

Economic Growth and innovation in Latin America; An analysis of panel facts from a Schumpeterian focus

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In this article we examined the roll of the innovation on the economic growth of Latin America. We use an analysis of panel data for twelve countries of the region, stating the fulfillment of the Schumpeterian hypothesis that the innovation activities impel the total productivity of the factors and the economic growth in Latin America.

Endogenous growth, I+D, Innovation.

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Introduction

The models of exogenous growth type Solow and Swan (1956), explained that the economic growth is related with the technic progress, however do not explain the factor that determinate the technic progress inside the economic system. In the mid of eighties and beginnings of nineties of the past century came out the theory of the endogenous growth, which fundamental contribution was to explain the technic progress from inside the system, made endogenous the technic progress and for the same the economic growth.

The endogenous growth points that with the research of Paul Romer (1986), where explain that the growth of per capita income could not be unlimited and there is not diminishing marginal productivity of the capital ¹.

Romer raised that in the long term the principal determinant of the economic growth is the technic progress, interpreted endogenously as human capital. The growing performances at scale of the production are result of the increase of the knowledge level in economic and that the increase of the production results from the existence of externalities which provoke growing performances of the production and in difference of the exogenous growth, this externality reinforce for the economic agents.

Robert Lucas (1988) put special interest in that the human capital is the factor which impulse the economic growth of the nations, the concept of human capital is big and includes the formal learning and doing introduces by Arrow, in theory of the economic growth.

¹ They are key characteristics of the endogenous growth and which difference it from the exogenous growth.

Both, Robert and Lucas point that the economic growth in the long term is attached with the human capital and the formal and informal knowledge, although they do not explicitly treat the role of innovation in the economic development.

To explain the differences of productivity and economic growth between the nations important researches study the role of the innovation and its endogenous sources, between which highlight the works of Helpman and Geroski (1991) and AH (1992), they are known as Endogenous Growth Schumpeterian ².

AH (1992) use the Schumpeterian ide of “Creative Destruction” and show that the innovator companies, the work quantity dedicate to the innovation, tent to increase the technologic progress and the economic productivity, economic is the production technology of innovations.

The theory of the Schumpeterian endogenous growth us on its model important assumed, Coe and Helpman (1995) try that the inversion in research and development impulse the total productivity of the factors, another research made by Young (1998) points that the growth of the Total Productivity of the Factors (PTF) follows the spent in Research and Development (I+D). Zachariadis (2002) in a study applied to the American manufacture industry show that the increases of the investment in research and development incite to the patents increment, these last, induce to a bigger technic progress which at the same time provokes, a bigger economic growth.

² The Schumpeterian Growth, is denominate like that, in honor to the honorable economist Joseph Schumpeter for his introduction of the role that the innovation have in the economic system, although he was not the creator of the Schumpeterian Endogenous Growth, set up the bases with his contribution “Creative Destruction”.

The difference of welfare income per capita and productivity between the rich nations and the developing countries could be linked to the technologic innovation activities in the different nations. Our hypothesis release from the former problem: "The innovation activities are of meaningful relevance for the increase of productivity and economic growth in Latin America.

In other words, the determinants of technologic innovation like: Investment in research and development, the number of patents, register brands, exportation of high technological content, could play a relevant role to increase the productivity and economic growth in the region.

The document examine the role that play the innovation in the economic growth of the region, endogenously analyze the role of the research and development, the number of patents, register brands and the exportation of high technological content in the impulse of the total productivity of the factor in the Latin American countries.

In order to prove the hypothesis we use analysis of fact panel for twelve Latin American nations, with information of the World Bank to prove if the predictions of the Schumpeterian Endogenous Growth are accomplished, analyze the innovation activities 3 and propose alternatives that allow increment the welfare levels in named countries.

The rest of the document is organized as the follow: the Second section give a short exposition o the Schumpeterian Endogenous Growth theory. The third section provides the information sources, facts and the used variables in our model. The fourth section is on charge of the preliminary descriptive analysis of the variables that will have on account our model.

The fifth section is presented the principal results of the panel estimations, the interpretation of the empiric evidence showed for the Latin American countries. Finally conclusions and politic proposals of derived politic of the research.

The Schumpeterian endogenous growth

The evidence shows that there are nation that have high their welfare levels like Ireland and Spain, while other have reduced their per capita incomes level like Chad and Venezuela, Helpman and Groosman (1994). Less than the half of the five hundred of the biggest companies of the middle of seventies, kept this privilege position nowadays (Fortune magazine). The explanation for the former situation could be joined to the innovation strategies that named countries and companies develop.

The key to achieve the success and keep seems to be, continuously innovating.

Schumpeter (1912) introduces the concept of innovation and classifies the innovations in the apparition of new product, a new process; new intermedium consumptions, new organization type, and new market. Schumpeter (1928) defines the innovation as the use of productive resources in uses without be proved in the practice until now. Schumpeter (1939) explain the as the creation of a new production function. Schumpeter (1942) introduces the term "Destructive Creation" explain the role of the innovation for the company and the economy dynamism.

³ Not only analyze the role of the Inversion in research and develop but also the productivity of the same (Patents), its impact and diffusion (Exportations of High Technologic Content).

In the theory of endogenous economic growth, the first to promote the role of the innovation in the increase of the income are Romer (1990) and Segetrom (1990). Griliches (1990) shows the existence of a strong and positive relationship between investment in Research and Develop and the Patents. Kortumm (1993) conclude with a study of panel that there is a positive and meaningful relation between rate of growth of the Patents volume and the Total Productivity of the Factors.

AH (1992) shows that the economic growth of the per capita income and the technic progress in a country is attached to the increase of the inputs variety and the quality of its products, which are explained by the elasticity of intermedium wells demand and for the productivity of its researches.

Coe and Helpman (1997) proof that the spent in research and develop of the commercial associates have a positive effect over the total productivity of the domestic factors.

To support the Total Productivity growth of the Factors is necessary the increase of the spent in Research and Develop. AH (1998) and Peretto (1998).

Harris and Vicker (2001) show that the arrived of the foreign companies has a positive impact in the innovation, because from one site reduce the utilities of the local companies to high their investment in research and develop in order to enjoy of bigger profits, therefore the biggest competence incite to the biggest rate of innovation.

Zachariadis (2002) studies the relation of the different steps of the innovation process: first step is the investment in Research and Develop, the second step, consist in obtain Patents, with the induction of the phases to the increase of the total productivity of the factor and the product growth.

Ha and Howitt (2007) affirm that the total productivity of the factors follows to the investment in per capita research and develop. On its work Madsen (2008) study five principal countries of the Organization for Economic Cooperation and Development (OECD) through a panel and conclude that the Schumpeterian theory is adequate to explain the increases in Total Productivity of the Factors and that not only are related with the intensities of local research, but also with the foreign research.

We consider a function of production Cobb-Douglas type with constant outputs of scale:

$$Y = AK^\alpha L^{1-\alpha} \quad (1)$$

Where Y is the Production, A is the Knowledge, K is the Capital, L the work, α is the marginal productivity of the capital and $(1-\alpha)$ is the marginal productivity of the work. Posteriorly we define the technologic knowledge growth as g_A , which we represent as:

$$g_A = \frac{\dot{A}}{A} = \lambda \left(\frac{X}{Q} \right)^\sigma A^{\theta-1} \text{ donde } 0 < \sigma \leq 1; \theta \leq 1$$

$$Q \propto L^\beta \text{ In the stationary state} \quad (2)$$

This function is used by (Ha and Howitt, 2007) and (Madsen, 2008), in which, Q is the product variety, θ is the rebate of the scale in the knowledge, σ is a parameters of the duplication, which is zero if all the innovations are duplications and 1 if there are not duplication innovations, β is the coefficient of the product proliferation, λ is a parameter of the investigation productivity, L is the use of the population and X are entries or inputs of Research and Develop. Q is the product variety measured by the work or the population because the product variety is proportional to the population if the stationary state, the equation (2) then covert in:

$$g_A = \frac{A}{A} = \lambda \left(\frac{X}{L\beta} \right)^\sigma A^{\theta-1} \tag{3}$$

The models of Schumpeterian Growth suppose that $\theta=1$, $\beta=1$, and like X represent the investment in Research and Develop (I+D), results that:

$$\frac{A}{A} = \lambda \left[\frac{I+D}{L} \right]^\sigma \tag{4}$$

The quotient between $\left[\frac{I+D}{L} \right]$ is denominate in this works the investigation intensity in other words is the inversion in per capita research and develop or per person in a country. The inversion in per capita research and develop in the Equation (4), we substitute it for the quotient of $\left[\frac{I+D}{PIB} \right]$, in fact, and we use the inversion in research and develop per dollar in the economy, instead of research and develop per person 4. For the present work the intensity in research and develop is the quotient between I+D and the income of the country.

The equation 4 converts in:

$$\frac{A}{A} = \lambda \left[\frac{I+D}{PIB} \right]^\sigma \tag{5}$$

Introducing logarithms kept:

$$\ln \left[\frac{A}{A} \right] = \ln \lambda + \sigma \ln(I + D) - \sigma \ln(PIB) + e_{1,t} \tag{6}$$

Taking out common factor σ

$$\ln \left[\frac{A}{A} \right] = \ln \lambda + \sigma \ln[(I + D) - \ln(PIB)] + e_{1,t} \tag{7}$$

Now we suppose that $\frac{A}{A}$ is stationary, according to the found for Howitt (2007)

$$\varepsilon_t = \ln(I + D) + \ln(PIB) \tag{8}$$

Then the changes in the inversion in Research and Develop and the Gross Domestic Product of a country, are necessary, but not enough, to explain the variation in the Total Productivity of the Factor.

Helpman and Groosman (1992), AH (1992) relate the increases of the total productivity of the factor with the diffusion of the technology through the international commerce, also Romer (1990).

Sejerstrom (1990) get to the conclusion that the quality of final products of a country is related with the new technology implement to the intermedium wells imported from abroad with which produce, these, the intermedium wells imported, high the efficacy and increase the variety of the produced wells.

Howitt (2007) and Madsen (2008) analyze the role in the diffusion of the technology, and consider the geographic proximity as an element which could influence in the exploitation of the international overflow of the technologic knowledge.

Other researches like Helpman (1995) and Madsen (2008) related the increase of the total productivity of the factors with the importations of intensive wells in Research and Develop, with the patents of the commercial associates.

⁴ We suppose that the inversion in research and develop per monetary unit in a sample economy of a better form of intensity in research, in comparison with the inversion in per capita research and develop heritage of the macroeconomic tradition.

To estimate the increase rate of the Total Productivity of the Factor (PTF), we follow to Joseph Stiglitz (2004) where on his book of Macro-economy, start from the contribution of the capital to the increase of the production and explain it in the following form:

$$\Delta Q = r \Delta K \quad (9)$$

Where ΔQ is the increase of the Production, r is the output of the Capital and ΔK is the increase of the Capital.

The percentage increase of Q is simply:

$$\frac{\Delta Q}{Q} = r \frac{\Delta K}{K} \quad (9.1)$$

Now we multiply the numerator and the denominator of the right part of the equation 10.2 for k , we have:

$$\frac{\Delta Q}{Q} = r \left(\frac{\Delta K}{K} \right) \frac{K}{Q} = r \frac{K}{Q} \frac{\Delta K}{K} \quad (9.2)$$

Then $r \frac{K}{Q}$ is the quota of participation of the Capital in total PIB, rK is the output of the Capital, Q in the total production, Therefore the percentage increase of the production attributable to the Capital, is the percentage increase of the multiplied capital for its quota of participation.

In the same logic, the percentage increase attributable to work is the percentage increase of the multiplied work for its quota of participation.

The increase rate of the factor productively, is increase of the product, which is not explained for the work and capital increase, in other words, that is the increase of the production explained by other factors, like the efficiency en the use of the resources, the technologic advance, the investment in Research and Develop, patents, exportation of high technologic content products, etc.

$$PTF = g_Q - (S_K * g_K) - (S_L * g_L) \quad (10)$$

The increase rates of the factors total productivity could be found in the following forms, Stiglitz (2004):

Where g_Q the growth rate of the product, S_L is the participation of the capital in the product, g_K is the capital increase rate, S_L is participation of the work in the PIB, g_L is the work increase rate. The equation (11), is the one we use in the present work in order to calculate the factors 5 in the graphic analysis.

Sources of information, principal variables and descriptive analysis

In the graphics we use facts of the Iberoamerican network of Science and Technology Indicators, while in the estimation we use the information of the World Bank, the variables will be expressed in American dollars of the parity of the acquisitive power of 2000, except the variables like the Work, Patent and Register Brands which are measure in units.

Initially the estimations are made in the period of 1960-2008 with unbalanced panel, posteriorly the estimations with logarithms are made with a balanced panel in the period 1996-2008, this is because the information availability.

With these facts we examined the correlation between the different variables of the model for the Latin American countries and we get to relevant conclusions. Analyze the participation of each one of the variables respect to Gross Domestic Product centering our attention in Research and Develop, Given Patents, register Brands and Exportation of High Technologic Content.

After that we present, the variables that we will use in the work, its definition and denotation.

The Gross Domestic Product (PIB) understand the total value of final wells and services in a country, in a determinate period of time, for all the countries including Mexico, the PIB will be expressed in American dollars of the Acquisitive Power Parity (PPA) of 2000. The work (L), is one of the production factors and we will take as proxy variable to the total of the population of each Latin American country, which will be expressed in people; the Capital is another relevant factor of production and we will take as its proxy variable to the Gross Formation of Capital in each Latin American country, which will be expressed in American dollars of the PPA of 2000 and its denote as K.

The Research and Develop inversion (I+D) is the value of the investment in research and develop on each one of the countries, expressed in American dollars of PPA of 2000. The Given Patents: is the number of given patents on each one of the Latin American countries and denote as *PatenO*.

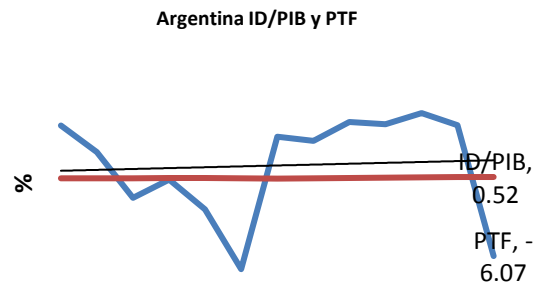
The register Brands is the number of Register Brands on each one of the Latin American nations and is denote as MR. Exportation of High Technologic Content: is the value of the exportation which are intense in technology, for example, the exportation from airplane part, cars, medicaments, software, and hardware.

It is measure in American dollars of the PPA of 2000, and is denote as XAT. The Schumpeterian Growth theory predict that the Factors Total Productivity (PTF) growth proportionally vary with the intensity of the spent in research and develop. The levels of inversion in the research and develop are dissimilar between rich nations and the developing countries, the develop countries invest in research and develop around 3% of it incomes, for example, according to the World Bank, in 2007, Japan invested the 3.4% of its income, Finland the 3.7%, Israel and South Korea invest the 2.70% of its PIB, Germany invest 2.60%.

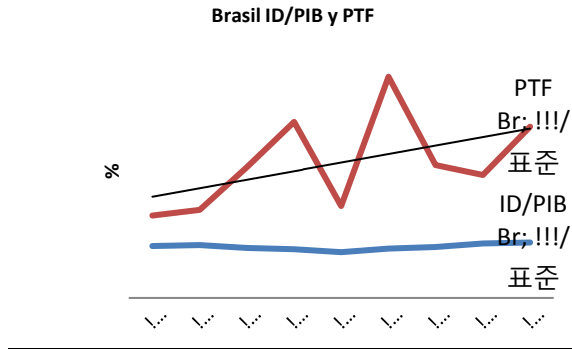
The average of the OCDE is 2.5% of the PIB proportion. Developing Countries like China and India invest the 1.5% and the 0.8% of theirs income respectively, in 2007, according with the World Bank.

The following charts, show the growth of the inversion in research and develop as proportion of the PIB, the factors total productivity growth for some of the Latin American countries like: Mexico, Argentine, Chile and Brazil.

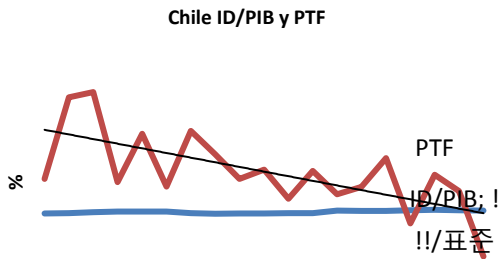
Proportion of I+D respect to the PIB and the Growth of PTF of some Latin American Countries



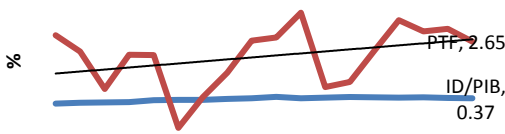
Graphic 1



⁵ There are many forms to estimate the Factor Total Productivity like the used by Angus Madison, Anthony Douglas and others; produce similar results.



Mexico ID/PIB y PTF



Source: Own elaboration with facts of the Iberoamerican network of Science and Technology Indicators

In the graphic 1, is noticeable that in Argentine the inversion of Research and Develop do not get to the 1% as proportion of the Gross Domestic Product (PIB) of the South American country. In Argentine the increase of the PTF 6 seems not to follow the inversion in research and develop, because the proportion of the I+D respect to the PIB is insignificant.

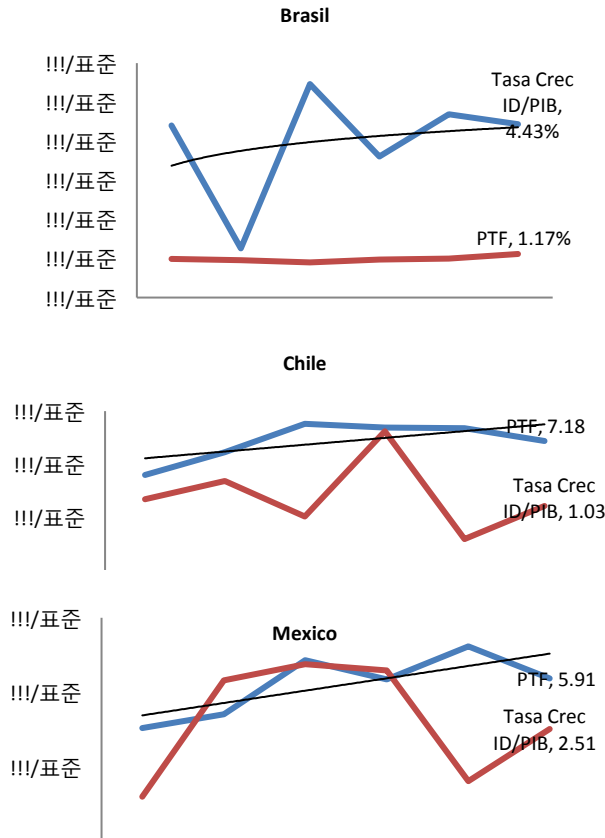
The reader could notice, that the spent in research and develop respect to the PIB has been almost constant in the analyzed period, while the PTF has gone to the low in the period of 1997-2003 and falls again in 2003-2007.

The behavior of the Brazilian economy is different to the Argentinian, and also the weight of the spent in research and develop, overcome the 1% of the PIB. It is possible to observe that while increase the inversion proportion in I+D respect of the PIB as in 2000-2001 and 2004-2008 increments the PTF. And when reduce named proportion as in the period of 2002-2004 falls the Factors Total Productivity. The dynamic of the Brazilian Economy follows the prediction of the Schumpeterian hypothesis; this maybe is attributable to the weight of the ID/PIB is bigger than the other Latin American economies.

In the Chilean case in general we could say that the inversion proportion in I+D respect to the PIB is insignificant and that in general has been rising in the analyzed period, while the average behavior of the PTF has tendency to the shod.

In relation with Mexico, in general we could say, that even do the important variations of the PTF, the generalized behavior of the 1990-2007 period, is the rising, while spent more research and develop, as proportion of the income. Although the proportion of I+D/PIB has been increasing, still being inferior to develop countries and inclusive to nations of similar develop like Brazil, Chile and China.

The increase of the weight of I+D in the PIB and the PTF Growth in some Latin American Countries (2001-2008)



Graphic 2

Source: Own elaboration with Facts of the Iberoamerican Network of Science and Technology Indicators 2011

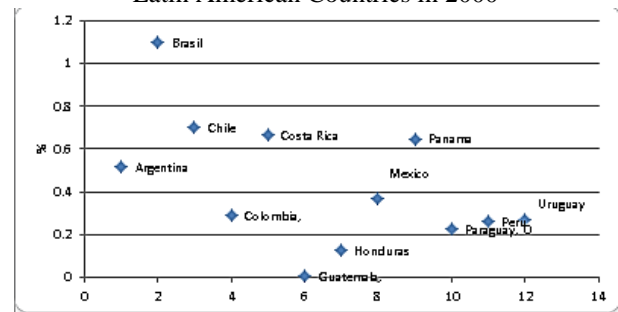
Considering the former graphic, which shows the factor total productivity growth and the growth of the research and develop weight in the income of the four most important Latin American economies, we could say that in general that they do not behave in a stable form the intensity increases of I+D in the region.

But in general is possible to appreciate in the tendency lines that the increases of the research intensity, tending to increase of the factors total productivity.

In general, we can realize of the experiment growth of the TFP and an increase of the research intensity in the analyzed period, which accord with the predictions of the Schumpeterian growth theory, the evidence of the chronologic series, until certain point, constant with Schumpeterian growth theory.

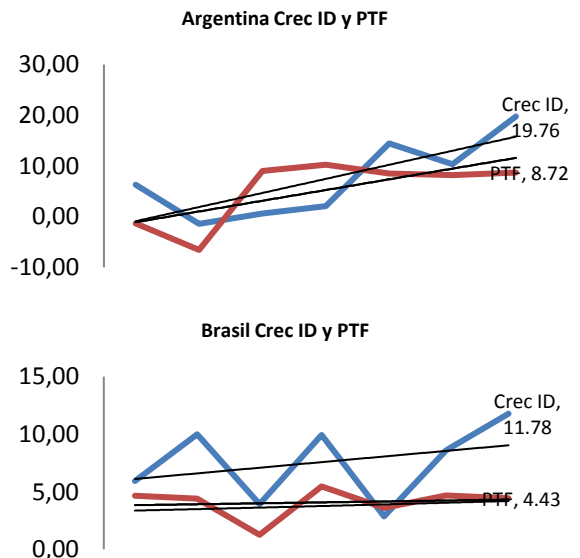
6 The calculations of the Factors Total productivity used in the graphic are determinate following to Stiglitz (2004), commented in the former section.

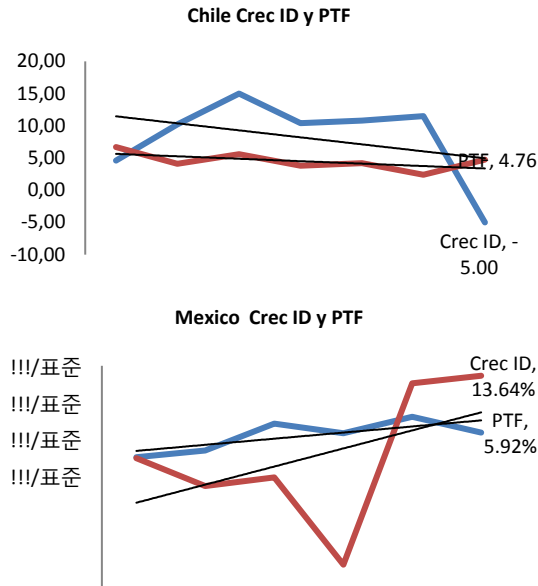
The investment in I+D as proportion of the PIB of some Latin American Countries in 2000



Source: Own elaboration with facts of the Latin American Network of Science and Technology Indicators 2011.

Dynamic of the Investment Growth in I+D and the Increase of the PTF (2001-2008)





Graphic 4

Source: Own elaboration with facts of the Iberoamerican Network Sciences and Technologies Indicators 2011.

The graphic 3, shows the growth rates of the inversión in research and develop with the growth of the factors total productivity in the most important economies of Latin America and the Caribbean. In Argentine we could appreciate a growth general tendency of the inversion in scientific and technologic development which tent to promote the growth of the factors total productivity.

In Mexico and Brazil the tendency is similar to Argentine, and increase of the growth rates of the inversion in research and develop that promote the growth of the factors total productivity.

In Chile the opposite happens, a tendency to the decline of the inversion in research and develop which causes a negative tendency in the factor total productivity.

The empiric evidence matches with the predictions of the Schumpeterian growth theory.

Although Brazil still investing very little respect to the income in comparison with pointers countries like Israel and Sweden that spend 4.5% and 4.2% in relation to its income respectively.

We could resume in this section to the increases of the inversion in research and develop in the region, the effort still poor in comparison with the develop countries and even do in comparison with China, the intensity of the research could be high to increase the productivity in region as well as the life levels of the Latin American population.

The increase of the inversion in research and develop in Latin America should be fundamental object for the politicians and decision makers to foment the economic growth, the employment and the welfare.

Empiric estimations

This epigraph will be divided in two sub-epigraphes, the first will be dedicated to the panel theory and the second part of the epigraph will show the principal results and we will interpret mention information.

About panel

The use of the panel analysis is each time more frequently, because is very useful for the applied research. A Panel is a sample of characteristics (variables) which have the Countries all over the time.

The Panel relates facts of transversal cuts (information of many countries, individuals in given moment) during many time periods. The general model that we pretend to estimate is the following:

$$y_{it} = \alpha + \beta X_{it} + u_{it} \tag{11}$$

If all the variables of influence are not available then $Cov(X_{it}, \varepsilon_{it}) \neq 0$, in other word the residuals are not independent of the observations for that Minimum Ordinary Charts (MCO) will be biased. In order to solve it are proposed alternative models to the grouped regression through the nesting of the facts: Panel of Fixed Effects and Panel of Random Effects that we will comment after.

The use of panel presents may advantages because has bigger number of Observations, more and better information, admit more number of explicit variables, more efficiency in the estimation, another advantage is that could be made a tracing to each country or individual. Also relieves the problem of omitted variables, because they could be eliminating for difference those that do not change the time. For a detailed analysis revise more advantage of panel revise Baltagi (1995).

The panel also presents disadvantages because the facts are more complex, it is not about heterogeneity or the individualities, if all the qualities of the country are observable then the errors will be correlated with observation and the MCO will be inconsistent.

The model of fixed effects implies fewer suppositions about the behavior of the residuals. Supposed that the model to estimate is now:

$$y_{it} = \alpha + \beta X_{it} + \varepsilon_{it} \tag{11.1}$$

We consider that $\varepsilon_{it} = v_i + u_{it}$, replacing in (12) keep:

$$y_{it} = \alpha + \beta X_{it} + v_i + u_{it} \tag{11.2}$$

In other words, is supposed that the error ε_{it} could be decomposed in two parts, a fixed part, constant for each country v_i and another random which accomplish the requisites MCO ($\varepsilon_{it} = v_i + u_{it}$), which is equivalent to make a general regression and give, to each individual an origin point (order) different.

The model of random effects has the same specification that the fixed effect with the only different that v_i , besides to be a fixed value for each individual and constant over time is a random variable with medium value v_i and a variant $Var(v_i) \neq 0$. Therefore, the specification of the model is the same to (11.2).

$$y_{it} = \alpha + \beta X_{it} + v_i + u_{it} \tag{11.3}$$

Results of the panel estimation

The objective of this sub-epigraph is analyze the information in a model of panel which allows analyzing two aspects of importance when someone work with that kind of information and that are part of the non-observable heterogeneity: the specific individual effects and the temporal effects. In which referred to the specific individual effects, is said that these are those that affect in unequal form to each one of the selected countries in the sample that are invariables in time and affect in direct form the decision that make named units. Usually these types of effects are identified with politic stuff in each one of the countries, soundness of institutions, efficiency, access to the technology, etc.

The temporal effects would be those that equally affect to all thee individual units. This type of effects could be associated, for example, to the macroeconomic crashes, economic crisis that could equally affect to all the countries of the region, study objectives.

Our model includes a sample of twelve Latin American countries: Mexico, Argentine, Brazil, Chile, Colombia, Costa Rica, Guatemala, Honduras, Panama, Paraguay, Peru and Uruguay.

Having on account the variables like the Gross domestic Product, Work, Factors Total Productivity, The inversion of the Research and Develop, the number of Given Patents on each country, the number of Register Brands, the Exportation of High Technologic Content of the analyzed period from 1960 to 2008, counting with 586 observations. The panel was estimated with the econometric package: Stata. The principal Results that were obtained are the following:

Estimation of the PIB with many technologic variables (1960-2008)

Estimation	Method	Result	F	R ²	Rho
Es01	Be	PIB= -81.85 ID +3.26e ⁸ PatenO -30.37 XAT + 1533171 MR (0.12) (0.02) (0.19) (0.26)	0	0.99	78.58
Es02	Fe	PIB= 7.33 ID + 9917729PatenO +4.50 XAT + 2778716 MR (0.00) (0.00) (0.00) (0.00)	0	0.94	79.96
Es03	Re	PIB= 6.54 ID + 1.02e ⁷ PatenO +4.84 XAT + 3579866 MR (0.00) (0.00) (0.00) (0.00)	0	0.93	79.95
Es04	Hausman	Chi2=-77 chi2<0			

Table 1

The table 1, show estimations made with the Stata package, the first estimation (Es01) was effected with the generalized Panel Method (be, Ordinary Least Squares)¹.

¹ In the estimation models that is the second column, Be, means estimation for Ordinary Least Squares; Fe is the estimation of Fixed Effects and Rem with Random Effects.

Obtaining the coefficients that accompanying the variables in the first estimation; with a coefficient of correlation really high of the 99%, the number under the coefficients ad that is inside the parenthesis is about the T probability.

The reader could realize that the coefficient of the Inversion in Research and Develop is negative (-81.85) and the T probability for mention coefficient is 88%. In general, in the estimation (es01) we could say that is only significant the coefficient of the given patents and that the expected signs accord with the given patents and the register brands; while the negative signs of the inversion in research and develop with the exportations of high technologic content are not the expected, but neither are meaningful.

The second estimation (Es02), was made with the fixed effects panel (fe) resulting all the coefficients of the technologic variables (research and develop given patents, register brands, exportations of high technologic content) and the signs of all the variables are positive, in other words, the expected signs; The coefficient of correlation really considerable of 94.6%. In the third estimation (Es03), was made with the random effects panel (re) resulting that all the coefficients and the signs of the technologic variables are the expected, positive and significant. The coefficient of the correlation really considerable of 93.3%, a little bit minor to the fixed effects.

The F test in the estimations point that there are meaningful individual effects of each one of the countries and suggest that the panel of Ordinary Least Squares would not be suitable. The rho suggests that the changes in the gross domestic product are related with the rates of technologic variables of each of the countries.

The Hausman test which result is $\chi^2 = 77$. The negative sign of χ^2 , points that the fixed effects have bigger consistence than the random effects, this is, the individual effects of each one of the countries have bigger weight, that the one of the region in group, about the individualities, in other words, the politics implemented in each one of the nations, the efficiency of the organization of each country, the role of the institutions, the access to the technology of each one of the countries of the region have bigger relevance, more weight in the economic performance of each nation; While the group performance has less influence over individualities.

Logarithm estimation of the PIB with many technologic variables (1996-2008)

Estimation	Method	Result	R ²
Es05	Be	lnPIB= 0.19lnID +1.24 lnPatenO +0.31lnXAT + 0.13 lnMR (0.81) (0.01) (0.03) (0.26)	0.957
Es06	Fe	lnPIB= 0.001lnID - 0.01lnPatenO +0.41ln XAT + 0.39lnMR (0.61) (0.15) (0.00) (0.00)	0.855
Es07	Re	lnPIB= 0.001lnID - 0.01ln PatenO +0.40ln XAT + 0.41lnMR (0.68) (0.26) (0.00) (0.00)	0.856
Es08	Hausman	$\chi^2 = -2.03$ $\chi^2 < 0$	

Table 2

The Table 2, shows logarithm estimation of the PIB respect to technologic variables, the result are alike to the char 1.6, the conclusions are the same, the variables are significant, the fixed effects are more consistent than the random effects, which points that the individualities of each one of the Latin American nations have more relevance that the group of the nations about each one of the region countries.

Estimation of the unitary roots and cointegration in panel

Gujarati (2009) the cointegration means that even that the series are no stationary in the individual level, a lineal combination of two or more series of time could be stationary. Granger (2003) defines the cointegration as the stationary difference, between a pair of series: and add that two or more series are non-stationary of order I... ((1)), are cointegrated if exist a lineal combination of the roots that are stationary or the order I_((0)). The vector of coefficients which create this stationary series is the cointegrant vector.

Guisan (2002), the cointegration is related with the casualty and sense of Casualty between Variables and also is related with Prediction and Forecasts. The cointegration also means that even do the variables individually do not cause the explained variable, a combination or integration of two or more variables could result more robust an then explain to the changes in the depended variable. It is said that two series are cointegrant over time, and the differences between them are stable (stationary).

The cointegration reflects the convergence of the economy in a balance in the long term. The differences (error term) represents the error of the unbalance in each point of time.

The cointegration from the economic point of view represents Banxico (1995). According the economic theory means that, some variable should not go far, ones from others in the long term. Such variables could go far in the short term but there is an economic force, whether they market mechanisms or interventions of the government, which tent to join them in the long term.

For example: the interest rates, the prices of the same well in different localities of a country, incomes and government spends, money offer and price level, etc. If there are a pair of series, each one of which is I(1), in general a lineal combination of this series is also I(1). However, if exist a constant A such that t could be consider a relation of long term or balance. Granger (2003) if two series are cointegrated at least one of them should cause to the other.

Estimation of Unitary Roots and Cointegration (1990-2008)

	Test	Null Hypothesis	Series	ADF	Prob.	Obs.
Es09	Unitary Root	Exist	PIB, ID, XAT, PATENO, MR	-8.79	0.00	Reject H_0
Es10	Unitary Root	Exist	A, ID	-4.49	0.00	Rechaza H_0
Es11	Pedroni With integration	No Cointegration	PIB, ID	2.58	0.01	Accept H_0
Es12	Pedroni With integration	No Cointegration	PIB, ID, XAT, PATENO, MR	-3.27	0.00	Reject H_0
Es13	Pedroni With integration	No Cointegration	ID, XAT, MR, PATENO	2.96	0.00	Accept H_0
Es14	Pedroni With integration	No Cointegration	A, ID, XAT, MR, PATENO	-2.52	0.01	Reject H_0
Es15	Johansen-Fischer	No Cointegration	A, ID	(52.8)	0.00	Reject H_0
Es16	Kao With integration	No Cointegration	A, ID	-3.07	0.00	Reject H_0

Table 3

The Table 3 shows the estimation of stationarity and cointegration, in the estimation (es09) examine if there is a unitary root of the PIB series and the technologic variables, obtaining an ADF quite negative that points that is rejected the null hypothesis that there is unitary root and therefore the series are stationary.

In the estimation (Es10) is proved the stationarity of the series of inversion in research and develop with the factors total productivity and the evidence show that the series are stationaries, because, ADF is negative and the probability is of 0.00.

This show that there is a stability of the variables in the long term and one of them cause to the other as our work prognostic, that the inversion in research and develop cause the increase of the factors total productivity. The estimation (Es11) shows the cointegration test of residuals of Pedroni for income series and the inversion in research and develop, resulting that ADF is positive and of entry is accepted the null hypothesis that there is not cointegration between esteemed variables, Follow by a cointegration test of the Pedroni residuals between the product and the technologic variables where we obtained a negative ADF indicating that we should reject the null hypothesis of cointegration non-existence between variables and therefore there is cointegration between the gross domestic product and the technologic variables. Posteriorly we estimate Pedroni cointegration between the technologic variables where we accepted the null hypothesis of that there is not cointegration between DTF and the technologic variables. At the end is accomplished the prediction of the Schumpeterian theories with the cointegration estimations with the methods of Johansen-Fischer and Kao, that show that exist cointegration in the principal motor of the inversion in research and develop.

Causality test of Granger

The Granger causality is a fundamental analysis to detect relation between variables; this is a test which consists in measure the level of relation between two or more variables.

The test consists in establish the null hypothesis that there is no causality between variables, the reject criteria is based in detect the t static value and its level of probability, the t statistic are rejected which have associate level minor or equal to 0.05. The causality test is done for the different variables of interests for this research.

Granger causality in the period (1990-2008)

Lags	Hypothesis	Prob.	Observations
Delay 0	PIB does not Granger Cause PATENO	0.01	Reject H_0
	L does not Granger Cause ID	0.05	Reject H_0
	K does not Granger Cause PATENO	0.01	Reject H_0
Delay 1	PIB does not Granger Cause PATENO	0.01	Reject H_0
	ID does not Granger Cause PATENO	0.04	Reject H_0
	ID does not Granger Cause K	0.05	Reject H_0
	L does not Granger Cause ID	0.05	Reject H_0
	K does not Granger Cause PATENO	0.01	Reject H_0
Delay 2	PIB does not Granger Cause PATENO	0.01	Reject H_0
	L does not Granger Cause ID	0.05	Reject H_0
	K does not Granger Cause PATENO	0.01	Reject H_0
Delay 3	K does not Granger Cause PATENO	0.03	Reject H_0
Delay 4	ID does not Granger Cause PATENO	0.00	Reject H_0
	PATENO does not Granger Cause L	0.02	Reject H_0
Delay 5	ID does not Granger Cause PIB	0.04	Reject H_0
	ID does not Granger Cause PATENO	0.05	Reject H_0

Table 4

In the former Table is done the causality test between all the variables of interest with different lags, we find important findings. This is, that in the short term (until three years) the Gross Domestic Product, and Capital are those which promote the technologic variables (Given Patents, Research and Develop, Register Brands and Exportation of High Technology). While the technologic variables promote the product, capital and work in midterm (four or five years) cause the Given Patents in the same year.

From the Granger analysis we could deduce that in the short term the production and its factors (capital and work) impulse the scientific and technologic development, and that the technologic progress in the countries will promote the growth of the income and welfare with delays of three years.

Conclusions

The Literature of the Schumpeterian endogenous growth is emphatic in pointing that the activities generator of innovation like the inversion in research and develop, the patents, have important effects in the economic growth.

A bigger effort in research and develop promote the increase of the factors total productivity of an economy and with that the economic growth and the population welfare. Howitt (1999) points that the high rates of economic growth of a nation are generate by the high rates of intensity in research and develop.

The empiric reference presented in this document show the prediction of the Schumpeterian hypothesis for the Latin American countries that are study objectives, we point that there is a positive impact of the intensity in research and develop and other technologic variables with the increase of the factor total productivity and the economic growth in the analyzed period 1960-2008.

Our work starts of endogenize the PTF, endogenize also I+D in function of its results or its productivity that we suppose (Given patents in the country) and the impact that have not only locally (PatenO, Register Brands) but also the international impact (Exportation of Wells of High Technologic Content).

Because the different infrastructures: economic, technologic, social, place, geography, etc. we propose that each Latin American nation should search the tools, appropriate incentives in order to promote the innovation activities, that impact in the increase of the Factors Total Productivity and therefore in the Economic Growth and the population Welfare.

These actions could be oriented to the private sector with physical, financial, etc. incentives which promote the innovation actions, also guaranty the property rights and the best laws which impact in more innovation activities.

Promote a major link between academics and entrepreneurs. In the other hand the international commerce, the financial and commercial opening, the competence could be conditions to promote the inversion in research and develop and channel for the access to international technologic knowledge.

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