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Types of codified knowledge and their effect on economic performance in a developing economy: the case of Mexico

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Abstract

The purpose of this work is to explain the way in which the different types of codified knowledge (Patents, Utility Models and Industrial Designs) have an impact on economic performance (GDP Per Capita and Investment) but taking into account input variables (scientific-educational variables). For this, a context of a developing country, such as Mexico, is taken into account, where there are various trade treaties that require harmonization of their industrial protection laws, with respect to TRIPS. A multivariate analysis technique is applied, called canonical correlations, where a double causality is established, from codified knowledge to economic performance and vice versa, where it is found that there is a negative relationship between codified knowledge and economic performance.

Keywords: patent, utility models, industrial designs, codified knowledge, canonical correlation.
JEL Classification: C53, O34, O47.

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Resumen

Tipos de conocimiento codificado y su efecto en el desempeño económico en una economía en desarrollo: el caso de México

El objetivo de este trabajo es explicar la forma en que los diferentes tipos de conocimiento codificado (Patentes, Modelos de Utilidad y Diseños industriales) tienen un impacto sobre el desempeño económico (PIB per cápita e Inversión), pero teniendo en cuenta variables de entrada (variables científico-educativas). Para ello, se toma en cuenta un contexto de un país en desarrollo, como México, con diversos tratados comerciales que obligan a armonizar sus leyes de protección industrial, respecto de los ADEPIC. Se aplica la técnica de análisis multivariado de correlaciones canónicas, donde se establece una doble causalidad del conocimiento codificado al desempeño económico y viceversa. Se encuentra que existe una relación negativa entre el conocimiento codificado y el desempeño económico.

Palabras clave: Patente, modelos de utilidad, diseños industriales, conocimiento codificado, correlaciones canónicas.

Clasificación JEL: C53, O34, O47.

Introduction

For a long time, it's been a debate about knowledge production and information processing (Foray, 2004), one approach centers the analysis on the specialized sectors development such as high-tech sectors, and the other approach points to the generalization of knowledge-intensive activities throughout the economy.

Nevertheless, the elements of knowledge are unobservable, so that new knowledge can be measured only by the approaches like embedded, codified and tacit knowledge (Aboites & Soria, 2008), where the first refers to software and computers, the second refers to patents and manuals, and the third to human capital. There are some advantages of using codified knowledge in statistical research over other types of knowledge, this is due to two reasons, on the one hand, we have measurements on patents, utility models and industrial designs granted by the IMPI. On the other hand, there are no proxy variables of tacit knowledge or human capital, since although there is a population with different levels of education; they also have experience and non-school knowledge due to different training modalities. As for software and integrated circuits, these are not taken into account, because they affect a smaller number of economic sectors than patents, UM and ID.

But also, there isn´t a stable model that can be used to convert inputs (into the creation of knowledge) and outputs (economic effects), there has been some knowledge production functions where patents are functions of research and development (Griliches, 1990) with not concluding remarks.

In this sense, it is important to point out that the patents has been the most important measure for the codified knowledge studies (Mansfield, 1986; Levin *et al.* 1987; Griliches, 1990; Granstrand, 1999; Cohen, Nelson & Walsh, 2000; Foray, 2004; Encaoua, Guellec & Martinez, 2006; Hall, 2007; Aboites & Soria, 2008), although there are other measures like utility models, industrial designs, industrial secrets, integrated circuits, copyrights among others that has been ignored to study codified knowledge as input and their effects on outputs in different knowledge production functions.

In fact, in the last decade there has been some studies exploring the effects of utility models and their importance for the technological change (Kim *et al.*, 2012; Heikkilä & Lorenz, 2018), the technological impacts of R&D grants on utility models (Beneito, 2006; Milesi *et al.*, 2013; Chen *et al.*, 2014; Torres, Mendez & Hernandez, 2016) and the impact of utility models on innovation (Odman, 2010). By another side, literature on industrial secrets, industrial designs, integrated circuits, copyrights and their economic and social effects are scarce. It is for these reasons that the main target of this study is to prove the usefulness of patents, utility models and industrial designs as inputs for the codified knowledge and their social and economic effects.

The first role of the patents, industrial designs and utility models is social. As a mechanism for the diffusion of knowledge and as a mechanism for increasing the amount of codified knowledge[1]. The second role of the patents, industrial designs and utility models is economic, since it acts as an exclusion mechanism for agents in the market (Soria, 2019).

In this way, both roles tend to distinguish between input variables and effect variables.

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1 Since, at the end of the patent protection period, the patent owner must disseminate the invention.

The reasons to take only patents, utility models (UM) and industrial designs (ID) are threefold, the first is that patents are the most utilized measure for codified knowledge, the second is that in most industries the second most useful tools for codifying knowledge are UM (that are very similar to patents) and ID (draws and ornamental models) that are applied to clothing industry, automotive, transportation, electronics, appliances, furniture, crafts and ornamental, among other industries, which means that are a knowledge codifying tool for a lot of industries.

The last reason is that industrial secrets are data not available in public databases, the other measures like integrated circuits and copyrights are useful for a very specialized industries (*e.g.* electronics, cultural industries).

The method of this study consists on a multivariate analysis, specifically a canonical correlation analysis that shows the correlation between the two set of variables, variables of codified knowledge (Patents, UM and ID) and socio-economic variables at the same time. In this kind of analysis, we can find different dimension of these relations, and these dimensions are important to describe the context in which the variables show a relation.

The research was conducted in Mexico, because of the lack of studies on codified knowledge on developing countries, since Mexico is an example of liberalization policies that can improve the patents, UM and ID signing different agreements like NAFTA (now UMSCA) and other agreements that encourage the patent, UM and ID activities.

In Mexico the Federal Law for the Protection of Industrial Property was generally approved, which is part of the harmonization standards of the T-MEC (https://www.milenio.com/politica/t-mec-senado-aprueba-ley-proteccion-propiedad-industrial). This proposal, seeks to adapt to the legal framework issues in matters such as patents, utility models, industrial designs, layout designs of integrated circuits, trademarks, commercial notices, trade names and protection of designations of origin and geographical indications. The purpose of this initiative was to strengthen patenting activity in Mexico; however, the rest of the codified knowledge activities remained unchanged. Therefore, this study proposes to clarify whether this patenting activity is the one that most influences the input and effect variables.

The structure of this study is as follows, also to this section the next section shows a review of literature on the relations between patents, UM and ID and other social and economic variables such as GDP, Population, Internet, Postgraduate Enrollments, National Researchers, Research Centers and Capital Investments. The third section explains the research method called canonical correlation, which points the canonical correlation analysis as an approximation method to multiple relations and dimensions. The fourth section describes the results, explaining the main relations and the dimensions of these relations. The last section shows a discussion and make some concluding remarks of the research.

1. Conceptual framework

1.1. The Mexican IPR

To understand the intellectual property rights, it is necessary to review the Trade Related Aspects of Intellectual Property Rights (TRIPS) (WTO, 2019), specifically those who protect and strength the intellectual property rights to rise their appropriability.

The WTO Agreement on TRIPS constitutes an attempt to reduce the differences in the way of protecting these rights in the different countries of the world and of some of them to common international standards. It complies with the minimum protection that each government must grant to the intellectual property of the other WTO Members[2].

In this sense, Foray (2004) explains that the technological knowledge is different to the production of standardized goods and services. This difference is located in the non-exclusive and non-rival nature of knowledge consumption (Encaoua, Guellec & Martinez, 2006). Non-rival because it can be consumed by a large amount of people at the same time, and non-exclusive because it can be shared at a cost cero for most of the cases.

In this way, a strong Intellectual Property Right (IPR) is characterized by a strong system of appropriation of knowledge, where the imitation is difficult, and the exploitation of knowledge is high.

However, this strength in the IPR has some consequences such as the weak diffusion of knowledge (Aboites & Soria, 2008).

Because of the last, it is important to analyze the different instruments of knowledge appropriation, to be specific we analyze the

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2 https://www.wto.org/spanish/thewto_s/whatis_s/tif_s/agrm7_s.htm

instruments that are applied in the Mexican context, where the study is conducted. The Mexican legislation known as "Industrial Property Law" (DOF, 2018), recognize different IPR: patents, UM, ID, Industrial Secrets, Brands and Appellation of Origin. Although there are other IPR like copyrights in the "Author Copyright Federal Law" (DOF, 2018) and the Vegetal Variety in the "Vegetal Variety Federal Law" (DOF, 2012), nevertheless the most common IPR for the industries are patents, UM and ID.

Despite of the variety of IPR instruments, it is common for most of the industries to protect their knowledge by patents, UM and ID, mainly because brands are of public knowledge, appellation of origin cannot be imitated, and industrial secrets are not disposable in public databases. By another way, copyrights apply to a few industries (i.e., cultural and software), and vegetal varieties to a smaller amount of industries. In this sense, patents, UM and ID are in the Mexican case the most common IPR, and those, they will be taken for this study.

1.2. Patents, Utility Models and Industrial Designs

According to WIPO (2016), the patent system is designed to contribute to promoting innovation and the transfer and diffusion of technology, in favor of the inventors, the users of the inventions and to all the public. Once a state or regional office grants a patent, then the patent holder has the right to prevent a third party from exploiting the patent for a period of 20 years. In the form of compensation, the owner must release or disclose the invention to the public at the end of said period.

By another side, WIPO (2016) states that not all knowledge is patentable, therefore, requirements of: patentable matter, industrial application (utility), novelty, inventive step, disclosure of the invention. The first case refers to the impossibility of patenting exceptional cases, such as medical treatments. The second case refers to the practical industrial application. The third case refers to the fact that, in the invention, it must be observed a new feature so far not known in the body of knowledge. The fourth case concerns something that cannot be deduced by a person with general knowledge in the technical field in question. The last case refers to the fact that the invention, must be disclosed clearly and completely.

The rights conferred by a UM are similar to those conferred by a patent. WIPO (2016) states that utility model protection generally applies to minor inventions. Technical complexity and inventions expected to be marketed for only one period limited time. By another side, the requirement of "inventive step" to sometimes it is not contemplated or is less rigorous.

One of the basic purposes protections of ID is to encourage design activity for the product elaboration. According to WIPO (2016), protection of ID that is contemplated in the laws only applies to designs corresponding to articles or products or that are integrated in them. This protection does not, therefore, prevent other manufacturers produce or do business with similar articles or products, this is due to the condition that in the latter it is not integrated or reproduced protected design.

The maximum term of protection for industrial designs varies between countries, and ranges from 10 to 25 years.

1.3. Studies of patents, UM and ID, and their differences

The use of patents, UM and ID has increased their usage as an appropriation mechanism, nevertheless there are some differences among industries and countries (Aboites & Soria, 2008). These differences are historical, Wyatt (1986) explains that in Japan the patent is a more important appropriation mechanism than in USA; Levin *et al.* (1987) explains that the differences in IPR mechanisms differ from one industry to another; Mansfield (1986) in his research find out that the propensity to patent is different from industry to industry.

In recent studies Encaoua *et al.* (2006) describes how the patent system can encourage the sequential innovation. Anton & Yao (2004) Shows that the value of disclosure is offset by the increase threat of imitation, these in scenarios where the property rights are weak. Heikkilä & Lorenz (2018) explains that the patents effects on the direction of technological change, productivity growth and welfare is disputable, and those the study of UM models is a necessary step to understand the knowledge production. Torres *et al.* (2016) study how the public grants have an impact on the patent activity and production, but it has no effects on the UM production, by another side the study shows that improving firm capabilities and combining them with public grants has an important effect on the UM production. Odman (2010) refers to UM as an alternative way to protect the patent system, remedying problems related to the appropriation of knowledge. Ribeiro & Shapira (2020) explains that patent system is a socially shaped institution, because it is the intersection between public and private interests.

The studies of ID and their IPR mechanisms are not new; Denicola (1983) signals the importance of copyright mechanisms to protect the applied art and their differences from ID. By another perspective Reichman (1993) points out the importance of ID arguing that the real problem that face some industries (mainly design industry, software and biogenetic) is the difficult to protect incremental innovation, those a strong design law is indispensable to protect incremental innovations.

Frenkel (1999: 534), in addition explains that "industrial designers are currently faced with an intellectual property void: no matter where they turn –whether it is to copyright, trade dress, or design patent law – their work remains extremely difficult to protect". Because the protected features of designs must be in some way separable from the functional features that can be imputed to the product. Although there are a few studies that remark the positive impacts of ID on competitiveness (Gemser & Leenders, 2000), there is a lack of studies pointing to the effects of ID refered to IPR mechanisms.

Although the patents, UM and ID are different they remain been the best proxies to codified knowledge in most of the industries, and in most of the countries. In this sense, the different countries are mixtures of different kind of industries, especially in the developing countries, since there are some countries advocated to primary resources and other that are manufacturers. These differences point out to different dimension of the codified knowledge, starting from the different kind of variables and systems of innovation inside each country, in this case for Mexico.

1.4. Patents, UM and ID and their effects and input variables

There are different index and variables to measure the codified knowledge. In this study, we try to resume the main studies to understand the relations between codified knowledge and variables related to socioeconomic and research and development conditions.

Maybe the first study of codified knowledge was that of Schmookler (1952), where he proposes the patent as the main variable to measure the knowledge production in the economy. From this study there has been a discussion of the patent as a proxy variable for the codified knowledge, however it is the pioneering work to create new proxy variables or knowledge index in the actual state of art.

Griliches (1973; 1998) proposes a production function that uses as a proxy variable of knowledge the R&D expenditures combined with a stock of physical capital, that has as an output the production. Where one of the main problems were the market valuation of R&D expenditures to approach their effects on the national output.

Jaffe (1999) proposes a framework for the index in the economics of knowledge for the health public sector; he divides the index in three parts inputs (expenditures, use of particular organizational practices), outputs (papers, prizes, patents, new drug applications) and impacts (citations, expert evaluations, life expectancy, statistical analysis of healthcare expenditures, revenue growth, profitability). As it is seen, this view of Jaffe has three categories of variables including patents, its effects on socioeconomic variables and inputs for increasing the patenting activities.

Archibugi & Coco (2004) proposes the ArCo index to measure the knowledge, and this index is conformed by three variables 1) knowledge production (patent and scientific articles), 2) technological infrastructure (internet penetration, telephone penetration and energy consumption) and 3) human capital formation (enrollment in science and engineering, higher education tuition).

The World Bank (2008) presents two index, the knowledge index (KI) and the knowledge economic index (KEI), where the KI becomes part of the second index KEI, but both index has outputs between 0 and 10. KI is conformed of literacy, high school and professional, payment of fees and income, patents, scientific articles, telephones, PCs and internet users. KEI is conformed of KI, tariffs regulatory quality and law authority. In this index, there are two main topics, the institutional aspects integrated in the KEI index and the economic and social aspects related to codified knowledge.

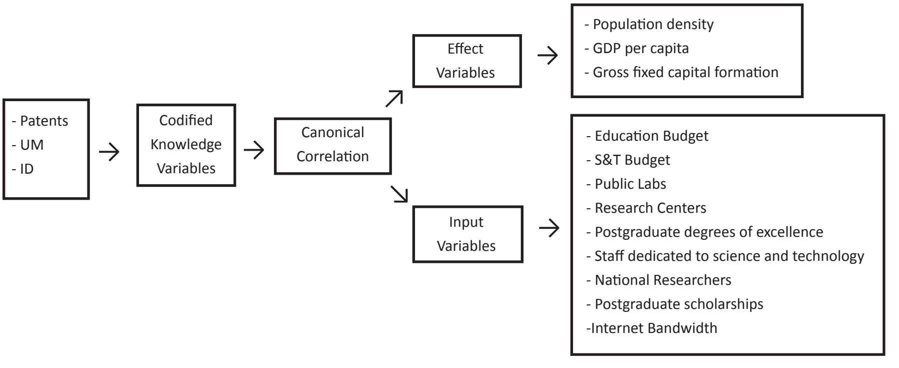
In this sense, the different index and proxy variables are proposed in a specific context, where the measurement is possible or feasible, and in the major cases these measurements recognizes three categories or aspects that has to be taken into account for the relations between codified knowledge (patents, UM and ID), inputs for knowledge and effects of codified knowledge.

1.5. A proposed model to measure the relation between codified knowledge, their inputs and effects

The variables described above are some of the most cited works on the measure of codified knowledge. However, the main problem is that these variables and index are only proxies, this means that the index and information depend on the availability of information on each country.

For this reason, the proposed model is shown in the Figure 1.

Figure 1
PROPOSED MODEL



Source: Own Elaboration.

The model in Figure 1, take into account codified knowledge in the form of patent, UM and ID, which means that take almost all the codified knowledge information. By another side, it takes into account effect-variables like population density, GDP per capita and gross fixed capital formation, which are some of the most important socioeconomic variables in Mexico. Finally, it takes into account the input variables such as public education Budget, S&T Budget, Public Labs, Research Centers, postgraduate degrees of excellence (research and professional degrees), staff dedicated to science and technology, national researchers, postgraduate scholarships, internet bandwidth.

The model describes two variable groups, one (the left side) that shows the codified knowledge (Patents, UM and ID), but a second group (the right side) that shows the rest of variables. So that, there are a double side effect, by one side codified knowledge determining the economic and education and scientific variables, but by another side, this model shows the effect of economic and education and scientific over the codified knowledge. In the model and the theory described above, there is a relation between codified knowledge and input variables, as well as codified knowledge and effect variables, so the Figure 1 resumes all of these relationships.

2. Method

2.1. The canonical correlation analysis

The canonical correlation analysis is a multivariate model to find relationships between two set of variables. The model was propose by Hotelling (1936) to find the maximum projections for each set of variables in a linear way.

In this case it consist in a two column vectors X = {Patent, UM, ID} and Y = {population density, GDP per capita, gross fixed capital formation, public education Budget, S&T Budget, Public Labs, Research Centers, staff dedicated to science and technology, national researchers, postgraduate scholarships, internet bandwidth}. So, the target is to find linear transformations of scalars u1=aTx and v1=bTy that maximizes the relationship of the scalars.

$$\rho_1 = \max_{a,b} Corr(u_1, v_1) = \max_{a,b} \frac{E[a^T x y^T b]}{\sqrt{E[a^T x x^T a] E[b^T y y^T b]}} \quad (1)$$

It is common to replace the expressions xy^T, xx^T and yy^T by estimates from samples of the matrices X and Y, which gives as a result the canonical correlation.

$$\rho_1 = \max_{a,b} \frac{a^T R_{xy} b}{\sqrt{[a^T R_{xx} a][b^T R_{yy} b]}} \quad (2)$$

Where R_xy, R_xx and R_yy are correlation matrices of the random variables x and y, and the correlation matrix is expressed as follows:

$$R = \begin{bmatrix} R_{xx} & R_{xy} \\ R_{yx} & R_{yy} \end{bmatrix} \quad (3)$$

Therefore, the maximization problem is reduced to maximize the numerator in equation 2, which leads to solve the eigenvalues and eigenvector of the next equation:

$$\begin{bmatrix} 0 & R_{xy} \\ R_{yx} & 0 \end{bmatrix} \begin{bmatrix} a \\ b \end{bmatrix} = \rho \begin{bmatrix} R_{xx} & 0 \\ 0 & R_{yy} \end{bmatrix} \begin{bmatrix} a \\ b \end{bmatrix} \quad (4)$$

Which gives a number of canonical correlations equal to the minimum number of variables in the vectors, for this case three dimensions which then are uncorrelated between them (an orthogonal condition for the solution).

Table 1
VARIABLE DESCRIPTION

Variable	Description	Measure	Year	Source
DENSITY	Inhabitants per Km2.	Fractions	2017	CONAPO/INEGI
GDP_PC	Gross Domestic Product by Federative Entity at 2013 Prices per nhabitant.	Pesos	2017	CONAPO/INEGI
FBKF/VACB	Reason for Gross Formation of Fixed Capital at Gross Census Value Added.	Pesos	2014	INEGI-CE
SEP_PC	Transfers of Resources from the Ministry of Public Education to Federal Entities by Agreement of Decentralization per Inhabitant.	Millions of Pesos	2017	Public Account
S&T/TOTAL	Budget Reason Allocated to CTI to Total Resources of Federal Entities.	Millions of Pesos	2016	Public Account / CONACYT
RENIECYT	Institutions in the National Registry of Scientific and Tenological Institutions by Federative entity.	Integers	2017	CONACYT
LAB_ CONACYT	National Laboratories Registered by the National Council of Science and Technology Registered in the Period 2006-2018.	Integers	2006-2018	CONACYT
CENTROSINV	CONACYT Research Centers.	Integers	2018	CONACYT
PNPC-PRO	Postgraduate Programs PNPC-CONACYT (Professionalizing).	Integers	2017	CONACYT
PNPC-INV	Postgraduate Programs PNPC-CONACYT (Research).	Integers	2017	CONACYT
SNI100	Members of the National System of Researchers of CONACYT per 100 Inhabitants.	Fractions	2017	CONACYT/ CONAPO
SCHOLAR100	PNPC-CONACYT Postgraduate Scholars for Every 100 Inhabitants.	Fractions	2017	CONACYT/ CONAPO
AB_BAJADA	Download Bandwidth.	Megas	2015	México Conectado
PATENTS	Patents.	Units	2017	IMPI
ID	Number of Registered Industrial Designs.	Units	2017	IMPI
UM	Number of Utility Models Registered.	Units	2017	IMPI

Source: Own Elaboration.

The canonical correlation analysis has been applied to a variety of problems in economics (from describing macroeconomic relations, to relations between macroeconomics and stock prices, to microeconomic problems), which at the time is not a new tool (it´s been applied since 1980s to economic problems), in this sense, here we propose to analyze the relationship between codified knowledge to input variables and effect variables.

Table 2

Correlations between variables

	PATENTS	ID	UM
DENSITY	0.821	0.58	0.715
GDP_PC	0.291	0.223	0.324
FBKF/VACB	-0.284	-0.255	-0.286
SEP_PC	-0.526	-0.501	-0.513
S&T/TOTAL	0.123	0.157	0.177
RENIECYT	0.828	0.612	0.710
LAB_CONACYT	0.714	0.589	0.581
CENTROSINV	0.926	0.739	0.856
PNPC-PRO	0.894	0.827	0.904
PNPC-INV	0.951	0.795	0.92
SNI100	0.686	0.463	0.544
SCHOLAR100	0.742	0.525	0.61
AB_BAJADA	0.712	0.582	0.693

Source: Own Elaboration.

With the information in Table 1, the canonical correlation analysis was performed; the results are shown in the next section.

3. Results

First, it is necessary to explain, that in Mexico, there are 32 federal entities and as a result 32 observations, the variables were collected for the federal entities and the correlations between the codified knowledge and the rest of variables in Table 1 are shown in the Table 2. From Table 2 the patents have a positive correlation with all variables except Reason of Fixed Capital Gross Formation divided by Gross Censal Value Added (FBKF/VACB), and for Transfers of resources from the Ministry of Public Education to federal entities by agreement of decentralization per inhabitant (SEP_PC).

Industrial Designs are also negative correlated with FBKF/VACB and SEP_PC, as well as UM. From this correlation analysis, it can be said that there is a negative relation between codified knowledge and private investment, and this result can be interpreted as private investment as a substitute for the investment in the production of codified knowledge. By another hand, the transfers for education in the federal entities have negative impacts on the codified knowledge, which is an abnormal result and needs an in deep study.

For the results of the canonical correlations, there are three roots of canonical correlations, of which, only the first dimension is statistically significant. The results are shown in Table 3.

Table 3
Test Statistics for the Canonical Correlation Analysis

Roots	Canonical Correlations	Wilks Lambda	df1	df2	P-Value
1 through 3	0.981	0.013	39	48	0.000
2 through 3	0.658	0.343	24	34	0.489
3 through 3	0.629	0.604	11	18	0.433

Source: Own Elaboration.

Table 3 shows that all canonical correlations are simultaneously significant since the p-value is near cero. This means that there are three dimensions to analyze the correlations between codified knowledge and effect and input variables. The canonical correlations are high (0.981, 0.658 and 0.629), the interpretations for the Wilks Lambda is inverse, the low the coefficient the higher correlations. A characteristic of canonical correlations is that the highest correlation (0.981) is higher than, any of the correlations shown in Table 2. The loadings of the canonical correlation analysis are shown in Table 4.

From Table 4, the canonical correlations are divided into three dimensions; the third dimension shows a scenario in which there is a low population density, GDP per capita and Fixed Capital Gross Formation. In this first scenario, the effect variable of gross formation of fixed capital is positive, as well as Transfers of resources from the Ministry of Public Education, which is an input variable. This is a clear contrast with the results shown in Table 2, which means that the simple correlation analysis is not sufficient to understand the relations between codified knowledge and input and effect variables. The second dimension has some interesting results, since it shows a positive relation between patent activity and effect variables as population density and gross formation of fixed capital, but also positive with input variables as Transfers of resources from the Ministry of Public Education, researchers, research centers, laboratories, scholarships, internet wideband and research postgraduates. These results point to input variables as an important factor to encourage the codified knowledge in the form of patents, and the effects of patent activity on the socioeconomic spheres.

Table 4
Canonical Loadings

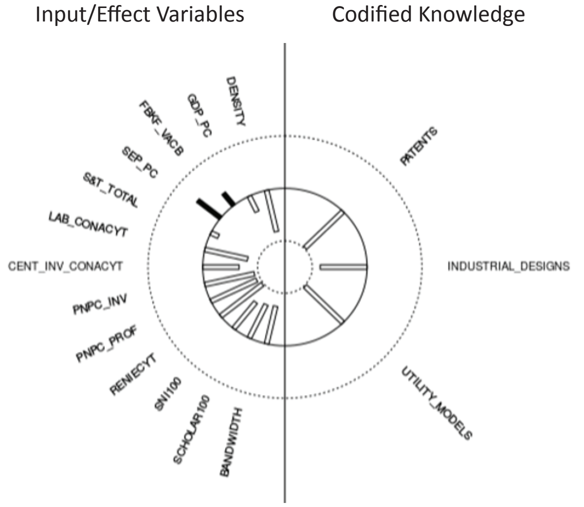
	Dimensions		
	I	II	III
Codified Knowledge			
Patents	-0.979	0.141	0.147
ID	-0.855	-0.325	0.405
UM	-0.981	-0.192	-0.040
Effect and Input			
DENSITY	-0.806	0.475	0.019
GDP_PC	-0.327	-0.029	-0.224
FBKF/VACB	0.296	0.015	-0.012
SEP_PC	0.534	0.035	-0.182
S&T/TOTAL	-0.155	-0.207	-0.067
RENIECYT	-0.974	0.133	0.024
LAB_CONACYT	-0.803	0.464	0.145
CENTROSINV	-0.665	0.377	0.439
PNPC-PRO	-0.930	-0.097	0.103
PNPC-INV	-0.929	0.283	0.081
SNI100	-0.643	0.561	0.171
SCHOLAR100	-0.706	0.517	0.168
AB_BAJADA	-0.734	0.113	-0.039

Source: Own Elaboration.

The last dimension shows that the other form of codified knowledge is the Industrial Designs, since this form of codified knowledge combined with the patent activity has positive effects on density population, but also positive effects on Reniecyt, laboratories and research centers, postgraduates (professional and research), researchers and scholarships. Which means that in Mexico, that is a manufacturer country the codified knowledge in form of ID is important to protect or create a temporary monopoly and it has positive effect in contexts where the patent activity is also important.

One last important result is that UM are not an important mean for the codified knowledge in Mexico, in none of the three dimensions was an important factor for effect variables, nether it was encouraged by input variables. Which the Mexican government apply, to produce some political programs, to encourage the production of codified knowledge, use. The visual report is shown in Figure 2.

Figure 2
Heliograph of canonical loading from the first dimension. The inner and outer dotted circles show correlations of -1 and +1, respectively. The solid circle shows a correlation of 0



Source: Own Elaboration.

Conclusions

To answer the question "Are patents the most relevant measure for codified knowledge?" which is the title for this manuscript, it is important to consider that there exist many forms of codified knowledge, in this research we only took into account three forms of codified knowledge: patents, UM and ID.

The results show that, there are contexts in which is important to take into account the different kind of codified knowledge. As an example, if we do not consider these dimensions, FBKF and SEP_PC are negative related with all forms of codified knowledge. Nevertheless, the results in Table 4, shows that there is one dimension in which these factors are importantly and positive related with codified knowledge, in fact it is the dimension with the higher canonical correlation, corresponding to a federal entity with small population density and PIB_PC, and low rates of codified knowledge.

The second dimension shows that there is a scenario in which the patent activity is important if it is combined with different input variables except budget of Science and Technology and research postgraduates, which are rivaling with the investment in codified knowledge.

However, at the same time are entities with high population density or agglomeration for people, which are in Mexico very correlated with the manufacturing entities.

The third dimension can be analyzed as a scenario in which ID combined with patents are highly correlated with federal entities with high population density, and the input variables negative related are SEP_PC and CTI, which again are rivalizing with the production of codified knowledge. Therefore, it can be said that the second important codified form of knowledge is the ID.

An important conclusion is that the UM are not an important codified sources of knowledge in Mexico, since in none of the three dimensions has a positive loading. Perhaps in terms of political programs it is important in Mexico to stimulate all the forms of codified knowledge and not just the patenting activity.

Another important conclusion is that in the first dimension, all the sources of codified knowledge have a negative impact on input and effect variables. In this sense, in the Mexican context, industrial property laws tend to favor patenting, but only as a performance measure of the knowledge economy. In fact, the harmonization of Mexican intellectual property laws only harmonizes with respect to the main commercial treaties, even though this harmonization discourages innovation in Mexico, instead of generating knowledge spills.

The main limitations of this research are the different sources of data, since in Mexico there is not a single source of statistics for these problems. Another limitation is the periodicity of statistics publication in Mexico, since not all the years has information for these variables presented. Future research has to take into account a dimension reduction method, since the quantity of the variables related to codified knowledge make difficult to set up a model to study these relationships, as well as graphical methods to understand these relationships.

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