Science and Technology Policy in Latino America Countries: A panel Data Approach*

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Abstract

This paper analyzes science and technology policy in Latino America. Making use of panel data methods, we test for successful science and technology policy, and supporting innovation practices in Argentina, Brazil, Chile and Mexico. There are three paradigms that explain science and technology policy: the market failure paradigm, the mission paradigm, and the cooperative technology paradigm. The market failure paradigm assumes that market mechanisms will lead to optimal rates of science production and technical change. The mission technology paradigm assumes that governments may play an important role in the programmatic mission of agencies. The cooperative technology policy paradigm assumes that markets are not always the most efficient route to innovation. The results suggest that there is room for government involvement when defining a science and technology policy that aims to support the development of innovative capabilities. We conclude that mission and/or the cooperative technology paradigms are adequate for defining a successful science and technology policy in Latino America.

Keywords: Science and technology policy, Latino America countries, innovative activity and panel data models.

Resumen

Este trabajo analiza la política de ciencia y tecnología en América Latina. Haciendo uso de los métodos econométricos datos panel, se busca probar la pertinencia de las políticas de ciencia y tecnología para apoyar exitosamente a los procesos innovadores en Argentina, Brasil, Chile y México. En este sentido, se puede decir que existen tres paradigmas que intentan explicar el desempeño de las políticas de ciencia y tecnolo-

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gía: el paradigma neoclásico, el paradigma como misión y el paradigma de la política para la cooperación tecnológica. El paradigma neoclásico asume que los mecanismos de mercado pueden generar tasas óptimas de producción de ciencia y cambio tecnológico. El paradigma como misión asume que los gobiernos pueden jugar un papel importante en la misión programática de las agencias gubernamentales. El paradigma de la política para la cooperación tecnológica asume que los mercados no son siempre los mecanismos más eficientes para alcanzar mayores niveles de innovación. Los resultados alcanzados en esta investigación sugieren que los gobiernos deben jugar un papel importante al momento de definir una política de ciencia y tecnología que busque desarrollar capacidades innovadoras. Una conclusión importante en este trabajo es que los paradigmas como misión y de la política para la cooperación tecnológica son adecuados al momento de definir las políticas de ciencia y tecnología en América Latina.

Palabras clave: política de la ciencia y la tecnología, países de America Latina, procesos innovadores y métodos datos panel.

Clasificación JEL: C23, O54, O31 y O38.

1. Introduction

Since the emergence of the knowledge-based economy, science and technology has been recognized as an important engine for successfully innovate by firms. In fact, many scholars have stressed the importance of coevolution of science and technology (S&T) and innovation developments in emerging economies for catching up industrialized countries (Dutrénit et al. 2003; Nelson 1994, 1995). In the same manner, for example, Kim (1997), Lundvall (1996) and Nelson (1995) have pointed out that the fundamental resource for developing competitive advantages in modern economies is knowledge. Actually, knowledge-based innovations and human resources training are both required to transit into the development process (Dutrénit et al. 2003). In this context, any successful policy aiming to support science and technology for improving innovation in Latino America should take into account however its role as accelerating productivity and a source of value in the economy. In consequence, science and technology policy in Latino America should emerge aiming to identify the most important institutions, capabilities and resources needed to fostering economic development. A science and technology policy should be a way for preventing a sustainable economic development in these countries. Such a policy may follow at least three objectives: (1) to develop R&D capabilities at public institutions for research and universities, (2) to stimulate firms' demand for scientific and technological knowledge through establishing close relations between universities, firms, and governments, and (3) to support and develop national innovation systems in countries of this region.

This paper is organized as follows. Section 2 contains a short review of alternative paradigms in relation to science and technology policy. Section 3 deals with science and technology policy in some specific countries in Latina America: Argentina, Brazil, Chile and Mexico. Section 4 discuses an econometric panel data model for testing the importance of research and development (R&D) expenditure in case of these countries. Section 5 presents some results achieved in this model. Finally, section 6 contains some conclusions.

2. Science and Technology Policy

This section discuses the debate in relation to science and technology policy from a theoretical perspective. In this sense, it is pointed out that there are three important theoretical paradigms for discussing science and technology policy. It is argued that the mission paradigm and the cooperative technology paradigm are however the most important frameworks when defining a science and technology policy in Latino America countries.

From the macroeconomic perspective, Bozeman (2000) found that there are three competing paradigms that explain science and technology policy: the market failure paradigm, the mission paradigm, and the cooperative technology paradigm. This author points out that the market failure paradigm is rooted into the neoclassical economic theory, and thus it assumes that market mechanisms will lead to optimal rates of science production, technical change and economic growth. Actually, three other assumptions underlie this assumption: (1) markets are most of the time an efficient allocator of information and technology, (2) public research developed by government laboratories should be limited just to market failures (for example, extensive externalities, high transaction costs and information distortions), and thus university research must be limited to basic research, and (3) most of the time innovation flows adequately from and to private sector. The basic technology and science policy derived from this paradigm is that governments may intervene in the economy just in case of clear externalities. Deregulation of science and technology activities, contraction of government role in science and technology activities, and R&D tax credits are good examples of this type of policies.

The mission technology paradigm assumes that government may play an important role in the programmatic mission of agencies. Under this paradigm, the government role should be closely tied to authorize programmatic missions of agencies. In this case, university R&D supports only traditional roles, such as agricultural and engineering extension, manufacturing assistance, and contract research for defense. Furthermore, under this paradigm, government should not compete with private sector in innovation and technology, but government and university R&D roles should be complementary.

Finally, the cooperative technology policy paradigm assumes that markets are not always the most efficient route to innovation, and thus there is room for government actors and universities in Latino America countries to play an active role in the process of technology transfer and development. Typically, government's role can be as a research performer, including supplying applied research and technology to industry, or developing policies affecting industrial technology development and innovation. In fact, the cooperative technology paradigm emphasizes cooperation among sectors, or even among rival firms when developing pre-competitive technologies. Bozeman (2000) concludes that universities and public research laboratories are particularly important players into the mission technology paradigm and the cooperative technology policy paradigm. However, under the cooperative technology policy paradigm, science and technology policy of government can play a highly important role supporting innovation and technology transfer through public laboratories and universities. Indeed, this author continues, it is within the conceptual framework yielded by the cooperative technology policy paradigm that university-industry technology transfer and academic spin-off companies creation can be considered as extended phenomena.

3. Science and Technology in Latino America

This section summarizes the main features characterizing science and technology policy in Argentina, Brazil, Chile, and Mexico. This section highlights the importance of developing supporting institutions for boosting innovation activities and competitive industries in these countries. The section contains a description of the most important features of the programs supporting science, technology and innovation programs in Argentina, Brazil, Chile and Mexico in the last years.

3.1. Argentina

The science and technology system in Argentina is headed by the Ministry of Science, Technology and Innovation, and regulated by the Law on Science, Technology and Innovation. Since the 1950s, Argentina created many agencies to develop R&D projects into specific areas: the National Atomic Energy Commission (CNEA), the Research Institute of Science and Technology for the Armed Forces (CITEFA), the National Institute of Agricultural Technology (INTA), the National Institute of Industrial Technology (INTI), and the Argentine Antarctic Institute (IAA). In the 1970s, the government of Argentina continued making significant R&D efforts creating the National Water Institute (INA), and the National Institute for Fisheries Research and Development (INIDEP). In the 1990s, it was created the National Commission on Space Activities (CONAE), the National Institutes of Health Laboratories (ANLIS), and the Argentine Geological Mining Service (SEGEMAR).

The National Council of Scientific and Technical Research (CONICET) was established in 1951. The CONICET is an agency in charge of promoting and implementing scientific and technological activities into various fields of knowledge. Along with the CONICET, the National Agency for Promotion of Science and Technology (ANPCYT) was established in 1996 to promote activities related to science, technology, and innovations. The ANPCYT administers three funds: the Argentinean Technology Fund (FONTAR), the Fund for Scientific and Technological Research (FONCYT) and the Trust Fund for the Promotion of Software Industry (FONSOFT). The FONTAR aims to develop the Argentinean National Innovation System through financing projects for the modernization and technological innovation in enterprises. Additionally, the FONTAR and the FONCYT encourage different actors to establish strategic projects for developing innovations. The FONCYT aims to promote and develop specific areas of scientific and technological knowledge through managing financial resources in terms of the areas set out in the National Plan for Science and Technology.

On the other hand, the Science and Technology Oriented Research Projects (PICTO) program focuses on the generation of new knowledge in areas of science and technology of interest to common partners willing to co-finance innovation projects. In the same way, Argentina has established the Argentinean Fund Sector (FONARSEC) designed to promote scientific, technological and strategic innovation in productive sectors, as well as the Strategic Areas Program (PAE) and Argentina Nanotechnology Foundation (FAN) to foster collaboration among different actors and integrating the innovative potential of micro and nanotechnology to national development.

In Argentina, there are many rules designed to encourage R&D projects through tax credit incentives consisting in both exemptions and reductions. The Tax Credit Certificates (*Certificados de Crédito Fiscal*) (CF), for example, covers up to 50% of total project costs of technological development, technological upgrading, the cost of patenting, technology services for institutions, technology services for SMEs, training, technical assistance, program technology councils, incubators, technology parks poles through certificates for cancellation of income tax. Additionally, Argentina started developing a venture capital market through establishing the Risk Capital Program for Enterprise in Science, Technology and Innovation which is addressed to entrepreneurs that prioritize efforts to exploit the results of R&D carried out in national scientific and technological institutions, as well as the creation of companies from incubators and technology parks.

3.2. Brazil

In Brazil, the National Council of Science and Technology (CCT) aims to develop competent human resources for supporting R&D projects and innovation. A priority policy in Brazil is to encourage the participation of academic, business, and government sectors in human resources training. The Ministry of Science and Technology (MCT) is responsible for implementing the national policy on science, technology and innovation. The MCT performs its functions through four technical secretariats: Secretariat for Policy and R&D Program (SEPED), the Ministry of Science and Technology for Social Inclusion (SECIS), the Secretariat of Technological Development and Innovation (SETEC), and Secretariat of Policy Informatics (SEPIN).

In the same way, the National Council for Scientific and Technological Development (CNPq) that it is a MCT agency seeks to promote scientific and technological research, as well as human resources training for researching purposes. The CNPq is integrated by various institutes and research centers in different disciplines and various fields of technological development. The CNPq provides scholarships to promote scientific and technological projects. In line with the MCT and in close collaboration with CNPq, the Funding Agency for Studies and Projects (FINEP) promotes and finances innovation and scientific and technological research at universities, technological institutes, research centers, as well as many other public and private institutions. Its goal is to promote economic and social development. The most important programs administered by the FINEP are the Program for Supporting Innovation at Enterprises (PRO-INNOVACION), the Program for Supporting Scientific and Technological Institutions (PROINFRA), MODERNITE that is focused to restructuring technological research, PROSPEQ that aims to support projects implemented by research institutes at strategic areas, EVENT that supports meetings, seminars and conferences on science, technology and innovation, PROSOCIAL that is focused on supporting activities in the field science and technology for social development, the Research Program in Basic Sanitation (PROSAB), HABITARE which supports projects in the area of housing technology, and the National Technological Incubators of Popular Cooperatives (PRONINC). In 1999, a sector funding program was established as an instrument to finance R&D and innovation projects.

In Brazil, the private sector participates in the national science and technology activities through the implementation of various promotional, operational and coordination functions. The private sector in this country is involved into the corporate sector, private technology institutes, laboratories and research centers linked to companies, as well as some non-profit organizations. In this sense, one of the most important programs of the government of Brazil is the Program to Support Scientific and Technological Development. This instrument has been developed in three phases: PADCT I from 1985, PADCT II from 1991 and PADCT III from 1998. The first phase of this program aimed to expand, improve and strengthen the technical and scientific expertise in universities, research centers and companies. The second phase focused on the incorporation of relevant forms of technological innovation, particularly with regard to industrial policy and foreign trade information. Finally, the third phase of this program has been aimed at improving the performance of Brazilian sector of science and technology through activities that promote the transformation of the science and technology in an efficient innovation and/or adaptation of new technologies.

Finally, in this country, the Achievement Plan for Science, Technology and Innovation 2007-2010 is looking for companies to invest in scientific research, applied technology and technological innovation. Under this scheme, Brazilian companies would be exempt from paying taxes taking into account criteria of intellectual property protection. Since 2000, Brazil is aiming to build an institutional environment to encourage the development of a venture capital market for supporting innovative project that includes various tools for development, such as the Brazilian Forum of Venture Capital Fund Incubators INNOVATE, the Brazilian Forum of Innovation Venture Capital, Portal Brazil, the Innovative Network of Exploration and Business Development, the Program for Developing and Training Venture Capital Manager.

3.3. Chile

In Chile, the policies that make up the National Innovation Strategy are proposed to the President of the Republic by the National Innovation Board (IASB) which sets up the general guidelines to be reviewed by the Committee of Ministers for Innovation. The Committee of Ministers for Innovation defines the policies and courses of action for defining the national strategy on science, technology and innovation. Until the 1970s, innovation policies to strengthen basic and higher education, as well as to encourage the competitiveness of business were defined separately. In the 1980s and the 1990s, the science and technology policy in Chile aimed to strengthen graduate studies and basic strategic sectors. Finally, in the 2000s, the main objectives of the institutional reforms were to create links between academia, government and business.

In Chile, the participation of the public administration in the scientific and technological research is through the creation of technological institutes and research centers that receive public funding. In line with the National Innovation Strategy, the government of Chile established the National Commission for Scientific and Technological Research (CONICYT) who serves as an autonomous public institution. Its strategic function is to support human capital formation, as well as to strengthen a scientific and technological base. The CONICYT operates two programs related to the formation of advanced human capital: the Human Capital Program, and the Bicentennial Graduate Scholarship Program. These two programs aim to support the development of a scientific and technological base through seven programs: the National Fund for Scientific and Technological Development (FONDECYT), the Astronomy Program, the Program of Regional Units of Scientific and Technological Development, the Financing Centers of Excellence in Research (FONDAP), the Fund for the Promotion of Scientific and Technological Development (FONDEF), FONIS, and the Research Associations (PIA).

The government of Chile has boosted six programs for supporting business innovation activities: the Innovation Fund for Competitiveness (FIC), InnovaChile, Associative Promotion Projects (PROFO), Technical Assistance Fund (FAT), Program Support Management Companies (PAG) and the Supplier Development Program. Some of these programs are managed by CORFO, while the administration of FIC also involves InnovaChile and CONICYT, as well as some other public universities and research centers. The FIC is an instrument to finance research projects. The main objective of this program is to strengthen the National Innovation System. Most of the programs administered by CORFO are intended to cover counseling and joint stock companies to boost their competitiveness. However, InnovaChile primarily focuses on encouraging innovation by funding collaborative research initiatives with companies, universities and research centers.

Finally, in this country, there are some sector programs aiming to strengthen priority areas that have been established by the Foundation for Agrarian Innovation (FIA) and more recently the Fisheries Research Fund (FIP) for marine resource conservation. In this regard, in order to allow the transfer of international knowledge, Chile has developed the program ChileGlobal. Since 2006, the government of Chile has instituted a program for supporting innovation activities: InnovaChile. The objective of this program is to seed money for planning and implementation of innovative business projects with high growth expectations (pre-investment studies and support for implementation). Additionally, this country has implemented an angel investor network, aiming to support people committed to invest in innovative projects.

3.4. Mexico

In Mexico, the General Council of Scientific and Technological Development is the federal body responsible for implementing and formulating science and technology policies, as well as it is in charge of coordinating other scientific and technological activities. The General Council of Scientific and Technological Development Council is chaired by the President. The ministers of state participate in this Council. The Council takes advice from scientific and technological experts, scientific associations, and the academia. The National Council for Science and Technology (CONACYT) is an important member of the General Council of Scientific and Technological Development. CONACYT holds the technical secretary of this Council.

In Mexico, the scientific and technological activities are primarily developed by CONACYT who is in charge of promoting innovation activities, as well as strengthening scientific and technological capabilities in this country. In this sense, the CONACYT is the entity who heads the Mexican science and technology sector. In 2002, CONACYT was bought its current autonomy. Its mission is to promote and strengthen scientific development and technological modernization at national and regional levels, establish training programs for skilled human resources, as well as to disseminate scientific and technological advancements.

Some important actors developing these tasks are the SEP-CONACYT research centers. The main functions of these institutions are to conducting world-class scientific research and technological development. The SEP-CONACYT research centers system is composed by 15 centers in the field of natural sciences, eight centers in the field of social sciences and humanities, and nine centers devoted to technological developments. In addition, the SEP-CONACYT research centers system administers also the National System of Researchers (SNI) which aims to support public and private academic researchers for encouraging efficiency and quality in research.

For supporting human resources training, CONACYT provides scholarships for national and foreign students. CONACYT also supports funding for sabbaticals and postdoctoral stays at national and foreign universities. The Council also administers trust funding that consists of joint projects with agencies and entities of the federal government seeking to allocate resources to scientific research and technological development. To support innovation activities, CONACYT administers several programs. For example, the AVANCE program encourages new companies creation based on the exploitation of scientific and/or new technologies. The ADVANCE program has three lines of action: Last Mile, CONACYT-Entrepreneurs Program, and Guarantee Fund NAFIN (CONACYT-NAFIN).

Another program to support the improvement of technological capabilities is the IDEA program. Through the IDEA program, firms incorporate professional graduate students profiting from research, developments and innovations carried out by these students. The Technology Innovation Fund is a trust fund created to support micro, small and medium enterprises. Finally, other important program implemented by CONACYT is the Innovation Network. This program is a tool aiming to promote links between research institutions and enterprises in order to increase the competitiveness of the productive sector.

4. The Model

From a general perspective, it is recognized that the scientific knowledge is characterized at least partially as a public good and non rival (Arrow 1962; Nelson 1959). Effectively, when knowledge is recognized as a public and non rival good, it arises an appropiability problem for inventors, and thus opening up the possibility to generate some kind of positive externalities. In this sense, there is a kind of asymmetries in capital markets when financing R&D projects. Actually, these arguments may justify the government intervention into science and technology activities.

In this section, we analyze the importance of R&D spending on patenting activity in Argentina, Brazil, Chile and Mexico. Specifically, we tested a panel data econometric model to determine whether the variables R&D, dependency rate, and inventive rate are important to determine patent applications in these countries. In so doing, the Hausman specification test (1978) is firstly performed to select the right method for estimating this model: the fixed effects method or the random effects method. The null hypothesis is then tested to confirm that there is no misspecification (random effects method is efficient and consistent), meanwhile the alternative hypothesis is that there is a misspecification (random effects method is inconsistent) (Asteriou and Hall 2007; Baltagi 2005; Wooldridge 2002).

The results of the Hausman specification test indicates that the random effects method is best suited for the model estimated in this research, accepting the null hypothesis, according to the data. The equations estimated for this model were specified as follows:

$$Patent_{it} = \beta_{1i} + \beta_2 RD_{it} + \beta_3 DR_{it} + \beta_4 IR_{it} + u_{it}$$

where RD is the R&D expenditure, DR is the dependency rate, IR is the inventive rate, β_{1i} is a random variable with an average value of β_1, and the intercept value for each country is expressed as $\beta_{1i} = \beta_1 + e_i$ for i= 1, 2, ..., N with e_i a random term, and u_{it} is error term.

The model is estimated using the GLS (generalized least squares) method through Period SUR that corrects for heteroskedasticity and general correlation of observations within cross section between countries. The estimation of the model is developed with EViews7.

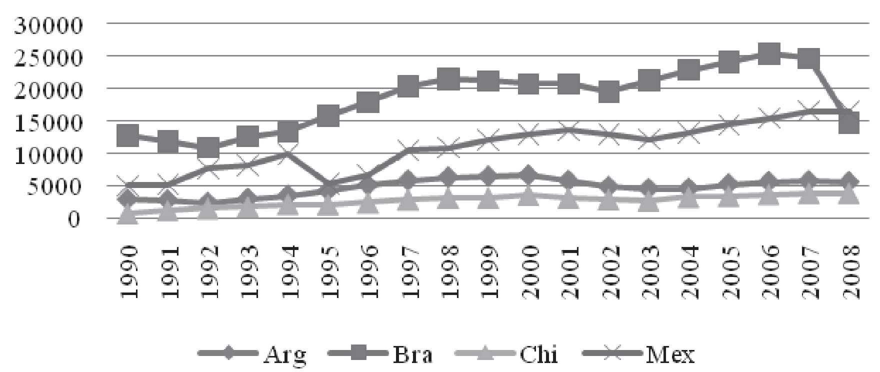
5. Results

The main results of the econometric regression model estimated in this research are presented in this section. Table 1 shows the results from the Hausman test and Table 2 contains the main results from the regression model estimated in this research. Making use of data released by the *Red Iberoamericana de Ciencia y Tecnología*, the econometric model estimated in this research includes information of the period 1990-2008 (Albornoz et al. 2008; Emiliozzi et al. 2009).

Graph 1 shows the total number of patent applications in Argentina, Brazil, Chile and Mexico from 1990 to 2008. As it would be expected, the total number of patent applications in each country is correlated to the size of their economies, given that they can invest more resources in R&D activities. In this case, Brazil and Mexico are characterized for developing a more vigorous patenting activity. This variable is thus taken as an indicator of a successful innovation policy that it is influenced by R&D expenditure, internal (inventive rate) and external (dependency rate) environmental conditions for developing successful innovations. In this research, we assume that the main objective of the science and technology policy in Latino America is to develop innovation projects for competing into the markets.

Graph 1

Total Number of Patent Applications in Argentina, Brazil, Chile and Mexico: 1990-2008



In relation to the econometric model estimated in this research, as it was already stated in section 4, the Hausman specification test indicates that the random effects method is best suited for the panel data econometric model estimated in this paper to test for the importance of R&D, dependency rate, and inventive rate on patent applications in Argentina, Brazil, Chile and Mexico. The null hypothesis is thus accepted, suggesting that there is no misspecification in the model (random effects method is efficient and consistent) (Table 1).

In terms of importance of the variables included into the model, the results suggest that the variables R&D expenditure (RD) and dependency rate (DR) are both significant. However, the variable inventive rate (IR) is less important in this model for explaining the number of patent applications in Argentina, Brazil, Chile and Mexico (Table 2).

Table 1

Science and Technology Policy Panel Data Model:
Hausman Test

Test Summary	Chi-Sq. Statistic	Chi-Square d. f.	Prob.
Cross-Section Random	0.065468	3	0.9956

Table 2

Science and Technology Policy Panel Data Model (Random Effects)

Dependent Variable: Patent Applications

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Constant	0.477510	0.006234	7.660200	0.0000
R&D (RD)	0.158992	0.055257	2.877297	0.0054
Dependency Rate (DR)	0.160107	0.060947	2.626968	0.0108
Inventive Rate (IR)	0.300777	0.159774	1.882512	0.0643

These results may reveal several important features in relation to science and technology policy and innovation activity in Latino America countries. As it would be expected, the R&D expenditure is the most important variable for explaining patent applications in Argentina, Brazil, Chile and Mexico. However, the point to stress here is that in these countries, the main source to financing science and technology developments is the one coming out from governments. In fact, in these countries, it would be not exaggerated to say that public funding reveals to be the only source for developing basic science through subsidies to universities and public research centers. Nevertheless, authorities in Argentina, Brazil, Chile and Mexico are every time more conscious of the importance of establishing strong linkages between governments, universities and firms to develop technology and innovation advances.

In relation to the variables dependency rate and inventive rate, the results suggest a strong technology dependency on science and technology advances developed abroad. These results confirm the troubles many times mentioned in relation to Latino America countries for catching up industrialized countries. However, when we analyze the variable inventive rate individually for each country, we can get other kind of conclusions. In the case of Mexico, for example, the inventive rate is characterized to be very low. This characteristic may suggest that many firms in Mexico are more willing to patent in the United Sates as a mechanism to ensure economic rents and establishing market barriers in this country (Gómez and Rodríguez 2008, 2009). Moreover, in relation to this problem, scholars agree on the insufficient rate of technology change for being incorporated into the productive structure of Latino America economies (Katz 2006, 2007).

Finally, the values of the econometric tests achieved in the case of the inventive rate variable suggest the existence of important differences among countries in terms of inventive capabilities effectiveness. In fact, in some cases, strong economic relations of Latino America countries with industrialized economies may influence their inventive capacity through patenting domestic inventions in markets of developed countries.

6. Conclusions

The model developed in this research reveals the importance of the expenditure in science and technology for developing innovative capabilities in Latino America countries. In this sense, there are many variables that influence the development of technological capabilities at different levels (macroeconomic, industrial and firm levels). However, the results achieved in this research confirms the importance of R&D for improving innovative activity in Argentina, Brazil, Chile and Mexico, measured by means of the total number of patent applications in these countries.

The dependency rate and the inventive rate confirm a strong technological dependence in Latino America from abroad. In some cases, the strong economic relations that can be observed between some Latino America countries and other industrialized countries make the former to established closer relations with the latter countries in terms of their science and technology agendas. Actually, this fact may influence the science and technology policy, as well as the innovative efforts carried out in many Latino America countries.

Finally, it would be important for further research to develop other explanations in terms of suppliers and users of science and technology for developing innovation processes in Latino America countries. As it was already suggested by many scholars, these explanations should take into account the structure of the economic system, the actors (governments, universities and public research centers, and firms) that participate in the generation and development of science and technology, as well as the nature of the innovation process carried out in Latino America (Barrere et al. 2008; Katz 2006). Actually, this scheme may allow us to understand different levels of competitiveness and heterogeneity among firms and sectors in this region.

References

Arrow, K. J. 1962. Economic Welfare and the Allocation of Resources for Invention. In R. R. Nelson (ed.), The Rate and Direction of Inventive Activity: Economic and Social Factor. Princeton: Princeton University Press.

Asteriou, D., and S. G. Hall. 2007. Applied Econometrics: A Modern Approach. Palgrave MacMillan.

Baltagi, B. H. 2005. Econometric Analysis of Panel Data. New York, USA. John Wiley and Sons.

Barrere, R., M. Bageneta, and L. Matas. 2008. Sistemas Científicos Complejos y su Abordaje Metodológico. In M. Albornoz, C. Vogt, and C. Alfarez (eds.), Indicadores de Ciencia y Tecnología en Iberoamérica: Agenda 2008. Buenos Aires: Ricyt.

Bozeman, B. 2000. Technology transfer and public policy: A review of research and policy. Research Policy 29: 627-655.

Dutrénit, G., M. Puchet, L. Sanz-Menendez, M. Teubal, and A. O. Vera-Cruz. 2003. A Policy Model to Foster Coevolutionary Processes of Science, Technology and Innovation: The Mexican Case. Working Paper Series 08-03. Globelics.

Emiliozzi, S., G. A. Lemarchand, and A. Gordon. 2009. Inventario de Instrumentos y Modelos de Políticas de Ciencia Tecnología e Innovación en América Latina y el Caribe. Working Paper 9. Banco Interamericano de Desarrollo.

Gómez, M., and J. C. Rodríguez. 2008. Innovative Activity in NAFTA and EU Countries: An Analysis of Structural Change in Patent Granted Trends. Proceedings of the Applied Econometrics Association. AEA: Tokyo, Japan.

Gómez, M., and J. C. Rodríguez. 2009. Multiple Structural Changes in Patent Granted Series and Innovative Performance: The Case of NAFTA and EU Countries. Proceedings of the International Society for Professional Innovation Management. ISPIM: New York, United States.

Katz, J. 2006. Cambios Estructurales y Ciclos de Destrucción y Creación de Capacidades Productivas y Tecnológicas en América Latina. Working Paper Series 07-06. Globelics.

Katz, J. M. 2007. Structural Reforms, Productivity and Technological Change in Latin America. Santiago: CEPAL.

Kim, L. 1997. From Imitation to Innovation: The Dynamics of Korea's Technological Learning. Boston, MA: Harvard Business School Press.

López-Acevedo, G. 2002. Determinants of Technology Adoption in Mexico. Policy Research Working Paper. World Bank. Washington, DC.

Lundvall, B. A. 1996. Information technology in the learning economy: Challenges for development strategies. Working Paper – Group on IT and Development. UNCSTD.

Nelson, R. R. 1959. The simple economics of basic scientific research. Journal of Political Economy 76: 297-306.

Nelson, R. R. 1994. The coevolution of technology, industrial structure and supportinginstitutions. Industrial and Corporate Change 3: 47-63.

Nelson, R. R. 1995. Coevolution of industry structure, technology and supporting institutions, and the making of competitive advantage. International Journal of the Economics of Business 2: 171-184.

Vilela, C., and S. Moro. Investigating the interaction and mutual dependence between science and technology. Research Policy 36: 1204-1220.

Wooldridge, J. 2002. Econometric Analysis of Cross Section and Panel Data. Cambridge, MA: MIT Press.