DECAY OF TECHNOLOGICAL RESEARCH AND DEVELOPMENT IN VENEZUELA

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SUMMARY

The most relevant indicators of technological research and development, such as production of patents, publications in indexed journals or value of exported industrial goods, are analyzed to review technology performance in Venezuela. While during the first three quarters of the 20th century the country did not have a relevant technological and innovative production apparatus, with the nationalization of the Venezuelan oil industry in 1976, the government created the Center for Research and Development (INTEVEP) of Petróleos de Venezuela S.A., in order to provide the oil and energy sector of the country with greater technological independence. As a result, technological development formally began in Venezuela. An analysis of patent production reveals that Venezuelan inventors have been granted a total of 394 patents from the US State Patent Office. It is observed also that: 1) the Venezuelan public sector is responsible for the production of 85% of the patents; 2) INTEVEP is responsible for 80% of all patents granted to Venezuelan institutions and enterprises, and 3) after a sustained evolution, the maximum production of patents from Venezuela, about 24 in the late years of the 20th Century, is currently at its lowest point. A similar conclusion is reached when either INTEVEP's scientific publications production or the value of high technology exported industrial goods are analyzed. Given these facts, it is concluded that the Venezuelan technological system is immersed in a deep crisis.

A patent is the commercial realization of an innovation process, generally based on a specialized knowledge that, once it is put into service, should bring benefits to the community (and the proprietor). It is granted by an official entity and, for a limited period of time, exclusive rights apply for its exploitation. In turn, the inventor (or an assignee) allows disclosing details about its invention. Production of patents is used as a thermometer of the technological development activity, and within the industrial sphere, as an indicator of leadership.

Among Venezuelans, innovation is not a totally strange activity. By the end of the 18th century, inventiveness of Martín del Pozo and Sucre was known and during all the 19th century there were many attempts to improve production tools or methods (Bifano, 2001). However, and despite the originality they could have shown, nothing transcended to other societies. Great achievements of scientific research and technological development during and after the Second World War, led nations to adopt science and technology as levers for development; representing modernity and the long awaited production of welfare and wealth. Three important technological advances made an impact in Venezuela. The first one was the precooked corn flour, a great advance from the private sector; the second one was a series of concatenated inventions made by a scientist, and the third one, the development within the public sector of a new source of energy.

There is some controversy relating to the intellectual authorship of corn flour, which is now used in the making of traditional Venezuelan corn bread known as *arepa*. Corn flour was patented in Venezuela by the engineer Luis Caballero Mejías (1954). Simultaneously, between 1954 and 1960, the master brewer Carlos Roubicek together with Lorenzo Mendoza Fleury and Juan Lorenzo Mendoza Quintero, from *Cervecería Polar*, developed the industrial procedure to prepare the cornmeal. Corporate management from Polar was looking for replacements of imported ingredients needed for the process of fermentation during brewing. The brand name, known as PAN, under which cornmeal from *Empresas Polar* is marketed, was launched in 1960. Undoubtedly, cornmeal is the local innovation of highest impact, since it revolutionized Venezuelans´ lifestyles. On one hand, with respect to nutrition, and on the other hand, it was a factor that contributed to the modernization of its society. Indeed, the traditional method of preparing the dough for *arepas* is laborious and takes long time and energy.

KEYWORDS / Development / Research / Technology / Venezuela /

Received: 02/15/2011. Modified: 04/11/2011. Accepted: 04/14/2011.

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The second important technological advance made in Venezuela was that of the scientist Humberto Fernández Morán. He developed an instrument for ultrafine sections of biological materials that permitted the observation of structures at the subcellular, or nearly molecular, level (Fernández-Morán, 1964). The patent that protected the 'diamond knife' was filed in 1954. Fernández Morán substantially improved the capacity for mechanic work, precision and reliability of ultramicrotomes. With that and other related patents, later developed abroad by him, he succeeded in pushing the resolution and effectiveness of electron microscopes to their limit.

While the second half of the XX century was advancing, opportunities for casual or solo inventions anywhere in the world (and the necessary resources to perform the development of state-of-the art technology) were reduced. A new pattern for technological development started to emerge: the intensive use of knowledge by groups in which individual leadership gives way to corporate effort. A new paradigm came up for the process of technological development; inventions or innovations came to be considered the fruit of the work of many, but only the glory of large corporations. Limited only by the rate of return, enterprises offered the best conditions to research groups, in order to generate innovative products of high economic and social impact. Venezuela could not escape from that approach. The Center for Research and Development (INTEVEP) of *Petróleos de Venezuela, S.A.* (PDVSA) produced, as an institution, the third great national technological success.

Orimulsión® is the trademark given to fossil fuel made out of natural bitumen (70%) mixed with water (30%) and stabilized with surfactant agents. Its development is protected by the patent "Viscous hydrocarbon in water emulsions" (Layrisse *et al*., 1989). The patent is described as a "method for the formation, processing, transport and final use of a hydrocarbon emulsion in water". Orimulsión® (or Inmulsión 400®), is a fuel for electric or steam generation power plants, and competes advantageously with coal and diesel (Carquez Saavedra, 2003b), regarding acquisition costs and environmental benefits (Guerrero *et al*, 2004).

Orimulsion® became a milestone for the Venezuelan science and technology community, since its formula and success entailed paradigmatic changes, both in the energy sector and the national scientific and technological community. This is because, first of all, they became aware of the local capacities and potential; secondly, because the exploitation of the Orinoco bituminous sands was demystified; and thirdly, because it became a true intellectual and creative outbreak that opened doors to new technological possibilities that could even be considered as better ones, such as the catalytic transformation into synthetic crude oils. But furthermore, in products like Orimulsión® may lie, to a large extent, the future of Venezuela, since it gives a commercial solution to large non conventional oil reserves. Indeed, the 42 billion metric tons forming the bituminous sands in the Orinoco Belt (*Faja del Orinoco*) warrant a reliable supply (at a 3 million Orimulsión® barrels daily) up to a long way into the XXIII century.

For all the above, it is convenient to mention the origins of INTEVEP, fruit of a public long-term policy for science and technology. In 1970, the newly created National Council for Scientific and Technological Research (*Consejo Nacional de Investigaciones Científicas y Tecnológicas*; CONICIT) created a work group dedicated to studying the situation of the national oil industry. In their final report (CONICIT, 1975) they mention, among other points, that lack of oil research was a serious economic threat in the medium and long term. They recommended creating an entity for the hydrocarbon and petrochemical research, which ought to pay special attention to heavy oils technology development.

Simultaneously, the Ministry of Energy and Mines advanced several initiatives, such as the creation in 1974 of the Venezuelan Technological Institute of Oil (INVEPET), and Foninves, a fund dedicated to advanced training of oil industry staff and funding of hydrocarbon research projects. In turn, a group of chemists from the Venezuelan Institute for Scientific Research (*Instituto Venezolano de Investigaciones Científicas*; IVIC) had organized themselves in a Center for Oil and Chemistry. All of these actions headed to nationalization (or anticipated reversion) of the oil industry, when the Venezuelan state should, at least, have the minimum cadres that could guarantee the research and technology development mechanism needed to face challenges ahead. Nationalization of the oil industry was decreed in August 1975, and on January 1st, 1976 it became a reality.

Personnel from INVEPET together with professionals from IVIC were transferred to INTEVEP, with the purpose of strengthening the technological capacity in the newly nationalized Venezuelan hydrocarbon industry through applied research and development, specialized technical services, conceptual and basic engineering, information and advisory (Brossard, 1994). INTEVEP infrastructure at the beginning of the 21st century was made up of a set of buildings and laboratories (16000m2) equipped with state-of-the-art instruments, a complex of 27 pilot plants with 11 service units for process simulation. INTEVEP workforce was integrated by 1580 employees, including 334 for administrative support and 985 professionals qualified for research, development and technological management; 164 held Ph.D. degrees, 241 had Master level degrees and 577 were qualified in various engineering fields.

Databases and Methodology

Patents database

The US Patent and Trademark Office (USPTO) is the federal agency in charge of granting patents and trademarks in the USA. It advises the US government on issues related to public policies in respect of intellectual property and their protection. USPTO makes available to the public a comprehensive database that delivers an electronic record with all the information concerning patents granted from 1976 onwards. Before that year and since its creation, in 1790, USPTO database will only deliver images of documentation. This database is available to the public at http://patft.uspto.gov/netahtml/PTO/search-adv.htm.

The total of Venezuela's patents extracted from USPTO for the period 1976-2010 was 394, obtained by 446 individual technologists. Overall, 1193 researchers (comprising Venezuelan authors and foreign colleagues) contributed to the effort. That represents an average of 3.03 technologists per patent made in Venezuela. For the purposes of the present study, the entity responsible for the patent is the institution to which it is assigned by USPTO.

Publications database

A database generated by the author is used in this study. It gathers articles published from any Venezuelan institution as listed in the Web of Science' (WoS) database of the Institute of Scientific Information (ISI). It covers the period between 1981 and 20010. This publications database keeps a record of all publications indexed in ISI/WoS where the word 'Venezuela' appears at least once in the "address" of any of the authors. Data collection was initiated by Manuel Bemporad in 2000; at that time the publication database format began to be transformed and refinement of its entries was started. The database content was standardized such that it only includes articles subject to external peer review. That decision involves the removal of all entries bearing the descriptor "DT = ME" from the original Wos/ISI listings. Those correspond to abstracts to congresses.

The main issue with some of the WoS/ISI entries is the incorrect assignment of Venezuela as country to institu-

tions located in streets that carry that name, or in cities in other countries that have the same name as cities in Venezuela (such as Mérida). Another issue is the inadequate identification or affiliation of the authors of publications. Although in the last two years ISI has made an effort to correct these deficiencies, still some 7.5% to 10% of the raw data is incorrectly assigned to Venezuela. Author entries in the publications database have been correctly identified through algorithms for intelligent comparison with data in a Venezuelan scientists' database elaborated by the author.

The total of Venezuela's publications extracted from WoS/ISI for the period 1981-2009 was 20708 scientific works, produced by 85322 Venezuelan authors and foreign colleagues. In that great universe of collaborators, 30684 individual authors can be uniquely identified. That represents an average of 2.78 authors per publication made in Venezuela.

International commerce database

The main source of information on international commercial trade rests upon a data base maintained by the United Nations COMTRADE program. The Uniform Classification of International Trade (*Clasificación Uniforme para el Comercio Internacional*; CUCI, Rev. 2') permits to report official statistical values (in absolute or relative terms) for items such as country imports or exports, segregated according to the intensity of the technology process involved in the corresponding manufacturing process. The UN agency, CEPAL (*Comisión Económica para América Latina y el Caribe*), maintains that sort of data for regional countries, Venezuela being one of them. The interactive database can be seen at www.eclac.org/comercio/serieCP/eclactrade/serie_spanish_108.html

Results

In the Venezuela's master planning adopted at the onset of democracy, in 1958, technological development was considered to be a consequence of scientific activities. Thus, it is not surprising that technology activities in the country began to have a movement, worthy of consideration, a quarter of a century after the fall dictator Pérez Jiménez back in 1958 (Avalos, 1984). A good starting point for a study of Venezuelan technological activity is the year 1976, the date of the creation of INTEVEP, which began to confer to the national oil and energy sector some degree of technological independence.

Table I shows Venezuelan production of patents as granted by USPTO. From 1976 to the end of 2010, Venezuelan inventors were granted 394 patents by the US Government. In Table I patents have been segmented according to the nature of the entity that funded the development being from the public or private sector. Of all patents, 85% have been the result of the effort of researchers who worked for the Venezuelan government. Within that public sector, INTEVEP (where the other patents from PDVSA have been consolidated) stands out. Patents assigned to INTEVEP represent 93% of the total number of patents granted at the public sector and 80% of the national total. The table also shows the ranges corresponding to the peak years for each institution. With the data presented it is justified that INTEVEP be taken as a model for performance of the Venezuela's technological sphere.

TABLE I
PATENTS GRANTED TO VENEZUELAN RESEARCH INSTITUTIONS AND INDUSTRIAL ENTERPRISES

Sector	Institution	Number	%	Year
Public	INTEVEP	314	80%	All
	SIDOR	9	2%	1979-1995
	IVIC	6	2%	1978-1987
	USB	5	1%	1991-2008
	Others (UCV)	60	15%	
Private	(Various)	58	15%	1977-1983 1992-1995 2000-2002
Total		394	100	1977-2010

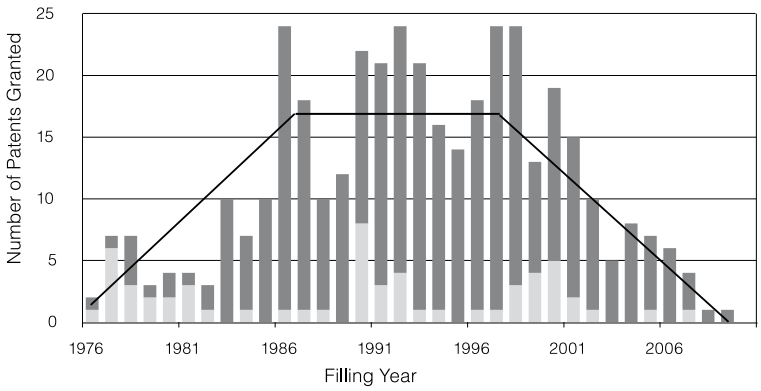

Figure 1. Historical series of the number of patents granted to Venezuelans according to year of filing. Patents originated from the private sector of the economy are shown in light gray, public sector in dark gray.

Figure 1 shows the historical series for the number of patents granted by USPTO to Venezuela, according to the filing date of the patent application. This time parameter was chosen instead of the granting date since it is closer to the date of project execution; on average, the Venezuelan inventor has to wait more than two years to obtain a patent. In the figure, each bar represents the total of patents received and it is made up of the contributions of the two sectors that have been taken into consideration, private and public. Figure 1 reveals three phases in the evolution of patent production in Venezuela. Each phase has an approximate duration of a decade. A first or starting phase goes from 1976 to 1986; a second phase or consolidation phase extends until 1998 and a third or disintegration phase, started in 1999 and continues to date.

During the first or starting phase of technological development in Venezuela, it is seen that the private sector had an important level of participation. However, with the appearance of INTEVEP this participation is progressively reduced, and thus the relative weight of patent production from the private sector of Venezuela became marginal, in comparison to the public sector. During the intermediate phase, the country produced an average of 16 patents annually, almost all of them from the public sector except for a slight recovery in the private activity around the years 1990 to 1992 and, on a small scale, in 1998-2000. It was during this intermediate phase that Orimulsión® was developed by the public sector, at INTEVEP. The country had literally taken a decade to prepare to enter into the competition of the world of energy innovation. During the last phase, the last ten years, patent production in the country decreased to almost nil, the private sector does not have much to report, and for the year 2008, Venezuela's private sector did not present any records to the USPOT.

While Orimulsion® was the best known product of INTEVEP it was not its main technological success. Other successful methods to transform heavy and extra heavy crude oils into useful products such as synthetic oils or derivatives were obtained by chemical catalysis. HDH, Aquaconversion, FCC or NAP are some of the acronyms of some of those processes (Ramírez, 2004).

Throughout its history, PDVSA and its subsidiaries, especially INTEVEP, have been granted 314 patents in areas such as perforation, gas, exploitation,

pumps, emulsions, catalysts, processes, oils, petrochemicals, distilled products, gasoline and heavy crude oils. The steel industry in the public sector, represented by SIDOR, part of the group *Corporación Venezolana de Guayana* (CVG), has received nine patents, all of them during the last two decades in the 20th century. The national academic sector (also funded by the public budget) has produced a dozen patents from institutions such as *Universidad Central de Venezuela* (UCV), *Universidad de Los Andes* (ULA), *Universidad Simón Bolívar* (or USB) or IVIC, almost all of them in association with INTEVEP. The above facts give an idea of the effort on the part of the Venezuelan public sector to control two key industrial sectors and their development through technology; the oil and steel sectors.

Figure 1 reveals that the national effort to produce own technologies reached a peak in 1998/1999. Since then, that effort has been deteriorating in a way that, virtually, it has now stopped. Indeed, while by the end of the 20th century, INTEVEP was able to obtain up to 24 patents in one given year, currently it hardly produced four or five patents per year.

By definition, the life of a patent is ephemeral and when it implies improvements to a technology, is considered as a novelty. In other words, obsolescence is consubstantial to the patent. Although patents can be in force through the accumulation of concatenated innovations, their final destiny is to be consigned to oblivion when new scientific or technological paradigms arise. The above is relevant since one could think that if a good deal of the technological effort by INTEVEP was focused on Orimulsión®, it could be possible that once this product became obsolete, it would not be necessary to continue improving the product and institutional efforts on that direction of its research and innovations could cease.

Table II shows the collection of patents with which INTEVEP could modify and improve Orimulsión®. As it can be seen, the product was improved at least 19 times, and the last year a patent was granted is 2010, after having been filed in 2007. Obviously, INTEVEP has continued to be interested in Orimulsión® as a technological advance and its possible obsolescence has no relationship with the poor institutional performance during the last years.

In contrast to the public sector, 15% of all patents granted to Venezuelans correspond to efforts by the private industry. Table III shows a breakdown of the 58 patents granted to the national private sector in accordance to its nature or operative area between 1976 and 2010. There, it is revealed that most of them are related to the metallurgical/mechanical industry (41%) and petrochemical industry (31%). In such sense, the private sector continues the pattern established by the public sector, whose focus has always been on these technological areas. The private sector worked on improvements or search for innovative solutions to problems in the service and maintenance areas, or improvements on pumps, catalysts, extraction or movement of crude oils. Many of the patents granted to the private industry were produced in cooperation with foreign companies.

TABLE II
PATENTS RELATED TO ORIMULSIÓN®

Patent #	Year	Title
4,795,478	1987	Viscous hydrocarbon in water emulsions
4,801,304	1986	Process for the production and burning of a natural emulsified liquid fuel
4,834,775	1987	Process for controlling sulfuroxide formation and emissions
4,923,483	1988	Viscous hydrocarbon in water emulsions
4,994,090	1990	Process for controlling sulfuroxide formation and emissions
5,354,504	1991	Method of preparation of emulsions of viscous hydrocarbon in water
5,419,852	1991	Bimodal emulsion and its method of preparation
5,480,583	1993	Emulsion of viscous hydrocarbon in aqueous buffer solution
5,503,772	1995	Bimodal emulsion and its method of preparation
5,505,876	1994	Emulsion of viscous hydrocarbon in water which inhibits aging
5,556,574	1995	Emulsion of viscous hydrocarbon in aqueous buffer solution
5,603,864	1994	Method for preparation viscous hydrocarbon in aqueous buffer emulsions
5,622,920	1995	Emulsion of viscous hydrocarbon in aqueous buffer solution
5,725,609	1996	Water in viscous hydrocarbon emulsion combustible fuel for diesel engines
5,902,227	1997	Multiple emulsion and method for preparing
5,976,200	1997	Water in viscous hydrocarbon emulsion combustible fuel for diesel engines
6,903,138	2002	Manufacture of stable bimodal emulsions using dynamic mixing
7,276,093	2000	Water in hydrocarbon emulsion useful as low emission fuel
7,704,288	2007	Water in hydrocarbon emulsion useful as low emission fuel

Table III reveals that key sectors for development which in turn have traditionally been the foundation for private wealth, as could be the case of construction or agriculture, can barely exhibit a couple of technological developments as part of their effort for progress. As for the "agro" sector, the patent "Forage compaction apparatus with constant angle rotor" (N° 5,178,061 from 1993) could be classified within the metallurgical/metal mechanic sub-sector. In the health field there are barely two patents, one of them from *Empresas Polar*, which is responsible for the two patents in the food sub-sector, related to the improvement of brewing processes.

The collapse of patent production observed in recent years, can also be fornd in the production of scientific articles by INTEVEP. The historical series of the number of articles from INTEVEP and gathered by the WoS/ISI database is represented in Figure 2. It can be observed that, after maintaining a production pace close to 30 articles per year on academic science since the mid '90s until 2003/2004, the current pace of production hardly reaches five articles per year.

Economic progress does not depend solely upon the production of new patents. Technological research and development embraces other processes such as purchasing, transfer, learning or adaptation. Thus, the technological strength of a society also depends on the use and enhancement of existing patents. And while these facets are not on the top of the technological pyramid, where patents are, they do require a good deal of professionalism or creativity, constituting a significant part of the virtuous circle of innovation and production. However, measurement of their impact, in quantitative terms, is not straightforward or easy. Notwithstanding, an approximation can be found within the domain of exports of industrial goods.

The behavior of Venezuelan exports of high technology goods (*altas tecnologías*), as defined by CUCI, is shown in Figure 3 and depicted as the historical series of its percentage on total value of exports. The goods it refers comprises machines for data processing or telecommunication, TV equip-

TABLE III
TYPE OF PATENTS GRANTED TO THE VENEZUELAN PRIVATE SECTOR

Field of Knowledge	Number	%
Mechanic, transport and metallurgy	24	41
Oil and chemistry	18	31
Clothing	3	5
Food	2	3
Construction	2	3
Informatics	2	3
Health	2	3
Agro	1	2
Other	4	7
Total	58	100

ment, electronic parts, turbines, energy generators, pharmaceutical goods, avionics, optical or precision instruments or photographic cameras. While Venezuela is not a bridge for high tech commerce of them (*maquila*) nor it is reckoned to be a significant player as manufacturer of high tech equipment such as listed, the referred commerce trade figures must reflect the development, innovation or adaptation effort included in the manufacturing of oil or metal industry derivatives produced in the country and sold abroad.

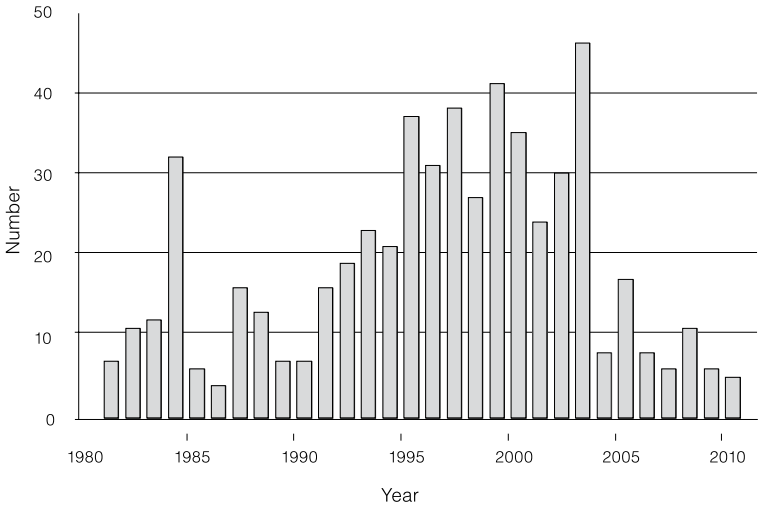

Figure 2. Historical series of the number of publications produced by INTEVEP and recorded by WoS/ISI

It can be observed in Figure 3 that after climbing to a maximum level of participation of around years 2002/2003, the exports of high technology goods made in Venezuela has nowadays fallen to its lowest level. It should be mentioned that the decay of export levels of Venezuelan industrial goods observed during the last years does not depend on the level of technology employed the manufacturing process. The same pattern is observed for low, medium or high technology goods. For the sake of information, the value of 0.78% level of participation of high tech goods exported by Venezuela, corresponds to 194 Million US$ in 2003.

Discussion

The professionalization and institutionalization processes of science and technology in Venezuela caught pace with the arrival of democracy, upon the downfall of General Pérez Jiménez' military dictatorship in 1958. Those processes were the cornerstone of the modernization paradigm embraced by Venezuela's elite of the '50s, who started to consider science as an ingredient of productive forces. Research ceased to be the work of a group of "romantic ones looking for the truth" and was no more seen as "esoteric". (Ávalos, 1984).

The organization of the modern science and technology Venezuelan apparatus was subject to many factors; endogenous, such as the creation of the science faculties or the reconversion of IVIC in year 1958, and exogenous. Among the latter ones, out of the control of the emerging academic and political elites, was the development paradigm (*desarrollista*), supported during the 60's by the United Nations Development Program (UNDP) and the Economic Commission for Latin America and the Caribbean (ECLAC, or CEPAL in Spanish). For a comprehensive view of the subject see Prebish (1950), Sábato (1975) and Silva Michelena (1979).

According to its predicates, science and technology were instruments of social change. Scientific knowledge was given a universal value and benefits were recognized to technology as a mean for social welfare. It was expected that a vigorous scientific activity would result on an important technological development in the industrial sector. Even more, it was believed they were connected in a sequential, almost linear, manner (Marí, 1982).

The new Venezuelan democracy embraced the CEPAL paradigm of development, with the creole variations of state-owned basic industries, protectionism of intermediate industries and a selective program of imports substitution. The Venezuelan public sector took control of the major industries (oil, iron and aluminum) confining the private sector to trade and intermediate industries (including construction and agri-business). In the midst of these ideas and circumstances CONICIT, created in 1967, set priorities and dictated public policies for the science and technology sector. Since then, a significant number of institutions dedicated to scientific and technological research activities were created in priority sectors. Such is the case of INTEVEP for the oil industry, FONAIP/INIA for agriculture, CIEPE for food exports, or the research units in metallurgy from SIDOR/CVG, or telecommunications from CANTV. As a result, research and development activities were the object, almost exclusively, of the public sector, while the private sector showed no major interest in finding out the potential benefits of technological development and innovation in their industries or enterprises.

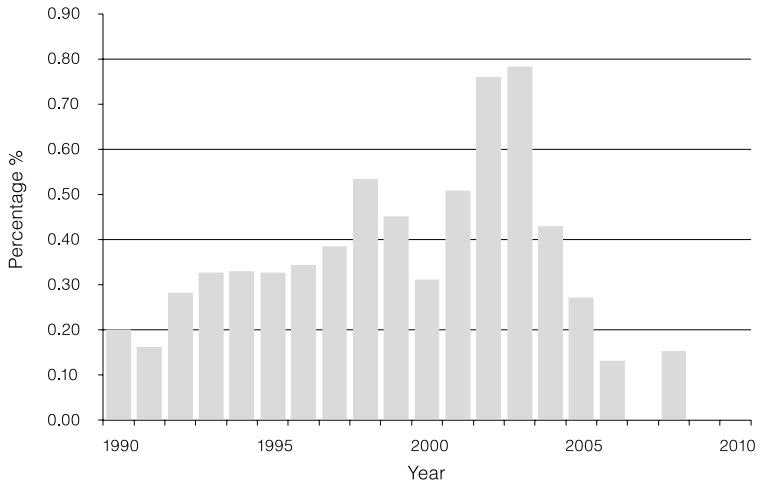

Figure 3. Historical series of the percentage value of high technology industrial goods exported by Venezuela as referred to the total value of exports.

During the first phase of activities and well into the '70s, CONICIT focused its activity in the world of academy, laboratory and university. In a second stage, technological policy started to be vindicated before the scientific policy and it was the start of an approach to the world of economy, production and enterprise. As Ávalos (1984) would put it, the 'discovery' of technology transfer in the mid '70s, encouraged Venezuelan technological policy to search for an identity, different from the scientific policy, and started to get rid of the adopted schizoid model, of two lines of action, scientific *vs* technological. This began to be evidenced in the country during the last 25 years of the 20th century, when a model that favored the service industry and technology related to hydrocarbons started to operate. However, it did it mostly at the expense of agricultural or academic research at universities.

By the mid '80s, the depletion of the political, economic, and science and technology sector benefits derived from the doctrine of *desarrollismo* became obvious (COPRE, 1992). It was evident that what had been planned

did not give the expected results (Ávalos and Antonorsi, 1980). New conditions started to emerge and new situations were being generated in a world that became more globalized. The need to diversify industries that everyday required larger and more complex technological processes, which had to be found in an environment of financial constraints, high competitiveness and relative lack of talent, encouraged the Venezuelan CONICIT to go into a third stage during the '90s. CONICIT took the subject of technological development seriously with the variant of innovation and established the program of *Agendas*. This would become the first step for the establishment of an effective technological policy, characterized by its relationship with an economic policy that privileged the enterprise; based on learning local experiences and relatively separated from the scientific policy.

With the arrival of Hugo Chávez to the country's presidency in 1999 this public policy on science and technology was discarded. In one of his first decisions as President elect, at the end of 1998, he described PDVSA as a 'black box'. He notified the national oil industry that as soon as he would take office, he would undertake a deep review of it, including INTEVEP, and that poor or inconvenient businesses had to be resized and eliminated. Four years later, on the occasion of a national labor strike that requested his resignation, President Chávez took up again the theme of the restructuration of the oil company and headed batteries against INTEVEP, its researchers and its flagship product, Orimulsion®.

While at the beginning of his mandate, in 1999, President Chávez was convinced of the benefits of Orimulsion®, committed himself to sell large quantities to China and set up production plants in Asia, two years later the new fuel began to be victimized (Párraga, 2003) and the production plants were ordered to be reduced to their minimal expression or dismantled (Carquez Saavedra, 2003a, c). According to the official version, the decision was justified by tax considerations; its trade was judged to be unprofitable and marginal (Mommer, 2004a, b).

Orimulsion® always faced difficulties and detractors. When it started to be developed during the '80s, Venezuela did not have the tradition or guidelines to address the difficult and complex task of producing a new type of fuel for global use (Vessuri and Canino, 2002). There was a small community that had to develop the basic concepts or the 'know', while in parallel also had to learn the 'how', i.e., the storing, transportation and commercialization methods. However, the controversy that involved Orimulsion® in the first years of the 21st century went further than the academic issues; it had a political and ideological background (see Orimulsión, 2004). According to that interpretation, the disappearance of Orimulsion® was necessary since it was reaching within the national imagination the status of an icon of the national capacity in science and technology. The political leadership at that time could not accept that there could be a technological breakthrough of global relevance in the energy sector (in addition to a commercial success) as the result of the work of professionals who were not ideologically committed to the government political party (Requena, 2004).

The political crisis at the start of 2003 was focused, to a large extent, on PDVSA. In such context, with a country in turmoil, it was now the turn of its Center of Technological Development and Research. On February 4th, through a press release published in a newspaper (Ultimas Noticias, 2003), it was informed to 881 technologists, professionals and technicians from INTEVEP, that they had been dismissed because they had taken part in the national strike (Núñez, 2003; Prieto, 2003).

At one blow, 164 Ph.D. graduates and 199 Master graduates in the INTEVEP payroll were dismissed; almost three quarters of its professional workforce for research and technological development. Among those dismissed, 97% were professionals and technicians, 76% were between 30 and 45 years old, and 49% had 11 to 20 years of experience in the industry. Only some workers and a few administrators were not expelled. As for PDVSA, it is said that around 18000 employees were dismissed from their jobs. This draconian measure taken by the Government to regain control of operations in the state-owned oil company that was paralyzed put an end once and for all to the national strike.

It is obvious that the loss of such an important fraction of its human capital had to incapacitate INTEVEP as a research organization. This, together with the lack of a policy and plans for the replacement or reengineering of the institution, explains the almost complete loss of its productivity; whether regarding patents or scientific publications. Only a total naive could think that the massive dismissal of scientific and development staff from that institution would not bring serious consequences (Requena, 2003, 2005).

Conclusions

The analysis of either the strength of the technological capacity of Venezuela, exemplified by the value for exported goods manufactured with either low, medium or high technological content; or the development of Venezuelan technologies, taken as the number of patents granted in the USA; or the number of technologically oriented scientific publications; all based mainly upon the relative weight of INTEVEP as the largest and most important innovator in the country, leads to a single conclusion: technological research and development is deteriorating rapidly in Venezuela. A similar conclusion was reached for scientific research en Venezuela (Requena, 2010).

During the last ten years, accordingly to official sources, the Venezuelan scientific and technological system has been capable of recruiting more talents than in the past. However, this must have has been done inefficiently, in as much as the productivity rate, measured by the number of publications or patent per researcher, is revealed in a free fall since 1998. In absolute terms, both academic publications and patents have dropped significantly since 2008. Those facts and the issue of the dramatic increase during the last four years, by up to a factor of six, in the level of investment on science and technology in the country, as a result of the enactment of the so called LOCTI Law, lead to questioning the soundness of current public policies in Venezuela.

Indeed, the deep crisis that nowadays suffocates the Venezuelan system of science and technology was accentuated in the year 1999 with the change in public policies regarding funding and human resources management brought by the creation of the Ministry of Science, Technology and Innovation, the structural centralization that it enforced and the philosophical questioning of the nature and reason of being of science and technology in society.

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DECADENCIA DE LA INVESTIGACIÓN Y DESARROLLO TECNOLÓGICO EN VENEZUELA

Jaime Requena

RESUMEN

Los principales indicadores de investigación y desarrollo tecnológico, como lo son la producción de patentes, publicaciones en revistas indexadas o el valor de bienes industriales exportados, son analizados a fin de revisar el desempeño tecnológico en Venezuela. Mientras que durante los tres primeros cuartos del siglo 21 el país no tuvo un aparato relevante de producción tecnológica y de innovación, con la nacionalización de la industria petrolera venezolana, en 1976, el gobierno creó el Centro de Investigación y Desarrollo (INTEVEP) de Petróleos de Venezuela, S.A. (PDVSA), a fin de proveer al sector de energía y petróleo con una mayor independencia tecnológica. Como resultado de ello comenzó formalmente el desarrollo tecnológico en Venezuela. El análisis de la producción de patentes revela que la Oficina de Patentes de EEUU ha otorgado un total de 394 patentes a los inventores venezolanos. También se observa que 1) el sector público venezolano es responsable del 80% de las patentes, 2) INTEVEP generó el 85% del total de patentes otorgadas a instituciones y empresas venezolanas, y 3) después de una evolución sostenida, el máximo de patentes producidas por Venezuela, unas 24 al año a finales del siglo 20, se halla ahora en su punto mínimo. Se alcanza una conclusión similar al analizar la producción de publicaciones científicas de INTEVEP o el valor de los bienes industriales de alta tecnología exportados. Dados estos hechos, se concluye que el sistema tecnológico venezolano se halla inmerso en una profunda crisis.

DECADÊNCIA DA INVESTIGAÇÃO E DESENVOLVIMENTO TECNOLÓGICO NA VENEZUELA

Jaime Requena

RESUMO

Os principais indicadores de investigação e desenvolvimento tecnológico, como são a produção de patentes, publicações em revistas indexadas ou o valor de bens industriais exportados, são analisados a fim de revisar o desempenho tecnológico na Venezuela. Enquanto que durante os três primeiros quartos do século 21 o país não teve uma estrutura relevante de produção tecnológica e de inovação, com a nacionalização da indústria petroleira venezuelana, em 1976, o governo criou o Centro de Investigação e Desenvolvimento (INTEVEP) de Petróleos de Venezuela, S.A. (PDVSA), a fim de prover ao setor de energia e petróleo com uma maior independência tecnológica. Como resultado disto começou formalmente o desenvolvimento tecnológico na Venezuela. A análise da produção de patentes revela que o Escritório de Patentes de EEUU tem outorgado um total de 394 patentes aos inventores venezuelanos. Também se observa que 1) o setor público venezuelano é responsável por 80% das patentes, 2) INTEVEP gerou 85% do total de patentes outorgadas a instituições e empresas venezuelanas, e 3) depois de uma evolução sustentada, o máximo de patentes produzidas por Venezuela, umas 24 por ano a finais do século 20, se encontra agora em seu ponto mínimo. Se alcançada uma conclusão similar ao analisar a produção de publicações científicas de INTEVEP ou o valor dos bens industriais de alta tecnologia exportados. Devidos estes fatos, se conclui que o sistema tecnológico venezuelano se encontra imerso em uma profunda crise.