The Formation of Intellectual Capital in Mexico

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By

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FOREWORD

This book presents multiple results that help us to value and, above all, position the science and technology that is created and disseminated in Mexico. Likewise, the main outputs of Mexican researchers (publications, citations, books, and book chapters, among others) show us a scientific community that converges and is recognized by the most important program that supports science and technology in Mexico: The National System of Researchers (SNI). Undoubtedly, in the SNI are concentrated some of the most important human resources dedicated to creating science and technology in Mexico, however, when considering all the researchers that integrate the SNI in Mexico, the science and technology indicators leave much to be desired. That is to say, in Mexico, it is understood that SNI researchers are responsible for the most important scientific and technological discoveries attributed to Mexico, even in the world context, although in reality, this is not the case. The reader will have in his hands multiple results that will allow him to build comments, totally solid, about the scientific and technological community that receives more economic support from the main governmental institution in charge of directing, supporting, and disseminating Mexican science: The National Council of Science and Technology (CONACYT, now known as CONAHCYT). It may be thought that the periods analyzed in this book are not recent, however, it is important to mention that the SNI currently evaluates, and consequently selects, its members in the same way since its creation. Therefore, the photographs (periods) presented in this book can be considered as recent photographs.

The first chapter shows the congruence and impact of the public policy implemented in Mexico, during the period 2000-2012, and adopted by the highest body that supports and strengthens science and technology (CONACYT) that is developed in national territory concerning the support granted for postgraduate studies, whether these are carried out in an institution abroad or national territory. The analysis allows us to know, through the Scopus database, the scientific production of these Mexican grantees, during the period 2000-2015. Subsequently, a dichotomous logit model is presented to identify the items that increase the probability that

these specialized human resources are accepted in the National System of Researchers (SNI).

The second chapter presents the profile of the category called Candidate to National Researcher from its beginnings and upon joining a research elite in Mexico; from the perspective of its scientific production to be admitted to this circle of Mexican researchers. Based on this profile, a probability model is elaborated, which uses the information presented by these researchers in their applications and, based on this production, the transit of these relatively young researchers to the two higher levels of the SIN is analyzed. With this dynamic, the movement of the main levels promoted in the SNI is known, that is, the promotions of a National Researcher Candidate and a National Researcher Level I National. These variables are shown first at the moment of entry to the SNI and second when the first promotion is made in this Mexican research system.

The third chapter analyzes the dynamics of the applications received by the SNI during the period from 1997 to 2008. This analysis allows us to delve deeper into the characteristics of this evaluation process initiated to improve the Mexican science policy system. An analysis is made of the percentage of researchers who opt for evaluation, the favorable versus unfavorable responses, the differences achieved by areas of knowledge, as well as the average indicators that must be reached to obtain a positive evaluation at the different levels of the SNI. Consequently, a first assessment of the Internal Evaluation Criteria defined by this Mexican research system can be made.

The fourth chapter shows the relevance of Mexican research in the international arena, based on the level of publication achieved by Mexican researchers in Institute for Scientific Information (ISI) journals during the period 1997 to 2008. Likewise, for the sub-period from 1997 to 2002, it is evaluated whether there is a correspondence between the level of ISI publication and the researchers who were part of the SNI, to know whether being part of this program is related to a higher level of publication quality (as it is to publish in journals indexed in the ISI).

Chapter five presents some reflections, based on the results of other publications, that help to evaluate and/or reevaluate the role and importance of SNI within scientific research programs in Mexico. Specifically, does the SNI, over time, represent today a success in Mexico's scientific policy? Some actions are also proposed, derived from three components detected in the operation of the SNI that will undoubtedly work as triggers for this

Mexican research circle to consolidate itself as the best program of scientific policy in Mexico.

Chapter six discusses that Mexico's National System of Researchers (SNI) evaluates, selects, and recognizes through an economic stimulus the national human capital that carries out quality research. This logistics can be considered a selection of projects, which necessarily leads to the selection of specialized human capital. This article uses the data analysis and grouping technique known as clustering (k Means) to study in depth the criteria followed by the SNI in the selection of researchers. Once the productive profile of each appointment defined by the SNI is known, and through the Hamming distance, a comparison is made between the estimated and real data associated with each appointment. The estimations allowed the conclusion that the current classification into four groupings (appointments) is not justified, perhaps because the SNI evaluators use information not collected in the variables reported by the applications. In addition, the need to improve the statistical information used as a database for the evaluation is demonstrated; the differences that exist in the estimated classifications for the seven areas of knowledge defined by the SNI are pointed out and some of the results are recommended to complement the peer evaluations currently carried out, provided that the quantity and quality of the available information is improved. Undoubtedly, this should make the future selection of research and development projects concerning a public research policy program in Mexico more efficient.

Chapter 7 analyzes the productivity achieved by consolidated Mexican researchers, level III of the SNI, in the disciplines defined by the ISI, based on the number of Mexican publications from 1996 to 2003. Thus, the Bauwens criterion is used to carry out a ranking by institution and individual author in the ISI discipline with the highest concentration of Mexican publications, i.e., Physics Multidisciplinary. This bibliometric analysis served to detect the consolidated Mexican researchers who showed the greatest international support, as it is to publish in ISI quality journals. The main finding is that level III researchers have a low level of ISI publication (annual average of 0.4 articles per researcher) and represent 18% of Mexican publications in the ISI. UNAM and CINVESTAV were the institutions with the most citations in the Physics Multidisciplinary field.

The last chapter of this book, chapter eight, comments that Mexico has historically allocated less than half a percentage point of its gross domestic product (GDP) to spending on research and experimental development (R&D). This article attempts for the first time to evaluate the country's

scientific and technological policy through its main program: the National System of Researchers. The results obtained show whether the SNI has succeeded in improving research in Mexico. We also analyze whether the program offers ways to improve and strengthen the scientific policy model adopted by Mexico and whether it could be extended and/or introduced in other nearby countries with similar levels of development or characteristics to Mexico.

CHAPTER 1

THE FORMATION AND INTEGRATION OF HIGHLY SPECIALIZED HUMAN RESOURCES: A PENDING COMMITMENT OF MEXICO'S CONACYT

Human capital, seen as a whole and through a knowledge-based economy, is a key element that, when combined with other factors, benefits, among other things, the scientific and technological development of a country or region (National Economic Council, 2011; European Commission, 2010; Grosse, 1996). Many of the models that address the issue of human capital describe how education relates to and enriches an entire production system, which, in turn, directly benefits from the externalities generated by a society with a higher level of education[1]. Then, the level of knowledge is undoubtedly fundamental to generating innovation and enabling its adoption by third parties. A large number of reports and projects have highlighted this relationship (Crespi and Zuniga, 2012; Nomura, 2007; Moon and Kym, 2006; Audretsch and Keilbach, 2004; Hansen et al., 2002; Bessant and Rush, 1995; Krueger and Ruttan, 1989; Romer, 1986, 1990a, 1990b; Schultz, 1961).

The intellectual human resources available to a country are limited, and even more so those considered to be of a high level. Their training goes beyond an economic expense to be considered an intangible resource that transforms a country's economy. However, education has become a priority in modern society, since it has become a fundamental factor in enabling economic development (Gómez and Sanchez, 2005). However, the so-called intellectual capital by itself does not create any value or generate growth and therefore needs to be combined simultaneously with explicit factors of production (Moon and Kym, 2006). This is because education is

[1] The pioneering work of Barro (1991) and Mankiw et al (1992), using some schooling rates, find that human capital positively and significantly contributes to GDP growth for a given group of countries.

involved with every component and issue that can be identified, from economic ones to social coexistence (Grosse, 1996). Webber (2002) mentions that a considerable amount of research has shown that education, which is nothing more than the process of education, is the factor that directly and positively influences the growth of income (per capita) of a given group of countries. However, the process of education implies, in a way, sacrificing current earnings to obtain a higher level of future earnings (CONACYT, 2007). Against this background, Bils and Klenow (2000) showed that economic growth implies education, rather than education implying economic growth.

Although an increasing number of countries are investing large amounts of money in the training of specialized human resources, these countries have also realized that quality is one of the main concerns in the educational process (Hanushek and Luque, 2003). In this area, Neira (2007) provides a transcendent result, which emphasizes that the countries with the highest levels of education in the twentieth century have also been those that have had a more prominent position in terms of their economic growth performance, even with minimal natural resources about their territory and population. Therefore, the performance and quality of human capital, as well as its participation in technology transfer, are increasingly widely recognized. This participation in technology transfer is presented in a variety of ways including, among others, training specifically directed to the management of technology transfer (Grosse, 1996), the use of specialized consultants (Bessant and Rush, 1995), the training of students, with the international training and experience of these students being of utmost importance (Nataraajan and Chawla, 1994), the exchange and/or transfer of personnel with specialized knowledge (Hicks, 1993) and, of course, the indirect or informal relations between the different scientific levels (Bozeman et al., 1995).

In this context, Mexico is an OECD member country that has historically been characterized by allocating less than 1% of its Gross Domestic Product (GDP) to the item known as Experimental Research and Development Expenditure (GERD). To make it comparable with future data presented in this work, in the year 2012[2]. Mexico allocated 0.45% of its GDP to GIDE, compared to 0.74 in Argentina, 0.42 in Cuba, or 1.21 in Brazil (2011) and far from the average of OECD member countries (2.40), the European

[2] OECD (2016). Main Science and Technology Indicators. http://stats.oecd.org/

Union (2.05) but close to the Latin American average (0.82)[3]. In addition, the total number of publications attributed to Mexican researchers in the Institute for Scientific Information (ISI) has shown an insignificant contribution, since during the 2001-2012 period this participation never exceeded 1% per year of the total number of articles in the ISI[4]. If we add to this the fact that Mexico, like a large number of Latin American countries, has a science and technology system that does not stand out for its specific weight, then, in relative terms, it can be said that Mexico has indicators similar to Brazil, Argentina or Chile, but far from European or North American countries. Moreover, the total number of Mexican researchers in full-time equivalent per thousand members of the Economically Active Population (EAP) in 2011[5] was 1.0, compared to 2.9 in Argentina, 7.0 in Spain, and 8.0 in the United Kingdom. In the same year 2011, the average for the European Union was 6.8 researchers, and for the OECD countries, it was 7.2 researchers[6]. Undoubtedly, Mexico urgently needs to achieve a quality education that generates human resources capable of competing with their peers in a globalized world. This goal will not be easy to achieve because, if we add other political, social, and economic factors that, in turn, influence the improvement of human development, then it could be elucidated that Mexico needs to generate growth opportunities in all the aforementioned areas (Flores and Hernández, 2010). For this reason, and to generate quality education that allows postgraduate graduates to produce and generate national wealth, the Federal Government has decided to train and support internationally competitive human resources through its main public scholarship program, for which CONACYT is responsible.

At the national level, the CONACYT scholarship program has been approached from multiple perspectives (Gómez et al., 2012; Luchilo, 2009;

[3] The Latin American average was calculated taking into account the RICYT database (http://www.ricyt.org/) and only for the countries that registered data in 2012.

[4] For 2012, the percentage for Brazil is 2.80%, followed by Mexico (0.83%), Argentina (0.62%), and Chile (0.47%). Outside Latin America, this percentage is 27.48% in the USA, 7.71% in the UK, and 3.97% in Spain.

[5] OECD (2016). Main Science and Technology Indicators. http://stats.oecd.org/

[6] More recent data show that Mexico is still limited in research areas; according to the 2013-2018 development plan, for every 1000 members of the EAP, Mexican researchers represent about one-tenth of what is counted in more developed countries. Moreover, the total number of Ph.D. graduates per million inhabitants (29.9) is quite limited to satisfy, shortly, the indispensable and necessary human capital involved in the creation of science and/or technology considered of high level (Diario Oficial de la Federación, 2013).

Tovar, 2004). However, CONACYT's annual reports and its recent self-evaluation studies have become the main, and perhaps the only, source of information for science and technology at the national level. Therefore, knowing these quantitatively limited and specialized human resources that reach/absorb quality knowledge leads to the need to evaluate or reevaluate the CONACYT scholarship program in Mexico, which is one of the public programs that consume more economic resources at the level of scientific policy in Mexico. In this context, the following question makes sense: Could the CONACYT scholarship program be considered consolidated within the multiple public programs implemented in the national territory, and which are financed with federal resources, whose primary objective is the training of high-level human resources? This should reflect on whether the current public policy on science and technology adopted by CONACYT is adequate or should be reoriented in another direction.

In a globalized world where countries increasingly base their economic growth on knowledge, Reyes and Suriñach (2013) recommend that Mexico should move towards a better scenario to improve its scientific and technological level. In other words, Mexico lacks measures to considerably improve its science and technology system, measures that would make it possible to know and, consequently, evaluate the impact of its public programs aimed at supporting and generating specialized human resources through postgraduate studies. In this sense, the following questions are important: What has been Mexico's strategy, if any, for the training of scientists and technologists considered to be of high level? Specifically, are the scholarship holders who studied/studied a postgraduate degree abroad, and received/received a CONACYT scholarship, more productive than those who studied/studied a postgraduate degree in national institutions and who also received a CONACYT scholarship? In other words, is the CONACYT scholarship program profitable? In the sense that is it equally profitable for students who stay in Mexico as for those who study abroad? Moreover, what impact do these CONACYT scholarship holders have on Mexico's National System of Researchers (SNI)?

The CONACYT Scholarship Program

Some relevant data

In recent years, there has been a special concern about achieving scientific and technological development in Mexico, a concern that was not present before, when the economic strategy was based on the protection of the internal market, which generated dependence on external technology,

causing a lack of incentives for national competition and, therefore, few incentives to promote innovation and the training of highly qualified personnel. At the end of 1970, as part of the necessary instrumentation to promote the scientific/technological development of the country and based on a very elaborate study, carried out by a scientific community of 800 researchers from the federal sector and the private sector, an institution of a consultative nature was created to promote and advise the government and with an explicit interest in science and technology on the part of the Mexican government for the development of the same: This is how CONACYT was born. From that date on, CONACYT has been the main institution that advises the executive branch on public policies, which have an impact on the strengthening of scientific/technological research in Mexico. In addition, it manages the public policy strategy on innovation, introducing sectorial funds to increase its support and backing for all innovation created in the national territory.

CONACYT has offices in each State of the Mexican Republic, which support and strengthen the mobilization of elements that interact with business competitiveness. In parallel, these State Councils work jointly with the Federal Council through the well-known National Conference on Science and Technology (OCDE/CEPAL, 2011). In addition, in Mexico, there are research centers coordinated by CONACYT which, together with public universities, form groups specialized in providing their scientific/technological and linkage services, generally between companies or some institutions oriented to specific technologies such as information, consultancy or training, such as the National Chamber of the Transformation Industry (CANACINTRA) and the Information and Documentation Fund for Industry (INFOTEC).

In economies similar to Mexico's, specifically in Latin America, Argentina is one of the countries that has allocated the most public resources to increase its capacities related to science, technology, and innovation. This trajectory was outlined in the 1950s when this country began to invest considerable economic amounts for the creation of some research-oriented public agencies, which led to new governance in its public policies. In this context, Brazil created the Science and Technology Council (CCT), which is in charge of formulating and creating strategies concerning the scientific/technological and innovation fields. In 2005, Chile set up the National Innovation Council for Competitiveness (CNIC), which is responsible for formulating innovative and inclusive strategies for both the academic and business sectors, thus fully complying with its mission.

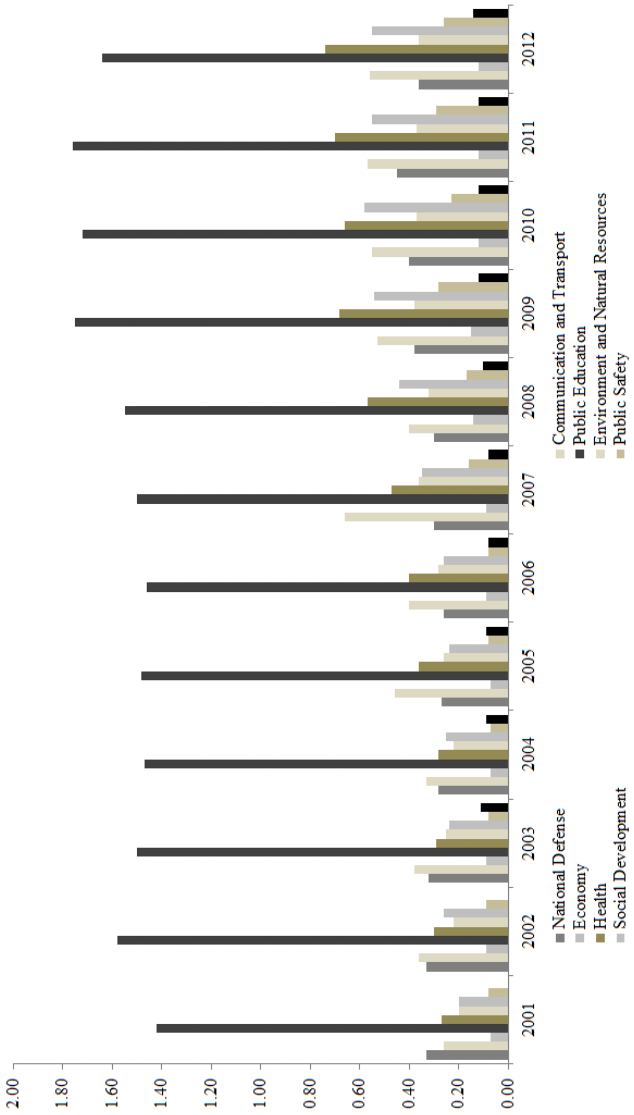
Among the multiple powers that CONACYT has, two stand out: (1) To support the formation of scientific and technological human capital through the formulation and financing of scholarships in their various modalities and; (2) Through the current regulations, to conduct and operate the National System of Researchers (SNI). Among the multiple activities, the following stand out establishing its objectives, responsibilities, powers, form of operation, and organization (Diario Oficial de la Federación, 2014). These two programs absorb more than half of the budget allocated to CONACYT, at least from 2002 to 2011 (Graph 3). In Mexico, it is understood that the SNI brings together the human capital with the best skills to develop and implement science and technology at the highest level, at least at the national level. In turn, and since its foundation in 1970, one of CONACYT's main objectives has been the allocation of scholarships to Mexicans to carry out postgraduate studies, considered academic excellence, either abroad or in Mexico. For these reasons, it is more than justifiable to know the performance of those students awarded scholarships by CONACYT.

It is logical to assume that a large number of CONACYT fellows are accepted by the SNI in its annual call for applications. Firstly, because the CONACYT scholarship program is designed to train researchers of academic excellence and, secondly, because the SNI accepts only Mexican researchers with the best vocation and/or research training. Also, the inertia of logic leads to the following question: Of the CONACYT scholarship holders approved by the SNI from 2000-2012, is the proportion of scholarship holders who carried out postgraduate studies abroad greater than the conglomerate of scholarship holders who studied a postgraduate degree in national institutions? The answer to these two questions will allow us to confirm whether CONACYT has a strategy for the formation and consolidation of human capital defined as high performance, at least in the national context.

Federal spending in Mexico is an investment in science and technology

In correspondence with some data that will be presented later, this section shows some information related to spending on science and technology during the period from 2002 to 2012. Thus, in 2003 the Mexican government managed to establish Ramo 38, defined for CONACYT, which has since been separated from the Ministry of Public Education (SEP). This transparency provision allows and will allow, a better appreciation of federal spending on science and technology. In this way, and during the period 2001-2012, the Mexican government allocated greater investment,

Figure 1. Accrued Net Expenditure of the Budgetary Public Sector in Administrative Classification, 2001-2012. (Percentages of Mexico's GDP)



Source: Own elaboration with data from the Center for Public Finance Studies of the Chamber of Deputies.

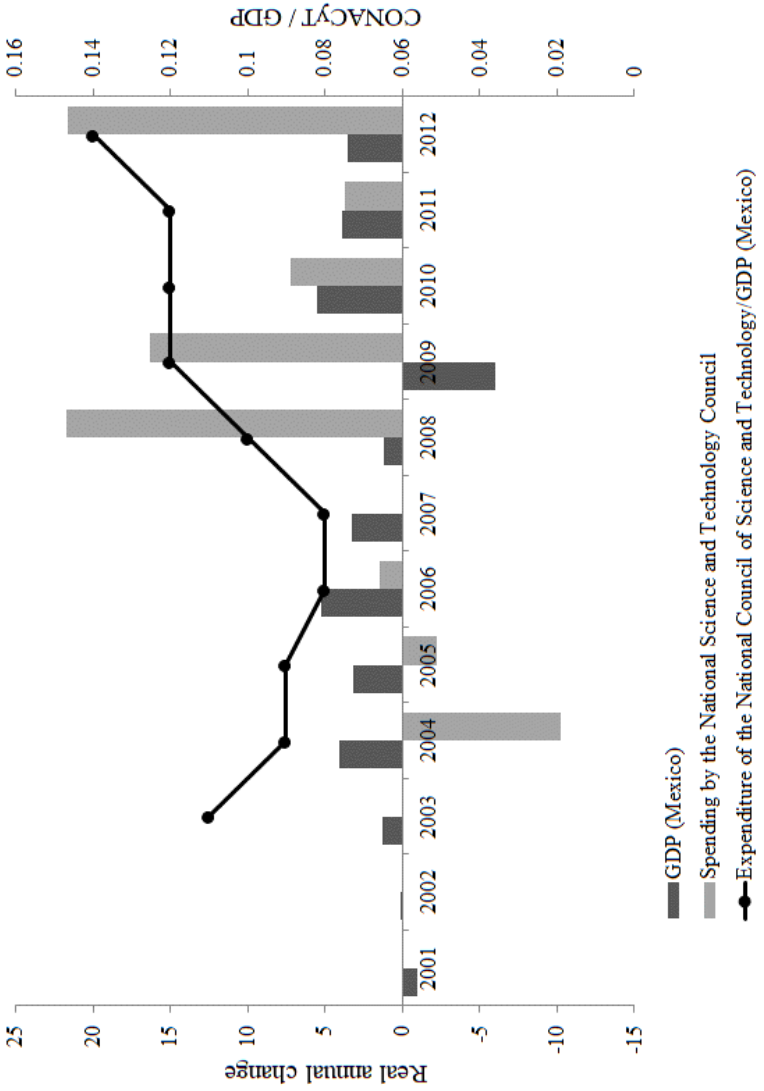
concerning its Gross Domestic Product (GDP), in the following areas: Public Education, Health, Communications and Transportation, Social Development, and National Defense. However, the greatest variation, in the said period, occurred in Public Security (225%), followed by Social Development (175%) and Health (174.1%); while for the period 2003-2012, this concept for CONACYT was a discreet 27.3% (Figure 1).

A large part of the interest in Mexican science policy is reflected in the total expenditure allocated to CONACYT, which has taken up an evident interest of the Federal Government, since the ratio CONACYT Expenditure/GDP (Mexico) showed, at least from 2007 to 2012, a clear growth (Figure 2). However, Figure 2 also shows that there is no relationship between CONACYT Spending and Mexico's GDP. Such behavior implies, at least in the first instance, that the allocation of resources to CONACYT by the Federal Government has been carried out without showing any strategy.

The CONACYT[7], during the entire 2002-2011 period, approximately half of its budget (48.9%) was allocated to Research and Experimental Development (R&D). Likewise, 38.0% of this budget was allocated to Education and Scientific and Technical Education; 6.9% to Scientific and Technological Services, and the remaining 6.2% to Technological Innovation. The scholarship program and the SNI together accounted for 60%, on an annual average from 2002 to 2011, of the budget managed by CONACYT. In other words, in each year from 2002 to 2011, more than half of the CONACYT budget was destined both for the generation of human capital with academic excellence and for its recruitment by the SNI (Figure 3). However, it is surprising that the individual participation of these two programs has not varied much during the mentioned period, and that their maximum participation (which implies a minimum investment for other CONACYT programs in the same period of analysis) was in 2007 42% for the scholarship program and 29% for the SNI.

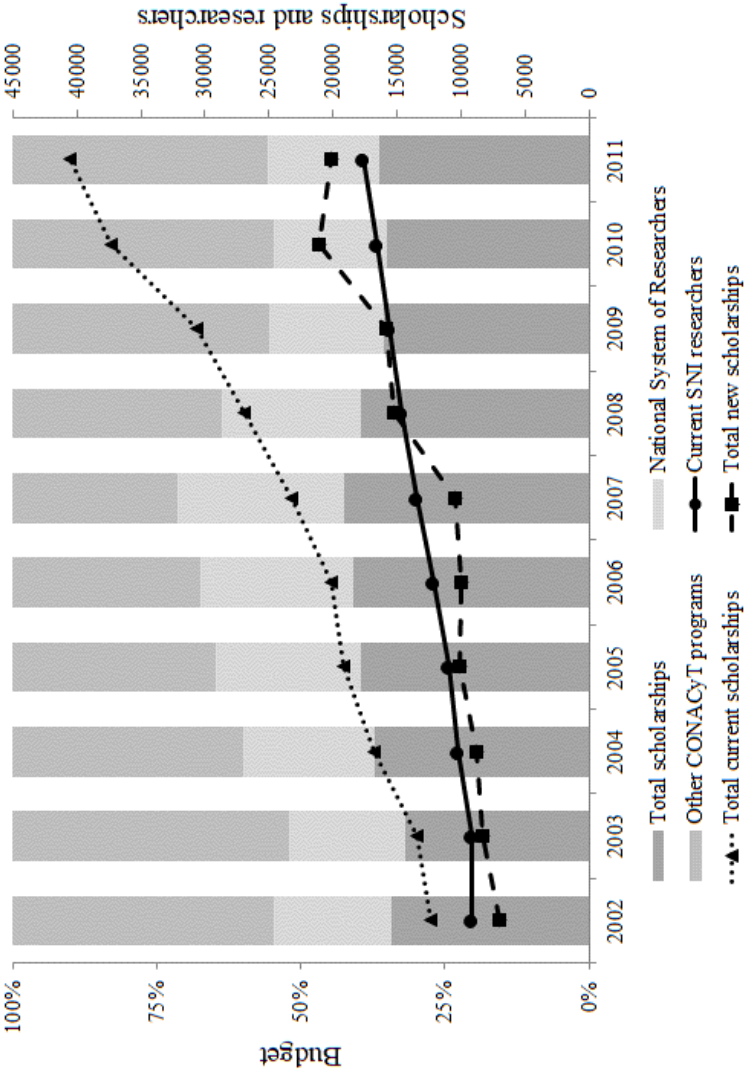
[7] I thank CONACYT, in particular the Scholarship Directorate and the SNI, for all the information provided to prepare this chapter.

Figure 2. Evolution of GDP and Total Expenditure of CONACYT, 2003-2012.



Source: Own elaboration with data from the Center for Public Finance Studies of the Chamber of Deputies.

Figure 3. Performance of the scholarship program and the SNI concerning the CONACYT budget, 2002-2011.



Source: Own elaboration with historical data from CONACYT. The % of the budget was calculated at about thousands of 2011 pesos.

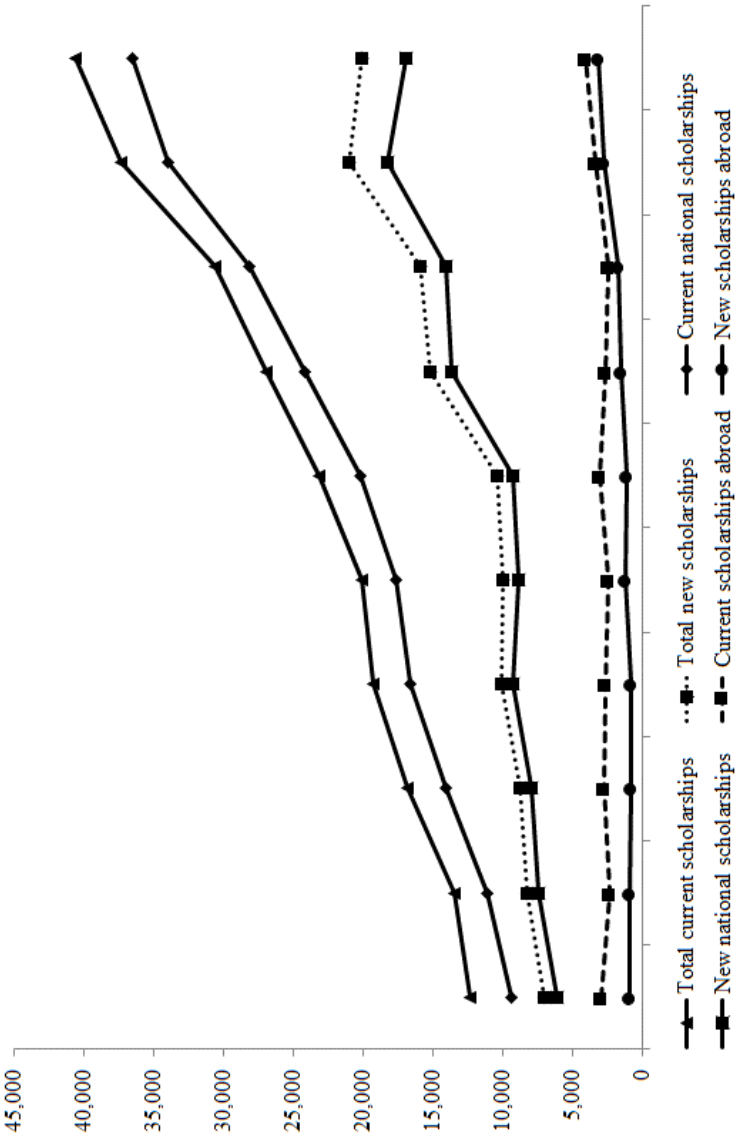
Also in Figure 3, it can be seen that the current scholarship concepts [8] (with an annual average of 24078 scholarships administered), new scholarships (total of 126897 scholarships awarded), and SNI researchers (with an annual average of 12956 researchers) showed sustained growth. Moreover, the concept of new scholarships -which directly impacts the concept of current scholarships- showed a clear dependence on the total budget assigned to the scholarship program by CONACYT (a correlation coefficient of order one of 0.97507968 was obtained between both items), which implies that this concept shares a close relationship with its budget item administered by CONACYT. The selection, and consequently the number, of grantees made by CONACYT during the 2002-2011 period may not have been arbitrary, but it was, and to a large extent, dependent on the budget allocated to CONACYT.

The behavior of CONACYT scholarships during the period from 2002 to 2011 is interesting since there was a clear influence of national current scholarships on the total number of current scholarships. Likewise, new national scholarships had a notable influence on the total number of new scholarships, and the behavior of current scholarships abroad was influenced by the allocation of new scholarships abroad (Figure 4). In this decade CONACYT gave increasing emphasis to the national academic and scientific context, thus strengthening the National Postgraduate Register (PNP), which is also administered by CONACYT.

The analysis of current scholarships would undoubtedly lead to considering decisions made by past CONACYT administrations. On the other hand, the new scholarships allow us to visualize the congruence that exists between the decisions made by CONACYT and the corresponding Special Programs for Science and Technology. Table 1 shows some indicators related to the current scholarships administered by CONACYT during the 2002-2011 period.

[8] Scholarships in force are defined as the total amount of financial support granted in a given period.

Figure 4. Evolution of CONACYT scholarships, 2002-2011.



Source: Own elaboration with historical data from CONACYT.

Table 1. Indicators of current CONACYT scholarships, 2002-2011.

Concept	Nationals	Abroad	Total
Average scholarships	21,189	2,889	24,078
Average total expenditure	2,445,751	908,083	3,353,834
Average scholarships			
Master's Degree	---	---	13,047
Doctorate	---	---	10,407
Others[1/]	---	---	624
Average total expense			
Master's Degree	---	---	1,799,280
Doctorate	---	---	1,466,446
Others[1/]	---	---	88,108
Average cost per scholarship holder			
National and abroad	---	---	149
National	---	---	121
Abroad	---	---	323
By scholarship award destination			
Mexico City	8,917	---	8,917
by State (except Mexico City)	396	---	396
by Country (except Mexico)	---	81	81
Current SNI researchers (average)	---	---	12,956
Average cost per current SNI researcher	---	---	157

Source: Own elaboration with historical data from CONACYT.
1/ Includes scholarships for specialization studies, academic exchange, and sabbatical stays.
Thousands of pesos from 2011.

Based on Table 1, the following can be deduced: 1) It is clear that for several years CONACYT decided to strengthen its national postgraduate programs, since the average number of national scholarships in force -where the

average number of master's degree scholarships stands out- is considerably higher than the average number of scholarships in force abroad; 2) As a consequence of the previous point, CONACYT spends more on master's degree scholarships, which is consistent with its guidelines, since priority is given to doctorates for studies abroad; 3) As a consequence of the above, CONACYT spends more on master's degree scholarships, which is consistent with its guidelines, since priority is given to doctorates for studies abroad; 4) As a consequence of the above, CONACYT spends more on master's degree scholarships, which is consistent with its guidelines, since priority is given to doctorates for studies abroad[9]; 3) Perhaps CONACYT administers more scholarships on national territory because a national scholarship is much cheaper than a scholarship abroad[10]. The average cost of a scholarship abroad was higher than the average cost of an SNI researcher and, 4) The concentration of current national scholarship holders in Mexico City is overwhelming compared to current scholarship holders who carry out their postgraduate studies in the other states of the Mexican Republic. This result is congruent since Mexico City is home to the institutions (Universidad Nacional Autónoma de México with an average of 5036 current scholarship holders; the Instituto Politécnico Nacional with 1203 and the Universidad Autónoma Metropolitana with 1113) that concentrate the largest number of programs in Mexico[11] registered in the National Program of Quality Postgraduate Programs (PNPC)[12], which is also endorsed and administered by CONACYT.

In this context, it is important to mention that during the 2002-2011 period, an average of 926 programs were registered in the PNPC. This implies, in turn, that an average of 23 national scholarship holders (21189 current national scholarship holders distributed in 926 programs) carried out their postgraduate studies, preferably master's degrees, in some of the programs registered by the PNPC. During the entire period 2002-2011, CONACYT

[9] According to CONACYT, this type of scholarship holder are a group of talented individuals who have been evaluated by specialized academics and are subsequently recognized with financial support to pursue postgraduate studies.

[10] Since we do not have the necessary information to perform a more detailed analysis, it is assumed that the average cost of a scholarship abroad includes living expenses, medical insurance, and tuition.

[11] In September 2011, the Federal District, now Mexico City, accounted for 27% of the total number of graduate programs registered (1313) in the PNPC.

[12] The PNPC is a CONACYT program that recognizes the academic quality of national graduate programs and to receive a national scholarship from CONACYT, the graduate program to be studied must be registered with the PNPC. Otherwise, it is unlikely that the student will obtain any direct support from CONACYT.

awarded 12,689,997 new scholarships: 88% of these were for postgraduate studies in the national territory and 12% for studies, preferably doctoral studies, abroad (Table 2).

Table 2. New CONACYT scholarships by destination, 2002-2011.

State	New Fellowships	Graduate programs in the PNPC	Fellows by program in the PNPC	Country	New Fellowships
Mexico City	43,604	355	123	EUA	3,692
State of México	7,547	87	87	Spain	2,871
Jalisco	6,098	92	66	United Kingdom	2,645
Puebla	5,948	73	81	Germany	1,195
Nuevo León	4,618	94	49	France	1,084
Rest of the States	43,999	612	72	Other countries	3,596
Total	111,814	1,313	85	Total	15,083

Source: Own elaboration with historical data from CONACYT.
Postgraduate programs registered as of September 2011.

Based on the data in Table 2, it can be seen that only five Mexican states accounted for 61% of new national scholarships, while, at the same time, only five countries accounted for 76% of new scholarships abroad. In the national context, it is evident that Mexican students choose to do their postgraduate studies in Mexico City, which is undoubtedly due to its wide range of programs registered in the PNPC[13]. In the international context, it is clear that Mexican students prefer to do their postgraduate studies in the United States of America. However, this last result may not be due to chance, since together these five countries are the ones with which

[13] The PNPC programs are classified as 1) Internationally competitive; 2) Recently created; 3) Under development; and 4) Consolidated.

CONACYT has signed the largest number of international scholarship agreements[14].

Objective

The objective of this work is to show, for a certain period, the effort of the public policy concerning science and technology in Mexico, which has been adopted by CONACYT. The analysis focuses on its support program for graduate studies, whose main strategy is oriented to the formation and/or generation of specialized intellectual human capital considered to be of high level. For this federal program, its characteristics and results are analyzed, specifying its performance based on the international scientific publications attributed to its grantees, recognized in the Scopus database and, finally, the affiliation of these grantees to the SNI, which groups the most relevant Mexican researchers, is verified.

Methodology

This article makes use of the following databases: 1) CONACYT grantees who chose to pursue their graduate studies abroad or in national institutions during the period from 2000 to 2011; 2) Researchers with a new entry status in the SNI during their annual calls from 2000 to 2015; 3) Researchers in force in the SNI during the period 2000-2015 and 4) Scopus database to detect publications attributed to CONACYT grantees (national and abroad).

In presenting the evolution of the CONACYT scholarship program during the period 2000-2012[15], the performance and congruence of the objectives adopted, during that period, by the program that receives the largest economic subsidy from the Mexican government for the formation of specialized human capital is evaluated. Subsequently, and for the period 2000-2015, a match is made between a statistically significant sample, obtained from the databases of CONACYT grantees -national and abroad-, and the databases integrated by the SNI. This analysis will make it possible to know the level of admission of CONACYT scholarship holders to the SNI up to 2015. This will undoubtedly show the success and congruence of

[14] The purpose of an international agreement is to share the cost of the scholarship (individual or group). For example, the host institution grants tuition discounts and/or provides round-trip airfare per year for the duration of the scholarship.

[15] This period is considered because it is very likely that the 2011 scholarship recipients will have already completed their graduate studies in 2015 and, in turn, may be detected in the SNI databases.

the CONACYT scholarship program in terms of training human resources considered to be of high level. As a corollary, it will be obtained if the conglomerate of CONACYT scholarship holders who studied a postgraduate degree abroad is more productive, in terms of the publication of articles registered in some Scopus journals, about the group of CONACYT scholarship holders who studied their postgraduate degree in a national institution.

Two sources of information were used to compare the productive level of national versus foreign scholarship holders, both from CONACYT[16]. The first of these refers to the inherent aspects associated with CONACYT grantees (national and abroad); in the second instance, the Scopus database is used, which is considered the largest repository of abstracts and bibliographic references of scientific literature that is evaluated by peers. Through these sources of information, it is undoubtedly possible to know the productive level of these CONACYT grantees. With this result, it is expected to find substantial differences between national and foreign scholarship holders, since for the latter, doing their graduate studies in foreign institutions is a plus in their graduate studies.

Thus, and with all the information defined up to this point, a non-linear probability model is proposed for both categories of CONACYT scholarship holders (national and abroad). That is, a dichotomous logit model (Greene, 2012) is used to detect statistically significant variables and thus explain the probability of SNI membership. In this nonlinear probabilistic model, the response variable will be: accepted in the SNI (takes the value 1) or not accepted in the SNI (takes the value 0). The statistically significant variables detected through this nonlinear probability model will be of utmost importance for a CONACYT grantee since they will allow knowing those items that increase his/her probability of being accepted by the SNI. Therefore, the results obtained through this probabilistic model will validate (1) the decisions taken in scientific policy, particularly by the CONACYT

[16] The existence of more robust criteria to measure the productivity of a set of individuals is recognized (Abramo, D'Angelo, and Rosati, 2016; Waltman, 2016; Nygaard, 2015; Abramo and D'Angelo, 2014; Pendlebury, 2014; Cohen et al, 2012). However, and because CONACYT grantees were studying for a postgraduate degree, during the period 2000-2012, it is unlikely that they have the following criteria, which are very important to enter the SNI: citations, patents, technological developments, distinctions received, research stays, books, edited books, translated books, postdocs, research groups and directed theses. However, the articles published in national and even international journals are a plausible indicator of their productivity.

scholarship program, for the formation of specialized human capital in Mexico and; (2) the congruence that exists between former CONACYT scholarship holders, who studied a postgraduate degree in national institutions or abroad, and their admission to the SNI.

Results

The first result presented is for the sample size. Since there are two types of categories for the destination of a scholarship, the first is for the sample size[17] (domestic and abroad), then they can be considered as independent populations. Thus, defining the following for each of the scholarship recipient populations; a) the average number of scholarship recipients in force from 2002-2011[18]; b) a confidence level of 95%; c) a precision of 5%, and; d) an expected proportion (p) of 0.5, a statistically significant sample size of 378 was obtained for national scholarship holders, while for scholarship holders abroad the sample size was 340. In addition, since the probability of selection of a scholarship holder is not the same per entity or country, a stratified random sampling with proportional allocation was performed (Table 3).

It is interesting to mention that based on the sample size of the ten states presented in Table 3, a representativeness of close to 80% is obtained, while with the sample size of the ten countries, a representativeness of 95% is obtained. Once the sample for each state and country of scholarship destination was integrated, a first *match* was made with the SNI databases (new and current)[19]. A CONACYT grantee may have been accepted in any SNI call before 2002, so the search was extended to the period 2000-2015. For this period107 (46 women and 61 men) national scholarship holders accepted by the SNI were obtained, while for scholarships abroad127 (39 women and 88 men) scholarship holders accepted by said research system were obtained. This result implies that, effectively, studying a postgraduate degree abroad leads to a greater probability of being accepted by the SNI. For this subsample of scholarship holders, Table 4 shows both the Mexican

[17] There are mixed scholarships, which may have both categories. However, in this study, we consider the host country as the one reported at the beginning of the fellowship term.

[18] The average is considered and not the sum of the current scholarship holders because a scholarship holder can be counted n times during a study period longer than one year, as in our case.

[19] Both the full name of the CONACYT grantee and the full name registered in the SNI databases were standardized for the corresponding *match*.

state and the country of destination of the CONACYT scholarship that has shown greater participation in the SNI, at least during the period 2000-2015.

Table 3. Results of stratified random sampling with proportional allocation.

State	Average number of scholarship recipients 2002-2011	Sample size	Country	Average number of scholarship recipients 2002-2011	Sample size
Mexico City	8,917	159	EUA	749	88
State of México	1,485	26	United Kingdom	696	82
Jalisco	1,124	20	Spain	504	59
Puebla	1,074	19	France	291	34
Nuevo León	910	16	Germany	190	22
Baja California	772	14	Canada	187	22
Guanajuato	735	13	Australia	50	6
Morelos	590	11	Holland	49	6
Veracruz	587	10	Japan	24	3
Chihuahua	571	10	Italy	17	2
Rest of the States	4,425	79	Rest of countries	132	16
Total	21,189	378	Total	2,889	340

Source: Own elaboration with historical data from CONACYT.

The first result that emerges from the information presented in Table 4 is that the scholarships granted for studies abroad show greater adherence to the strategies of the corresponding special science and technology programs of CONACYT. In addition, it is clear that in the national context, studying a doctorate in Mexico City increases the probability of entering the SNI, while scholarship holders who study in Great Britain and the United States of America have the profile desired by the SNI evaluators and, thus, obtain a positive evaluation by the evaluators of the SNI system. To determine the productive level of the selected CONACYT scholarship holders for the

period 2000-2011, a second match was made, but this time with the Scopus database (Table 5).

Table 4. State and country of destination for CONACYT scholarship recipients who entered the SNI, 2000-2015.

State	Fellows	Country	Fellows
Mexico City	42	Britain	34
Jalisco	10	United States of America	33
Puebla	6	Spain	22
Yucatán	6	France	18
Nuevo León	5	Germany	8
Rest of the States	38	Other countries	12
Total	107	Total	127

Source: Own elaboration with historical data from CONACYT.

The results obtained in Table 5 are conclusive for the period under study since CONACYT scholarship holders who are pursuing a postgraduate degree in a national institution publish more articles than CONACYT scholarship holders who are studying a postgraduate degree in some institutions abroad. This result, undoubtedly, should favor the former to the extent that they have the productive profile desired by SNI evaluators. Therefore, it is expected that in the non-linear probability model, the variable denoting the State or Country of destination of the scholarship is statistically significant. The results obtained in Table 4 and Table 5 are not surprising, because, in the national context, the scholarship holders who carry out their studies in Mexico City are those who are most likely to enter the SNI and, in addition, are those who present a greater number of articles published in some Scopus journals. On the other hand, the result by country of destination of the scholarship coincides with Didou and Etienne's comments, which refer to Mexican scholarship holders and graduates in the United States as those who have the most suitable profile to enter the SNI (Didou and Etienne, 2010, p. 119).