World Academy of Science, Engineering and Technology
International Journal of Economics and Management Engineering
Vol:8, No:3, 2014

Innovation Trends in Latin America Countries

José Carlos Rodríguez, Mario Gómez

Abstract**—**This paper analyzes innovation trends in Latin America countries by means of the number of patent applications filed by residents and non residents during the period 1965 to 2012. Making use of patent data released by the World Intellectual Property Organization (WIPO), we search for the presence of multiple structural changes in patent application series in Argentina, Brazil Chile, and Mexico. These changes may suggest that firms' innovative activity has been modified as a result of implementing a particular science, technology and innovation (STI) policy. Accordingly, the new regulations implemented in these countries during 1980s and 1990s have influenced their intellectual property regimes. The question conducting this research is thus how STI policies in these countries have affected their innovation activity? The results achieved in this research confirm the existence of multiple structural changes in the series of patent applications resulting from STI policies implemented in these countries.

Keywords**—**Econometric methods, innovation activity, Latin America countries, patents, science, technology and innovation (STI) policy.

I. Introduction

THIS paper analyzes the innovation activity in Latin America countries by means of the number of patent applications filed by residents and non residents in Argentina, Brazil, Chile and Mexico during 1965 to 2012. The question conducting this research is thus how the new dispositions implemented in Argentina, Brazil, Chile and Mexico during the last decades in relation to STI policy have affected trends in patent applications in these countries. The aim is to test the possibility of finding some structural changes in patent applications data series filed by residents and non residents in these countries. However, testing for structural change in patent applications data has been performed through various econometric models and methods [1], [2]. However, the analysis developed in this research allows testing the possibility of endogenous determining multiple structural changes in patent application series in Argentina, Brazil, Chile and Mexico.

In addition to this introduction, the paper is organized in five sections. Section two discusses some theoretical contribution in relation to patent granting and innovation activity. Section three analyzes some features characterizing STI policy in selected Latin America countries. Section four discusses the econometric model used in this research to test the possibility of finding structural changes in patent applications series in Argentina, Brazil, Chile and Mexico. Section five highlights the main results achieved from applying the econometric model discussed in this paper. Finally, Section six presents some conclusions obtained in this research.

J. C. Rodríguez and M. Gómez are with the Economic and Business Research Institute, Universidad Michoacana de San Nicolás de Hidalgo, Edificio ININEE, Ciudad Universitaria, Morelia, Mich., Mexico (e-mail: jcrodriguez@umich.mx mgomez@umich.mx).

II. Literature Review

Changes observed in intellectual property regimes over the past decades have moved into the same direction [3]: expanding and strengthening the protection of innovation. Since the 1970s, many changes have been observed in relation to intellectual property regimes around the world. The passage of the Bayh-Dole Act in the United States (1980) and many other changes observed in its intellectual property legislations and technology transfer practices during 1980s and 1990s has intensified these trends in that the legal and administrative changes observed in the United States uncovered the need to adjust other intellectual property regimes in the world. Actually, the outcomes drawn from the new realm in terms of intellectual property have opened up further opportunities to commercialize new knowledge through patents and licenses [4], [5].

In this paper, it is assumed patents of residents and non residents as major indicators of innovation activity. In this sense, national patent applications have continued to be driven by some particular factors [6], [7]: (1) firm size, (2) market power, (3) technological opportunity, (4) research efforts, and (5) intellectual property strategies adopted by the firm.

The effect of firm size on national patent applications derives from the Schumpeterian hypothesis suggesting that large firms are more innovative than small firms [8]. Large firms benefit from economies of scale and scope, spillovers and access to financial markets in order to financing risky innovation projects [9]. In some cases, small firms are more likely to patent to compensate for disadvantages in terms of market share and brand name [10]. The relation established between market power and patent applications also derives from Schumpeter's hypothesis in that firms with a higher market power are more innovative than firms with weak market power [8]. Even if this factor has also been controversial, there is evidence of a positive impact of firm's market power on its innovation activity [11], [12]. Technological opportunity is defined as the extent to which an industry relies on science-based research [13]. In consequence, firms in high technology opportunity sectors are found to patent more than other firms [10]. The relation established between research efforts and patent applications goes from R&D to patents, as a process that affects firms' innovative performance. In this sense, the relationship between R&D and patents can be seen as a virtuous cycle that requires further development costs in order to reach the market [6]. Finally, in relation to the intellectual property strategy adopted by firms, there are also many factors influencing their innovative capabilities, such as the relative importance of basic and applied research in total R&D, the product or process orientation of innovation efforts, the extent to which R&D is jointly performed with other institutions, and the limitations and inefficiencies of the patent system [6]. In this sense firm's patenting behavior might correlate with the type of innovation strategy pursued, the perceive barriers to the innovation process (internal, external, risk and cost-related barriers), and the limitations of the patent system they recognize [6].

III. STI Policy in Latino America Countries

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, on the one hand, and innovation developments, on the other, in the case of emerging economies for catching up industrialized countries [14]-[16]. In the same way, the fundamental resource for developing competitive advantages in modern economies is knowledge [16]-[18]. In fact, in the case of emerging economies, knowledge-based innovations and human resources training are both required to transit into the development process [14].

Therefore, any successful science, technology and innovation policy aiming to support science and technology developments for improving innovation should take into account its role as accelerating productivity factor, and as a source of value in the economy. In consequence, science, technology and innovation policy in Latino America should identify the most important institutions, capabilities and resources needed to foster economic development. A science, technology and innovation 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.

A. 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, three other agencies were 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 for 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 innovation. 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 indicated 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 science and technology areas of interest to 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 projects to productive sectors. The Strategic Areas Program (PAE) and the Argentina Nanotechnology Foundation (FAN) aim to foster collaboration between actors that integrate 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 (exemptions and reductions). In this country, the Tax Credit Certificates (*Certificados de Crédito Fiscal*) (CF), covers up to 50% of total project costs of technological developments, technological upgrading, cost of patenting, technology services for institutions, technology services for SMEs, training, technical assistance, program technology councils, incubators, technology parks poles. Actually, 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 and companies from incubators and technology parks.

B. Brazil

In Brazil, the National Council for 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 for Science and Technology Social Inclusion (SECIS), the Secretariat for Technological Development and Innovation (SETEC), and Secretariat for Policy Informatics (SEPIN).

The National Council for Scientific and Technological Development (CNPq) is a MCT agency seeking to promote scientific and technological research, and human resources training for research purpose. The CNPq is made up of various institutes and research centers from different disciplines and 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, scientific and technological research at universities, technical institutes, and research centers. The objective is to promote economic and social development by means of the programs administered by the FINEP: Program for Supporting Innovation at Enterprises (PRO-INNOVACION), Program for Supporting Scientific and Technological Institutions (PROINFRA), MODERNITE focused to restructuring technological research, PROSPEQ aiming to support projects implemented by research institutes at strategic areas, EVENT focused to support meetings, seminars and conferences on science, technology and innovation, PROSOCIAL focused on supporting activities in the field science and technology for social development, the Research Program in Basic Sanitation (PROSAB), HABITARE aiming to support projects in the area of housing technology, and the National Technological Incubators of Popular Cooperatives (PRONINC).

In Brazil, the private sector is involved in defining the national science and technology priorities through the implementation of various promotional, operational and coordination functions. In addition, 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. One of the most important programs of the Brazilian government 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. In the first phase, this program aimed to expand, improve and strengthen the technical and scientific expertise in universities, research centers and companies. In the second phase, this program focused on incorporating relevant forms of technological innovation, particularly with regard to industrial policy and foreign trade information. Finally, in the third phase, this program 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, the Achievement Plan for Science, Technology and Innovation 2007-2010 searches to invest in scientific research, applied technology and technological innovation. In this scheme, Brazilian companies are exempt from paying taxes, taking into account criteria of intellectual property protection. Since 2000, Brazil aims to build an institutional environment to encourage the development of venture capital markets to support innovation projects. This effort includes 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 Managers.

C. Chile

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

The participation of the Chilean public administration in scientific and technological research is through the creation of technical institutes and research centers that receive public funding. In line with the National Innovation Strategy, the government of Chile establishes 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: the Human Capital Program, and the Bicentennial Graduate Scholarship Program. These programs aim to support the development of a scientific and technological base through seven initiatives: 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 supports six programs for business innovation: 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 programs are managed by CORFO, and the administration of FIC involves InnovaChile, CONICYT and other public universities and research centers. FIC is an instrument to finance research projects and its main objective is to support the National Innovation System in Chile. Most of the programs administered by CORFO are intended to cover counseling and joint companies to boost their competitiveness. InnovaChile primarily focuses on encouraging innovation by funding collaborative research initiatives with companies, universities and research centers.

Finally, there are some sector programs aiming to support priority established by Foundation for Agrarian Innovation (FIA) and Fisheries Research Fund (FIP). To allow transferring knowledge from abroad, Chile has developed the program ChileGlobal. Since 2006, Chile has established a program to support innovation activity through InnovaChile. Additionally, this country has implemented an angel investor network aiming to support investment in innovation projects.

D.Mexico

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

Scientific and technological activities in Mexico are primarily developed by CONACYT who is in charge of promoting innovation activity and supporting scientific and technological capabilities. CONACYT heads the Mexican science and technology sector. Its mission is to promote and support scientific development and technological modernization at national and regional levels through establishing training programs for human resources and disseminating scientific and technological advancements. SEP-CONACYT research centers develop these tasks by conducting world-class scientific and technological research projects. The SEP-CONACYT research centers system is composed by fifteen centers in the field of natural sciences, eight centers in social sciences and humanities, and nine centers devoted to technological developments. In addition, this system administers the National System of Researchers (SNI) which aims to support public and private academic researchers for encouraging efficiency and quality in research.

To support human resources training, CONACYT provides financial support for national and foreign students. CONACYT also supports funding for sabbaticals and postdoctoral internships at national and foreign universities. CONACYT also administers trust funding for joint projects with agencies and entities of the federal government in order to allocate resources for scientific research and technological development. To support innovation activity, CONACYT administers the AVANCE program that encourages new companies creation to 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).

The IDEA program of CONACYT also supports the improvement of technological capabilities through incorporating professional graduates into companies. The Technology Innovation Fund is another trust fund created by CONACYT to support micro, small and medium enterprises. Finally, the Innovation Network is a tool to promote links between research institutions and companies to increase competitiveness.

IV. Econometric Methods and Model

This paper analyzes the possibility to find one or more structural breaks in the series of patent applications filed by residents and non residents in Argentina, Brazil, Chile and Mexico. It is expected that these results might be resulting from the new dispositions implemented in relation to intellectual property in these countries during the last decades. Structural change or structural instability has been interpreted as a change in the regression parameters [19]. In the case of patent application series, the structural or stability change hypothesis can be rejected when it is observed a change into a prevailing regime [20]. The existence and time location of a structural change can be econometrically tested through an autoregressive statistical time series dynamic model of order one AR(1) as follows [21]:

$$Y_t = \alpha + \rho Y_{t-1} + e_t \quad (1)$$

$$\sum_{t=1}^{n} e_t^2 / \left(n-k\right) = \sigma^2 \quad (2)$$

Y_t in (1) represents a time series, and Y_{t-1} is the same time series lagged one period. It is assumed that the error term e_t is not serially correlated. Equation (2) represents the formula for estimating the variance, where the numerator is the sum of squared errors and the denominator are the degrees of freedom [22]. When one or all parameters of the model change at some point in time in the sample, we can say that a structural break has occurred. The possibility to find structural breaks in the series of patent applications filed by residents and non residents in Latin America countries results from the new regulatory changes implemented into the intellectual property regimes in these countries during the 1970s, 1980s, or 1990s. To test for structural breaks, we used patent data released from WIPO.

Table I shows the definition of variables used in this model to test for one or more structural breaks in the series of patent applications filed by residents and non residents in Argentina, Brazil, Chile and Mexico. The model was estimated using absolute values of the growth rates of the number of patent applications filed by residents and non residents in these countries.

World Academy of Science, Engineering and Technology
International Journal of Economics and Management Engineering
Vol:8, No:3, 2014

TABLE I
VARIABLES DEFINITION

Variable	Definition
PATARR	Rate of growth of patent applications filed by residents in Argentina
PATARN	Rate of growth of patent applications filed by non residents in Argentina
PATBRR	Rate of growth of patent applications filed by residents in Brazil
PATBRN	Rate of growth of patent applications filed by non residents in Brazil
PATCHR	Rate of growth of patent applications filed by residents in Chile
PATCHN	Rate of growth of patent applications filed by non residents in Chile
PATMXR	Rate of growth of patent applications filed by residents in Mexico
PATMXN	Rate of growth of patent applications filed by non residents in Mexico

The model used to test for multiple structural breaks in the number of patent applications was specified following a multiple linear regression with m breaks (m+1 regimes), where all coefficients are subject to change:

$$y_t = z_t^{'}\delta_j + u_t \qquad (t = T_{j-1}+1,...,T_j)$$

$$\text{for } j = 1,...m+1,\ T_0 \text{ and } T_{m+1} = T$$

In this case, y_t is the observed dependent variable, $z_t(qx1)$ is a covariance vector, $\delta_j(j = 1,...,m+1)$ is the corresponding coefficients vector, and u_t is a disturbance term. The parameter m indicates the number of breaks. The break points $(T_1,...,T_m)$ are explicitly treated as unknown. The estimation methods used in this research is based on the least square principles proposed by Bai and Perron [23], [24]. For each m-partition $(T_1,...,T_m)$, denoted as $\{T_j\}$, the associated least squared estimated of δ_j is obtained by minimizing the sum of the squared residuals $\sum_{i=1}^{m+1}\sum_{t=T_{i-1}+1}^{T_i}\left[y_t - z_t^{'}\delta_t\right]^2$ constrained to $\delta_i \neq \delta_{i+1}$ $(1 \le i \le m)$. Let $\hat{\delta}\left[\{T_j\}\right]$ to be the resulting estimations. Substituting it into the objective function and denoting the resulting sum of squared residuals as $S_T(\hat{T}_1,...,\hat{T}_m)$, the estimated break points $(\hat{T}_1,...,\hat{T}_m)$ are such that:

$$(\hat{T}_1,...,\hat{T}_m) = \arg\min_{T_1,...,T_m} S_T(T_1,...,T_m)$$

where the minimization is taken over all partitions $(T_1,...,T_m)$, such that $T_i - T_{i-1} \ge q$. Thus, the break point estimators are global minimizes of the objective function. Finally, the regression parameter estimates are the associated least-squares at the estimated m-partition $\{T_j\}$, i.e. $\hat{\delta} = \hat{\delta}\left[\{T_j\}\right]$.

In this research, $AR(k)$ models were applied for each variable. The appropriate number of lags was determined using Ng and Perron methods [25], and estimating an AR(k) process using the maximum value $k_{\max}$. If the latest lag was not significant, then the selection of k was reduced by one. This process continued until the latest lag was significant or k = 0. In this case, 5 was taken as the maximum value of k and the significance of the lags was evaluated using the critical value of 10% of the normal standard distribution. To determine the number of structural breaks, the Bayesian Information Criterion (BIC) was used [26]. The number of estimated structural breaks $\hat{m}$ was determine by minimizing the above-mentioned information criterion give a fixed upper bound for m, $M = 5$.

V. RESULTS

Table II shows the results achieved in this research. In the case of Argentina, structural breaks are mostly observed in the 1990's. In this case, breaks in the series of patent applications of non residents may suggest the importance of foreign actors in patenting activity (multinational corporations). In the cases of Brazil and Chile, structural breaks are typically observed in patent applications of residents in 2000's. This fact corroborates the importance of Brazil and Chile to be more competitive in relation to other Latin America countries during the last decade. In fact, Brazil and Chile are two Latin America economies well known for successfully being more innovative than other countries in this region.

In the case of Mexico, structural breaks are typically observed in patent applications of non residents during 1990's. This fact may suggest that the intellectual property regime in Mexico has been modified as a result of the reforms implemented into the intellectual property regime in the United States during the 1980's and 1990's. Actually, the new dispositions implemented in the United States in terms of intellectual property in this period may have affected the intellectual property regime in Mexico through the North America Free Trade Agreement (NAFTA) and the Trade-Related Aspects of Intellectual Property Rights (TRIPS) [27].

TABLE II
BREAKING YEARS IN PATENT APPLICATIONS IN LATIN AMERICA COUNTRIES

Patent Applications (Residents)			Patent Applications (Non Residents)		
Country (Variable)	Breaking Year	BIC	Country (Variable)	Breaking Year	BIC
Argentina (PATARR)	1991 1993	-3.16240	Argentina (PATARN)	1984 1990 1995 1998 2002	-5.49605
Brazil (PATBRR)	2009	-4.55347	Brazil (PATBRN)	1994 1997	-4.11723
Chile (PATCHR)	2005 2007 2009	-3.17472	Chile (PATCHN)	2008	-3.87289
Mexico (PATMXR)	1990	-3.96913	Mexico (PATMXN)	1986 1991 1994 1997 2008	-4.57260

These results also suggest that Argentina and Mexico are more dependent on foreign inventors than Brazil and Chile. In fact, Brazil and Chile have been followed a more successful STI policy that is focused on developing indigenous capabilities for innovation.

VI. CONCLUSIONS

This research aimed to test the possibility of finding structural changes in patent applications series of residents and non residents in Argentina, Brazil, Chile and Mexico. The use of the econometric methods presented in this paper allowed endogenously determining the existence of structural breaks in these series. The results achieved in this research demonstrate that Mexico has been more influence by the new dispositions implemented in relation to intellectual property and other STI policies in the United States. Meanwhile, Brazil and Chile demonstrate to be more independent than Argentina and Mexico in terms of foreign inventions.

Even if this a first contribution to study the relationship between STI policy and innovative capabilities development in Latin America countries, further research should be done to understand the impact of alternative policies on many other STI variables in these countries.

REFERENCES

[1] B. H. Hall, "Exploring the Patent Explosion", *Journal of Technology Transfer*, vol. 30, no. 2, pp. 35-48, 2005.

[2] M. Gómez, M., and J.C. Rodríguez, "Innovative Activity in NAFTA and EU Countries: An Analysis of Structural Change in Patent Granted Trends", *Proceedings of the Applied Econometrics Association* (AEA), Tokyo, 2008.

[3] D. Encaoua, D. Guellec and C. Martínez, "Patent Systems for Encouraging Innovation: Lessons from Economic Analysis", *Research Policy*, vol. 35, no. 9, pp. 1423-1440, 2006.

[4] A.B. Jaffe and J. Lerner, "Reinventing Public R&D: Patent Policy and the Commercialization of National Laboratory Technologies", *The RAND Journal of Economics*, vol. 32, no. 1, pp. 167-198, 2001.

[5] D.S. Siegel, D.A. Waldman, L.E. Atwater, and A.N. Link, "Toward a Model of the Effective Transfer of Scientific Knowledge from Academicians to Practitioners: Qualitative Evidence from the Commercialization of University Technologies", *Journal of Engineering and Technology Management*, vol. 21, no. 1/2, pp. 115-142, 2004.

[6] C. Peeters, and B. van Pottelsberghe de la Potterie, "Innovation Strategy and the Patenting Behavior of Firms", *Journal of Evolutionary Economics*, vol. 16, no. 1, pp. 109-135, 2006.

[7] G. de Rassenfosse and B. van Pottelsberghe de la Potterie, "Per un Pugno di Dollari: A First Look at the Price Elasticity of Patents", *Oxford Review of Economic Policy*, vol. 238, no. 4, pp. 588-604, 2007.

[8] J.A. Schumpeter, *Capitalism, Socialism and Democracy*, Harper, New York, 1942.

[9] W.M. Ccohen and R.C. Levin, "Empirical Studies of Innovation and Market Structure", in: R. Schmalensee and R. D. Willing (eds.), *Handbook of Industrial Organization*, North-Holland, Amsterdam, 1989.

[10] E. Brouwer and A. Kleinknecht, "Innovative Output and a Firm Propensity to Patent: An Exploration of CIS Micro Data", *Research Policy*, vol. 28, no. 6, pp. 615-624, 1999.

[11] E. Duguet and I. Kabla, "Appropriation Strategy and the Motivations to Use the Patent System: An Econometric Analysis at the Firm Level in French Manufacturing", *Annales d'Économie et Statistique*, vol. 49, pp. 289-327, 1998.

[12] A.O. Nielsen, "Patenting, R&D and Market Structure: Manufacturing Firms in Denmark", *Technology Forecast and Social Change*, vol. 66, no. 1, pp. 47-58, 2001.

[13] R.C. Levin, A.K. Klerovick, R.R. Nelson and S.G. Winter, "Appropriating the Returns from Industrial Research and Development", *Brookings Papers on Economic Activity*, vol. 18, no. 3, pp. 783-831, 1987.

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

[15] R. R. Nelson, "The Coevolution of Technology, Industrial Structure and Supporting Institutions", *Industrial and Corporate Change*, vol. 3, pp. 47-63, 1994.

[16] R. R. Nelson, "Coevolution of Industry Structure, Technology and Supporting Institutions, and the Making of Competitive Advantage", *International Journal of the Economics of Business*, vol. 2, pp. 171-184, 1995.

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

[18] B. A. Lundvall, "Information Technology in the Learning Economy: Challenges for Development Strategies", Working Paper – Group on IT and Development. UNCSTD, 1996.

[19] G. S. Maddala and I. Kim, *Unit Root, Cointegration and Structural Change*, Cambridge University Press, Cambridge, 1998.

[20] A. Pulido, *Modelos Econométricos*, Ediciones Pirámide, Mexico, 2001.

[21] B. Hansen, "The New Econometrics of Structural Change: Dating Breaks in U.S. Labor Productivity", *Journal of Economic Perspectives*, vol. 15, no. 4, pp. 117-128, 2001.

[22] D. Gujarati, *Econometría*, McGraw-Hill, Mexico, 2004.

[23] J. Bai and P. Perron, "Estimating and Testing Linear Models with Multiple Structural Change", *Econometrica*, vol. 66, no. 11, pp. 47-78, 1998.

[24] J. Bai and P. Perron, "Computation and Analysis of Multiple Structural Change Models", *Journal of Applied Econometrics*, vol. 18, no. 1, pp. 1-22, 2003.

[25] S. Ng and P. Perron, "Unit Root Tests in ARMA Models with Data Dependent Methods for the Selection of the Truncation Lag", *Journal of the American Statistical Association*, vol. 90, no. 429, pp. 268-281, 1995.
[26] Y. C. Yao, "Estimating the Number of Change Points via Schwarz Criterion", *Statistics and Probability Letters*, vol.6, pp. 181-189, 1988.
[27] J. C. Rodríguez and M. Gómez, "Innovation Trends in NAFTA Countries: An Econometric Analysis of Patent Applications", *Journal of Technology Management & Innovation*, vol. 6, no. 3, pp. 116-124, 2011.