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INSTITUTIONAL GEARING, INNOVATION AND ECONOMIC GROWTH: EMPIRICAL ESTIMATION FOR 32 ECONOMIES

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Abstract

The objective of the paper is to estimate the relationship between institutional gearing and economic growth for 32 economies of the world. For this it is considered that institutional gearing is the positive effect that one institution has over another, but also above all the system that generates innovation. In addition, other variables were included that affect innovation. To do this, we estimate a data model panel with fixed effects for the period 2011-2015. The results show that institutional gearing, high technology exports and capital stock have a positive effect on economic growth. We conclude that the positive effect of the existence of an institution on another institution and on the system of innovation (institutional gearing) has a positive effect on the economic growth of the countries used.

Keywords: institutional gearing, economic growth, innovation

1. INTRODUCTION

Several papers have demonstrated the links between economic growth and innovation (Schumpeter, 1984, Romer, 1990, Grosmman and Helpman, 1991, Aghion and Howit, 1998, Nelson, 2007). Barro and Sala - i - Martin (1996) point out that research and development activities and the stock of human capital are the main source of inventions. From the above, a group of studies have confirmed their relationship with innovation and economic growth (Coe, Helpman and Hoffmaister, 2009, Marroquín and Ríos, 2012, Rendón, 2014, Valera and Sifontes, 2014). However, there is empirical evidence showing a negative relationship between these variables for specific regions (Benhabib and Spiegel, 1994; Ulku, 2004 and Rendón and Ochoa, 2014).

Fu, Pietrobelli and Soete (2011) show that the promotion of research and development activities is an innovation strategy aimed at the assimilation, adaptation and creation of new technologies; through a panel data study they show that exports have a significant impact on economic growth. These results coincide with Ffrencha-Davis's (2002) research; Ciarli and Giuliani, (2005); Hausmann and Klinger, (2007); Aditya and Roy, (2007); Rodríguez, (2009) and Lee, (2011).

According to Lundvall (1992, 2007, 2010) the process of innovation represents a complex system involving the interaction of a number of agents and institutions. On the one hand, universities, research centres, companies and individuals will share knowledge to create new products and services. On the other hand, institutions will be in charge of providing a regulatory framework that protects their rights, provides the appropriate legal environment, and offers programmes and policies that motivate agents to innovate (Lundvall, 1992, Freeman 1993, Nelson 1993, Dutrénit, 2009). However, the systemic approach to innovation does not recognise (at least explicitly) that the efficiency of one institution increases or decreases the efficiency of another (Aoki, 2007, 2011, Amble, 2007, Fernández and Alfaro, 2011; Lo-Vuolo, 2013; Acemoglu and Robinson, 2013); It is for this reason that we propose the construct of institutional gearing to recognise and measure the collaborative, cohesive and directed work developed by institutions in the processes of innovation (Borges and Saucedo, 2017).

From the institutional gearing construct, we developed an index of institutional gearing for 32 developed and developing economies (6 liberal market economies, 9 coordinated market economies, and 17 hierarchical market economies (Scheider y Korcher, 2012)). Considering the duality of results and including a new variable, it is pertinent to question whether there is a relationship between institutional gearing, R&D investment, capital stock and high technology exports with economic growth. For this, an econometric model of data panel was considered that allows the relationships among different variables to be studied, and to mix the time dimension with the transversal section, which allows making greater statistical inferences (Robledo, 2012).

The results show a significant and positive relationship between institutional gearing, high technology exports and capital stock with economic

growth. However, R&D investment has a negative relationship with economic growth, because such a variable is instrumental and depends on the level of education of the population, the number of researchers, absorption capacities, among others (Benhabib And Spiegel, 1994).

The main conclusions are: the countries with the highest levels of institutional gearing are those that have achieved the greatest economic growth, that is why countries with low institutional mechanisms, especially Latin American ones, require transformations in an institutional capacity (Hall, Sobel and Crowley, 2010 and Doner and Schneider, 2015), since they need to have a regulatory framework that provides security to the economic entities involved in innovation (Saucedo and Borges 2016), thus achieving greater economic growth.

2. LITERATURE REVIEW

Research has demonstrated the positive relationship between innovation and economic growth, with different methodologies, variables and country selection. Research and development activities, human capital and capital stock are strongly and positively related to economic growth (Coe, Helpman and Hoffmaister, 2009, Marroquín and Ríos, 2012, Rendón y Ochoa, 2014, Valera and Sifontes, 2014).

Marroquin and Ríos (2012) show through a study data panel for Mexico, the positive effect of investment in research and development activities with economic growth. On the other hand, Rendón (2014) performs a panel data study for 6 Latin American countries, finding a positive effect among such variables. However, Benhabib and Spiegel (1994) conduct a study for a number of countries and find a negative relationship between human capital accumulation and R&D investment with economic growth rates. Similar results were obtained by Ulku (2004) and Rendón and Ochoa (2014).

According to Fu, Pietrobelli and Soete (2011) the promotion of R&D activities is an innovation strategy aimed at the assimilation, adaptation and creation of new technologies; It can be said that there is a relationship between high technology exports with innovation and economic growth (Ffrencha-Davis, 2002, Ciarli and Giuliani, 2005, Hausmann and Klinger, 2007, Aditya and Roy, 2007, Rodríguez, 2009 and Lee, 2011).

Lee (2011) conducts a study to estimate the relationship of high technology exports with economic growth, in his analysis he considers 71 developed and developing countries; Applying an econometric test, he concludes that economies tend to grow faster when they have specialised in the export of high technology compared to those that specialise in the export of textile or food products. This makes it possible to identify a direct and positive relationship between high technology exports and economic growth. Also, Aditya and Roy (2007) conduct a panel data study for 65 developed and developing countries, finding that the diversification and composition of exports are determinants of economic growth; however, this relationship differs from each group of countries.

Hall, Sobel and Crowley (2010); Dias and Tebaldi (2012) and Kim, Lee, Park and Choo (2012) demonstrate a positive relationship between institutions, human capital and capital stock with innovation and economic growth in developed and developing countries. However, Kim, Lee, Park and Choo (2012) conclude that patent protection is an important variable for innovation and for economic growth in developed countries, but not in developing countries. This is due to the fact that developing country institutions benefit a small group of people (Amable, 2007, Acemoglu and Robinson, 2013, Schneider and Karcher, 2012), as well as lacking a reliable and secure regulatory framework for agents involved in the various economic processes.

Thus, empirical research findings show a mixed picture, making clear the relationship - positive or negative - between determinants of innovation, institutions and economic growth. However, none consider the institutional gearing, which recognises joint and collaborative work (among institutions) aimed at improving innovation processes (Saucedo and Borges, 2016), in addition to being considered a pillar of national innovation systems and economic growth (Borges and Saucedo, 2017).

3. DATA AND METHODOLOGY

3.1 Data

The paper seeks to observe the impact of institutional gearing and the determinants of innovation on the economic growth rate of 32 developed and developing countries for the period 2011-2015.

The institutional gearing indicator contains two sub-indices: input index (stability of laws, rule of law and effective government) and product index (patents, competitiveness and company-university links).

The procedure for calculating the institutional gearing index consists in obtaining a weighted average for both sub-indices:

- The standard deviation was calculated for each variable from the 32 countries
- We divided 0.01 among the standard deviations to find the weighting of each variable

$$\text{Ai} = 0.01 \,/\, (\text{standard deviation})$$

- Once the weights were obtained, the weighted average of each sub-index was calculated:

$$Weights\,(Z) = Ai / \sum_{1}^{3} Ai$$

- Subsequently, each variable was multiplied by its weight, then added and the value of each sub-index was obtained:

$$Subindex = (W_1 * Z_1) + (W_2 * Z_2) + (W_3 * Z_3)$$

– Once the procedure was performed, a simple mean of the two sub-indices was estimated to quantify the institutional gearing indicator

Table 1

Variables used in the data panel, unit of measurement, definition and sources.

Variable	Unit	Definition	Source
A. Dependent			
Gross Domestic Product, constant prices	% Change	Total value at constant prices of final goods and services produced within a country for a specified period of time, such as one year.	International Monetary Fund, World Economic Outlook Database, April 2016
B. Independents			
Institutional gearing	From 1 to 100	Indicator that recognises the joint and collaborative work carried out by the institutions in the field of innovation. It is subdivided into inputs (effective government, rule of law and stability of laws) and products (number of patents, competitiveness index and collaborative university-enterprise research).	Own elaboration with data from: WIPO (2016); WEF (2016), Global Innovation Index (2016) and Rule of Law (2016)
High technology exports	US dollars at constant prices, 2010	They are products with high R&D intensity.	World Bank, 2016
Gross capital formation	% GDP	It includes investment in new and existing fixed assets of the economy plus net changes in the level of inventories.	World Bank, 2016
Investment in Research and Development	% GDP	Public and private expenditure incurred to increase the stock of knowledge and use of it for new applications.	World Bank, 2016

Sources: Own elaboration with data from World Bank (2016), International Monetary Fund (2016), WEF (2016), GII (2016) and Rule of Law (2016).

The above data were obtained for 32 developed and developing economies, specifically Argentina, Australia, Austria, Germany, Belgium, Bolivia, Brazil, Canada, Chile, Colombia, Costa Rica, Denmark, Ecuador, El Salvador, Ireland, Japan, Mexico, Netherlands, Nicaragua, Norway, Panama, Paraguay, Peru, Sweden, Switzerland, United Kingdom, United States, Uruguay and Venezuela.

3.2 Methodology

With the information provided by international institutions, a panel data analysis was applied for 17 Latin American (Hierarchical Market Economies), 9 coordinated (Coordinated Market Economies) and 6 liberal (Liberal Market Economies) economies in the period 2011-2015.

Considering the impact of institutions on economic growth (Álvarez et al, 2009, Hall, Sobel and Crowley, 2010, Dias and Tebaldi, 2012, Kim et al, 2012) and the perspective that innovation arises as a consequence of knowledge, human capital, investment in R&D activities, and the volume of high-technology exports (Aditya and Roy, 2007; Coe, Helpman and Hoffmaister, 2009; Fu, Pitrobell and Soete, 2011; Marroquin and Ríos, 2012, Rendon and Ochoa, 2014), we estimate the following equation:

$$\mathrm{lgr}_t = \beta_{it}^1 \mathrm{lig} + \beta_{it}^2 \mathrm{lr\&d} + \beta_{it}^3 \mathrm{lhte} + \beta_{it}^4 \mathrm{lcs} + \beta_{it}^5 \mathrm{time} + U_{it} \quad (1)$$

Where:

lgr = logarithm of the growth rate of GDP

lig = logarithm of institutional gearing index

lr&d = logarithm of research and development activities

lhte = logarithm of high technology exports

lcs = logarithm of capital stock

time = variable that reflects the temporal effect of the panel

This functional specification, and according to the conformation of the data in the variables, is required of the econometric technique of the data in panel. In this way the previous equation was estimated with a fixed effects model.

The Hausman test determined that the best of the models consisted of a functional specification of fixed effects, but not corrected for heteroscedasticity, due to the presence of variance of the residuals in the sample.

The variables mostly appear in their logarithmic transformation because they had better properties than the original variables in the model. As pointed out by authors such as Baltagi (2008), the individual effect is in both cases random; however, the assumption that the individual effect correlates with the set of independent variables is that of panel data with fixed effects; the random effects model assumes that the independent variables and individual effect is zero.

The robust option was estimated considering the heteroskedasticity in the sample to avoid the inefficiency of the parameters of the model and the possibility that these parameters are biased. Temporal effects variables are incorporated to detect some kind of phenomena such as economic crises or reforms in economies.

4. RESULTS

All variables were considered for the 32 countries in the period 2011-2015. The variables together show high significance in the models as set by the p-value of the three types of R2 which reflect a goodness of fit of 0.4658 within the groups, 0.4337 between the groups and 0.2957 in the overall estimate.

Table 2

Economic Growth, Institutional Gearing and innovation determinants: Panel estimation

Dependent variable: growth rate of GDP	
Independent variables	Coefficient
Lig	1.098 *** (.1084)
lr&d	-7.209*** (2.204)
Lhte	.1383*** (.0320)
Lcs	5.353** (2.20)
Iyear_2012	.0394 (.2216)
Constant	-13.368
sigma u	7.6979
sigma_e	0.7196
Rho	0.9913
R	
Within	0.4658
Between	0.4337
Overall	0.2957
Obs.	63
Countries	32
Estimation method	Fixed effects

Note: coefficients: *, **, *** represent the level of significance at 10, 5 and 1% respectively

Source: own elaboration

The results in table 2 indicate that the growth of economies is closely related to institutional gearing, which implies that economies react favourably to a reliable and secure regulatory framework. The inclusion of variable institutional gearing reinforces the theoretical approaches of modern institutional economics that point to the evolution of societies over time. In this sense, institutional change (for instance: institutional gearing) allows economies to grow faster (North, 1981, 1993; Lundvall, 1992, Edquist and Johnson, 1997; Rodrick, 1999; Acemoglu, Johnson and Robinson, 2005; Hall, Sobel and Crowley, 2010, Dias and Tebaldi, 2012 and Kim, Lee, Park and Choo, 2012).

High-tech exports are another element that has slightly favourable repercussions for the growth of economies; one-percentage-point changes in foreign trade are not accompanied by changes in the same proportion in economic growth. The latter should not be discouraging as in conjunction with a good institutional gearing are prone to better economic performance. These results go hand in hand with those obtained by Ffrencha-Davis (2002): Ciarli and Giuliani (2005); Hausmann and Klinger (2007); Aditya and Roy (2007); Rodríguez (2009) and Lee (2011).

Gross capital formation is one of the key variables in explaining the models of economic growth and, in this sense, the economic growth rate is very sensitive to this variable, since it is directly related with the activities of R&D, high technology exports, innovation processes and institutions (Coe, Helpman and Hoffmaister, 2009, Hall, Sobel and Crowley, 2010, Dias and Tebaldi 2012).

This allows us to visualize the positive and significant influence of the institutional gearing and the determinants of innovation on economic growth, since the degrees of significance are 5 and 1% for the countries analysed. However, investment in R&D activities has a negative relationship with economic growth, such results follow the line of Benhabib and Spiegel (1994) and Ulku (2004), such a lack of significance can be presented because the variable is instrumental and depends on the level of education of the population, the number of researchers, absorption capacities, among others (Benhabib and Spiegel, 1994). In addition, this behaviour is due to the fact that growth rates increased more than R&D spending in developed countries, while in developing countries growth rates were not so high and therefore investment in R&D remained almost the same.

It is essential that the economies characterised by having a low indicator of institutional gearing, generate a significant change in their regulations, laws and programs, since the degree of institutional quality promotes greater economic growth (Hall, Sobel and Crowley, 2010).

5. CONCLUSIONS

This paper explores the relationship of institutional gearing, high technology exports, capital stock and investment in R&D activities with GDP growth rates for 32 countries. We find a relationship among the variables according to the literature. It was shown that countries with a high rate of institutional gearing are those with the greatest economic growth, since the institutional environment is a key aspect of sustained economic growth (Acemoglu, Johnson and Robinson, 2005).

Latin American economies are characterised by low institutional gearing and low economic growth. Therefore, they must focus on developing laws, regulations and programs that work collaboratively and aim to motivate the creation of inventions, thus achieving a higher economic growth.

The institutional gearing construct represents a theoretical contribution to the systemic approach to innovation. This indicator represents a data that measures the gear developed by the institutions involved in the innovation processes. The findings in this study are important in formulating new public policies, regulations and laws aimed at the same goal: to achieve higher innovation rates and greater economic growth.

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