

Basic indicators of innovation activities from Puerto Ricans: a patent-based analysis.

C. A. Suárez-Balseiro^{a*}, M. Maura-Sardó^b, E. Sanz-Casado^c

^a Observatorio de Estudios Relacionados con la Información (OERI).
Escuela Graduada de Ciencias y Tecnologías de la Información.
Universidad de Puerto Rico, Recinto de Río Piedras, PO Box 21906, San Juan PR 00931-1906
Puerto Rico
E-mail: csuarez@uprrp.edu Fax. +1-(787) 7642311

^b Decanato de Estudios Graduados e Investigación
Universidad de Puerto Rico, Recinto de Río Piedras, PR 00931-1790 Puerto Rico
E-mail: mmaura@degi.uprrp.edu

^c Laboratorio de Estudios Métricos de Información (LEMI)
Departamento de Biblioteconomía y Documentación.
Universidad Carlos III de Madrid, Getafe, 28903 Madrid, España.
E-mail: elias@bib.uc3m.es

Abstract

Patents reflect the current inventive and innovation development in modern technology. Since this kind of document have become more available through electronic databases, the studies and interest for use patent indicators with other research related data to explore and depict technological profiles and general characteristics of innovative activity of countries, industries or companies, have been growing. This paper examines the profile of Puerto Rico patent activity during the period 1975-2004. Both, one-dimensional and multidimensional indicators have been used to analyze patents granted by the United States Patent and Trademark Office (USPTO) where at least one inventor is from Puerto Rico. A particular type of factor analysis –Correspondence Factor Analysis (CFA) – to analyze and present the patenting profile of a thirty years period has been used.

Keywords: patentometrics, technology maps, Puerto Rico

* Corresponding author: Carlos A. Suárez-Balseiro

Introduction

Patents provide information of particular interest about the claimants (inventor, patent assignees), the technological area or domain (keywords, classification codes), and the relation with precedent research of innovation work (citations). Studies based on patent activity of countries or companies commonly look at the number of patents, specialization on sectors, patent growth ratios and other more elaborated indicators like, for example, the named Current Impact Index and Science Linkage [1].

Patent analysis, named patentometrics, has become a valuable tool to identify main lines and trends of innovative activities, and to know more details about the research process and its impact on innovation indicators [2]. On the other hand, under specific conditions and combining with the use of text mining tools, patent analysis become a key factor to the so-called “tech mining” process [3] in order to generate effective competitive technical intelligence from acute analysis of the huge volume of science and technology information sources available today.

In the case of Puerto Rico, there is a growing concern about the development of the current economic model and the necessity to articulate effective strategies in order to reinvent the driving forces of the local economy. In this effort Puerto Ricans are looking to other economic models like a “mirror” to learn best practices and apply them to economic improvement. A key factor is a systematic and coordinated collaboration between the industry and the academia and the adaptation of scientific research results to commercial purposes.

Finland, Ireland and Singapore, countries with a population very similar to Puerto Rico, are a good example of commitment with the scientific research and the innovation, which is reflected in its successful economies. In the United State, the models of Florida and North Carolina are also mentioned commonly as good examples to Puerto Rico.

The situation mentioned above is the framework to introduce the use of some basic indicators related to innovation activities. If scientific research and technological efforts in Puerto Rico are key factors to improve the economy, it is important to know “where” the country is respect to technological and scientific production. Patents indicators are a useful tool to explore the issue. Moreover, the declared aims of many local companies related to the reinforcement of global

vision in business are a challenge framework to carry on efforts on patents analysis for business intelligence purposes.

This paper examined some aspects of Puerto Ricans inventors patenting activity over a thirty years time period, from 1975 to 2004, no matter if their work have been performed in the framework of local or foreign industries. This first approach could be a reference to other in-deep studies of regional technological innovation scenarios using patents data, which could be useful for strategic purposes according to the statements and priorities expressed by the government and other decision making groups in the island [4].

Methodology

The source of data was the United States Patent and Trademark Office (USPTO). We used the Patents BIB database on CASSIS DVD-ROM, which contains bibliographic information for utility patent grants issued from 1969 to the present and for other types of patent documents issued from 1977 to the present [5].

The CASSIS set-disc provides an easy way to search and download selected bibliographic data for placement in a database. Furthermore, data contained on the CASSIS product have been cleaned to some degree while the data available from the USPTO Search Site have not undergone data cleaning. In particular, corrections in inventor-residence and in assignee name variations are present in the CASSIS product data.

It was felt that to uncover the patent activity in Puerto Rico in a comprehensive manner, analysis should be based on inventor's residence data and not only assignee data. It means that the search was performed using the Inventor State field and not the Assignee State or Assignee Country fields of the database. For this approach was used to search the normalized code of state [PR] (i.e. Puerto Rico) in the Inventor State field of Patents BIB database; in order to identify and retrieve all patents with at least one inventor whose residence was in Puerto Rico at the moment of the patent was granted. The records found were processed using the appropriated methodology [6] [7]. The data set created contains basic information about inventor's name, inventor's residence, patent title, US patents classification codes, assignee and date of issued.

Both one-dimensional and multidimensional indicators were used. There are five key indicators of technology development performance commonly found in the literature and industrial practice: number of patents, patent growth, cites per patent, current impact index, technology cycle time, and science linkage. These indicators have been profusely used in the framework of the ipIQ's Technology Quality Model (TQM) [8].

We used two basic one-dimensional indicators from TQM model in this article: Number of patents (Np), that is the number of patents issued by the U.S. patent system to an analytical unit (e.g. company, country or a technology field) and patent growth (Pg), the percentage growth in the number of patents granted to an analytical unit compared to the year before. The Np indicator measures technological productivity and the Pg indicate the commitment to innovation. Although, in the framework of the TQM this two indicators are commonly used to analyze patenting profile of companies (i.e. "micro" level analysis) in this article they are applied to profiling the activity of inventors pertaining to a nation with a commonwealth government system (a "macro" level analysis).

A particular type of factor analysis –Correspondence Factor Analysis (CFA) – to analyze and present a patenting profile of a thirty years period has been used. Other authors to the study of time series have used this method [9] [10]. In this case we performed a CFA in which time is one of the variables of the matrix and a subject matter category (patent classification codes) is the other one.

Furthermore the data set was segregated according to patent types: utility, design and plant patents as distinguished under USPTO. Utility patents are the major category in USPTO database, the other three categories: Design, Reissue, and Plant, are minor patent categories [11]. Notice that, technological space that depicts the activity of a country under different technology sectors is mainly defined by the utility patents [12]. That's why we have used only utility patents for the analysis and mapping of patenting profile.

Finally, utility patents were aggregated in various technological sectors and sub-sectors using the scheme proposed by other authors [11]. The scheme adapts the patent classes used by USPTO into thirty-six sub-categories and six main categories (see Appendix). It is to be noted that a

single patent could be classified under one or more sub-categories pertaining to the same or different main categories. All statistical analyses were run with Microsoft Excel® and SPSS® for Windows.

Results

The total patents found were 750 for the period 1975-2004. Figure 1 depicts the numbers of patents granted by USPTO system which have at least one inventor resident in Puerto Rico by the time the patent was issued. (P_n). Figure 2 shows the percentage growth in the number of patents granted in the previous year, compared to the year before (P_g)

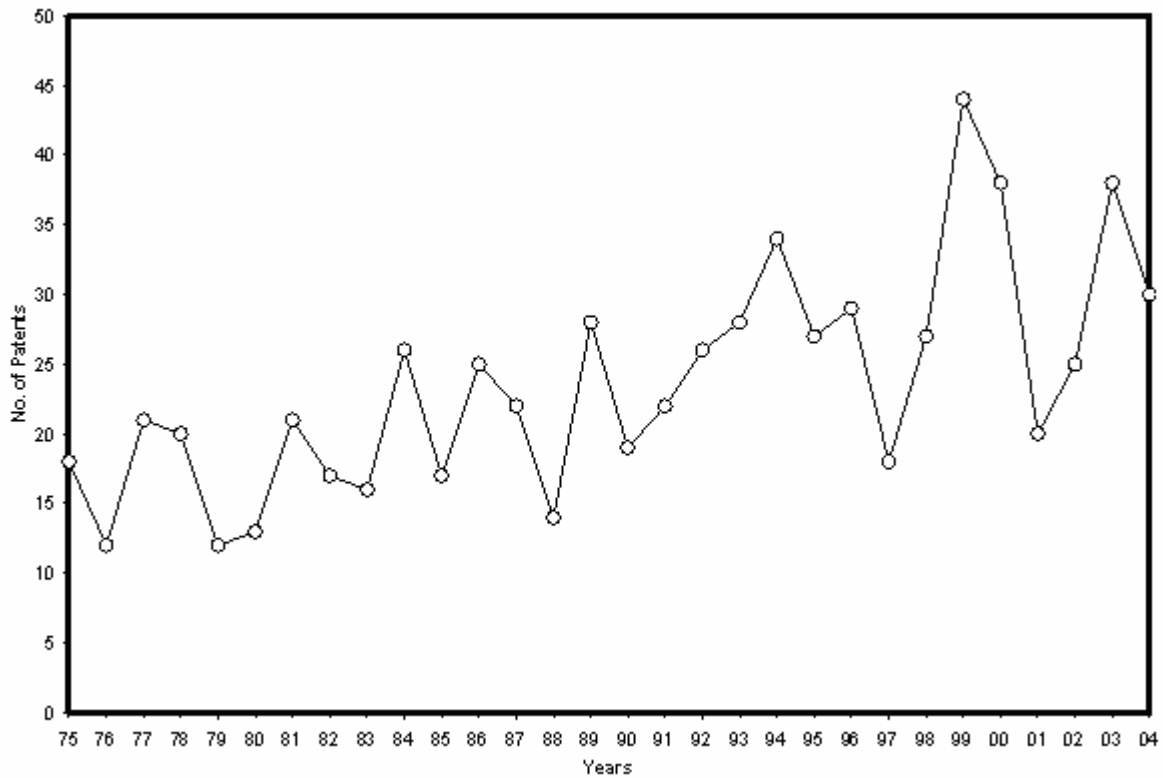


Figure 1: Number of patents (N_p)

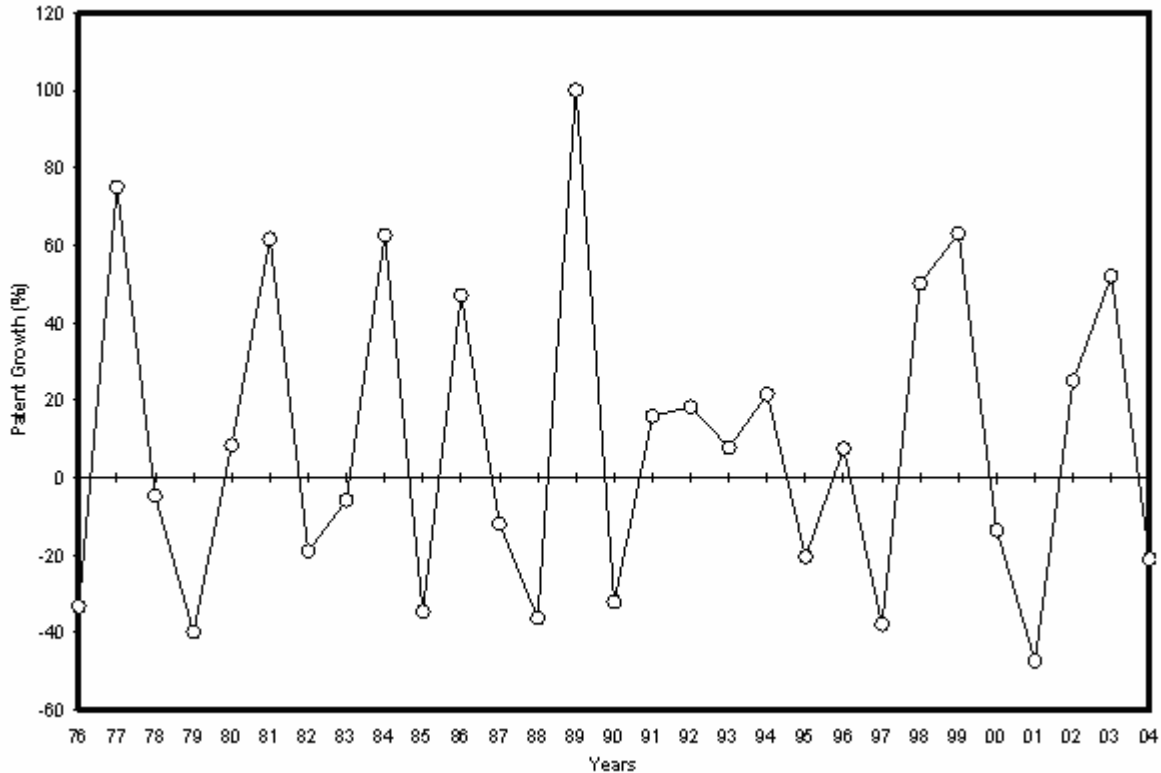


Figure 2: Patent Growth (Pg)

Both time series show a poor innovation and technological landscape for Puerto Rico. Although Np values show some growing trend to the 90's decade the total number of patent stays under 100 patents a year. In addition, the Pg evolution shows that there is not a true commitment to innovation. Several factors might influence this situation. Since 1940s the economic model of Puerto Rico was aimed at the development of industries that produced a high number of jobs. It is not until the beginning of the 2000 when this model came into crisis and it is tried to transform the economy into a knowledge-based one.

By many years in Puerto Rico a policy did not exist that fomented the generation of patents, is not until 1998 when the UPR established the Office of Intellectual Property and Commercialization of Technology that it has between his functions to promote the production of patents. Years later, in 2001 it was approved the Puerto Rico's Policy of Science and Technology that included strategies to stimulate the activities of R&D. In 2004 the Science and

Technology Trust, a non-profit organization that integrate to the public sector, the industry and the academia with the mission to promote the economic development of the Island.

Table 1 highlights the distribution in terms of patent types (utility/design/plant). Utility patents are dominant. Notice that it represent more than 80 percent for the all period analyzed. Design patents show a very discrete number, however they have been growing from 1990-1994 to 2000-2004.

Table 1. Type of Patents

Period	Utility	Design	Plant
P7579	73	10	0
P8084	87	6	0
P8589	88	17	0
P9094	105	22	2
P9599	125	20	0
P0004	172	23	0
Total	650	98	2
Total %	86.67%	13.07%	0.27%

Prepared by the authors

There are 383 individually-owned-patents during the period. In this way Table 2 shows that the main “actors” in the patenting profile among first organization are the Government of Puerto Rico and the University of Puerto Rico (public sector), and Vassallo R&D Corp. (private sector), a leading local company with business in the industry of plastics. When the remaining organizations included in Table 2 are grouped by NAICS codes it is noticeable that agriculture related activities appear only once. The reason to explain this fact is the declining track of agriculture in Puerto Rico. This trend has also been found when studying the scientific research productivity in the island [13]. Agriculture has lost its relative importance within the sectorial structure of the economy. While in 1950 it contributed the 18,2% of the Gross Internal Product, in the 2000 this figure lowered to the 0.5%. On the other hand, the electronic and medical product industry, next to the pharmaceuticals, composes the core of the present manufacturing industry that contributes the 40,4% of the GIP. [14] [15]

Table 2. Assignee Organizations

Name	NAICS* Code	No. of Patents
Government of Commonweal of Puerto Rico	Government (Public)	35 (4.67%)
General Electric Company	3336 Engine, Turbine, and Power Transmission Equipment Manufacturing	29 (3.87%)
University of Puerto Rico	Educational (Public)	27 (3.60%)
Vassallo Research & Development Corporation	326122 Plastics Pipe and Pipe Fitting Manufacturing	20 (2.67%)
Filtertek Inc.	326122 Plastics Pipe and Pipe Fitting Manufacturing	8 (1.07%)
Aventis Pharmaceuticals Inc.	325412 Pharmaceutical Preparation Manufacturing	6 (0.80%)
Caribbean Microparticles Corporation	3391 Medical Equipment and Supplies Manufacturing	6 (0.80%)
Challenger Caribbean Corporation	423610 (Electrical Apparatus and Equipment, Wiring Supplies, and Related Equipment Merchant Wholesalers)	6 (0.80%)
Gaymar Industries Inc.	423450 Medical, Dental, and Hospital Equipment and Supplies Merchant Wholesalers	6 (0.80%)
Hewlett Packard Development Company	3341 Computer and Peripheral Equipment Manufacturing	6 (0.80%)
Ethicon Inc.	339112 Surgical and Medical Instrument Manufacturing	5 (0.67%)
Novoste Corporation	339112 Surgical and Medical Instrument Manufacturing	5 (0.67%)
Asgrow Seed Co Llc.	111422 (Floriculture Production), 111421 (Nursery and Tree Production)	4 (0.53%)
Besenbruch Hofmann Inc.	333513 (Machine Tool (Metal Forming Types) Manufacturing)	4 (0.53%)
Caribe Circuit Breaker Co Inc	423610 Electrical Apparatus and Equipment, Wiring Supplies, and Related Equipment Merchant Wholesalers	4 (0.53%)
Checkpoint Systems Inc	56162 Security Systems Services	4 (0.53%)
E I Du Pont De Nemours And Company	325320 Pesticide and Other Agricultural Chemical Manufacturing	4 (0.53%)
Stryker Instruments	339113 Surgical Appliance and Supplies Manufacturing	4 (0.53%)
Telular Corporation	33421 Telephone Apparatus Manufacturing	4 (0.53%)
Others (121)		180 (0.24%)
Individually Owned Patents		383

Prepared by the authors

**NAICS: North American Industry Classification System*

Table 3 shows patents activity in main sectors according to the aggregated scheme used in this study. Although the categories Other, Electrical & Electronic and Mechanical are dominant, it is notable the positive increasing of Drugs & Medical and Computers & Communications. The second bigger group within the manufacturing industries in Puerto Rico, behind pharmaceuticals, is the one of the technology industries and electronics. The industry of the computer and electronic products includes computers, related products, like printers, communications equipment and electronic equipment for use in the home, as well as an ample one spurred of products of commercial and military use. Sixty eight per cent of the facilities of electronics and development of applications of Puerto Rico are subsidiary of companies of the Continental United States, including manufacturing of equipment as they are it manufacturing *Hewlett-Packard* and *Sensormatic Electronics Corp* and by contracts like *Solectron Corp.* and *Smart Modular Technologies, Inc.* Nevertheless, a great group of emergent companies of technology in Puerto Rico exists that already reach the number of 70. [16]

Table 3. Patents activity by main sectors (Utility Patents only)

Main Categories*	75-79	80-84	85-89	90-94	95-99	00-04	Total
Others**	28	44	45	52	56	57	282
Mechanical	21	24	26	19	28	33	151
Electrical & Electronic	10	28	18	18	23	39	136
Drugs & Medical	6	4	12	25	30	28	105
Chemical	14	6	12	19	20	30	101
Computers & Communications	2	5	8	10	11	15	51

*Based on the scheme proposed by Hall, Jaffe, & Trajtenberg, 2001. (Patent Classification System as of 12-31-1999)

** Agriculture-Husbandry-Food, Amusement-Devices, Apparel-Textiles, Earth-Working-Wells, Furniture-House-Fixtures, Heating, Pipes-Joints, Receptacles, Miscellaneous-Others
Prepared by the authors

Finally, the CFA of the matrix formed by thirty-six sub-categories and six sub-periods gave the results shown in figure 3. It depicts the patenting profile map for the period at all. Inertia of 61% was accounted for the internal time scale of the system and the time-points distribution reveals a logic chronological order. Notice that the intervals between the time-points when they are projected onto the first factor (horizontal) present some variations. These variations could reveal a turning point in patenting activity. In this case the change is more notable between the periods 1995-1999 and 2000-2004. In addition, the position of periods 1975-1979 and 1980-1984 very

close each other reveals a similar profile and could be interpreted like a sign of homogenous patenting profile characterizing them; however the differences respect to the rest of periods has been increased chronologically.

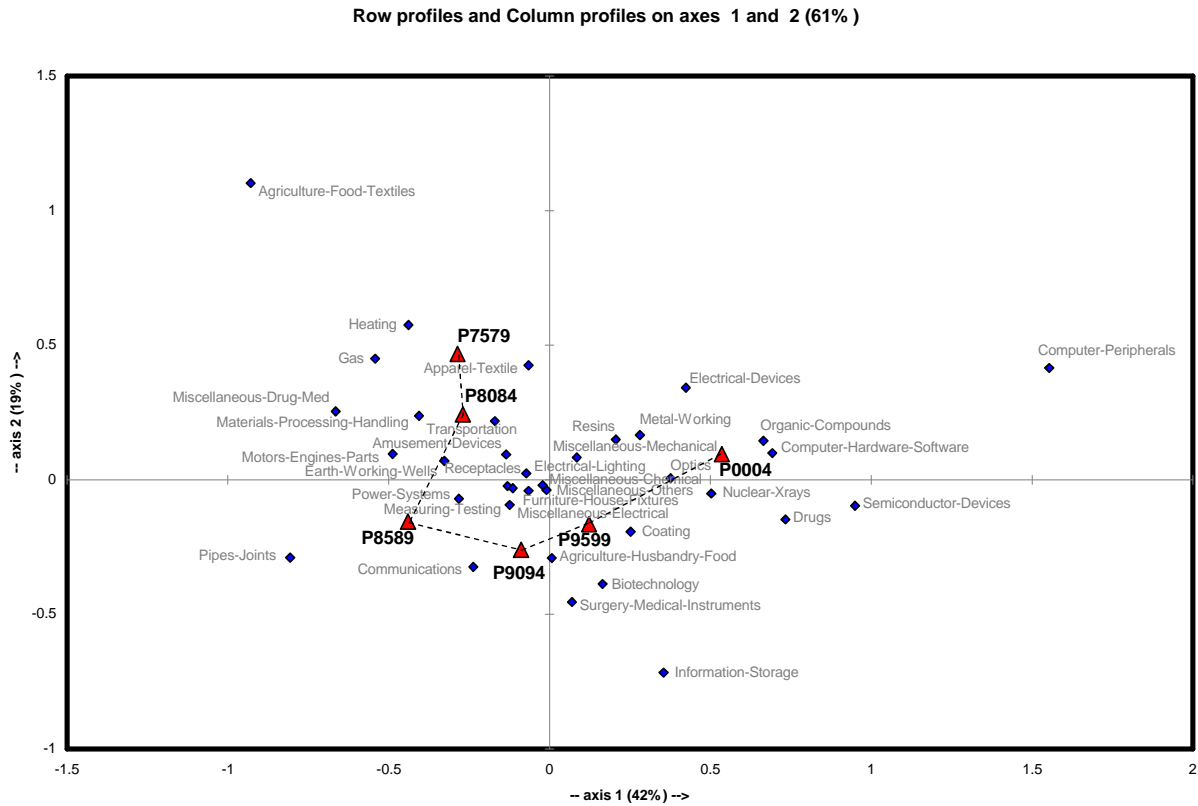


Figure 3: Patenting Profile Map (1975-2004 Utility Patents only)

The distribution of sub-categories (subject terms) according to the grouping defined by the internal time scales show topics related to Others main category (e.g. Furniture-House-Fixtures; Agriculture-Husbandry-Food; Amusement-Devices; Miscellaneous-Others) close to the coordinates origin. A similar position is observed for Transportation, Metal-Working and Electrical-Lighting, topics related to Mechanical and Electrical & Electronic main categories respectively. It could be noted four outliers on the map. On the left side can be observed: Pipes-Joints (Others) and Agriculture-Food-Textiles (Chemical) and, on the right side Computers Peripherals and Information Storage (Computers & Communications). Innovation activities in

subcategories like Pipes-Joints and Agriculture-Food-Textiles are mainly related to the period between 1975 and 1989. Most patents assignee to Vassallo R&D on PVC plastic components are from this period. On the other hand economics changes taking place in Puerto Rico have had a negative influence on Agriculture-Food-Textiles related activities. This might be another effect of the declining position of agriculture in the Island, as indicated previously.

Discussion and Conclusions

Preliminary results above commented are the starting points for the development of our research line on inventive/innovation activity in Puerto Rico. Although more extensive analysis is required and it would be improved in next stages, we can make emphasis in general aspects characterizing patenting profile. It is a suggested growing trend of patents granted from 1981-1985 to 1997-2000. This trend is remarkable for utility patents, which are the dominant type of patent in the profile. It is right to indicate that unlike other countries, it was not until August of 2004 when in Puerto Rico one settled down by means of Law 214 the Science and Technology Trust Fund intended to promote the generation of patents, among other aspects. Previous to 2004, only are isolated cases like the one of the University of Puerto Rico that established an institutional policy for the promotion of the patents in this organization.

Trends in the six main sectors or categories defined show a growing rate respect the first period for Chemical and Drugs & Medical categories comparing to more traditional sectors like Mechanical and Electrical & Electronic. The category named Others (e.g. Agriculture-Husbandry-Food, Amusement-Devices, Apparel-Textiles, Earth-Working-Wells, Furniture-House-Fixtures, Heating, Pipes-Joints, Receptacles, Miscellaneous-Others) account for most of the patents activity. It could be a reason to explain the central position shown by some topics belong to Others main category (e.g. Amusement-Devices, Agriculture-Husbandry-Food, Furniture-House-Fixtures).

The first three sub-periods, 1981-1984, 1985-1988 and 1987-1990 are associates mainly with topics related to Mechanical, Electrical & Electronics and Others main categories, meanwhile the last two sub-periods, 1993-1995 and 1996-2000 seems to be more closely related to topics associated with Chemical, Drugs & Medical and Computers & Communications sectors.

Peculiarly these same industrial sectors, and for such years, showed increases in their exports that fluctuated between 18, 5% and 57, 25% [17].

The effort in this paper is an attempt to show some basic indicators, which can be available from patents based analysis. We believe that current and future results would be useful to Puerto Rican decision-makers and other social actors in the government, industry or academia in order to improve and support better decisions. The systematic analysis of patent activity is a valid tool to know more details about inventive/innovative activity that is carried on in Puerto Rico. Moreover, identifying the most active sectors and categories in the inventive/innovation environment in Puerto Rico could be the starting point to conduct more specific studies on these sectors in order to know competitor's patent profiles, technological trends, target markets, and potential alliances. To medium term, it will be interesting to examine the effects that the Science and Technology Trust in the production of patents of Puerto Rico has.

Putting in context this information, and considering other business indicators, local companies could be much better prepared to expand their business successfully. However, perhaps a more important objective is to demonstrate, expand and improve the usefulness of patentometrics or technometrics approach as a critical business information analysis tool for strategic purposes among industrial local sector in Puerto Rico, taking advantage from a global information age perspective of doing business.

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