam 2014). Saidi, Hassen & Hammami (2015) showed that in Tunisia, a positive relationship exists between GDP growth and the ICT usage index (measured by the number of mobile phones and by fixed telephone lines). Chew, Ilavarasan & Levy (2015) found that in Chennai, India, mobile phone use for business purposes amplifies the impact of business expectations, resulting in higher microenterprise growth. Similarly, focusing on Indonesia, Anwar & Johanson (2015) emphasised the benefits of mobile phone usage among micro entrepreneurs. The mobile phone has evolved into a smartphone and is an essential part of life today (Linge & Sutton 2016). Moreover, mobile phone subscriptions should remain as the top priority when ICT policies are formulated regardless of income; Moreover, mobile phone subscriptions remain the most robust technology and crucial in improving economic growth (Albiman & Sulong 2017).

Vu (2011) found that in 102 countries there was a positive effect of ICT penetration on economy; there was for computers 0.0156 percentage points, for cell phone was 0.025 percentage points, and 0.08 percentage points for netizens. So it is important the relationship between the use of cellular phone, the internet and computers to have economic growth. Sassi & Goaied (2013) said that ICT penetration (internet, cell phone) has an important and positive causal link on economic growth in 22 countries of the Middle East and North Africa. Blauw & Franses (2016) found a positive impact of the proportion of mobile phone users in the household, because so users can receive information more efficiently and can reduce some communication costs by reducing multiple trips in Uganda.

Therefore, contribute more to household welfare and can quickly change economic development. Mobile services in China contribute more to economic growth (Ward & Zheng 2016). The estimated parameters for the economic growth in cell phone was around 0.017 indicating that 1.7 percent of the GDP growth can be explained by the cell phone subscription in Asian countries (Das, Chowdhury & Seaborn, 2016). Furthermore, the role of ICT in Latin America has been very low,

representing less than one – sixth of the total capital contribution (Hofman, Aravena & Aliaga, 2016). So is important studied the relationship between ICT like mobile phones that positively affect economic growth in Mexico.

3. Materials and methods

3.1 Proposed Model

The model we need to estimate is for assesses the impact of the ICT on the Mexican economy. Our innovation is putting the Mobile phone as an exogenous variable (technological variable); so it is relevant to include it into the equation to be estimated the impact of the ICT on economic.

A Solow model with the following characteristics is introduced. We assume that competitive companies produce homogenous goods, Y, through physical capital combinations (K), human capital (H) and labour (L) (Barro& Sala-i-Martín 2009) of the Cobb-Douglas production function with technology and by means of constant scale returns. This is reflected in the following equation.

$$Y = AK^{\propto}H^{\beta}L^{\chi} \quad (1)$$

It is assumed that the marginal productivity of the factors is positive but decreasing. Additionally, we assume that the marginal productivity of capital approaches zero when capital tends toward infinity and that it tends toward infinity when capital approaches zero. In turn, the Inada conditions are satisfied. The same is applied for the labour factor.

The model for estimation takes the Cobb–Douglas functional form and it was considered by a Solow model, this is reflected in the following equation:

$$Y = GFCF^{\propto}MobPhUs^{\beta}EAP^{\chi} \quad (2)$$

where

Y: represents the gross domestic product and three exogenous variables

GFCF: represents the Gross fixed capital formation indicates the physical capital (K)

MobPhUs: represents the Mobile phone, it is the variable that expresses technology in the human capital (H)

EAP: represents the Economically active population change rate as physical capital (L)

For the calculation of these variables in equation 2, an econometric model of simultaneous equations was performed. The model allows capturing their interactions. Model variables are described in Table 1 and are represented as follows in equation 3 and 4.

$$\text{MobPhUs} = T_0 + T_1\text{Computer} + T_2\text{Internet} + T_3\ \text{Internet Pric} + T_4\text{Fibre Optics} + u_2 (3)$$

$$\text{GDP} = E_0 + E_1\text{EAP} + E_2\text{GFCF} + E_3\text{MobPhUs} + u_1 (4)$$

We assume that competitive companies produce homogenous goods (Y) of the Cobb-Douglas production function with technology and by means of constant scale returns.

3.2 Presentation of Variables

This model includes the following endogenous variables that are used to define the problem: 1) mobile phone in the population, and 2) GDP. Both are considered predetermined variables to the factors that may affect the relevant variables. Using these variables, an attempt is made to associate economic theory with technological analysis (mobile phones) so that with the help of statistical methods, variable behaviours can be predicted.

The study was executed in Mexico. Statistical data from the National Institute of Statistics and Geography and Bank of Mexico were used; economic data are reported in real pesos. A 1990 - 2014 study period was employed. The period is short, because in Mexico there are only 25 observations of the variable independent, so the analysis was not made by method projection Box Jenkins of time series. The econometric model was estimated using three-stage least squares (3SLS) via a simultaneous function adjustment carried out based on the SYSLIN procedure offered through SAS (SAS Institute Inc., 2002) version 9.0. This procedure involves estimating the parameters of an interdependent system of linear regression equations. SYSLIN offers several techniques that produce consistent and asymptotically efficient estimations for the regression system equations. The 3SLS method involved estimating the variance and covariance matrix and then applying generic minimum squares that are feasible for the whole model. This method is more efficient than the Two-Stage Least Squares method.

Gujarati & Porter (2010) noted that simultaneous equation models are unique in that the dependent variable of an equation may emerge as an explanatory variable of another equation in the system. For this reason, such explanatory dependent variables become stochastic, and generally speaking, they are correlated with the disturbance term of the equation, where they are included as explanatory variables. The proposed model consists of two equations, and both are functional relationships. It also includes two endogenous variables and six exogenous variables, which are represented in Figure 1 and described in Table 1.The observed data are shown in Appendix 1 which are national statistics.

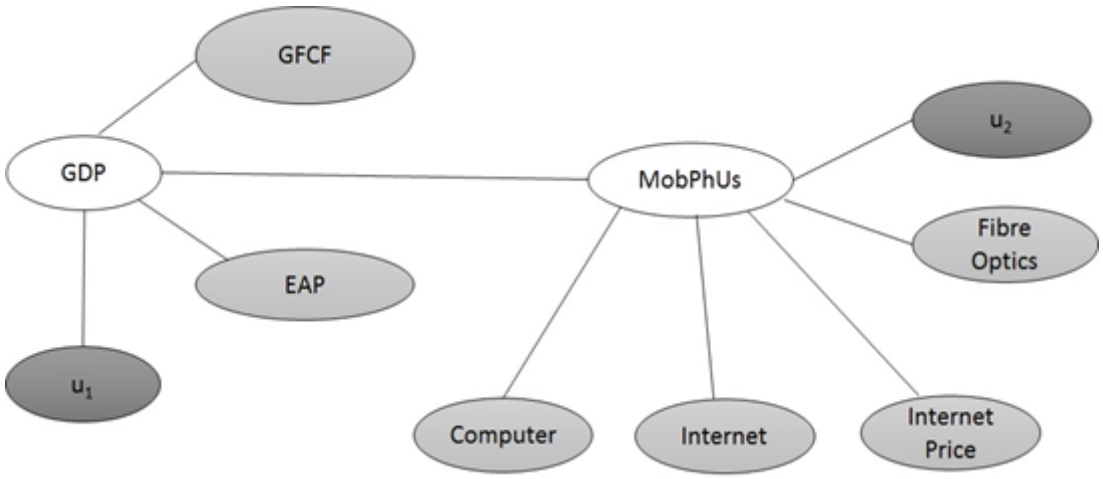

Figure 1: Econometric model with endogenous and exogenous variables.

Table 1
Study variables

Variable	Description	Type and relationship
MobPhUs (X_3)	Mobile phone (in logarithms) deemed human capital (H)	Endogenous: it is related to the GDP variable in the model. It is also recognised as human capital that uses technology for the economic growth function.
GDP (Y_1)	Gross Domestic Product in real pesos (in logarithms)	Endogenous: main study variable
Internet (X_5)	Internet user quantity (in logarithms)	Endogenous: it is related to the MobPhUs variable, as it is an essential consumable good for mobile phone use in addition to being a complementary good.
Computer (X_4)	Computer quantity change rate	Endogenous: it is related to the MobPhUs variable, as it is a competitive good.
Internet Price (X_6)	Internet price in real pesos, weighted to the lead provider in Mexico (in logarithms)	Endogenous: it is related to the MobPhUs variable, as mobile phone usage depends on the price.
Fibre Optics (X_7)	Kilometres of fibre optics. A very thin transparent thread that facilitates information transmission at high speeds. It is mainly used in telecommunications (in logarithms)	Endogenous: it is related to the MobPhUs variable. It is considered an essential consumable good for mobile phone use.
EAP (X_1)	Economically active population change rate. Referred to as Labour (in logarithms)	Endogenous: it is related to the GDP variable, as labour forms part of the economic growth function.

GFCF (X_2)	Includes gross fixed capital formation and changes in inventories for a given period. Gross fixed capital formation: represents the durable goods value that institutional units acquire to increase their fixed assets for a period longer than a year (in logarithms). Referred to as physical capital.	Endogenous: it is related to the GDP variable, as it denotes the durable goods value and the increase or decrease in inventories of goods that are not part of fixed capital or institutional units.
u_1, u_2	Estimation errors.	

The equations 3 and 4 are represented using matrix notation in the following manner:

$$X_3 = T_0 + T_1X_4 + T_2X_5 + T_3X_6 + T_4X_7u_2$$
$$Y_1 = E_0 + E_1X_1 + E_2X_2 + E_3X_3 + u_1$$

$$\begin{bmatrix} X_3 \\ Y_1 \end{bmatrix} = \begin{bmatrix} T_0 \\ E_0 \end{bmatrix} + \begin{bmatrix} T_1 & T_2 & T_3 & T_4 \\ E_1 & E_2 & E_3 & 0 \end{bmatrix} \begin{bmatrix} X_4X_1 \\ X_5X_2 \\ X_6X_3 \\ X_7\ 0 \end{bmatrix} + \begin{bmatrix} u_1 \\ u_2 \end{bmatrix}$$

where X_3,Y_1 are the endogenous variables of the model; X_i (i=1,…,7) are the predetermined or exogenous variables of the model and include all exogenous and endogenous variables; T_i (i=0,1,2,4); E_i (i=0,1,2,3) are the variable coefficients; and u_(i) (i=1,2) are the random perturbations contained in the model equation.

The following model selection process was employed: 1) theoretical model approach based on the Solow Swan method, 2) assumptions (competitive companies produce homogenous goods, Y, through physical capital combinations (K), human capital (H) and labour (L) of the Cobb-Douglas production function with technology and by means of constant scale returns), 3) mathematical model development and main variable identification, 4) functional econometric model elaboration, 5) data collection 6) variable selection with significant partial regression coefficients, 7) econometric model coefficient estimation and 8) model validation via statistical testing.

Regarding economic factors, the results were analysed based on the sign of the expected estimators and based on the magnitude of elasticity coefficients obtained in two the forms: structural and reduced.

Elasticity in the structural form shows short-term effects on certain variables, and in the reduced form, it reveals the simultaneity of the model and the relations between predetermined exogenous variables.

4 Results and discussion

The t-statistics and probability values of the structural model estimation are shown (Table 2). The two functional relations show acceptable R2 coefficients of between 0.95 and 0.99, along with respective t-statistics and probability values. Additionally, the probability of finding a tabular F greater than the calculated F is too low (less than 0.01%), and so based on the F-test, the model works properly and rejects the null hypothesis at a confidence level of 0.0001, showing that the model coefficients may have a zero value. The technology endogenous variable, mobile phone (MobPhUs), had positive effects on the variables (computers, Internet and fibre optics), benefiting GDP. However, the Internet price variable has a negative effect, suggesting that it is not convenient to increase Internet prices to the detriment of mobile phone use.

The most important endogenous variable in this work is GDP, which includes the other endogenous variable (mobile phone - MobPhUs). Aside from the exogenous variables (economically active population (EAP) and gross fixed capital formation (GFCF)) variable, all of the variables had a positive effect on GDP. Additionally, the individual contributions of the model variables are judged based on a t-test. The result must be larger than a unit, indicating that the estimated (statistical) parameter is larger than its standard error. With this criterion, the explanatory variables were found to

be significant. The reduced form coefficients are shown in Table 3, which shows the effects of the predetermined variables on the endogenous variables.

Table 2
Structural form coefficients, estimated for physical capital, technological capital and GDP in Mexico by the period of the years 1990 to 2014

Dependent Variable	Intercept	Exogenous Variables				R^2	Prob> F
MobPhUs		Computer	Internet	Internet Price	Fibre Optics	0.99766	<.0001
Coefficient	9.165213	0.002679	0.638115	-0.501	0.190543	0.99716	
Estándar Error	2.865035	0.001246	0.039808	0.210647	0.047799		
t -Value	3.2	2.15	16.3	-2.38	3.99		
p-Value	0.0047	0.0447	<.0001	0.028	0.0008		
GDP		EAP	GFCF	MobPhUs		0.9651	<.0001
Coefficient	-0.49955	1.578782	0.142576	0.040527		0.95987	
Standard Error	5.73238	0.330237	0.03758	0.014733			
t -Value	-0.09	4.78	3.79	2.75			
p-Value	0.9314	0.0001	0.0011	0.0123			

The reduced form coefficients of the endogenous variables of the model are shown in Table 3. These results show that dependent variable effects are explanatory in the functional relations and generate the best lineal and unbiased results. Economically speaking, the results were analysed based on both estimator signs expected through economic theory and based on the magnitude of the reduced form coefficients obtained, assuming ceteris paribus and average variable values for 1990 to 2014.

Table 3
Reduced form coefficients, estimated for technological capital and GDP in Mexico by the period of the years 1990 to 2014

		Exogenous Variables					
Dependent Variable	Intercept	Computer	Internet	Internet Price	Fibre Optics	EAP	GFCF
MobPhUs	9.165213	0.002679	0.638115	-0.501000	0.190543	0	0
GDP	-0.128110	0.000109	0.025860	-0.020300	0.007722	1.578782	0.142576

Using GDP as the main indicator, gross fixed capital formation as physical capital, mobile phone as technology, and the economically active population as labour, we found that a 1% change in computer use boosts GDP growth by 0.000109%. If the number of Internet users increases by 1%, GDP will increase by 0.02586%. If Internet prices increase by 1%, GDP will decrease by 0.0203%. If the length (in kilometres) of fibre optics are increased by 1%, GDP will increase by 0.007722%. Consequently, a 1% increase in mobile phone will increase GDP by 0.013391%. If the change rate of the economically active population increases by 1%, GDP will increase by 1.578782%. For each 1% increase in gross fixed capital formation, GDP will grow by 0.142576%.

The contribution of this work is the inclusion of the variables computers, Internet, Internet price and optical fiber; which act differently in a model of simultaneous equations with the inclusion of mobile telephony users; so these results are complementary with results on economic growth as a function of mobile telephony reported by the following authors: Sassi&Goaied (2013), Saidi et al. (2015), Shahiduzzaman&Alam (2014), Anwar &Johanson (2015), Blauw&Franses (2016), Ward & Zheng (2016), Das et al. (2016), Palvia et al. (2017), Qureshi &Najjar (2017), Ghosh (2017), Albiman&Sulong (2017; in addition ICT promoting economic growth (Castaldo et al. 2018).

The results shown in Table 3 denote the existence of a direct relationship between GDP and mobile phone, as all of the coefficients (computers, the Internet, fibre optics, the economically active

population and gross fixed capital formation) have a positive effect with the exception of Internet prices.

The estimated data of the structural form indicate the short-term effects of certain of the variables, and the reduced form coefficients are those in which we recognized the simultaneous effects of the model and the links between the exogenous and endogenous variables.

According with the results, we present the following public policy recommendations:

(1)Motivate mobile telephony investment and provide training on its use. Well, according to the results presented, the increase the mobile phone allows economic growth. This happens to facilitate communications and reduce travel times, which makes for a more productive in any area.

(2)The mobile phone generates economic growth and includes mobile applications, so it is proposed to promote the development and use of mobile applications (apps) in the business area to raise the Global Innovation Index (GII) and labour productivity in all respects and to increase competitiveness as mobile applications are used to carry out business operations; shopping tasks; logistical activities (e.g., mass media information dissemination); and recreational, technical and scientific tasks. Apps allow for the use of functions such as GPS technologies and maps that shorten travel periods, and cameras can be used for more targeted purposes. Free instant messaging services, synchronization between apps with social networks and contact groups, and cloud services are also available. With the use of mobile phone apps is expected to have more innovation and be a more competitive country.

(3)The government, along with leading businesspersons of mobile telephony, must foster the promotion of unlimited data availability to enable broader capacities for the use of mobile apps. Which leads to longer the use the mobile phone and to generate greater economic growth.

(4)The government must foster foreign investment from leading businesspersons of mobile telephony and monitor direct foreign participation in regards to telecommunications. Because the use of mobile phones favourable economic growth.

(5)Increase and redistribute public expenditures in technological infrastructures that increase cell phone incursion levels and in turn labour productivity and business competitiveness. Higher GDP growth is expected as a result. Although this is difficult because public spending in Mexico has been reduced in many ways. However, the Government should consider trends in telecommunication reform and invest in broad band infrastructure to promote economic growth in mobile phone function.

(6)Expand technological infrastructure with regards to hardware to allow for more virtual public workspaces where cell phones can be charged and where mobile data can be used. To promote economic growth.

(7)Modify universities study programs to include course content on mobile phone applications. To generate greater use of the mobile phone to be more apps, which leads to greater economic growth.

5 Conclusions

The objective was to carry out an analysis of the use of ICT, in terms of mobile phones, computers, Internet, fiber optics and the price of the Internet, as well as the gross fixed capital formation and the economically active population, to know their relationship in the Gross Domestic Product (GDP) or economic growth in Mexico and generate recommendations based on ICT. So that, mobile phone users have a positive influence on economic growth, so according with results in Mexico a 1% increase in mobile phone will increase GDP by 0.013391%; on the other hand, in order to increase the number of mobile telephony users is necessary: 1) Increase computers which work as complementary goods 2) Increase the use of the Internet and fibre optic, which are basic consumer goods for the use of phones mobile, 4) Decrease the price of the internet. These are aspects to be considered for the government to elaborate public policies that use mobile telephony to promote economic growth, because of the fact that mobile phones with internet, increase commercial and productive activities in general with the use of communications through social networks and this is reflected in GDP.

One limitation was to have few data, to perform another statistical method, as a series of time. This work contributes to the knowledge regarding the coefficients found for mobile telephony users in Mexico, and other studies could be done with the data found to compare the data in some world scenario.

Seven important points were recommended: 1) Motivate mobile telephony investment and provide training on its use, 2) Use of mobile applications, 3) The government must negotiate with entrepreneurs and leaders in mobile telephony, so that there is unlimited availability of data to allow greater use of mobile applications, 4) The government must foster foreign investment from leading businesspersons of mobile telephony and monitor direct foreign participation in regards to telecommunications, 5) Increase and redistribute public expenditures in technological infrastructures that increase cell phone incursion levels and in turn labour productivity and business competitiveness, 6) Expand technological infrastructure, and 7) Modify universities study programs to include course content on mobile phone applications.

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Appendix 1

Year	GDP	GFCF	EAP	MobPhUs	Computer	Internet	Internet Price	FibreOptics
1990	5498649459784	7704370	28402000	64000	680000	29600	43145	360
1991	5767816935879	6490622	29195000	161000	900000	38800	35184	750
1992	5937322033898	5948754	29593000	313000	1306963	48000	30458	5520
1993	6062343629344	5388575	29861000	386000	1717822	57200	27753	15787
1994	6425104693141	5688101	30567000	572000	2165149	66400	25949	37494
1995	5900917112299	3146610	29636000	689000	2369717	75600	19219	42765
1996	6008820135296	2716510	30632000	1022000	2724519	94000	14302	56150
1997	6277255031343	2655610	31820000	1741000	3289864	187000	11857	65130
1998	6525848036426	2513063	33186000	3349000	4113327	596000	10228	75174
1999	6761706334676	2315677	33944000	7732000	4778294	1222000	8773	85705
2000	7205776390592	2289400	34634000	14078000	7791935	1822000	8012	98094
2001	7095365751415	2081387	34388000	21758000	14931364	5058000	7533	106159
2002	7144780482938	1992268	34096000	25928000	19970852	7097000	7172	111548
2003	7344554304257	1962075	34244000	30098000	21319301	10718000	6860	111901
2004	7944110390204	2020000	35608000	38451000	22667750	11883000	6569	116701
2005	8276803717016	2052244	35847000	47129000	26373695	13983000	6301	126714
2006	8914740715675	2152432	37234000	55395000	28313816	17967000	6081	153783
2007	9343873320223	2209796	37917000	66559000	30550748	20564000	5890	171687
2008	9606444862450	2218371	38486000	75303000	31953523	23260328	5634	188390
2009	9020578802118	1915494	37097000	83528000	34735349	28439250	5361	194544
2010	9417229863868	1844032	37636000	91363000	38862930	34871724	5096	212200
2011	9877809911745	1903703	38172000	94583000	39852417	40605959	4880	243500
2012	10259789915966	1928960	39263000	100727000	42161834	43000000	4719	250800
2013	9601811792734	1722615	38996000	105006000	44471252	44000000	4281	275800
2014	9799169540230	1699794	39197000	110000000	46780669	45108655	4131	305800