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CORPORATE SATISFACTION WITH PUBLIC CENTERS OF INVESTIGATION: THE CSIC

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Abstract

The goal of this article is to analyze company satisfaction with intangible assets that have to do with collaborative work in Research Development activities between corporations and centers of investigation, while focusing ourselves particularly on the Spanish National Research Council (CSIC) case. Firstly, maintaining an approach focused mainly on the Intellectual Capital, this investigation extensively and thoroughly addresses corporate satisfaction with the CSIC. Secondly, by means of multiple logistic regression analysis, a study was conducted utilizing characteristics of both corporations and institutes of the CSIC that yielded a greater influence in the overall corporate satisfaction. The extensive analysis reveals that corporations prove to be satisfied with the three dimensions of Intellectual Capital, as a reference of worth and quality of its intangibles. Some aspects, however, can be greatly improved upon. The regression analysis indicates that the institutes' source of revenue and companies' chief financing market are characteristics that influence the companies' satisfaction when participating in Research Development activities.

Keywords: knowledge transference, Intellectual Capital, Innovation

JEL Codes: I23, O32, O34

1. Introduction

Ameliorating the links and the interaction between both the scientific and productive environments are notable objectives worth achieving in any class of innovation system. Among the aforementioned system's agents, universities and public investigational institutions, and the companies, the benefits of collaboration is an important key in order for the advancement of current societies along with its modernization, both social and economic, to take place. Commencing midway through the 19th century, a greater perspective of science as a basic means of economic development made its way to becoming solidified, also while receiving the utmost influence all while this same perspective begins to be used as a primordial means of technological progress in the later half of the 20th century. Ever since, the vast majority of academic studies note that the correlation between science and corporation is in fact the principal factor for the creation of technological innovation¹. Some of these studies make reference to scientists' abilities, their intellectual dominion in all disciplines, and the contribution,

* This article is part of the work performed in the framework of the doctoral thesis entitled: "Impact on the productive system of transfer of knowledge from CSIC". José Antonio Pedraza and M^a Amalia Trillo Holgado (University of Cordoba, Spain), and Manuel Fernández Esquinas (CSIC). José Antonio Pedraza <td2peroj@uco.es>

¹ Creation of technological innovation understood as the practical application of scientific knowledge, where both science and technology alike take on an essential importance in the satisfaction of social and economic needs

which garnered from science, would later go towards economic and innovative expansion. (Sábato y Botana, 1968; OECD, 2002; Nowotny et al. 1991; Chesbrough, 2006; Popkova et al., 2015). Meanwhile, other analysts focus more on analyzing the benefits that the productive environment acquires from scientific knowledge and how useful it is for the process of innovation. Studies that seek to analyze the collaborative connections between an Innovation System's agents with the intent of learning more about the efficiency of said system. Inquiring into interactions between the Human Capital (knowledge, capacities, and attitudes), the investigation's results worth, the financial and institutional support, productivity profit, and the effect on the innovation. (Bozeman, 2000; OECD, 2002; Santoro & Chakrabarti, 2002, Fernández Esquinas et al., 2011).

Precisely, this renowned function of said scientific institutions and their importance in the innovation process is what we see motivating, and at the same time, legitimizing public investment in Research Development Innovation. A public support that, at a European level, brings life to the Marco Horizon 2020 Program and whose fundamental objectives are those that European scientists procure that new and original contributions are made in order to resolve the principle social challenges, foster industrial leadership in Europe, and better scientific excellence² (European Committee, 2014). Some objectives are expanded on by integration into European regions and country's policies. The responsibility that should be assumed by the scientific environment to transform knowledge into innovation, however, is an arduous task. It is to be advised that a great number of studies point out that the heterogeneous perspective epistemological, theoretical, and empirical make way for thought that the link between science, corporation, and innovation is that of a complex and evolutionary one. (Fernández de Lucio et al., 2011). There are authors, like those previously indicated, that try to shed light upon this matter. However, very little is still known about the characteristics of the links between science and corporation (Gulbrandsen et al., 2011). One seemingly basic issue is that of the elimination of obstacles that impede the transference of knowledge so that, finally, they are later converted into ones that are useful and beneficial for contemporary societies.

In the setting in which both science and corporations find themselves compelled to interact, Ziman (1996) suggests the importance that are both the planning and management of the scientific entities' investigational activities by taking into account an important double-faced task, that is: the combining the efficiency of public resources' utilization with the specific needs of the company in question and, additionally, bearing in mind the environment's social and economic needs. A means of making and managing science that allows the scientific environments to take on the continuous responsibility as a main source of knowledge, this proves to be most pertinent in order for development in the corporate innovation processes (Schartinger et al., 2001). Also, by constructing processes and scientific organizational structures that, from spectators point of view, this can contribute towards the betterment of Innovation Systems agents interactions, particularly with corporations.

² The European Committee (2014) has provided a multiannual budget of 76,880,000€ for the new Marco Horizon 2020 Program.

This article aims to learn more about the collaborative relationships between science and corporations, concretely those of corporations with the CSIC, the chief public body of investigation in Spain. In order for that to take place, this study must first analyze the collaborative relationships between corporations and this public body from a descriptive point of view. In the first part of this analysis, corporations' satisfaction with the work developed by the CSIC is measured. Corporations particularly evaluate investigation group's abilities, the adaptive effort put forth by said groups, the referred procedures of administrative management and the protection of results or level of trust, confidentiality, among others. The combination of analyzed items refers to the corporations' satisfaction with the intangible aspects of collaborative relationships, for which we tried to analyze by using the Intellectual Capital logical approach. The explanatory variables of intangible assets have been grouped in a way according to their nature in three dimensions, that is to say: Human Capital, Structural Capital, and Relational Capital.

Secondly, maintaining the same intangible grouping perspective, we used the same dimensions as factors seeking to compare the links of dependency between the corporation's satisfaction with the intangibles, CSIC institutes' characteristics, and the very own corporation's characteristics as well. In order to measure the influence of the variables, a multiple logistic regression was made. The technique's statistical implementation has permitted us the ability to learn more about the institutes' and corporations' profiles that most influence in the corporations' overall satisfaction. This perspective could prove useful in collaborative relationships. Thus, this study's arrived conclusions could most definitely spark interest in public centers of investigation, as to serve as a way of identifying critical intangible assets in order for the creation of organizational worth. Such information can be used in the planning sphere and the management of public resources. Additionally, the results can also prove advantageous for defining strategies and actions geared towards the betterment of collaborative relationship between the scientific and productive environments while, all the while, resulting in bettering both the knowledge transference and innovation processes.

2. Theoretical and empirical fundaments

As per the diverse perspectives of Intellectual Capital, the main generators of worth within organizations are the intangible assets they possess. Sullivan (2000) associates Intellectual Capital with the knowledge that generates profit. In order to later become familiar with the real worth of an organization, the consideration of their assets is essential. From this point of view, organization find themselves needing to identify their intangibles and becoming familiar with their worth. Great portions of capital intellectual models try to measure them with such purpose. Our hypothesis is not to determine, but rather to prove how these intangibles influence in the collaborative relationship between corporations and centers of investigation, while analyzing the particular case of the CSIC.

Great portions of Intellectual Capital models include satisfaction indicators in the evaluation of Intellectual Capital components. Kaplan and Norton's *Balanced Scorecard* (1996) model recognizes that one of the crucial building blocks towards an organization's success is having satisfied interest groups. This model contemplates

indicators related to the relationship's quality, attributes of the services provided or the fulfillment of the receiver's expectations measured by the level of loyalty or the degree of satisfaction. Additionally, the dashboard analyzes the internal processes considering the satisfaction of the services' users. Also, in order to measure the capacity and competency of employees, satisfaction indicators are introduced. Sveiby's *Intellectual Assets Monitor* (1997) includes satisfaction indexes of clients when the goal is the measurement of an organization's efficiency. Similarly, Edvinsson and Malone's *Navigator Skandia* (1997) model also incorporates satisfactions indicators as to better understand the organization-client relationship. The measurement model *Intelect* (Euroforum, 1998) and model *Intelectus* (Bueno et al., 2011) try to measure the worth of the external relationships maintained resulting from client loyalty and quality, and its potential for new client acquisition, and it does this through the implementation of satisfaction indicators of said clients.

Though, the debate over the measurement and evaluation of the Intellectual Capital in organizations continues, the evaluation of these assets remains a matter pending resolution. However, information that can be observed from the Intellectual Capital indicators, like those referring to satisfaction, constitute a base for evaluating the management of an organization's intangibles, as Ittner and Larcker (1996) demonstrate once proven that client satisfaction holds a significant link to an organization's market worth.

This association between the Intellectual Capital's worth and satisfaction, in turn, shares a connection with the perspective of service quality, measured by user expectation. This perspective considers service quality to be dependent on the degree of satisfaction of receiver expectation, in our case, the degree of corporation satisfaction with the intangible aspects of the work carried out by the CSIC. Such viewpoint has been defended by (Berkeley & Gupta, 1995; Martínez Tur et al., 2001; Zeithaml et al., 1985). According to Parasuraman et al. (1988) and Grönroos (1984), this viewpoint of the service quality by the client would indicate that the rendered service exceeds clients' prior expectations. Service quality is in this way a multidimensional concept whose functional and relational components could resemble those elements that make up Human, Structural, and Relational Capital. Basing these authors' concept of service quality and the description of Intellectual Capital's dimensions on Bueno Campos & Moreno (2007) and Bueno Campos et al. (2011), we arrive at the next correspondence between the satisfaction with service quality and the satisfaction of Intellectual Capital:

- a) Service quality and Human Capital are associated with efficiency, functionality with the knowledge that the individuals possess, their capacity to generate it, and that said knowledge being useful to the receiver of the service.
- b) Service quality and Structural Capital relate to the efficiency and functionality of the combination of knowledge stemming from administrative and technological processes that are property of the service's borrowing organization and serve so that, whomever is to receive said service, can capitalize on benefits or advantages derived from the issuer's organizational knowledge, organizational processes, effort put towards Research Development Innovation, technological resources, and the intellectual and industrial attributes that the aforementioned issuer possesses.

- c) Meanwhile, the relationship between service quality and Relational Capital takes part in the combination of knowledge relative to aspects related to trust or loyalty, confidentiality or the flow of communication between both parties.

This analytical viewpoint which allows us to investigate further the keys to science-corporation relationships through the degree of corporate satisfaction with the quality of the work done by the CSIC relating to Research Development activities, which both parties carried out in joint agreement.

3. Methodology

3.1. Population and sample

The main sources used are of quantitative nature, stemming from the CSIC's internal database. Concretely, the data relative to the contracted investigation derives from a survey given to a representative population of corporations, public administrations, and other agents of the Spanish socioeconomic environment that had collaborated in Research Development activities from 1998-2010. Meanwhile, the database on the CSIC's characteristics are result of the compilation of information that the very entity carried out concerning the resources at institutes disposal, and which served as a base for the elaboration of this public body's strategic program for the 2005-2009 duration.

In the case of the survey towards corporations, the collection of information took place by means of a conducted, closed, and structured interview through a questionnaire that was sent to those that, within the company, had the knowledge and capacity to have a solid opinion about the relationship with the CSIC. This information collection procedure allowed for interviewing various labor figures³ and that the sample was comprised of 794 companies, to which correspond a trust level of 95% and a sampling error of $\pm 2.7\%$.

3.2. Questionnaire design and available variables

The survey was divided into five segments. In order to analyze corporations' satisfaction with the CSIC, we utilized the segment referring to the evaluation of collaboration, concretely, the part which asked for the degree of satisfaction. This section included 14 items about different aspects relating to the job realized by the CSIC. The questions in particular account for the satisfaction of followed procedures, the task force, work method, and the relation between the CSIC and the corporations.

The questionnaire consisted of simply written questions with subjective responses utilizing a Likert scale of four points in which each interviewee indicated their current job position. Such design responds to literary described approaches and measurements referring to the public investigation's socioeconomic effects. The work cued its focus particularly in analyzing the entities of public investigation and their way of interacting with corporations in Research Development processes (Schartinger, et al., 2001, Cohen et al., 2002), whose studies tackle the subject of transference mechanisms and the

³ In 98% of the cases, positions interviewed held titles of Chairman, Manager, Chief Executive Officer, Research and Development Department Director, Director of other departments, Research and Development Area Manager, Manager of other areas, Area Coordinator, Technician, Administration.

impacts incurred due to the relations among the agents within the scientific and production environments (Cohen et al., 2002).

3.3. Phases of analysis

The first step was to factor the items of the satisfaction variables (see Block 1). For that, we went about validating these items by way of factorial analysis that, factors forcibly or unnaturally constructed following the criteria of the Intellectual Capital standpoint (Bontis, 1999; Bueno Campos et al., 2011)⁴, maintained the natural grouping resulting from the reduction of data in a statistical manner. The results of the factorial analysis yielded no similarity.

This lead us to applying the recommended method of polychoric matrices according to different authors (Ferrando, 1996; Brown, 2006; O`Connor, 2006; Elosua & Zumbo, 2008; Bandalos & Finney, 2010;)⁵ in order to find evidence on how its items in a level of ordinal measurement are grouped together, as is this case.

Block 1. Studied variables of satisfaction

| Factors | Variables |
|---------------------------|--|
| Human capital | f2_1: CSIC team abilities. f2_2: CSIC team dedication. f2_3: CSIC team adaptive effort to the context and needs of the corporation. f2_10: Attitude and courtesy while facing queries and complaints. |
| Structural capital | f2_6: Equipment availability within the CSIC. f2_7: Scientific-technical quality of the work fulfilled. f2_8: Observance of deadlines. f2_9: Project planning and organization. f2_12: Economic costs of the contracts. f2_13: Administrative procedures relating to management (contracts, collections, invoices, etc.). f2_14: Procedures for the protection of intellectual property (before or after collaboration). |
| Relational capital | f2_4: Communication between the CSIC team and the corporation. f2_5: Atmosphere of trust between the CSIC team and the corporation. f2_11: Guarantee of work confidentiality. |

⁴ The *Intellectus* model (Bueno et al., 2011), in reality, incorporates alterations to Bontis' classification (1999). Structural Capital is broken down into Organizational and Technological Capital and Relational Capital into Business Capital and Social Capital, while at the same time adding a new measurement that refers to capital as entrepreneurship and innovation. However, given its being characterized by its own authors as a systematic, open, flexible, adaptive, and dynamic model, and, given its limitations on information on certain capital, we have understood that this does not in anyway impede analyzing the capital proposed in the aforementioned model as a whole.

⁵ These authors recommend utilizing the polychoric matrices method in order to analyze the correlation between variables when they are polytomic, as appears in Likert's scale and, furthermore, when the scale utilized has less than 5 possible answer choices. This leads to items being analyzed as ordinal variables and that; correspondently, the correlation is studied with the cited method.

This second analysis, in addition to verifying factorial analysis results, it demonstrated that this was due to the high correlation of all variables amongst themselves (see Block 2) and that, correspondently, constructing a global indicator of satisfaction for items as a whole would make sense. Therefore, interpreting them grouped in factors or dimensions gives rise to a redundant measurement. Its use, although, is not invalid. So, high variable correlation must be interpreted accordingly: corporations that exhibit being satisfied is understood as being so in all variables and, oppositely, those exhibiting dissatisfaction would be understood as wholly dissatisfied. Given the result yielded in the polychoric correlations matrix and the high correlation between the variables of satisfaction, it was decided to continue measuring the effect of independent variables over unnatural factors, encouraging a factorial structure in the three dimensions of Intellectual Capital with the goal of having a more broken down image of the perceived worth by corporations about the aforementioned dimensions.

Block 2. Polychoric correlations between ordinal variables

| Factors | f2_1 | f2_2 | f2_3 | f2_4 | f2_5 | f2_6 | f2_7 | f2_8 | f2_9 | f2_10 | f2_11 | f2_12 | f2_13 | f2_14 |
|---------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| f2_1 | 1,000 | 0,848 | 0,741 | 0,745 | 0,770 | 0,591 | 0,821 | 0,655 | 0,700 | 0,789 | 0,615 | 0,455 | 0,383 | 0,499 |
| f2_2 | 0,848 | 1,000 | 0,875 | 0,805 | 0,777 | 0,556 | 0,792 | 0,772 | 0,815 | 0,791 | 0,590 | 0,584 | 0,478 | 0,485 |
| f2_3 | 0,741 | 0,875 | 1,000 | 0,817 | 0,732 | 0,501 | 0,708 | 0,702 | 0,781 | 0,753 | 0,591 | 0,522 | 0,483 | 0,507 |
| f2_4 | 0,745 | 0,805 | 0,817 | 1,000 | 0,885 | 0,514 | 0,663 | 0,629 | 0,740 | 0,818 | 0,577 | 0,483 | 0,445 | 0,470 |
| f2_5 | 0,770 | 0,777 | 0,732 | 0,885 | 1,000 | 0,542 | 0,744 | 0,593 | 0,710 | 0,837 | 0,652 | 0,461 | 0,422 | 0,525 |
| f2_6 | 0,591 | 0,556 | 0,501 | 0,514 | 0,542 | 1,000 | 0,654 | 0,496 | 0,534 | 0,579 | 0,575 | 0,458 | 0,486 | 0,502 |
| f2_7 | 0,821 | 0,792 | 0,708 | 0,663 | 0,744 | 0,654 | 1,000 | 0,674 | 0,728 | 0,771 | 0,629 | 0,509 | 0,444 | 0,533 |
| f2_8 | 0,655 | 0,772 | 0,702 | 0,629 | 0,593 | 0,496 | 0,674 | 1,000 | 0,853 | 0,699 | 0,498 | 0,568 | 0,523 | 0,475 |
| f2_9 | 0,700 | 0,815 | 0,781 | 0,740 | 0,710 | 0,534 | 0,728 | 0,853 | 1,000 | 0,809 | 0,610 | 0,575 | 0,569 | 0,592 |
| f2_10 | 0,789 | 0,791 | 0,753 | 0,818 | 0,837 | 0,579 | 0,771 | 0,699 | 0,809 | 1,000 | 0,675 | 0,521 | 0,450 | 0,580 |
| f2_11 | 0,615 | 0,590 | 0,591 | 0,577 | 0,652 | 0,575 | 0,629 | 0,498 | 0,610 | 0,675 | 1,000 | 0,557 | 0,522 | 0,735 |
| f2_12 | 0,455 | 0,584 | 0,522 | 0,483 | 0,461 | 0,458 | 0,509 | 0,568 | 0,575 | 0,521 | 0,557 | 1,000 | 0,584 | 0,500 |
| f2_13 | 0,383 | 0,478 | 0,483 | 0,445 | 0,422 | 0,486 | 0,444 | 0,523 | 0,569 | 0,450 | 0,522 | 0,584 | 1,000 | 0,646 |
| f2_14 | 0,499 | 0,485 | 0,507 | 0,470 | 0,525 | 0,502 | 0,533 | 0,475 | 0,592 | 0,580 | 0,735 | 0,500 | 0,646 | 1,000 |

Source: personal compilation

The steps for dividing the global satisfaction index into the three dimensions of Intellectual Capital were the following: a) First, the values on Likert’s scale were converted into binaries; b) Following that, the variables were recoded as to define two different populations: satisfied population and dissatisfied population. The corporations that gave a “Very Satisfied” response to all items on the scale were assigned a value of 1. Among these, the companies that showed true satisfaction with all collaborative aspects were included, leaving absolutely no room for dissatisfaction between the sought service and the proper service. On the other hand, “Satisfied”, “Somewhat Satisfied”, and “Not At All Satisfied” responses were given a value of 0. All things considered, it is worth understanding that dissatisfaction could arise upon the sought services and the proper services failure to coincide (Zeithaml et al., 1993). “No Opinion” and “No Response” responses were considered lost values.

Once the scale’s values were compiled, the procedure for determining the degree of global satisfaction in each element involved counting the number of questions whose values had been given “Very Satisfied” and assigning it the code number of 1. This is a way of establishing different degrees of satisfaction. Thus, the corporations that were most satisfied with all variables that formed the factor would be those that gave a

“Very Satisfied” response. Then, corporations that gave a similar response to all but one variable would sequentially follow, and so on, and so forth. Such breaking down of the code number 1 gives us the opportunity to determine a point of dissatisfaction based on the variable of “n” and to carry out new recoding once again.

This new recoding with the value of 1, the level of global satisfaction, is attained from those who responded as being “Very Satisfied” with more than half of the questions that comprised the factor. Results yielded after the latest regrouping can be observed in Block 3 below.

Block 3. Degree of global satisfaction with the CSIC collaborative agreement

| Factors | Frequency | Number of "very satisfied" with each item | | | | | | | Dissatisfied | Satisfied | Percentage of satisfied | | |
|------------|-----------|---|-----|-----|-----|-----|----|----|--------------|-----------|-------------------------|-----|-----|
| | | 0 | 1 | 2 | 3 | 4 | 5 | 6 | | | | 7 | N/A |
| Human | | 342 | 111 | 65 | 73 | 159 | | | 44 | 518 | 232 | 31% | |
| Structural | 794 | 337 | 112 | 90 | 57 | 54 | 34 | 23 | 42 | 45 | 596 | 153 | 20% |
| Relational | | 324 | 124 | 122 | 180 | | | | | 44 | 570 | 180 | 24% |

For the Human Factor, 232 cases corporate giving a “Very Satisfied” response to at least three out of the four items comprising the factor were tallied. For the Structural Factor, the degree of global satisfaction was attained when the corporations voiced “Very Satisfied” to at least four of the seven items. In Relational Factor’s case, those satisfied include the corporations that responded “Very Satisfied” to the three items that comprised the aforementioned factor. The yield of this analysis reveals that all corporations that declare being satisfied show equal satisfaction for each factor. And, on the other hand, those corporations that declare being dissatisfied with any factor also express dissatisfaction with the other two as well.

4. Descriptive results

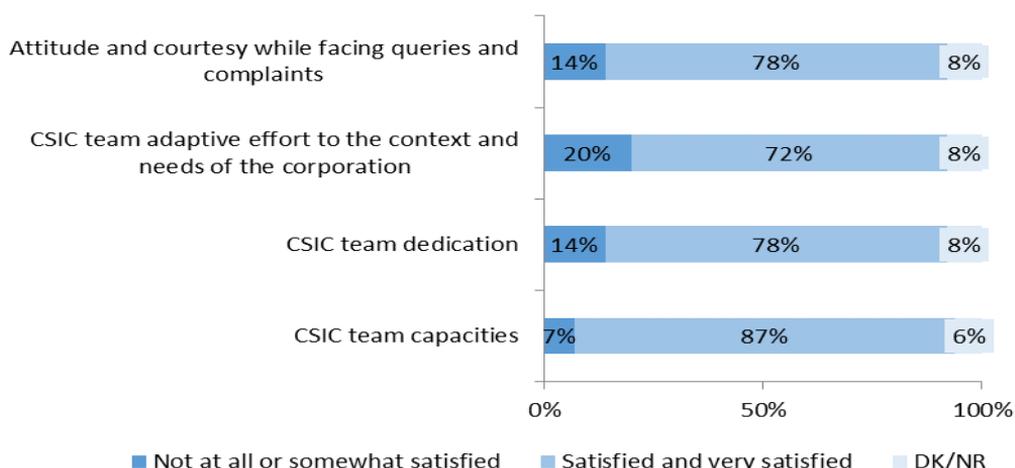
The comprehensive results yielded on corporate global satisfaction with collaborative activity indicate that nine out of ten corporations positively rated the collaborative agreement signed with the CSIC, 28% of them declaring having a very positive relationship without going into further details on specific aspects of the aforementioned evaluation. Nevertheless, a more detailed assessment on the level of satisfaction has allowed for a better comprehension of the relationship’s minute details. The best and the worst rated by corporations.

Regarding the CSIC’s Human Capitals’ worth, corporations voiced an overall satisfactory response. In all items asked about the task force, the degree of satisfaction was above 70% (see Chart 2), while the CSIC task force’s adaptive effort towards context and corporate needs were both principal motives for overall dissatisfaction. Such attribute could lay bare a weakness in an organization’s interaction with the productive environment.

Block 4. Global evaluation of the CSIC collaborative agreement

| Factor | Frequency | Percentage |
|-----------------|------------|-------------|
| Very Positively | 223 | 28% |
| Positively | 488 | 61% |
| Negatively | 33 | 4% |
| Very Negatively | 5 | 1% |
| DK | 27 | 3% |
| NR | 18 | 2% |
| Total | 794 | 100% |

Graph 2: Degree of satisfaction with CSIC Human Capital



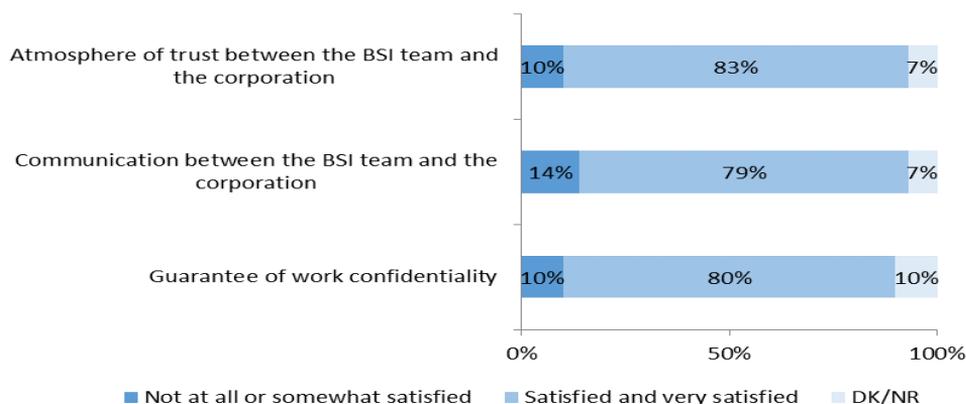
As far as Structural Capital is concerned, corporate evaluations indicate that there are a great number of dissatisfied corporations with this dimension. Results yielded exhibit that there are corporations discontented more with the efficiency and functionality of the combination of knowledge and intangible assets stemming from CSIC’s administrative and technological processes than with the rest of Intellectual Capital’s dimensions. Referring to organizational capital in particular, there are aspects relating to the CSIC’s organizational culture and organizational processes with which one out of every three corporations expresses being dissatisfied (refer to Graph 3 for items on contract economic cost, observance of deadlines, administrative procedures, and management). Additionally, regarding the technological capital, which measures corporations’ satisfaction with procedures for the protection of intellectual property (before or after the collaboration), the number of dissatisfied corporations (15%) is also relevant considering that the percentage of dissatisfied corporations is 57% and that nearly one out of three corporations do not know or simply do not respond to these items, surely due to being corporations that possess little knowledge acquisition ability with requesting patents. These aspects give meaning to or favor a framework of collaborative work, while hindering it for dissatisfied corporations. It is worth mentioning here that the procedures as well as the very administrative management

utilized by the CSIC are influenced by the rules and organizational culture of entities within the public sector. Authors such as Turpin et al. (1996), Bonaccorsi and Piccaluga (1994), Davenport et al. (1998), Lee (1998), Siegel et al. (2003), and Arvanitis et al. (2008) state that the main impediment for collaboration between corporations and public investigation institutions are of the cultural nature. Such cultural differences have to do with the objectives, work method, and the organizational environments of each party.

Graph 3: Degree of satisfaction with CSIC Structural Capital



Graph 4: Degree of satisfaction with CSIC Relational Capital



As for corporations’ satisfaction with Relational Capital, the results yielded reveal a great number of corporations are satisfied with this dimension; around 80% of the

corporations indicate this. The atmosphere of trust, communication between the CSIC team and the corporation, and the guarantee of work confidentiality constitute the intangible elements with which a good part of corporations find themselves satisfied (see Graph 4). These types of aspects, according to Rapper et al. (1999), should not be undervalued given their forming part of the informal relationships that aid towards forging bonds between the parts that are the foundation for bringing a formal relationship to life.

The results yielded from corporations' degree of satisfaction in relation to these agents who have had interaction in the collaborative Research Developments agreement's sphere could draw the following conclusions:

- a) The exchange relationship between the CSIC and the corporations is understood as a process of generating value for both parties. For the CSIC, the satisfaction of corporations should be considered as a value that encourages this entity's ability to accredit the efficiency of the public service provided, while at the same time serving as a way of authenticating the public resources and public policies allocated to fostering the generation of knowledge from the public sector towards the productive sector.
- b) Corporations have evaluated the CSIC's human resources, procedurals, and relationships from an organizational point of view. Intangible aspects that determine the organization's Intellectual Capital understood in three dimensions, Human, Structural or Organizational, and Relational Capital. Evaluation that in terms of satisfaction, yield as a result that the human and relational aspects have been more adequately esteemed by a greater number of corporations than the structural and organizational aspects.

5. Multiple logistical regression model results

Finally, the multiple logistic regression analysis was derived utilizing the prior mentioned factors as dependent variables and as independent variables, those that were characteristic of both CSIC institutes and corporations in determining their profile. Three regression models were specifically made (see Block 5).

Results yielded from the multiple logistical regression analysis demonstrate a significant link between corporations' satisfaction and the characteristics of both CSIC institutes and corporations. The percentage of competitive financing, financing in the national market, and financing in the local or regional scope are all variables that could explain corporations' degree of satisfaction with the collaboration. Having not found any relationship that explains the satisfaction with the characteristics of corporations relating to its knowledge acquisition ability.

While comparing the satisfaction of corporations with the Human Capital, percentage of competitive financing, and the percentage of the corporate invoicing, it is worth affirming that when CSIC institutes' chief source of revenue derives from European, national, or regional Research Development programs and when corporations' invoicing is obtained in the national market, corporations' satisfaction increases, having a negative effect such combination of both characteristics (see Block 6).

Block 5. Regression model description for each dimension of satisfaction

| Variable Criteria | Model 1: Human Capital | Modelo 2. Structural Capital | Modelo 3. Relational Capital |
|---|---|------------------------------|------------------------------|
| Dependent variable | Dissatisfied (Value 0) | Dissatisfied (Value 0) | Dissatisfied (Value 0) |
| | Satisfied (Value 1) | Satisfied (Value 1) | Satisfied (Value 1) |
| Independent variable | Block. Characteristics of CSIC centers | | |
| | Information on size and number of personnel per scientific area | | |
| | Percentage of competitive financing | | |
| | Percentage of noncompetitive financing | | |
| | Total budget of the center | | |
| | Percentage between the center's total budget and the number of center personnel | | |
| | Percentage between the number of managing personnel in the center and the total number of personnel in the center | | |
| | Block. Structural characteristics of the corporations | | |
| | Total number of workers | | |
| | Typology of activity sector (high/medium/low technology) | | |
| Percentage of invoicing in the European market and third world countries regarding total invoicing | | | |
| Age of the company (number of companies established over 7 years ago) | | | |
| Age of the company (number of companies established less than 7 years ago) | | | |
| Block 3. Acquisition capacity | | | |
| Percentage of corporate workers with levels of education similar or greater to mid-university studies | | | |
| Percentage of corporations in relation to the total that have its own Research and Development departments in its establishment | | | |
| Percentage of Research and Development and technology producing corporations relating to the total amount of corporations | | | |
| Percentage of total investment regarding the total invoicing of the corporation | | | |
| Corporations that have carried out short-term and mid-term product or service innovations (within the last three years) | | | |
| Corporations that have ever petitioned for a patent | | | |

Block 6. Satisfaction with Human Capital (SHC)

$$SCH = -2,3886 + 0,0493B_1 + 0,0126B_2 - 0,0005B_3$$

Model 1: Complementary variables and statistics from the multiple logistic regression analysis.

| Independent and constant variables | Probability coefficients (B) | Standard deviation (E.T.) | Parametric statistic (Wald) | Smallest level of significance (p-value) | Risk associated to the occurrence frequency exp(B) |
|--|------------------------------|---------------------------|-----------------------------|--|--|
| Constant | -2,3886 | 0,6504 | -3,6726 | 0,0002 | 0,0918 |
| (B ₁) Competitive financing | 0,0493 | 0,0160 | 3,0814 | 0,0021 | 1,0505 |
| (B ₂) % of national market invoicing | 0,0126 | 0,0106 | 1,1929 | 0,2329 | 1,0127 |
| (B ₃) B ₁ -B ₂ interaction | -0,0005 | 0,0003 | -1,8518 | 0,0641 | 0,9995 |

Model 1: Authenticity accuracy test (Table LRT)

| Goodness of fit | Chi-squared (LR Chisq) | Df | Pr(>Chisq) |
|--|------------------------|----|------------|
| (B ₁) Competitive financing | 8,8145 | 1 | 0,0030 |
| (B ₂) % of national market invoicing | 4,5340 | 1 | 0,0332 |
| (B ₃) B ₁ -B ₂ interaction | 3,4409 | 1 | 0,0636 |

The measurement of corporations' satisfaction with the Structural Capital through the regression analysis indicates that there is a significant link with competitive financing of the institutes and the percent of corporate invoicing in the local and regional sphere. The regression takes estimates of negative indication into account, which indicates that

while the percentage of competitive financing in institutes increments and the percentage of invoicing is focused more in the local or regional sphere, corporations' dissatisfaction with the CSIC's Structural Capital is also given in a large number of institutes (see Block 7), having a positive effect on satisfaction such combination of these two variables.

Block 7. Satisfaction with Structural Capital (SSC)

$$SCE = -1,2609 - 0,0025B_1 - 0,0238B_2 + 0,0007B_3$$

Model 2: Complementary variables and statistics from the multiple logistic regression analysis.

| Independent and constant variables | Probability coefficients (B) | Standard deviation (E.T.) | Parametric statistic (Wald) | Smallest level of significance (p-value) | Risk associated to the occurrence frequency exp(B) |
|--|------------------------------|---------------------------|-----------------------------|--|--|
| Constant | -1,2609 | 0,5220 | -2,4154 | 0,0157 | 0,2834 |
| (B ₁) Competitive financing | -0,0025 | 0,0132 | -0,1878 | 0,8510 | 0,9975 |
| (B ₂) % of local/regional market invoicing | -0,0238 | 0,0120 | -1,9792 | 0,0478 | 0,9765 |
| (B ₃) B ₁ -B ₂ interaction | 0,0007 | 0,0003 | 2,3170 | 0,0205 | 1,0007 |

Model 2: Authenticity accuracy test (Table LRT)

| Goodness of fit | Chi-squared (LR Chisq) | Df | Pr(>Chisq) |
|--|------------------------|----|------------|
| (B ₁) Competitive financing | 4,1802 | 1 | 0,0409 |
| (B ₂) % of local/regional market invoicing | 0,6371 | 1 | 0,4248 |
| (B ₃) B ₁ -B ₂ interaction | 5,7647 | 1 | 0,0164 |

Block 8. Satisfaction with Relational Capital (SRC)

$$SCR = -1,1504 + 0,0008B_1 - 0,0179B_2 + 0,0005B_3$$

Model 3: Complementary variables and statistics from the multiple logistic regression analysis.

| Independent and constant variables | Probability coefficients (B) | Standard deviation (E.T.) | Parametric statistic (Wald) | Smallest level of significance (p-value) | Risk associated to the occurrence frequency exp(B) |
|--|------------------------------|---------------------------|-----------------------------|--|--|
| Constant | -1,1504 | 0,4872 | -2,3612 | 0,0182 | 0,3165 |
| (B ₁) Competitive financing | 0,0008 | 0,0123 | 0,0665 | 0,9470 | 1,0008 |
| (B ₂) % of local/regional market invoicing | -0,0179 | 0,0109 | -1,6400 | 0,1010 | 0,9822 |
| (B ₃) B ₁ -B ₂ interaction | 0,0005 | 0,0003 | 1,7445 | 0,0811 | 1,0005 |

Model 3: Authenticity accuracy test (Table LRT)

| Goodness of fit | Chi-squared (LR Chisq) | Df | Pr(>Chisq) |
|--|------------------------|----|------------|
| (B ₁) Competitive financing | 3,0025 | 1 | 0,0831 |
| (B ₂) % of local/regional market invoicing | 0,0011 | 1 | 0,9731 |
| (B ₃) B ₁ -B ₂ interaction | 3,1658 | 1 | 0,0752 |

Regarding the link between corporations' satisfaction with the Human Capital and the characteristics of corporations and institutes, the regression model proves that there is also a significant link with the competitive financing of institutes and the financing

percentage in the regional or local market. The relationship between the independent variables and the corporations' satisfaction with the CSIC's Relational Capital shows that when competitive financing in CSIC institutes increments, this has a similar effect on the satisfaction of corporations. However, the effect on satisfaction with Relational Capital is inversed while the percentage of invoicing is situated in the local or regional sphere (see Block 8).

6. Conclusions and guidelines

The descriptive analysis reveals that the CSIC's interaction with the productive environment is generally satisfactory. The dimension of Intellectual Capital where we discovered a large number of satisfied corporations is with the Relational Capital, that is to say, the value for those corporations that maintain continuous relationships with the CSIC. Within this capital, the confidentiality guarantee, communication level, and atmosphere of trust are intangible aspects that having arisen, such as this case; the acquisition ability of each interacting entities is improved. Human Capital, in great measure, is also esteemed greatly by a large number of corporations. Investigation team capacity is principally emphasized in this dimension. On the other hand, satisfaction with the Structural Capital falls deeper into question. In this dimension we discovered intangible aspects a great number of corporations, around 80%, express being satisfied with, since the case is that of the scientific-technological quality of the tasks carried out. But, on the contrary, we also found more intangible attributes that give way to a considerable amount of corporations dissatisfied with the efficiency and functionality of knowledge flow originating from CSIC administrative and technological procedures. We essentially refer to the particular dissatisfaction of corporations when faced with the difficulty of assuming the economic cost of contracts and obstacles derived from the incompliance of deadlines, administrative and management procedures, and the protection of industrial and intellectual property.

The multiple logistic regression analysis, on its behalf, demonstrates that a significant link between the satisfaction of corporations and the public investigation centers' type of financing exists. This link indicates to us, in the case of corporations' satisfaction with Human and Relational Capital, that a percentage increase of competitive revenue with respect to the total (this being of European, national, or regional programs held in public Research and Development open calls) increases the possibility for corporations being satisfied with the intangibles annexed to these dimensions of Intellectual Capital. While the effect is opposite when dealing with measuring corporations' satisfaction with Structural Capital.

Additionally, we have discovered a significant link between corporations' satisfaction and their chief financing market. This correspondence reveals that when the corporations' chief market is neither local nor regional, there is a greater possibility for their overall satisfaction with all dimensions of Intellectual Capital.

The descriptive as well as regression analyses both demonstrate corporations' difficulties with the CSIC's organizational culture, proving to be a factor that reduces the collaborative quality between this public body of investigation and the productive sector. This characteristic, already indicated by existing literature (Lee, 1998; Arvanitis et al., 2008; Turpin et al., 1996; Davenport et al., 1998; Bonaccorsi & Piccaluga, 1994), explains that the culture, administrative procedures, Research and Development management procedures, and the economic costs of contracts are not motives for corporation dissatisfaction.

Conclusions yielded in this work suggest two types of improvements, or at least two opinions on the CSIC's role in the knowledge transference process towards corporations and/or active participation in the innovative process. Firstly, the acceptable opinion corporations have regarding the CSIC's Intellectual Capital, Human and Relational Capital particularly, cannot be overlooked nor allowed to be the cause that discourages corporations from collaborating with this entity. However, such aspect denoting a certain institutional weakness for collaborating with lesser-globalized corporations could be related to the higher possibility of dissatisfaction between corporations as main financing placeholders in the local or regional market.

On the other hand, corporations' satisfaction being positively correlated with CSIC institutes' revenue gained from public Research and Development financing programs reminds us that the knowledge transference strategy towards the productive sector and active participation in the Innovation System should be combined with the strategy for revenue expansion, originating from the distinct public Research and Development financing or competitive financing programs.

Lastly, public investigation institutions' way of governance is also worth mentioning, considering the dissatisfaction it generates among corporations; proving to be a challenging weakness to dissolve due to the protagonists situated within the public sector. The normative regulations that standardize the Public Administration, budgetary limitations, and control over public accounts tend to be inconveniences that hinder relationships between public centers of investigation and the productive sector. Such hindrance has already been expressed by the OECD (2011) in case studies and surveys carried out using corporations that recognize that both the governing manner and decision-making processes in public investigation institutions do not permit changes that contribute new ideas and perspectives during the collaborative process to be implemented.

These complications, however, in fact do have solutions, and they deal with entities more flexible in their management and those that possess capacity for risk taking, something that administrative procedures lack. Christensen and Eyring (2011) give name "mutant" scientific organizations to those that, from within the public, are coming forth to tackle these types of problems associated to the traditional bureaucratic model. A good number of initiatives have already been taken in order to avoid this way

of governance in public investigation institutions, that is to say: the laboratory for public innovation under the Danish government (MindLab), the United States Defense Advanced Research Projects Agency (DARPA), the Medical Research Council (MRC) in the United Kingdom, the Public Service Division of the Prime Minister's Office of Singapore, responsible for promoting change and innovation in this country's public administration (Ps21 Offices), the Government Laboratory of Chile (GobLab), and the Catalan Institution for Research and Advanced Studies (ICREA). These are just some examples that seek to open a new path for science for when it interacts with the non-scientific environment.

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