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La Sub-Capitalización de Activos Intelectuales en América Latina

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Prefacio

Hoy en día, los activos intangibles como la propiedad intelectual (PI) constituyen el epicentro del valor empresarial de las multinacionales. Desafortunadamente, América Latina se encuentra rezagada y necesita de una gran revolución en sus políticas de innovación orientada a desarrollar mercados de tecnologías.

Si los líderes de empresas latinoamericanas desean innovar, deberán superar ciertos procesos cognitivos que limitan el uso de estrategias de PI. En este sentido, los gobiernos pueden hacer mucho para superar dichas barreras.

Introducción

Actualmente, "la propiedad intelectual es la moneda de la economía del conocimiento" (Ghafele & Gibert 2012). El conocimiento de estrategias de propiedad intelectual no debiera ser encajonado como dominio exclusivo de las oficinas de transferencia tecnológica (como ocurre hoy en la región). De seguir así, las empresas innovadoras corren el riesgo de no rentabilizar sus esfuerzos creativos e innovadores por desconocer las estrategias óptimas de apropiación y comercialización de sus ideas. Además, la incapacidad para rentabilizar activos intelectuales aumenta los riegos de inversión en nuevas empresas, lo que impacta directamente en sus costos de financiamiento (De León & Fernandez Donoso 2016a).

Existen distintas estrategias para gestionar apropiadamente los activos intelectuales. La estrategia óptima para cada activo no necesariamente requiere el uso de derechos de propiedad intelectual. Por ejemplo, se puede proteger una innovación aumentando la complejidad del diseño de componentes que dificulten su ingeniería inversa (Hall et al. 2014), separando procesos de estratégicamente para dificultar que sean replicados (Keupp et al. 2009) o simplemente porque la complejidad tecnológica es en sí una barrera para imitar un producto o proceso (Fernandez Donoso 2014) o porque el ciclo de vida producto es lo suficientemente corto como para hacer inviable la absorción y réplica del conocimiento (Bilir 2014).

A continuación, analizaré algunos de los limitantes para el uso de estas estrategias y para el desarrollo de mercados de tecnología en la región

Estrategias de Propiedad Intelectual

La solución no es simple dado que la comercialización exitosa de activos intangibles es, en sí misma, un puzle complejo. En 2015, apenas el 9% de las PYMEs europeas eran propietarias de algún derecho de propiedad intelectual. En promedio, éstas generaban un ingreso 32% mayor por empleado (OHIM 2015) que sus pares sin activos intelectuales. Por otro lado, de los 2,1 millones de patentes activas en Estados Unidos en 2014, el 95% no pudieron ser comercializadas exitosamente —entre ellas 50.000 patentes de invención universitarias de alta calidad (Walker 2014)—. Por su lado, América Latina apenas representa el 2,5% de las patentes mundiales (WIPO 2014). Del total de patentes latinoamericanas, sólo un 12% son solicitadas por empresas residentes (WIPO 2014) y todos los países de la región, sin excepción, muestran ingresos netos negativos por licenciamiento[2].

Entre otros inconvenientes, la teoría de propiedad intelectual convencional (Machlup 1958, Kitch 1977, Besen & Raskind 1991, Bessen 2005) no analiza la gestión de propiedad intelectual, ni por qué las empresas eligen determinadas estrategias de propiedad intelectual. En el libro "Innovation, Startups and Intellectual Property Management" (De León & Fernández Donoso 2017), se identifican cuatro grandes categorías de estrategias de gestión de la propiedad intelectual:

(i) Estrategias Convencionales: son aquellas en las que se ejerce poder de mercado a través de la propiedad intelectual. Incluyen la diversificación de portafolios a través de distintas formas de propiedad intelectual, el desarrollo de tecnologías alternativas para competir con variedades, la publicación defensiva para limitar la competencia, la "donación" de patentes o las cláusulas de no competencia.

(ii) Estrategias colaborativas de propiedad intelectual: definen habilidades que pueden ser desarrolladas con otros negocios y cómo los títulos de propiedad intelectual pueden ser utilizados con otras empresas para obtener capacidades faltantes, ya sea por intercambios o por licenciamiento conocido como "patent pooling".

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(2) De acuerdo a Indicadores de Desarrollo Mundial (2015), los ingresos netos por licenciamiento de patentes (en millones de dólares de EEUU corrientes): Argentina (-1.799,9), Brasil (-5.547,6), Chile (-1.461,9), Colombia (-442,2), Costa Rica (-134), México (-368,3), Perú (-253,5), en contraste con Estados Unidos (88.237).

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(iii) Estrategias ofensivas: estrategias basadas en la litigación como activo de inversión, donde las ganancias del litigio, los costos y los riesgos son medidos con valor esperado positivo.

(iv) Estrategias de ocultación: estrategias de propiedad intelectual cuyo objetivo es no haber público un conocimiento determinado. Incluyen el uso de múltiples patentes con información segmentada, las cláusulas de confidencialidad, etc.

Al igual que en la definición de teoría de juegos, la estrategia óptima para una determinada innovación debería contemplar todas las contingencias posibles. Una estrategia puede también ser una composición de elementos pertenecientes a distintas categorías: publicación sólo de una parte de la innovación (estrategia de tipo convencional) -aunque insuficiente para ser replicada por terceras partes- y además cláusulas de confidencialidad (estrategia de ocultación).

La conveniencia de cada estrategia dependerá de diversos factores: (i) condiciones externas a la empresa —por ejemplo: industrias de alta complejidad tecnológica, absorción tecnológica de países donde se localiza la producción, protección institucional de la propiedad intelectual, etc.—, (ii) características de la innovación (Hall et al. 2014, Fernandez Donoso 2014) —por ejemplo: patentabilidad, complejidad tecnológica, ciclo del producto, diferencias inventivas con productos similares, etc.— y (iii) condiciones internas de la empresa –por ejemplo: aversión al riesgo, cultura de interna de innovación, disonancia cognitiva a sistemas formales de propiedad intelectual, entre otros.

Pequeñas empresas innovadoras en América Latina y limitaciones cognitivas

La identificación de la estrategia óptima de propiedad intelectual de cada innovación empresarial debe formar parte de la estrategia global de la empresa. Este componente –el de propiedad intelectual- es aún más importante en la estrategia empresarial de emprendimientos dinámicos, cuyo motor de crecimiento es la comercialización de activos intelectuales[3]. La no elaboración de una estrategia adecuada limita la capacidad para capitalizar estos activos intelectuales y, cuando la falta de estrategias es generalizada, la sub-capitalización de activos incide en el riesgo de invertir en *startups*.

En América Latina, este riesgo incremental está detrás de la poca disponibilidad de financiamiento privado al emprendimiento. Sin embargo, las pequeñas empresas innovadoras en América Latina muy rara vez elaboran una estrategia para proteger sus activos intelectuales (De Leon & Fernandez Donoso 2016b). Se pueden identificar los siguientes procesos que limitan el uso de los sistemas de propiedad intelectual:

- Disonancia cognitiva: cuando hay fuertes convicciones en contra del uso de los sistemas de propiedad intelectual ("fumar es malo, quiero a fumar"). Existen empresas que, aun sabiendo la importancia de proteger y capitalizar estos activos, tienen creencias y convicciones en contra, por lo que optan por no usarlas.

- Sobrecarga cognitiva: emprender, innovar y poner en marcha un negocio requiere importantes esfuerzos cognitivos (especificidades técnicas de producto o proceso, marketing, comercial, tributación, etc.). El emprendedor (empresario) simplemente se ve desbordado en ocupaciones, dejando de lado la elaboración de una estrategia de propiedad intelectual.

- "Sheer ignorance" (Kirzner 1997): no saber cómo acceder a un conocimiento específico por el simple hecho de no saber que no se sabe.

El sesgo cognitivo detrás de estas limitaciones es un sesgo confirmatorio (De Leon & Fernandez Donoso 2017). Entrevistando en profundidad a más de 350 empresas innovadoras de la región, buscamos cuantificar los costos efectivos de uso de los sistemas de propiedad intelectual, a partir de cuatro hipótesis iniciales: (i) costos legales excesivos, (ii) imitación una vez publicada la innovación por grandes empresas con capacidad de financiar grandes litigios, (iii) tramitación larga y costosa antes de obtener el derecho de propiedad intelectual y (iv) poca protección durante proceso de revisión del derecho de propiedad intelectual.

Adicional a una baja presencia de las hipótesis iniciales como limitantes del uso de estos derechos, identificamos la tendencia a favorecer, buscar, interpretar y recordar información que confirma la creencia de la inutilidad de los sistemas de propiedad intelectual. La desproporcionada falta de consideración a los beneficios de capitalizar activos intelectuales es un serio impedimento para el desarrollo de mercados tecnológicos y de innovación en la región.

Discusión e implicancias de política

El diseño de una estrategia pública para fomentar el uso inteligente de la propiedad intelectual requiere un previo entendimiento del ecosistema de innovación que acompaña la implementación de la estrategia. Este contexto debe tomar en cuenta factores tales como la madurez de la tecnología, las expectativas de los receptores de algún tipo de política y el compromiso de esos receptores. Existen factores a nivel macro y micro que influyen en la transferencia tecnológica. Los factores a nivel macro se determinan a nivel nacional y son más difíciles de controlar en el corto plazo (apertura comercial, disponibilidad de insumos específicos, infraestructura, institucionalidad, condiciones de mercado, etc.). Los factores a nivel micro incluyen la cultura organizacional, ética, capital social, distancia al poder, proactividad para buscar nuevas tecnologías, capacidad de absorción tecnológica y factores sociales.

(3) Un caso emblemático y popular de la región es la empresa Crystal Lagoons. Sin embargo existen otros casos de empresas en América Latina que han crecido en torno a la capitalización de activos intelectuales (ver De León & Fernández Donoso 2017).

El análisis cognitivo de los demandantes de derechos de propiedad intelectual es fundamental para el diseño de políticas microeconómicas que favorezcan la transferencia y comercialización de activos intelectuales. A modo de ejemplo, en Colombia se intentaron diversas reducciones a las tasas de registro de patentes sin impacto alguno en el número de patentes solicitadas (De León & Fernández Donoso 2015). El escaso impacto de este tipo de políticas se explica sucintamente al entender las limitaciones cognitivas de los usuarios de los sistemas de propiedad intelectual.

Por otro lado, la literatura sugiere que en la región se debiesen favorecer políticas orientadas a la transferencia de capacidades, al establecimiento de culturas de protección o a la divulgación de conocimiento práctico en torno al tema de la apropiación de activos intangibles y su rentabilidad para el negocio. En cualquier caso, el puzle de la comercialización de activos intelectuales no tiene una única solución, pues la complejidad de cada nueva creación, idea de negocio, producto, algoritmo, obra literaria o fórmula para mejorar un proceso es tan único como la originalidad de sus autores.

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An Institutional Framework to Explain the University-Industry Technology Transfer in a Public University of Mexico

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Abstract: In the last years, studies and modifications to the science and technology regulatory framework in Mexico show the increase in the attention to transfer the research results of professors and researchers from higher education institutions, towards the productive sector with the purpose of generating regional, national and international growth and development. This study has conducted to the search of the factors that determine the increase of linkage activities and technology transfer. Based on the literature review, this study develops a framework integrated with the factors considered that have a significantly impact in the university-industry linkage and technology transfer. The proposed independent variables are the following: Institutional Factors, Academic Profile, and Innovation.

Keywords: technology transfer; institutional factors; academic profile; innovation; researchers; university-industry collaboration.

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1. Introduction.

Since the industrial revolution started two centuries ago, it came with a radical change in the productive sector, and social structures, the technological and organizational innovation were the seed of these transformations. At that moment the technology was the competitive key factor, and this advantage is preserve for a strict protection; it was demonstrated not just through the exportation of the technology included in the machinery, but also through the prohibition to the engineers from England to work outside. According with this, the innovation has been considered as an important factor to the economic growth and international leadership (Heijs, 2001). And this is linked to the research activity.

According with Sabato & Botana (1968), the research activity requires a scientific and technological structure, that integrates some articulated and interrelated elements, such as: a) the education system, that generates scientists, technicians, operators, managers; b) laboratories, institutes, centers, pilot spaces to do research; c) research committee, sciences academies; d) administrative, legal mechanisms that regulate the operation of the institutions and activities mentioned above; and e) the economic and financing resources applied to its functioning.

The triple helix denotes not only the university, industry and government relation but also the internal transformation of each of these spheres. The university has changed of a teaching institution, to in one that combines teaching with research, this is a revolution that continues, not only in the United States but also in other countries; it can play an improved role in the innovation, as well as in the increasing of knowledge-based societies. The potential of the science to promote the economic development has become a source of regional and international competence in the millennium change. The university can be seen to remain as the core institution of the knowledge sector always that keep its original education mission (Etzkowitz & Leydesdorff, 2000).

During the last part of XIX century in the universities of United States, it was originated an embryonic entrepreneurial academic dynamic, when the absence of a research funding system, gave it more importance to the individual and collective initiatives to obtain resources to support research. The academic entrepreneurship was expanded from an organizational growing regimen towards an economic and social regional development strategy (Etzkowitz, 2003).

In Mexico, until the seventies, public universities had to focus in accomplish the substantive functions in charge. Mainly the human resources training, promote knowledge and extend and transmit its research and teaching functions. Is necessary to remember that in this period in Mexico the scientific and technological infrastructure was still developing, and the specialist´s number in some areas is limited. Due to the economic crisis in Mexico in the first part of the eighties, starts the change of conception that the productive sector had about the useful of knowledge, beginning to be more valued. As a result, the industrial sector begins to request the national technological and scientific capacities, those that concentrates in public universities (De Gortari, 1997). The higher education institutions in Mexico, started formally its linkage processes in the eighties, but gains force in the nineties (Bajo, 2006).

Such as Zubieta & Jiménez (2003) indicates, that the economic development of XXI century depends on a large degree of the successful grow of the productive sector, that at the same time, depends on the value added resulting from research and technology related to the manufacture of products and services. For that reason, is necessary the strengthening of the relationship between higher education institutions (HEI), enterprises and government. The HEI, such as knowledge entity, have to acquire new responsibilities, in the face of the explicit necessity to linkage their results of scientific research and technological development with the issues of competitiveness to industrial sector and services global scale.

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The aim of this study is to develop a framework integrated by a group of variables identified in previous studies of university-industry collaboration and technology transfer, to propose the possible dimensions and indicators for these variables; suggesting the basis of a future evaluation instrument of university-industry technology transfer to a public university of Mexico. The variables identified are the following: Institutional factors, Academic profile, and Innovation.

2. Literature Review.

2.1 University-industry collaboration and technology transfer.

Based on Debackere & Veulegers (2005) the university-industry collaboration refers to different types of interactions between industry and science sector, which has the purpose of exchange technology. The formal forms that they consider are the following: start-up enterprises; research and development projects with firms and science institutions; contract research and know-how consultancy; intellectual property rights development; advanced training for personnel and systematic exchange of research personnel between companies and research institutes.

As reported by Shubert et al. (2014) the university-industry collaboration is used to describe the active commitment of an industry member on a research project with academics. By Lizardi & Velázquez (2010) in its origins, the technology transfer is a linkage process that relates the driving of an idea with the delivery channel towards the intermediate or final user. The technological knowledge base mostly resides in technicians, engineers, scientists and researchers of different disciplines. It´s overriding the approach between such professionals and the production and commercialization entities to achieve the technology transfer.

The technology transfer concept ¨relates with an active and voluntary process to disseminate or acquire new experiences or knowledge with the aim of improving products, services and productive processes of the enterprises. Commonly, this transfer is carried out with commercial agreements, for that reason the technology is treaty as merchandise¨ (Solleiro et al., 2012, p. 45).

On Mexico, the technology transfer is the process that involves the move of knowledge generated by the university to an enterprise, allowing innovate and extend its technological capacity, giving the possibility to obtain a competitive advantage in the market. The university technology transfer towards a firm includes 1. Linkage activities: a) technological services, analyses, essays, calibrations, measurements, certifications, consultancy; b) training services; c) information services: national and international database search, patent search, technological information in general; d) innovation and development projects: basic and applied research, experimental development; e) enterprises incubators projects; f) junior firms projects, consultancy, and services. 2. Knowledge transfer through the intellectual property rights licensing: patents, software, plants obtained by artificial selection; as well as the not protected knowledge transfer (know-how) to consolidated enterprises in the market (Lizardi & Velázquez, 2010).

2. 2 Technology transfer barriers.

In America, the university-enterprise relationship has been conducted in particular circumstances deriving of the economic, technological, entrepreneurial, political and social status. Such terms determine distinctive characteristics in the university-enterprise relationship that differs from similar experiences in other countries, especially the developed world. Some problems relates with the university academics lacking culture and disposition to linkage with productive sector. Nowadays, the evaluation of professors and researchers in most of the Latin American universities basis on traditional parameters and criterion. It is for that reason that the typical Latin American university researcher prefers to dedicate its time to basic research and publish the results, given that this represents a more reliable path of rising and possibilities of salary improvement. Also, is still common to find that universities have not the suitable institutional structure to commercialize its technologies and services (Solleiro et al., 2012).

In Mexico, within the main barriers on technology transfer are the absence of an entrepreneurial culture in the Higher Education Institutions and Public Centers of Research; the limited offer of researchers and research with commercialization possibilities; the scarcity of knowledge and technology demand by firms; the lack of connection between the possible offer and demand; the reduced interaction between research, development and innovation actors; and some regulatory frames (Lizardi & Velázquez, 2010).

The university-productive sector technology transfer has been studied by various authors in different countries, detecting factors that determine the success of this activity, as well as those that represent barriers or obstacles to achieve it. Wu et al. (2015) mention that to a large extent the researcher´s attitudes and perceptions become significant; the institutional frame conditions affect the academics behavior regarding commitment in knowledge transfer activities; at the same time to

D´Este & Patel (2007) mention that the institutional features influence the interactions established with industry. In the university-industry relation scheme proposed by Bercovitz & Feldmann (2006), within the university environment exist formal rules that are the incentives and rewards, as well as informal rules, standard procedures of operation and norms. Finally, at the core of technology transfer is every academic motivated by a combination of personal and institutional incentives. Some personality traits and factors influence and shape the type of university-industry relationship (Shubert et al., 2014).

Additionally, the innovation is another important factor. The universities are not required only to perform an active role in education and science and technology development, also to transform their scientific results in useful innovations always that can be possible and desirable. The main competitive advantage of the universities in the knowledge market is their competence to generate new original discoveries and new approaches to solve problems (Debackere & Veugelers, 2005).

In this sense, have been outlined three independent variables related to university-industry technology transfer (dependent variable): Institutional Factors, Academic Profile, and Innovation. For this study, the elements explains below.

2.3 Institutional Factors.

Some studies emphasize in factors related to the university management (Díaz, 2014; Cabrero et al., 2011; Harman, 2010); such as the scarcity of norms and procedures (Solleiro et al., 2012; Bercovitz & Feldmann, 2006; Bajo, 2006); research evaluation parameters, financial regulations and administrative practices to the academics involvement in activities oriented to the commercialization, as well as specific management practices of the productive sector (Solleiro et al., 2012; O´Shea et al., 2005); and the incentives (Díaz, 2014; Padilla & Garrido, 2012; Cabrero et al., 2011; White & Bruton, 2011; Caldera & Debande, 2010; Link, Siegel & Bozeman, 2007; Bercovitz & Feldmann, 2006; O´Shea et al., 2005;).

Likewise, the focus on the execution of activities oriented to the technological and innovate objectives of the productive sector (Rubio, 2014; White & Bruton, 2011); the limited offer of researchers and research with commercial possibilities, limited management of intellectual property rights (Cabrero et al., 2011; Lizardi & Velázquez, 2010). The lack of information about the Technology Transfer Office (TTO) (Rubio, 2014); the insufficient experience on business and marketing of the Technology Transfer Office (Wu et al., 2015; Padilla & Garrido, 2012; Harman, 2010; Link, Siegel & Bozeman, 2007;); as well as its performance (D´Este et al., 2009); the lack of support in the identification of the research results that have a commercial value, as well as the discoveries documentation, and the determination of if it is possible the protection of the intellectual property rights (Rubio, 2014; Cabrero et al., 2011); are recognized as important factors in the university-industry relationship and technology transfer.

By the objective of this study and based on the literature review; the authors mentioned before, refers to different factors related to institutional issues in the university-industry technology transfer. Due to that, the Institutional Factors integrates the next elements: Technology Transfer Office (TTO); Linkage Activities Planning; Diffusion of Technological Development Projects; Incentives and Intellectual Property.

2.4 Academic Profile.

Some authors refers to professors and researchers as a key factor of university-industry technology transfer. The research conducted by Rivera et al. (2011) include the researcher characteristics as a variable; and is integrated by the education degree, the Researchers National System membership, funding, types of research, institution type, linkages and results. Shubert et al. (2014) proposed a group of factors to characterize the researchers profile in the information systems field, who are actively seeking the university-industry linkage; those factors are the following: organization size and type, funding source, industry members' number, university members' number, commitment, main result.

In a study carried out by D´Este & Patel (2007) in the United Kingdom, examine the different channels through which the academic researchers interact with industry and the factors that influence the researchers' commitment on a variety of interactions. As part of this, they examine the relative impact of the institutional characteristics, as well as the individual characteristics to explain the likelihood to engage in a wide variety of interactions with the industry, and this are the number of joint publications, researcher seniority and the status.

Boardman & Ponomariov (2009) study the individual and professional characteristics that affect the university scientist interactions with private companies, and the used ways. The authors considered a group of individual and professional predictors of the scientist´s interactions with the private sector, including funding sources, institutional affiliations with research centers, peer and student collaboration, status, academic discipline and demographic attributes, such as gender, race, age and scientific values. According to Boardman & Ponomariov (2009), gender influence the diverse types of interaction with the industry. Specifically, male scientists are more likely to be formal consultants receiving a payment; as wells as to position graduate students in industry jobs, and of being an entrepreneur (as owner or as a partner in a company), and to commercialize its research with the company personnel. On age, the old scientists are less prone to have approaches with private enterprises to request information but is more likely that they have worked with industry personnel generating patents and coauthoring papers. On the other hand, young scientists tend to socialize in an environment in which increase the closer relations between university and industry.

Giuliani et al. (2010) applied a survey to researchers of Piedmont Italy, Chile and South Africa. Their researchers focus on wine issues and diverse disciplines as viticulture, enology, agronomy, microbiology, genetics, chemistry and engineering. The authors emphasize the importance of the researcher´s individual characteristics and of the institutional environment to explain the propensity towards the commitment in different types of university-industry relation. They identified some factors that influence in the likelihood of interactions between researchers and industry, within which stand out the following: researcher demographic characteristics (age and gender); researchers education characteristics (degree); and academic reputation effects (status and scientific production). They found that demographic characteristics, such as age and gender, are linked to the researcher´s propensity to establish university-industry relations; while the degree background, status, and publications performance appear to have not influence in that relation. For this, the authors have two explanations: first, the education, status and publications are not perceived or have a superficial value for industry professionals; second, is possible that professionals with a higher academic degree and high scientific quality do not engage with applied research projects guided to solve practical problems relevant to the industry. Regarding to the age, younger professors tend to establish more university-industry linkage compared to older colleagues. Another interesting find is that women have a high propensity to establish relations with industry. The authors mention that a work environment that promotes the university-industry relations perhaps acts as a detonator of the women researchers capacities to engage with industry.

According to De Fuentes & Dutrénit (2012), the main characteristics of researchers that promote long-term benefits to enterprises are related to the institutional and individual characteristics, such as field of knowledge, education degree, research equipment size and acquisition of public funding to the research.

2.5 Innovation.

According to the Organisation for Economic Cooperation and Development (OECD), ¨the innovation is the introduction of a product (good or service) or a process, new or significantly improved, or the introduction of an organization or commercialization method, newly applied to the business practices, to the work organization or the external relations¨ (OCDE, 2005, p.56). For the academy context, the innovation process ¨is to use scientific techniques to know and define the problems that affect the cost and quality; is to apply the developed knowledges, scientific knowledge, to do something to resolve the problem, an existing problem or a necessity, innovation means that is new that does not exist before¨ (Casas, 2003, p. 349).

Based on Chesbrough (2003), the enterprises had a change in their conception about innovation; the author name this as closed innovation model and open innovation model. Such change consists in how business generates new ideas and bring them to market. In the closed innovation model, firms have this philosophy: successful innovation requires control. Which means, companies have to generate their ideas that subsequently will be in conditions to develop, manufacture, sell, distribute and service themselves. For years, closed innovation is understand as the right way to bring new ideas. Firms invested more in research and internal development, compared with their competitors. This enables them to reap most of the benefits, which they protected their intellectual property to prevent competitors from exploiting it. As a result, they could reinvest their profits in more research and development, which subsequently enable them progress, creating a virtuous cycle of innovation. Towards the end of the 20th century, a combination of factors started to generate a negative impact in the closed innovation model in the United States. One of these factors was the dramatic rise in the number and mobility of knowledge workers, making it difficult for companies to control their proprietary ideas and expertise.

This enables the change to the open innovation model, in which the companies commercialize external ideas (as well as internal) through the implementation of external ways (as well as in-house) to market. The ideas can originate outside of the firm´s labs and be brought inside to its commercialization; with this the University gained significant contribution and played an important role in the open innovation model.

In the open innovation context, the universities have a crucial role since they are institutions that cooperate and share knowledge with other organizations in knowledge transfer exchange processes. The researchers as part of universities, are involved in the technology transfers interchange processes, and for that reason, are ultimate elements. Consequently, is important to understand which factors influence the researcher´s commitment in the open innovation context (Padilla & Garrido, 2012).

3. Research Aim.

The purpose of this study is to develop a framework integrated by a group of variables identified in previous studies of university-industry collaboration and technology transfer. The independent variables identified are the following: Institutional Factors, Academic Profile, and Innovation.

The specific objectives of this study are the following:

Objective 1. Identify in the literature review the factors involved in the independent´s variables.

Objective 2. Develop a framework for university-industry technology transfer in a public university of Mexico.

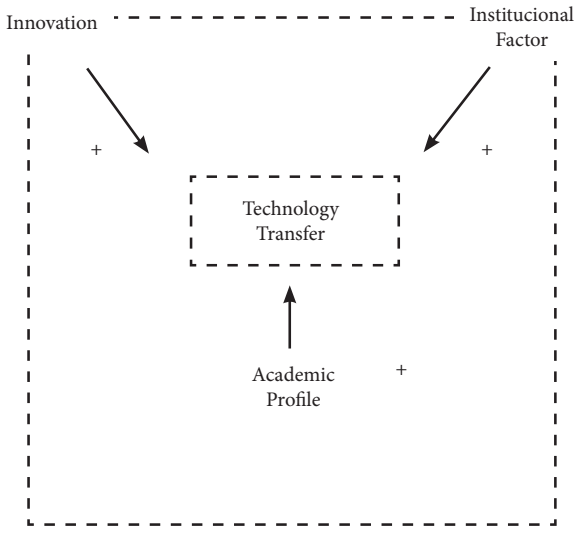
4. Research Methodology.

This study basis on significant findings obtained in previous studies of university-industry collaboration and technology transfer. For that reason, and with the purpose of identifying the independent variables with their dimensions and indicators, has been developed a framework that could explain the university-industry collaboration and technology transfer in a context of a public university of Mexico.

5. University-Industry Technology Transfer Conceptual Framework.

This section presents the university-industry technology transfer framework and the dimensions and indicators of the independent variables (Institutional Factors, Researcher Profile, and Innovation). The authors of this study consider that the Institutional factors, Academic Profile, and Innovation determine the University-Industry Technology Transfer. Is outstanding to mention that based on the literature review, this paper refers to university collaboration/linkage and technology transfer to another different context, as university-industry or university/productive sector collaboration/relation/technology transfer.

Figure 1. A Framework for University-Industry Collaboration and Technology Transfer.



Source: Own elaboration.

Table 1. Dimensions and indicators proposed to the Institutional Factors independent variable.

Independent Variable No.1	Dimension	Indicator	Author
Institutional Factors	Technology Transfer Office (TTO)	Perception about the TTO. -Information about the TTO functions. -TTO efficacy and efficiency -Business and marketing TTO experience -Use of the TTO.	Wu et al. (2015); Díaz (2014); Rubio (2014); Padilla & Garrido (2012); Harman (2010); D´Este et al. (2009); Link, Siegel & Bozeman (2007); Siegel et al. (2003).
	Linkage activities planning	Perception about the linkage activities orientation. -Technological and innovative activities mentioned in the university Institutional Development Planning. -Impact of the linkage activities.	Díaz (2014); Rubio (2014); White & Bruton (2011)
	Diffusion of Technological Development Projects	Perception about the technological development projects diffusion -Diffusion efficiency	White & Bruton (2011)
	Incentives	Incentive perceptions -Incentive types -Incentive evaluations	Díaz (2014); Padilla & Garrido (2012); White & Bruton (2011); Cabrero et al. (2011); Caldera & Debande (2010); Link, Siegel & Bozeman (2007); Bercovitz & Feldmann (2006); Debackere & Veugelers, (2005); O´Shea et al. (2005)
	Intellectual Property	Researcher´s perception about the intellectual property management support. -Identification of the commercial value -Discoveries management	Rubio (2014)

Source: Own elaboration.

As is mentioned by Lizardi & Velázquez (2010) the technological knowledge resides in the human capital involve in a science and academic context; for that reason in technological change and innovation, is relevant to know how professors and researchers perceive the Institutional Factors. It infers that a positive perception of the management of this factors, could influence positively in the linkage and technology transfers activities of the professors and scientists.

Some authors emphasize in the TTO role in the university, the indicator of perception of TTO suggest determining if the professor or researcher is informed about the TTO functions and how is perceived its performance. The dimension of linkage activities planning, attempt to know how the academics notice the university efforts are in linkage activities planning; the same occurs with the Diffusion of Technological Development Projects. A factor mentioned by different authors is the incentives, for that reason is interesting to know the type of incentives (additional payment per project, scholarships, among others) that professors and researchers are obtaining with this activities and how do they perceive the evaluation to gain access to them. The research results of some researchers suggest the intellectual property management support; therefore, is considered significant to explore what is the professors and researchers perception about the university support in this field (Table 1).

Table 2. Dimensions and indicators proposed to the Academic Profile independent variable.

Independent variable No.2	Dimension	Indicator	Author
Academic profile	Individual characteristics	-Age -Gender -Degree	Callaert et al. (2015); Rivera et al. (2011); Giuliani et al. (2010); Boardman & Ponomariov, (2009); D´Este & Patel, (2007)
	Professional characteristics	-Seniority -Status -Faculty	Shubert et al. (2014); Boardman & Ponomariov, (2009); D´Este & Patel, (2007)
	Research Project	-Project area -Project registration category -Economic sector -Organization type -Organization size -Project scope -Project management channel	Callaert et al. (2015); Shubert et al. (2014); Rivera et al. (2011); Boardman y Ponomariov, (2009); Luna & Velasco (2003); Meagher (2003); Casas (2003).

Source: Own elaboration.

In respect of the researcher profile, is interesting to determine if in the context of a Mexican public university, characteristics such as age, gender and degree influence their activities of linkage and technology transfer. Also, the type of projects in which they tend to engage with other institutions. The project area refers the field of knowledge in which the professor/researcher is involved. Additionally, the project registration category allows knowing if the project guided by a researcher or a group of researchers. With the economic sector can be identified if the user is from the primary, secondary or tertiary sector; the same occurs with the organization type, due to can be a public entity, a private entity (national or foreign) or Higher Education Institution. Other important indicators are the project scope (local, regional, national or international) and project management channel, that the University offers, requested by the user or that the researcher searched for the user (Table 2).

Table 3. Dimensions and indicators proposed to the Innovation independent variable.

Independent variable No.3	Dimension	Indicator	Author
Innovation	Projects with productive sector	Innovation type -Product -Process -Organizational -Marketing	OCDE (2005)
		Innovation source	Sabato & Botana (1968); Drucker (1985)

Source: Own elaboration.

The innovation variable suggest to explore the type of innovation projects in which the professors and researchers have participated, also the source of this innovation, such as search of customer's needs, internal processes needs, market changes needs and regional development needs (Table 3).

Table 4. Dimensions and indicators proposed to the Technology transfer dependent variable.

Dependent variable	Dimension	Indicator	Author
Technology transfer	Professor and researcher perceptions	-Barriers -Benefits	Díaz (2014); Rubio (2014); Debackere & Veugelers (2005); Luna & Velasco (2003); Meagher (2003); Casas (2003); Siegel et al. (2003)
	Research project result	-Type of result	Rivera et al. (2011)
	Linkage and technology transfer background	-Activity type -Contact channel	Lizardi & Velázquez (2010); D´Este & Patel (2007)

Source: Own elaboration.

In relation to the technology transfer variable, is important to explore the professor and researcher perceptions, as the barriers (link between project members; funding resources scarcity, excess of procedures; time; technical aspects; geographic distance and academic and industry personnel differences of training) and benefits (to obtain ideas for new projects; to accomplish ideas for more research; information/knowledge exchange; reputation; equipment and instruments exchange; publications; additional payment; funding for graduate and postdoctoral students) that can promote or hinder their propensity to engage in collaboration research projects. Also is important to identify the activity type in which tend to involve, to characterize according to the field of knowledge; and the type of result obtained with the research as an intellectual property registration (Table 4).

5. Conclusions

In recent years the knowledge and scientific research has been seen strategically for government and higher education institutions. In the university context, has increased the interest and necessity to generate research projects with significant potential to be transferred to different users, such as industry, government, and society in general. Therefore, the university conceived as an entity with human capital in the knowledge frontier, have to explore the factors that determine the university-industry collaboration and technology transfer to improve the institutional environment and to achieve the research results transfer.

The framework proposed, can be used as a basis to develop a measurement instrument in a future study; and explain the relation between the Institutional Factors, Researcher Profile, Innovation and the Technology Transfer in the context of a public university in Mexico. In this study the researcher´s perceptions, experiences, and characteristics play an important role understanding their position in the innovation and technological change.

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Global Organization of Innovation and Cooperability in Brazilian Multinationals

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Abstract: Understanding the dissipation of innovations is necessary to develop them, as a company on its own does not have all the capabilities that it needs. On the contrary, they are increasingly spread over internal and external contexts, and are not developed in isolation. Most of the time, they depend on interactive, innovative processes in a global context. The aim of this study is to evaluate how the global organizational structure of innovation affects the dynamic capability of cooperation (cooperability) in Brazilian multinationals (BMNs). To achieve this goal, we conducted a survey of BMNs, and a final sample of 60 companies answered a structured questionnaire. We performed statistical tests such as Factor Analysis, Cronbach's Alpha, Multiple Regression and Hierarchical Cluster, and cross-analysis of quantitative results that enabled us to create a Cooperability Model, that is, a model of local, international and global development for a dynamic capability of cooperation in BMNs. The results show that technological strengths of foreign subsidiaries and the reverse transfer of their capabilities to the parent company and technology partners affect the dynamics of cooperation in BMNs (inputs and results of cooperability). Furthermore, we detected an inverse relationship between the autonomy of foreign subsidiaries and the dynamic of cooperation in BMNs.

Keywords: Cooperability; Innovation; Dynamic Capability; Brazilian Multinationals.

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1. Introduction

In recent years, markets have become more and more dynamic, and new forms of competition have appeared. Therefore, companies have to adapt to the new landscape, explore changes in their business environments, and seek opportunities to devise new technological and strategic cycles (McMahon and Thorsteinsdóttir, 2013; Teece, 2007). Experiencing and exploring changes is a challenge that companies face to remain operational. Nevertheless, to survive and succeed under changing conditions, companies must develop dynamic capabilities to create, expand and modify the ways in which they survive (Hanaki et al., 2010; Helfat et al., 2009).

To develop dynamic capabilities, especially those related to innovation, it is necessary to understand how they are distributed (Hanaki et al., 2010). This means that a company on its own does not have all the capabilities it requires, as it is increasingly common to find spread over internal and external business environments. They do not develop in isolation and usually depend on innovative processes that interact globally (Helfat et al., 2009).

The current challenge does not rely exclusively on generating product and process innovation locally, but on building dynamic capabilities to create innovative solutions and new business models on local and global scales. In this sense, the competitive challenge of cooperability (i.e., the intentional capability of dynamically developing cooperative projects in which partners create and share technological and innovative resources in local and/or global contexts) is the sustainable creation of competitive advantages of innovation that are distinct and difficult to replicate. Hence, dynamic capabilities are particularly important since the current stock of resources is less important than the capacity to accumulate and combine new resources both internally and externally – mainly if these interactions can contribute to building singular skills in R&D, new product development, technological innovation and others (Doz et al., 2001).

Cooperability is a challenging and complex process for multinationals from emerging economies since they are usually newcomers and compete against multinationals from advanced economies that already dominate global markets. Therefore, unlike the incumbents, new multinationals must develop and systematize global innovation, including the reverse transfer of capabilities from foreign subsidiaries to headquarters and technological partners, and give them autonomy to develop their scientific attributes.

It should be emphasized that recent discussions have highlighted academic challenges regarding the organizational arrangements established by multinationals and their subsidiaries and external partners, including technological agility, responsiveness, load-balancing innovation and efficiency, environmental sensitivity and, specifically, the sharp increase in cooperation. This shows a trend of involvement between actors with unique skills that are shifting the locus of work previously defined as the core of the company (such as innovation) outside its borders (Gulati; Puranam & Tushman, 2012). Thus, the theoretical gap is concerned with scientific discussions and the development of analytic models on the importance of cross-border

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coordination. This is because organizational structure theories tend to emphasize intrafirm dimensions and formal authority (Gulati; Puranam & Tushman, 2012), in other words, dimensions that are discrete or foolishly absent in contexts of close collaboration between companies that are often geographically far apart and formally independent.

This article aims (a) to check whether the reverse transfer of capabilities from foreign subsidiaries to headquarters and technological partners affects cooperation in BMNs; (b) to determine if there is a connection between the autonomy of foreign subsidiaries and cooperation in BMNs; (c) to analyse if technological attributes of foreign subsidiaries determine the dynamic capability of cooperation in BMNs, and finally (d) to propose a model for the dynamics of cooperation in BMNs.

This article is relevant because of its empirical contributions to the theme of dynamic capabilities of cooperation and their association with the reverse transfer of capabilities between subsidiary and headquarters, the autonomy of foreign subsidiaries and their technological competence. The present article validates a multidimensional construct for cooperability. It is also worth noting that 60 BMNs showed interest in taking part in this research. However, the sample represents 82% of the universe of these companies.

2. Relational Capabilities and Globalization of Innovation

Relational capabilities are the ones involved in the deliberate setting of interaction networks intended to accumulate and refine the company's resource base (Lorenzoni and Lipparini, 1999; Dyer and Kale, 2007; Schilke and Goerzen, 2010). They comprise technical and interpersonal skills necessary to manage the general alliancing process efficiently. They range from recognition of cooperation opportunities to evaluation and internalization of results in a continuous learning process and preferably formalized in a function/area, including procedure definition and coding related to implantation and process execution.

Developing relational capabilities is only possible by forming alliances focused on learning and achieving future returns. To manage an alliance network effectively, a company must acquire practical experience in this activity. Consequently, the company could develop terms of trade (access and transfer of knowledge and skills), choose a suitable governance structure for each alliance and extract value from internalized knowledge, among other competences (Dyer and Kale, 2007; Lorenzoni and Lipparini, 1999; Wuyts and Dutta, 2014). These capabilities create value due to the (Helfat et al., 2009; Schilke and Goerzen, 2010): (a) creation of assets inherent to these partnerships; (b) mutual access to complementary resources; (c) existence of a routinely substantial transfer of knowledge between partners; and (d) efficient governance mechanisms that can limit transaction costs between stakeholders (Table 1).

Relational capabilities require systematic actions not only through the careful selection of alliances but also through making investments and outlining deliberate cooperation strategies with external sources (Schilke and Goerzen, 2010). Moreover, the development of relational capabilities depends on a management process that involves (Leischnig et al., 2014): (a) efficient prospection of allies to ensure the effective interest during the partnership; (b) active contribution from partners; (c) setting a quality project management; (d) adjusting the objectives of stakeholders; (e) effective communication throughout the cooperation process; and (f) monitoring the alliance.

Within the context of relational capabilities, multinationals can be understood as coordinated systems or networks that 'create' value activities. Some of these activities are conducted within the hierarchy of the company and others through contracts and social relationships (Doz et al., 2001; Gibbons and Henderson, 2012). In this sense, a multinational cannot be defined only by the extension of its foreign production premises but by the sum of all of its internal and external activities that aggregate value (Andersson et al., 2007; Zaheer and Hernandez, 2011). As a result, multinationals are turning their structures into open and flexible networks with subsidiaries that generate and share knowledge in local and global contexts (Cantwell et al., 2010; Zohdi et al., 2013). Such structures require multinationals to disseminate and institutionalize the management process of cooperation relationships to create and continuously integrate the knowledge developed at headquarters, subsidiaries and alliances, both in local and global contexts (Dunning and Lundan, 2010; McMahon and Thorsteinsdóttir, 2013).

Table 1. Relational Capacity elements that create value.

Elements of Relational capacity to generate value	Description
Creation of specific assets for the partnership	Companies create stronger relational skills when they find technological opportunities and highly complementary strategic partners. It should be noted that companies can improve the chances of identifying additional partners through continuous prospecting and classification of new partners and the use of monitoring and evaluation of current ones. Reputation and previous experience play an important role in this assessment. Moreover, interdependence between partners is necessary to provide incentives for cooperation. A high level of dependence appears to be of particular importance, especially when tacit knowledge is involved in the cooperation project. Thus, the interdependence between partners should be considered by the partner in planning a cooperative project.
Mutual access to complementary resources	Enables the development and combination of appropriate structures to the relationship and the actors involved. Note also that the creation of specific assets requires time and systematic investment in the partnership and the partner institutions need to increase their specific assets to make the most of their relationships. Asset specificity may occur in several ways, including local specificity, specialization of physical asset, and human asset specificity. Human co-expertise allows partners to work together more efficiently and effectively, reducing communication errors and improving the quality of the outcome of the relationship.

Substantial flow of knowledge transfer between partners	Refers to the existence of a regular model of interaction at business level, enabling the transfer, recombination or creation of knowledge. Effective knowledge transfer processes between the company and its partners need to be developed and then institutionalized. The ability of a company to absorb knowledge from the partner depends on prior knowledge or "absorptive capacity", which constitutes the ability of a company when it comes to organizing and assimilating new knowledge, and then applying it for commercial purposes.
Effective governance mechanisms	Adoption of contracts or ownership structures that effectively protect each partner's opportunistic behavior. Formal agreements must protect the interests of each side, so there will be a higher probability of relations based on equality, given the existence of high levels of asset specificity on each side. The new element of effective governance assigned stands for the importance of informal measures to protect the interests of each side against opportunism. The relationship between evidence suppliers in Japan has shown high levels of effectiveness of the "trust and reputation" elements to control of opportunistic behavior.

Source: Gibbons and Henderson (2012), Helfat et al. (2009), Leischnig et al., 2014, Petruzzelli (2011), Schilke and Goerzen, 2010, and Wuyts and Dutta (2014).

In response to the increasing need to balance the pressures of global integration and local responsiveness, foreign subsidiaries should play a prominent role in creating knowledge that is valuable to the MNE (multinational enterprise) as a whole (Rabbiosi, 2011; Zaheer and Hernandez, 2011). Teece (2014) claims that the proper integration of the R&D units of a MNE may result not only in new products but also in organizational dynamic capabilities. Ester et al. (2010) argue that R&D internationalization has a positive influence on the development of dynamic capabilities.

According to Rabbiosi (2011) one of the principal managerial problems in MNEs is the balance between coordination mechanisms and knowledge transfers from subsidiaries to the parent company (known as reverse knowledge transfer) (Yang et al., 2008). The implementation of coordinating instruments in the parent company-subsidiary relationship, such as the decentralization of decision-making processes and communication mechanisms must be seen as a prior and fundamental element for reverse knowledge transfer (Rabbiosi, 2011). In this regard, a consensus has been reached in the literature as to the elements that could define global coordination and integration of subsidiaries. They include knowledge assets transfer, autonomy of the subsidiary and role of the subsidiary (Ambos and Schlegelmilch, 2007; Noorderhaven and Harzing, 2009; Keupp et al., 2011).

The transfer of knowledge assets is closely related to the appearance of a shared global knowledge base that creates mutuality and regular knowledge transfer among subsidiaries. Knowledge assets encompass information, know-how, practices, capabilities, technology and products (Yang et al., 2008) that when transferred can stimulate the development of skills that affect the subsidiary's performance (Mudambi and Navarra, 2004). Subsidiaries, in turn, can increase their bargaining and strategic influence power within the business network of a multinational. For that reason, understanding the following scenario is of great importance: does the reverse transfer of capabilities from foreign subsidiaries to headquarters affect a multinational's dynamic capability of cooperation, especially in the case of Brazilian multinationals? Thus, the following null hypothesis (H_{01}) is formulated: *(H_{01}) Reverse transfer of capabilities from foreign subsidiaries to the headquarters and technological partners does not affect the dynamic capability of cooperation in BMNs.*

The autonomy of the subsidiary is subdivided into two distinct categories: strategic and operational. Strategic autonomy is the capacity of a subsidiary to define its own agenda, whereas operational autonomy is the capacity of a subsidiary to manage the activities previously designated by the corporation (Nobel and Birkinshaw, 1998).

Authors such as Ambos and Schlegelmilch (2007) and Keupp et al. (2011) claim that strategic autonomy will negatively influence the performance of a subsidiary for two reasons. First, because the integration of highly independent subsidiaries tends to be smaller due to the coordination difficulties and this leads to the isolation of such subsidiaries. Second, resources of independent subsidiaries are likely to be less compatible with the stock of resources of the multinational's business network. Therefore, additional incentives and investments tend to be more controlled, which negatively affects the bargaining power and performance of the subsidiary (Zaheer and Hernandez, 2011).

The level of operational autonomy of a subsidiary reflects on the reach and extension of tasks set by the corporation. Subsidiaries with operational autonomy can take their own decisions regarding cooperation with external companies and other organizations. By doing so, they promote recognition and proper use of resources available through local innovation systems. Thus, the more operational autonomy a subsidiary has, the greater its ability to explore external innovation sources and improve both its resource base and performance. According to Teece (2014, p.26), "it is important to recognize that once a MNE creates a subsidiary that establishes its own networks and learning path, the subsidiary can accumulate specific assets and capabilities that can find useful application elsewhere". Operational autonomy must also offer the opportunity for subsidiaries to address problems creatively and stimulate creativity and organizational innovation (Ambos and Schlegelmilch, 2007), which leads us to formulate the following null hypothesis (H_{02}): *(H_{02}) There is no link between the autonomy of foreign subsidiaries and the dynamic capability of cooperation in BMNs.*

When a subsidiary's role is strategically set by the multinational company, it is implied that it will perform certain activities on behalf of the corporation as a whole. As a result, responsibilities will have international rather than local implications. By performing activities with an international impact, a subsidiary can receive additional

investments (Zaheer and Hernandez, 2011) and develop skills that are difficult to replicate. That will positively affect its bargaining power and performance (Mudambi and Navarra, 2004). Therefore, to understand whether the technological attributes of foreign subsidiaries define the dynamic capability of cooperation in a multinational, we formulated the following null hypothesis (H_{03}: *(H_{03}) Technological attributes of foreign subsidiaries do not determine the dynamic capability of cooperation in BMNs.*

Finally, there is the challenge of seeking full development of cooperation in companies from the institutionalization and management of relational capacity at headquarters and branches in a systematic and synergistic manner. For this purpose, we present a model of innovation that makes continuous use of internal and external sources of ideas and local and global knowledge, involving the transfer of resources, autonomy, technological attributes and overall structure of R&D activities.

3. Research Methodology

We conducted a survey with 166 BMNs from industry, commerce and service sectors. All of them have production or commercial units overseas. We classified them to suit the scope of this study. We then identified which BMNs actually had international R&D units or developed cooperative projects with foreign universities and research institutes in the last three years. This resulted in 73 BMNs that have internationalized their internal activities or R&D cooperatives. Of these, 60 BMNs were interested in taking part in the research. However, the sample represents 82% of the universe of these companies.

A structured questionnaire was applied to collect data from the sample of 60 BMNs. A 6-point Likert scale was used to obtain the opinions of the respondents regarding elements that define cooperation locally and globally. The questionnaire was made available both online and in .doc format to R&D or Innovation executives and coordinators at their companies' headquarters. The data were analysed using bivariate and multivariate statistical techniques, processed by version 20.0 of SPSS software (Statistical Package for Social Sciences). Main Component, Cronbach's Alpha (Cronbach, 1951), Multiple Regression and Hierarchical Cluster statistical tests were used (Hair et al., 2005). Table 2, below, describes the dependent and independent variables used in the statistical tests and the research hypotheses.

Table 2. Variables and research hypotheses.

Description of variables	Operating description	Research Hypotheses
Global organization of innovation: addresses the configuration of autonomy and technological attributes of foreign subsidiaries, as well as the reverse transfer of capabilities.	Reverse transfer of capabilities*: the level of occurrence concerning reverse transfer of capabilities in the last three years. It includes the transfer of technological capabilities from foreign subsidiaries to cooperative R&D projects, involving headquarters and technological partners.	H_{01}: Reverse transfer of capabilities from foreign subsidiaries to headquarters and technological partners does not affect the dynamic capability of cooperation in BMNs. H_{02}: There is no link between the autonomy of foreign subsidiaries and the dynamic capability of cooperation in BMNs. H_{03}: Technological attributes of foreign subsidiaries do not define the dynamic capability of cooperation in BMNs.
	Autonomy of foreign subsidiaries*: the level of frequency given to the autonomy of subsidiaries in the last three years, regarding decisions on the development of cooperative R&D projects.	
	Technological attributes of foreign subsidiaries*: the level of frequency in which foreign subsidiaries used internal and/or cooperative technological attributes in the last three years, considering cooperative R&D projects.	
Cooperability: the dynamic capability of cooperation. These capabilities range from the identification of opportunities to form partnerships to the definition and encoding of procedures related to their implementation and management and the evaluation and internalization of their results, in a continuous learning process that is preferentially formalized in a function/area of the firm.	Cooperability inputs**: conditional elements of the dynamic capability of cooperation; i.e., the level of frequency in which formal and systematic managerial processes are used during the development of cooperative R&D projects involving headquarters, subsidiaries and technological partners.	
	Cooperability results**: technological and managerial indicators of dynamic capability of cooperation, i.e., the level of frequency in which results were reached in the last three years, considering cooperative R&D projects.	

Key to table: * Independent variables, **Dependent variables.

4. Results

In this study, 75% of the BMNs are industries, while 23% stand for service providers and only 4% are commercial companies. Moreover, we found that 52.5% employ over 500 people. As to the nature of technology partners of the BMNs, we observed that domestic clients (32.5%) were more relevant regarding innovations, along with Brazilian Universities and Research Institutes (30%). This is evidence that companies still use traditional sources of innovation entailing cooperation mechanisms that may have already been institutionalized.

To obtain a better fit for the regression models, we previously conducted the factor analysis of dependent and independent variables. We detected three factors (Table 3) that explain 82% of the variance of the responses on the independent variable of the global organization of innovation with 1% significance. We arrived at the following classification: (Factor 1) reverse transfer of capabilities; (Factor 2) autonomy of foreign subsidiaries; and (Factor 3) technological duties of foreign subsidiaries.

The highest degree of explanation is for Factor 3 (50%), i.e., the degree of frequency which foreign subsidiaries have been developing internal R&D activities in the past three years, considering cooperative R&D projects. Factor 1 refers to the occurrence of reverse transfer of capabilities in the last three years, including the transfer of technological capabilities of foreign subsidiaries for cooperative R&D projects, involving headquarters and technology partners. Factor 2 stands for the frequency which autonomy was granted to foreign subsidiaries in the last three years regarding the decisions involved in the development of cooperative projects of R&D with the same degree of explanation (16%) (Table 3).

Table 3. Factors of the global organization of innovation.

Factors *	Factor loading	Cumulative variance explained
Factor 1: Reverse transfer of training		**16%**
Performance of the subsidiaries as suppliers of technological capabilities	0.894	
Performance of the subsidiaries as integrators of technological capabilities	0.843	
Leading performance of subsidiaries in certain technological capabilities	0.782	
Factor 2: Autonomy of foreign subsidiaries		**32%**
Purchasing foreign technologies	0.721	
Hiring specialized consultants in R&D and innovation	0.897	
Creating internal teams focused on the development of R&D and other innovative activities	0.886	
Training and continuous training of R&D staff	0.858	
Investment in companies with promising technologies or with the potential to generate them	0.778	
Know-how exchange with trading partners	0.734	
Shared technological development with universities and research institutes	0.739	
Acquisition of start-ups to optimize the efforts in R&D and innovation	0.715	
Creation of spin-offs to disseminate technological skills	0.708	
Licensing patents to the market	0.701	
Factor 3: Technological duties of foreign subsidiaries		**82%**
Prospecting for scientific and technological trends	0.945	
Definition of R&D scope	0.904	
Selection of technology partners, including universities and research institutes	0.874	
Conducting research activities	0.851	
Carrying out development activities	0.821	
Non-routine engineering	0.748	
Customization of products and processes	0.735	
Project portfolio management	0.726	

Key to table: *KMO = 0.730; Chi-square = 841,651; p = 1%.

Table 4. Factors of Cooperability.

Factors *	Factor loading	Cumulative variance explained
Factor 1: Cooperability results		**34%**
Generating new knowledge	0.962	
Generating new products and processes	0.958	
Generating new marketing methods	0.877	
Generating new organizational methods	0.826	
Emergence of new technologies	0.809	
Patent applications deposit	0.785	
Software registration deposit	0.761	
Trade mark registration application	0.745	
Licensing technologies	0.738	
Emergence of new business	0.732	
Factor 2: Cooperability inputs		**85%**
Adoption of decision criteria	0.878	
Planning	0.846	
Monitoring	0.805	
Knowledge management	0.794	
Evaluation	0.768	
Meeting deadlines and budgets	0.757	
Achievement of objectives	0.721	

Key to table: *KMO = 0.908; Chi-square = 875.319; p = 1%.

In Table 4, it is clear that two factors explain 85% of the variance of the responses over the dependent variable of cooperability with 1% significance. Cooperability Results explain (Factor 1) and Inputs of cooperability account for (Factor 2). The highest degree of explanation is related to Factor 2 (51%) followed by Factor 1 (34%).

Factor 1 refers to the technological and managerial indicators of the dynamics of cooperation, i.e., the frequency by which the results were achieved in the last three years, considering cooperative R&D projects. Factor 2 refers to the conditional elements of the dynamics of cooperation, i.e., the frequency by which a formal and systematic management process is adopted during the development of cooperative R&D projects, involving the parent company, subsidiaries and technology partners (Table 4).

The Cronbach's Alpha coefficients were higher than 80%, suggesting that compound variables can be explained by the set of categories from which they are made (Table 5).

Table 5. Cronbach's Alpha coefficient.

Nature of the variable	Composite variables considered in the research model	Coefficient
Independent variables of global organization of innovation	Reverse transfer of capabilities*	0.87
	Autonomy of foreign subsidiaries*	0.89
	Technological attributes of foreign subsidiaries*	0.91
Cooperability-dependent variables	Cooperability inputs*	0.96
	Results of cooperability*	0.97

Key to table: *Likert scale variables: 1 = low frequency; 7 = high frequency

Initially, it is worth mentioning that the prerequisites of the regressions generated were seen as indicating the tests of normality (*Kolmogorov-Smirnov and Shapiro-Wilk)* and tests of collinearity (VIF) presented in tables 6 and 7.

The coefficients presented in Tables 6 and 7 show the explanatory power of independent variables through factor analysis (Reverse transfer of capabilities, Autonomy of foreign subsidiaries, Technological attributes of foreign subsidiaries, as they have an explanatory level of 82% as seen in Table 3) over dependent variables (Cooperability inputs and results, since they present an explanatory level of 85% as seen in Table 4). For the regressions conducted after the multicollinearity test (regression 1) we obtained an adjusted R-squared of 95% for cooperability inputs (Table 6) and 94% for the results of cooperability (Table 7). We specifically found that reverse transfer of capabilities from foreign subsidiaries to the parent company and technology partners affects the dynamic capability of cooperation in BMNs, with 10% significance for inputs and results of cooperability (Tables 6 and 7). Therefore, hypothesis H_{01} was rejected.

Table 6. Regression results considering cooperability inputs as dependent.

Y1 (dependent variable) = COOPERABILITY INPUTS			
Independents	Operational definitions of variables and factors	After multicollinearity test	
Constant		Coefficients	VIF
		0.741	-
Independent variables of global organization of innovation	X1 = Reverse transfer of capabilities	0.430***	1.412
	X2 = Autonomy of foreign subsidiaries	-1.582**	1.015
	X3 = Technological attributes of foreign subsidiaries	0.957**	1.326
Adjusted R-square		0.950	
Kolmogorov-Smirnov		0.155*	
Shapiro-Wilk		0.979*	

Key to table: *p 1%; **p 5%; ***p 10%.

Table 7. Regression results considering results of cooperability as dependent.

Y1 (dependent variable) = COOPERABILITY RESULTS			
Independents	Operational definitions of variables and factors	After multicollinearity test	
Constant		Coefficients	VIF
		1.857	-
Independent variables of global organization of innovation	X1 = Reverse transfer of capabilities	0.503***	1.456
	X2 = Autonomy of foreign subsidiaries	-1.384**	1.059
	X3 = Technological attributes of foreign subsidiaries	0.976**	1.240
Adjusted R-squared		0.947	
Kolmogorov-Smirnov		0.163*	
Shapiro-Wilk		0.968*	

Key to table: *p 1%; **p 5%; ***p 10%.

The autonomy of foreign subsidiaries proved to be relevant for both inputs and results of cooperability, with 5% significance (Tables 6 and 7). Thus hypothesis $H_{02.}$ was rejected. Nevertheless, we found a negative correlation, which proved that the greater the autonomy of a foreign subsidiary the lower the frequency of results that translate the managerial and technological efficiency of cooperative R&D projects involving headquarters, subsidiaries and technology partners. Technological attributes also proved to be relevant for both inputs and results of cooperability, with 5% significance (Tables 6 and 7). Thus, hypothesis H_{03} was rejected.

As for cluster analysis (Tables 8 and 9), we observed the formation of three different groupings. Cluster 1 has 33 companies (55%), of which 60% are industries, 72% have up to or over 500 employees and 65% consider domestic clients to be their most relevant external technology partners (Pearson chi-squared = 10.219; α = 0.047; significant at 5%). Cluster 2 includes 15 companies (25%), 60% being service providers, 70% having between 100 to 499 employees and 55% considering international suppliers to be their most relevant technology partners, (Pearson qui-square = 9,173; α = 0,032; significant at 5%).

Cluster 3, in turn, contains 12 companies (20%). 74% are industries, 60% have over 500 employees and 65% consider domestic and international universities and research institutes to be their most relevant technology partners (Pearson's qui-squared = 8.265; α = 0.028; significant at 5%).

The results shown in Table 9 must be emphasized, as the t test results indicate a difference between representative BMNs in the clusters, suggesting that the variables considered discriminate the global organization of innovation and the dynamic capability of cooperation in each group.

Cluster 1 represents large industrial companies with domestic clients as their principal technology partners. They account for BMNs with a high degree of application of cooperability related managerial inputs, and they transfer capabilities from foreign subsidiaries to parent companies at a medium frequency. Despite achieving average managerial and technological results when it comes to cooperability, granting autonomy and delegation of technological attributes to foreign subsidiaries, the frequency remains low (Tables 8 and 9).

Table 8. Cluster Analysis.

Clusters		Variables	Averages
1 = 33	Global organization of innovation	Reverse transfer of capabilities	3.28
		Autonomy of foreign subsidiaries	1.75
		Technological attributes of foreign subsidiaries	1.04
	Cooperability	Cooperability inputs	**5.37**
		Results of cooperability	3.56
2 = 15	Global organization of innovation	Reverse transfer of capabilities	1.26
		Autonomy of foreign subsidiaries	**5.63**
		Technological attributes of foreign subsidiaries	3.36
	Cooperability	Cooperability inputs	2.25
		Results of cooperability	2.32
3 = 12	Global organization of innovation	Reverse transfer of capabilities	**5.32**
		Autonomy of foreign subsidiaries	4.21
		Technological attributes of foreign subsidiaries	**5.68**
	Cooperability	Cooperability inputs	4.08
		Results of cooperability	**4.85**

Cluster 2 encompasses medium service-provider BMNs with international suppliers as their most important technology partners. These BMNs grant autonomy to foreign subsidiaries at a high frequency, and delegate technological attributes to foreign subsidiaries at a medium frequency. Even so, despite the distinction between autonomy and technological attributes aimed at foreign subsidiaries, we argue that these BMNs still present a low frequency of applications for managerial inputs and technological and managerial results (Tables 8 and 9).

Cluster 3 includes large industrial companies with domestic and international universities and research institutes as their most important technology partners. They have a high frequency of managerial and technological results due to cooperability. Moreover, they are capable of promoting the reverse transfer of capabilities and delegating technological attributes to foreign subsidiaries at a high frequency. These BMNs grant autonomy to foreign subsidiaries and apply cooperability related managerial inputs at a medium frequency (Tables 8 and 9).

Table 9. T test between clusters.

Variables		T Test between clusters 1 and 2	T Test between clusters 1 and 3	T Test between clusters 2 and 3
Global organization of innovation	Reverse transfer of capabilities	-0.873***	2.047*	-2.410*
	Autonomy of foreign subsidiaries	2.364*	1.064**	0.874**
	Technological attributes of foreign subsidiaries	0.873**	2.35*	-1.052**
Cooperability	Cooperability inputs	-1.892*	-0.712**	1.741**
	Results of cooperability	-0.768**	1.370*	2.752*

Key to table: Significance level 1% = *; 5% = **; 10% = ***.

4.1 Proposed Model

By analyzing the regression models, we can infer that the global organization of innovation affects the dynamic capability of cooperation (cooperability) in Brazilian Multinationals (BMNs). Consequently, research hypotheses H_{01}, $H_{02,}$ and H_{03} were rejected, proving that technological attributes of foreign subsidiaries and the reverse transfer of capabilities from foreign subsidiaries to headquarters and technology partners affect the dynamic capability of cooperation in BMNs (cooperability inputs and results).

Furthermore, we found an inverse relationship between the autonomy of foreign subsidiaries and cooperation in BMNs, meaning that the more autonomy is granted to subsidiaries, the less frequent the configuration of inputs and results of cooperability will be. This indicates the need to develop practices to coordinate actions in foreign subsidiaries with the definition of strategic and operational roles that were previously aligned with the level of autonomy granted.

After performing an aggregate analysis of the clusters presented in Tables 8 and 9 and the hypothesis tests presented in Table 10, we arrived at a **Cooperability Model**, i.e., a development model for cooperation in BMNs. In this model, the movement from a local towards a more international or global configuration would denote a technological advance (to boost the results of cooperability), and managerial progress, would promote the global organization of innovation from the configuration of autonomy and the technological attributes of foreign subsidiaries, as well as the reverse transfer of capabilities.

Table 10. Results of regression models and hypotheses tests.

Variables Cooperability inputs		Cooperability Results of Cooperability		Hypotheses tests
Global organization of innovation	Reverse transfer of capabilities	Has a positive effect	Has a positive effect	H_{01} was rejected. Reverse transfer of capabilities from foreign subsidiaries to the parent company and technological partners does not affect the dynamic capability of cooperation in BMNs.
	Autonomy of foreign subsidiaries	Has a negative effect	Has a negative effect	H_{02} was rejected. There is no link between the autonomy of foreign subsidiaries and the dynamic capability of cooperation in BMNs.
	Technological attributes of foreign subsidiaries	Has a positive effect	Has a positive effect	H_{03} was rejected. Technological attributes of foreign subsidiaries do not define the dynamic capability of cooperation in BMNs.

The variables taken into account in this Cooperability Model were validated by the hypothesis tests (Table 10). As for the configurations of the model (local, international and global arrangements), they were validated by the t-test results (Tables 8 and 9), indicating a difference between representative BMNs in the clusters. It also means that the variables in fact discriminate the global organization of innovation and the dynamic capability of cooperation in each group. External partners with greater relevance for each arrangement were also validated since they have a significance of 5%, as follows: for the local arrangement, partnerships with domestic clients had a Pearson's chi-square = 10.219 and $\alpha = 0.047$; for the international arrangement, partnerships with international suppliers had a Pearson's chi-square = 9.173 and $\alpha = 0.032$; finally, for the global arrangement, partnerships with national and international universities and research institutes had a Pearson's chi-square = 8.265 and $\alpha = 0.028$.

By observing the Cooperability Model, we inferred that in the first arrangement a **local configuration** prevails over the relevance of partnerships with national clients and high application of managerial inputs from the parent company when it comes to the dynamic capability of cooperation. In this configuration, foreign subsidiaries have already transferred capabilities to the parent company. Nevertheless, their autonomy and technological attributes are infrequent. Finally, managerial and technological results occur at a medium frequency due to the dynamic capability of local cooperation (headquarters and domestic clients) (Table 11, Fig. 1).

In the second arrangement, we see the predominance of an **international configuration** rather than the relevance of partnerships with international suppliers and a considerable concession of autonomy to foreign subsidiaries that have already taken over distinct

technological attributes. However, these BMNs still show infrequent reverse transfer of capabilities and application of managerial inputs from the parent company concerning the dynamic capability in question. Likewise, managerial and technological results occur at a low frequency due to the international dynamic capability of cooperation (subsidiaries and foreign suppliers) (Table 11, Fig. 1).

Table 11. Model of cooperability in BMNs.

Variables / Arrangements		**Cooperabilty configurations**		
Local arrangement (Cluster 1**)		**International Arrangement** (Cluster 2**)	**Global Arrengement** (Cluster 3**)	
Cooperability	Cooperability inputs*	High frequency	Low frequency	Medium frequency
	Results of Cooperability*	Medium frequency	Low frequency	High frequency
Global organization of innovation	Reverse transfer if capabilities*	Medium frequency	Low frequency	High frequency
	Autonomy of foreign subsidiaires*	Low frequency	High frequency	Medium frequency
	Technological attributes of foreign subsidiaries*	Low frequency	Medium frequency	High frequency
Eternal partners of greater relevance* **		Domestic clients	International suppliers	National and international universities and research institutes

Key to table: *Variables validated by hypothesis tests presented in Table 10; **Test results presented in Tables 8 and 9 indicate a difference between representative BMNs in the clusters, suggesting that the variables certainly discriminate the global organization of innovation and the dynamic capability of cooperation in each group ***Significance of 5%.

Finally, in the third arrangement, a **global articulation** prevails rather than the relevance of partnerships with national and international universities and research institutes and the high frequency of managerial and technological results from the dynamic capability of local cooperation (headquarters and domestic universities and research institutes) and international cooperation (subsidiaries and international universities and research institutes). In this arrangement, foreign subsidiaries take over the technological attributes and transfer capabilities to headquarters quite frequently. Furthermore, these BMNs grant autonomy to foreign subsidiaries and apply managerial inputs in favor of the dynamic capability of cooperation at a medium frequency (Table 11, Fig. 1).

Attention should be paid to the fact that the sets proposed here are not necessarily a sequential path. In other words, companies with local cooperability can quickly evolve to a global cooperability set to meet their immediate technological needs, and this does not necessarily mean that they have gone through the international set (the case of a born global, for instance). Likewise, hybrid cases are possible to meet the requirements of certain sectors. Moreover, due to the diversity of product portfolios, BMNs in global, international or national sets can demand local, international or global sets.

4.2 Discussion of Results

To compete globally emerging multinationals should prospect, obtain and operationalize technology and knowledge dispersed in the international market, which shows a learning opportunity that can put the MNB in a good position (Doz et al., 2001; Andersson et al., 2007). Therefore, BMNs changing their structures to make them more open and flexible, with arrangements that create and share knowledge and technologies in local and/or global contexts (Cantwell et al., 2010), as demonstrated by the proiposed arrangements of local, international and global cooperability (Figure 1), since the most important competitive partnerships the MNBS investigated were established with external sources of knowledge and technology. These are, respectively: domestic customers (local arrangement); international suppliers (international arrangement) and national and international research institutes (global arrangement).

An open and flexible structure requires the multinational systematization of relations of cooperation and continuous integration and knowledge and technological dynamics developed and absorbed into the array, the subsidiaries and the partnerships in local and global contexts (Dunning and Lundan, 2010). In response to the need to promote global integration and local response, multinationals from emerging countries are challenged to align dynamically with autonomy and technological assignments of the subsidiaries. They also have to promote the transfer of training reserves from subsidiaries to the parent company and subsidiaries and place them in international value chains. They also have to transfer knowledge and network technology to enhance performance in the local and global market, offering products, processes and services with higher added value (Yang et al., 2008).

As demonstrated by the proposed cooperability arrangements (Figure 1), it is necessary to develop dynamic relational capabilities (cooperability) through the modification or intentional extension of these arrangements to suit the dynamics of the market and promote global integration and local response.

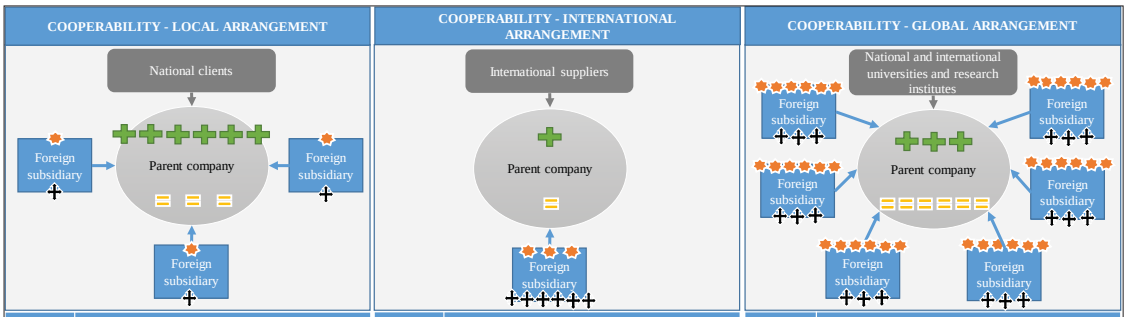
To differentiate from traditional multinationals, multinationals from emerging countries, specifically the BMNs, should establish and maintain multifaceted and interactive relations with external partners. The systematization and agility of these collaborative processes will ensure that these companies are able to create dynamics, modify or extend their resource bases by developing and incorporating resources and competencies with partners. On their own, they would not have the necessary resources and stock to keep pace with the technological development of multinationals from developed countries (Helfat et al., 2009).

The BMNs in the study with predominantly local relational capability attributed great importance to competitive partnerships with domestic clients. They also had effective governance mechanisms capable of limiting the transaction costs in the partnerships between headquarters and national technology partners, specifically customers, which positively affected the efficiency of relational capacity and its performance in the generation of knowledge, innovations and new local markets (Figure 1).

The BMNs under study with predominantly international relational capacity attributed great importance to their competitive international partnerships with international suppliers and granted autonomy to strategic foreign subsidiaries (Nobel and Birkinshaw, 1998). Strategic autonomy means that these subsidiaries can set their own R&D agenda with international suppliers. However, there are negative implications of this arrangement regarding the managerial and technological results of partnerships with external sources in terms of generating knowledge, innovations and new markets.

It should be emphasized that the negative implications of strategic autonomy delegated to subsidiaries are potentially associated with the two situations. First, the integration of highly autonomous subsidiaries tends to be lower due to the difficulty of coordination, leading to the isolation of these branches (Keupp et al., 2011). Second, the capabilities of autonomous subsidiaries are potentially less compatible with the stock of network resources of multinational business. Therefore, incentives and additional investment tend to be more contained, which will negatively affect bargaining power and performance (Both and Schlegelmilch, 2007).

Fig. 1. Description of cooperability model in BMNs.



Subtitle	Description - LOCAL ARRANGEMENT	Subtitle	Description - INTERNATIONAL ARRANGEMENT	Subtitle	Description - GLOBAL ARRANGEMENT
	External partnerships of greater relevance are formed with national clients.		External partnerships of greater relevance are formed with international suppliers.		External partnerships of greater relevance are formed with national and international universities and research institutes.
	Dynamic capability of cooperation is related to a high level of application of managerial inputs coming from the parent company.		Dynamic capability of cooperation is related to a low level of application of managerial inputs coming from the parent company.		Dynamic capability of cooperation is related to a medium level of application of managerial inputs coming from the parent company.
	Capabilites are transfered from foreign subsidiaries to the parent company at a medium frequency.		Capabilites are transfered from foreign subsidiaries to the parent company at a low frequency.		Capabilites are transfered from foreign subsidiaries to the parent company at a high frequency.
+	Autonomy is granted to foreign subsidiaries at a low level of frequency.	+	Autonomy is granted to foreign subsidiaries at a high level of frequency.	+	Autonomy is granted to foreign subsidiaries at a medium level of frequency.
	Foreign subsidiaries take over technical attributes at a low level of frequency.		Foreign subsidiaries take over technical attributes at a medium level of frequency.		Foreign subsidiaries take over technical attributes at a high level of frequency.
=	Managerial and technological results occur at a medium level of frequency due to the dynamic capability of local cooperation (headquarters and national clientes).	=	Managerial and technological results occur at a low level of frequency due to the international dynamic capability of cooperation (subsidiaries and foreign suppliers)	=	Managerial and technological results occur at a high level of frequency due to the dynamic capability of local cooperation (headquarters and national universities and research institutes) and international cooperation (subsidiaries and international universities and research institutes).

Finally, the BMNs with global relational capacity attributed great importance to competitive global partnerships with both national and international universities and research institutes. Furthermore, their subsidiaries took on distinct technological assignments (Noorderhaven and Harzing, 2009) and transferred them to headquarters (Schlegelmilch, 2007; Keupp et al., 2011), resulting in mutual access to complementary resources (Petruzzelli, 2011) and the creation of specific assets, such as innovations, technologies and new markets globally (Helfat et al., 2009).

It should also be mentioned that the BMNs with global relational capacity granted operating subsidiaries autonomy. These subsidiaries were able to manage activities previously handled by headquarters. Therefore, they were able to make their own decisions on cooperation with external companies and organizations, promoting the recognition and use of the resources made available by the local systems of innovation. These reflections corroborate the findings of Schlegelmilch (2007), i.e. the greater the operational autonomy of a subsidiary, the greater its ability to explore external sources of innovation and enhance its resource base and performance.

Finally, it can be concluded that the dynamic relational capability is the convergence between the proposed cooperability arrangements and the needs of global integration and local response. In addition to the BMNs in the study, multinationals from other emerging countries can assess the possibilities for using dynamic relational capacity to flow between one arrangement and another to satisfy specific needs that might require more or less global integration and local response.

5. Final Remarks

The main contribution of this study is the proposal of a model for the local, international and global dynamic of cooperation in BMNs and that the shift from a local arrangement to an international or global one would represent a significant leap not only in terms of science and technology but also in management. It would promote a number of positive implications for the innovative performance of BMNs by adopting an intentional governance model that would make the process more systematic and promote shared cooperation between the parties involved.

By performing a cross-analysis of quantitative results, we succeeded in articulating a Cooperability Model. Attention should be paid to the fact that the sets proposed here are not necessarily a sequential path. Likewise, hybrid cases are possible to meet requirements from certain sectors and due to the diversity of product portfolios, BMNs in global, international or domestic sets can demand local, international or global sets.

The limitations of this study are related to the size of the sample, although the sampling process was intentional. Therefore, the conclusions must be carefully considered and generalizations cannot be made concerning the findings. As to future research, we suggest performing an in-depth analysis of cooperability in multinationals from developed economies and conducting quantitative studies comparing determinants of the results of cooperability in developed and developing economies.

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Regulation – Do or Die: An Analysis of Factors Critical to New Product Development in a Regulatory Context

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Abstract: This study explores new product development in a strict regulatory and historically secretive environment. Adopting a systems perspective and a mixed methods approach in our research, we examine medical device development in Ireland. Findings indicate that the possession of a regulatory strategy expedites the rate of commercialization, so too does the generation of clear product definitions and marketing claims in the earliest developmental phases. Moreover, results suggest that if the regulated industry strengthens its culture for regulation by prioritizing regulation over speed to market, by encouraging cross-functional team collaborations, and by taking a more proactive approach in post-marketing surveillance activities, it has the potential to improve customer satisfaction and enhance product innovation. This study provides unique empirical data enriched by the homogeneity of its sample. It also contributes guidance to practitioners of new product development within a regulatory context.

Keywords: new product development; medical device development; innovation; technology innovation management; regulation management; regulatory culture; post-marketing surveillance.

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1. Introduction

Unlike most other industries, strict regulatory oversight exists in the medical device industry primarily to mitigate against potential risks to human health. Regulation obliges medical device companies to prove efficacy and safety of their products (Tobin & Walsh, 2011), before being permitted market entry. Thus, for medical device companies, gaining and maintaining regulatory compliance is essential and synonymous with market access and ongoing trade viability but expensive, time-consuming and risky (Engberg & Altmann, 2015). In today's fast-paced, dynamic and highly competitive marketplace, only companies able to innovate rapidly will survive (Collyer, Bakal, & Verma, 2013). It is vital, therefore, that medical device companies learn how to manage regulatory and innovative demands simultaneously, for their sake and for the economies and patients they serve.

However, we find little direction exists to guide medical device companies on how to manage their regulatory obligations during new product development (NPD). Furthermore, of the regulatory information that does exist, Engberg and Altmann (2015) explain that "manufacturers often have problems navigating the regulatory text." Thus, while the extant literature is rich in prescriptive regulatory information (e.g. routes to regulatory compliance; how regulations impact innovation etc.), there is scant empirical evidence to support medical device companies in the management of regulation-bound technology innovation (Medina, Kremer, & Wysk, 2013), despite the necessity of regulatory compliance to gain and maintain marketing approval. Additionally, the medical device industry is highly competitive and historically slow to share its *modus operandi*. Despite this, the medical device industry provides the ideal backdrop to explore new product development (NPD) in a strictly regulated environment to provide industry and context-specific data.

The overarching research goal, therefore, is to provide exploratory, context-rich, empirical data where currently it is lacking and fragmented. To this end, and we believe for the first time in the literature, we posed questions directly to stakeholders of medical device development (MDD), namely regulatory affairs, quality assurance, and marketing specialists about three, regulation-controlled, product development activities, crucial to MDD and concomitantly to the acquisition and ongoing retention of regulatory approval; 1. Defining the product 'intended use(s),' 2. Defining product 'marketing claims,' 3. Conducting 'post-marketing surveillance.' Furthermore, building upon the extensive body of literature in non-regulated new product development (NPD), we identified five recurring themes (Table 1), widely accepted as drivers of successful NPD, ('*culture*,' '*strategy* for regulation,' '*commitment*,' '*organisation* of teams,' and '*process*') to examine their influence on medical device development (MDD). Preliminary interviews with experts in regulation and MDD, in conjunction with the literature, helped us to establish a framework (Table 2) that guided development of a 40-item questionnaire.

Overall, we believe this study contributes valuable, new empirical insights that will help progress understanding and thus management of vital industries where increasing regulatory controls exist, and it provides practical guidelines for more efficient management of medical device innovations.

Since this research builds upon learnings from NPD research, an outline follows of the literature on five key themes driving NPD. We adapt these themes to the regulatory context of MDD to provide an explanation of our study framework. Next, we present the methodology, findings, and discuss our data analyses making recommendations for management. We conclude the paper with contributions.

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2. Literature on New Product Development (NPD) and Themes of Success

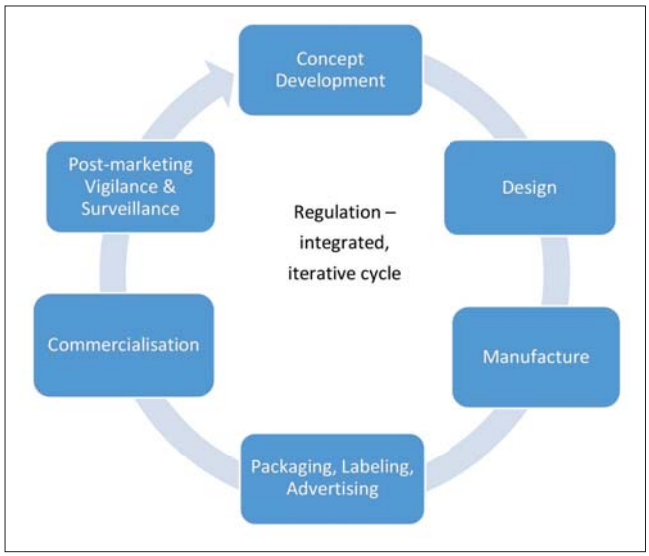
The extant literature in NPD covering over forty years' research, espouses five main themes drive successful NPD, namely "*Process*, *Organization, Strategy, Commitment* by senior management, and *Culture*" (Table 1). However, little empirical data exists that is particular to the medical device industry. We incorporate and adapt NPD themes to the regulatory context of medical device development (MDD) to explain our study framework, and review them next.

2.1 The *Process* of new product development

The NPD *process* refers to the strict set of activities beginning with an innovative idea (concept phase) and culminating in a new product for the market (commercialization) (Sun & Wing, 2005). Khurana and Rosenthal (1998), describe the development process as a set of "distinct phases." De Waal and Knott (2010), advocate the existence of a "high quality, rigorous new product process" is "one of the strongest drivers of profitability." The significance of a well organised development process continues to be extolled (Cooper & Kleinschmidt, 2007) and would be expected to apply equally to the regulated process of MDD (Collyer et al., 2013) as to the non-regulated process of NPD. Therefore, we investigated the MDD process.

Various models have been proposed but no consensus has yet been established. Models range from the simple (Holger, 2002), to the complex (Pietzsch, Shluzas, Paté-Cornell, Yock, & Linehan, 2009). Based on the literature and our interviews with regulatory experts, we developed a simplified model (fig.1) which identifies six main phases to MDD. We used this model to target our questions to specific process phases to enhance the value of our findings.

Figure 1. The Process Phases of Medical Device Development



2.1.1 Intended use(s) and Marketing Claims

Two essential outputs of the heavily regulated MDD process are the product definitions of 'intended use(s)' (which describes the planned purpose(s) of the product), and 'marketing claims' (statements aimed at users in support of the product). These definitions are conceptualized, refined and defined during the process of MDD and come under regulatory scrutiny (Tobin & Walsh, 2011).

A critical challenge for manufacturers of regulated goods is that to meet regulation's strict standards requires documented proof of product validity (product performs as it is planned to and for the purpose(s) it is intended) and product reliability (product performs consistently), (Tobin & Walsh, 2011). Consequently, designing definitions of 'intended use(s)' requires great care, and assertions made by 'marketing claims' must correspond with those of 'intended use(s).' Since these product definitions come under such strict regulatory control, their management would be expected to impact regulatory approval and innovative outcomes, however, no empirical data for this exists. Moreover, once regulatory approval has been given for a stated purpose, any alterations to the product requires renewed approval by regulatory authorities. No data exists that measures the impact of such changes. In line with the literature in NPD, authors Fritz and Cardle (2012), Collyer et al. (2013), condone and indeed promote early phase definition of product characteristics, the earlier, the better for more efficient market access (Kumar & Addie, 2006; Tobin & Walsh, 2011). We examine these activities.

2.1.2 Post-marketing surveillance

A phase unique to that of regulated products is termed post-marketing surveillance (fig.1), which describes activities conducted after market entry for the regulatory obligation and purpose of providing evidence of on-going product safety and effectiveness in the marketplace (Tobin & Walsh, 2011). Controversy exists in the literature. Some demand stricter regulatory controls enforcing the industry to proactively gather post-marketing feedback to help predict potential hazards by incidents such as the de Puy faulty hip joints scandal and other failures (Dhruva & Redberg, 2012; Sorenson & Drummond, 2014). Others argue that stricter regulation will impede innovation and delay patients gaining access to the newest and best treatment options (Gregory, Curfman, & Redberg, 2011; Kierkegaard & Kierkegaard, 2013). Kumar and Addie (2006) advise, customer feedback offers a powerful tool for measuring performance, "good and bad."

These facts offer a compelling argument for a closer examination of the MDD *process* paying particular attention to activities defining intended use(s), marketing claims, and post-marketing surveillance (Table 2).

2.2 Organisation

The theme of *organization* describes an "organizational setting within which the new product development process is active" (Cooper & Kleinschmidt, 1995). It refers to teams of individuals who work together, led by an "empowered leader." Planning of the work is stressed, inter-team and cross-functional collaborations are encouraged (Sivasubramaniam, Liebowitz, & Lackman, 2012). Kumar and Addie (2006), stress that "employee involvement and management

attention ensured the ultimate success." Morgan (2012), describes how inter-team collaborations build company capability. Thus, the body of knowledge conveys the criticality of employees within organizations and across teams being able to work well together so that companies can acquire and expand their capabilities to drive NPD.

In the medical device industry, the rapid development of new technologies incorporating complex entities has meant that, increasingly, cross-functional team collaborations are essential in their development (Hede, Nunes, Ferreira, & Rocha, 2013). Individuals heretofore not used to working together, find themselves expected to co-operate and collaborate. The importance of good communication, trust in communication and opportunities for timely communications, are highlighted in the current literature. What is lacking are empirical data on relationships, communication, and levels of trust within and between teams involved in MDD. Our research seeks some of this data (Table 2).

2.3 Strategy

The literature is replete with references to the theme of *strategy*, a comprehensive review of which is beyond the scope of this paper. We conclude that a strategy for NPD describes a charter for NPD which directs the actions a company must take to achieve its goals for innovation and match its innovation capabilities (Cooper & Kleinschmidt, 2007; Teece, 2008). Possession of a clear and formalized strategy links with successful NPD (De Waal & Knott, 2010; Dodgson, Gann, & Salter, 2008). It must be clearly communicated and understood by employees (Holger, 2002). A corporate strategy for NPD "states a well-defined role of NPD in the company's overall strategy" (Cooper & Kleinschmidt, 2007), which makes the allocation of resources toward the strategy more likely (De Waal & Knott, 2010).

Thus, we expect that the possession of a regulatory-strategy and one backed up in corporate strategy will support MDD. Our study tests for this in the medical device industry (Table 2).

2.4 Commitment

Cooper and Kleinschmidt (1995), describe senior management *commitment* as senior management's "involvement with and corporate commitment to new product development." Sun and Wing (2005) say it is when senior management "wholeheartedly" supports NPD and "visibly demonstrates this support" through clear communication, good employee relationships and the provision of resources toward NPD. Cooper and Kleinschmidt (1995), provide early evidence that making senior management accountable for NPD and tying in their incentives to successful outcomes, enhances NPD success.

Research indicates that the longer senior management holds responsibility for any project, the less likely they are to terminate that project (Jonas, 2010). On one hand, this could prove unhelpful if senior management becomes so deeply attached it fails to cull projects displaying signs of economic non-viability. On the other hand, senior management support can be powerful in holding off internal conflicts from negatively impacting the projects that they specifically back. A significant volume of literature exists which demonstrates that a lack of senior management support results in project failure (Easterby-Smith, Thorpe, & Jackson, 2008). In our study, we examine the commitment shown by senior management toward regulation during MDD (Table 2).

2.5 Culture

Poolton and Barclay (1998) describe an innovation culture as one where "the will to innovate is enshrined in the corporate culture and forms the basis for innovation policies." It is considered essential in driving NPD success (Baker & Sinkula, 2007). Senior management is expected to promote the company's innovative culture by providing a product "champion," supporting new ideas, encouraging creativity and rewarding risk taking, even if the outcome is failure (Rodriguez & Hechanova, 2014).

Some authors say an integral element of an innovative culture is the active collection and distribution to staff of performance measurements (De Waal & Knott, 2010; Kumar & Addie, 2006). The theory is that employees who receive measures of performance become motivated to take personal responsibility for their contribution to performance (Morgan, 2012). We test for employees' knowledge of regulatory performance (Table 2).

A unique source of performance information is available to medical device companies through the activities of vigilance (responsive) and post-marketing surveillance (proactively sought) which provide direct customer feedback. Vigilance and post-marketing surveillance activities are also regulatory requisites in this industry. Feedback informs about users' real-life experiences and thus reflects customers' actual satisfaction or otherwise with the product in its market. This feedback can be very useful if it alerts an organization to a problem that could escalate to something more serious. Similarly, positive customer feedback could encourage and enhance further innovations. We test for a culture that supports regulation during MDD (Table 2).

Table 1. Five themes associated with successful new product development and quotes.

Theme	Best Practice Statements / Quotations	References
Process	Importance of a formal process High quality, rigorous new product process Importance of robust design A clear concept of the future product & its future markets [...] early in the NPD process A clear definition of the product before development begins	Griffin 1997; Medina et al. 2013 De Waal & Knott 2010 Zapata & Cantu 2008 Kumar & Addie 2006 Ika et al. 2012 Salomo et al. 2010; Holger 2002
Organisation	Effective leaders/champions essential Employee involvement & management attention ensures success Cross-functional issues are most important in the early stage of NPD It is essential to engage team members in the planning process to ensure ownership of the plan	Griffin 1997; Lewrick 2009 Kumar & Addie 2006 Sun and Win 2005 Salomo et al. 2010 Asgary & Thamhain 2016
Strategy	Having a clear & shared vision/charter It is imperative to have clear & specific strategies A corporate strategy for NPD incorporates NPD into the company's overall strategy Strategy determines the most appropriate process design & complexity for the firm's context & targets A formalized NPD strategy correlates with improved performance	Griffin 1997 Lester 1998 Cooper & Kleinschmidt 2010 Khang & Moe 2008 Lynn et al. 1999 Dodgson et al. 2008 De Waal & Knott 2010
Commitment	Provision of top management attention Provision of sufficient resources Senior management commitment is key prerequisite for success Commitment to quality is continually emphasized by senior management	Griffin 1997; Lester 1998; Khang & Moe 2008; Saloma et al. 2010 Rodriguez & Hechanova 2014 Poolton & Barclay 1998 Kumar & Addie 2006
Culture	An ethos that supports the entrepreneurial spirit Rewards new ideas, permits risks to be taken Encourages employee initiative Knowledge of performance is essential Management at all levels is accountable for achieving business, quality and compliance success	Cooper & Kleinschmidt 1995 Griffin 1997; Sun & Wing 2005 De Waal & Knott 2010 Ulrich & Eppinger 2008 George et al. 2007

3 Method

3.1 Survey design and target population

This exploratory study followed a two-phase, mixed-methods approach to data collection (Creswell, 2009; Dillman, 2007). During phase one, we conducted semi-structured interviews with regulatory specialists working in MDD, namely regulatory affairs and quality assurance. From these interviews, we identified constructs for the contents of our questionnaire (Table 2). Next, we pre-tested and piloted the questionnaire among eight individuals to confirm its validity and reliability (Fink, 2013).

In the second phase, we targeted a sample of 64 medical device companies based in Ireland (for homogeneity) and across all size categories, small (<50 employees), medium (51-249 employees) and large (>250 employees), and involved in MDD and commercialization, thus necessitating regulatory approval. We sourced these companies through the Irish medical device association's membership directory (IMDA, 2016), supplemented with an on-line search of each organization. We excluded companies described as training business, software developer or supplier.

We dispatched 128 personalized requests for participation in the research, directing on-line questionnaires to the manager of two stakeholders' teams per company, namely, regulatory affairs and marketing. Employing best practice protocols (Saunders, 2012) to maximise response rate, we made a phone call to each of the 64 targeted companies requesting these managers' names, because, according to Sauermann and Roach (2013) "personalization increases the odds of responding by as much as 48%." Through the process of snowballing or "response cascading" (Fink, 2013), we encouraged first contact respondents to ask their team colleagues to partake in the research. We assured anonymity, and to motivate completion of the relatively long questionnaire we interspersed long questions with short ones, added a 'progress bar' and offered a small prize from a draw to all participants completing the survey and willing to submit their contact details. We sent the survey using an on-line link which we left open for fourteen days. We followed up direct contacts with a reminder e-mail on day ten, and used statistical packages to analyze the data retrieved.

Since respondents were unknown to us, it guaranteed no "participant or observer bias response" (Saunders, 2012). Furthermore, because we presented respondents with an identical set of carefully selected questions, the questionnaire in the current study is deemed valid and reliable (Pallant, 2010).

3.2 Questionnaire design

We divided the questionnaire into seven categories (Table 2), five integral to the themes of our research, another to render sample background information (e.g. company size, years in role etc.), and one to collect various measures of performance. Some measures were inherent in the questionnaire by directly comparing responses to question sets (e.g. 'ideal' versus 'actual'). We requested other measures using empirical queries sourced mostly from De Waal and Knott (2010).

Table 2. Themes to Construct and Questionnaire Development

Construct	Description	Rationale	Reference
Theme 1 Process of MDD			
Intended use(s)	Determine phase when these product definitions are made	Early-phase definitions associate with best practice design & market satisfaction	Rochford & Rudelius 1997 Khurana & Rosenthal 1998 Kumar & Addie 2006 De Waal & Knott 2010 Tobin & Walsh 2011 Fritz & Caudle 2012
Marketing Claims	Determine phase when these product definitions are made	Early-phase definitions associate with best practice design & market satisfaction	
Intended use(s) & Marketing Claims	Determine how closely the definitions align or match	Close alignment links with best practice & design	
Post-marketing surveillance activities	Explore the emphasis on, and involvement in post-marketing surveillance activities	Regulatory oversight demands post-marketing surveillance	Tobin & Walsh 2011 Resnic and Normand 2012 Sorenson & Drummond 2014
Theme 2 Organization for regulation during MDD			
Team size	Determine satisfaction with team size	Provision of adequate labour resources links with success	Cooper & Kleinschmidt 1995;2007; Holger 2002
Input by teams	Examine when teams become involved in development phases	Early-stage involvement promotes early product definitions; late-stage involvement affiliates with post-marketing surveillance	Tobin & Walsh 2011 Ulrich & Eppinger 2008 Santos et al. 2012 Sorenson & Drummond 2014
The Impact of teams	Examine the roles of teams during development phases	Cross-functional collaboration is necessary for making product definitions & for gathering post-marketing surveillance info.	Tobin & Walsh 2011 Ulrich & Eppinger 2008 Resnic & Normand 2012 Medina et al. 2013
Levels of trust	Examine levels of agreement & co-operation between teams	Trust & communication are critical to effective collaboration	Kumar & Addie 2006 George et al. 2007 Tobin & Walsh 2011
Frequency of Meetings	Examine frequency of intra-team & inter-team meetings	Regular meetings promote flow of information & generate trust	Morgan 2012 Hede 2013
Theme 3 Strategy for regulation in MDD			
Clearly defined & communicated goals	Determine how clearly regulatory strategy is communicated & understood	Clearly communicated goals corresponds with success	Cooper & Kleinschmidt 1995 Griffin 1997; Sun & Wing 2005
Corporate strategy	Testing for presence of regulatory strategy backed up by corporate strategy	Whole company buy-in correlates with success	Poolton & Barclay 1998 Holger 2002; Foster 2013
Theme 4 Commitment for regulation by Senior Management (SM)			
Priority of regulation to Senior Management (SM)	Examine level of importance placed by SM on regulatory management issues	Backup by SM is a pre-requisite for success & is associated with better performance	Griffin 1997; Khurana & Rosenthal 1998; Sun & Wing 2005; Drucker 2011; Foster 2013
Resources	Determine team satisfaction with resources toward regulation	Senior management is responsible for resources access and allocation	Cooper & Kleinschmidt 1995; 2007; Sun & Wing 2005 Khang & Moe 2008
Relationships	Examine levels of trust & communication with SM	Good relationships foster effective teamwork	Cooper & Kleinschmidt 1995 Diallo & Thuillier 2005 Sivasubramaniam et al. 2012
Theme 5 Culture for regulation			
Regulatory Knowledge	Determine levels of knowledge respondents have regarding regulation	A culture provides the basis for policies - it is essential in driving success	Poolton & Barclay 1998 Cooper & Kleinschmidt 2007
Strategy for regulation	Determine if a regulatory strategy exists in the organization	Having a strategy or vision associates with success	Cooper & Kleinschmidt 1995 Lynn et al. 1999
Regulatory Performance knowledge	Determine the culture for regulation performance results	Knowledge about performance, individual and team performance, links with success	Morgan 2012 Kumar & Addie 2006 Ulricht & Eppinger 2008 De Waal & Knott 2010

Performance Measures			
Construct	**Description**	**Rationale**	**Reference**
Questions related to development phase activities	Identify actual vs. ideal phases for definition of intended use(s) & for definition of marketing claims Assess actual vs. ideal level of alignment vs. between intended use(s) & marketing claims Determine presence of post-marketing surveillance activities	Knowledge of performance is linked to success Early definition is associated with good practice Close match is a prerequisite for regulatory approval Post-marketing surveillance contributes to performance & customer knowledge	Poolton & Barclay 1998 Tobin & Walsh 2011 Collyer et al. 2013 Resnic & Normand 2012
Questions seeking empirical measures of performance	Market approval rate within expected time interval Rate market approval rejection/ delay Length market approval delay in months Number products submitted/approved for market approval in previous year Number new products commercialized in previous year Percentage value of overall sales from newly approved products in previous year	Knowledge among employees of individual and company performance is linked to ownership, motivation & success	Kumar & Addie 2006 de Waal & Knott 2010 Tobin & Walsh 2011 Morgan 2012

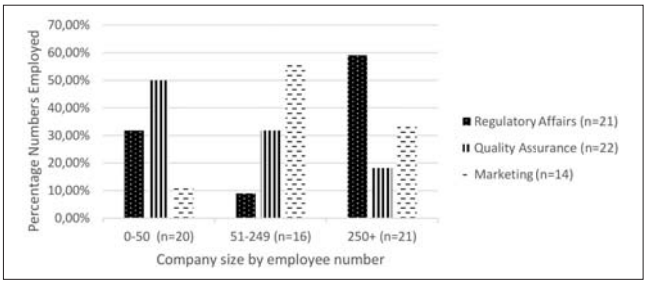
4 Results

Our empirical findings identify some factors impacting MDD. At a granular level, we show that the earlier product definitions of intended use(s) and marketing claims are completed, and the better aligned they are with each other, the sooner regulatory approval and thus commercialization, are achieved. We find there is less emphasis on post-marketing surveillance than expected. We reveal insufficient engagement by marketing teams compared with regulatory affairs and quality assurance experts during early-phase, and late-phase MDD activities that impact regulatory approval rate, and we find that cross-functional team meetings are rare. At the holistic level, we demonstrate a significant correlation between possession of a strategy for regulation and 'speed to market,' and that 'speed to market' is deemed the activity of greatest importance to senior management. Finally, we uncover a low level of tacit knowledge about a selection of regulation-specific performance measures.

4.1 Sample demographics

The survey was despatched directly to a purposefully targeted sample of 128 managers, 50% in marketing and 50% in regulatory affairs (or in charge of regulatory affairs duties). The overall response rate was 45% represented by 57 individuals from similar numbers of small (<50; n= 20), medium (51-249; n=16) and large (>250; n=21) medical device companies. Respondents included 14 marketing, 21 regulatory affairs and 22 quality assurance specialists, the vast majority of whom had over 11 years' experience in their specialty (fig.2).

Figure 2. Respondent Role and Company Size.



4.2 The process of MDD

Due to the relatively low number of marketing specialist respondents, and since most (except 3) dropped out after answering the early background questions, most of our analyses include responses from the 21 regulatory affairs and 22 quality assurance respondents.

4.2.1 Intended use(s) definition

Most specialists in both regulatory affairs and quality assurance (Table 3), recommend early phase confirmation of intended use(s) definitions, namely during concept development and design phases, with an emphasis by regulatory affairs specialists on confirming definitions during the first phase. However, in reality, intended use(s) definitions are often made during later developmental phases. A higher percentage of regulatory affairs (90%) than quality assurance specialists (65%) achieve intended use(s) definitions during the earliest development phases.

Table 3. Preferred timing and actual timing of product definition - intended use(s).

Preferred timing of intended use(s) definition by specialty		**Development Phase**	***Actual*** timing of intended use(s) definition by specialty	
Regulatory Affairs	Quality Assurance		Regulatory Affairs	Quality Assurance
76%	50%	Concept Development	33%	35%
24%	45%	Design	57%	30%
-	-	Manufacture	-	5%
-	-	Packaging, Labeling, Advertising	9.5%	25%
-	2%	Commercialization	-	5%

4.2.2 Marketing claims definition

The majority of respondents (Table 4) support early phase definition of marketing claims, with an emphasis by regulatory affairs specialists on achieving these definitions by the end of the design phase. In reality, marketing claims are often defined during later developmental phases. Again, a higher percentage of regulatory affairs (67%) than quality assurance specialists (40%) achieve earlier phase definitions.

Table 4. Preferred timing and actual timing of product definitions – marketing claims.

Preferred timing of marketing claims definition by specialty		**Development Phase**	***Actual*** timing of marketing claims definition by specialty	
Regulatory Affairs	Quality Assurance		Regulatory Affairs	Quality Assurance
48%	40%	Concept Development	24%	25%
48%	30%	Design	43%	15%
-	5%	Manufacture	-	10%
-	20%	Packaging, Labeling, Advertising	33%	40%
2%	5%	Commercialization	-	10%

A closer analysis reveals that in 29% of the smallest companies and in 35% of the largest companies, marketing claims are defined as late as during the phase of packaging, labeling, and advertising. Interestingly, 100% of marketing management respondents (though small in number) said that marketing claims should be defined by the end of the design phase at the latest.

4.2.3 Alignment between intended use(s) and marketing claims definitions

The vast majority (81%) of respondents believe that marketing claims and intended use(s) definitions should be 'very' closely aligned. More specifically, 95.2% of regulatory affairs specialists and 80% of quality assurance experts advocate preference for 'very' close alignment.

Figure 3 shows that the level of alignment achieved in reality, is not as close as experts deem preferable. Further analysis demonstrates that the closest alignments occur in the smallest and largest companies, which are also associated with the greatest proportion of regulatory affairs employees. Regulatory affairs respondents quote achievement of 'very close' alignment in 93.3% of cases, and only 6.7% report them to align 'somewhat closely.' By comparison, quality assurance specialists describe achieving 'very close' alignment in only 50% of cases.

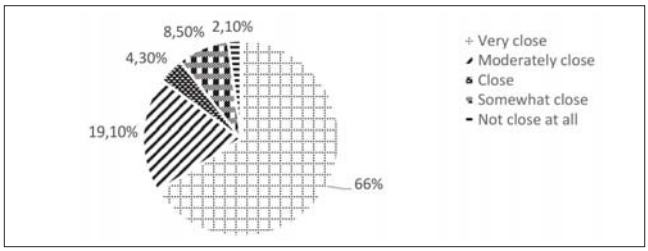
4.2.4 Impact of product definitions inaccuracies on rate of commercialization

Respondents were asked about the delay caused to regulatory approval achievement, by different product definition inaccuracies (1-4 below). Pearson Chi-squared tests for correlations found associations of significance between "*achieving clearance for market within the planned time-frame*" (which is equivalent to achieving on-time regulatory approval) and each of the 4 product definition inaccuracies examined, namely;

1. *unclear intended use(s) definition* (r = .476, N=41, p =.002),
2. *missing data regarding intended use(s) definition* (r = .402, N=42, p = .008),
3. *unclear marketing claims definition* (r = .410, N=40, p = .009),
4. *missing data regarding marketing claims definition (r = .397, N=41, p = .010)*

All correlations were positive indicating that as the frequency of various inaccuracies increased, the frequency of gaining 'on-time approval' moved in the same direction from 'always' (1) to 'never'/'don't know' (4/5) i.e. on-time approval outcome decreases as delays are more regularly encountered.

Figure 3. Actual alignment between marketing claims and intended use(s).



4.2.5 Post-marketing surveillance

Table 5 shows that regulatory affairs and quality assurance teams are involved in post-marketing activities 93% of the time where they make an impact 70% of the time. In contrast, respondents reported that marketing teams are involved in post-marketing surveillance 47% of the time, making an impact only 40% of the time. Figure 4 indicates that, in only 18.8% of cases, senior management place a 'very high' level of importance on post-marketing surveillance activities.

4.3 *Organization* for regulation during MDD

4.3.1 Engagement by teams - Involvement and Impact

Regulatory affairs and quality assurance teams demonstrate a greater level of involvement and make a greater impact in all developmental phases, except product launch, compared with that of marketing teams (Table 5). Marketing teams are involved in the earliest phases of concept development and design, 54% and 34% of the time respectively, making an even smaller impact during those periods, 40% and 34% respectively. Marketing teams' participation is highest during two development stages, product launch (82%) and packaging, labeling and advertising (73%), typically seen as marketing-specific responsibilities. The low levels involvement by marketing teams in post-marketing surveillance has already been highlighted.

Table 5. Involvement & impact levels of teams during MDD.

Regulatory Affairs & Quality Assurance Teams	Marketing Team	**Phase of Development**	Regulatory Affairs & Quality Assurance Teams	Marketing Team
Involvement	**Involvement**		**Impact**	**Impact**
81%	**54%**	Concept Development	**43%**	**40%**
91%	**39%**	Design	66%	**34%**
100%	19%	Manufacture	62%	7%
98%	73%	Packaging, Labeling, Commercialization	81%	77%
70%	82%	Product Launch	45%	85%
93%	**47%**	**Post-marketing surveillance**	**70%**	**40%**

Table 5. Involvement & impact levels of teams during MDD.

4.3.2. Relationships, Trustworthiness, Communication and Meetings frequency

We examined the levels of trust and ease of communication felt by quality assurance and regulatory affairs respondents towards team colleagues and cross-functional team members. Respondents expressed lower levels of trust with marketing teams than with senior management or own team members. Communication with senior management showed a greater number who were 'satisfied', rather than 'very' or 'highly' satisfied. Few were 'highly' satisfied with communication between themselves and marketing teams.

Neither inter-disciplinary nor cross-functional team meetings are held frequently. Cross-functional team meetings take place once a week according to only 20% of quality assurance and 29% of regulatory affairs respondents. 14% of regulatory affairs respondents said they hold cross-functional team meetings every two weeks. 45% of quality assurance respondents report monthly cross-functional team meetings or even less frequent.

4.4 *Senior management* support for regulation during MDD

4.4.1 Senior management emphasis of importance

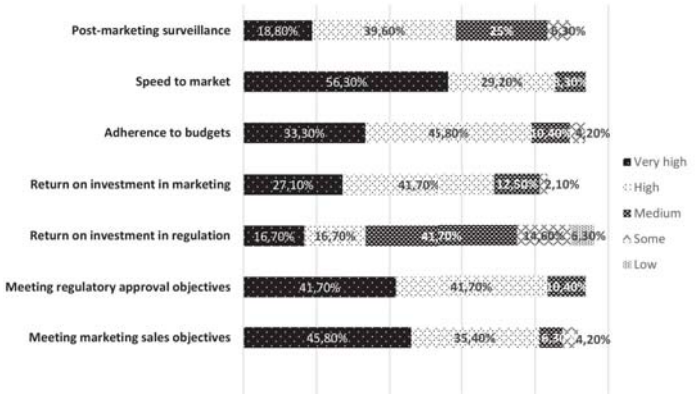
Figure 4 reveals respondents' perception of senior management priorities; its 'highest' level of importance attaches to achieving '*speed to market*' (56.3%), and its 'lowest' to '*post-marketing surveillance*' (18.8%). Furthermore, respondents reported that senior management attaches a 'high' to 'very high' level of importance on '*return of investment in marketing*' (68.8%). 79.1% of respondents say senior management places a 'high' to 'very high' level of importance on '*meeting overall budgets.*'

4.4.2 Resource allocation by senior management

Overall, respondents report a 'high level of satisfaction' (69.2%) with '*team size,*' and with '*financial resources*' (65.2%), the greatest satisfaction is in the largest companies.

80% of respondents who are 'dissatisfied' with team size and budgets are quality assurance specialists.

Figure 4. Senior management support per management activity.



4.4.3 Relationships with senior management

A robust relationship appears to exist between senior management, regulatory affairs, and quality assurance respondents; 75% describe senior management as 'very' or 'highly' '*supportive,*' and report overall '*level of trustworthiness*' from 'good' to 'very high' in 93.5% of cases.

The study reveals lower '*levels of satisfaction*' with '*communication between teams*'. Only 23.9% of respondents are 'highly satisfied,' 28.2% are 'very satisfied.'

4.5 Regulatory strategy findings

The majority of respondent companies (87%) possess a regulatory strategy. In 76% of these cases, the regulatory strategy is backed up by corporate strategy.

A Pearson's Chi-Squared test reveals a medium but significant negative correlation ($x^2/r = -.332$, N = 45, $p = 0.026$), reflecting an increasing frequency of achieving on-time approval associated with possession of a regulatory strategy (variable scores for frequency of achievement go from 1 = always to 5 = never, hence negative correlation). There is no association of significance between achieving on-time approval and having the regulatory strategy supported by corporate strategy. Further analysis shows that possession of a regulatory strategy is more likely in larger companies.

Most respondents report that regulatory strategy goals are clear and well communicated to them. 56% of respondents declare regulatory objectives are 'very clear,' 28% claim they are 'moderately clear' and of these, 40% work in quality assurance.

4.5 Regulatory *culture* findings

4.5.1 Regulatory knowledge

Not surprisingly, the study shows that regulatory affairs specialists have the highest level of knowledge on regulatory matters. 95% say their '*regulatory knowledge*' is 'very good' or 'expert.'

Only 10% of quality assurance experts report an 'expert' level of regulatory knowledge, 45% say their regulatory knowledge is 'very good,' 40% call it 'good.'

None of the marketing personnel report an 'expert' level of regulatory knowledge.

In order of 'impact,' respondents reported that regulation has its 'largest impact' on '*safety*' and '*quality*' followed by '*reliability,*' '*effectiveness,*' '*speed to market,*' and interestingly, they see regulation having its 'least impact' on product '*cost*.' However, a notable finding is that only 27.3% consider that regulation has its 'greatest impact' or its 'second greatest impact' on '*speed to market.*'

4.5.2 Regulation-related performance results

Many respondents were unable to comment on the different performance related queries posed, and the more empirical the questions, the higher the percent of '*don't know*' responses. Examples below;
On average, do new products attain market approval within the expected time-frame? '*Don't know*' (17%)

On average, how many products were submitted for market approval in the last year? '*Don't know*' (39%)

On average, how many products were approved in the last year? '*Don't know*' (41%)

On average, how many newly-approved products were commercialized in the last year? '*Don't know*' (52%)

What was the average percent value of overall sales contributed by newly approved products in the last year? '*Don't know*' (83%).

Even when presented with some reasons (5) that might cause regulatory approval rejection or even delay, a third of respondents in regulatory affairs and quality assurance could not say how frequently rejection resulted. On average, 55% could not even give an average length of delay in months.

5 Discussion

Operating within a strict regulatory context means that regulated industries face an everyday struggle with competing demands. On the one hand, a market that expects rapid innovation to provide its customers with the newest technology at best price. On the other hand, regulatory oversight insists on precious and costly time investment to provide documented proof of product validity, efficacy, and safety, to gain permission to launch into and remain in the market. This conflict between the need to reach markets faster than the competition while simultaneously devoting adequate time to acquire and maintain regulatory compliance status, is an on-going yet critical challenge faced uniquely by regulation-controlled industry, and one not yet adequately addressed in the literature. Our study provides badly needed empiric insights into NPD in one highly regulated industry, the medical device industry in Ireland. Thus, we provide a more detailed picture of the realities of innovation within a regulatory context and add to the body of awareness about MDD in Ireland, to assist the industry in managing MDD.

5.1 Sample demographics

The medical device industry is a difficult one from which to extract information, we are very satisfied with a response rate of 45% (57 respondents).

The study achieves a good balance in all company sizes (large, medium, small), and of regulatory affairs and quality assurance specialists. As a result, the study reveals some trends associated with company size and some associated with the respondents' role. Moreover, since our respondent companies are all located in Ireland, we have a homogenous sample providing context-specific data. As such, we can make comparisons between companies since all are operating within the same economic and political environment. Also, our respondents have more than eleven years' experience in their respective specialty making their responses more likely valid, e.g., Cooper and Kleinschmidt (1995) only accepted respondents into their research who had a minimum of 3 years' experience.

5.2 Activities associated with the process of MDD

The activities of defining product use(s) and marketing claims are process development activities within MDD that are central to creating and selling a new product's identity. These activities are also critically analyzed as part of regulatory oversight. The activities of post-marketing surveillance are a prerequisite of continued regulatory satisfaction, and the feedback produced has the potential to add to a company's body of information on its customers and its products. Consequently, gaining deeper insight into these three regulation-controlled process activities was pivotal in our research.

5.2.1 Intended use(s) and Marketing claims

In agreement with the literature that associates early phase product definitions with more successful NPD (Cooper & Kleinschmidt, 2007; De Waal & Knott, 2010), our research supports a more closely integrated process for MDD.

First, we find significant agreement among specialists that intended use(s) and marketing claims definitions should be confirmed preferably during the first and no later than the second phase of the MDD process. These respondents who are important stakeholders in regulation, agree with a high degree of alignment between intended use(s) definitions and marketing claims. However, our findings show that in the real world, product definitions are often incomplete after early process phases, and there is less alignment between definitions than respondents deem preferable. Further analysis of findings indicates that inadequacies in the clarity of these product definitions ('unclear definitions') and in their completeness ('missing data'), extend the time-frame for the achievement of regulatory approval and thus of market commercialization.

Khang and Moe (2008), advise on "the impact early phases have on later stages." Like dominoes, the effect of tardiness in one step affects the next, several mini changes can accumulate to lead to a sizeable deviation by completion of all development stages. We suggest that delays in completing medical device product definitions and poor alignment between them, negatively impact MDD outcome.

Study findings show that regulatory affairs respondents most strongly advocate and achieve early phase definitions of, and a very close alignment between, intended use(s) and marketing claims descriptions, compared with other respondent roles. This must have implications on regulatory approval timelines. In our research, a regulatory affairs expert with fourteen years' experience contends that "intended use(s) definitions must be made during concept development because product design depends on the intended use(s)." The expert adds "this is commonly misinterpreted but the whole design and testing should be based on what the intended uses are as well as the design - you can have identical designs with different classifications based on your intended use - very few engineers get this." This emphasizes the significance of clear product definitions. Thus, we posit that regulatory affairs specialists are best placed to promote optimal regulation-controlled product definitions outcomes, during MDD.

It is well-accepted that making alterations to product definitions becomes increasingly expensive as product development proceeds (Collyer et al., 2013; Fritz & Cardle, 2012). Thus, we suggest that our findings have implications for improved MDD, directing companies to specify and align intended use(s) and marketing claims definitions early, clearly and in full, to drive more successful MDD.

It is noteworthy that the smallest teams of regulatory affairs specialists are associated with medium-sized companies (fig.2). Perhaps quality assurance respondents in medium-sized companies are expected to conduct regulatory as well as quality assurance functions (Tobin & Walsh, 2011). Thus, quality assurance respondents may be overburdened which might explain the aforementioned trend for less alignment and later achievement of product definitions associated with the quality assurance role and medium-sized companies.

5.2.2 Post-marketing surveillance

As explained elsewhere in this paper, the requirement for the medical device industry to monitor the performance of its marketed products is obligatory. The reason is to satisfy regulatory authorities that the medical devices remain useful and safe in the community where far greater numbers of people access and use them compared with limited users during clinical trials. As such, the industry might be expected to a) place a high priority on conducting post-marketing surveillance and b) encourage the active participation of teams involved in regulation and customer contact, in gathering post-marketing feedback.

Contrary to expectations, we find that a) senior management attaches a 'very high' level of importance to post-marketing surveillance activities in less than 20% of cases. Instead, 'speed to market' is senior management's leading priority. The emphasis on post-marketing surveillance comes only 6th place in priority, and b) while marketing teams are best placed to gather post-marketing feedback because of their frequent and on-going direct contact with customers and users, they demonstrate a disappointing less than 50% involvement in the activity.

We suggest this is a missed opportunity for the industry. First, we recommend that the industry should regard post-marketing surveillance more highly and conduct it more proactively so that potential problems become identified when they are on a small scale. In so doing, it could prevent the type of large-scale scandals mentioned earlier which not only jeopardize peoples' health but also negatively impact a company's reputation that can take years to rebuild. Secondly, such scandals have led to increasing calls for increased regulation of the industry to pre-empt such disasters (Kierkegaard & Kierkegaard, 2013). By taking a more proactive role in post-marketing surveillance, the industry could increase its control over the management of safety issues and ameliorate calls for greater regulatory oversight. Moreover, it could provide useful information to MDD teams to feed into future product improvement and innovation plans.

Finally, by placing 'speed to market' and 'return on marketing budgets' at higher priority levels than the pursuit of 'post-marketing activities,' senior management may be inadvertently creating conflict between marketing teams and regulatory affairs/quality assurance teams. Since the future of medical device innovation calls for increasing cross-functional collaborations (Hede et al., 2013), this issue needs further examination. After all, improving rates of regulatory approval will contribute to greater speed to market!

5.3 Teams and MDD

The research asked respondents during which phases in the MDD process do their respective teams become involved, and, arguably more importantly, how influential they believe their input is. Unexpectedly, we found that in approximately half of cases, marketing teams are not involved in the concept development phase while in even more cases, they are not involved in the design phase. The literature contends "it is shown that, in particular, the preparatory work […] in the early phases of the NPD process […] are decisive for the success of new products" (Holger, 2002), which begs the question how organizations expect to make clear, unambiguous and timely product definitions if the experts who are expected to market these products are not present to provide input and have an impact on product definition decisions. Indeed, 100% of marketing management respondents concur that marketing claims should be defined by the end of the design phase at the latest, which further highlights the questionable absence of marketing teams in a substantial number of cases, during early NPD phases.

We examined the relationships, levels of trust and communication between cross-functional teams and enquired about the frequency of team meetings. In some cases, findings showed low levels of trust, lower levels of communication and infrequent cross-functional team meetings. These findings may explain our discovery of less collaboration than expected between teams during the earliest and latest process phases. It may reflect the tensions we surmise exists between marketing teams and regulatory affairs/quality assurance teams due to senior management's emphasis on 'speed to market' over 'achievement of regulatory approval.' If emphasis is placed on improved collaboration between teams, it could foster improved relationships, engender higher levels of trust and enhance communication within and between teams, and drive earlier phase product definitions and later phase post-marketing surveillance activities, improving MDD (Cooper & Kleinschmidt, 2007).

5.4 Senior management support for regulation

The literature advocates that commitment by senior management to innovation enhances NPD. We advocate that commitment by senior management to regulation will enhance MDD. We propose that senior management should exhibit this commitment to regulation in the same way it does to innovation. In summary, senior management should continually and consistently support regulatory authorities' requirements by emphasizing the priority and value of regulatory compliance to employees ahead of the expedition of products to market. Senior management should provide adequate resources to support regulatory goals, and develop excellent relations with employees who manage regulation issues.

Findings reveal that respondents are, in the main, satisfied with resources toward regulation provided by senior management and that the best relationships of trust and communication exist between respondent teams and senior management. This bodes well for regulatory management.

However, lower levels of both trust and communication appear evident between regulatory affairs/quality assurance teams and marketing teams. We have seen that 'speed to market' is perceived by our respondents to be the highest priority of senior management. Thus, achieving regulatory approval including support for post-marketing surveillance activities, competes with senior managements' desire to reach the markets quickly. Gaining market access is seen as a responsibility of marketing teams and may explain the poorer relationship and levels of trust we find between marketing teams and the other respondent teams. Marketing may feel that regulation holds back progression towards markets. Such findings may indicate that a gap exists in the knowledge of senior management about the interdependence between achieving regulatory approval and timely market access. We suggest senior management raises the priority level of 'achieving regulatory approval' ahead of achieving 'speed to market' and encourages stronger alliances and co-operation between marketing, regulatory and quality assurance teams to expedite both regulatory approval rates and consequently commercialization.

Furthermore, the relatively low emphasis placed on post-marketing surveillance by senior management suggests a low appreciation for the potential contribution toward improved product development that is inherent in such feedback. A greater emphasis on post-marketing surveillance should drive product innovation and overall customer satisfaction.

5.5 Strategy for regulation

Most of the companies in our research sample purport to have a regulatory strategy and of these, three- quarters say that it also forms part of corporate strategy. Our findings show that where a regulatory strategy exists, most respondents believe it is clear and well communicated. The study shows no findings of statistical significance between company size and the possession of a regulatory strategy. However, there is a statistically significant correlation in the association between having a regulatory strategy and achieving on-time approval more frequently which leads us to recommend that all companies should strive to ensure a clear, well-communicated regulatory strategy exists in their organization. According to the literature in NPD, integration of the strategy within the corporate strategy can only further advance successful MDD.

5.6 A culture for regulation

It is no surprise that regulatory affairs specialists possess the greatest levels of knowledge on the subject of regulation. What is surprising is that only 45% of quality assurance respondents deem their regulatory knowledge to be "very good" and as many as 30% of marketing respondents report their knowledge at the lowest level. These findings suggest a disadvantage for companies in which the regulatory affairs position does not exist and where quality assurance personnel carry out regulatory and quality duties. The importance of and distinction between each of these separate roles is illustrated by Fritz and Cardle (2012), who say "Regulatory Affairs deals mostly with issues related to compliance. Quality Assurance encompasses the processes, procedures, and culture that permeate an organization — enabling it to consistently develop and produce high-quality […] products that will meet or exceed regulatory requirements." In our study, while we cannot be sure that quality assurance respondents did not work alongside regulatory affairs colleagues in their respective organization, it seems unlikely. During survey dispatch, we requested the identity of regulatory affairs personnel. If we received information saying the regulatory affairs role was non-existent, we were advised that someone in quality assurance was in charge of regulatory affairs duties. Nevertheless, our results suggest a greater knowledge capacity for regulation in the largest companies where regulatory affairs teams are at their biggest. In organizations where quality assurance employees have direct and sole responsibility for maintaining regulatory compliance and quality assurance, these specialists may be under significant work-pressure. This may explain our findings of greater levels of dissatisfaction among quality assurance respondents regarding regulation-related resources provided to them, team sizes, and the lower regulatory compliance performance seen associated with quality assurance versus regulatory affairs specialists.

We cite a lower level of regulatory knowledge among marketing respondents. Perhaps this reflects a gap in knowledge of the value marketing teams could offer NPD, and perhaps it explains the absence of marketing teams during concept and design development phases in a high number of cases, which a stronger culture for regulation could help redress.

Interestingly, we reveal a low level of respondent knowledge regarding regulatory-related performance data; the extant literature advises that employees should have knowledge of performance results to improve their performance. We suggest that MDD would benefit from greater stakeholder knowledge of regulatory performance outcome measures.

The knowledge amongst respondents that regulation impacts a product's safety and reliability, appears to be well communicated to respondent. This finding reflects a culture that associates regulation with good practice. It is interesting that only 27.3% consider that regulation has its "*greatest impact*" or its "*second greatest impact*" on '*speed to market.*' This finding suggests that respondents do not feel that regulation hinders speed of market access. However, it may also suggest that the majority of respondents are ignorant of the direct connection between acquisition of regulatory approval and market access. In other words, stakeholders may not fully appreciate that if regulatory approval is achieved efficiently through a wholehearted company approach and employee commitment toward regulation, it will positively influence the speed of market access. This finding may be the most significant one of our study.

Consequently, a culture that would encourage *embracing regulation* has the potential to improve outcomes of all the measures in our study. A culture of regulation would insist on a number of conditions; first, a strategy for regulation supported by the corporate strategy; second, senior management displaying very strong commitment to regulation including promotion of regulatory knowledge training, dissemination of regulatory performance data to employees and encouragement of high levels of communication on regulatory matters; third, teams fostering cross-functional collaborations including

marketing teams' involvement during earlier product development phases to confirm product definitions and drive closer alignment of definitions leading to more rapid commercialization. Furthermore, a stronger culture for regulation would encourage marketing teams, in particular, to take a more proactive approach in gathering post-marketing surveillance information that would improve compliance and could advance improved medical device innovation outcomes. As Medina et al. (2013) explain, "the regulatory requirements […] play a substantive role in shaping activities and decisions in the [development] process." Consequently, regulatory requirements must always be at the forefront of all considerations regarding MDD.

6 Conclusions and Recommendations

Regulatory strategies are built around the classification of devices according to risk, so, as medical devices become increasingly elaborate and complex, regulatory strategy demands will grow (Holger, 2002; Tobin & Walsh, 2011). Tensions between NPD and regulatory compliance are therefore likely to become increasingly salient in MDD. Also, new collaborations will grow between multidisciplinary teams and will require nurturing because of divergent and competing objectives. This is a highly complicated scenario that companies must learn to navigate to enable timely market entry and organizational survival.

Our findings expose serious gaps in the management of medical device innovation. We emphasise the need for management within the industry to put a stronger emphasis on regulatory management over speed to market; incorporate regulatory strategy into the corporate agenda; encourage improved relationships and collaborations between multidisciplinary teams during MDD, particularly in the earliest process phases of development when product definitions are being determined; actively gather and share post-marketing feedback; and encourage knowledge of regulatory performance amongst key stakeholders; all to enable more effective and efficient MDD within its regulatory framework.

If our work exposes nothing more than the direct influence regulatory management has upon the speed at which new medical devices can enter and continue to thrive in their markets, it will have been worthwhile. We conclude by recommending that the medical device industry adopts an organizational culture for regulation by "embracing regulation" throughout all MDD activities.

7 Contribution

This research is significant first because it is built on real world empirical data and to our knowledge no comparable data exists; we believe our study within the medical device industry based in Ireland is the first and largest of its kind. Given the size and significance of this industry in Ireland and globally, this in itself makes our contribution meaningful. Our work contributes to the study and practice of MDD. It identifies factors associated with expediting MDD and exposes key issues requiring further research into the management MDD. Overall, it expands our knowledge and deepens our understanding in an area of mutual benefit to our economy, the medical device industry, medical professionals and the public at large.

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Characterisation of the Manufacturing Sectors of High and Medium-High Technology Compared with Other Industrial Sectors

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Abstract: This study aims to identify the main characteristics of the activities concentrating on R&D and innovation in the industrial sector of high and medium-high technology, and also the main differences with regard to non technological sectors. In order to do so we use data on 1540 manufacturing companies in Spain in two subgroups according to the National Classification of Economic Activities (CNAE). The data correspond to the values of 44 variables organised into 5 blocks of activity that have to do with R&D and innovation. The study includes an exploratory-descriptive analysis with the aim of providing information, and evidence of the outstanding characteristics of sectors with more technological components compared with other industrial manufacturing sectors. Although the study refers to Spanish companies, a large proportion of the results are easily transferrable to similar socioeconomic environments.

Keywords: High Technology; Medium-High Technology; innovation, R&D.

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Introduction

Sectors with a high added value, such as the production of high technology that requires a more demanding preparation, have not experienced the desired drive and are still in a minority in Spain (as far as the number of companies, the generation of employment, and added value are concerned). The result of all this is a lower competitiveness than other neighbouring countries (Instituto de Estudios Fiscales, IEF, 2014).

With the aim of analysing the impact of technology on industrial performance, it is important to be capable of identifying those industries and products that are more technology-intensive by means of special classifications (Hatzichronoglou, 1997). In Spain in order to determine the list of high-technology activities and products we start from the methodological studies carried out by the OECD on this subject, together with their adaptations to the European situation carried out by Eurostat (Instituto Nacional de Estadística, INE, 2005).

High and medium-high technology

The Spanish National Institute of Statistics INE (2013) considers technology to be the stock of knowledge that is necessary to produce new products and processes. High technology is particularly characterised by: i) fast renovation of knowledge far superior to that of other technologies, and ii) its degree of complexity, which requires a continuous research effort and a solid technological base (INE, 2005, 2011).

For statistical purposes, the definitions of high technology and medium-high technology are generally achieved by an exhaustive listing of the branches of activity (sector approach) and of the products (product approach) which are considered at a given moment to be of high technological content. It should be stressed that on establishing definitions for high and medium-high technology a certain ambiguity can be observed because the choice of thresholds for separating the segments is arbitrary (INE, 2005). On the other hand, according to Hatzichronoglou (1997) the construction of a complete classification of industries based on their technological intensity raises a series of difficulties:

- The first is the difficulty in establishing the criteria to identify the technological content of an industry, given the dynamic of change present in technologies.
- The second, the difficulty in establishing the concept of what a high technology industry is: is it one producing technology or one using technology in an intensive manner?
- A third aspect or problem is that there is always some degree of arbitrariness in the selecting of the cut-off points among the classes of technology.

It should be pointed out that owing to the very nature of high technology its definition changes over time; the high technology of the present will be traditional technology in the future if it still survives. The speed at which technological change occurs constitutes a difficulty in the measuring of this phenomenon as the field of study may vary from one moment to the next (INE, 2005).

Eurostat (2007) stresses that the subsectors of high technology and medium-high technology manufacturing are of great importance to science and technology. In accordance with this, in recent years the INE has been carrying out joint analyses for high and medium-high technology sectors, joining them both and associating statistical data in a combined manner (INE, 2011, 2013b, 2016). It is for this reason that this study also takes high and medium-high technology as

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the only industrial segment to be analysed. Moreover, previous studies (Delgado-Verde, et. al., 2011; Grimpe & Sofka, 2009; Robertson, et. al., 2009; Santamaría, et. al., 2009; and Santos & Vázquez, 1997) emphasise the links and special features of each of the sectors and between them.

Origin of the CNAE classification in Spain

By means of RD 475/2007 the Spanish Ministry of Economy and Finance (2007) approves the National Classification of Economic Activities (Clasificación Nacional de Actividades Económicas 2009, CNAE-2009) with the aim of reflecting the structural changes in the economy and in particular technological development. This decree is developed as from the latest revision of the latter (RD 1560/1992), which established a classification of economic activities known as CNAE-93 that underwent a minor updating in 2003. In accordance with the CNAE-2009 classification, the high and medium-high technology manufacturing industry will be made up of the sectors in Table 1 depending on the intensity of their R&D.

Table 1. Classification of manufacturing industries in high and medium-high categories.

CNAE 2009	Sectors
	High technology manufacturing sectors
21	Manufacturing of pharmaceutical products
26	Manufacturing of computer, electronic, and optical products
30.3	Aeronautic and spatial construction and its machinery
	Medium-high technology manufacturing sectors
20	Chemical industry
25.4	Manufacturing of arms and ammunition
27 a 29	Manufacturing of electrical material and equipment; manufacturing of machinery and equipment n.c.o.p (not classified in other places); manufacturing of motor vehicles, trailers, and semi-trailers
30-30.1 30.3	Manufacturing of other transport material except: naval construction; aeronautical and spatial construction and its machinery
32.5	Manufacturing of medical and dental instruments and supplies

Source: INE (2016)

Indicators for high and medium-high technology

With the objective of being able to analyse and measure the impact of R&D on the various industrial sectors, a set of indicators is necessary with a clear definition that allows the carrying out of comparative analyses. High technology indicators are conceived precisely as a means of measuring the results and the impact of R&D (INE, 2011). In this sense the OECD has been gathering data regularly from the member countries since 1960. During the 1990s it also gathered R&D data for a selection of the economies of non member countries.

In accordance with the INE (2005) there are many sources of Spanish statistics including sets of R&D indicators for the high and medium-high technology sector. These are as follows: i) Statistics on R&D activities (the proportion of companies carrying out R&D internally, personnel employed in R&D activities, researchers, technicians, assistants, money spent on internal R&D activities, and R&D intensity…). ii) Surveys on technological innovation in companies (innovation in products, processes, innovative activities, money spent on innovative activities, on internal and external R&D, on purchasing machinery and equipment related to technologically new or improved products and processes, on purchasing immaterial technology, on training related to technologically new or improved products and processes, on marketing technologically new or improved products,…) iii) industrial survey of companies (business turnover, sale of products, and added value).

However, given the existence of indicators for technological activity involving R&D, other aspects that may play an important part are: a) technology incorporated in patents, licenses, and know-how; b) technical cooperation strategies among companies; c) rapid obsolescence of the knowledge available; d) rapid rotation of equipment (Hatzichronoglou, 1997); e) external sources such as the use of consultants, the contracting of personnel, and collaboration and external R&D agreements (Santamaría et al., 2009) and f) The adopting of knowledge (OCED/Eurostat, 2007).

According to Hatzichronoglou (1997), the INE (2005), the OCED/Eurostat (2007) and Santamaría et al. (2009), a set of variables linked to R&D and innovation activities has been identified and are commonly used to establish high and medium-high indicators with an approach of classification by industrial sectors. The variables selected establish the carrying out or otherwise of various types of activities that are grouped in 5 factors and which will be described in detail in a next section.

State of the high and medium-high technology manufacturing sector in Spain

With the objective of having an initial idea of the situation of the sector of high and medium-high technology manufacturing companies in Spain, official statistics of the Spanish National Institute of Statistics (INE) were used. The year selected for the study, 2014, corresponds to a period with very special characteristics in Spain with an economic crisis that was at its peak. According to the INE (2016), i) The business turnover of manufacturing companies in Spain from the high and medium-high technology sector was 158,058 million euros in 2014, which represented an increase of 5.2% compared to 2013. ii) The high technology sectors employed 1,205,500 people in 2014, which was 7.0% of the total number of the working population of the Spanish economy. 28.9% of the total number of people working in these sectors were women. The number of those working in the high technology manufacturing sectors rose to 136,400, while those of medium-high technology employed 542,900 people. iii) Companies from high technology sectors invested 4,506 million euros in R&D in 2014, 1.5% less than the previous year. This figure meant 66.4% of the total expenses of the business sector in R+D activities. The number of full-time employees devoted to R&D tasks in the high technology

sector rose to 56,165.7, which was 0.1% less than the previous year. The branches of the high technology sector brought together 64.1% of the total number of personnel devoted to R&D in the business sector and 66.6% of researchers. iv) 41.9% of the companies belonging to the high and medium-high technology sectors were innovative during 2012-2014. In this sense we can emphasise the branches of the manufacturing of pharmaceutical products (with 64.4% of innovative companies during the period), the manufacture of computer, electronic, and optical products (with 54.6%) and the chemical industry (with 50.5%).

Methodology

Descriptive exploratory analysis

The methodology used in this study is of the descriptive-exploratory type. Exploratory studies are carried out when the objective is to examine a subject that has been little studied or not approached before. Exploratory studies allow one to become familiar with relatively unknown phenomena, to obtain information on the possibility of carrying out more complete research regarding a specific context, to research new problems, to identify promising concepts or variables, to establish priorities for future research, and to suggest affirmations and assumptions (Hernández, et al. 2006). On the other hand, descriptive studies describe phenomena, situations, contexts and events and give details on what they are like and how they appear. Descriptive studies aim to specify the properties, characteristics, and profiles of people, groups, communities, processes, objects, and any other phenomena subjected to an analysis. In other words, they measure, assess, and gather data on various concepts, aspects, dimensions, or components of the phenomenon to research; their objective is not to indicate how the variables measured interact. Exploratory studies are essentially for discovering and prefiguring; descriptive studies are useful for showing precisely the dimensions of a phenomenon, event, community, context, or situation (Hernández, Fernández, and Baptista, 2006).

Source and identification of the data to use

The source of data for carrying out this study was the Survey of Business Strategies (Encuesta Sobre Estrategias Empresariales, ESEE) of 2012 of the SEPI foundation (Sociedad Estatal de Participación Industrial). In the first place a total of 44 nominal (dichotomic) and ordinal variables were selected to allow the identification the performance or nonperformance of several R&D and innovation activities in companies of the high and medium-high technology industrial sector and other companies in industrial manufacturing sectors.

The sample consists of a total of 1540 companies of which 439 belong to high and medium-high technology segments compared with 1101 companies from other industrial manufacturing sectors. Within companies of technological segments the sample includes representatives of the chemical and pharmaceutical industry (137 companies), computer and electronic products (31 companies), machinery and electrical material (74 companies), agricultural and industrial machines (110 companies) and motor vehicles (87 companies).

The sample also includes companies of different sizes. If we use a classification between companies with 200 workers or less and companies with over 200 workers, the group of smaller companies is more numerous in both industrial sectors. In high and medium-high technology companies those with 200 workers or less represent 69.25% of the sample compared with 84.74% in the remaining companies. In other words, the group of companies with over 200 workers has a higher proportion with 30.75% in the high technology sector in comparison with 15.26% in the segment of other manufacturing sectors.

State of the high and medium-high technology industrial manufacturing sector in Spain

As has been mentioned, in order to identify relevant characteristics that allow the description of the R&D and innovation activities in high and medium-technology companies a set of 44 nominal dichotomic variables (existence or not) were considered. According to the type of activity they measure, the variables were divided into the following 5 factors:

1) Marketing activities
2) Technological activities
3) Activities of incentives and financing in R&D and innovation
4) Activities of innovation
5) Personnel contracted devoted to R&D activities

The following sections will indicate the variables corresponding to each factor and at the same time they will present the results of the analysis of their values in the companies of the sample. Particular attention will be paid to the most significant differences when the results of the subgroup of the 439 high and medium-high technology companies are compared with those of the 1101 manufacturing companies from other sectors.

Marketing activities

The variables related to marketing activities include 7 that measure whether products not manufactured by the company are marketed and whether import and export activities or internet sales are carried out and the impact of the latter on business results. Table 2 includes an identifier of the variable together with its name, a brief description, and the percentages of companies in the two subgroups of the sample (high and medium-high technology on the one hand and the remainder on the other) carrying out the corresponding activity. The last column in the table shows the ratio between the number of high and medium-high technology companies and companies from other manufacturing sectors carrying out the activity.

Table 2. Marketing activities: percentage comparison by activity type and by industrial manufacturing sector.

Variable	Description	High and medium-high technology	Other sectors	Ratio
Commercialization of national products not manufactured by the company (COMNP)	% of companies reporting commercialization of products not manufactured by them	27,79	35,60	0,78
Commercialization of foreign products not manufactured by the company (COMFP)	% of companies commercializing foreign products	35,31	18,17	1,94
Importing (IMPORT)	% of companies importing	89,98	65,67	1,37
Exporting (EXPORT)	% of companies exporting	89,98	61,31	1,47
Sales to companies on the Internet (WEBB2B)	% of companies with a system for selling to other companies on the Internet	10,71	9,45	1,13
Sales to final consumers on the Internet (WEBB2C)	% of companies with a system for selling to final consumers on the Internet	6,15	10,17	0,60
Effect of sales on the Internet (WEBE)	% effect (strong or light) that the presence of Internet has had on the sales of the company	37,81	36,97	0,98

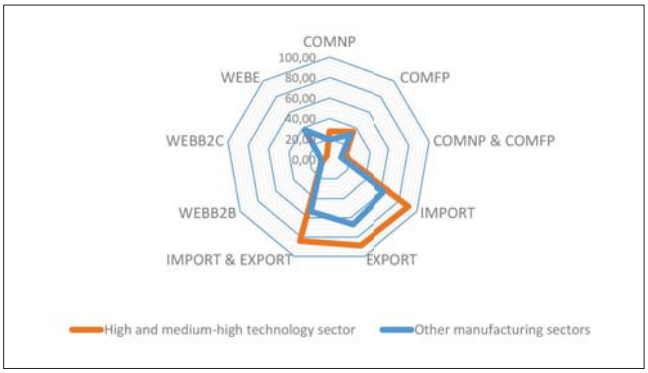
As can be seen in both Table 2 and Figure 1, both in the high and medium-high technology industrial manufacturing sector and in other sectors the percentage of companies commercializing products that they have not manufactured is greater in the case of products manufactured in other countries than in Spain. Moreover, this type of marketing activities is more frequent in high and medium-high technology companies.

It should also be stressed that 89.98% of high and medium-high technology companies are involved in importing and 89.98% in exporting. In the same way, all these activities are more numerous in the high and medium-high segment in relation to other manufacturing sectors in ratios of 1.37:1 for importing and 1.47:1 for exporting respectively.

Regarding e-business activities, the percentage of companies making sales on the Internet to other companies (B2B models) is 9.45% for companies belonging to the segment of other industrial manufacturing sectors and 10.71% for companies in the high and medium-high technology segment, which are very similar figures. However, in e-business sales to final consumers (B2C models) high technological companies have less activity. This is confirmed on analysing the variable in which companies declare the effect that e-business has on their trading; 36.97% of manufacturing companies from other sectors declare a strong or light effect while in the sector of higher technology this percentage is 37.81%.

It can be observed, particularly in Figure 1, how the profiles of the activities of companies from the high and medium-high technology industrial segment and from that of the remaining manufacturing companies follow a similar pattern in which the intensity of the activities is greater in the high and medium-high technology company segment.

Figure 1. Marketing activities: percentage comparison by activity type and by industrial manufacturing sector.



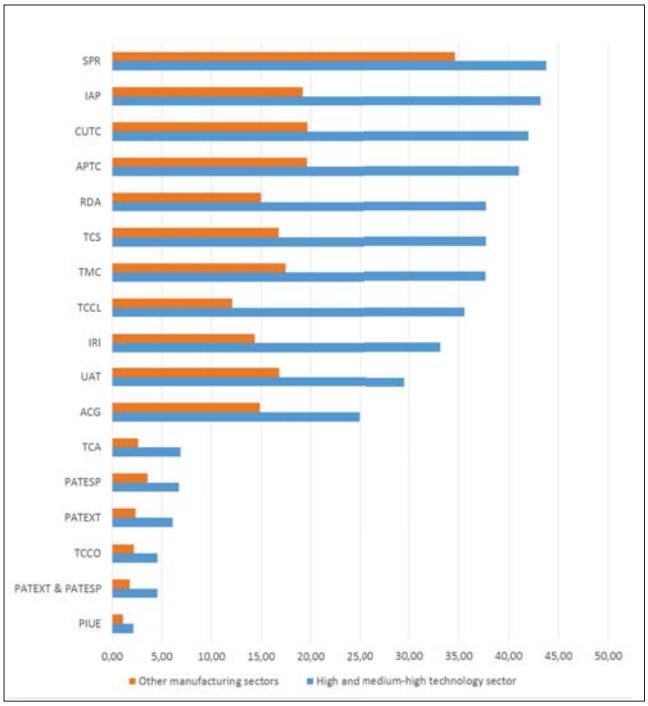
Technological activities

The second of the factors to analyse is determined by a total of 16 variables that refer to aspects such as the existence of technological cooperation agreements, the acquiring of capital goods to improve products, R&D activities, the existence of technology management or committees, a plan of innovation activities, subcontracting products or components, using advisers to find out about technology, indicators of results of innovation, the assessment of perspectives of technological change, technological collaboration with clients, competitors, suppliers, and with universities, participation in EU research programmes, and the registering of patents both in Spain and abroad. Together with the values measured in the sample, all these variables are included in Table 3. Figure 2 aims to illustrate the differences observed on analysing these variables in the high and medium-high technology industrial segments and other manufacturing sectors. The values shown indicate the percentages of companies from each segment carrying out the corresponding technological activity.

Table 3. Technological activities: percentage comparison by activity type and by industrial manufacturing sector.

Variable	Description	High and medium-high technology	Other sectors	Ratio
Technological Cooperation Agreements (TCA)	% of companies with cooperation agreements (joint venture)	5,92	2,45	2,42
Acquiring Capital Goods to Improve Products (ACG)	% of companies acquiring capital goods for improving products	22,10	14,71	1,50
R&D Activities (RDA)	% of companies with R&D activities contracted or carried out	61,50	27,70	2,22
Technology Management or Committee (TMC)	% of companies with technology management or committees	45,10	15,53	2,90
Innovation Activity Plan (IAP)	% of companies with innovation activity plans	41,46	17,71	2,34
Subcontracting of products or components (SPR)	% of companies subcontracting products or components	44,87	31,15	1,44
Using advisers to find out about technology (UAT)	% of companies using advisers to find out about technology	27,79	17,08	1,63
Innovation result indicators (IRI)	% of companies drawing up innovation result indicators	31,66	14,08	2,25
Assessment of perspectives of technological change (APTC)	% of companies assessing perspectives of technological change	37,59	19,16	1,96
Technological collaboration with clients (TCCL)	% of companies with technological collaboration with clients	33,49	9,81	3,41
Technological collaboration with competitors (TCCO)	% of companies with technological collaboration with competitors	4,56	1,73	2,64
Technological collaboration with suppliers (TCS)	% of companies with technological collaboration with suppliers	37,13	15,71	2,36
Collaboration with universities and/or technological centres (CUTC)	% of companies with technological collaboration with universities and/or technological centres	40,32	18,71	2,15
Participation in EU research programmes (PIUE)	% of companies participating in European Union programmes	1,82	0,91	2,01
Patents registered abroad (PATEXT)	% of companies that during the accounting period register patents outside Spain	6,83	1,63	4,18
Patents registered in Spain (PATESP)	% of companies that during the accounting period register patents in Spain	7,74	2,63	2,94

Figure 2. Technological activities: percentage comparison by activity type and by industrial manufacturing sector.



In Figure 2 four subgroups of technological activities in high and medium-high technology companies can be observed; they are classified according to the degree of appearance in the sample analysed:

- The first subgroup includes those activities carried out by over 40% of companies in the high and medium-high technology segment. It is here that we can find activities such as the subcontracting of products or components, the drawing up of innovation activity plans, technological collaboration with universities and/or technological centres, the existence of technological management or committees and the contracting of R&D.

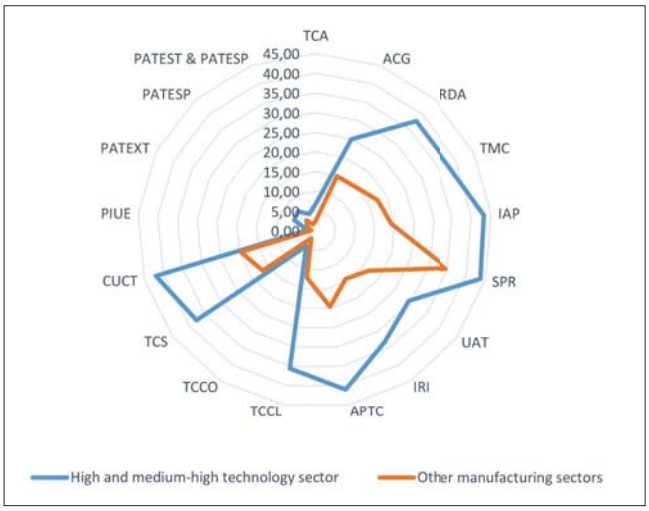
- The second sub-group, with percentages of activities carried out of between 30 and 38%, includes activities such as, technological collaboration with clients and suppliers, the assessment of perspectives of technological change and the drawing up of innovation result indicators.

- The third subgroup, which includes between 20 and 30% of the companies in the segment, includes activities such as the use of advisers to find out about technology, and the acquiring of capital goods for improving products.

- Finally there is a subgroup of activities present in small percentages of companies (less than 8%): technological cooperation agreements, registering patents in Spain or elsewhere, technological collaboration agreements with competitors, and participation in European Union research programmes.

In the case of manufacturing companies from other industrial sectors, the most common activities are the subcontracting of products or components, the contracting of R&D, the assessment of perspectives of technological changes, the technological collaboration with universities, but all of these with a lower range of intensity (in between 18 and 22% of companies) in comparison to companies belonging to the high and medium-high technology segment. Precisely when the results obtained in the segment of technology companies are compared with those of the remainder of companies, a similar pattern can be observed in relation to the activities carried out (see Figure 3). Nevertheless, in general terms for each company from other sectors carrying out one of the activities there are on average 2.22 technological companies carrying out this activity. The most striking differences are found in technical cooperation with clients (for each company from other sectors carrying this out there are more than 3 technological companies) and in the registering of patents both in Spain and elsewhere.

Figure 3. Technological activities: percentage comparison by activity type and by industrial manufacturing sector.



Activities of incentives and financing in R&D and innovation

Within the factor of incentives and financing in R&D and innovation only two variables have been considered, on the one hand identifying whether companies apply tax incentives for R&D and technological innovation, and on the other whether they choose to finance innovation with subsidised loans. Table 4 shows the percentages of companies in the two industrial segments in which these variables have a positive reading. As can be seen, both activities are more frequent in companies from the high and medium-high technology industrial segment in a ratio of almost 3 if we compare them to other sectors in the case of incentives for R&D, and more than double in the case of the use of subsidised loans.

Table 4. Activities of incentives and financing in R&D and innovation: percentage comparison by activity type and by industrial manufacturing sector.

Variable	Description	High and medium-high technology	Other sectors	Ratio
Applying R&D tax incentives (RDIN)	% of companies applying R&D tax incentives	32,35	11,44	2,83
Financing innovation with subsidised loans (FISL)	% of companies financing innovation with subsidised loans	20,05	7,27	2,76

Innovation activities

Innovation activities can be divided into four categories: innovations in marketing, in organisational methods, in products, and in processes. In total the 16 variables included in Table 5 have been considered. The first category contains innovations in marketing by design, by promotion, in sales channels, and in pricing. Innovations in organisational methods also include innovations in work organisation or in external relations. When analysing innovations in products a differentiation is made between innovations in new components, new functions, and new materials. Finally, process innovations may be due to the use of new equipment, new computer programmes, or new techniques. Table 5 includes the percentages of companies considered in the two segments carrying out the various activities of innovation. As in the previous cases, a greater intensity in innovation actions can be observed in the high and medium-high technology segment of companies.

Table 5. Innovation activities.

Variable	Description	High and medium-high technology	Other sectors	Ratio
Marketing innovations (MKI)	% of companies carrying out marketing innovations	22,55	19,53	1,15
Innovations in retail channels (IRCH)	% of companies carrying out innovations in retail channels	7,29	8,08	0,90
Innovations in marketing by design (IDES)	% of companies carrying out innovations in marketing by design	12,76	11,35	1,12
Pricing innovations (PRI)	% of companies carrying out pricing innovations	7,52	5,00	1,50
Innovations in marketing by promotion (IPROM)	% of companies carrying out innovations in marketing by promotion	11,16	9,81	1,14
Innovations in organisational methods (IOM)	% of companies carrying out innovations in organisational methods	31,21	18,98	1,64
Innovations in the management of external relations (IMER)	% of companies carrying out innovations in the management of external relations	14,35	9,54	1,50
Innovations in work organisation (IWO)	% of companies carrying out innovations in work organisation	28,93	17,98	1,61
Product Innovations (PI)	% of companies with product innovation	30,75	14,08	2,18
Innovation of product by new components (IPNC)	% of product innovation by new components	22,78	8,27	2,76
Product innovation by new functions (IPNF)	% of product innovation by new functions	23,01	9,08	2,53
Product innovation by new materials (IPNM)	% of product innovation by new materials	20,05	9,99	2,01
Obtaining process innovations (IPR)	% of process innovations	43,28	28,52	1,52
Process innovations by new equipment (IPRNE)	% of process innovations by new equipment	33,03	21,71	1,52
Process innovations by computer programs (IPRCP)	% of process innovations by computer programs	20,96	10,90	1,92
Process innovations by new techniques (IPRNT)	% of process innovations by new techniques	28,25	14,17	1,99

In Figure 4 it can be observed that those innovation activities that are most frequent in high and medium-high technology companies, being present in over 30% of companies, are process innovations, innovations by new equipment, innovations in organisational methods, and product innovations. At a second level, with percentages of between 20 and 30%, we find innovation in work organization, process innovations by the use of new techniques, product innovations by new functions or new components, marketing innovations, process innovations by the use of computer programmes and product innovations by new materials. With a presence in less than 15% of companies we find innovations in the management of external relations, in marketing by design or by promotion, in marketing outlets, and in pricing innovations.

Figure 4. Innovation activities.

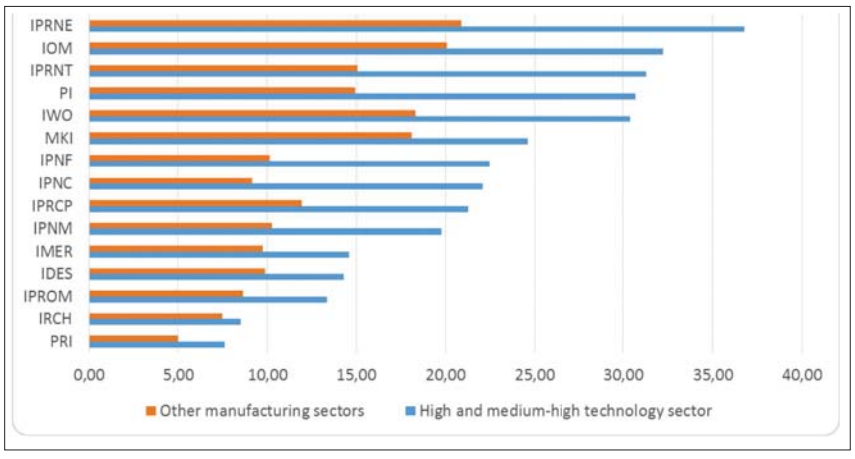


Figure 5 shows in overall graphic form that both high and medium-high technology companies and companies from other industrial sectors follow a similar pattern in relation to the activities carried out. However, in general terms innovation activities are more frequent in technological companies; for each company from other industrial sectors there are on average 1.69 companies from the high and medium-high technology industrial segment carrying out such activities.

Figure 5. Innovation activities.

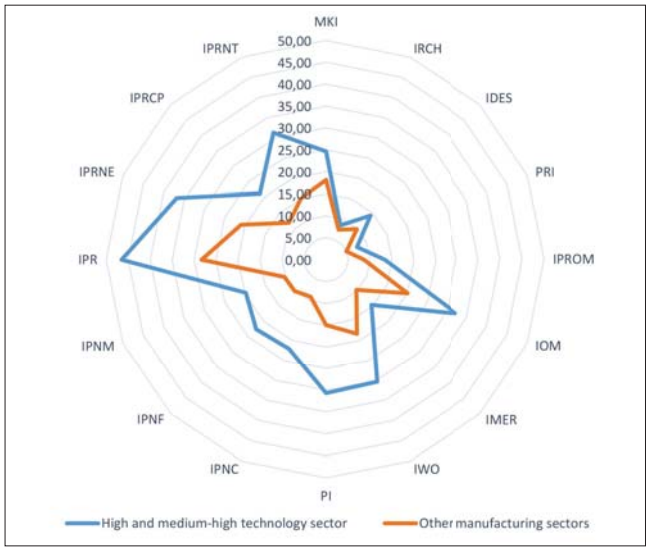
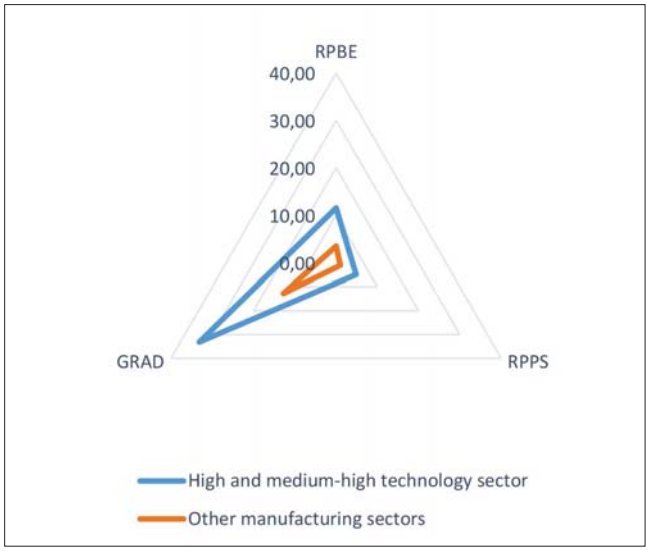


Figure 6. Personnel contracted devoted to R&D activities



Personnel contracted devoted to R&D activities

Finally, the last factor that was considered important in the analysis was that of the human resources that companies devote to R&D activities. In this case only 3 variables are considered: if during the year the companies recruited personnel with R&D business experience, personnel with professional experience in the R&D public system, or engineers and/or recent graduates. Table 6 shows the percentages of the companies of the two segments in which variables are positive; this same information is shown in graphic form in Figure 6.

Table 6. Personnel contracted devoted to R&D activities

Variable	Description	High and medium-high technology	Other sectors	Ratio
Recruiting personnel with R&D business experience (RPBE)	% of companies recruiting people with R&D business experience	10,71	3,09	3,47
Recruiting people with R&D professional experience in the public sector (RPPS)	% of companies recruiting people with R&D experience in the public sector	4,10	0,82	5,02
Hiring of engineers and/or recent graduates (GRAD)	% of companies hiring engineers and/or recent graduates	32,57	10,17	3,20

In both Table 6 and in the corresponding Figure 6 the same pattern can again be seen as to the contracting of R&D personnel in the two business segments, but to a substantially higher degree in high and medium-high technology companies. The effort made to contract research personnel is more than trebled in these companies. The difference that can be observed in the hiring of personnel with R&D experience in the public sector is particularly striking. It is also noticeable that a third of the companies in the technological sector contracted recent graduates, more than triple the figure for the remaining sectors.

Conclusions

In essence this exploratory and descriptive study has served to gather preliminary evidence allowing the identification of characteristics of high and medium-high technology manufacturing companies which differentiate these companies from those belonging to other industrial manufacturing industries in Spain. Considerable differences have been observed in reference to the intensity with which these companies carry out different activities related to R&D and innovation. It should be emphasised that the study has been carried out in consolidated form for each of the two segments established without a differentiation by industrial subsector type within each one of them. Some of the most important aspects observed in the study are highlighted below.

Small and medium-sized enterprises with 200 workers or less are predominant in all industrial sectors; however this predominance is not so great in companies in the high and medium-high technology segment. To be precise, 69.25% of the companies in this segment are small or medium-sized enterprises compared with a percentage of 84.74% in other sectors.

It is observed that the profile of activities of companies belonging to the high and medium-high technology industrial segment and to other industrial manufacturing sectors follows a similar pattern. However, the intensity of the activities is greater in the segment of high and medium-high technology companies. In general terms, for each company from other industrial sectors carrying out the activities studied, 2.07 companies have this same activity in the high and medium-high technology sector. Perhaps the only aspect of those analysed in which a rather different pattern is observed is that related to e-business, in which technological companies rely more on B2B models and not so much on B2C models. Another noticeable difference is that in companies in other manufacturing sectors there is a greater proportion of companies that commercialize products not manufactured.

It has been possible to confirm that a set of technological activities exist that are quite common in high and medium-high technology companies; they are present in over 50% of the companies of the sample. These actions include importing, exporting and contracting R&D activities. On a second level can be found the existence in the companies of technology management or committees, the subcontracting of products or components, process innovations, management based on innovation plans, collaboration with universities and research centres, effect of sales on the Internet, the assessment of perspectives of technological change, technological collaboration with suppliers and commercialization of foreign products not manufactured by the company; these activities have been declared by over 35% of technological companies. It is also of note that almost 30% of the companies in the technological segment have recourse to advisers to find out about technology. Some of these activities are also relatively common in companies from other sectors, but in clearly lower percentages.

It may be important to analyse those actions in which the percentage of their presence in technological companies is considerably greater than in other companies. The most notable differences are found in the hiring of personnel with experience in R&D; for example, during the year some 4% of technological companies hired personnel with professional R&D experience in the public sector compared with less than 1% in companies from other sectors. It should also be understood that the situation prevalent during the study was one of economic crisis and the need to reduce the public deficit, which led to major cutbacks in research personnel in research centres and universities. The hiring of new personnel with R&D business experience was also considerably higher in technological companies with a percentage that trebled that of the remaining sectors. Differences were also observed in the hiring of recent graduates, which is multiplied by 3.2 in technological companies. It therefore seems clear that an important feature of these companies is the faith placed in highly qualified human capital and experience in research, development, and innovation.

Other activities in which the percentage of technological companies that have carried them out during the year under study are significantly higher than those of other sectors are: the registering of patents in both Spain and elsewhere, the existence of technological cooperation agreements, the existence of technological management, application to R&D tax incentives, access to subsidised loans for financing innovation and product innovations (by new functions, components, or materials). In general these companies have much more intense R+D activity, they are concerned with innovation in its different facets and are aware of the importance of technological supervision and devote resources to it. In relation to the first aspect, that of innovation, there are 3 subgroups in high and medium-high technology companies. The first concerns the carrying out of process innovation activities by new equipment and new techniques, of organisational methods, and of product innovations; a second subgroup concerns the carrying out of marketing innovation activities, production innovations by new functions, by new components, by new materials, and process innovation by the use of computer programmes. The third subgroup is more orientated towards the carrying out of innovation activities in the administration of external relations, in marketing by design and promotion, innovation in marketing outlets, and pricing innovation.

Finally, significant differences have also been observed in the search for external sources of financing. It is observed that during the year under study a 20.05% of technological companies resorted to subsidised loans for innovation activities and 32.35% made use of R&D tax incentives, compared with percentages of 7.27 and 11.44% respectively in the remaining sectors. There are also clear differences in participation in research programmes of the European Union, where despite the fact that only 2% of companies took part this figure doubled that of companies from the remaining sectors.

This study has achieved its aim of identifying characteristics of companies from industrial manufacturing sectors linked to high and medium-high technology and establishes a basis for possible more complex future studies. As a future line of work we propose the use of data mining techniques to explore the data of the survey analysed and discover hidden relationships in the data. Although the study has been a static one concentrating on only one year, it is true that this moment in time is an important one that can justify the study as it refers to an economic crisis. It is proposed to carry out a dynamic study in the future as complete data are obtained from the Business Strategy Survey (Encuesta Sobre Estrategias Empresariales, ESEE) of the SEPI Foundation on later periods.

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Vectors of Innovation Definition for Application During Conceptual Design Stage of Product Development Process

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Abstract: The quest for product with unique attributes and added value, along with the shortening of product life cycle are directly related to the degree of competitiveness of organizations. The identification of innovation opportunities in the early stages of the product development process is seen as a means for increasing competitiveness. Among those stages that have relevant impacts during the design process, is conceptual design, when many important decisions related to the degree of novelty of a design solution are taken. This study aims at identifying elements connected to innovation issues that can contribute to the selection of conceptual proposals that have potential to be transformed into novel and successful products. To map these elements, a literature review was conducted in parallel with a reverse analysis of a set of so called innovative products. From the recognition and grouping of these elements that can induce innovation, a field research was conducted with professional designers in order to identify if they recognized the set of elements as representing vectors of innovation, as well as, their relative importance. Next, a descriptive application was run, considering a real design situation extracted from literature, illustrating how to select a conceptual design solution that presents the greater potential for innovation, from the set of elements identified. Thus, this study provides the identification and determination of degrees of importance for inducing elements innovation in order to demonstrate the possibility of assessing potential for innovation in the early stages of the product development process.

Keywords: innovation; conceptual design; selection of alternatives; early stages of product development process.

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Introduction

Considering the current scenario of economic contention companies are required, at least, to maintain their level of competitiveness, so they can keep the business going. Also since the customers are better informed, they look for products that exceed their expectations, usually presenting attributes that differentiate them in the market. It is also being observed the need to launch new products at shorter intervals, mainly due to the reduction of the product life cycle (Coral; Ogliari; Abreu, 2008).

Xie et al. (2016) argue that knowledge, as both a source of power and a resource, is strategically important for innovation activity. Companies should look for ways to enhance the development of knowledge and use it effectively. Organizations that always follow the same pattern, working with products and saturated technologies, tend to lose its share in the market. From these observations, it is possible to understand that innovation becomes an essential requirement during the PDP (Product Development Process). The definitions reflect a common idea in which innovation is a process conducted since the invention (the basic idea, sketch or model for a project, product, process or new (or enhanced) system) to the results dissemination for a group of potential customers (Padilha, 2008). The conversion of this new idea into a product involves various activities such as research, design, development, embodiment engineering and manufacturing, among others. Therefore, innovation should be inserted into a systematic process, so it will not occur randomly (Pahl et al., 2005; Rozenfeld et al., 2006; Coral; Ogliari; Abreu, 2008; Back et al., 2008).

The innovation comprises a complex and multidisciplinary arena in which the new products development process should be considered as a core component. Decisions taken during the PDP can directly influence the outcome expected to be achieved (i.e. innovation), in addition to the regular and planned activities that constitute the PDP (Zabala- Iturriagagoitia, 2012).

The PDP models found in several references are composed of several stages. It is during the conceptual design stage that principles of solution that define the final product are identified (Back et al., 2008). The selection process defines which concepts should be developed and those that must be abandoned. Thus, this stage can be seen as a gatekeeper of creative ideas that can lead to innovative products (Toh; Miller, 2015). Therefore, identifying elements that are innovation inducers, at early stages of the PDP, enables creative ideas to be promptly identified and matured so that they can result in a product with a potential of innovation.

From this context, this paper aims at identifying elements/criteria that can be used by the design team as vectors of innovation, during the early stages of the PDP. The research approach is based on an extensive literature review, coupled with a reverse analysis of five products considered innovative. The matches identified are described as innovations inducers and will be called elements that can integrate the framework for the decision-making process when the focus is centered on innovation. They were validated by a field survey with design professionals, who also defined their relative importance. An exemplifying application, structured from a real design case illustrates the approach developed.

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Theoretical Background

The literature highlights the importance of innovation capability as a critical success factor for the growth of organizations and the only means by which companies can obtain competitive advantage (Ukko, Saunila, 2013). There are various definitions and concepts related to the innovation term. The Oslo Manual (OECD, 2005) contains a general definition in which an innovation is the implementation of a product (good or service), new or improved, a process, a marketing method, or organizational method in the business practices, in the working arrangement or external relations.).

Zawislak et al. (2008) define innovation as the application of knowledge to generate technical or organizational changes capable of offering benefits to the company that produces it. This knowledge is new to the business, but not necessarily new to its competitors, to the market or the world. Thus, incremental changes would be in the center of the innovation process in developing countries.

The systematization of the new products development allows the company to identify opportunities, set priorities of their projects and optimize time and costs. "For organizations to ensure sustainability and launch new products/services systematically and continuously, they need to manage with caution the innovation issues" (Carvalho; Reis; Cavalcante, 2011, p. 55).

Product development is an activity that encompasses aspects of planning and design, from market research, through product design, manufacturing process design, distribution and maintenance plan, product use and its disposal. Thus, the product development should be seen as a holistic process "…transformation process of information needed for identifying the application, production and use of the product" (Back et al., 2008, p. 04).

Tondolo et al. (2012) consider two main streams for product development: i) the NPDP (new product development process) in a very close connection to radical innovations. In this case, the company must develop new management processes, new technologies, new materials or tools; and ii) PDP (product development process) in a context that includes any change in the product, including minor modifications or improvements implemented into existing products.

Among the stages that integrate the PDP it is during the conceptual design phase that, from the design specifications, concepts for a product are developed (Coral; Ogliari; Abreu, 2008). Li et al. (2009) emphasize the importance of design stage, in which it is possible to determine the level of innovation of the final product. Errors at this moment can compromise 70 to 80% of the investment allocated to the project. It is important to highlight that the term "product" refers to an idealized object, produced on an industrial scale, that has features and functions, which aim to meet desires or needs from customers or organizations, to whom it will be marketed. Usually, the attributes that are relevant for products are: appearance, shape,color function, image, material, packaging, brand, after-sales service and warranty (Back et al., 2008).

The Conceptual Design phase is characterized by the search, creation, representation and selection of solutions (Back et al., 2008). The central difficulty for the concept selection process is the main feature of the conceptual design phase: technical information is still limited and abstract (Rozenfeld et al., 2006). Pahl et al. (2005) state that there is no absolutely safe method that prevents there is no completely safe method that avoids wrong decisions to be taken. However, they reinforce that the use of systematic and verifiable selection methods enable a better management of this activity.

About the process of selection of alternatives, the literature points to the existence of models and tools that are intended to assist the design team, identifying desirable parameters or attributes into the product concept to be developed. These parameters enable a qualitative and quantitative evaluation of the solutions proposed using of weights and valuation of their attributes (Back et al., 2008). However, there is a lack of specific criteria with the focus on innovation aspects. Very often, innovation is one of the criteria to be evaluated and not the central point of the evaluation process.

Yilmaz and Seifert (2011) highlight the use of heuristics in the process of product ideation as a way to drive new possible solutions for the design problem. These heuristics may also serve as a starting point for the transformation of an existing concept into a set of new ideas. The authors gathered 21 heuristics observed during the evaluation of 50 sketches. The study by Yilmaz and Seifert (2011) aimed to describe the design heuristics, considering form and function issues, to identify transformational steps that can assist the design team in presenting a systematic variation in their current concepts, leading to a diversity of products in the company's portfolio.

To evaluate and select an alternative solution for a design problem, criteria related to the use, appearance, ergonomics, production, costs, among others, can be employed. Therefore, "a complete set of principle solution models should be developed to reach the so-called product concept models" (Rozenfeld et al., 2006, p. 265).

Rozenfeld et al. (2006) point to the importance of material definition during the development and selection of conceptual alternatives. Often, this selection is based on previous design decisions, limiting the possibility of adopting new materials, thus restricting the opportunity to innovate, by the usage of a new material or a new application for an already known material. A full understanding of functions implemented by industrial products can be valuable during the concept generation stage. Since certain products may be more related to a particular type of use than others, this factor can represent a differential attribute when designing a product.

Lobach (2001) states that the relations between customers and industrial products are those functions that the product implements. The functions are related to the consumer requirements satisfaction. The author highlights three types of functions: i) practical (related to the physiological aspects of the product usage), ii) Aesthetic (concerns the psychological aspect of sensory perception when using a product); and iii) symbolic (refers the psychological and social issues of a product handling).

During the process of developing suitable principle solutions (and, therefore, concepts), several factors should be considered: i) methods that help the searching for creative solutions, whether intuitive or systematic; ii) definition of the product architecture; iii) analysis of systems/subsystems/components; iv) identification of possible materials and production processes; v) forecast of aspects about life cycle of the product and vi) ergonomic issues and inter-relationship with the end-user (Rozenfeld et al., 2006).

Back et al. (2008) established a set of criteria that represent typical product attributes and can provide support in the process of selecting conceptual design alternatives. They are classified as i) elementary basic attributes (functionality, ergonomics, aesthetics, security, reliability, liability, patenting, standardization, robustness, environmental impact); ii) attributes of the life cycle (manufacturability, assembly ability packaging, transportability, storability, marketability, usability, maintainability, recyclability, disability; and iii) specific attributes (geometry, kinematics, forces, energy, materials, signs, automation). Several authors emphasize that the criteria should be clear, independent, unambiguous and equally applicable to all conceptions (Pahl et al., 2005; Back et al., 2008).

Sarkar and Chakrabarti (2011) state that an approach to assess the novelty of a product is through of products comparison with the same function. If no other product fulfils the same set of requirements, the proposed product design can be regarded with some degree of novelty. In the SAPPHIRE model proposed by Sarkar and Chakrabarti (2011), the level of novelty of a product can be framed as high, medium or low. Usually, when designing a new product, the information available at early stages of the design process is still abstract. Thus, it is necessary to identify which elements can convey the innovation to the customer, so these parameters can be used to assess in defining how potentially innovative is a design about others.

Research method

In this section, a planning and deployment of a reverse analysis is described. It involved the selection and in-depth examination of five Brazilian products, recognized as innovative (either by the awards received or by the positive customer response). From the literature review, innovation vectors were compiled. Next, this set was cross-referenced with the products selected, to confirm (or reject) their occurrence in practice. From that, a particular set of elements (innovation inducers) was identified, which can be applied in several activities at the early stages of the PDP, especially, during the conceptual design stage.

Assumptions

During the literature review, elements that can induce innovation were identified, which can assist in mapping innovative features on the product being developed. However, they these elements are not correctly grouped and classified to permit an evaluation focused on assessing the innovation potential of a conceptual design alternative. The evaluation criteria that support the assessment process is usually derived from items that integrate the product design specification (Pahl et al., 2005), which are of qualitative nature and are not directly addressed to innovation. Therefore, this study aimed at complementing and validating the identification of these elements by a reverse analysis conducted with five household products.

It has been assumed that if it is possible to recognize, in current products on the market, elements that characterize innovation, they can be used as vectors to, either develop conceptual design alternatives or identify the solution with the strongest innovation potential.

Procedures

The selection of the existing products, objects of this study, was based on awards won and customer response about their degree of novelty. The reference products from the household appliances sector (e.g. cleaning devices, furniture). Information regarding the products was obtained through reports, magazines, specialized literature and, in some cases, companies' websites. Thus, the procedure adopted to implement the reverse analysis involved the following steps:

1. Identification and selection of products considered to be innovative in the Brazilian market;
2. Organization that indicates that the product selected is innovative;
3. Mapping the elements that characterize the product as being innovative.

Reverse analysis: implementation

Tables 1 to 5 show each product selected, its description, the awards received and the identification of the elements that characterize these products as being innovative.

Table 1. SUPERPOP Washing Machine. Source: Museu da Casa Brasileira (2006).

Product/ Description	Innovative Characteristics
Washing Machine SUPERPOP (2006) - Mueller Household Appliances The appliance is a semi -automatic washing machine (does not present the spinning cycle, as do the automatic washing machines). It was developed focusing on customers from middle-lower class. 	▪ The machine is sold disassembled. This results in a package 40 % smaller than the traditional ones. This reduced the cost of shipping the product and the need for space for storage in warehouses; (*Transport*) ▪ There are specific side spaces so the final user can easily carry the product; (*Ergonomics*) ▪ The customers can take the washing machine home at the moment of purchasing. This avoids delivering taxes and waiting time; (*Transport*) ▪ The design team chose to divide into two parts the traditional washing machine cabinet. Thus, the bottom part (which is smaller), can fit into the upper part (which is larger). This generates a compact packing, ideal for transporting; (*Manufacturing and Transport*) ▪ The design adds value to the product, with focus on cost reduction without compromising the aesthetic, which influences the self-esteem of the low-income targeted customer (statues issues); *(Form)* * Research and development in the manufacturing process has enabled the production of a transparent version of the product called "Superpop Glass", launched in March 2007. This is the first transparent washing machine in the Brazilian market.
Judging Panel	
▪ Award Mercado Design - Top XXI, sponsored by the magazine ARC Design; 20th Brazilian House Museum Award (2006); 37th Edition of National Top of the Marketing ADVB (Sales and Marketing Directors Association of Brazil).	

Table 2. TRILOBITE Vacuum Cleaner. Source: Electrolux (2016).

Product/ Description	Innovative Characteristics
TRILOBITE Vaccum Cleaner (2001) - Electrolux Vacuum cleaner that has capabilities to self-guide, inside the room boundaries. It performs the task of removing particles without human assistance. It is powered by rechargeable nickel batteries. 	▪ Display that provides product information for the user; (*Ergonomics*) ▪ Use of ultrasound (analogy with the bat) to avoid obstacles such as table legs and pets. The system determine the dimensions of a room and the best route that can be followed during the cleaning process; (*Technology*) ▪ Use of magnetic tapes to establish the boundaries of the area to be cleaned; (*Technology*) ▪ The aesthetic design of the product (analogy with trilobites - extinct marine arthropod), harmonious and organic lines, differentiate Trilobite from other existing vacuum cleaners; (*Form*) ▪ Ability to set different levels of aspiration (normal, fast, specific), according to the user's needs; (*Function*) * Other companies have already developed prototype of robots that work as vacuum cleaners. However, Trilobite was the first to be traded.
Judging Panel	
▪ Survey with Trilobite owners indicated a high degree of satisfaction. The main reasons that led people to buy the product were: i) high technology - 67%; ii) convenient - 46%; iii) "fun " - 56%; iv) practical - 53%; v) new design - 50 %; vi) saves time - 39%; and vii) " personal" - 17%.	

Table 3. JANGADA Furniture Collection. Source: Museu da Casa Brasileira (2001a); Grilli, Silvia (2015).

Product/ Description	Innovative Characteristics
JANGADA Furniture Line (2001) Kakakis Industry and Commerce of Furniture Limited ▪ "Jangada" Furniture Line consists of a series of chairs, tables, bookcases and armchairs inspired by the same name ship. The concept of this type of ship generated several alternatives in the development of the collection. 	▪ Simplification of the production process through tapered fittings, merging pressure and friction, therefore without the use of nails; (*Manufacturing*) ▪ Constructive details originated a collection of products with its own aesthetic characteristics. It emphasizes and enhances elements from the local culture, which creates its own unique identity; (*Form*) ▪ The rational and differentiated use of the raw material - reforested wood (*Lyptus*, an hybrid from *Eucalyptus urophilla* and *Eucalyptus grandis*), which certifies and customizes the product; (*Manufacturing*) ▪ The chairs from Jangada collection are collapsible. The furniture in the collection can be easily assembled by the user. (*Transport*)
Judging Panel	
▪ Honorable Mention at the 15th Brazilian House Museum Award (2001), by Enora chair design; Honorable Mention in Movelsul Design Competition 2002, by the Minburá chair. The complete furniture collection was a finalist in the same competition. Honorable Mention in Expodema Design Regional Competition, in Argentina, by the Tauaçu chair design; The Jangada collection was exhibited at the Salon Satellite 2003, in Milan, Italy.	

Table 4. SPIRIT Ceiling Fan. Source: Museu da Casa Brasileira (2001b).

Product/ Description	Innovative Characteristics
SPIRIT Ceiling Fan (2001) - Plajet Ceiling Fan, manufactured in polycarbonate, which adopts minimalist style. It consists of three pieces in different colors 	▪ Minimization of parts and simplification of the product. Most ceiling fans in the market have at least seven pieces. The Spirit fan has its core composed of three parts; (*Manufacturing*) ▪ Integration of form and function: its design, inspired by the propellers of the aircraft, is intended to optimize its aerodynamics, generating a performance 30% superior than average fans in the market; (*Form and Function*) ▪ Differential in the material. Existing fans in the market are assembled with three or more blades in wood and steel casing, which generates low ventilation and does not provide a good integration with the chandelier; (*Function and Manufacturing*) ▪ Raw material. It uses, basically, polycarbonate, which is a recyclable material, light, with great strength (including the marine air); (*Manufacturing*) ▪ Due to the variety of colors available, it allows several combinations with the chandelier (better integration). Most fans have more than 20 years of existence, with few variations in designs, colours and chandeliers; (*Form*) * With the awards received, the Spirit enabled the company to develop a strong marketing strategy, further strengthening the product brand in the market. The percentage of revenues spent on design (around 2 %), incremented the revenues by, approximately, 50 %.
Judging Panel	
▪ Second Place at the 15th Brazilian House Museum Award, 2001. IF Design Award 2002 – Category: Building. Ecodesign Award 2003 – Fiesp. Moinho Santista Award 2003; IF Design Award 2004 – Category: Lighting. Top of Marketing ADVB Rio 2003 and 2004. Rio Faz Design Award 2004 and 2006; POPAI (Point of Purchase Advertise International) 2004. The Bizz Awards 2005. Marketing and International Business Award 2004. Quality Award Brazil 2005. IF Design Hannover Award, in 2005 ..	

Table 5. DUO FLUX Flushing Valve. Source: Museu da Casa Brasileira (2005).

Product/ Description	Innovative Characteristics
DUO FLUX Flushing Valve (2005) - Deca Flushing valve which allows selecting the volume of water  Judging Panel First Prize at the 19th Brazilian House Museum Award (2005), Category: Construction equipment; Market Design Award - Top 21 (2007) Category: Bathroom equipment.	▪ The innovative design of its finishing allows the identification of the type of intended flushing, with more water (big button) or less water (small button); (*Function*) ▪ The product can be installed either horizontally or vertically, replacing existing valves, increasing water savings and avoiding waste; (*Form*) ▪ Pressing the small, an inner restrictor is activated, releasing a flow of approximately three liters of water per flush, allowing water savings. The larger button does not trigger flow restrictor, permitting a complete flushing, ideal for the removal of solid wastes. The product can be installed in single or double-story houses, or multi-story apartments; (*Function*) ▪ Its working principle, with two flushing options, is suitable for any type of sanitary bowl and can be adapted to existing facilities. (*Transport*)

After finishing the analysis of the products in the set, it was possible to identify and group elements (highlighted in italics), in the column "Innovative Characteristics" that confirm the innovation occurrence for the examined context. The next step was to seek the theoretical definitions that confirm (or reject) these elements as being central to the customer's perception of product innovation.

Thus, six elements were identified and are presented next:

a. Ergonomics: the heuristics demonstrated by Yilmaz and Seifert (2011), "Adjust according to the different needs of users" and "Change the way you physically interact with the system" are references that support to enlist this element as a possible criterion to assess a potentially innovative design. Rozenfeld et al. (2006) also indicate "ergonomics" as a requirement to be evaluated in the selection of alternatives. In the reverse analysis procedure, ergonomics is highlighted in two products: Trilobite vacuum cleaner and Superpop washing machine;

b. Form: Lobach (2001) and Rozenfeld et al. (2006) reinforce the importance of aesthetic and formal issues when differentiation is a major requirement in the product development. Lobach (2001) also emphasizes the psychological and social aspects of a product as a means for promoting the distinction between products. In the reverse analysis procedure, form was addressed on all situations in the set;

c. Function: the heuristics presented by Yilmaz and Seifert (2011), "Applying an existing mechanism in a new way" and "Using a common element for multiple functions" supports that function can be used to assess the innovation potential of a design solution. Similarly, Rozenfeld et al. (2006) emphasize that the product architecture is how the functional elements can be arranged, as well as, defines the ways of their interaction. Knowing these arrangements can contribute to the ideation of differentiated solutions. During the reverse analysis activity, function was strongly perceived in three products: i) Trilobite vacuum cleaner; ii) Spirit ceiling fan; and iii) Duo Flux flushing valve;

d. Manufacturing: among the heuristics cited by Yilmaz and Seifert (2011), there is: "Merge a variety of parts ; "Add, remove or bend components that are not in use"; "Replace an element for another one"; and "Divide a component into several smaller pieces as principles that allow variation of manufacturing solutions. Furthermore, Rozenfeld et al. (2006) affirm that the decisions related to materials selection (whether a new material or a new way of using an already known material) can be an opportunity to leverage innovation in the set of design alternatives. Manufacturing was detected as a major issue during the reverse analysis in three products: Jangada furniture line, Spirit ceiling fan and Superpop washing machine;

e. Technology: Back et al. (2008) indicate that products specific attributes, such as: "force", "energy", "signal", "automation" and "time" can serve as a basis for identifying differentiated design solutions. Similarly, Tondolo et al. (2012) highlight the importance of developing new technologies as an element of implement differentiation into a product. During reverse analysis, technology as innovation vector was observed in the Trilobite vacuum cleaner;

f. Transport: Back et al. (2008) have listed a set of attributes related to the life cycle, such as: "assembly ability," "packaging," "transportability" and "storability." These attributes can orient the selection process when seeking for differents design solutions. Transport was identified, when conducting the reverse analysis, in three products: Jangada furniture line, Superpop washing machine and Duo Flux flushing valve.

Additional elements (i.e. innovation vectors) could be examined considering products from other areas (e.g. computer segment, industrial devices, packaging solutions, among others). However, this would fall outside the scope of this study. Another consequence of the research conducted was the derivation of so-called "general conditions". These conditions help in framing an alternative solution, when assessing its innovation potential, considering the elements defined. Table 6 contains a mapping of the components elicited and the two general conditions established. It is observed that, in some cases, a factor can comply with two conditions (i.e. C1 and C2). Thus, the innovation potential is considered "perceived" if either, C1 or C2 or both conditions are contemplated. For example, for the element "form" to be elicited as a vector of innovation, the proposed solution must fulfill C1; or C2; or C1 and C2.

Table 6. Conditions that supports characterizing the innovation potential.

Element	Condition 1 (C1)	Condition 2 (C2)
Ergonomics	The product has a distinctive ergonomic design, which is not found in similar design solutions.	X
Form	The formal solution must be significantly different from other competing products.	The design solution allows a certain level of customization (e.g. colours, compositions, textures).
Function	Implement new features or add more functions than concurrent products.	Implement the same function as concurrent products, but in a distinct approach.
Manufacturing	The manufacturing process has been simplified or improved.	The material selected for manufacturing the product presents a significant differential from its major competitors.
Technology	The product contains a technological attribute that is promptly recognized by the customer.	X
Transport	The approach for packing the product is novel and different from the company´s concurrents.	A new approach to transport the product is devised.
X	Not applicable	

In order to verify the consistency of the analysis conducted, the set of products was reexamined. However, now the elements (vectors of innovation) were coupled with the "general conditions" defined. The results can be found in Table 7, where the "general condition" now have a particular description, considering specific attributes that can be mapped into the product examined.

Table 7. Innovation vectors *versus* Framing conditions for the product examined in the reverse analysis activity

Elements	Trilobite Vacuum Cleaner	Jangada Furniture Line	Spirit Ceiling Fan	Superpop Washing Machine	Duo Flux Flushing Valve
Ergonomics	C1: the existence of a display which allows the product interface "to communicate" with the user.	X	X	C1: The washing machine provides specific space on the sides so the user can carry it without difficulty.	X
Form	C1: product whose formal design -organic and harmonious- stands out in relation to those already on the market.	C2: a product identity was valued by exploring the local culture characteristics	C1: analogy to aircraft propellers provided a light and harmonious formal solution. C2: various colour options allows for a variety of compositions between fan and chandelier.	C1: a product with added value targeted to low income customers. C2: first washing machine with a transparent cover in the Brazilian market..	C2: product can be installed either vertically or horizontally.
Funçtion	C1: allows adjusting the level of suction. C2: vacuum cleaner that executes the cleaning task and energy replacement autonomously.	X	C2: it implements the same function than competing fans, but with a 30% better performance..	X	C1: Product implements an additional function: selection the flushing mode (with more or less water use).
Manufacturing	X	C1: the analogy to constructive system of a typical raft has simplified the production process. C2: consistent use of the raw material – reforested wood.	C1: reduction in the number of components - from seven to three, with no loss of performance. C2: use of a material that is lightweight, resistant and recyclable (polycarbonate).	C1: research and development in the manufacturing process have enabled the production of transparent version of the product without increasing the cost to the customer.	X

Technology	C1: use of ultrasound to guide into the room being cleaned. Use of magnetic tapes to define the boundaries of the area to be cleaned	X	X	X	X
Transport	X	C1: the product is disassembable and collapsible and can be easily packed. C2: the customer can easily assemble the product.	X	C1: product is sold disassembled, in a packing volume 40 % smaller than similar version. C2: the customer can take the washing machine home on the moment of purchasing it.	C1: the product can be adapted to existing hydraulic systems.
X	Not observed				

It is important to notice that, despite an element fulfil, at least, one general condition for each product examined (e.g. form), this does not mean this element is more relevant than others. Similarly, a unique mapping (e.g. technology) is nota demerit for an element being a innovation vector.

Next, a field survey was structured to verify how designers with different levels of experience recognize the elements elicited as valid for characterizing the innovation potential of a design solution. It also aims to capture the perception of the elements relative importance.

Field Survey

This field survey was designed to obtain information from professionals working with product development, in different areas of industry (e.g. furniture industry, household appliances, electronics, amongst others), that have developed innovative products. In order to maintain confidentiality, those participants were labelled with the letter "P" followed by a number. For example, P3 (participant number three). The number allocation for each participant was at random. Table 8 contains the main characteristics of each professional contacted.

Table 8. Relevant information from professionals that participated in the field survey.

Participant	Formal Education	Number of years the participant is working with product development	Position	Number of years that the company is in the market
P1	Design	16	Partner/manager	24
P2	Design	21	Director	21
P3	Design	33	Designer	33
P4	Design	17	Coordinator	23
P5	Design	33	Director	10
P6	Technician in Mechanics	28	Director	23
P7	Design	10	Director	10
P8	Design	15	Coordinator	12

The respondents and companies profile allows inferring that the answers produced are well supported from experiences and practical cases in the product development field. The objectives of the survey were declared through a formal presentation. The data collection instrument was explained. Each participant should assess the level of importance for the elicited elements (innovation vectors) using a scale of 1 to 5 (where: (1) Irrelevant; (2) Not very relevant; (3) Relevant; (4) Very relevant; and (5) Essential).

From the data gathered, the following criteria was established *a priori*: if for a specific element, all participants should indicate that its level of importance was irrelevant (i.e. scale 1), it should be disregarded (i.e. this element is not perceived as a vector for inducing innovation). It is important to notice that this situation did not occur for this set of elements. The results obtained are shown in Table 9.

Table 9. Participants' perception of importance value for each element elicited.

Elements	Scale value assigned by the participants								Total	Weighted Value
	P1	P2	P3	P4	P5	P6	P7	P8		
Ergonomics	3	4	4	2	5	4	3	3	28	0,152
Form	5	4	5	5	4	4	2	3	32	0,174
Function	5	4	3	5	5	5	5	5	37	0,201
Manufacturing	3	4	5	3	5	4	5	5	34	0,185
Technology	2	4	5	5	3	3	5	4	31	0,168
Transport	1	4	4	2	3	1	2	5	22	0,120
								Total	184	1

The same table also shows the relative weight of each element according to the scores given by the respondents. In the above context, it is noted that the element "Function" scored highest, followed by "Manufacturing", "Form", "Technology", "Ergonomics" and "Transport", respectively.

In order to establish a uniform interpretation on the meaning of each element (innovation vector), an individualized statement was defined. All of them begin with the same set of words: "attribute that refers ... " in order to not favour any particular element.

Thus, Table 10 shows the set of elements with their defined statements and specific weighted values, which can be used in a process of assessing the innovation potential of an alternative solution for a design problem.

Table 10. Elements and statements description ranked according to their weighted values.

Element (Relative Weight Value ranking)	Statement description	Weighted Value
Function	Attribute that refers to the product´s usage.	0,201
Manufacturing	Attribute that refers to the product´s production.	0,185
Form	Attribute that refers to the product´s aesthetics.	0,201
Technology	Attribute that refers to presence of technological features in the product	0,185
Ergonomics	Attribute that refers to the interaction between the customer and the product.	0,168
Transport	Attribute that refers to approaches to packing/transporting the product.	0,120
Total		1,000

Descriptive Application

In order to verify the response in applying the elicited elements in a project situation, it is proposed a descriptive application considering a product developed and presented in a Brazilian context called, I Paraná Creation, 2002 Edition.

The goal of the Paraná Creation Program (where, I Paraná Creation was one of its initiatives) was to disseminate, between the industries located in the Paraná State-Brazil, the application of industrial design as an innovation tool, through which they could develop competitive products with added value (Centro de Design do Paraná, 2002).

The product selected for running the descriptive application is a portable amplifier device for helping hearing impaired people to improve their auditive capabilities, called "Bio Amp".

The opportunity for developing this product was perceived from the difficulties experimented by people with hearing limitations to have access to portable devices, by either their high costs or their aesthetic aspects (the available products resembled medical devices).

From this context set, the product should meet the following requirements:

a) Be a good quality portable amplifier, which form should map the visual appeal of portable stereos;

b) Be accessible to the hearing impaired people, regardless of their income;

c) Use existing and available technology;

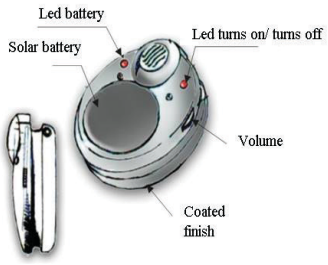
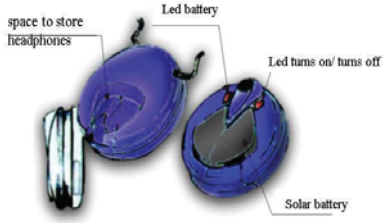
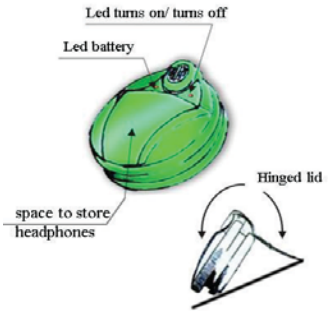
d) Allowing high volume of production;

e) Have compatible dimensions and be easy to transport.

The product should be manufactured by injection split mold, processing ABS material. From the opportunity identification and product design specification, the design team developed three concepts that are illustrated in Table 11.

The three alternative solutions are represented by drawings in perspective, with details, features and specifications described accordingly.

Table 11. Description of the three Bio Amp proposed conceptual solutions. Source: Centro de Design do Paraná (2002).

	Alternatives description	Characteristics
A1		▪ Organic form and "clean" visual; ▪ Differentiated finishing in certain details (e.g. metalizing; galvanizing); ▪ Solar batteries; ▪ Assembling system by using screws; ▪ Easy access to the button for adjusting the volume (on the side of the product); ▪ Space to install on/off leds; ▪ Space to install led to show the battery level.
A2		▪ Organic form and "clean" visual"; ▪ Compartment to accommodate headphones (on the back of the product); ▪ Solar battery; ▪ Option for several colours; ▪ Assembling system using snap fit; ▪ Easy access to the button for adjusting the volume (on the front part of the product); ▪ Space to install on/off leds; ▪ Space to install led to show the battery level.
A3		▪ Organic form and "clean" visual"; ▪ Easy access to the button for adjusting the volume (on the side part of the product); ▪ Assembling system using snap fit; ▪ Option for several colours; ▪ Space to install on/off leds; ▪ Space to install led to show the battery level. ▪ Hinged front cover, which allows the product to be supported on a surface (e.g. a table top); ▪ Compartment to accommodate headphones.

The alternatives in the solution set were examined according to the elements elicited and respective weighted values. For each alternative (A1, A2 and A3) it was checked whether the element maps a framing condition (by an X) or does not map (empty cell) (see Table 12). Each filled cell means that the element´s weighted value should be added to the total sum presented on the column "Total". In this assessment procedure, it was verified the presence/absence of the framing conditions presented in Table 6. Thus, it is important to mention that if an alternative fulfils two framing conditions, it does not imply in doubling the weighted value for that element in the total value for that alternative (e.g. despite alternative A1 fulfiling C1 and C2 framing conditions for form, the weighted value for the total sum for this element is 0,174).

Table 12. Conceptual design alternatives assessment.

	Elementè	Ergonomics	Form		Function		Manufacturing		Technology	Transport		Total
	Weight Value è	0,152	0,174		0,201		0,185		0,168	0,120		(sum of individual weighted values)
	Framing conditions	C	C1	C2	C1	C2	C1	C2	C	C1	C2	
Alternatives	A1		X	X				X	X			0,527
	A2		X	X	X		X		X	X		**0,848**
	A3		X	X	X		X					0,560

The column on the right end contains the sum of weighted values for each alternative. In this assessment procedure, it was possible to identify that the conceptual proposal A2 presents the greater potential to become an innovative product when compared to the others in the solution set.

It must be noticed that for the proposed assessment routine, there is no need for a developed conceptual solution to meet all framing conditions. Additionally, as a side effect, this assessment highlights where there are gaps in a specific design solution, which, therefore, could be reviewed, in the process of generating other concepts that could present a better potential of innovation.

Results and Discussion

The global economy is requiring the design team to deliver innovative solutions with regularity and consistency. The innovation process is object of study in different areas. In the product development arena, it is not different.

From examining products already in the market, which are known as being innovative solutions, a set of elements (innovation vectors) have been identified. These elements were contrasted with definitions found in literature. This cross-reference approach validates the set proposed for the context examined. Two framing conditions for characterizing the innovation potential are also suggested.

The results from a field survey show that experienced designers recognize that the elements elicited can map the innovation potential of a conceptual solution. Additionally, for this context, a weight value has been established for each element, which can improve the decision making process.

From a practical case study, the overall evaluation process is detailed, showing that it can be applied during the early stages of design process.

Closing Remarks

This research confirms that the innovation process cannot be an *ad-hoc* activity. On the contrary, it should be structured inside a Product Development Process, with the aim at guiding the decision making routines.

With this study, it was possible to identify a set of elements (innovation vectors) that can map the innovation potential of a conceptual solution for a design problem.

The innovation vectors of innovation are derived from literature support associated with innovative product analysis. A field survey, conducted with experienced designers, recognized the validity of elicited elements for identifying the innovation potential of a conceptual solution.

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Proposal for a Method for Business Model Performance Assessment: Toward an Experimentation Tool for Business Model Innovation**

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Abstract: The representation of business models has been recently widespread, especially in the pursuit of innovation. However, defining a company's business model is sometimes limited to discussion and debates. This study observes the need for performance measurement so that business models can be data-driven. To meet this goal, the work proposed as a hypothesis the creation of a method that combines the practices of the Balanced Scorecard with a method of business models representation – the Business Model Canvas. Such a combination was based on study of conceptual adaptation, resulting in an application roadmap. A case study application was performed to check the functionality of the proposition, focusing on startup organizations. It was concluded that based on the performance assessment of the business model it is possible to propose the search for change through experimentation, a path that can lead to business model innovation.

Keywords: Business model Canvas; Business model performance; Balanced Scorecard; Performance Management.

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1. Introduction

Developing innovative business models cannot be limited to brainstorming sessions. The study of business models plays an important role in the first stages of development of startups; mainly because these models are responsible for connecting the created value with its commercialization in the market (Chesbrough 2010; Teece 2010). Given its important role, the conception of a strong business model cannot be narrowed to discussions about its elements, and the adoption of useful tools only for representing it (Euchner and Ganguly 2014).

Some startups fail by several possible reasons, even with: the presence of market opportunities, adequate resources, and innovative ideas. An explanation for that could be related with the business model driving the venture (Chesbrough 2010; Teece 2010; Morris et al. 2005). Business models play a fundamental role in the success of innovation, which requires the formulation and articulation of a relevant business concept, as demonstrated in Aranha et al. (2015) to service innovation and in Zilber and Araujo (2012) to e-business adoption.

The literature presents some tools that enable creating representations of these kinds of models, which may help the entrepreneur on making hypothetical representations of a given business model. Nevertheless, despite some recent studies dealing with the assessment and development of business models (Euchner and Ganguly 2014), there is still a lack of studies in that direction. According to Kijl e Boersma (2010) "[...] most of current literature is focused on business model design only, whereas there is almost no attention for business model validation and actual implementation of and experimentation with business models". The research question within the context presented above is how to assess the performance of a business model.

In order to answer the research question proposed, even if hypothetically, the studies of Osterwalder (2004) are taken as a starting point: the possibility of combining the practices of Balanced Scorecard (Kaplan and Norton, 1992) and his business model ontology (which would later evolve to become the Business Model Canvas) (Osterwalder and Pigneur, 2009).

In other words, the hypothesis established for this project is the possibility that the combination of both these methods (Balanced Scorecard and Business Model Canvas) may result in a method for assessing a venture's business model performance. In Osterwalder (2004) there is no delimitation suggested for testing and applying this hypothetical method, inferring its global application. However, this article, as a first approach of the problem situation, will limit the hypothesis verification in startup ventures.

Although there is certain complexity in defining the concept of a startup, the option is made regarding the intrinsic relation between business model innovation and the life cycle of startups. This kind of organization reaches its potential only after testing its technology and/or business model in the market (Hyytinen and Maliranta, 2011). From such perspective, and for allowing us to reach the aim of adapting a method for the assessment of business model performance, this work will seek to:

- Study the main concepts of Business Model Canvas and Balanced Scorecard, via bibliographical research, enabling verification of the theoretical adherence between both.
- Provide a roadmap approach to the method developed, targeting the replicability of this study.
- Carry out a case study in a startup venture with the purpose of presenting a first application instance for this experimental method.

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2. Theoretical adherence and conceptual proposals

The discussions about the conceptualization of business models, their role and elements have become major points for debates. Notwithstanding, the literature expresses certain concern around the lack of consensus on determining a universal concept for business model (Morris et al. 2005).

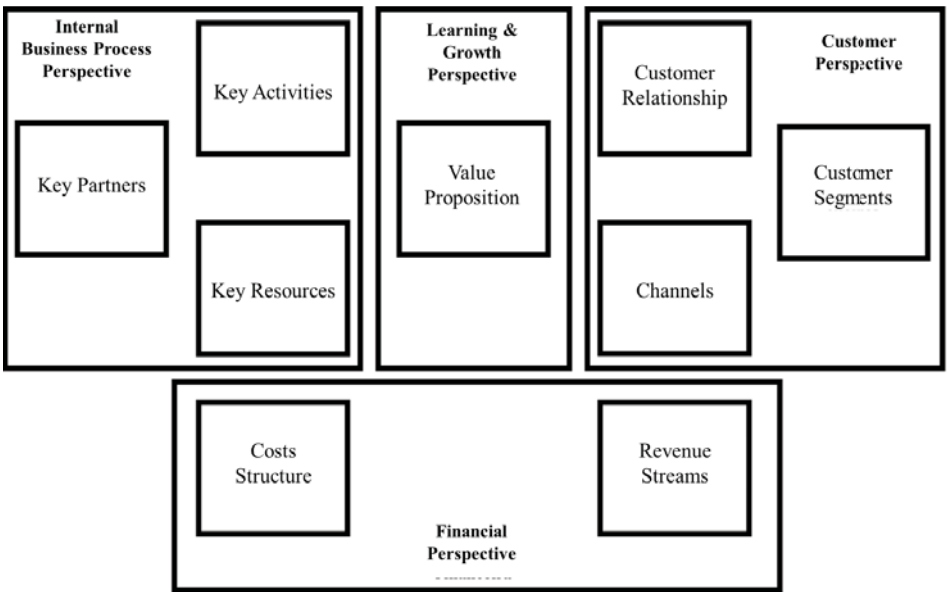
In order to meet the purpose of this work, the adoption of elements on the subject was necessary. Thus, the Business Model Canvas, a tool developed by Osterwalder and Pigneur (2009), was adopted as the meta-business model (business modeling method). The Business Model Canvas divides a business model into nine blocks, providing an integrated visual representation that facilitates the discussion and the debate about the business (BERTELS et al, 2015).

Such option resulting from the following reasons: (1) It is the most widely used tool for developing and analyzing business models, as expressed in Bertels et al. (2015); (2) For its availability for representing a business model (Euchner and Ganguly 2014); (3) For its theoretical adherence to a performance assessment method, the Balanced Scorecard, given its origin in the thesis of Osterwalder (2004); and (4) For its capacity to support the creation of a startup (Zaina and Álvaro 2015).

The performance measurement system, Balanced Scorecard, is presented in Kaplan and Norton (1992). It was initially designed as a performance measurement tool, and later evolved as a way to implement the strategy by creating alignment and focus. This system allows the inclusion of financial and non-financial measurements, through four perspectives: financial, customer, internal business process and learning & growth. The success of the four perspectives relies on the fact that the perspectives themselves and the measures chosen are consistent with the corporate strategy (Fernandes, Raja and Whalley 2006).

Osterwalder (2004) considered that these perspectives were suitable as a starting point for the creation of his business model ontology. His studies would later evolve and take the current format, introduced as the Business Model Canvas. Considering the logic presented, Figure 1 seeks to show the relation among the nine blocks of Business Model Canvas, overlapped by the four perspectives of the Balanced Scorecard.

Figure 1. The nine blocks of the Business Model Canvas, overlapped by the four perspectives of the Balanced Scorecard.



Other notable examples of performance management tools could be considered for a possible integration with a business model. As examples may be referenced the performance measurement matrix (Keegan, Eiler and Jones, 1989), the performance pyramid (Lynch and Cross, 1991) and the performance prism (Neely et al., 2002). However, the Balanced Scorecard was the performance management method selected, especially for this conceptual compatibility with the Canvas, presented in Osterwalder (2004). Besides the compatibility, the scalability feature of the Balanced Scorecard also show up as factors contributing to the proposed work. In the words of Savioz and Blum (2002): "The scalability of a balanced scorecard makes it interesting and applicable for any company."

As the Balanced Scorecard has the ability to transform into action the business strategy through a well-defined process (Fernandes, Raja and Whalley 2006), is purpose of this work suggest steps that business models can also be translated into action.

2.1 Conceptual roadmap steps proposal

Based on the theoretical study of the presented tools, a method comprising five steps was established, providing a roadmap application in compliance with the guidelines determined for this study. It has also shown to be appropriate the use of the Balanced Scorecard concept for the determination of iterative processes. Figure 2 shows the roadmap of the method proposed in this article.

Step 1 - Representation of the choices of the startup's business model: For Step 1, one should avail of the study of Osterwalder and Pigneur (2009). However, there is no script with predetermined steps guiding the development of the Business Model Canvas. According to Osterwalder (2004), the order in which one fills out the business model enables a wide range of possibilities. The Business Model Canvas depends, above all, on the understanding of the meaning of each block, and on how the combination of these blocks develops the logic representation of the company's business model.

Step 2 - Selection of performance indicators: As noted in the studies of Kaplan and Norton (1996), Balanced Scorecard performance measures are designed from the understanding of the organization's strategy. The same should occur when stipulating indicators for a business model's choices. The indicators must be designed to provide a means of measuring the performance of each of the choices of each block of the Business Model Canvas. It is important to point out that the Balanced Scorecard does not have a group of generic performance measures. In the proposed method indicators should be linked to the choices made in each business model of the block. As well as the balanced scorecard indicators are linked to goals. It is not known a study that shows performance indicators that are generally accepted by academics and managers to assess the business models of performance. Such studies exist to specific areas as shown in Molina-Castillo and Munuera-Aleman (2009). Thus, from the moment an organization defines its business model, it also has its particular set of relevant indicators to select. One may find similar indicators among different companies; however, that does not imply the existence of generic indicators. It is also worth add that we share the concept of Molina-Castillo and Munuera-Aleman (2009) that managers do not attach the same level of importance for different performance indicators. It would be relevant in this context and, along with other factors of the practice of choice of performance indicators, a more accurate study on how to determine the selection of indicators for the proposed method.

Step 3 - Current measurement of selected performance indicators: Once the indicators have been defined for each of the choices of the business model, it is up to the organization's executives to measure them. For the application of the Balanced Scorecard it is important to consider that not all the data for evaluation will be derived from the same source: important data can be spread throughout the organization. To reduce errors of collection of such data, it may be highlighted the relevance of it being centralized at the highest possible level of the company. It is important not to underestimate the effort and energy required to maintain the evaluation indicators. As much as the company's information system is computerized and integrated, there will always be necessary compilation work and analysis (Kaplan and Norton, 1996).

Step 4 - Creation of goals for the selected performance indicators: The Balanced Scorecard requires performance targets to demonstrate the evolution of its strategy. The same should be done in this method to demonstrate the business model performance improvement. The need to set goals is to demonstrate if the business model follows the direction in which the company and its stakeholders want. According to Dewagan and Godse (2014), meet the needs of multiple stakeholders is especially important given the complex ecosystem in which companies work today. Thus, performance indicators should be aligned to organizational goals. It would be incongruent to determine, therefore, incompatible goals with reality and with the environment in which the business model is inserted.

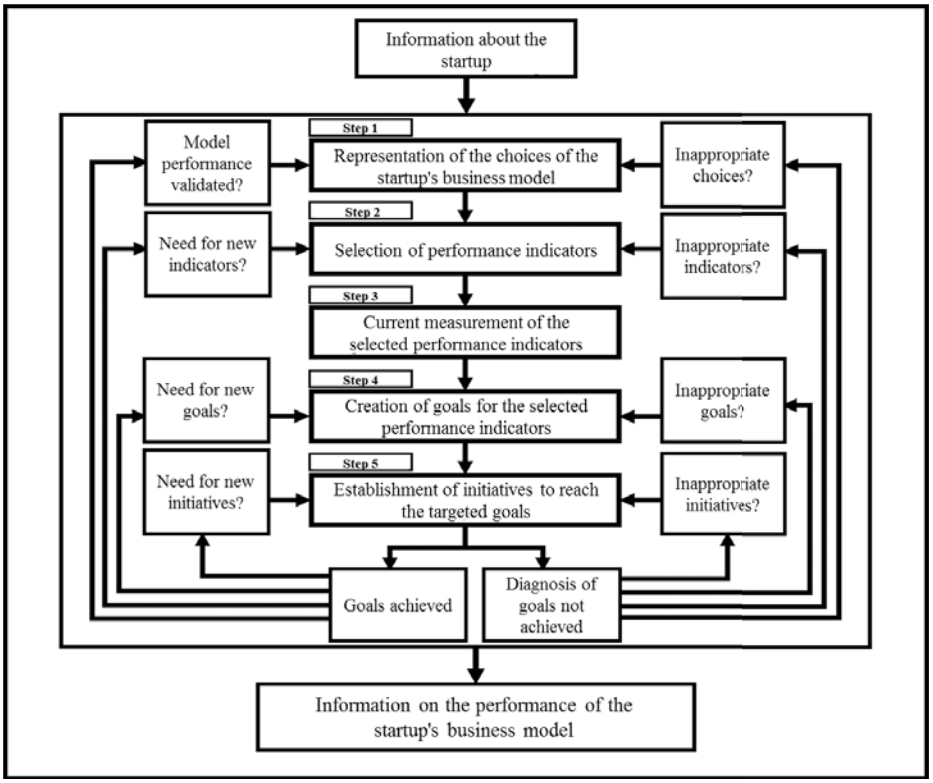
Step 5 - Establishment of initiatives to reach the targeted goals: In the Balanced Scorecard, once defined the goals to be met, i.e. required to achieve the strategic objectives, the planning of initiatives must be executed. The initiatives should be planned similarly to the business model performance assessment method; i.e., the establishment of the desired goals should seek to find ways, actions, and initiatives that enable the achievement of such goals.

Iterative process: After the initiatives have been applied, new measurements shall be performed in order to assess which results the initiatives are providing and especially to investigate whether the stipulated targets are being met. Thus, the method proposed in this research is established in an iterative manner. If after the new measurements it has achieved its targets the following questions can be raised:

- Is there a need for new initiatives?
- Is there a need for new goals?
- Is there a need for new indicators?
- Is the business model performance validated?
- Were the appropriate initiatives selected?
- Were the selected targets inappropriate?
- Were the appropriate indicators selected?
- Are the choices of our business model inappropriate?

Based on the conceptual study it was possible to draw up a proposal for aggregating the Business Model Canvas and the performance evaluation practices provided by the Balanced Scorecard. It is feasible to argue that the simple conceptual study would allow a myriad of combinations to work out a method as proposed. However, it is emphasized that this study sought rapprochement with the hypothesis of combination of the two methods exposed in Osterwalder (2004).

Figure 2. Flow for the development of the evaluation method of business model performance.



3. Methodological procedures

In this research, a set of steps and characteristics were determined aiming the coherence with scientific methodology. The main research basis found in the literature review were books, thesis, and portals (for instance: CAPES journals, Web of Knowledge and Scielo), with the review being fundamental to propound the theoretical adherence for the method developed in this work. And, hence, the theory outlined enabled the development of a case study.

Based in Yin (2013), the case study methodology is not necessarily limited to exploratory research strategies. Hence, its utilization in the description or test propositions is allowed. Such condition of methodological procedure seemed appropriate for the objectives established for this article. The case study research increase understanding of how things work, and allows us to identify important events.

The adoption of this procedure allowed for the first test of the roadmap method, following the objectives presented in the results section of this article. However, for research purposes, and for the first test, the profile of the analysis unit was narrowed. According Hayton (2002), a startup can be understood as a newly started organization, with lifetime varying from eight to ten years. Furthermore, according to Hayton (2002), at that age they are, therefore, organizations in their initial cycle of existence, and have not achieved full operations in a sustainable manner.

The analysis unit selected for this single case study is a company that deals with videos on the Internet. Specifically, the initial value proposition of its business model is the offer of software for managing videos for companies that need to show their videos on the Internet.

The development of the case study proceeded with providing the method and instructing the startup managers on how to use it, not interfering in their decision making. The purpose of such approach was to allow the observation of the performance measurement of the company's own business model so as to evaluate the initial adaptation to the method and the need of adjustment. It is also worth mentioning that the case study was limited to a two-month period of the operation of the analysis unit. This period was considered the minimum time for basic application of the proposed method, i.e., a month for the assessment of the company's current situation, and another month for the evaluation of company behavior and results.

It is emphasized that the choice for a single case study results from this work's main objective: to present a first application for the proposed method. This work seeks to provide the conceptual roadmap framework to enable the performance evaluation of company business models. Thus, we part from the presentation of the framework and of this first case study aiming to propose a variety of future tests enabling the verification of the effectiveness of the proposal in various scenarios.

In order to delineate the research, the case study focused on showing the method for only two blocks: "Channels" and "Customer Relationship". The need for this segmentation was due to the broad scope of possible results. The method applied to the nine blocks of the Canvas would entail a broad and extensive discussion, and would hinder a detailed analysis. The choice was based on the observed influence of the block "Channels" over the block "Customer Relationship", actually verified after the measurement of both, as will be demonstrated in the following sections.

3.1 Structure for data collection and applying the method

Aiming at an orderly data collection and a structured application of the method, a performance evaluation scoreboard of the business model choices was developed, as shown in Figure 3. Each element of the scoreboard will be explained in this section of the research.

The element "business model block" refers to one of the nine blocks established by Osterwalder and Pigneur (2009): value proposition, channels, customer segments, customer relationships, revenue streams, key resources, key activities, key partners, and cost structure. The element "choice", in turn, represents decisions made for each of these blocks. For each of these choices, performance indicators are drawn up for the "indicator" element so that these decisions can be measured. The element "current" represents the results of an admeasurement of these indicators at the present time.

With the performance measurement data, performance goals for each of the choices are established in the "goal" element. The goals will provide indexes to be reached for each indicator. The "initiative" element refers to the attitude required for successful goal setting. And, finally, the "results" element represents the values measured after the initiatives have been set.

It is added that each choice may have more than one indicator, which would provide more than one current level and goal. There is no way to set a maximum number of indicators. However, as it is recommended in the Balanced Scorecard studies must be careful with stipulating a large number of indicators, the same goes for the selection of indicators for the business model choices.

As noted, it is clear the relationship of synergy between the roadmap framework and its scoreboard. With this structure, it was possible to develop a first pilot test in the form of a case study.

Figure 3. Generic Scoreboard of business models performance analysis.

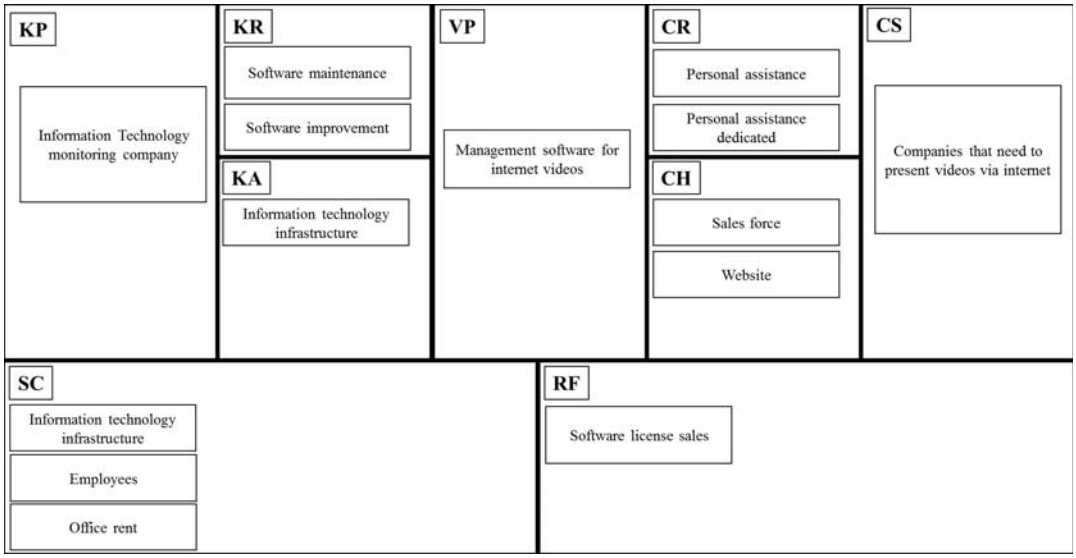
Business Model Block					
Choice	**Indicator**	**Current**	**Goal**	**Initiative**	**Results**

4. Results

Complying with the study design, it was possible to develop a first pilot test in the form of a case study. Following the proposed roadmap, in Step 1 the Business Model Canvas is established for the selected analysis unit, as shown in Figure 4. Steps 2-5 are performed using the Scoreboard structure developed. With the business model of the analysis unit defined in Figure 4, only the choices of the selected blocks will be detailed in this study, i.e., Channels and Customer Relationships, as explained previously.

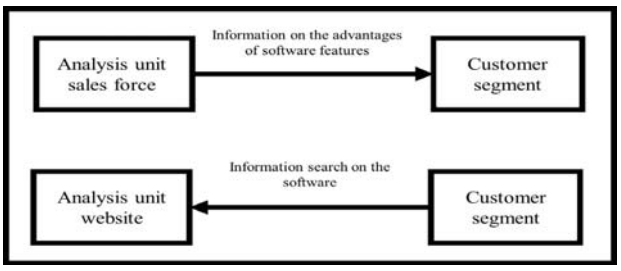
4.1 Applying the Business Model Canvas

Figure 4. First version of the business model of analysis unit, using the Business Model Canvas (Osterwalder and Pigneur, 2009).



Channels: The analysis unit uses the "sales force" as a channel to reach the customer segment "companies that have video on the Internet." The company's commercial department searches and contacts customers that could potentially acquire the resources available in its software. Through the "website" channel, the company can reach a large number of customers because information on the software resources is available there. Note the difference between the two channels in Figure 5.

Figure 5. Relationship between channels and customer segments of company's business model.



Customer Relationship: In the customer relationship block, the unit of analysis declares that its business model possesses two ways of relating. The first, "personal assistance", is a personal relationship that the company offers its customers. That is, all requests, questions, complaints are dealt with in a personal manner by an assistance team.

The other form of relationship that the analysis unit proposes is "personal dedicated assistance". This type relationship is offered, however, only to a single customer. This client is a large organization that requires a different form of relationship, defined by the analysis unit managers as a "partner". As banks offer dedicated assistance to certain types of customers, the startup focus of the case study does the same for that big client.

4.2 Applying the business models Scoreboard structure

The statement of Steps 2, 3, 4 and 5 of the proposed roadmap framework can be performed using the business model scoreboard. Evidently, each step takes place separately and has specific characteristics. However, for presentation and discussion of results, the scoreboard structure will be used to summarize the application of the method.

Channel Scoreboard: In the scoreboard of Table 1, the application is presented for the channel block.

The indicators chosen for the Channel block were:

- **Number of companies contacted by the commercial department:** Refers to the number of companies contacted through the actions of the commercial sector; i.e, offer the software solutions to companies that might be potential customers.
- **Number of closed deals with companies by the commercial department:** This indicator shows the quantity of companies contacted that decided to become clients of the analysis unit.
- **Number of companies that requested budget through the website:** Reflects the number of companies that spontaneously requested budget through the website to verify the possibility of acquiring the software features of the analysis unit.
- **Number of closed deals with companies through the website:** This indicator shows the number of companies that were converted into customers through budget request via website.

Table 1. Channel Scoreboard

		Channels			
Choices	**Indicators**	**Current**	**Goal**	**Initiative**	**Results**
Sales Force	Number of companies contacted by the commercial department	5	20	Train human resources in the commercial department	15
	Number of closed deals with companies by the commercial department	3	12		5
Website	Number of companies that requested budget through the website	3	20	Increase publicity and promotion of the website	10
	Number of closed deals with companies through the website	0	4		1

As observed, the commercial department was able to contact a larger number of companies compared to the current period via website. At the same time, it also increased the number of deals and had great influence on other panels of the analysis unit as well as the performance of the company's business model as a whole.

Through the website the analysis unit also showed some advances since it has already started the initiative for greater dissemination and advertising. Performance is practically identical in the "current" column comparing with the "results" column, as for deals closed. The "current" column had no closed deals through this channel; the closure of a single deal can be seen in the "results" column.

However, even though the investments in advertising and promotion had been modest, there was an increase in the number of companies that asked for budget analysis unit through that channel. It might mean it is valid to have that channel as long as it is developed as a new key activity, i.e., disseminating the company's solutions. This would alter the way business model analysis unit is designed.

Customer Relationship Scoreboard: Table 2 presents the application of the Customer Relationship block.

The indicators chosen for the Customer Relationship block were:

- **Average response time for clients:** Clients often ask questions about the system's functionality. This indicator seeks to measure how long it takes for clients get answers to their questions.

- **Number of defects per month reported in software:** This indicator shows the number of defects that were identified in software by clients: important for assessing the quality of software.

- **Average response time to company with exclusivity:** Refers to the average response time of any request from the company exclusively (partner). Requests like answering questions or technical support, might have its response time measured by this indicator.

Table 2. Customer Relationship Scoreboard

Customer Relationship					
Choices	**Indicators**	**Current**	**Goal**	**Initiative**	**Results**
Personal Assistance	Average response time for clients	60 hours	48 hours	Create a FAQ (Frequently Asked Questions)	72 hours
	Number of defects per month reported in software	10	0	Create quality program	12
Personal Dedicated Assistance	Average response time to company with exclusivity	24 hours	12 hours	Train human resources	24 hours

An event that happened in Customer Relationship Scoreboard: the worsening of the indicators in the comparison between the "current" and "results" columns. That is possibly due to the increase of new customers, as a consequence of the growing results in the Channel Scoreboard, which may have brought a higher demand for the staff of the analysis unit exceeding the company's management capacity. That can be observed in the average response time having increased from 60 hours in the "current" column to 72 hours in the "results" column. For that reason, and given the method's iterative feature, a new indicator can be suggested for future measurements, i.e.: the number of completed requests.

Hence, it would be possible to know whether this worsening of the indicator "average response time" is due to an increase in demand or to the team's operational inefficiency. Further, the initiative to create a page with answers to FAQ was not finalized during the period under review of the case study.

The number of defects reported by customers also draws attention.

There was an increase of defects, from 10 reported in the "current" column to 12 in the "results" column, wherein the goal set by the founders of the unit of analysis was zero defect. Though personal dedicated assistance offered exclusively to the partner company managed to maintain its standard, it did not show improvement.

Such status of Customer Relationship Scoreboard may reveal the need to create a new initiative for this panel. For instance, hiring new employees is an initiative hypothesis that could be tested by the unit of analysis in order to enhance its performance of Customer Relationship.

5. Discussion

The application has shown different characteristics of the implementation of the Balanced Scorecard. Although the application of the Balanced Scorecard do not point restriction on changing objectives of an organization, these are usually stable and guide the goals and initiatives of a company. Assess a business model, however, does not seek to achieve objectives, but mostly validate the choices that form the model. Or, in other words, evaluate whether the model choices reveal themselves as valid for the moment of the company. This implies the need for flexibility, so that eventual changes in the choices of a business model may occur.

Business models must have this characteristic for adaptation to be responsive to the competitive environment. As an example, Tongur and Engwall (2014) show that technological changes are lethal to many manufacturing companies. However, also second Tongur and Engwall (2014), "previous research indicates that this is not purely a problem of technological innovation, but is closely related to the inertia of business models and business model innovation.". The proposed method, in this sense, can contribute as a systematic way that provides a condition to manage this need to adapt.

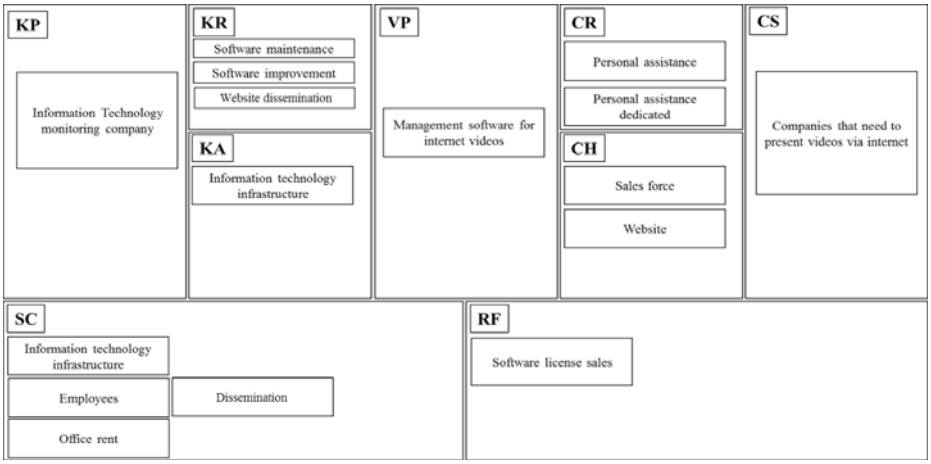
It is easier to measure things that are established, stable and well-understood. However, measuring something new, on evolving and dynamic creates challenges, especially on knowing "what" and "how" to measure (Kirchhoff et al., 2013). In the presented case study, this potential instability given the dynamics of a startup business model, it was probably mitigated by the guidance provided by a roadmap and its characteristic to iterate the hypothetical choices of the model.

Thus, the work could be aligned with the established initial hypothesis. It was possible to contribute to the literature presenting a method suggestion for assessing the business models of performance, by the integration of the Balanced Scorecard and the Business Model Canvas. However, although it was not that the initial proposal of the work, it was observed in the method the ability to experience solutions as a managerial implication. This potential application will be better discussed in the following section.

5.1 Toward an experimentation tool for business model innovation

It is relevant to report the behavior of the method while applying the roadmap framework. It was observed in the Customer Relationship Scoreboard, for instance, that the exercise of adopting such method suggested the founders of the analysis unit that a new indicator and a new initiative be created.

Figure 6. Second version of the business model analysis unit, after applying the Canvas Scoreboard



Another important result was that on the Channel block the increase in performance of the website revealed this channel as an important choice for new clients to contact the analysis unit. If these satisfactory results are still being confirmed in the coming periods, it may propose a change in the company's business model.

The dissemination of the analysis unit solutions can be considered a new key activity. That would also generate a new choice to consider in the cost structure: dissemination costs. Thus, changes would occur in the business model of the analysis unit, as shown in Figure 6.

The change can demonstrate that the method has the potential to verify the performance of a business model as a way to modify the choices of business models. The method proposed in this article can be targeted in future studies providing a systematic process in the search for innovation in business models, adding to proposals based on design, such as in Zott and Amit (2015).

Some authors like Chesbrough (2010) report the experimentation as a factor conducive to innovation in business models. According to Chesbrough (2010), to overcome the barriers of innovation in the business model, experimentation processes, effectiveness and organizational leadership for change must be exercised.

Recent studies have demonstrated the importance of business models for the competitiveness of enterprises. According to Velu et al. (2015) "[…] new firms with a high or low degree of business model innovation are more likely to survive for longer than new firms with a moderate degree of business model innovation.".

On the other hand, empirical analysis of management applied to innovative business models are scarce (Burmeister, Lutgens and Piller 2015). The study presented in this article could be a starting point toward an experimentation tool for innovation in business models based on performance.

5.2 Limitations and proposals for future work

The conceptual investigation of the tools studied demonstrates complementarity on one hand, but on the other hand there are other questions unanswered in a more clear sense. Regarding a discussion of the concept, one might question what relationship exists between business models and strategy in an organization. This is likely to mean discussing the use of tools of both, their elimination and synergy. Osterwalder and Pigneur (2002) have worked similar situations, but it is not known studies that address comparison and complementarity between such tools. The study presented in this article, however, was limited to providing the theoretical framework for the development of the proposed method.

In this approach there was no in-depth study in defining the elements of a performance management system. The option of this study was to seek an adaptation of methods to assess the performance of a business model, and does not provide all the features and capabilities of Balanced Scorecard applied to a given context. Is worth mentioning that even the Balanced Scorecard sought to evolve their elements over time, and from initial applications. According to Fernandes, Raja and Whalley (2006) "The balanced scorecard, originally seen by Kaplan and Norton as a measurement tool, is now presented as a means for implementing strategy by creating alignment and focus."

Although all the elements deserve emphasis seems to be a need for better understanding of indicators for hypothesis choices. An important question seems to arise in this context: What criteria to use to determine if an indicator is suitable for validating a choice in a business model? In the study presented, this situation was absolutely arbitrary and in charge of decision-makers of the analysis unit. Evidently issues such as: definition of short and long-term goals, questions of cause and effect and data collection are other key points that deserve more future attention.

From a methodological point of view, it is necessary to perform new case studies in different contexts to make it possible observe the behavior of the proposed method, applied to a variety of business models. Even though new case studies are needed, methodologically will be important broader quantitative studies.

The possibility raised in the previous subsection, of providing a framework for innovation in business models will depend on the adaptation with innovative concepts. The method currently suggests the possibility of change in different parts of a business model, but not all change necessarily mean the generation of innovation. An important study would consider the business model innovation concepts based on the framework of Linton (2009) about the dimensions of innovation.

6. Conclusion

The conceptual conditions were created for the application of the adapted method in a startup company. It was also important to provide a framework to assist in organizing the implementation of the roadmap, as well as in data collection. The case study examined the usefulness of the method and found out that by such adaptation it is possible to evaluate the business model's performance of a startup. Confirming, therefore, the initial hypothesis proposed in this work and broadening our understanding of how to solve the research problem posed by this investigation.

The process of creating the business model of companies still seems to be fairly crude and subjective. In other words, they restrict the creation of hypotheses for the design of a business model. The submission of a roadmap application offered procedural characteristics for the design and development of the business model. The iterative capability that was attributed to the method during its development might mean the search for continuous improvement. However, this same characteristic explores the hypothesis of operating as a mechanism of learning by trial and error, triggering the discussion among fields concerned with business models innovation.

Finally, the contribution left by this study is enabling a starting point in the search for methods and tools that allow an objective manner of developing a new business model, measuring the assumptions made in the sessions that discuss and devise a business model.

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Study of the Start-Up Ecosystem in Lima, Peru: Analysis of Interorganizational Networks

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Abstract: According to the literature, In the context of changes at a global level the formation of new businesses drives the economy, being important start-ups, which are linked to a community of entrepreneurs, mentors, incubators, accelerators, providers of common services, angel investors, venture capitalists, universities and public support entities, which together configure an ecosystem that is linked to other ecosystems. In this way, this work focuses on the Lima, Peru ecosystem with the aim of providing an understanding of the interorganizational networks that are established based on the analysis of the interactions that occur in the LinkedIn social network. Definitions, methodology, results and conclusions are presented.

Keywords: innovation ecosystems; entrepreneurial ecosystems; technological entrepreneurship; start-ups; social network analysis; interorganizational networks analysis; linkedin.

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1. Introduction

At the global level, the way to boost the development of the countries' economies is through the creation of new enterprises through entrepreneurship, as this will guarantee jobs and taxes in the future. Due to the need of nations to face new challenges in the coming years, the entrepreneurs and the conditions that allow the phenomenon of entrepreneurship, that is, the ecosystem, have become very important at the academic, business and governmental level (World Economic Forum, 2009; Schumpeter, 1911; Serida, Morales, & Nakamatsu, 2012; OECD, 2009)

According to WEF (2009) it is important to know the ecosystem that houses the enterprises, the elements that make it up and the interaction between them, because this knowledge will allow raising better policies and therefore to improve the conditions in the medium and long term to stimulate the entrepreneurship at the level of sectors, cities and countries.

On the linkages in the technological entrepreneurship ecosystem in Peru, there are documented records in different articles since 2001, on the incubation of companies in Peru and a methodology proposed to guide the development of entrepreneurship from universities (Gonzalez, Vela, & Ochoa, 2001). For 2003, the university-based entrepreneurial potential of the technological base is evaluated; among the evaluated levels is the university networking and the environment (González, Vela, & Ochoa, 2003). In 2004, the PERUINCUBA project (Peruvian Association of Business Incubators) was analyzed and funded by the InfoDev-Incubator program (González & Campelo, 2004). In an earlier research, through a collective case study, it was found that from the perspective of the founders of start-ups there is presence of the different elements in the technological entrepreneurship ecosystem in Lima (Hernández & González, 2016).

In the case of Lima, the entrepreneurial ecosystem dates back to 1880 with the founding of the Lima Chamber of Commerce, founded to contribute to national reconstruction, the defense of private enterprise and free enterprise, fiscal balance, management Transparency of public resources, legal security, investment and savings, as well as their adherence to democracy and respect for human rights (CCL, 2016).

On the other hand, social networks today have been enhanced by the Internet, as demonstrated by the term networking, which is used by different people on a daily basis. The social networks analysis has become a very powerful tool for sociology and its applications in other areas. Being able to be connected through a social network can help through contacts to find a better situation, networks can allow seeing and use information in the most diverse fields, from business to national security, these networks constitute conduits by which flows and collects information and can be used for different purposes (Kadushin, 2013).

One of the most important social networks on the Internet is LinkedIn, which connects professionals from around the world with more than 430 million members (LinkedIn Corporation, 2016b).

In this article we first define the state of the art of the concepts of the technological entrepreneurship ecosystem and its elements, the analysis of social and interorganizational networks, the research methodology to later apply this theory to the collected data of LinkedIn of the elements of the technological entrepreneurship of Lima.

For this, the strategy that is proposed to follow is the literature review on the technological entrepreneurship ecosystem and the elements are contained in this, in addition to the theory of social and interorganizational network analysis and then apply this knowledge to the data collected from LinkedIn.

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2. The entrepreneur and the technological entrepreneurship

The entrepreneur is responsible for economic change and transformation, applying different techniques to achieve his business goals (Esuh Ossai-Igwe & Mohd Sobri, 2011). On the one hand, the business entrepreneur aims at profit and seeks to achieve this goal through innovation to capture an increasing percentage of the market (Zahra & Nambisan, 2012), while the technological entrepreneur depends on the knowledge of others People who have skills and knowledge about different technologies (Hausmann, y otros, 2011).

Entrepreneurship is the process of creating a new company with a series of stages that allow finding, evaluating and developing an opportunity creating something new, and involves different aspects: technological, social, psychological, legal, etc. (Shane & Venkataraman, 2000). These stages are not necessarily sequential but are progressive, being the following: identification and evaluation of the opportunity, business planning, determination of the necessary resources and management of the resulting company (Hisrich, Peters, & Shepherd, 2012).

This research is focused on the entrepreneurship called start-ups, for which according to Startup Commons (2015) and Churchill & Lewis (1983) there are 4 stages: the first is the stage of definition in which the idea is developed, the second is the Validation stage in which a minimum version of the product or service is launched, the third is the efficiency stage in which the project and the profits are consolidated and finally the fourth stage of growth or expansion.

3. The start-up ecosystem

The entrepreneurship ecosystem is the set of entrepreneurs who seek to develop new companies and for this purpose establishes diverse links in their academic, business, social, political and economic environments (Fetters, Greene, Rice, & Butler, 2010). The entrepreneurship ecosystem of the start-ups is composed of a community of technology-based entrepreneurs, their leaders and facilitators who support this community such as universities, government, investors, service providers and other stakeholders (Feld, 2012). A start-up is a type of company with a high level of projection of growth due to the intensive use of the technology in its construction and development, whose main objective is to innovate in products or services for its clients (UNAM, 2013).

In the provision of services to new enterprises, the incubator is a physical space usually linked to a knowledge center (university, research institute, business school, etc.) and through this, spinouts and business ideas are supported by in exchange for a monthly fee or some type of future remuneration. This provides physical offices, mentoring, consultancy, training programs, and linkage with public and private investors, among other services (Salido, Sabás, & Freixas, 2013). An extension of the incubation of companies is the accelerator which is a model that became known with the Y-Combinator in the USA, and it has spread all over the world. It is characterized by having an open application process and usually has pre-seed investments in exchange for a stake in the start-up property, has a limited time, offers intensive tutoring and is grouped in new ventures that start simultaneously (Salido, Sabás, & Freixas, 2013).

In the area of financing are located angel investors who are legal or natural persons with business experience and who are interested in participating in new ventures. The mechanism consists in financing companies with capital in the initial stages, focusing their decision to finance one or another company in the business plans. The main difference between angel investors and venture capitalists is those angels use their own funds to invest (Ayala & González, 2010).

According to Feld (2012), the basis to be effective for an entrepreneurial ecosystem is that certain conditions are met:

- The most experienced entrepreneurs must lead the entrepreneurial community.
- Facilitators can lead the support to the entrepreneurial ecosystem but not create or lead the ecosystem.
- The commitment of leaders should be long-term (several years).
- Mentorship and collaborative participation must exist.
- There must be continuous events for the entire entrepreneurial community, networking and feeling of belonging to community are important.
- There must also be willingness to experiment, risk and fail quickly, as these allow the entrepreneurship to evolve.
- The entrepreneur community must be open to new members regardless of their origin.
- There must be a high density of entrepreneurs and quality of life conditions.
- There is a need for start-ups to resort to self-financing at the beginning of the ecosystem, until there is more closeness between entrepreneurs and investors.
- There is a need for an attitude of detachment from the community to help other members.

In addition, the interaction of entrepreneurs with the business community and the development of networks are important (Kerrick, Cumberland, Church-Nally, & Kemelgor, 2014).

4. Analysis of interorganizational networks

The analysis of interorganizational networks is based on the social networks analysis, where the nodes of the network are the organizations or entities.

Social networks have existed with the interaction between people, that is, since the beginning of humanity, this interaction has immediate and future consequences in their lives, these can be fatal or positive, as one is responsible for shaping the network, and we are partly responsible for these consequences. When studying social

networks, it is possible to determine which individuals are most active and which interactions are stronger, because individuals can belong to different networks and in each network; the organization will be different according to the interaction that is required by the objectives of the network. These interactions follow certain rules that allow identifying how the activity occurs among the members of the network (Christakis & Fowler, 2009).

According to Kadushin (2013) the term networking is used on a daily basis and may be thought to exist with Internet, but in reality Internet is just another way of communicating and has made possible to refer to social networks in a systematic way. Being immersed in social networks cannot let see details that it is possible to see with the analysis of these networks.

The most important points of the network analysis are: connections, networks as information maps, leaders and followers, and networks as conduits, as detailed below (Kadushin, 2013):

- The connections you have with online sites are important for networking because you can reach a very high number of users. Users of social networks hope that these connections can be useful, for example to find employment.
- The social networks analysis allows you to see what cannot be directly observed, the use of this information can be used in different fields such as marketing to influence the purchase of products. Also in applications from different fields such as legal and security.
- Intermediation for leaders' followers through Web services is important, although in the event that they fail and have problems they would affect the networks that depend on these services, as in the case of electricity networks, the failure of one of the components can cause the entire network to fall. In the case of people who have certain characteristics, will cause them to look for people of the same affiliation called homophily. So persuading in that network will be very easy: like viral marketing, although sometimes it might not work.
- Connections are consequences of behavior, and ideas are shared through those relationships and ideas will become similar. Human networks can also be analyzed structurally and there is feedback between structure and behavior.

The following are the most important concepts in the social network analysis (Wasserman & Faust, 2013):

- **The actor:** the actors or nodes are individual, corporate or collective discrete social units.
- **The relational link:** actors are related or connected to each other through social ties or connections: they can be evaluation (such as friendship and pleasure), transference (such as loan, sale), affiliation, behavioral interaction, etc.
- The dyad: it is the bond that is established between two actors through a link between them.
- The triad: it is a subset of three actors and the links between them.
- The subgroup: any subset of actors and the links between them.
- The group: it is a collection of all the actors whose ties must be measured.
- The relationship: is the collection of links of a specific type among the members of a group.
- The social network: is a set of several finite sets of actors and the relationship or relationships defined between them.

The data used to analyze social networks are as follows (Wasserman & Faust, 2013):

- **Structural variables:** the bonds of some kind between pairs of actors.
- **Composition variables:** they are the attributes of the actors.
- Mode: is the distinctive set of entities in which variables are measured.

At the discretion of the researcher, this should identify the population that is formed by the actors or social units to which the measures would be taken and in case it cannot be measured in its entirety, it must find the mechanisms to take a sample (Wasserman & Faust, 2013).

When performing social network analysis measurements are taken based on the statistical and matrix theory (Wasserman & Faust, 2013; UNS, 2016):

a. **Centralization indexes:** These are measures that allow comparing in what magnitude a network is organized around a central point or zone.

b. **Degree, Centrality Degree:** It is the measurement of the number of nodes with which each actor is connected, this value is an indicator of the influence of the actor in the network.

c. **Betweenness Centrality:** It is the measure of the dependency that the actors have of the focal nodes to make their contacts.

d. **Closeness Centrality:** The radial length measurement that calculates the average of the shorter geodetic distances of the actors towards all the others.

e. **Density:** It is the measure of the number of existing links in relation to the number of possible links.

f. **Reciprocity:** It is the measure of the number of links involving mutual dyadic interactions on the total of links.

g. **Eccentricity:** The eccentricity of a node is the longest path from that node to any other node in the network. A path is any path between two nodes where no node is visited more than once. Nodes with less eccentricity are more central by this measure.

h. **Eigen centrality:** In this measure the most central actors are identified in terms of the global structure of the network, leaving aside the more local patterns.

i. **Clustering:** It is an index that indicates the level of grouping of an actor with its neighboring nodes, a coefficient of high grouping indicates that it is closely related to neighbors, whereas a low coefficient indicates the opposite.

j. **Modularity Class:** Modularity is a measure of the structure of networks or graphs. It was designed to measure the strength of the division of a network into modules (also called groups, grouping or communities)

k. **Harmonic Closeness Centrality:** It is a measure of centrality focused on the transfer of information, indicates the degree of connection with other nodes through short paths (Rochat, 2009).

One of the most important social networks on the Internet is LinkedIn, which connects professionals from around the world with more than 430 million members, including Fortune 500 executives; LinkedIn is the world's largest professional network on the Internet. The company has a diversified business model; its revenues come from talent solutions, marketing solutions and premium subscription products. It is based in Silicon Valley and has offices in different countries (LinkedIn Corporation, 2016b).

5. Methodology

In this study a quantitative-qualitative research design is used (Hernández, Fernández, & Baptista, 2010), quantitative by the determination of the social network indicators and qualitative due to the revision of records and attributes that allow to give an interpretation of these indicators, in the social network analysis these methods are complementary (Edwards, 2010). The data of the relationships between the actors are collected directly from an Internet social network, LinkedIn, data allows making the analysis about the state and characteristics of the technological entrepreneurship ecosystem in the city of Lima, and in this case the situation will be investigated through network measurements.

Using the social networks analysis it will determine the indexes between the different elements of the technological entrepreneurship ecosystem in Lima: the community of entrepreneurs, mentors, incubators, accelerators, common service providers, angel investors, venture investors, universities, public support entities and linkages with other ecosystems.

5.1 Obtaining and pre-processing network data

For this study we obtained the data of the contacts of Linkedin of one of the authors, who registered during three years of an active participation in the entrepreneurial ecosystem of Lima including diverse actors of this system. In this way, this network of contacts represents a sample of that ecosystem and the interactions within this interorganizational network. The procedure applied was as follows:

a. An application was implemented with scripts in PHP and JavaScript for LinkedIn's API (Application Programming Interface) (LinkedIn Corporation, 2016c) to obtain node information automatically. In order to use the application, the registration was done on LinkedIn, the new application was first configured on the application registration page and an authorization code was requested for it. This enabled you to initiate a user session to obtain an access authorization code to perform authenticated data requests (LinkedIn Corporation, 2016a). The user must have among his contacts, actors of the network to be studied.

b. The application was developed to perform the requests for downloading the data of contacts, the data to be considered for the study are the links between the contacts, the entity to which they are related, the industrial sector to which they belong, the city, the country And the job title. Pre-processing of the downloaded data has been done through the text editor Notepad++ and the spreadsheet program, Excel. Scripts in PHP and JavaScript were developed in the text editor and those in R using RStudio.

c. On the basis of the data considered, the elements identified were the founders of start-ups, mentors, representatives of accelerators, incubators and companies that provide services to start-ups, investors, representatives of universities and public institutions related to the ecosystem.

d. In the resulting network, the nodes are start-ups (STUP), mentors (MENT), incubators (INCU), accelerators (ACCE), common service providers (SERV), angel and venture investors (INVR), universities (UNIV) and public institutions (PUBL). The nomenclature in parentheses will be used in the presentation of the network diagrams and the tables of the results.

e. Numeric labels were assigned to the nodes for social network analysis.

5.2 Measurements of the social network and elaboration of the network diagrams

For this study measurements of the network were made using software for this purpose UCINET, GEPHI and R on pre-processed data.

The data on the actors are used to create network diagrams using nodes and arrows; these allow visualizing the relationships between the actors of the ecosystem. The diagram can let us see the flow of financing, services, mentoring or information between different elements of the network.

5.3 Identification of the central entities, subgroups in the network

The network diagrams allow identifying which entities are the most important within the network or a group, as well as the centrality indexes found, for example a high degree of centrality indicates the leadership or the influence of an actor in the network or in its subgroup.

Subgroups in a network are presented because of location, function, activity, influence, dependency, among other characteristics with the other actors.

5.4 Criteria for interpreting results

In this case, the presence or absence of elements of the entrepreneurship ecosystem and the influence of the elements in the interorganizational network described in the revised literature will be verified. Reviewing the records and attributes of actors and the ecosystem allows interpreting and understanding the results.

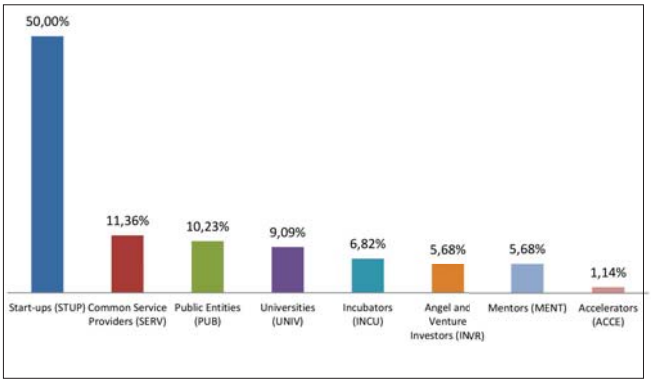
6. Results, analysis and discussion of results

First the results were analyzed considering an interorganizational network with only the nodes of Lima and then considering additionally the nodes of other countries.

6.1 Results of the interorganizational network with only Lima nodes

Figure1 shows the presence of the different elements in the Lima ecosystem: entrepreneurs (start-ups), mentors, incubators, accelerators, common service providers, angel investors, venture capital investors, universities and public support entities. In the case of the accelerators only the presence of an organization of this type is evidenced. Of a total of 88 nodes, 50% are Start-ups (STUP), 11.36% are Common Service Providers (SERV), 10.23% are Public Entities (PUB), 9.09% are universities, 6.86% are incubators (INCU), 5.68 % Are angel investors and risk investors (INVR), 5.68% are mentors (MENT), 1.14% of Accelerators (ACCE). It is also observed that start-ups and mentors (community of entrepreneurs) together constitute the largest percentage of entities in the network.

Figure 1. Distribution of the organizations in the network of Lima

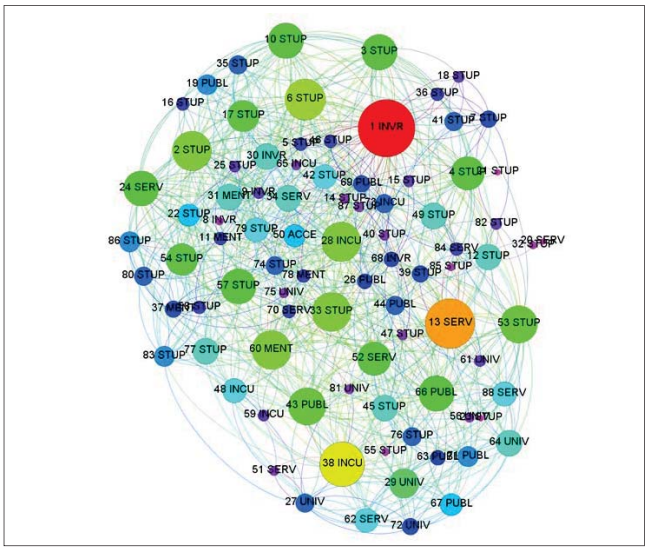


Source: Prepared by the authors

Figure 2 *shows* the interorganizational network, which has 88 nodes of Lima and 814 links, corresponding to a density of 10.6% and to link two organizations without direct link, in the worst case it should be done using 6 links in the network, so the network has a diameter of 6 and an average degree of centrality of 18.5. The nomenclature used is the node number followed by the category of the entity, for example node 1 is an investor, so it is labeled 1 INVR. The color and size indicate the degree of influence, the greater the size, the greater influence, and the colors ordered from greater to lesser influence are: red, orange, yellow, green, sky blue, purple and pink.

Figure 2 and the *Table 1* show the influence of the nodes on the network (lists of highest to least degree of influence in each category): of the accelerator, node 50, incubators, nodes 38, 28, and 48, of the investors, nodes 1, 30, and 68, of the mentors, nodes 60, 31 and 37, of the public entities, nodes 43, 66 and 67, of the common service providers, modes 13, 24 and 52, of the start-ups, nodes 6, 33, 2, 53, 3, 10, and 57, of the investor, node 1, of the service provider, node 13 and of the incubator, node 38. The indices indicate a high centrality of the investor 1 INVR, The incubator 38 INCU, the most connected actors, have greater influence, are intermediaries among other actors, have greater proximity to other nodes and are connected to the closest entities.

Figure 2. Interorganizational Network with only nodes of Lima



Source: Prepared by the authors

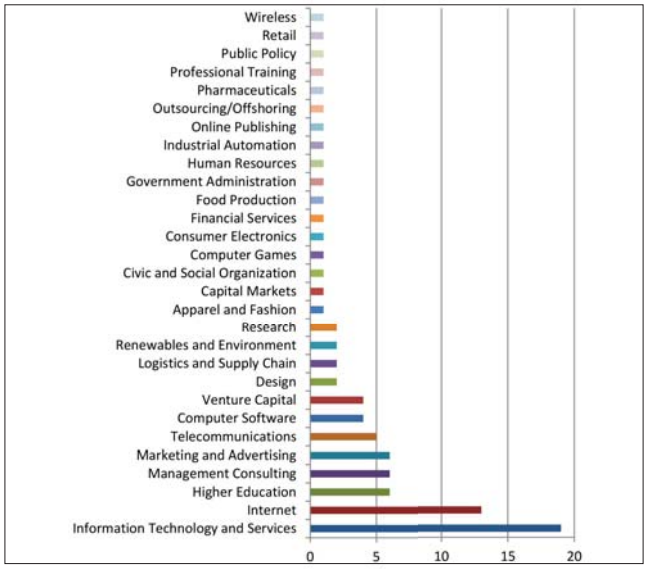
Figure 3 and Figure 4 show that ecosystem entities are most active in the information technology services sectors, followed by the Internet, Marketing and Advertising and Management sectors.

Table 1. Organizations with higher indexes of centrality in the network of Lima

Id	Category	Degree	Eccentricity	Closeness Centrality	Harmonic Closeness Centrality	Betweenness Centrality	Clustering	Eigen Centrality
50	Accelerator	20	4	0.46	0.51	83.42	0.311	0.404
38	Incubator	44	4	0.50	0.59	628.35	0.173	0.612
28	Incubator	38	4	0.53	0.59	205.37	0.298	0.806
48	Incubator	22	4	0.47	0.52	138.97	0.273	0.467
1	Investor	58	3	0.58	0.66	828.68	0.182	1.000
30	Investor	24	4	0.47	0.52	71.73	0.424	0.505
68	Investor	12	4	0.44	0.47	66.34	0.067	0.193
60	Mentor	38	4	0.51	0.58	326.13	0.211	0.672
31	Mentor	24	4	0.47	0.53	88.18	0.258	0.487
37	Mentor	14	5	0.40	0.44	17.58	0.286	0.225
43	Public Entity	36	3	0.53	0.59	276.83	0.222	0.716
66	Public Entity	34	3	0.50	0.56	261.05	0.272	0.631
67	Public Entity	20	4	0.45	0.50	34.05	0.511	0.386
13	Com. Ser. Provider	50	4	0.55	0.63	571.70	0.230	0.913
24	Com. Ser. Provider	34	4	0.48	0.56	229.79	0.110	0.517
52	Com. Ser. Provider	32	3	0.51	0.57	333.04	0.200	0.524
6	Start-up	40	3	0.52	0.59	353.50	0.253	0.757
33	Start-up	38	4	0.52	0.59	347.66	0.211	0.710
2	Start-up	38	4	0.51	0.58	365.13	0.135	0.595
53	Start-up	36	4	0.51	0.58	491.36	0.163	0.603
3	Start-up	34	4	0.49	0.56	267.25	0.243	0.607
10	Start-up	34	4	0.50	0.57	164.92	0.324	0.637
29	University	28	4	0.47	0.53	148.49	0.275	0.440
64	University	24	4	0.46	0.51	79.91	0.394	0.428
27	University	16	4	0.38	0.44	48.88	0.214	0.205

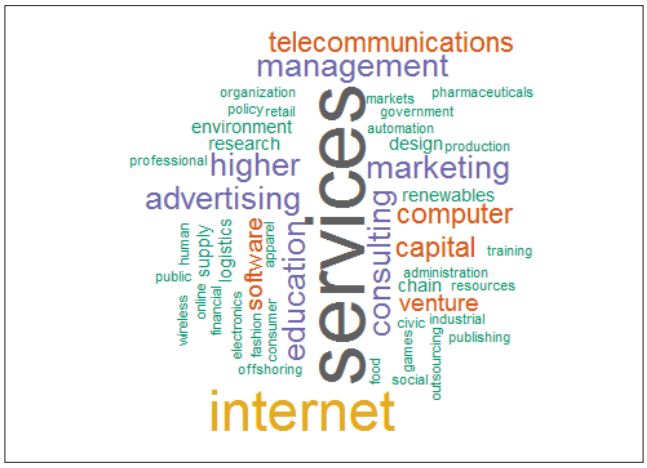
Source: Prepared by the authors

Figure 3. Distribution in the industrial sectors of the Lima network



Source: Prepared by the authors

Figure 4. *Cloud of the industrial sectors of the Lima network*



Source: Prepared by the authors

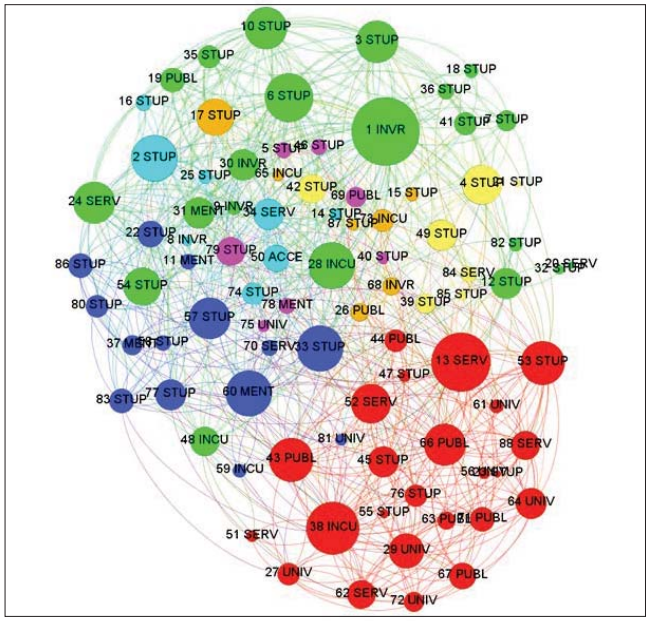
Table 2 shows 7 subgroups identified in the analyzed network and *Figure 5* shows that the leadership of the start-ups in the ecosystem is evident, due to its high indexes of centrality of these are presented in the different subgroups. Except for subgroup 6, which is formed mainly by universities and governmental organizations, which shows a high link between these entities, but the lack of integration with a greater number of start-ups in the Lima ecosystem by these entities, except for The incubators of the universities that have activity in other subgroups, which evidences the governmental intervention in the ecosystem, now with a fourth generation of 69 Start Up Peru ventures that are incubated (PRODUCE, 2016). Subgroup 2 is formed by start-ups and a service provider, which shows that start-ups in the ecosystem do not have a high link with other types of organizations and this may be due to the fact that they are in the early stages, nature of the sector of the start-ups or the ecosystem is in process of maturing.

Table 2. Members of the subgroups in the interorganizational network of Lima

Subgroup	Members of the subgroup	Organizations with greater centrality
0 (Light blue)	50 ACCEL 8 INVR 34 SERV 2 STUP, 14 STUP, 16 STUP, 25 STUP, 74 STUP	2 STUP 34 SERV 50 ACCEL
1 (Green)	28 INCU, 48 INCU 1 INVR, 9 INVR, 30 INVR 31 MENT 19 PUBL 20 SERV, 24 SERV, 3 STUP, 6 STUP, 7 STUP, 10 STUP, 12 STUP, 18 STUP, 32 STUP, 35 STUP, 36 STUP, 41 STUP, 54 STUP, 82 STUP	1 INVR 6 STUP 28 INCU
2 (Yellow)	84 SERV 4 STUP, 21 STUP, 39 STUP, 42 STUP, 49 STUP, 85 STUP	4 STUP 49 STUP 42 STUP
3 (Orange)	65 INCU, 73 INCU 68 INVR 26 PUBL 15 STUP, 17 STUP, 87 STUP	17 STUP 73 INCU 26 PUBL
4 (Pink)	78 MENT 69 PUBL 5 STUP, 40 STUP, 46 STUP, 79 STUP 75 UNIV	79 STUP 69 PUBL 5 STUP
5 (Blue)	59 INCU 11 MENT, 37 MENT, 60 MENT 70 SERV 22 STUP, 33 STUP, 57 STUP, 58 STUP, 77 STUP, 80 STUP, 83 STUP, 86 STUP 81 UNIV	33 STUP 60 MENT 57 STUP
6 (Red)	38 INCU 43 PUBL, 44 PUBL, 63 PUBL, 66 PUBL, 67 PUBL, 71 PUBL 13 SERV, 51 SERV, 52 SERV, 62 SERV, 88 SERV 23 STUP, 45 STUP, 47 STUP, 53 STUP, 55 STUP, 76 STUP 27 UNIV, 29 UNIV, 56 UNIV, 61 UNIV, 64 UNIV, 72 UNIV	13 SERV 38 INCU 43 PUBL

Source: Prepared by the authors

Figure 5. Subgroups in the interorganizational network of Lima

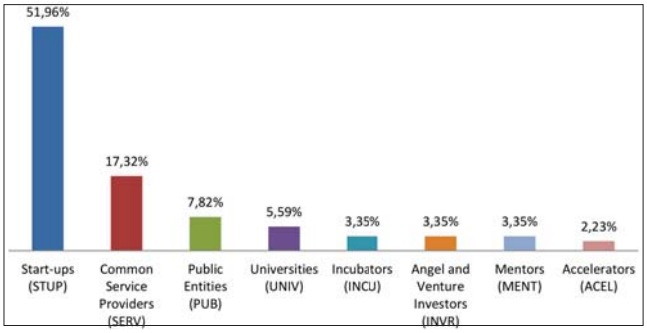


Source: Prepared by the authors

6.2 Results of the interorganizational network including foreign nodes

Similar to the network with only nodes of Lima, *Figure 6* shows the presence of the different elements in the ecosystem, of the 179 nodes, 51.96% are Start-ups (STUP), 17.32% are service providers (PUB), 5.59% are universities, 3.35% are incubators (INCU), 3.35% are angel investors and risk investors (INVR), 3.35% are mentors (MENT), 2.23% Accelerators (ACCEL). It is observed that the start-ups and the mentors (the community of entrepreneurs) together constitute the greater percentage of entities in the network. The distribution of organizations is similar to the network in which only the nodes of Lima were considered.

Figure 6. Distribution of organizations in the network with foreign nodes

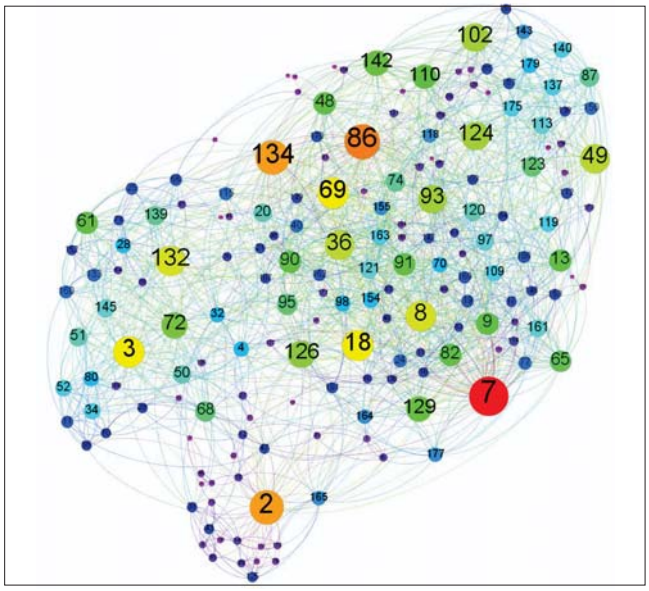


Source: Prepared by the authors

Figure 7 shows the interorganizational network with 179 nodes of Lima and the world and 1768 links, which correspond to a density of 5.5% and to link two organizations without direct bond, in the worst case it should be used Of 6 links present in the network, so the network has a diameter of 6 and an average degree of centrality of 19.75.

For the nomenclature in the network diagrams, the nodes with the corresponding number have been labeled. The color and size indicate the degree of influence, the greater the size, the greater the influence, and the colors ordered from greater to lesser influence are: red, orange, yellow, light green, green, sky blue, purple and pink.

Figure 7. Interorganizational network with foreign nodes



Source: Prepared by the authors

Figure 7 shows the influence of nodes from different countries on the network, accelerators from Peru, Chile and USA, incubators from Peru, investors from Peru, USA, Argentina and Chile, mentors from Peru, public entities from Peru and Chile, common service providers from Peru, start-ups from Peru, USA and Argentina, and Universities from Chile, Peru, Australia and Brazil. In this network also the indexes indicate a high centrality of the investors, they are the most connected actors and intermediaries among other nodes, and have more influence and more proximity to other entities.

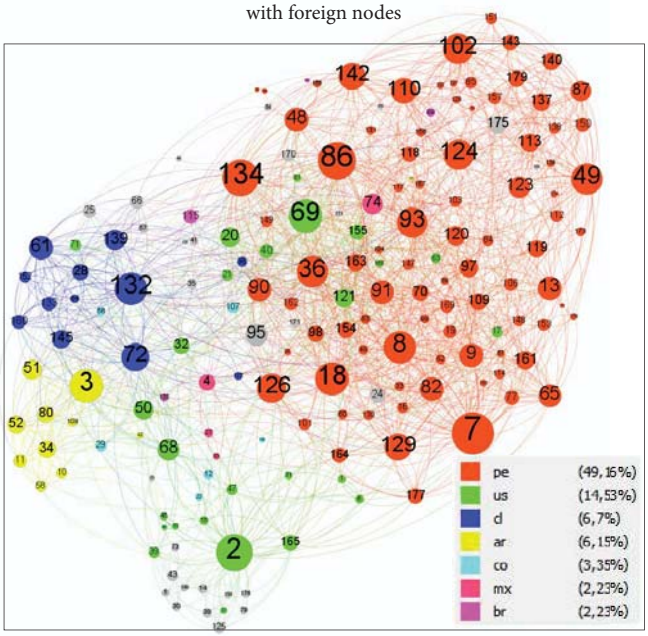
Table 3. Organizations with higher indexes of centrality in the network with foreign nodes

Id	Category	Country	Degree	Eccentricity	Closeness Centrality	Harmonic Closeness Centrality	Betweenness Centrality	Clustering	Eigen Centrality
120	Accelerator	Peru	30	5	0.40	0.45	261.30	0.248	0.439
145	Accelerator	Chile	28	4	0.42	0.47	307.03	0.429	0.368
1	Accelerator	USA	8	5	0.31	0.33	36.86	0.000	0.034
86	Incubator	Peru	64	4	0.47	0.54	1174.68	0.196	0.922
102	Incubator	Peru	50	4	0.42	0.49	1169.29	0.163	0.439
118	Incubator	Peru	22	4	0.41	0.45	239.43	0.273	0.384
7	Investor	Peru	72	4	0.48	0.56	1841.10	0.167	1.000
2	Investor	USA	62	4	0.46	0.53	4845.26	0.086	0.432
3	Investor	Argentina	56	4	0.43	0.50	1490.91	0.164	0.446
132	Investor	Chile	54	4	0.45	0.51	1378.85	0.199	0.621
134	Mentor	Peru	62	4	0.48	0.54	1780.52	0.161	0.823
91	Mentor	Peru	38	4	0.47	0.51	713.26	0.205	0.598
162	Mentor	Peru	18	4	0.39	0.43	69.90	0.333	0.296
142	Public Entity	Peru	44	4	0.44	0.50	1125.71	0.186	0.540
110	Public Entity	Peru	42	4	0.47	0.52	1003.12	0.176	0.616
70	Public Entity	Peru	24	4	0.41	0.46	206.80	0.258	0.414
28	Public Entity	Chile	24	5	0.38	0.43	202.02	0.303	0.241
49	Com. Ser. Provider	Peru	52	4	0.45	0.51	1052.26	0.237	0.732
82	Com. Ser. Provider	Peru	38	4	0.42	0.48	405.13	0.135	0.492
123	Com. Ser. Provider	Peru	34	4	0.42	0.47	487.63	0.213	0.386
18	Start-up	Peru	56	4	0.47	0.53	1244.20	0.217	0.847
69	Start-up	USA	56	4	0.47	0.53	719.74	0.267	0.926
8	Start-up	Peru	54	4	0.46	0.52	1022.89	0.137	0.700
36	Start-up	Peru	52	3	0.49	0.54	1451.06	0.243	0.810
93	Start-up	Peru	50	4	0.46	0.52	959.55	0.187	0.729
94	Start-up	Argentina	2	6	0.26	0.28	0.00	0.000	0.008
72	University	Chile	46	4	0.42	0.49	931.60	0.217	0.490
87	University	Peru	32	4	0.40	0.45	262.34	0.283	0.334
140	University	Peru	26	5	0.39	0.44	178.45	0.385	0.311
175	University	Australia	26	5	0.37	0.43	668.26	0.244	0.235
85	University	Peru	16	5	0.34	0.38	94.66	0.214	0.132
151	University	Peru	14	5	0.35	0.39	13.33	0.619	0.169
89	University	Brazil	10	5	0.33	0.37	66.48	0.300	0.080

Source: Prepared by the authors

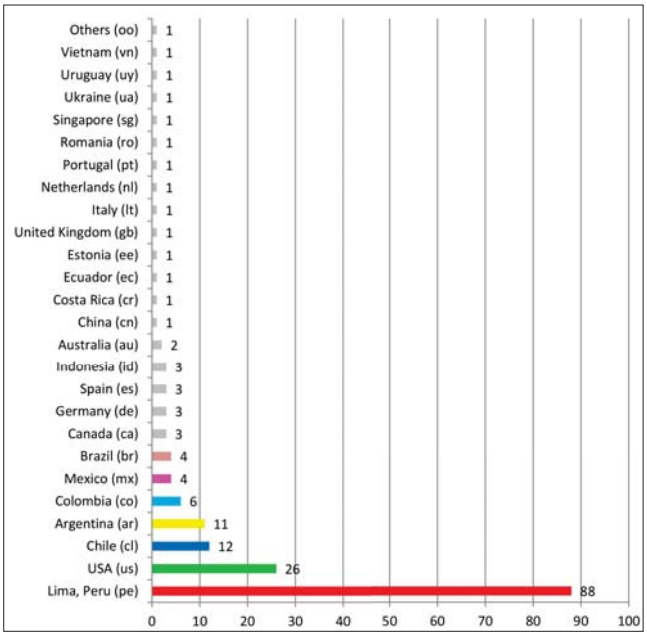
Figure 8 and *Figure 9* show that the ecosystems of USA (us), Chile (cl), Argentina (ar), Colombia (co), Mexico (mx) and Brazil (br) are the most influential in the start-up ecosystem of Lima in this order, but in addition there is evidence of linkage with ecosystems of Canada (ca), Germany (de), Spain (es), Indonesia (id), Australia (au), China (cn), Costa Rica (cr), Ecuador(ec), Estonia (ee), United Kingdom (gb), Italy (it), Netherlands (nl), Portugal (pt), Romania (ro), Singapore (sg), Ukraine (ua), Uruguay (uy) y Vietnam (vn).

Figure 8. Distribution of the organizations by country in the network with foreign nodes



Source: Prepared by the authors

Figure 9. Actors by country in the interorganizational network



Source: Prepared by the authors

Table 4, *Table 5*, and *Figure 10* show 4 subgroups, in which the overall leadership of the start-ups in the ecosystem is evident, and in addition a high influence of the investors is observed because of their high centrality in different subgroups, except in subgroup 3 which is mainly composed of universities, government organizations and common service providers. This shows the high link between these last entities, similar to the local network analyzed, and also the lack of integration of them with a greater number of start-ups of the Lima ecosystem. On the other hand, the incubators appear linked to all the types of elements of the ecosystem. In *Table 4* and *Table 5* we use as nomenclature the node number followed by the category of the entity and the country code for example node 1 is an Accelerator from USA, so the node is labeled 1 ACCEL us.

Table 4. Subgroups in interorganizational network with foreign nodes

Subgroup	Members of subgroup
0 (Green)	2 ACCEL us 126 INVR us, 129 INVR us, 82 INVR de, 161 INVR us, 164 INVR us, 177 INVR ro, 165 INVR ee, 77 INVR us, 169 INVR vn, 101 INVR sg, 43 INVR us, 125 INVR au 39 MENT pe, 47 MENT pe, 12 MENT us 46 SERV pe 130 STUP pe, 38 STUP pe, 14 STUP pe, 30 STUP pe, 6 STUP pe, 15 STUP pe, 41 STUP pe, 73 STUP de, 176 STUP co, 5 STUP pe, 1 STUP de, 31 STUP id, 45 STUP us, 79 STUP ec, 22 STUP id, 159 STUP lt, 174 STUP co, 146 STUP id, 37 STUP pe, 55 STUP ua, 100 STUP us, 23 STUP us, 88 STUP ca 116 UNIV us
1 (Red)	3 ACCEL cl 132 INVR ar, 72 INVR cl, 61 INVR cl, 68 INVR cl, 139 INVR us, 51 INVR ar, 50 INVR ca, 145 INVR cr, 34 INVR nl, 52 INVR ar, 80 INVR co, 28 INVR uy, 4 INVR br 32 PUBL cl 115 SERV cl, 133 SERV cl 160 STUP us, 11 STUP ar, 66 STUP us, 25 STUP ar, 10 STUP ar, 58 STUP ar, 152 STUP mx, 29 STUP br, 107 STUP cl, 71 STUP cl, 96 STUP ar, 35 STUP ar, 108 STUP co, 64 STUP co, 56 STUP us, 27 STUP cl, 57 STUP mx, 135 STUP cl, 172 STUP ar, 42 STUP mx 53 UNIV cl
2 (Blue)	7 ACCEL pe 86 INCU pe, 134 INCU pe, 18 INCU pe, 69 INCU pe, 8 INCU pe 36 INVR pe, 93 INVR pe, 9 INVR us, 13 INVR pe, 48 INVR pe, 90 INVR pe 91 MENT pe, 65 MENT pe, 95 MENT pe 120 PUBL pe, 20 PUBL pe 97 SERV pe, 121 SERV pe, 109 SERV us, 119 SERV es, 163 SERV pe 70 STUP pe, 98 STUP us, 154 STUP pe, 118 STUP pe, 155 STUP pe, 24 STUP pe, 40 STUP pe, 19 STUP pe, 106 STUP pe, 162 STUP es, 170 STUP us, 153 STUP us, 16 STUP pe, 103 STUP pe, 147 STUP pe, 148 STUP pe, 149 STUP pe, 17 STUP us, 21 STUP oo, 33 STUP pe, 60 STUP pe, 62 STUP gb, 83 STUP pe, 114 STUP pe, 63 STUP us, 171 STUP us, 99 STUP pe, 117 STUP pe, 131 STUP pe, 167 STUP pe, 59 STUP ca, 67 STUP pe, 104 STUP pe, 81 STUP pe, 168 STUP pe, 111 STUP pe, 26 STUP pe, 141 STUP us, 178 STUP cn, 158 STUP pe, 44 STUP co, 92 STUP pe, 94 STUP ar, 75 STUP pe 76 UNIV us
3 (Yellow)	49 ACCEL pt 102 INCU pe 124 PUBL pe, 142 PUBL pe, 110 PUBL pe, 123 PUBL pe, 74 PUBL pe, 87 PUBL pe, 113 PUBL pe 175 SERV pe, 137 SERV pe, 140 SERV pe, 179 SERV pe, 143 SERV pe, 150 SERV pe 85 STUP pe, 112 STUP mx, 157 STUP pe, 84 STUP pe, 138 STUP pe, 151 STUP pe 89 UNIV pe, 156 UNIV au, 173 UNIV pe, 128 UNIV pe, 136 UNIV pe, 166 UNIV br, 54 UNIV pe, 122 UNIV pe, 127 UNIV pe, 78 UNIV pe, 105 UNIV es 144 UNIV br

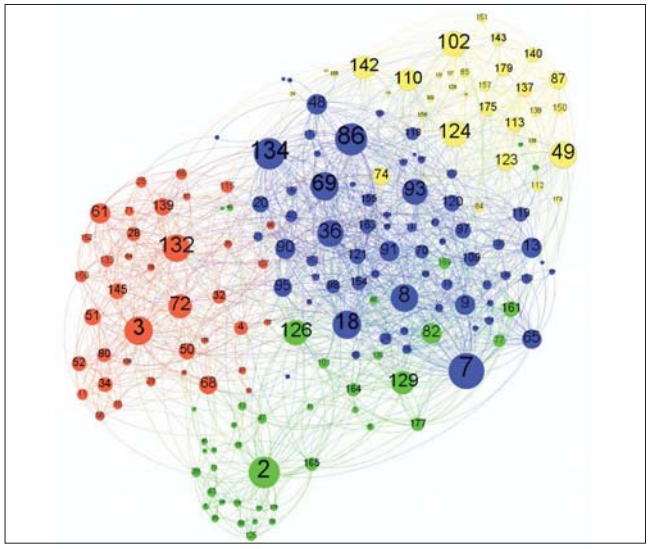
Source: Prepared by the authors

Table 5. Countries with more presence and more influential organizations in Subgroups

Subgroup	Countries with more presence	Organizations with greater centrality index
0 (Green)	Peru, USA y Germany	2 INVR us 126 STUP pe 129 STUP pe 82 SERV pe 161 STUP pe
1 (Red)	Chile, Argentina and USA	3 INVR ar 132 INVR cl 72 UNIV cl 61 INVR cl 68 STUP us
2 (Blue)	Peru and USA	7 INVR pe 86 INCU pe 134 MENT pe 18 STUP pe 69 STUP us
3 (Yellow)	Peru and Brazil	49 SERV pe 102 INCU pe 124 STUP pe 142 PUBL pe 110 PUBL pe

Source: Prepared by the authors

Figure 10. Subgroups in the Interorganizational network with global nodes



Source: Prepared by the authors

Conclusions

According to the work carried out in the analysis of interorganizational networks, it is concluded that there is an ecosystem of technological entrepreneurship in Lima with the link between the different elements: the community of entrepreneurs, mentors, incubators, accelerators, service providers Common investors, angel investors, venture capital investors, universities, public support entities and linking with other ecosystems. In this ecosystem, start-ups and mentors (the community of entrepreneurs) constitute the largest percentage of entities in the network and generally have a presence and leadership in the ecosystem.

The indexes show a high centrality of the investors, being the most connected actors, who have more influence, who are intermediaries among other actors and who have more proximity to other nodes. Thus, investors are also actors who have a significant presence in the ecosystem. On the other hand, universities and public institutions have a high link between them, but in general they show a low integration with the start-ups of Lima ecosystem, except the incubators of the universities that they interact with the start-ups through Government programs for ecosystem development.

In particular, in Linkedin sectorial classification, the information technology, Internet, management and marketing, and advertising services sectors of the ecosystem are more active. This means that start-up activity is not developing at the same level in other emerging technologies such as new materials and biotechnology, among others, which requires a special public policy effort.

With respect to international connections, it is observed that the ecosystems of the USA, Chile, Argentina, Colombia, Mexico and Brazil are the ones that have the greatest linkage and therefore are the most influential in the technological entrepreneurship ecosystem of Lima. In addition, there is a smaller link with ecosystems in Canada, Germany, Spain, Indonesia, Australia, China, Costa Rica, Ecuador, Estonia, United Kingdom, Italy, Netherlands, Portugal, Romania, Singapore, Ukraine, Uruguay and Vietnam.

In the exploratory study (Hernández & González, 2016) and prior to this investigation was concluded that from the perspective of the entrepreneurs, there are all elements of the entrepreneurial ecosystem in the city of Lima, although the perception of these is completing, as the enterprise is advancing in its stages of development. In this study of analysis of interorganizational networks, it is corroborated that the entrepreneurial ecosystem of Lima presents these elements and it is

added that there is an intense interaction between them, which has developed in the city in recent years. However, as noted in the previous conclusions, there is still a need for greater interaction between some elements, mainly universities and public entities.

Finally, as future research, it is proposed that the knowledge of Lima's technological entrepreneurship ecosystem could be further expanded through surveys of a representative sample of the members of the entrepreneurs community, in order to understand in greater depth which facilitators and barriers that are presented for the development of this ecosystem. Also, other tools from different branches of science could be applied to analyze the ecosystem, its determinants and its impact, as is the case of this study where the social networks analysis, a tool from sociology has been applied.

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Sustitución de Importaciones en la Industria Biofarmacéutica Argentina: Una Estrategia con Blanco Móvil

Pablo Lavarello [1], Evelin Goldstein [2], Juan José Pita [3]*

Resumen: Desde una perspectiva de sustitución de importaciones basada en la industria infantil, la protección del mercado interno es necesaria como un primer paso para generar un proceso de aprendizaje tecnológico. Esta perspectiva es de relevancia frente a la emergencia de la biotecnología como paradigma tecnológico. Para ciertos países en desarrollo como la Argentina que han alcanzado tempranamente un umbral mínimo de conocimientos y ciertas capacidades manufactureras, esto abre una ventana de oportunidad. Este trabajo muestra a partir de datos de comercio la existencia de espacio para sustitución de importaciones dependiendo de la complejidad de las tecnologías y discute ciertos aspectos para impulsar deliberadamente este tipo de estrategias.

Palabras clave: sustitución de importaciones; capacidades tecnológicas infantiles; biofármacos.

Import Substitution in Argentine Biopharmaceutical Industry: A Moving Target Strategy

Abstract: From an infant capability approach of import substitution, domestic market protection is a necessary first step to generate technological learning. This view is relevant in the face of biotechnology paradigm emergence. For developing countries as Argentina, that had early achieved a minimum threshold of knowledge and manufacturing experience, this opens a window of opportunity. This works shows that there is space for an importation substitution strategy in Argentina depending on the complexity of technologies involved discussing some aspects to encourage deliberately this strategy.

Keywords: import substitution; infant technology capabilities; biopharmaceutical products.

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Introducción [1]

Este trabajo se propone discutir las posibilidades para los países de América Latina para avanzar en un proceso de sustitución de importaciones en industrias de alta tecnología como lo es la industria de biofármacos. Industria en la que un conjunto acotado de firmas han desarrollado capacidades de exportación y en los cuales su complementación con mecanismos de protección selectiva del mercado interno pueden llegar a reducir el déficit comercial.

La sustitución de importaciones ha sido una estrategia implementada en diversos países en desarrollo, particularmente en América Latina y en Asia. Sin embargo, en algunos casos, la sustitución de importaciones ha sido un fin en sí mismo, con el objetivo de solucionar la falta de oferta de productos en el mercado interno y enfrentar los problemas de restricción de divisas, mientras que en otros ha constituido una pieza de la política de industrialización (Ocampo, 2009; Thorp,1998). Ha sido ampliamente estudiado cómo estrategias de sustitución de importaciones han tenido momentos de apogeo y de declive. Es por ello que la sustitución de importaciones ha sido objeto de críticas y controversias.

Al respecto, incluso Prebisch, que destaca el impulso a la transformación estructural que ha provisto la sustitución de importaciones, también reconoce que se ha incurrido en graves fallas, esencialmente por dos razones. La primera, porque no se han seguido consideraciones de economicidad, por lo cual no se ha logrado una reducción del coeficiente de importaciones; y la segunda, porque en algunos casos no se ha alentado complementariamente las exportaciones. De esta manera, propone ir más allá de la dicotomía planteada por algunos autores entre la sustitución de importaciones y la promoción de exportaciones como estrategia de desarrollo industrial.

El punto esencial que es importante remarcar, que ciertos autores enfatizan, es que la protección del mercado interno es necesaria como un primer paso para generar un proceso de aprendizaje tecnológico que permita a las empresas consolidar su posicionamiento competitivo (Kim, 1990; Ray, 1998). En línea con la literatura de la protección a la industria infantil inspirada en los trabajos de Frederich List y Alexander Hamilton, la sustitución de importaciones deja de ser un fin en sí mismo. La protección selectiva y transitoria del mercado interno posibilita el desarrollo de capacidades tecnológicas. Como lo demuestran los trabajos de Amsden (1985, 1995) y Kim (1990) basados en las experiencias de *catching up* de Korea y Taiwan, la protección a las capacidades tecnológicas infantiles fue el principal móvil de las experiencias de sustitución de importaciones en esos países.

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(1) Este trabajo presenta algunos de los resultados del proyecto PICT 2034 "Estrategias de inserción internacional de la industria farmacéutica frente a la biotecnología: el caso de la Argentina" desarrollado en el CEUR-CONICET

En el caso particular de la experiencia de sustitución de importaciones en Argentina entre los años 50 y 70 la producción de bienes finales de tecnología media no logró avanzar en un proceso acelerado de protección a las capacidades tecnológicas infantiles. Los esfuerzos tecnológicos se limitaban a la adaptación de procesos y ajustes de *lay outs* de plantas con un alto grado de integración de componentes. Si bien la adaptación tecnológica tardía posibilitó aprendizajes de proceso, fue generando con su desarrollo niveles de protección cada vez más altos para compensar la ampliación de las brechas tecnológicas en las industrias de insumos y componentes[2].

La introducción de la protección infantil de las capacidades tecnológicas como dimensión central en la estrategia de sustitución de importaciones plantea como interrogantes cómo pueden aprovecharse las ventanas de oportunidad y en que momento en el marco de una estrategia de este tipo. Mientras que ciertos autores plantean explícita o implícitamente que las posibilidades de *catching up* son mayores en la madurez de las tecnologías apostando a avanzar rápidamente en los procesos de aprendizaje en la producción, otros autores plantean que las posibilidades son mayores en los momentos iniciales de difusión de una nueva tecnología cuando los parámetros de los procesos de manufactura aún no se han consolidado y las empresas de los países periféricos pueden avanzar en el desarrollo imitativo de productos, componentes y procesos (Amsden, 2004; Perez y Soete, 1988).

Esta pregunta es de relevancia para ciertos países en desarrollo como es el caso de Brasil y Argentina quehan alcanzado tempranamente un umbral mínimo de conocimientos en biología molecular y ciertas capacidades de bioprocesamiento, en particular en el desarrollo y manufactura de productos biofarmáceuticos. A diferencia dela industria farmacéutica tradicional en los que dada la alta madurez de las tecnologías de síntesis química y las elevadas economías de escala hacen quela sustitución de importaciones de los insumos básicos no sea rentable, las bajas barreras de escala y experiencia requerida al inicio de la difusión de las biotecnologías abrirían una nueva ventana de oportunidad (Gutman y Lavarello, 2014).

Sin embargo, diversos trabajos internacionales realizados por especialistas del sector han relativizado las ventanas de oportunidad señalando las dificultades que puede implicar este tipo de estrategia dada la alta complejidad de los productos biológicos y sus procesos de producción y aprobación regulatoria (Moorkens, et al, 2016; Rader, 2013). Aspecto que es reforzado por el continuo surgimiento de oleadas de nuevos conocimientos y productos plantea nuevas barreras de conocimiento a tener en cuenta en este tipo de estrategias (Lavarello, 2014).

Este trabajo se plantea como interrogante exploratorio en qué medida dichas oportunidades han posibilitado procesos de sustitución de importaciones en productos farma-biotecnológicos en Argentina buscando identificar si las ventanas son transitorias o si existieron segmentos de productos en los que este tipo de estrategias fueron efectivas.

A fin de responder a este interrogante en la sección 1 desarrollamos, a partir de una revisión de aportes de los autores neoschumpeterianos, un marco conceptual que permita analizar cuáles son las barreras que enfrenta un país para entrar en un sector de alta tecnología a partir de una estrategia de sustitución de importaciones. En la sección 2 se analiza cómo evolucionó el déficit de biofármacos en Argentina durante los últimos 16 años. En la sección 3 se realiza un ejercicio exploratorio que busca identificar preliminarmente cuáles son los productos con posibilidad de sustitución de importaciones, discutiendo cuales son las eventuales barreras que pueden impedir ese proceso. En las conclusiones se presentan los resultados, sus implicancias para la política pública y los nuevos interrogantes para investigaciones futuras.

1. Marco conceptual: la sustitución de importaciones frente a los nuevos paradigmas tecnológicos.

Mientras que América Latina desmantelaba en los años ’80 sus políticas basadas en la sustitución de importaciones en sectores maduros, diversos países de Asia llevaban adelante un proceso de sustitución de importaciones en sectores de alta tecnología (Amsden, 2004). El éxito de la estrategia se basó, esencialmente, en el impulso de la producción imitativa de bienes de alta tecnología que estaban por entrar a su fase de madurez y a partir de allí avanzar a los más innovativos. Estrategia que se dio en simultáneo a la articulación de proveedores locales de las piezas e insumos. De esta manera, con la sustitución de importaciones de los bienes finales y, en algunas de las etapas, de producción de sus componentes, se evitaba caer en un estrangulamiento de la balanza de pagos.

El avance en la sustitución de componentes, por un lado, y la complementación de políticas coordinadas de créditos subsidiados, creación de centros de innovación para transferencia tecnológica y la fijación de metas claras de producción e industrialización, por el otro, han sido las principales diferenciales de la política de Asia respecto de América Latina, que han permitido la continuidad de la estrategia y el éxito de la misma.

Cabe destacar el activo papel de los gobiernos en los procesos de sustitución de importaciones en los países asiáticos, con la aplicación de un mix de políticas específicas para la promoción de la producción de bienes de alta tecnología, que incluían incentivos a la generación de capacidades tecnológicas, por ejemplo, beneficios fiscales, créditos con tasas de interés subsidiadas, la creación de parques industriales científico-tecnológicos. También ha sido clave el rol de las instituciones científicas públicas en la investigación, desarrollo y diseño de nuevos productos como en el fortalecimiento de recursos humanos idóneos para trabajar en los nuevos segmentos de mercado (Cimoli et al, 2006).

Pero fundamentalmente estas experiencias estuvieron signadas por una alta selectividad de los sectores (y de las firmas) a través de múltiples instrumentos que incluían desde la producción pública de componentes clave hasta la organización del mercado asegurando

(2) Aún cuando la estrategia de industrialización comienza a ser corregida a partir del año 1964 a partir de la promoción de inversiones industria pesada (acero, petroquímica, aluminio, papel), las políticas de apertura comercial y financieras de fines de los años ’70 abortan la emergencia de una incipiente industria de proveedores especializados de bienes de capital e industrias basadas en la ciencia (electrónica y farmoquímica)

un adecuado *mix* entre competencia y protección (Amsden, 1992). En estos casos la estrategia se basó en inicialmente apoyar industrias de ensamble en productos que comenzaban su fase de madurez focalizando el aprendizaje acelerado en los procesos de manufactura de los componentes tecnológicamente intensivos. El estado impulsó la creación de infraestructuras de CyT que resolvieran los cuellos de botella tecnológicos e impulsar desprendimientos privados de laboratorios estatales.

1.1 Las ventanas de oportunidad en el marco de los nuevos paradigmas
La selectividad de la política invita a reflexionar sobre cuáles es momento más adecuado del ciclo de los productos para comenzar la sustitución de importaciones. Los autores neoschumpeterianos analizan las condiciones bajo las cuales ciertos países en desarrollo han logrado entrar a una industria de alta tecnología frente a la emergencia de nuevos paradigmas tecnológicos (Perez y Soete, 1988: 458; Malerba y Nelson, 2011:1645).

Desde la perspectiva de la literatura del ciclo de producto (Vernon, 1966) la sustitución de importaciones en los países periféricos se da en el marco de la transferencia de la tecnología desde el centro cuando la misma ya ha alcanzado cierta madurez. Amsden (1992) señala a partir de los análisis de los sectores de semiconductores y los lectores de disco que las posibilidades de sustitución de importaciones son mayores cuando estos productos comienzan su fase de madurez. Es en esta fase que la competencia se centra en el aprendizaje acelerado.

Desde una perspectiva neo-shumpeteriana esta posición puede ser relativizada (Perez y Soete, 1988; Perez, 2002). En la medida que los productos maduros son justamente aquellos que han agotado su dinamismo tecnológico, la focalización de la sustitución de importaciones en los mismos puede generar un problema de "encerramiento" (Lock in) en un sendero de desarrollo de bajos salarios y bajo crecimiento. En línea con esta crítica del modelo de ciclo de producto plantean que los países semi-industralizados cuentan con posibilidades de entrada de las empresas de estos países en las etapas tempranas de difusión de la tecnología.

Perez y Soete (1988) plantean que en el momento de transición entre paradigmas tecnológicos, los países desarrollados han hundido inversiones y aprendizajes tecnológicos en las tecnologías preexistentes resultando en altas barreras a la salida. Esto implica que al inicio del ciclo de una nueva tecnología existirán posibilidades de ascenso industrial para aquellos países en desarrollo que generen la base de conocimiento en la nueva tecnología. Aún cuando la probabilidad de dicho proceso de ascenso industrial son limitadas, es de relevancia analizar las condiciones que los hicieron posibles[3].

Es posible avizorar que las condiciones favorables para un proceso de sustitución de importaciones varía según la etapa de difusión de la tecnología. En la fase inicial de emergencia de una nueva tecnología hasta que la misma se consolida en un conjunto de parámetros y heurísticas las economías de escala son bajas, exigiendo en contraste un alto umbral de conocimientos para asimilar las nuevas tecnologías. En la fase de crecimiento, en la que el mercado ya se creó y se expande a alto ritmo, los parámetros de los procesos ya se encuentran definidos y los productos están ampliamente testeados en el mercado. El foco cambia de la I+D a los aprendizajes en la producción. El umbral requerido de capacidades en I+D disminuye y aumenta el umbral mínimo de experiencia en la producción. En la fase siguiente, el crecimiento del mercado comienza a desacelerarse y los procesos ya han sido optimizados. Las economías de escala aumentan. Las posibilidades de nuevos entrantes disminuyen aunque el acceso al conocimiento CyT es mayor. Finalmente, en la fase de madurez, ya se estandarizaron tanto el producto como el proceso. Ya las posibilidades de mejoras en la productividad son menores y la ventaja se encuentra asociada a contar con costos más bajos en las materias primas o en la mano de obra.

El análisis del ciclo de la industria permite concluir que las dos etapas en las que existen mayores posibilidades de entrada para las firmas de los países en desarrollo son la primera en la que emerge la tecnología, a partir de una inserción autónoma como imitadores tempranos, y la última como productores de bajo costo en el marco de las estrategias deslocalización de las Empresas Multinacionales. No obstante, los desafíos no son menores en el primer caso para los países en desarrollo, en la medida que la entrada como imitadores tempranos exige tanto un alto esfuerzo en I+D y una infraestructura de CyT que brinde el conjunto de externalidades necesarias para compensar las desventajas vis a vis las ventajas de las empresas multinacionales de los países desarrollados (y sus respectivos sistemas nacionales de innovación).

1.2 Los ciclos de vida de los paradigmas tecnológicos: las especificidades de la biotecnología
El análisis para una tecnología particular puede ser ampliado para productos y tecnologías que forman parte de sistemas técnicos (Freeman y Perez 1988). En este sentido, las sucesivas tecnologías y productos que pueden ser comprendidos como mejoras incrementales en un mismo producto. Esta visión es altamente útil para el caso de las biotecnologías en la medida que la mismas comprenden el surgimiento de sucesivas oleadas tecnológicas – ingeniería genética, genómica, proteómica, bioingeniería de tejidos, otras- y sucesivas generaciones de productos que van dando lugar a la emergencia de un paradigma tecnológico.

Desde esta perspectiva cada nueva tecnología se beneficia del conocimiento y la experiencia de las tecnologías precedentes así como de la infraestructura de CyT desarrollada previamente. Pasamos a una dimensión analítica en la que estudiamos los ciclos de vida ya no de los productos sino de los paradigmas tecnológicos. Cuestión que tiene importantes implicancias para la economía del desarrollo. Aquellos países desarrollados en los que la base de conocimientos, los

(3) El logro de este este tipo de procesos se limita a unas pocas experiencias de industrialización tardía del siglo XIX como Estados Unidos, Alemania y Francia frente al declive de Gran Bretaña. Más recientemente Japón y Corea del Sur atravesaron experiencias similares en un conjunto de ramas entre las cuales la difusión de la micro-electrónica en procesos y productos, y más parte las TICs, lograron procesos de catching up exitosos.

aprendizajes y la organización de sus sistemas nacionales de innovación aún se encuentran orientados hacia paradigmas tecnológicos previos pueden quedar encerrados (*lock-in*) en un sendero de desarrollo de bajo crecimiento.

No obstante, el caso de las biotecnologías es posible mencionar un conjunto de aspectos que deben ser consideradas a la hora de analizar las condiciones de entrada.

En primer lugar, los umbrales mínimos de I+D no han disminuido como se esperaba al inicio de la difusión del paradigma. Las sucesivas oleadas de biotecnología no se han traducido necesariamente en una base de conocimientos común. Cada nueva oleada implica una ampliación de la base de conocimiento que aumenta la complejidad de la misma y aumenta los costos de I+D sin necesariamente resultar en rendimientos crecientes de la innovación (Pisano, 2002). Esto implica que el umbral mínimo de I+D no disminuya con la difusión del paradigma.

En segundo lugar, no es claro que el nuevo paradigma tecnológico reemplace necesariamente al paradigma preexistente en todas las aplicaciones de la biotecnología (Lavarello, 2014). En las aplicaciones de biotecnología industrial (Enzimas industriales e Ingredientes alimentarios) los bioprocesos son complementarios a tecnologías previas. Aún en las aplicaciones en biotecnología de salud en los que las técnicas y productos biotecnológicos han reemplazado los productos de síntesis química, muchos procesos en la I+D de una molécula requieren capacidades químicas y biológicas tradicionales.

En tercer lugar, no es claro en la literatura la tendencia al aumento en la escala coexistiendo producciones con escalas altas y bajas según el tipo de molécula. Si bien se manifestó un aumento en el requisito de escala – con grandes fermentadores de acero inoxidable[4] y procesos en continuo -, durante los últimos años surgieron nuevas tecnologías que posibilitan producir de forma más flexible aprovechando economías de *scope* (variedad)[5]. Estas tecnologías si bien requieren menor inversión en grandes plantas y menores tiempos de ajuste al cambiar de producto, involucran mayores costos unitarios, siendo compatibles con una estrategia de inserción rápida en nichos para productos de ciclo de vida corto.

En cuarto lugar, la experiencia es un requisito crítico en la medida que se avanza de moléculas más simples a aquellas más complejas. La producción a escala industrial de productos biológicos es altamente variable. El logro de lotes de producción manteniendo la estabilidad biológica resulta clave para asegurar la eficacia y seguridad de la droga. Esta condición es más difícil de lograr en las moléculas más complejas como los anticuerpos monoclonales utilizados para tratamientos oncológicos y enfermedades crónicas de alto costo que en moléculas biotecnológicas de primera generación como los interferones.

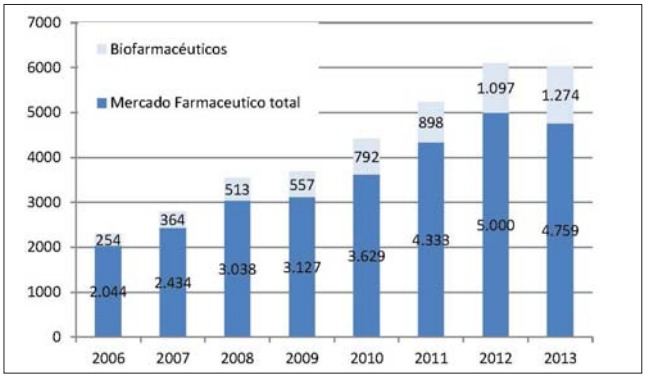
Last but not least, las barreras regulatorias en los medicamentos asumen una importancia mayor que los otros determinantes. La entrada como imitadores tempranos en las biotecnologías de salud implica cumplir con aprobaciones sanitarias y del régimen de propiedad intelectual específicas a cada país. En aquellos casos en los que la altura inventiva requerida para patentar sea baja y el alcance de las reivindicaciones sea amplio las barreras a la entrada de nuevos jugadores será mayor. Por su parte el establecimiento de marcos regulatorios estrictos exigiendo a los imitadores replicar los largos y costosos ensayos clínicos frenará las posibilidades de aprobación de moléculas similares a las originales (Gutman y Lavarello, 2015). Frente a ello una estrategia de propiedad intelectual y regulatoria que permita generar los aprendizajes de las firmas para sortear las barreras es clave para los países seguidores.

En resumen, la sustitución de importaciones en el caso de los biofarmacéuticos requiere un conjunto de intervenciones que logren absorber rápidamente nuevas oleadas de conocimiento biotecnológico y fomentar la generación de capacidades tecnológicas en la manufactura acompañados de un manejo estratégico de la propiedad intelectual y de la aprobación sanitaria a medida que aumentan los umbrales regulatorios. Los mayores riesgos en dicho proceso de sustitución de importaciones es el de elegir la técnica de producción correcta y el riesgo de mercado.

2. Industria biofarmacéutica Argentina durante los años 2000: expansión del mercado interno y déficit comercial creciente.

El mercado de productos biofarmacéuticos en Argentina experimentó una acelerada expansión entre desde mediados de los años 2000. Mientras que en el año 2006 los biofármacos representaban el 11% de las ventas totales de la industria farmacéutica, en el año 2013 estos llegaron a representar el 23% de dicho mercado. Esto muestra que los biofármacos constituyen una de las principales áreas de expansión del mercado farmacéutico.

Gráfico N°1. Argentina: mercado local. Millones de pesos



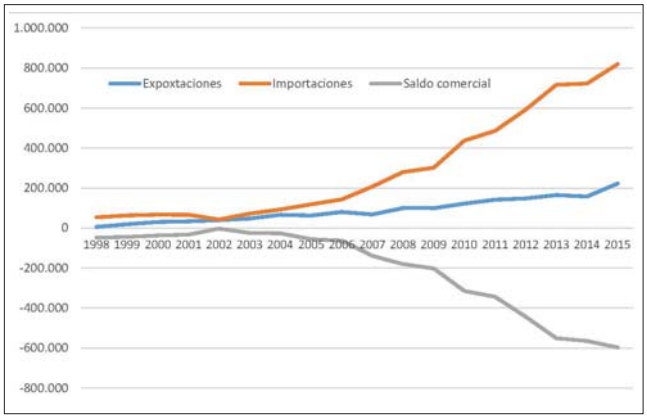
Fuente: elaboración propia a partir de datos de aduana y ministerio de economía

(4) No obstante existen trade offs entre la escala y el tiempo de bioproceso. En general los sistemas de producción de menor escala como los de perfusión requieren más tiempo de bioproceso. En contraste, los sistemas en batch o feed-batch son de mayor escala y menor tiempo de bioproceso.
(5) Se trata de sistemas de producción en bolsas descartables que posibilitan fabricar distintos productos en una misma planta disminuyendo los tiempos de limpieza y validación de la planta. Las bolsas tienen un alto costo y no pueden ser mayores a 1000 o 2000 litros. siendo compatibles con una estrategia de producción flexible.

La producción de biofármacos en Argentina se distingue de otros mercados de productos biotecnológicos por la presencia de empresas privadas nacionales asociadas a los grandes grupos farmacéuticos que desarrollan y manufacturan localmente. A diferencia de lo que sugiere la teoría del ciclo de vida de los productos de Vernon (1966), estas firmas exportaron tempranamente productos biotecnológicos de primera generación aún sin contar con una presencia dominante en el merado interno (Gutman y Lavarello, 2015). La inserción como exportadores tempranos posibilitó para un reducido conjunto de firmas aprendizajes en la manufactura de biológicos a partir de escalas chicas de producción –con sistemas de fermentación de 500 a 1000 litros- e importantes aprendizajes junto a la autoridad regulatoria en un momento donde los umbrales de escala y regulatorios aún no eran críticos.

A pesar de dicha dinámica fuertemente exportadora de las firmas biofarmacéuticas argentinas, el mercado local se encuentra controlado por las empresas líderes a nivel internacional. Una primera lectura de la trayectoria comercial de productos biofarmacéuticos en la Argentina muestra su carácter deficitario, el cual se ha profundizado a lo largo de la última década. Mientras el saldo comercial del conjunto de moléculas biotecnológicas era de US$ 50 millones en el año 1998, nueve años después superó los US$ 600 millones. La razón es que las importaciones se han expandido a un ritmo mayor a las exportaciones en el período, acelerándose la diferencia a partir del año 2008 (ver Gráfico 1).

Gráfico 2. Evolución de las exportaciones e importaciones del sector salud. Miles de dólares

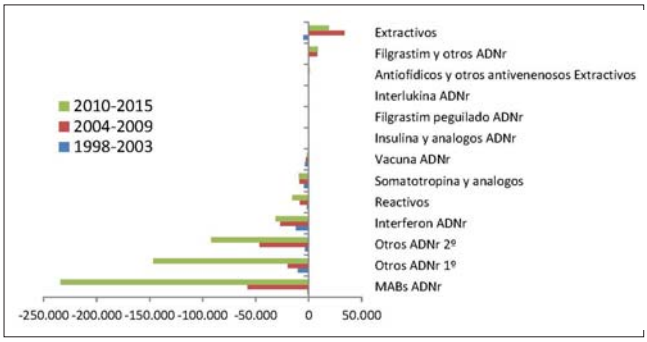


Fuente: elaboración propia en base a datos de ADUANA.

De este análisis agregado de la evolución del comercio exterior de los productos farmacéuticos, se obtienen, al menos, dos conclusiones. Por un lado, que las empresas locales han logrado consolidar su inserción como exportadoras de moléculas biotecnológicas; pero por el otro, en vistas de que las importaciones han mostrado un aumento vertiginoso, el sector biofarmacéutico argentino ha resultado deficitario y, año a año, profundiza dicho rasgo estructural de la industria, lo que invita a plantear la necesidad de observar la composición de dicho déficit, desagregando la evolución comercial según el tipo de producto.

Es posible apreciar en el gráfico N°2 que el déficit del sector biofarmacéutico argentino se encuentra asociado a las moléculas más complejas –como los anticuerpos monoclonales denominados MABs por sus siglas en inglés, utilizados en enfermedades de alto costo para los sistemas de salud como las oncológicas- y otras moléculas recombinantes que no pudieron ser identificados y figuran en "los demás" pero estimamos que se trata también de moléculas complejas que no cuentan con una desagregación adecuada en el del nomenclador común del MERCOSUR (NCM). Además de estos, hay otros productos biofarmacéuticos que también tienen un saldo negativo en el comercio exterior, aunque poco significativos en relación al total dado su menor volumen total de comercio. Estos son productos menos complejos ya ampliamente difundidos (como es el caso de los interferones, somatotropina y la insulina y el Filgrastim peguilado). Por tanto, si bien no es el único conjunto con signo negativo, son los MABS los productos del sector de biofármacos los que explican el resultado agregado deficitario y creciente en la última década.

Gráfico 3. Saldo comercial promedio por grupo de productos. Miles de dólares



Fuente: elaboración propia en base a datos de ADUANA.

Por su parte, existe un conjunto de moléculas biotecnológicas y biológicas en los que la Argentina ha logrado insertarse mostrando superávits crecientes desde mediados de los años '90. Este es el caso de numerosos productos biológicos extractivos, y drogas biotecnológicas correspondientes a la primera oleada de biotecnológicos como lo son los principios activos recombinantes de EPO y el filgrastim.

Apoyados en una larga trayectoria de producción de biológicos, un conjunto acotado de empresas locales se han insertado como exportadoras netas de estos productos. Mientras dos laboratorios nacionales explican el superávit en biológicos extractivos, otras tres empresas locales explican la inserción exportadora en las tres moléculas recombinantes de la primera generación. También existe un conjunto de proteínas recombinantes en los que si bien la Argentina aún es deficitaria, en los últimos años se ha logrado reducir el saldo negativo, como es el caso de las vacunas contra la hepatitis. Si bien se trata en todos los casos de moléculas de primera generación (recombinantes o extractivas) hoy ampliamente difundidas y con bajos márgenes de ganancia, estos resultados muestran que existe cierto potencial para la sustitución de importaciones de moléculas biotecnológicas y su inserción como exportador biotecnológico.

3. Las posibilidades de sustitución de importaciones en el sector de biofármacos

Las cifras de la evolución del comercio exterior de los productos del sector de biofármacos demuestran que el déficit es significativo y creciente en los últimos años. En este sentido, cabe indagar acerca de la factibilidad de sustituir importaciones y mejorar su inserción externa.

3.1. Un abordaje metodológico exploratorio.

Para identificar en forma preliminar los productos en los que la Argentina tiene capacidades para producir localmente, se procedió, en primer lugar, con la identificación de las posiciones arancelaras a 12 dígitos de la Nomenclatura Común del Mercosur (NCM) correspondientes a los productos biotecnológicos[6]. Para dichas posiciones arancelarias se calculó el Índice Grubel-Lloyd (IGL), con el objetivo de clasificar los productos que actualmente presentan déficit comercial en función de su factibilidad de ser sustituidos. Este índice muestra el grado de comercio intra-industrial de cada rama. Asimismo, en aquéllas posiciones en las cuales existen exportaciones, a pesar de que sean deficitarias, es posible considerar la disponibilidad de cierta capacidad local de producción. Al trabajar con elevada desagregación del nomenclador – posiciones a 12 dígitos - se logra despejar en buena medida las situaciones en las que productos de una misma posición son muy diferentes en términos de capacidades requeridas, complejidad de las moléculas y grado de diferenciación de los productos. No obstante la existencia de posiciones no bien especificadas limita el grado de precisión de los resultados.

A partir de la estimación de estos indicadores, se construyeron cinco categorías, de acuerdo al valor obtenido de IGL para cada posición arancelaria, para reflejar diferentes grados de probabilidad de sustitución de importaciones (SI):

1) superavitarias (posiciones arancelarias con saldo comercial positivo);

2) alta probabilidad de SI (saldo comercial deficitario, con IGL entre 0,66 y menor o igual que 1);

3) moderada probabilidad de SI (saldo comercial deficitario, con IGL , menor o igual que 0.66 y mayor que 0.33);

4) potencial probabilidad de SI (saldo comercial deficitario, con IGL entre 0,09 y menor o igual que 0,33)

5) baja probabilidad (saldo comercial deficitario, con IGL menor o igual que 0,09).

De acuerdo a los resultados obtenidos para los tres subperíodos considerados, como puede apreciarse en el Cuadro N°1, los productos biotecnológicos superavitarios estaban representados por 7 posiciones arancelarias durante 1998-2003 y pasaron a ser9durante 2004-2009 y 13 en 2010-2014 reflejando la capacidad de la industria de ampliar su cartera de productos. Esto se refleja, además, en un aumento del superávit promedio anual de estos productos que pasó de representar solo U$S 16 millones a 100 U$S millones. Asimismo, se observa que existen actualmente 2 posiciones con alta probabilidad de ser sustituidas, siendo que de las 4 posiciones que se identificaban en el período 2003-2009 en esta categoría, dos pasaron a ser superavitarias, una de probabilidad moderada de sustitución y la otra, con nula probabilidad. En cambio, sí se observan posiciones con probabilidad moderada y potencial. Hay tres posiciones con probabilidad moderada, que suman un déficit promedio en 2010-2015 de US$ 32 millones, y otras cuatro posiciones con menor probabilidad (potencial), que representan un resultado negativo de US$ 17 millones. Si efectivamente se sustituyeran la totalidad de las importaciones de las posiciones con alta, moderada o potencial probabilidad de sustitución, el saldo del sector biofarmacéutico podría reducirse en solo un10% del déficit total (considerando los datos de comercio del subperíodo más reciente).

Cuadro Nro 1. Biofármacos: posibilidad de sustitución de importaciones (N° de posiciones y millones de U$S dólares)

Probabilidad de sustitución Importaciones		N° Posiciones (NCM 12 digitos)			Saldo Comercial anual promedio (en miles de US$)		Moleculas representativas
		1998-2003	2004-2009	2010-2015	1998-2003	2010-2015	
Superavitarios	saldo comercial >0	7	9	13	16.401	101.557	Biológicos extractivos (gonadotropinas, antiofídicos), EPO, interferon alfa, filgrastim, somatotropina
Alta probabilidad SI (Deficitario pero existen exportaciones intensas)	Indice de Guber Lloyd de 1 a 0,66	2	4	2	-3.106	-10.523	Interferon alfa, AC extractivos
Moderada prob de SI (Deficitario pero existen exportaciones moderadas)	Indice de Guber Lloyd de 0,66 a 0,33	7	3	3	-12.323	-32.863	Insulina, interferon beta
Potencial prob de SI (Deficitario y existen exportaciones poco significativas)	Indice de Guber Lloyd de 0,33 a 0,10	7	9	4	-12.733	-17.164	Reactivos de diagnóstico, somatotropina, vacunas ADNr
Baja Probabilidad SI (no existen exportadores o lo hacen de forma exigua)	Indice de Guber Lloyd de 0,10 a 0	20	18	21	-21.152	-519.385	Etanercept (DCI); gemtuzumab; Abciximab; alfa1-antitripsina; basiliximab; infliximab, los demas AMC, factor VIII recombinante
Total		43	43	43	-32.913	-478.377	

Fuente: Elaboración en base a datos de Aduana, AFIP

(6) Esta metodología fue utilizada para estudios de diversos sectores, desde el metal-mecánico hasta el electrónico en la región de Tierra del Fuego (Peirano, 2013; Schorr y Porcelli, 2014). La misma es de carácter meramente exploratorio y su capacidad heurística depende del grado de desagregación de las posiciones arancelarias involucradas.

Por último, se identifican un total de 21 posiciones en el último subperíodo con baja probabilidad de ser sustituidas, que registran exportaciones insignificantes pero abultadas importaciones, por lo que el déficit promedio resulta muy relevante. Puede apreciarse que si bien en el período 2004-2009 el número de posiciones con baja probabilidad de sustitución habían disminuido, como resultado del *catching up* tecnológico en las moléculas importadas en ese momento, las mismas vuelven a crecer en cantidad de productos y en monto de déficit. Para el promedio 2010-2015 el déficit de este conjunto ha sido de US$ 519 millones explicando el 90% del total de las posiciones deficitarias.

Cuando analizamos cuales son los productos que explican la probabilidad (o no) de sustitución de se confirman varias de las hipótesis que se expusieron en la sección previa. Tal como se observa en el cuadro N°2, las moléculas más complejas como los anticuerpos monoclonales no solo constituyen el grupo con la contribución más significativa al déficit comercial del sector sino que dicho déficit es el que muestra menor posibilidad de ser sustituido para las capacidades existentes en el año 2015. Existen en nuestro país inversiones en plantas y su puesta en producción para el mercado depende de pasos regulatorios que se están llevando adelante[7]. Las moléculas con potencial alto de sustitución son moléculas de la primera generación de biofármacos como las hormonas de crecimiento y moléculas extractivas, que representan solo el2% del saldo deficitario. Existen moléculas con moderado potencial de sustitución que aún no se han comoditizado totalmente, como los interferones Beta 1 a 1 b e insulinas que explican el 6% del déficit.

Cuadro Nro 2. Composición del déficit comercial en el período 2010-2014

Grupo de productos	Pb. Alta	Pb Moderada	Pb. Potencial	Pb. Baja	Total
Extractivos	0,1%	0,0%	0,5%	7,0%	**7,5%**
Filgrastim peguilado ADNr	0,0%	0,0%	0,0%	0,0%	**0,0%**
Insulina y analogos ADNr	0,0%	0,1%	0,0%	0,0%	**0,1%**
Interferon ADNr	0,0%	5,5%	0,0%	0,4%	**6,0%**
MABs ADNr	0,0%	0,0%	0,0%	40,4%	**40,4%**
Otros ADNr 1º	0,0%	0,0%	0,0%	25,3%	**25,3%**
Otros ADNr 2º	0,0%	0,0%	0,0%	15,8%	**15,8%**
Reactivos	0,0%	0,0%	2,5%	0,2%	**2,7%**
Somatotropina y analogos	1,7%	0,0%	0,0%	0,0%	**1,7%**
Vacuna ADNr	0,0%	0,0%	0,0%	0,4%	**0,4%**
Total general	**1,8%**	**5,7%**	**3,0%**	**89,6%**	**100,0%**

Fuente: elaboración propia en base a datos de comercio INDEC
Nota: se incluye solo los grupos deficitarios.

Por tanto, se evidencia que de un total de 43 posiciones que corresponden a productos biofarmacéuticos, existen 13 que son superavitarias y que han mejorado el saldo comercial a lo largo de los últimos 16 años; un grupo de 5 posiciones, que sí podrían revertir la situación actual, comenzando a sustituir importaciones y mejorar su balance comercial; sin embargo aún existen 21 posiciones, que explican el crecimiento del déficit del sector y que dada la capacidad tecnológica y de producción hoy instalada presentan escasa probabilidad de ser sustituidas. Al analizar cuáles son los productos que explican la baja probabilidad de sustitución se corrobora que el déficit del sector se explica, principalmente, por los MABS, los cuales tienen un alto grado de complejidad de sus moléculas como también de los requerimientos de escala de producción y, por lo expuesto anteriormente, no cuentan aún con posibilidades en el corto plazo derevertir las importaciones (según la dinámica comercial).

Existen en este momento inversiones por parte de empresas locales buscando revertir esta situación para algunos productos – que están en proceso de validación de sus plantas por las autoridades regulatorias- y que aún no se reflejan en los datos comerciales (Gutman y Lavarello, 2015). En cambio, hay otros productos que actualmente presentan un saldo comercial deficitario pero que podrían comenzar a ser producidos con las capacidades actuales y, de esta manera, sustituirse importaciones, siendo que cuentan con una histórica trayectoria de exportaciones y, además, los requerimientos de escala no son altos y las moléculas tienen baja complejidad[8].

(7) Dicha escasa probabilidad de sustituir importaciones es posible que pueda revertirse la en los próximos años en caso que maduren las inversiones realizadas por una importante firma local en el desarrollo del Rituximab y se aprueben moléculas actualmente en estudio por la autoridad regulatoria como es el caso del Etanercept.
(8) En este ámbito, se encuentran algunas Vacunas con ADN recombinante, hormonas de crecimiento, interferones beta 1ª y 1b, interferones alfa peguilados, interferones gamma e insulina.

4. Conclusiones y futuros interrogantes de investigación

En los últimos quince 20 años un acotado conjunto de empresas argentinas ha logrado insertarse como exportadoras de moléculas biofarmacéuticas. No obstante, su participación en el mercado interno es secundaria. Si bien sus empresas se han insertado como exportadoras en ciertas moléculas extractivas y de primera generación, el déficit comercial es creciente y se explica por las moléculas de segunda generación (MABS). El fuerte crecimiento de las ventas internas de estos productos ha sido absorbido por las ventas de las grandes empresas líderes multinacionales que importan o la especialidad medicinal o los principios activos.

Esta situación plantea a las firmas locales el desafío de diversificarse hacia este segmento o enfrentar una situación en la que van a perder partes de mercado en el mercado farmacéutico global. Dadas las capacidades tecnológicas disponibles en términos de experiencia productiva las empresas cuentan con posibilidades de sustituir importaciones. No obstante, la tecnología no es estática sino que va mutando a lo largo de la difusión del paradigma: la entrada en los mercados de productos de la segunda generación implica mayores umbrales mínimos de escala y exigencias regulatorias que implican un gran salto para el sector.

La industria local cuenta con la posibilidad de avanzar hacia una segunda generación dado cuenta con la ventaja de haber alcanzado un umbral mínimo de conocimiento financiado por políticas de CyT, aprendizajes en la producción incorporadas en las rutinas de una base empresarial que supo ampliarse en los últimos años, y un status regulatorio que al igual que los otros elementos no es fácil de encontrar en un país en desarrollo. Valorizar estas ventajas plantea como interrogante cual es el tipo de empresas que llevaron adelante las estrategias incipientes de manufactura de biosimilares y cuál es el tipo de políticas de sustitución de importaciones a llevar a cabo a fin que estas experiencias se consoliden y adquieran un umbral mínimo como ara pasar de ser empresas exportadoras de la primera generación a la segunda generación de biosimilares.

En particular cabe interrogarse si es conveniente replicar los esquemas de políticas horizontales de CyT que inspiraron a las autoridades de Politica Tecnológica en los últimos años o si el Estado debe coordinar distintas de manera deliberada las acciones selectivas en términos de generación de capacidades, control selectivo del mercado interno y governance de las empresas. En este sentido existen un conjunto de acciones que fueron aplicadas en las experiencias de sustitución de importaciones en industrias de alta tecnología como la de semiconductores en Asia cuya aplicabilidad podría ser discutida para el caso de las industrias biotecnológicas:

- Incentivos fiscales y crediticios orientados a incentivar la I+D y fundamentalmente la inversión en plantas manufactura con la escala necesaria para producir moléculas más complejas.
- Una gestión selectiva del mercado interno a partir de la compra gubernamental orientada a aquellos proyectos que hayan aumentado la escala local de producción y cumplan con requisitos regulatorios.
- Nuevas modalidades de protección a la industria infante diferentes de las tarifas arancelarias: una gestión estratégica de la propiedad intelectual en la que la altura innovativa requerida para patentar sea lo suficiente elevada como para no bloquear las innovaciones incrementales asi como un marco regulatorio que vaya acompañando a las empresas locales para que las mismas adquieran la expertise regulatoria necesaria para competir en los mercados internacionales.

Cabe interrogarse por último si una estrategia nacional de promoción de la industrial no requiere se combinada con una *governance* flexible de las empresas promocionadas tal que la presencia del Estado en la propiedad de los joint-ventures– o algún esquema de inversiones cruzadas entre empresas nacionales- posibilite un horizonte de inversión más largo y evite la venta de las capacidades a grupos extranjeros. Quizás de esta manera Argentina podría insertarse a partir de una estrategia autónoma en la emergente industria biotecnológica

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Innovación y Emprendimiento en el Discurso Político Chileno**

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Resumen: El objetivo de esta investigación es determinar el significado político que han adoptado las nociones de 'innovación' y 'emprendimiento' en las cuentas públicas presidenciales del 21 de mayo en Chile desde el año 1990 hasta 2016, con el fin de revelar tanto las construcciones discursivas asociadas a estos términos como la manera en que éstas se relacionan con las prácticas políticas a través del tiempo. Para lograrlo, se emplearon herramientas de la lingüística de corpus para realizar el análisis del discurso político. Los resultados arrojaron que tanto 'innovación' como 'emprendimiento' son conceptos que están asociados a aspectos económicos. Además, mientras el primero se comienza a usar de manera sistemática en los discursos del primer gobierno de Michelle Bachelet, el segundo es empleado principalmente en los discursos de Sebastián Piñera. En cuanto a los ámbitos temáticos, 'innovación' se entiende, en mayor medida, como un concepto esencial en el desarrollo productivo del país y 'emprendimiento' se entiende como un trabajo en sí.

Palabras clave: innovación; emprendimiento; discurso político.

Innovation and Entrepreneurship in Chilean Political Discourse

Abstract: The objective of this research is to determine the political signification of the notions of innovation and entrepreneurship in the presidential public accounts of May 21 in Chile from 1990 to 2016, in order to reveal both the discursive constructions associated with these terms and the way they relate to political practices over time. To achieve this, corpus linguistics tools are used for the analysis of political discourse. The results showed that both innovation and entrepreneurship are concepts that are associated with economic aspects. In addition, while the first begins to be used systematically in the speeches of the first government of Michelle Bachelet, the second is used mainly in Sebastian Piñera's speeches. Regarding the thematic areas, innovation is understood as an essential concept in the productive development of the country and entrepreneurship is understood as a job in itself.

Keywords: innovation, entrepreneurship, political discourse

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1. Introducción

En la actualidad, Chile se está enfrentando a desafíos que requieren de la participación de una serie de actores comprometidos con el progreso social y productivo. Dichos desafíos se encuentran relacionados, principalmente, con alcanzar los índices de calidad de vida que se encuentran en países desarrollados. Este salto cualitativo y cuantitativo depende del cambio sustancial en la manera en la que se concibe la práctica económica en el país: una economía basada en la explotación de recursos naturales (como ha ocurrido hasta el momento) no facilitará las condiciones necesarias para superar las brechas que impiden el desarrollo, en otras palabras, "[…] la estructura productiva del país, concentrada en la extracción y exportación de recursos naturales y de procesos productivos de bajo nivel tecnológico y de escaso contenido de conocimiento, está lejos de asegurar el crecimiento económico en el largo plazo" (Ministerio de Economía, Fomento y Turismo, 2015, p. 5). En este sentido, el enfoque que tiene que tomar el país debe estar orientado hacia una economía en la que se enfatice el conocimiento, la innovación y, por supuesto, el capital humano (Bitrán, 2008). Reorientar las políticas públicas hacia la innovación y el emprendimiento se constituye como una necesidad fundamental, en la medida en que son las formas más efectivas en las que se puede contribuir con el progreso social y económico de los países (World Economic Forum, 2009). En este contexto, durante los últimos años en Chile se ha incentivado, desde la esfera pública, el desarrollo en innovación y emprendimiento, puesto que se entiende que solo gracias a este tipo de iniciativas se pueden alcanzar niveles económicos y sociales propios de los países desarrollados.

En la actualidad 'innovación' y 'emprendimiento' se han convertido en conceptos fundamentales en las discusiones académicas y políticas sobre la economía y el futuro de los negocios (Salaman y Storey, 2002; Perren y Jennings, 2005; Perren y Sapsed, 2013). Desde un punto de vista discursivo, la 'innovación' se ha abordado desde diferentes perspectivas. Salaman y Storey (2002) investigaron la percepción que tenían distintos gerentes del área de las tecnologías sobre la naturaleza de las teorías de la innovación que subyacían en sus prácticas dentro de las empresas. Los resultados demostraron que los límites de pensamiento que regían la innovación de estos gerentes estaban dominados por una cultura organizacional que imponía barreras que dificultaban la generación de procesos innovadores. Por su parte, Linton (2009) analizó el lenguaje de la innovación en la literatura especializada y pudo establecer un marco de referencia que permite

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entender la complejidad del significado de la innovación. En la misma línea, Denicolai (2010) identificó las palabras que más se relacionaban con innovación en las definiciones de la literatura especializada, a saber: novedad, proceso, éxito, espíritu emprendedor, implementación, mercado y cambio.

De la misma manera, el discurso sobre el 'emprendimiento' ha sido estudiado a partir de orientaciones divergentes. Por ejemplo, Drakopoulou (2002) desarrolló un modelo cultural del emprendimiento en Estados Unidos a partir del análisis de las metáforas que los emprendedores usan para dar sentido al emprendimiento en las narrativas de su vida y sus negocios. Este modelo cultural resulta fundamental para entender las características más fuertes y profundas que poseen los emprendedores sobre sus propias perspectivas y aspiraciones en relación con el proceso emprendedor. Además, en Nicolson y Anderson (2005) se comparó el discurso del emprendimiento en los artículos de noticias desde 1989 hasta el 2000 en un diario británico. El análisis reveló que los emprendedores hombres eran metaforizados como lascivos, gurús sobrenaturales, cohetes exitosos, salvadores de la comunidad o, simplemente, salvadores corruptos de la sociedad. Esta noción es complementaria con aquellas investigaciones que señalan que la imagen del emprendimiento es dual: negativa y positiva. Así, Perren y Jennings (2005) encontraron contradicciones en la manera en la que el emprendedor era concebido en las páginas web de los gobiernos, es decir, se representaba tanto como un ejecutor autosuficiente de la economía como un niño subyugado que necesitaba la ayuda gubernamental para sobrevivir.

Sin embargo, a pesar de la importancia que han adquirido, estos términos no se han investigado de forma consistente en el contexto del discurso político. Si bien se reconocen algunas aproximaciones importantes (Anderson, Drakopoulou y Scott, 2000; Horth y Steyaert, 2004; Miazhevich, 2007; Örge, 2011), rescatamos, a nuestro juicio, los estudios más relevantes que se han llevado a cabo. Perren y Sapsed (2013) investigaron el uso de término innovación en el discurso parlamentario británico desde la década de 1960 hasta la primera década del 2000. Los resultados dieron cuenta de que la frecuencia del concepto había aumentado durante el periodo estudiado, se utilizaba en una gran cantidad diferente de temas y, por último, se pudo determinar que se asociaba tanto con las barreras que impiden la innovación como con quienes la dirigen en último término: el gobierno. Esta orientación ayuda en la comprensión de términos que no están del todo claros en estos discursos, puesto que:

> El entender cómo el significado de la palabra *innovación* ha cambiado en el discurso parlamentario debe dar a conocer los símbolos y reglas que los políticos han asociado a este término, cómo han cambiado con el tiempo, qué acciones 'performativas' se han tomado en nombre de la innovación y la manera en que los políticos se han comprometido con el concepto para legitimar sus acciones y las de sus instituciones[2] (Perren y Sapsed, 2013, p. 1817).

Por otro lado, Perren y Dannreuther (2012) intentaron revelar las construcciones discursivas asociadas al término emprendedor y cómo éstas conllevan acciones subyacentes a la práctica política. Al igual que en Perren y Sapsed (2013), se exploraron los cambios en la construcción discursiva del término emprendimiento a través del análisis del discurso parlamentario de los últimos 40 años en Gran Bretaña. Los resultados indicaron que "ciertas palabras y frases como 'emprendedor' o 'pequeña empresa', que son parte del lexicon del *management*, se utilizan como 'significantes flotantes' cargados políticamente, que reflejan matices ideológicos profundamente arraigados en las creencias sociales" (p. 1816).

Estudiar la *significación política* (Perren y Dannreuther, 2012) que adquieren los términos innovación y emprendimiento en el discurso político entrega luces sobre la orientación ideológica de las políticas públicas asociadas. En este sentido, el lenguaje del discurso político –entendido como aquel que es producido por actores políticos en contextos institucionales como gobiernos, parlamentos o partidos políticos (Van Dijk, 2002) y que es portador del mensaje de aquellos que ostentan el poder– cuenta con tres funciones estratégicas (Chilton, 2004): coerción; legitimización y deslegitimización; y representación y tergiversación. Mientras la coerción se refiere a los actos de habla que producen control sobre el discurso (en tanto estrategia de poder), la estrategia de legitimización y deslegitimización se identifica con la necesidad, de los actores políticos, por establecer el derecho a que sean obedecidos por la ciudadanía. Por su parte, con respecto a la representación y tergiversación, el control político implica el control de la información, ya sea desde un punto de vista cuantitativo o cualitativo. La tergiversación cualitativa se puede plasmar de diferentes maneras: omisiones, evasiones, negaciones, eufemismos o significados implícitos de distinto grado de las unidades léxicas.

Este uso ambiguo de las unidades léxicas es una de las características esenciales del discurso político, puesto que posibilita que diferentes destinatarios infieran significados contradictorios (Gallardo Paúls, 2014). Lo anterior se relaciona con el concepto de *significante flotante* o *vacío*, que, a juicio de Nabers (2009), está caracterizado por un significado indistinto o no existente, es decir, términos que pueden tener diferentes significados. En este sentido, tanto la 'innovación' como el 'emprendimiento' han sido caracterizados como *significantes flotantes* (Perren y Dannreuther, 2012 y Perren y Sapsed, 2013) en la medida en que adoptan su significado a partir del contexto en el que son utilizados. Por tanto, aproximarse al análisis de estos términos desde una orientación discursiva nos parece necesario, ya que tal como señala Chilton (2004, p. 45):

Solo en y a través del lenguaje se pueden emitir mandatos y amenazas, hacer preguntas, hacer ofertas y promesas, siempre y cuando se haya convencido a los interlocutores de que cada uno tiene los recursos necesarios para hacer que el acto de habla sea creíble. Y sólo a través del lenguaje vinculado a las instituciones sociales se puede declarar la guerra, declararse culpable o no culpable, prorrogar los parlamentos o aumentar o bajar los impuestos.

(2) Todas las traducciones de las citas son nuestras.

Considerando que el discurso político permite identificar tanto la postura de un determinado actor político, así como la manera en que se desea transmitir el mensaje a la audiencia de dicho discurso (Wilson, 2001; Van Dijk, 2002, Chilton, 2004; Gallardo Paúls, 2014), la presente investigación (siguiendo a Perren y Danrreuther, 2012; Perren y Sapsed, 2013 e Ivanova, 2015) busca determinar el significado político que han adoptado las nociones de 'innovación' y 'emprendimiento' en las cuentas públicas presidenciales del 21 de mayo en Chile desde 1990 hasta 2016, con el fin de revelar tanto las construcciones discursivas asociadas a estos términos como la manera en que estas se relacionan con las prácticas políticas a través del tiempo.

2. Método

El discurso de 21 de mayo es un tipo de discurso político en el que el presidente, frente al poder legislativo, da cuenta al país sobre el estado administrativo y político de la nación. Desde un punto de vista lingüístico se ha definido como una

> "… variedad de discurso que, realizando funciones informativas, evaluativas y argumentativas, implica una mirada retrospectiva por parte del hablante, quien recapitula en él las acciones gubernamentales durante el año de gobierno inmediatamente anterior a la cuenta" (Soto y Zenteno, 2010, p.335).

Estos discursos son muy útiles para la investigación en general, dado que son representativos de lo que desea transmitir el jefe de estado y ayuda a descubrir, en nuestro caso, de qué manera se comunican los conceptos de 'innovación' y 'emprendimiento' a los ciudadanos (es decir, qué enfoque y en qué contexto se refieren a estos).

El corpus corresponde a todos los discursos presidenciales del 21 de mayo desde 1990 hasta 2016 (n=27), que fueron descargados directamente desde la página web de la Biblioteca del Congreso Nacional de Chile[3]. Se almacenaron en formato texto plano para facilitar su posterior análisis. Algunos de estos discursos se encontraban en formato PDF generado a partir de imágenes, por lo que la transformación a texto plano implicó, primero, el uso del programa Tesseract[4] y, posteriormente, una revisión completa de los discursos en cuestión para corregir los errores que surgieron del uso del programa. Por otro lado, cabe mencionar que se ha escogido un enfoque basado en corpus, puesto que permite identificar y analizar complejas asociaciones de patrones que serían muy costosas de analizar de otra manera (Biber, Conrad y Reppen, 1998).

Para analizar los textos, se empleó el programa Antconc (Anthony, 2014), que permite realizar una serie de tareas propias del análisis de la lingüística de corpus. En primer lugar, se caracterizó el tamaño del corpus, tal como se especifica en la Tabla 1.

Tabla 1. Características del corpus

	Años	Tokens
Aylwin	**1990-1993**	75.900
Frei	**1994-1999**	104.512
Lagos	**2000-2005**	62.996
Bachelet	**2006-2009**	62.294
Piñera	**2010-2013**	62.857
Bachelet	**2014-2016**	47.365
	Total	**415.924**

En segundo lugar, gracias al uso del mismo programa, se recuperaron las unidades léxicas que son relevantes para nuestra investigación con su respectiva frecuencia. Con el fin de ser más exhaustivos en la identificación de las unidades y no operar solo con las palabras innovación y emprendimiento, los discursos fueron lematizados (a través del mismo programa)[5]. Al lematizar los discursos se han reconocido los siguientes lemas para cada una de las nociones:

1. **Innovación:** innovación, innovador, innovativo, innovar.
2. **Emprender:** emprendimiento, emprendedor, emprender[6].

Por último, se identificaron los colocados de las unidades léxicas en un análisis KWIC (Keyword in Context) con el fin de establecer el significado que desea transmitir cada presidente a las nociones mencionadas. El análisis de concordancias es una técnica analítica muy valiosa porque permite desplegar un gran número de ejemplos de una unidad en su contexto original (Evison, 2010), lo que facilita el análisis temático (identificando los campos temáticos recurrentes) en este tipo de entornos. Esta estrategia ayudará a determinar lo que desean transmitir los diferentes gobiernos en relación con la 'innovación' y el 'emprendimiento', puesto que, tal como señala Wilson (2001, p. 406) "… no solo la simple ocurrencia de un término es importante, sino que también lo son los conjuntos de colocaciones, que a su vez producen y se basan en esquemas ideológicos para confirmar o reconfirmar visiones particulares del mundo".

Para categorizar los campos temáticos con los que se identifican los conceptos no se lleva a cabo solo una revisión de las colocaciones más frecuentes, sino que se analiza el contexto de aparición global, con el fin de determinar, fehacientemente, la manera en la que se comprenden por parte de los gobiernos. De esta manera, los ámbitos temáticos, a partir de los cuales se infiere el significado que adquieren los términos, está determinado por su contexto de aparición.

(3) Disponible en http://historiapolitica.bcn.cl/mensajes_presidenciales
(4) Tesseract es un optical captural retrieval gratuito que permite transformar archivos PDF en otro tipo de archivo legible para los programas de lingüística de corpus.
(5) El listado de lemas utilizado fue descargado desde http://www.lexiconista.com/en/ y modificado específicamente para la presente investigación.
(6) En estos lemas, se consideran las variaciones de género, número y las respectivas conjugaciones verbales.

3. Resultados y discusión

A partir de la aplicación de los métodos propuestos anteriormente, en este apartado se detallarán los resultados de cada uno de los conceptos estudiados de manera separada: 'innovación', por un lado, y 'emprendimiento', por otro. En cada uno de estos, se entregarán, en primer lugar, los aspectos cuantitativos del análisis y, posteriormente, a partir del análisis en contexto de las unidades léxicas, los resultados cualitativos que permitirán aproximarse al significado que adquieren estos conceptos en cada uno de los gobiernos desde 1990 hasta 2016.

3.1 Innovación

Con respecto al concepto de 'innovación', en la Tabla 2, se muestran las frecuencias totales y normalizadas del concepto, lo que nos permite entender la variación histórica que ha manifestado el uso de la noción desde 1990 hasta 2016. Se aprecia que en ambos gobiernos de Michelle Bachelet (2006-2010 y 2014-2016) la frecuencia promedio en los discursos es mayor en comparación con el resto de los gobiernos (0,67 y 0,65 veces por cada 1.000 palabras). Por otro lado, la frecuencia más baja se observa durante el gobierno de Ricardo Lagos (0,21 veces por cada 1.000 palabras), con una frecuencia incluso menor a la de sus predecesores (durante el gobierno de Patricio Aylwin se reporta 0,25 veces por cada 1.000 palabras, mientras que en el de Eduardo Frei, 0,34 por cada 1.000 palabras). Cabe destacar, además, la apropiación que hace del concepto Michelle Bachelet, lo que se puede comprobar, asimismo, con la menor frecuencia que presenta en el gobierno de Sebastián Piñera (0,29 veces por cada 1.000 palabras).

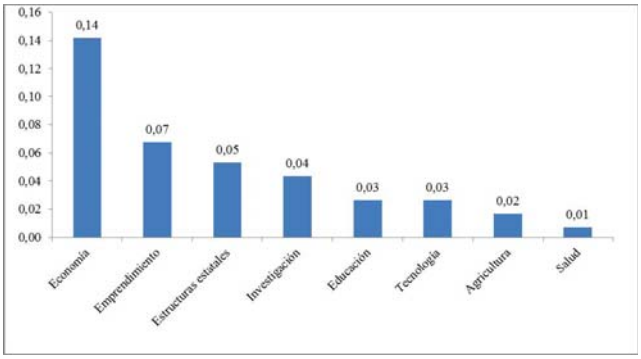
Tabla 2. Casos del concepto 'innovación' en los discursos presidenciales del 21 de mayo por gobierno (1990-2016)

	Frecuencia total 'innovación' (N=veces en el corpus)	Frecuencia normalizada 'innovación' (n=veces por cada 1.000 palabras)[1]
Aylwin (1990-1993)	19	0,25
Frei (1994-1999)	36	0,34
Lagos (2000-2005)	13	0,21
Bachelet (2006-2009)	42	0,67
Piñera (2010-2013)	18	0,29
Bachelet (2014-2016)	31	0,65

Desde otra perspectiva, de acuerdo al análisis KWIC realizado, se determinó el ámbito temático con el que se relaciona el concepto de 'innovación' para cada presidente. Como se aprecia en el Gráfico 1, se identificaron ocho ámbitos temáticos que se relacionan con la 'innovación': economía, emprendimiento, estructuras estatales, investigación, educación, tecnología, agricultura y salud. Dichos ámbitos facilitan el acceso al significado que se le quiere dar al término en cada uno de los mandatos.

Esta multiplicidad de temas asociados se podría explicar porque la 'innovación' se transforma en un concepto con una carga semántica positiva que viene a remediar todas las dificultades que se puedan encontrar en el país, tal como asegura Godin (2008, p. 5): "… la innovación se ha convertido en el emblema de la sociedad moderna, una panacea para resolver muchos problemas y un fenómeno que debe ser estudiado". Dado lo anterior, el campo temático con el que más es asociada la 'innovación' es el económico (0,14 veces por cada 1.000 palabras), con lo que se refuerza el vínculo que se establece entre: lograr ser una sociedad altamente innovadora y conseguir el progreso económico nacional. Asimismo, esta interpretación se reafirma al reconocer que el segundo ámbito temático más frecuente con el que se asocia la 'innovación' es el emprendimiento, es decir, se juzgan las prácticas innovadoras en función del posterior ingreso de dicha innovación en el mercado incluyendo un factor de riesgo económico. Así, los principales campos temáticos que se utilizan en el discurso político chileno se orientan hacia una de las interpretaciones más extendidas de la innovación en la actualidad: "La innovación es la combinación de un proceso inventivo y un proceso emprendedor para crear un nuevo valor económico" (Hindle, 2009, p. 5).

Gráfico 1. Campos temáticos del concepto 'innovación' (frecuencia normalizada)



Sin embargo, no basta tan solo con identificar los campos temáticos asociados, sino que es necesario analizar de qué manera se comportan estas áreas temáticas en cada gobierno. En el Gráfico 2, se puede observar que desde el gobierno de Aylwin (incluso hasta el segundo de Bachelet) se entiende que la innovación cumpliría un rol importante en el desarrollo económico del país. Durante este periodo, destaca el vínculo de la 'innovación' tanto con las estructuras estatales (dadas las transformaciones en la estructura administrativa del país luego de la dictadura militar) como con la tecnología (por ejemplo, a través de la implementación del proyecto Enlaces, que buscaba entregar conexión a Internet a las escuelas y liceos del país).

El gobierno de Frei, a través de sus discursos, destaca por su relación tanto con la economía, propiamente tal, como con la educación y la agricultura. Con respecto al ámbito educacional, cabe señalar que durante este periodo se implementaron grandes reformas educacionales, como la jornada escolar completa, la renovación de los materiales de estudio (textos escolares) y la reforma curricular. Por su parte, la identificación de la 'innovación' con el sector agrícola probablemente esté motivada por la ampliación por 15 años del decreto D.L. 701, que bonifica en un 75% las plantaciones forestales de pino y eucaliptus (creado en 1974).

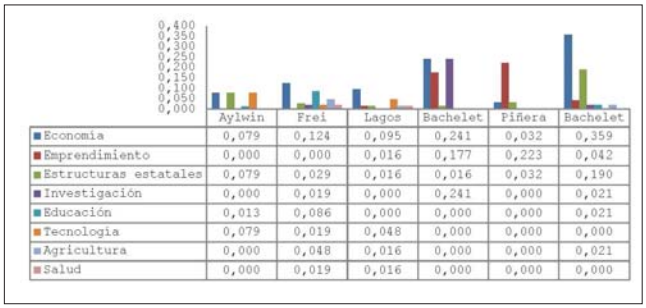
Como se ha mencionado anteriormente, durante el gobierno de Lagos se evidenció la menor frecuencia de 'innovación'. En cualquier caso, la economía y la tecnología son los campos temáticos más frecuentes con los que se asocia en este periodo.

Durante el primer gobierno de Bachelet se observa un aumento en la frecuencia del concepto 'innovación'. Dicho aumento podría relacionarse con la puesta en marcha del Consejo Nacional de Innovación para el Desarrollo (CNID)[7], cuya misión es asesorar al Presidente en la identificación, formulación y ejecución de las políticas que fortalezcan la competitividad en el país. En este contexto, se entiende que son materias de competencia de la innovación: la formación de capital humano, el desarrollo productivo, la transferencia tecnológica y la ciencia. De ahí, se desprende que los principales ámbitos con los que se asocia la 'innovación' sean: la economía, el emprendimiento y la investigación.

Ya con Piñera se puede observar una orientación diferente a lo que sucedió en el gobierno anterior: la 'innovación' se entiende, prácticamente, solo en función del emprendimiento, considerando ambos conceptos como los motores que facilitan el progreso económico. Lo anterior se ratifica al revisar la orientación que adquieren las políticas públicas al respecto. Por ejemplo, en este gobierno se suele hablar del incentivo a la "cultura de la innovación y el emprendimiento", que se verá beneficiada gracias a una serie de instancias provenientes del Ministerio de Economía. Además, desde Corfo se busca fomentar la innovación para mejorar la productividad de Chile. Se entiende, por tanto, la innovación como una práctica económica desprovista de otra función.

Un cambio en la forma en la que se concibe la noción de 'innovación' es la que presenta el segundo gobierno de Bachelet, el que, si bien entiende la 'innovación' como parte esencial de la práctica económica, deja de relacionarla de manera clara con el emprendimiento, como sí lo hizo el gobierno de Piñera. Al mismo tiempo, vuelve a relacionar la 'innovación' con las grandes estructuras estatales, lo que se relacionaría con el carácter propio del gobierno: un gobierno de grandes reformas (educacional y tributaria, por ejemplo). Cabe destacar, por último, que se deja de considerar la relación entre innovación e investigación como sí lo hizo en su primer período. Se deja ver, por tanto, el carácter eminentemente económico que adopta el término. A través de la innovación, se busca enfrentar de la mejor manera posible uno de los principales desafíos de las sociedades modernas: la productividad.

Gráfico 2. Campos temáticos del concepto 'innovación' por presidente (frecuencia normalizada)



	Aylwin	Frei	Lagos	Bachelet	Piñera	Bachelet
Economía	0,079	0,124	0,095	0,241	0,032	0,359
Emprendimiento	0,000	0,000	0,016	0,177	0,223	0,042
Estructuras estatales	0,079	0,029	0,016	0,016	0,032	0,190
Investigación	0,000	0,019	0,000	0,241	0,000	0,021
Educación	0,013	0,086	0,000	0,000	0,000	0,021
Tecnología	0,079	0,019	0,048	0,000	0,000	0,000
Agricultura	0,000	0,048	0,016	0,000	0,000	0,021
Salud	0,000	0,019	0,016	0,000	0,000	0,000

3.2 Emprendimiento

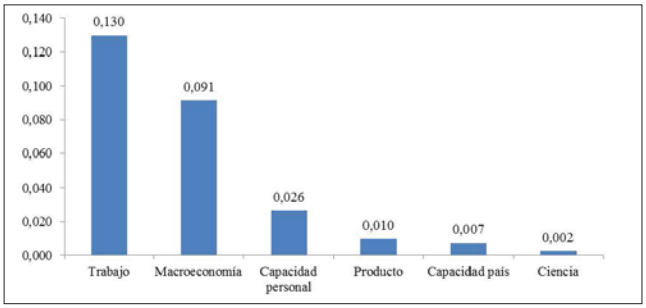
En la Tabla 3, se pueden observar las frecuencias normalizadas del concepto de 'emprendimiento' a lo largo de los diferentes gobiernos. Así, se trataría de un concepto que es muy infrecuente en los dos primeros gobiernos estudiados (0,04 veces por cada 1.000 palabras durante el gobierno de Aylwin y 0,08 en el de Frei), lo que acentúa la idea de que es un término relativamente nuevo dentro del discurso político y económico a nivel nacional. La frecuencia empieza a aumentar con el gobierno de Lagos (0,24 veces), puesto que presenta el triple de frecuencia que sus antecesores. Estos datos ratifican que este gobierno tiene una fuerte orientación económica, ya que el concepto de 'emprendimiento' tiene una frecuencia mayor, incluso, que el de innovación. Posteriormente, durante el primer gobierno de Bachelet la noción se asienta como un tópico cuya importancia va en aumento, al presentar una frecuencia de 0,43 veces. Asimismo, se desprende que es un término empleado, mayormente, durante el gobierno de Piñera (0,56 veces) lo que entrega ciertas luces sobre prácticas ideológicas: el 'emprendimiento' tiene una mayor importancia que la innovación. Por otro lado, aunque el segundo gobierno de Bachelet presenta frecuencias más altas que el primero (0,49 veces), son cifras menores a las que se pueden observar en los discursos de Piñera.

Tabla 3. Casos del concepto 'emprendimiento' en los discursos presidenciales del 21 de mayo por gobierno (1990-2016)

	Frecuencia total 'emprendimiento' (N=veces en el corpus)	Frecuencia normalizada 'emprendimiento' (n=veces por cada mil palabras)
Aylwin (1990-1993)	3	0,04
Frei (1994-1999)	8	0,08
Lagos (2000-2005)	15	0,24
Bachelet (2006-2009)	27	0,43
Piñera (2010-2013)	35	0,56
Bachelet (2014-2016)	23	0,49

Al llevar a cabo el análisis KWIC al concepto de 'emprendimiento', se pudieron establecer seis ámbitos temáticos con los que se relaciona el 'emprendimiento': trabajo, macroeconomía, capacidad personal, producto, capacidad país y ciencia. Como se ve en el Gráfico 3, el 'emprendimiento' se suele relacionar con el ámbito económico en general, con el que se vincula desde diferentes ejes. Por ejemplo, el ámbito con el que más se identifica es el trabajo, es decir, se entiende el 'emprendimiento' como un oficio o profesión para ganarse la vida. En la misma línea, es comprendido como parte esencial del progreso macroeconómico del país.

Gráfico 3. Campos temáticos del concepto 'emprendimiento' (frecuencia normalizada)



El análisis por presidente entrega resultados interesantes. En primer lugar, los tres primeros gobiernos (Aylwin, Frei y Lagos) presentan frecuencias bajas del concepto y sus vínculos no son fuertes con ninguna área temática específica (no hay predominancia de un área sobre otra). Como sea, se observa que la relación entre emprendimiento como motor de la macroeconomía del país se documenta desde el gobierno de Aylwin (0,026 veces por cada 1.000 palabras).

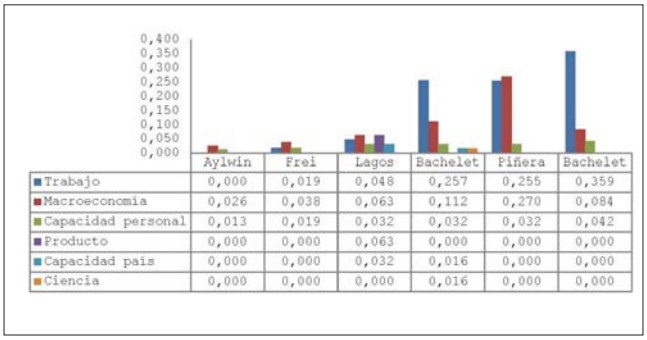
En el gobierno de Frei, se dan los primeros casos en los que se identifica el 'emprendimiento' como una práctica laboral (0,019 veces), aunque la vinculación más fuerte sigue siendo con aspectos macroeconómicos (0,038). Durante el mandato de Lagos, se comienza a ver una diversificación mayor de las áreas temáticas que se identifican con el 'emprendimiento'. Si bien sigue habiendo una articulación predominante con la macroeconomía y con el 'emprendimiento' en tanto producto (0,063 veces cada una de las áreas), el trabajo (0,048), la capacidad país y la capacidad personal (0,032) también adquieren relevancia en este periodo. Este énfasis es funcional a las políticas públicas que se empezaron a desarrollar en esta época. El año 2001 se creó el programa Chile Emprende, cuyo objetivo era promover las alianzas entre los actores públicos y privados en un nivel local para fortalecer y facilitar el desarrollo de oportunidades de negocio para pequeños y medianos empresarios. De esta manera, creemos que la aplicación de este programa es el primer paso que provocó un cambio en el discurso político: los pequeños y medianos empresarios pasan a llamarse emprendedores.

La frecuencia del término aumenta durante el primer gobierno de Bachelet y se relaciona fuertemente tanto con el trabajo (0,257 veces por cada 1.000 palabras) como con la macroeconomía (0,112). Se desprende de los resultados que el 'emprendimiento' es entendido, principalmente, como un trabajo que cumple una función esencial en el desarrollo macroeconómico del país. Como se ha venido mencionando, la interpretación de los resultados depende en gran medida de las políticas públicas que se hubieran implementado en los periodos que se están estudiando. En este caso, resulta interesante destacar la implementación, desde el año 2005, del fondo Capital Semilla Emprende del Servicio de Cooperación Técnica (Sercotec). El objetivo de este programa no es tan solo entregar dinero a las pequeñas empresas, sino que se les entrega asesoría técnica y financiera para llevar a cabo sus proyectos. Quienes obtienen este beneficio reciben una formación que les permite desempeñarse de manera efectiva en el entorno económico; así, el Estado cumple con la misión de profesionalizar las prácticas de los pequeños empresarios. Con esto, se reafirmaría lo que hubiera comenzado en el gobierno anterior: el cambio de denominación a los pequeños y medianos empresarios.

El gobierno de Piñera es el que manifiesta la frecuencia más alta y, además, los vínculos semánticos del concepto de 'emprendimiento' varían en comparación con el gobierno anterior. La asociación más frecuente es con el ámbito de la macroeconomía (0,270 veces por cada 1.000 palabras) y, posteriormente, con trabajo (0,255). A nuestro juicio, estos resultados se identifican con las prácticas ideológicas que se observan en las políticas implementadas, ya que el foco de este gobierno estuvo en el fomento al emprendimiento para elevar los niveles de productividad del país: Start-Up Chile, Día Nacional del Emprendimiento, diversificación de fondos de fomento al emprendimiento (capital semilla para ideas de negocio y capital semilla para emprendimiento menor a un año), sello ProPyme, entre otras.

Por último, el segundo gobierno de Bachelet pretende marcar distancia con respecto a lo que postula el mandato de Piñera. En este periodo, la mandataria reafirma la vinculación del 'emprendimiento' como una fuente laboral (0,359 veces por cada 1.000 palabras) y en mucho menor medida con las prácticas macroeconómicas (0,084). En este sentido, el enfoque de las políticas públicas sigue siendo similar al de su primer gobierno, esto es, apoyo explícito a los pequeños emprendedores (a modo de formación) y aumento de las posibilidades de acceso a ecosistemas de 'emprendimiento'.

Gráfico 4. Campos temáticos del concepto 'emprendimiento' por presidente (frecuencia normalizada)



	Aylwin	Frei	Lagos	Bachelet	Piñera	Bachelet
Trabajo	0,000	0,019	0,048	0,257	0,255	0,359
Macroeconomía	0,026	0,038	0,063	0,112	0,270	0,084
Capacidad personal	0,013	0,019	0,032	0,032	0,032	0,042
Producto	0,000	0,000	0,063	0,000	0,000	0,000
Capacidad país	0,000	0,000	0,032	0,016	0,000	0,000
Ciencia	0,000	0,000	0,000	0,016	0,000	0,000

4. Conclusiones

Para concluir, los resultados de esta investigación ayudan a entender cuál es el significado que se le quiere dar a los conceptos de 'innovación' y 'emprendimiento' en el discurso político chileno. El enfoque diacrónico adoptado permite visualizar que ambos conceptos tienen una presencia cada vez más activa en el discurso público a medida que se avanza en el tiempo: se comienzan a establecer como elementos esenciales del discurso de la productividad y el progreso económico nacional. Por lo mismo, se pudo observar que tanto la 'innovación' como el 'emprendimiento' presentan una fuerte orientación económica, considerando de forma muy escasa relaciones con áreas temáticas de otro tipo como ciencia o tecnología.

Las diferencias ideológicas en el empleo de estas nociones son mucho más latentes en los últimos tres gobiernos. Mientras el foco de Piñera estuvo puesto más en el emprendimiento que en la innovación, el de Bachelet fue completamente lo opuesto. Y las diferencias no tan solo se encuentran en las diferencias de las frecuencias de los conceptos: también las hay en las relaciones de los términos en cada uno de estos mandatos. Así, la innovación está asociada con prácticas económicas en general en los dos gobiernos de Bachelet y en el gobierno de Piñera se vincula directamente con el emprendimiento. Por otro lado, Bachelet entiende el emprendimiento como una fuente laboral más que como una característica que *per se* pueda actuar como motor de la macroeconomía nacional, como sí lo comprende Piñera.

Por último, cabe destacar el valor de la creación de este tipo de corpus textuales, en la medida en que permiten realizar una aproximación objetiva de lo que comúnmente se discute de manera impresionista.

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La Política de Compra Pública como Estímulo a la Innovación y el Emprendimiento

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Resumen: En los últimos años se ha produciendo una creciente tendencia hacia la incorporación de instrumentos de articulación de la demanda. Uno de los instrumentos que mayor atención ha recibido es el de la compra pública. En este artículo tratamos de ilustrar cómo el sector público puede comportarse de una manera estratégica, considerando la innovación como uno de los principios fundamentales a la hora de realizar dichas compras. Todo ello queda reflejado por medio de cuatro iniciativas de compras públicas como estímulo a la innovación. Además de ello, ofrecemos un marco conceptual en el que se relaciona la innovación con el emprendimiento y se analiza el potencial de la compra pública para estimular ambos fenómenos.

Palabras claves: compra pública; innovación; emprendimiento.

Public procurement policy as a stimulus for innovation and entrepreneurship

Abstract: In recent years a major use of demand side instruments to innovation policy has been witnessed, one of this instruments being public procurement. This article aims at providing some evidence on how the public sector can adopt a strategic behavior, considering innovation as one of the main rationales in their public procurement processes. We illustrate this role by analyzing four cases that shed some light on how public procurement for innovation can take place. In addition, we also introduce a conceptual framework relating innovation to entrepreneurship, and the potential role of public procurement as an effective instrument fostering both activities is analyzed.

Keywords: public procurement; innovation; entrepreneurship

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1. Introducción

La compra pública representa una parte muy importante del Producto Interior Bruto (PIB) de un país. De modo ilustrativo, en los últimos años, las administraciones públicas de los países que forman parte de la Unión Europea han invertido entre un 15 y un 20% de su PIB anual en este tipo de compras (Edquist et al., 2015). A pesar de que los porcentajes varían entre países/regiones, es innegable que la compra pública representa una fuente trascendental de demanda.

La mayor parte de las compras que se llevan a cabo desde las administraciones públicas podría categorizarse como compra pública regular (p.e. adquisición de bienes de consumo estándar). Es decir, las compras públicas carecen, de modo general, de impacto sobre las actividades innovadoras (Edquist et al., 2015). Sin embargo, la inclusión del criterio de la innovación en las compras públicas puede ofrecer mejores resultados para el comprador (Edquist y Zabala-Iturriagagoitia, 2012).

En este artículo consideramos que la compra pública como estímulo a la innovación (CPI) puede constituir uno de los instrumentos más relevantes en el contexto de los grandes retos del siglo XXI. La naturaleza de por sí compleja de dichos retos implica la necesidad de definir políticas e instrumentos que resuelvan algunos de los problemas derivados de los mismos.

Recientemente, las políticas de compras públicas han aparecido con mayor frecuencia y fuerza en las agendas tanto nacionales como regionales (OECD, 2011). Sin embargo, aún no se ha llegado a un escenario en el que se conciban este tipo de instrumentos como potenciales fomentadores no sólo de la innovación, sino también del emprendimiento. Este es precisamente el objetivo de este artículo, a saber, identificar a la compra pública como un instrumento de política pública que puede ofrecer oportunidades que deriven no solo en la generación de innovaciones, sino también en la generación de actividades emprendedoras.

El artículo queda estructurado de la siguiente manera. La sección segunda detalla el papel que desempeña la política de articulación de la demanda. La sección tercera, introduce los diferentes tipos de compra pública en relación con la innovación. La sección cuarta describe la metodología seguida, y detalla las experiencias desarrolladas en diversos países, y que ayudan a ilustrar las anteriores categorías de CPI. La sección quinta dota de un marco analítico que permita identificar las oportunidades que representa la compra pública como un instrumento estimulador del emprendimiento, un campo que no ha sido explorado hasta la actualidad. Finalmente, la sección sexta concluye el artículo ofreciendo las conclusiones derivadas del mismo.

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2. La articulación de la demanda en los sistemas de innovación

Uno de los principales puntos de partida de los sistemas de innovación radica en la percepción de la innovación como un proceso interactivo, por el cual, las organizaciones – públicas o privadas, desarrollan sus procesos en colaboración con otros agentes o actores del sistema (Edquist, 1997). El concepto de sistema de innovación enfatiza la importancia que tienen los factores relacionados con la demanda, entre los que se incluyen los usuarios finales y la interacciones entre usuarios y productores (Gregersen, 1992). Sin embargo, dicho enfoque no sólo se centra en el papel de la demanda, sino que también se pronuncia respecto a otros determinantes que influyen en el desarrollo y difusión de las innovaciones (Edquist, 2005). En este artículo nos centraremos en el papel que desempeñan las organizaciones con un carácter público, dejando de lado la influencia de otro tipo de agentes privados.

La justificación de la necesidad de intervención pública en políticas de articulación de la demanda queda explicada por los fallos sistémicos y de mercado que están presentes en la mutua relación de dependencia entre la demanda y la innovación (Dalpé et al., 1992; Edler y Georghiou, 2007; Edler, 2009; Gustafsson y Autio, 2011). Estos fallos se deben a que (i) los primeros usuarios tienen unos mayores costes de entrada, (ii) el mercado no reconoce el potencial de los productos y servicios innovadores, y por tanto no constituye una demanda suficiente para su introducción, (iii) los usuarios se encuentran inmersos en el uso de tecnologías anteriores, por lo que el cambio a nuevas trayectorias tecnológicas requiere de fuertes incentivos, (iv) durante los primeros estadios en la introducción de las innovaciones apenas se observan economías de red debido a la poca cantidad de usuarios, (v) los usuarios no son capaces de enumerar sus necesidades, y (vi) existe una incapacidad para traducir los requerimientos de la demanda en términos de nuevos productos y servicios.

Uno de los principales instrumentos de articulación de la demanda es la compra pública. Rothwell y Zegveld (1981) fueron de los primeros autores en estudiar el impacto que tenía la compra pública en comparación con los programas basados en subsidios públicos para las actividades de Investigación y Desarrollo (I+D). Análogamente, Geroski (1990) observó que los instrumentos de compra pública eran más eficientes al estimular las actividades de innovación que los subsidios a la I+D. Más recientemente, Aschhoff y Sofka (2009) han evidenciado que la compra pública de tecnología así como la provisión de una adecuada infraestructura de conocimiento en las universidades tenían un efecto similar sobre las actividades innovadoras. Sin embargo, el impacto de las compras públicas era más notorio en empresas de pequeño tamaño (PYMES) y en aquellas regiones con condiciones económicas desfavorables.

3. Tipos de compra pública como estímulo a la Innovación (CPI)

La compra pública regular se produce cuando una organización (pública) adquiere un producto (un bien o servicio, o la combinación de ambos, un sistema) ya existente con anterioridad. Es decir, no se requieren actividades de I+D previas, y sólo el precio y la calidad del producto son considerados en la selección del proveedor. Por su parte, se habla de CPI cuando una organización pública abre una invitación para solicitar un producto que no existe en el momento en que se abre la convocatoria, pero el cual podría desarrollarse dentro de un período de tiempo razonable (Edquist et al., 2000). En este tipo de compra pública sí se requiere de la compleción de actividades de I+D antes de que la entrega a la entidad o administración demandante pueda ser formalizada.

A continuación presentaremos una clasificación de los tipos de CPI que pueden distinguirse en base a tres dimensiones (Edquist et al., 2000; Edler, 2009; Hommen y Rolfstam, 2009; Uyarra y Flanagan; 2009). La primera hace referencia al usuario final de la CPI:

- La *CPI directa* se produce cuando el organismo demandante es también el usuario final del producto resultante de la compra. La agencia pública utiliza su propia demanda para inducir a otros agentes del sistema a innovar, en aras de cubrir sus propias necesidades.
- En La *CPI catalítica* las necesidades se encuentran fuera del ente que actúa como demandante, por lo que la agencia pública adquiere los nuevos productos no para cubrir sus propias necesidades, sino para la satisfacción de aquellas provenientes de otros actores.

La segunda dimensión hace referencia al carácter y grado de innovación demandados:

- La *compra pública pre-comercial* (PCP) hace referencia a la compra de resultados de investigación esperados, y confina la financiación de actividades de I+D. Sin embargo, no implica la adquisición de ningún producto.
- La *CPI adaptativa* tiene lugar cuando el producto adquirido es nuevo en el país o región en el que se sitúa la iniciativa. Se requieren de actividades de innovación para adaptar un producto ya existente a las particularidades de la demanda local.
- La *CPI evolutiva* conlleva el desarrollo de productos totalmente novedosos, por lo que se la relaciona con el desarrollo de innovaciones de carácter radical.

Además de las dos dimensiones anteriores, es preciso añadir una tercera, a saber, el hecho de que la CPI pueda desarrollarse de manera cooperativa. Esta cooperación hace referencia a la correspondencia entre el aprendizaje interactivo y la competición entre posibles proveedores. La *CPI cooperativa* ocurre cuando el órgano solicitante y los proveedores cooperan durante el proceso de la compra pública (ver Edquist et al., 2000). Esta cooperación público-privada puede tener lugar durante todo el proceso o durante algunas de las etapas del mismo. Por el contrario, la *CPI no-cooperativa* ocurrirá cuando no exista un diálogo entre las partes implicadas, es decir, en aquellos casos en los que no pueda haber un aprendizaje interactivo entre las organizaciones. En un principio, todas las categorías de CPI son susceptibles de ser cooperativas, por lo que en lugar de tener cinco categorías, se obtendrían un total de diez.

El hecho de que la cooperación no sea una variable dicotómica sino una cuestión de grado complica la categorización de un tipo de CPI como cooperativo o no-cooperativo. Dado que el aprendizaje interactivo constituye uno de los principios de un sistema de innovación, y por ende, de la mayor parte de las innovaciones, podrá observarse cómo en la mayoría de los casos incluidos en la siguiente sección existe cierto grado de cooperación entre los actores implicados en cada caso, si no durante todo el proceso, durante algunas de las etapas del mismo.

4. La compra pública como estímulo a la innovación

La información para la redacción de cada caso ha sido obtenida mediante el acceso a la documentación relevante en cada caso, tales como convocatorias de licitación, literatura científica, documentos de política y evaluaciones y otros materiales escritos e informes a los que se ha tenido acceso. La razón por la que nos hemos centrado en estos cuatro estudios de caso radica por una parte en la experiencia que cada uno de los países (Australia, Noruega, Estados Unidos y Suecia) atesora en la aplicación de la CPI.

Nuestra aproximación debe ser considerada como cualitativa y exploratoria. Dado que uno de los objetivos del artículo es el de ilustrar en qué medida la compra pública puede ofrecer oportunidades que deriven en el fomento de la innovación, el uso de un enfoque cualitativo parece razonable (Knafl y Howard, 1984). Dado el alcance aún limitado de experiencias de CPI, todavía no existe una fuente de datos estadística que permita realizar una evaluación cuantitativa de este instrumento. Es por ello por lo que nuestra información se limita a fuentes de información secundarias.

Son cuatro los casos mediante los cuales se pretende ilustrar el potencial de la CPI. Una versión más detallada del primer caso puede encontrarse en Edquist y Zabala-Iturriagagoitia (2015), mientras que los casos segundo y tercero están descritos en Edquist y Zabala-Iturriagagoitia (2015). La Tabla 1 caracteriza a qué tipo de compra pública se adhiere cada uno de los casos considerados. Como se puede observar, la casilla de CPI catalítica y evolutiva permanece en blanco. Esto es debido a que históricamente la CPI ha sido utilizada principalmente para la satisfacción de las necesidades de las agencias públicas (CPI directa), lo cual refleja que a pesar de que la CPI catalítica es considerada como un instrumento con gran potencial, se encuentra todavía en gran medida en desuso.

Tabla 1. Clasificación de los casos sobre CPI

Carácter del proceso de compra pública Usuario final	Compra pública Pre-comercial	Compra pública adaptativa	Compra pública evolutiva
Compra pública directa	MVP (Caso 1)	NødNett Norge (Caso 2)	ADS-B (Caso 3)
Compra pública catalítica		Hammarby Sjöstad (Caso 4)	

4.1 MVP

El Smart SMEs Market Validation Programme (MVP) es uno de los programas incluidos en el plan de innovación del Gobierno de Victoria (Australia), gestionado por el Departamento de Innovación, Industria y Desarrollo Regional (DIIDR). El principal objetivo del MVP es identificar las necesidades tecnológicas de las organizaciones públicas en Victoria y corresponder a las mismas con las capacidades innovadoras de las PYMEs del territorio (Berman y Squire, 2011).

El MVP toma al programa Small Business Innovation Research norteamericano (1982) como su punto de partida, con el que confluye en algunas de sus principales motivaciones. El MVP es considerado por el Gobierno de Victoria como un instrumento de PCP por el cual las PYMEs deben acometer actividades de I+D subsidiadas por la correspondiente agencia pública para poder dotar de soluciones a las mismas. El programa está dividido en tres etapas: (i) especificaciones y requerimientos tecnológicos, (ii) estudio de viabilidad, y (iii) testeo del concepto o solución.

El proceso comienza cuando una agencia pública de Victoria identifica una necesidad tecnológica específica asociada a su misión y para la cual no existe solución comercial disponible. Una vez definidas las especificaciones y requerimientos tecnológicos, se incluyen los mismos en un concurso público por el cual se invita a las PYMEs de la región a que propongan soluciones que puedan cubrir dicha necesidad tras la correspondiente y necesaria etapa de I+D. Durante la segunda etapa, las PYMEs desarrollan sus propias aplicaciones, de forma que aquellas que sean evaluadas positivamente recibirán una financiación de 100.000 AU$ del DIIDR para el desarrollo de su estudio de viabilidad y de las actividades de I+D asociadas al mismo. Hay que indicar que el MVP ofrece la posibilidad de financiar a más de una PYME para la misma iniciativa. Tras un período de 3 meses, el estudio de viabilidad es evaluado por la agencia correspondiente junto con otra serie de expertos y miembros del DIIDR. Algunos de los criterios de evaluación que se emplean incluyen el alcance de la I+D incluida en la propuesta, la localización de las actividades de I+D, los recursos requeridos para la misma, sus hitos, el personal, los gastos y la financiación y el futuro plan de comercialización.

En caso de que la propuesta sea evaluada positivamente, la PYME recibe un total de 1,5 millones AU$ para el desarrollo y posterior testeo de su concepto (2 años). La PYME conservará todos sus derechos de propiedad intelectual, mientras que la agencia financiadora retiene una licencia para la explotación de los mismos. En caso de que la agencia acepte la solución propuesta, las obligaciones de la misma en este caso de PCP se consideran terminadas, sin necesidad de que haya un compromiso para que dicha agencia adquiera la solución obtenida (Berman y Squire, 2011).

La primera ronda de solicitudes fue abierta en 2009. Dentro de la primera etapa se recibieron un total de 74 propuestas con especificaciones y requerimientos tecnológicos provenientes de 27 entidades públicas. A pesar de que la colaboración (entre PYMEs o entre PYMEs y universidades u otros organismos públicos de investigación) no era considerada como uno de los criterios de evaluación, 85 PYMEs (69%

de todas las propuestas recibidas) señalaban su intención de cooperar con otra empresa, universidad o centro de investigación en la búsqueda de una solución al problema/necesidad identificado. 19 de estas invitaciones progresaron a la segunda etapa, la cual atrajo un total de 124 propuestas de PYMEs de la región. Tras su correspondiente evaluación, nueve proyectos pasaron a la tercera y definitiva etapa de desarrollo de prototipos y conceptos.

La primera ronda del MVP ha terminado recientemente por lo que no es posible todavía evaluar su impacto económico. Sin embargo, sí se pueden observar ciertas particularidades. Una de ellas es el alto nivel de cooperación entre organizaciones de diverso tipo, así como la alta representatividad de aquellas empresas con menos de 7 empleados (Berman y Squire, 2011, p. 101). Finalmente, resaltar la gran cantidad de propuestas (un total de 70) recibidas desde PYMEs sin un historial previo en la recepción de fondos públicos de I+D. Esta última figura es particularmente significativa, ya que indica que el programa ha servido para apoyar la entrada de nuevos agentes en el sistema de innovación.

4.2 NødNett Norge

El proyecto NødNett Norge constituye un caso de CPI cooperativa ya que trataba de dar solución a las necesidades (comunes) de varias organizaciones públicas (p.e. bomberos, brigadas contra incendios, servicios de salud, fuerzas de policía, etc.). El objetivo era establecer una red de radio digital móvil que fuera capaz de coordinar las redes de comunicación análogas e independientes de los cuerpos de seguridad de Noruega. El Ministerio de Justicia y la Policía fueron designados como sus principales solicitantes. Estos agentes cooperaron activamente con otra serie de agencias, como la organización para la defensa logística, la policía del distrito de Sor-Trondelag, las brigadas antincendios de Trondheim, Klaebu, Malvik y Melhus, el hospital de St. Olav y Telenor (Lyngstøl, 2004). Respecto a su grado de innovación, se puede categorizar al proyecto como adaptativo, ya que conllevó la modificación de una tecnología ya existente.

El proceso de compra pública puede dividirse en dos grandes etapas, una primera de carácter pre-comercial y el proceso de CPI en sí mismo. La etapa pre-comercial tuvo lugar entre 1995 y 2004, periodo en el cual se desarrollaron tres tipos de actividades: estudio previo (1995-1996), estudio de viabilidad (1998-2001) y proyecto piloto (2000-2004). Telenor era el responsable de su coordinación, gestionado por la defensa nacional Noruega (Hommen, 2005).

El estudio de viabilidad derivó en la selección del estándar Europeo TETRA (TErrestrial Trunked Radio), el cual ya había sido implementado en varios países del área de Schengen. Durante el desarrollo del proyecto piloto, se implantó una instalación experimental en el área de Trondheim en Julio de 2000, el cual integraba la red TETRA con las redes de comunicación ya disponibles con anterioridad por la policía, los cuerpos antincendios y el departamento de salud. Con ello se daba por concluida la etapa pre-comercial en Junio de 2003.

El proceso de CPI comenzó en Noviembre de 2004 cuando el Gobierno Noruego presentó una estrategia para el establecimiento de una red nacional digital de radio para las brigadas antincendios, la policía y los servicios de salud. El parlamento autorizó al Ministerio de Justicia a abrir el proceso de recepción de propuestas y así determinar el beneficiario de dicha ayuda, responsable a su vez de cubrir las necesidades de comunicación de dichas agencias en 54 municipalidades. El proyecto estaba totalmente financiado por fondos incluidos en los presupuestos generales, de forma que el estado se convertiría en el propietario final de la totalidad del sistema, siendo los usuarios finales pertenecientes a los cuerpos de bomberos, policía, servicios de salud, así como otras organizaciones cuya participación era consideraba necesaria en casos de emergencia, tales como defensa, aduanas, prisiones y algunas ONGs.

Las especificaciones sobre el funcionamiento de la red sólo incluían los requerimientos funcionales de la misma desde el punto de vista del usuario. Sin embargo, éstos fueron detallados a tal extremo que incluían más de 4.000 especificaciones, lo cual dejaba poco margen de maniobra a los potenciales proveedores (Sylvest, 2008).

En Diciembre de 2005 se abrió un concurso público, tras el cual se recibieron cinco propuestas. Tras la evaluación de las mismas, en la cual el precio fue uno de los principales criterios (Sylvest, 2008), Siemens Networks Norway AS fue seleccionado como proveedor en 2006, y el acuerdo entre las partes fue firmado en Marzo de 2007.

El desarrollo del proyecto se llevaría a cabo en dos etapas, en la primera de las cuales se integrarían los sistemas en el este de Noruega, incluyendo Oslo, mientras que en la segunda se cubriría el resto del territorio (Directorate for Emergency Communication, 2007). El proyecto tuvo un impacto directo sobre la generación de nuevos puestos de trabajo en Nødnett Norway, así como mejoras en la eficiencia y en la provisión de servicios de emergencia (Sylvest, 2008, p. 76).

4.3 ADS-B

La compra pública en los Estados Unidos tiene lugar a dos niveles, el federal y el estatal. Las reglas que gobiernan las compras públicas de todas las agencias federales están incluidas en la "Federal Acquisition Regulation" (FAR). La FAR y otras regulaciones no son aplicables a las agencias estatales, las cuales tienen un control total sobre sus propios instrumentos de compra pública. Sin embargo, muchas de las agencias federales sustituyen y/o complementan las normas incluidas en la FAR con normas análogas que adaptan los contenidos de la FAR a sus necesidades específicas (p.e. Departamento de Energía, Departamento de Educación, Agencia para la protección del medio ambiente, etc.).

Dos de los principios fundamentales de la FAR, y por lo tanto, considerados en todas las compras realizadas por las agencias federales, son el coste y el apoyo a procesos competitivos. El criterio de la innovación, o la prioridad a procesos innovadores no es por lo tanto promovido por la FAR (Vonortas, 2015). Mientras que la FAR, así como sus adaptaciones federales, proveen normas que estandarizan los procesos de compra pública, las políticas de compra pública son responsabilidad de cada agencia federal, la cual es responsable de definir sus propias especificaciones y de evaluar las propuestas recibidas.

Uno de los casos en los que la innovación fue considerada como uno de los resultados intencionados de la compra pública fue el "Automatic Dependent Surveillance-Broadcast program" (ADS-B) de la Admi-

nistración de la Aviación Federal (FAA) (Vonortas, 2015). El objetivo del ADS-B consistía en desarrollar una estrategia que se alineara con el sistema NextGen (Next Generation Air Transportation System) y que supusiera un valor añadido para la Agencia Nacional del Espacio Aéreo. El ADS-B permitiría identificar la localización de un avión utilizando sistemas de navegación GPS y emitiendo continuamente la localización precisa de cualquier avión a otros aviones así como a controladores aéreos. Este caso constituye un claro ejemplo de CPI directa en la cual una agencia pretende cumplir sus propias misiones. El proceso de compra pública de la FAA comenzó con la difusión del programa por medio de los denominados 'industry days', los cuales permitieron a las empresas interesadas conocer así como contribuir a identificar y definir los detalles y funciones del sistema. Los detalles de las especificaciones eran funcionales, con la idea de dotar de una mayor flexibilidad a los participantes.

La FAA publicó una solicitud de licitación en Noviembre de 2006, en respuesta a la cual fueron preseleccionadas tres propuestas. La agencia emitió una solicitud de ofertas en Marzo de 2007 para conocer los detalles de las mismas. La evaluación determinó en Agosto de 2007 que la FAA otorgaba el contrato a la propuesta de ITT Corp., por combinar el menor riesgo y posibilitar una implementación menos costosa.

El proceso de implementación del ADS-B se desarrolló en dos etapas: (i) establecimiento de la infraestructura terrestre en asentamientos clave (Golfo de México, Louisville, Philadelphia y Florida del sur); y (ii) desarrollo del equipamiento necesario para desplegar el sistema ADS-B a escala nacional. La primera de las etapas se desarrolló bajo un contrato de costes fijos y un acuerdo por el cual la FAA cubría los gastos derivados de cualquier requerimiento adicional. La segunda etapa fue financiada por un contrato de costes fijos por el cual ITT Corp. debía desplegar suficientes sistemas para poder cumplir con los requerimientos establecidos en la licitación. Dicho contrato también establecía que ITT Corp. debía instalar y mantener el equipamiento terrestre, mientras que la FAA tenía que pagar por los servicios de vigilancia y de transmisión, además de los cargos derivados del equipamiento necesario para la recepción de dicha señal en aviones e instalaciones de control de tráfico aéreo.

Desde su concepción, el ADS-B ha sido considerado por la FAA como una de sus principales tecnologías para la transformación del espacio aéreo norteamericano. La FAA esperaba que el sistema ADS-B conllevaría la sustitución total de los radares terrestres ya que un avión en el que el sistema estuviera disponible proveería tanto a controladores aéreos como a otros pilotos de actualizaciones más rápidas y fiables sobre información aérea, lo cual incrementaría la seguridad de los pilotos. Ello tendría un impacto directo sobre la reducción del espacio aéreo necesario entre aviones, incrementando la eficiencia de dicho espacio además de mejorar la fiabilidad del trabajo de los controladores (McCallie et al., 2011).

4.4 Distrito de Hammarby Sjöstad en Estocolmo

En 1998, la ciudad de Estocolmo abrió una concurso medioambiental - Miljötävling 2000, que pretendía reducir el impacto medioambiental en los distritos de Hammarby Sjöstad, Östberga y Skärholmen, y por medio del cual se otorgarían premios para nueva construcción en dichas localizaciones. Con ello, se pretendía reconvertir antiguas áreas industriales en distritos urbanos sostenibles, utilizando un método para la integración y planificación de infraestructuras así como para la implementación de tecnologías innovadoras para el consumo de energía, agua y la gestión de residuos (Lember et al., 2007). Este proyecto constituye el programa de este tipo más amplio y diverso jamás acometido en Suecia tanto en términos de escala como de ambiciones, ya que implicaba la construcción de edificios, infraestructuras y soporte técnico (Kalvet y Lember, 2010, p. 250). Iniciativas como esta contribuyeron a que Estocolmo fuera nombrada capital verde de la UE en 2010.

Durante la construcción del proyecto de Hammarby Sjöstad, el consejo de la ciudad de Estocolmo alentó a promotoras y constructoras a que reforzaran sus principios de reciclaje, consumo y producción de energía. Para el año 2009 ya habían tenido lugar más de 30 proyectos de CPI catalítica, con resultados tanto en términos de innovaciones incrementales como radicales (Bylund, 2006). Los resultados de estos proyectos de CPI son variados. Algunos de ellos fracasaron (p.e. cédulas de gasoil, internet comunitario), otros fueron parcialmente exitosos (medición individual del consumo), mientras que aquellos que derivaron en mejoras incrementales – principalmente en innovaciones de proceso – fueron los más exitosos (p.e. ventanas energéticamente eficientes) (Kalvet y Lember, 2010). Como veremos con posterioridad, las innovaciones radicales tuvieron un mayor impacto en la apertura de nuevos mercados que en la generación de tecnologías radicalmente novedosas (Lember et al., 2011, p. 1384).

El plan de Hammarby incluía la construcción de 15.000 apartamentos y 10.000 oficinas. El programa incluía un amplio abanico de procedimientos de compra pública, desde procesos de negociación divididos en varias etapas, hasta la dotación de varios contratos en paralelo para fomentar la cooperación empresarial. A menudo, también se utilizaron mecanismos de diálogo con proveedores para la elección de la tecnología o procesos de compra más adecuados en cada caso.

Uno de los ejemplos de CPI catalítica es el caso de las ventanas energéticamente eficientes. El grupo de compradores incluía a todas las grandes promotoras y constructoras implicadas en el proyecto de Hammarby Sjöstad. El hecho de tener a dichas promotoras como clientes principales constituía por sí mismo un volumen de producción suficientemente elevado. Las ventanas energéticamente eficientes ya eran producidas con anterioridad en Suecia, pero con un precio superior al deseado en un 30-40%. Tras recibir propuestas de cuatro grandes fabricantes de ventanas, se aceptó un pedido de la constructora Skellefteå Snickericentral a Överrums Fönsterfabrik (una empresa fabricante de ventanas) en 1999 (Bylund, 2006, p. 92). Las nuevas ventanas fueron adquiridas al mismo precio que las ya existentes en el mercado en aquel momento, pero con las consiguientes mejoras energéticas, lo que implicaba una reducción de la demanda energética en los hogares.

Otro ejemplo lo constituye el desarrollo de nuevas tecnologías para la medición del consumo. El objetivo de dicha iniciativa era la creación

de un sistema de monitorización de la energía consumida y del coste de distribución en cada apartamento. Ello implicaba la necesidad de desarrollar nuevas tecnologías capaces de medir el consumo eléctrico, de calor, de gas y de agua de modo individual. Dicho proyecto se llevó a cabo entre 1998 y 2000, cuando este tipo de tecnologías todavía no se encontraban disponibles en el mercado Sueco. Las empresas demandantes incluían a 10 constructoras, las cuales definieron los requerimientos técnicos junto con una serie de expertos.

En 1999 se evaluaron las 13 propuestas recibidas, de las cuales cinco fueron invitadas a desarrollar un prototipo. En el año 2000, se efectuaron las correspondientes evaluaciones de los prototipos. Dos de ellos fueron designados como ganadores, y un tercero recibió una mención honorífica. Los prototipos fueron finalmente instalados en 2001 en 500 apartamentos (Bylund, 2006).

5. La compra pública como estímulo al emprendimiento?

Esta sección se centra en la relación existente entre la compra pública y el emprendimiento. Para una discusión más detallada de la utilidad de la compra pública como estímulo al emprendimiento, ver Timmermans y Zabala-Iturriagagoitia (2013). A pesar de que no sea posible a día de hoy encontrar contribuciones que dentro de los instrumentos de articulación de la demanda establezcan el nexo entre la compra pública y el emprendimiento, esta sección pretende dar un primer paso en dicha dirección.

5.1. La relación entre la compra pública y el emprendimiento

Como se ha evidenciado, las empresas beneficiarias de las iniciativas de CPI fortalecen su capacidad innovadora a través de las actividades de I+D que las encaminan al desarrollo de nuevos productos o sistemas. Por lo tanto, a priori, la CPI debería ser capaz de estimular también el emprendimiento. Sin embargo, la evidencia existente (Edler et al., 2015) muestra cómo las grandes empresas (mayoritariamente) nacionales son las principales beneficiarias de la mayor parte de iniciativas de CPI.

En este artículo definimos el emprendimiento como aquel proceso por el cual se generan nuevas empresas con alto contenido innovador y que abren nuevas oportunidades en varios sectores de actividad. Aquí solo consideraremos como emprendedoras a aquellas empresas que constituyan nuevas entradas en el mercado y que incluyan nuevo conocimiento, el cual derive en innovaciones bien de producto o de proceso. La compra pública puede respaldar aquellas actividades innovadoras que ya están teniendo lugar en el sector, tal y como hemos visto en los cuatro ejemplos de la sección anterior. Sin embargo, también se debe considerar la posibilidad de que la compra pública pueda derivar en el establecimiento de nuevas organizaciones o empresas. En esta sección nos centraremos en este segundo aspecto, considerando así el potencial de la compra pública como estímulo al emprendimiento (CPE).

Una de las razones por las que consideramos que la compra pública puede actuar como CPE es que la misma abre nuevas oportunidades de mercado. Por lo tanto, si como consecuencia de la intervención pública emergen nuevos mercados, sería lógico pensar que de igual modo deberían surgir nuevas formas organizacionales. En segundo lugar, la compra pública no solo puede impactar sobre el emprendimiento por la provisión de nuevas oportunidades de mercado, sino también, e indirectamente, transmitiendo oportunidades tecnológicas. Al demandar productos (bienes, servicios o sistemas) innovadores, la agencia pública está indirectamente solicitando a los potenciales proveedores a que desarrollen actividades de I+D que desemboquen en el desarrollo de nuevos productos. En consecuencia, se está estimulando la generación de conocimiento y de tecnología. Por tanto, estas oportunidades tecnológicas pueden simbolizar los incentivos necesarios para la generación de nuevas empresas.

En este sentido, hay que tener en cuenta que los emprendedores, se encuentran a menudo empleados en otras empresas cuando se produce ese efecto de reconocimiento de la oportunidad (Shane, 2003). Es aquí donde debe realizarse un importante inciso, y es que los emprendedores no provienen exclusivamente del sector privado, sino que también proceden del ámbito académico o de organismos públicos de investigación. Por ello, creemos que cuando se anuncian los procesos de compra pública a ciertos agentes – en su mayoría empresas, también deberían incluirse entre dichos potenciales proveedores a universidades y centros (públicos y privados) de investigación, ya que ello no sólo puede derivar en la mejora del conocimiento y de la tecnología requeridas para la satisfacción de la demanda, sino también en un crecimiento de la competencia empresarial por la generación de nuevas organizaciones empresariales tanto en la forma de nuevas spin-off académicas, como de empresas que surgen como consecuencia de un proceso de diversificación de las actividades ya existentes en otras unidades de negocio (intra-emprendimiento).

5.2. Caracterización de los componentes de la compra pública para la estimulación del emprendimiento

Esta sección pretende abrir un debate sobre la forma en que la compra pública puede estimular el emprendimiento, un campo que no ha sido explorado hasta la actualidad.

5.2.1. La identificación de las necesidades futuras

Uno de los principales retos al que se enfrentan los gestores de los programas de compra pública es el reconocimiento de aquellos productos que puedan cubrir las necesidades futuras. En este sentido, la formación y la profesionalización de los gestores y personal implicado en los procesos de compra pública resultan fundamentales (Wintjes, 2012).

Tal y como hemos reflejado, uno de los pilares sobre los que se sustenta la literatura sobre los sistemas de innovación es el aprendizaje interactivo. Como se ha indicado, los procesos de compra pública podrían beneficiarse de la inclusión de una mayor variedad de agentes, no limitando dicho proceso exclusivamente a organizaciones empresariales privadas. Algunos de dichos agentes podrían ser: potenciales usuarios finales, gestores políticos; investigadores y científicos, estudiantes. Desde nuestro punto de vista, los equipos con los que colaboran los gestores de programas de compra pública deberían integrar un adecuado 'mix' de individuos.

5.2.2. Requerimientos funcionales vs. técnicos

El modo en el que la agencia pública formule los requisitos que el nuevo producto deba cumplir tendrá una influencia directa sobre el comportamiento de los potenciales proveedores. Ya hemos indicado cómo la inclusión de una mayor variedad de agentes puede contribuir a una correcta formulación de los requisitos deseados, los cuales consideramos, deberían ser exclusivamente de carácter funcional. Es decir, las características técnicas del producto no deberían ser especificadas por el solicitante, sino que éste debería centrar sus esfuerzos en identificar los requerimientos funcionales que pueden ayudar a satisfacer la necesidad o a resolver el problema social que constituye el motivo de su intervención. Para el solicitante es irrelevante cómo el producto vaya a contribuir a lograr dichos objetivos, por lo que el despliegue de las especificaciones técnicas debe ser dejado en manos del proveedor (Cabral et al., 2006). La experiencia muestra que la definición de un conjunto de especificaciones excesivamente detalladas por el solicitante limita la capacidad y creatividad de los proveedores para proponer soluciones innovadoras (ver sección 4.3. NødNett).

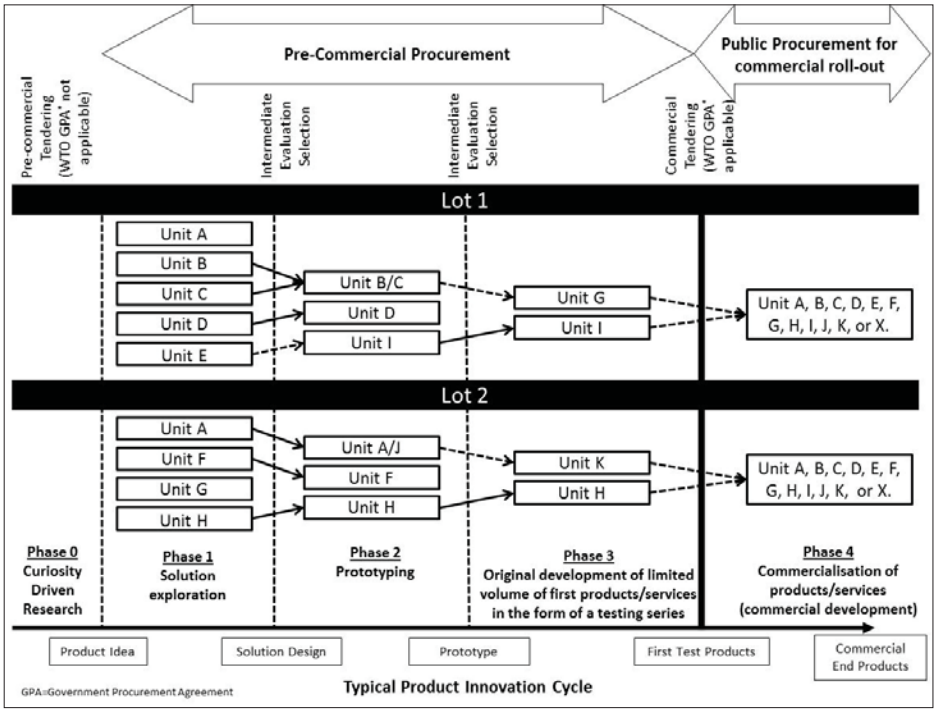
5.2.3. El papel de la "separación coordinada"

Uno de los aspectos más relevantes de la CPI y la CPE radica en si la demanda debería agruparse en un único contrato de licitación, de forma que el mercado objetivo sea lo más grande posible – lo cual favorecería a los grandes grupos empresariales, o si por el contrario el mismo debería dividirse en elementos más pequeños, de forma que se dote de estímulos para la participación de organizaciones de reciente creación (emprendedores) o que cuenten con un tamaño menor (PYMEs).

El hecho de crear un único contrato de licitación conlleva que el proveedor sea el responsable de suministrar en exclusiva todos los bienes y servicios relacionados con el mismo, lo que al garantizar una cierta economía de escala, constituye a menudo uno de las principales obstáculos a la participación de PYMEs (European Commission, 2006). Desde nuestro punto de vista este tipo de licitaciones estimulan muy poco la innovación por las siguientes razones: (i) las ideas novedosas y el conocimiento se encuentran distribuidos entre los agentes del sistema de innovación; (ii) incrementar la diversidad aumentaría la cantidad de alternativas; (iii) cuanto mayor sea la dimensión del contrato, mayores son las posibilidades de que el mismo sea otorgado a empresas que cuenten con un historial previo de cooperación con dicha agencia (Cabral et al., 2006).

Si además de estimular la innovación se quiere fomentar el emprendimiento, podemos definir un conjunto de alternativas. Por un lado, se puede garantizar que un porcentaje de las compras públicas esté reservado para las PYMEs o empresas de reciente creación (Karjalainen y Kemppainen, 2008), como ya ocurre en otros países como los Estados Unidos, Australia o los Países Bajos. La segunda de las opciones consiste en lo que aquí denominaremos como "separación coordinada" (ver Figura 1), con la cual se preserva el tamaño del mercado, ofreciendo de forma separada diversas licitaciones para las diversas tecnologías que se requieran en el producto. De esta forma, se podría incrementar la tasa de participación de PYMEs y start-ups (incluso ideas de proyecto provenientes de las universidades, centros de investigación, estudiantes, etc.), al mismo tiempo que se mantiene el incentivo del tamaño de mercado para que las grandes empresas también se vean incluidas.

Figura 1. La estrategia de la "separación coordinada"



Fuente: Timmermans y Zabala-Iturriagagoitia (2013)

Esta "separación coordinada" consta de dos dimensiones. La primera de ellas es la que denominamos como "separación horizontal". Acorde a ella, la convocatoria incluiría múltiples sub-convocatorias (de productos, de tecnologías, etc.), de modo que una empresa puede participar en una de dichas sub-convocatorias, en varias, o en todas. La segunda es la que denominamos como "separación vertical", ya que con ella se divide el proceso de innovación en varias etapas sucesivas. Así, un grupo de investigación podría participar en la etapa de diseño de la propuesta, pero sin embargo, no tendría por qué estar interesado en su fabricación, la cual podría ser desarrollada por una empresa manufacturera. Por supuesto, una misma empresa podría también presentarse a ambas convocatorias, tanto a la de diseño como a la de construcción.

El hecho de separar las etapas de exploración y de explotación es bien conocido (March, 1991; Greve, 2007). Ello responde a que no todas las empresas tienen recursos suficientes para participar en los dos procesos de forma simultánea. Hay que considerar asimismo que el conjunto de agentes que pueden participar en la generación de ideas es mayor que aquel centrado en la implementación y difusión de los productos, debido a las barreras de entrada existentes. Por tanto, el hecho de que la compra pública limite su ámbito de actuación al sector empresarial, nos parece que constituye una oportunidad aún sin explotar, ya que existe un claro potencial para relacionar agentes con competencias complementarias.

6. Conclusiones y discusión

En este artículo hemos definido lo que consideramos por CPI, mostrando una clasificación de los diferentes tipos de CPI que hemos ejemplarizado por medio de cuatro casos. Además de ello, también hemos realizado una propuesta de corte conceptual y metodológica por medio de la cual la compra pública puede actuar no sólo como estímulo a la innovación, sino también al emprendimiento (CPE). Con esta contribución sobre la CPE, nuestra intención es la de proporcionar un marco conceptual y metodológico para un campo de investigación que ha permanecido inexplorado. Por lo tanto, se requiere más investigación para profundizar en las implicaciones organizativas que la estrategia de separación coordinada puede tener para los organismos públicos encargados de los procesos de compra pública y las políticas de industriales y de innovación (Magro et al., 2014).

Otro área que requiere de mayor investigación futura es el relacionado con la evaluación de las políticas de innovación desde el lado de la demanda, un área que aún se encuentra en su infancia (Edler et al., 2012; Magro y Wilson, 2013). Sólo así será posible lograr una coevolución entre el desarrollo de la comunidad política de innovación y la práctica de su correspondiente evaluación.

Crecientemente, las políticas de articulación de la demanda se han ido complementando con otro tipo de instrumentos como la financiación de proyectos de I+D, incentivos fiscales, prospectiva tecnológica, regulaciones y estándares, etc. (Edler, 2009). Esto está directamente relacionado con el carácter multi-nivel y multi-agente de este tipo de políticas de innovación multi-instrumentales, a las cuales hay que concebir por tanto dentro de un 'policy-mix' más amplio que abarque varias iniciativas de carácter sistémico (Flanagan et al., 2011).

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Exportación de Objetos de Arte, Editorial e Industria Gráfica: Perspectiva para Argentina y Chile**

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Resumen: Frente a la oportunidad que brinda el mercado de bienes creativos a la diversificación exportadora y a la creación de empleo e inclusión, el objetivo principal de este artículo es analizar el mercado mundial y regional de objetos de arte, colección, antigüedad, editorial e industrias gráficas y determinar las variables que pueden estar influyendo en el comportamiento exportador de estos bienes creativos en Argentina y Chile durante el período 2002-2015. Para ello, se desarrollará una investigación descriptiva y empírica, revisando detalladamente datos y evidencias y; posteriormente, se determinará un modelo gravitacional ampliado que será estimado mediante datos de panel estáticos y dinámicos. Los principales resultados indican que el comportamiento exportador de estos bienes creativos en Argentina y Chile está explicado por un modelo dinámico, en que a mayor producto nacional bruto del país importador y mejor facilidad reglamentaria y legal para hacer negocios mayores será la exportación de estos bienes.

Palabra Clave: arte y colección; objeto de antigüedad; industria gráfica; editorial; exportación; bienes creativos.

Export of Art, Editorial and Graphic Objects: Perspective for Argentina and Chile

Abstract: The main objective of this article is to analyze the world and regional market for objects of art, collection, antiquity, publishing and graphic industries, and in order to analyze the opportunities offered by the creative goods market to export diversification and job creation and inclusion. Determine the variables that may be influencing the export behavior of these creative goods in Argentina and Chile during the period 2002-2015. For this, a descriptive and empirical investigation will be developed, reviewing in detail data and evidences and; Later, an extended gravitational model will be determined which will be estimated using static and dynamic panel data. The main results indicate that the export behavior of these creative goods in Argentina and Chile is explained by a dynamic model in which the greater gross national product of the importing country and better regulatory and legal facility to do business will be the export of these goods.

Keyword: art and collection; object of seniority; graphic industry; editorial; export; creative goods.

1. Introducción

Dada la desaceleración de la economía mundial, según CEPAL (2014), es necesario dinamizar el crecimiento económico de América Latina implicando amplios desafíos para la región, debido a que el aumento de la demanda externa será lento y complejo y dificultará el aporte que las exportaciones puedan hacer al crecimiento. Si bien el comercio internacional sigue siendo una fuente de oportunidades, CEPAL (2014) sugiere que Latinoamérica y el Caribe deben redoblar sus esfuerzos por volverse más competitivos en sus mercados externos y, a la vez, incrementar los esfuerzos por abrir nuevos mercados y diversificar sus exportaciones. Adicionalmente, otros autores como Beltrán (2013), Ocampo (2015) y Romero (2016) reconocen el lento dinamismo previsible del comercio internacional latinoamericano y la creciente dependencia de América Latina de sus exportaciones en recursos naturales, que hace aún más necesario repensar la tarea de mejorar la competitividad y la calidad de la canasta exportadora, así como el balance entre el mercado interno y el externo.

Ante esta necesidad de diversificar la canasta exportadora y abrir nuevos mercados, las industrias culturales y creativas podrían establecerse como un aporte importante para el crecimiento económico de países de América Latina. Al respecto, Barciela, López y Melgarejo (2012) señalan que la cultura transforma las realidades en "espacios de la innovación» culturalmente dinámicos y activos, internacionales por vocación, capaces de ofrecer a sus residentes la posibilidad de experiencias estimulantes, motivadoras en la inversión de nuevas capacidades, constituyéndose las industrias creativas en un aporte al desarrollo sostenible.

Según el informe de EY (2015) para el año 2013, este tipo de industrias generaron un ingreso mundial sobre los 2,25 billones de dólares y dieron empleo a 29 millones de personas, siendo la televisión, artes visuales y periódicos y revistas los principales mercados creativos. En el mismo año, Latinoamérica generaba ingresos por 124.000 millones de dólares (el 6% del mercado mundial) y 1,9 millones de empleos sólo por el desarrollo de dicha industria creativa, sustentado en los siguientes activos creativos: 131 sitios inscritos como patrimonio mundial que se contabilizaron como activos creativos, el dinamismo de escritores latinoamericanos y los conglomerados de multimedia en radios, prensa y televisión (EY, 2015). Al estudiar las industrias culturales en Cali-Colombia, Alonso y Gallego (2011) observaron que, para los años 2005 y 2008, este tipo de industria aportó 1,01% y 1,22%, respectivamente, al producto interno bruto (PIB) municipal;

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generó 6.632 empleos en el 2005, representando el 2,7% del empleo de la ciudad en ese año, y; las actividades que más aportaron a las ventas fueron fotografía (51,5%) y comercio especializado al por menor de libros (18,6%).

Con el propósito de contribuir a la diversificación de la exportación con políticas adaptadas a la realidad cultural de Argentina y Chile y como una forma de impulsar la cultura con orientaciones económicas y creativas en estos dos países, surgen las preguntas de investigación que motivan el desarrollo de este estudio. Las preguntas centrales de esta investigación son: ¿Qué características y evolución presenta el mercado mundial de objetos de arte, colección, antigüedad, editorial e industrias gráficas y cuál es la participación de Chile y Argentina?; ¿Qué factores están influyendo en el comportamiento exportador de estos bienes creativos en Chile y Argentina? y; ¿Que políticas culturales y comerciales pueden incentivar este tipo de mercado en estos países?

Por consiguiente, el objetivo principal de este artículo es analizar el mercado mundial y regional de objetos de arte, colección, antigüedad, editorial e industrias gráficas y determinar las variables que pueden estar influyendo en el comportamiento exportador de estos bienes creativos en Argentina y Chile durante el período 2002-2015. El estudio se centra en estos dos países sudamericanos, en primer lugar, por presentar continuidad exportadora durante todo el período a 37 países de destino, permitiendo construir una muestra de 1008 observaciones en total. En segundo lugar, por presentar semejanza idiomática, lo que permite medir el efecto de un idioma diferente del país importador; porque estos dos países tienen salida a diferentes océanos, por lo que aspectos logísticos, de costos, ubicación geográfica y facilitación comercial pueden ser factores influyentes para la exportación de estos bienes.

En la metodología aplicada en este estudio se consideró el planteamiento de algunos estudios, como el de Urrea (2012) el cual plantea que el mercado del arte y su comercialización está vigente en varios países, pero que es difícil la labor de investigación por la falta de información en los registros, por los constantes cambios de partidas o divisiones arancelarias y por las características de desarrollo del mercado en particular. De este modo, el desarrollo metodológico de esta investigación ha centrado sus esfuerzos en la búsqueda de datos, revisando cuidadosamente la información expuesta por la fuente Trade-Map (2015), ALADI (2016) y de las aduanas de cada país en estudio. Dado que una de las problemáticas de investigar los bienes creativos es la falta generalizada de recursos y experiencia para asegurar la alta calidad en labores estadísticas sobre el sector creativo (Van der Pol, 2007), se contrastaron las fuentes y se verificaron los datos por país, año y socio comercial. Aunque no había una variación significativa del monto exportado en estas partidas arancelarias, se observa que la base Trade-Map y ALADI solo contabilizaban datos mayor a 1000 USD, por lo que los registros de las aduanas se utilizaron para verificar montos menores y completar la muestra.

Revisando detalladamente datos y evidencias, se desarrollará una investigación descriptiva y empírica y, posteriormente, se determinará un modelo gravitacional ampliado que será estimado mediante datos de panel estáticos con efectos fijos y aleatorios y dinámicos, incluyendo en la muestra a 37 socios comerciales de Chile y Argentina durante el período 2002-2015, lo que representa el 96% del total exportado promedio de objetos de arte, colección, antigüedad, editorial e industrias gráficas durante este periodo.

Este estudio busca aportar al debate científico y cultural, ya que no se registran estudios con este objetivo y metodología en Argentina y Chile, como tampoco, se observan estudios semejantes en Sudamérica.

Demanda Mundial y Comportamiento Exportador Sudamericano

Los objetos de artes, colección y antigüedad y editoriales e industrias gráficas son clasificados como bienes culturales y creativos, según definición de UNESCO (2016) que define a las industrias culturales y creativas como aquellos sectores de actividad organizada que tienen como objeto la producción o la reproducción, la promoción, la difusión y/o la comercialización de bienes, servicios y actividades de contenido cultural, artístico o patrimonial, incluyendo, también, actividades relacionadas como la publicidad y el diseño gráfico, que contribuyen decisivamente en este proceso. A diferencia de un mercado de bienes tradicionales de producción y exportaciones de Argentina y Chile como el cobre y sus derivados, soya y otros granos, forestal y minerales, en general; este tipo de mercado cultural y creativo es conformado principalmente por las casas de subastas, grupo de anticuarios, clientes internacionales de trato directo, coleccionistas y artesanos, destacando que algunas de estas transacciones son informales y no se registran como bienes exportados. Adicionalmente, presenta características y evidencias de un mercado de competencia imperfecta, con un desarrollo exponencial en los últimos años, que ha dificultado tanto a la valorización de estos bienes y su gestión aduanera, al registro del derecho de autor y su control como a las políticas públicas y sus propuestas de presupuesto orientado a esta industria. Rowan (2014) reconoce que se vive un "inusitado momento de transición en lo que a las políticas culturales se refiere" (pp.1). Para el autor, se encuentran agotadas las dos principales tradiciones sobre las que se sustentaban las políticas culturales: aquella tradición en que la cultura es percibida como un ente educador y aquella tradición más reciente en que describe la cultura como un elemento de desarrollo y crecimiento económico. En el nuevo modelo y en actual transición, el principal gestor comercial es el artista, programador, diseñador o músico. No obstante, últimamente se ha perseverado en la construcción de una institucionalidad compuesta de incubadoras público-privadas, planes de promoción, oficinas de información, eventos, charlas y talleres, líneas de financiación o espacios de coworking, complementada con programas de televisión, eventos públicos, películas, libros y revistas, Rowan (2014) enfatiza las críticas y protestas que se han ido acumulando contra este tipo de iniciativas, cuyas estimaciones económicas están en entredicho.

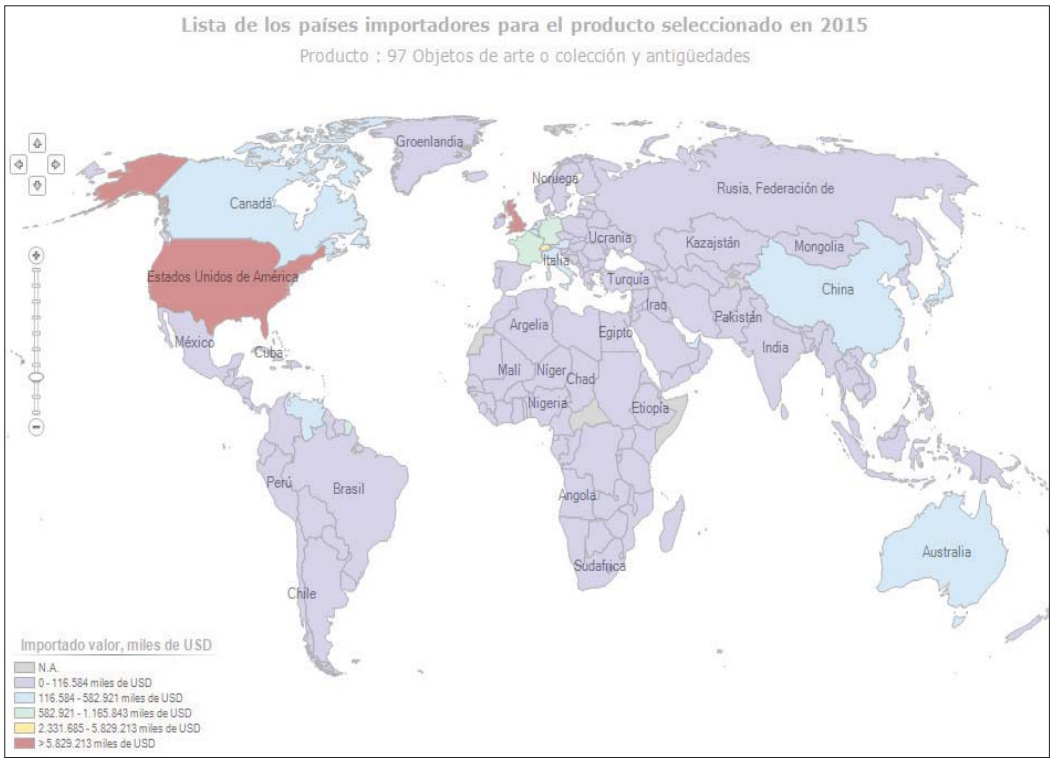
2.1 Mercado de Arte, Colección y Antigüedad (Partida 97)

Para Jarque (2007) el mercado del arte en los últimos veinte años es imparable, producto de nuevas tendencias marcadas por la educación y el desarrollo económico, lo que conllevará a una nueva relación entre los componentes del mercado del arte y los coleccionistas o instituciones que amplían sus colecciones. En la actualidad y ante un mercado del arte más dinámico, fraguándose en medio de los países productores, surgen las tendencias de una disciplina sobre otra en que la evolución de los artistas y la valorización de sus obras como piezas de valor no se pueden regir por la oferta y la demanda. Las potencias mundiales, como Inglaterra, Estados Unidos y China, han ingresados fuertemente a competir en dicho mercado. Inglaterra posee las subastas de mayor reconocimiento internacional (*Sotheby´s y Christie´s*) y Estados Unidos ostenta la capital del arte mundial, Nueva York, caracterizado por eventos artísticos de excelencia y subastas de prestigio mundial. China ha tomado protagonismo en el mercado del arte, ocupando el lugar de Francia en el arte contemporáneo y concentrando su fuerza en las ventas de arte moderno, participación que va en aumento.

Según Pérez y Sánchez (2011), las subastas constituyen uno de los intermediarios principales del mercado del arte y de los coleccionables, siendo su funcionamiento fácil, accesible y sobre todo ampliamente difundido. A nivel internacional, "*Sotheby´s y Christie´s* son actualmente las entidades más carismáticas y reconocidas de este peculiar mercado" (pp.543), abarcando el 76% del mercado de obras de arte. Adicionalmente, los autores destacan el "*boom*" de subastas por internet "…que permite al mediano y pequeño coleccionista facilitar el acceso a este mercado." (pp.544). Además, algunas subastas de reconocido prestigio utilizan su reputación como garantes para ofertar piezas de bajo costo, a través de salas virtuales como *Ebay.es* o *Mercadolibre.com*, y logran ampliar su mercado con clientes y medios de distribución.

En la Figura 1, se puede observar los países importadores de objetos de artes, de colección o de antigüedad en el 2015. Después del desplome del crecimiento económico y del comercio de bienes y servicios a nivel mundial en el 2009, se observa una pronta recuperación en el 2010, registrándose un aumento del 14,5% de las exportaciones de mercadería y una producción mundial de un 3,6% del PIB (Wto, 2011). Sin embargo, el mercado mundial de objetos de arte, colección y antigüedad comienza a recuperarse más lentamente que el general, observándose un repunte recién en el 2011. Estados Unidos, Reino Unido y Suiza son los principales países demandantes internacionales de estos bienes con un 68,4% del mercado en el 2014 (Figura 1).

Figura 1. Países Importadores de Objetos de Arte, Colección y Antigüedad en el 2015



Fuente: Cálculo de CCI basado en estadísticos de UM COMTRADE y Trade-Map (2015).

La evolución exportadora sudamericana de estos bienes se manifiesta en el promedio de crecimiento anual del 110%, superior al dinamismo observado a nivel mundial. Sin embargo, el monto exportado es insignificante, no superior al 0,36% de las exportaciones totales. Los principales exportadores sudamericanos son Brasil, Venezuela, Colombia y Argentina (ALADI, 2017). En la Tabla 1, se observa la baja considerable del monto exportado de bienes de arte, colección y antigüedad en Argentina, principalmente en pinturas, dibujos y artículos decorados a mano; obras originales de escultura y antigüedades de más de 100 años. En la Tabla 2, se observa en Chile un aumento paulatino del monto exportado de estos bienes, duplicando sus exportaciones en el 2015 (respecto del 2012) en pinturas, dibujos y artículos decorados a mano y aumenta progresivamente su exportación en colección y especímenes de interés histórico, arqueológico, paleontológico, etnográfico o numismático. Las exportaciones de sellos de correo, timbres, postales y sobres de colección son casi nulas en estos dos países.

Tabla 1. Exportación de Argentina Partida 97, Valores en Miles de USD (2012-2015)

Descripción	2012	2013	2014	2015
Pinturas y dibujos, hechos totalmente a mano, excepto los dibujos de la partida 49.06 y los artículos manufacturados decorados a mano; collages y cuadros similares.	3.486	2.576	922	858
Grabados, estampas y litografías originales.	4	21	0	50
Obras originales de estatuaria o escultura, de cualquier materia.	840	570	525	362
Sellos de correo, timbres fiscales, marcas postales, sobres primer día, enteros postales, demás artículos franqueados y análogos.			5	
Colecciones y especímenes para colecciones de zoología, botánica, mineralogía o anatomía o que tengan interés histórico, arqueológico, paleontológico, etnográfico o numismático.	261	348	369	290
Antigüedades de más de cien años.	627	62	535	223
Total	5.218	3.577	2.356	1.783

Fuente: Elaboración propia, según datos ALADI (2017).

2.2 Productos Editoriales, Prensa e Industrias Gráficas (Partida 49)
En la Figura 2, se puede observar los países importadores de productos editoriales, prensa e industria gráfica en el 2015. Desde el 2004 al 2015, la importación de estos productos creativos ha aumentado en un 25%, alcanzando un máximo en el 2008 de 46.185 millones de USD y, afectada por la crisis *subprime*, disminuye en el 2009 con una recuperación paulatina a contar del 2010. En el 2015, este tipo de importación alcanza los 42.427 millones de USD.

Tabla 2. Exportación de Chile Partida 97, Valores en Miles de USD (2012-2015)

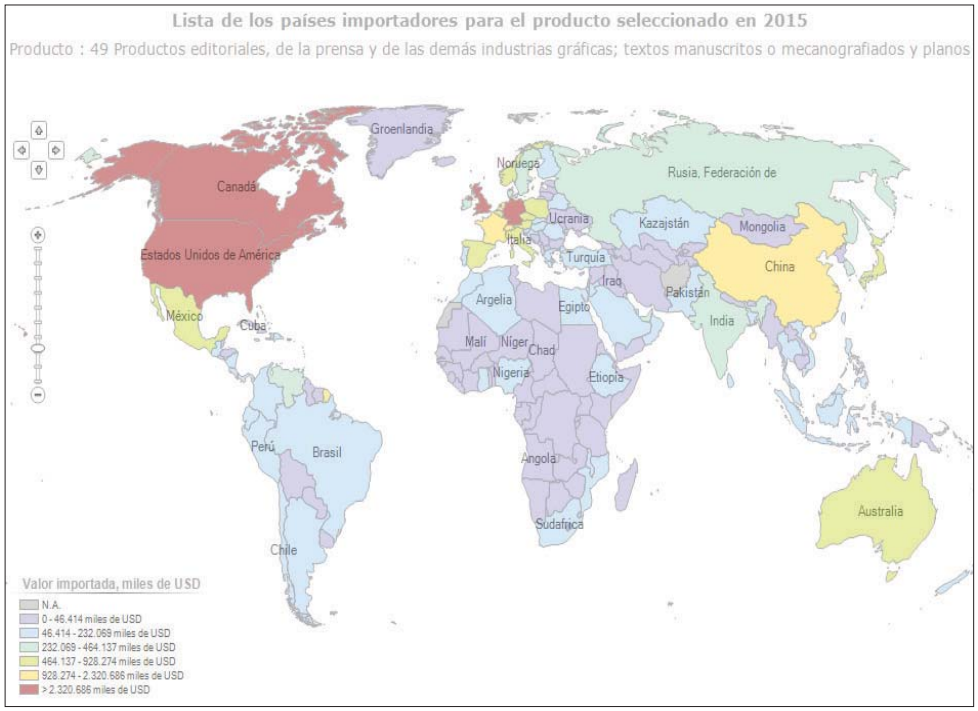
Descripción	2012	2013	2014	2015
Pinturas y dibujos, hechos totalmente a mano, excepto los dibujos de la partida 49.06 y los artículos manufacturados decorados a mano; collages y cuadros similares.	138	135	153	301
Grabados, estampas y litografías originales.	0	34	0	23
Obras originales de estatuaria o escultura, de cualquier materia.	122	322	4	28
Sellos de correo, timbres fiscales, marcas postales, sobres primer día, enteros postales, demás artículos franqueados y análogos.	54	1 0		0
Colecciones y especímenes para colecciones de zoología, botánica, mineralogía o anatomía o que tengan interés histórico, arqueológico, paleontológico, etnográfico o numismático.	51	5	368	322
Antigüedades de más de cien años.	41	139	0	50
Total	353	689	525	724

Fuente: Elaboración propia, según datos ALADI (2017).

Los principales países importadores son Francia (13%), Estados Unidos (10%) y Reino Unido (6%) del total importado a nivel mundial.

Al analizar las exportaciones mundiales, Francia, Estados Unidos, Alemania, Reino Unido y China son los principales exportadores de productos editoriales, prensa e industria gráfica. Mientras que, la tendencia exportadora en Sudamérica va progresivamente en disminución con el 0,4% del mercado mundial en el 2015. Los principales países exportadores son Perú, Argentina, Brasil y Chile.

Figura 2. Países Importadores de Productos Editoriales, Prensa y Gráfica en el 2015



Fuente: Calculo de CCI basada en estadísticos de UM COMTRADE y Trade-Map (2015)

Una de las causas de la progresiva disminución de exportación de estos bienes es explicable a través del estudio de Silvano (2014), al plantear que uno de los problemas que debe enfrentar las exportaciones de libros impresos en Sudamérica es el idioma español. Para el autor, la falta de centros de producción en América Latina y la cláusula de exclusividad sobre el idioma español en los contratos firmados por editoriales españolas provocan que la mayor publicación de libros se realice en España y lleguen a América con el precio duplicado y prohibitivo. Adicionalmente, Silvano (2014) advierte que las editoriales de América Latina no están aprovechando el libro electrónico y la distribución en plataformas de acceso masivo. En las Tablas 3 y 4, se puede observar las exportaciones en miles de USD de Argentina y Chile de la partida 49 de los años 2012 y 2015, respectivamente. En ambos países, la exportación de libros, folletos, impresos, diarios y publicaciones periódicas ha bajado considerablemente en los últimos años. En Argentina, la disminución del monto exportado de la partida 49 es mayor a la observada en Chile que presenta una pequeña alza exportadora en álbumes y libros de estampas, calcomanías y sellos de correo, timbres fiscales y análogos destinados a tener curso legal.

Tabla 3. Exportación de Argentina Partida 49, Valores en Miles de USD (2012 y 2015)

Descripción	2012	2015
Libros, folletos e impresos similares, incluso en hojas sueltas.	43.687	26.858
Diarios y publicaciones periódicas, impresos, incluso ilustrados.	8.590	2.940
Álbumes o libros de estampas y cuadernos para dibujar o colorear, para niños.	2.437	1.410
Música manuscrita o impresa, incluso con ilustraciones o encuadernada.	109	26
Manufacturas cartográficas de todas clases.	246	93
Planos y dibujos originales hechos a mano, de arquitectura, ingeniería, industriales, comerciales, topográficos o similares.	199	12
Sellos de correos, timbres fiscales y análogos, sin obliterar, que tengan o estén destinados a tener curso legal en el país en el que su valor facial sea reconocido.	148	32
Calcomanías de cualquier clase.	482	209
Tarjetas postales impresas o ilustradas; tarjetas impresas con felicitaciones o comunicaciones personales, incluso con ilustraciones o adornos.	263	95
Calendarios de cualquier clase impresos, incluidos los tacos de calendario.	299	102
Los demás impresos, incluidas las estampas, grabados y fotografías.	26.539	10.416
Total	82.999	42.193

Fuente: Elaboración propia, según datos ALADI (2017).

Tabla 4. Exportación de Chile Partida 49, Valores en Miles de USD (2012 y 2015)

Descripción	2012	2015
Libros, folletos e impresos similares, incluso en hojas sueltas.	15.510	4.922
Diarios y publicaciones periódicas, impresos, incluso ilustrados.	1.616	884
Álbumes o libros de estampas y cuadernos para dibujar o colorear, para niños.	457	804
Música manuscrita o impresa, incluso con ilustraciones o encuadernada.	0	3
Manufacturas cartográficas de todas clases.	84	2
Planos y dibujos originales hechos a mano, de arquitectura, ingeniería, industriales, comerciales, topográficos o similares.	4	21
Sellos de correos, timbres fiscales y análogos, sin obliterar, que tengan o estén destinados a tener curso legal en el país en el que su valor facial sea reconocido.	61	199
Calcomanías de cualquier clase.	55	342
Tarjetas postales impresas o ilustradas; tarjetas impresas con felicitaciones o comunicaciones personales, incluso con ilustraciones o adornos.	406	319
Calendarios de cualquier clase impresos, incluidos los tacos de calendario.	144	144
Los demás impresos, incluidas las estampas, grabados y fotografías.	17.505	19.253
Total	35.842	26.890

Fuente: Elaboración propia, según datos ALADI (2017).

2.3 Comportamiento exportador

Entre las variables que pueden estar influyendo en el comportamiento exportador de estos bienes creativos, se destacan:

a. Producto Interno Bruto (PIB) del País Importador y Exportador. Existe una correlación positiva entre los países con alto PIB per cápita de la última década (Estados Unidos; Canadá; Reino Unido; Francia; Islandia; Noruega; Suecia; Finlandia; Australia y Nueva Zelanda) y sus niveles de importación y exportación de bienes creativos en los últimos años.

b. Crisis *Subprime*: Domenech y Lazzoretti (2012) afirman que las industrias creativas de Sudamérica no han sido inmunes a los efectos de la crisis *subprime*.

c. Distancia y Costo de Exportación: Hoffman (2000) plantea que el comercio exterior de un país está estrechamente vinculado con su ubicación geográfica y así, los servicios de transporte que cubren las distancias hacia los mercados y los puertos son factores fundamentales para garantizar mayor eficiencia en el proceso exportador. La lejanía geográfica de Argentina y Chile con los principales importadores de bienes creativos puede estar obstaculizando la exportación de dichos bienes debido a los mayores costos de traslado. Adicionalmente, la salida a diferentes océanos de estos países, la infraestructura portuaria y su gestión logística son otros factores que pueden afectar los costos de exportación. Moreira et al (2013) consideran que tanto los responsables de la formulación de políticas como los investigadores Latinoamericanos a menudo pasan por alto la dimensión distributiva de los costos del comercio. En este estudio se concluye que la reducción de los costos internos de transporte permiten aprovechar al máximo las oportunidades de exportar.

d. Facilitación comercial y emprendedora: En el estudio de Moïsé y Sorescu (2013) se concluye que la disponibilidad de información relacionada con el comercio, la simplificación y armonización de documentación y la automatización de procedimientos tienen mayor impacto en los volúmenes y los costos del comercio exterior de un país. Pinilla-Rojas (2016) concluye que para llevar a cabo un buen desarrollo de un proyecto creativo es necesario disponer de lineamientos legales y comerciales facilitadores, tales como permisos locativos, sistema de contratación y reglamentación legal.

3. Estimación del modelo y metodología

En esta investigación se utilizará un modelo gravitacional ampliado, mediante datos de panel estáticos con efectos fijos y aleatorios y dinámicos, con el propósito de determinar las variables que pueden estar influyendo en las exportaciones de objetos de arte, colección, antigüedad, editorial e industria gráfica de Chile y Argentina durante el período 2002-2015. El modelo gravitacional tiene como premisa el estudio efectuado por Newton (1687), sobre la Ley de Gravedad Universal que expresa que la fuerza ejercida entre dos cuerpos con sus respectivas masas y separados a una distancia, es directamente proporcional al producto de sus masas e inversamente proporcional a la distancia que los separa. El economista pionero en adaptar estos principios físicos al comercio exterior, fue Tinbergen (1962), donde en este caso, la atracción se mide por el flujo del comercio bilateral del país exportador a un país importador, siendo la masa de los cuerpos sustituida por el tamaño de la economías (usualmente medido por el PIB o producto nacional bruto) y la distancia como proxy de los costos de transporte. Teóricamente, a mayor tamaño de las economías del país exportador e importador mayor atracción gravitacional entre ellos, mientras que a mayor distancia geográfica menor atracción.

Posteriormente, los autores que siguieron utilizando el modelo gravitacional para analizar el comercio internacional fueron Pöyhönen (1963) y Linnemann (1966), siendo Anderson (1979), Bergstrand (1985) y Helpman y Krugman (1985) los que le dieron sustento teórico. En las últimas décadas, el modelo gravitacional es uno de los modelos que más se utiliza para analizar los flujos de comercio internacional, migración o inversión extranjera debido a sus propiedades, soporte teórico y empírico, flexibilidad y adaptación a diferentes realidades regionales o de un país en particular. Además, se adapta a la estimación mediante datos de paneles estáticos y dinámicos.

Tradicionalmente, los métodos estadísticos que intentan explicar un fenómeno observado a través de una serie de variables han sido tratados mediante regresiones lineales, usando el método de Mínimos Cuadrados Ordinarios (MCO). En este estudio, el modelo lineal gravitacional ampliado estará dado por la ecuación expresada en logaritmos naturales (*Ecuación 1*) y estimada mediante MCO en datos de panel:

$$\ln(E_{ijt}) = \beta_0 + \mu_1 \ln y_{it} + \mu_2 \ln y_{jt} + \xi_1 \ln IFNE_{it} + \xi_2 \ln IFDLE_{it} + \alpha_1 \ln D_{ij} + \eta_1 \ln Cose_{it} + \sum_h \delta_h P_{ij} + u_{ijt}$$

(Ecuación 1)

Donde[1]:
i, j y t, representan al país exportador, país importador y año, respectivamente.

E_{ij} : Flujo de exportación del país *i* al *j*.

$Y_{i,j}$: Producto Nacional Bruto Real del país *i* y *j* respectivamente.

$IFNE_i$: Índice de Facilidad para hacer negocios del país exportador (cercano a 1 significa reglamentación más favorable).

$IFDLE_i$: Índice de Fortaleza de los derechos legales del país exportador (0 es débil y 12 es fuerte)
D_{ij} : Distancia geográfica entre capitales de los países *i* y *j* en Kilómetros.
$Cose_i$: Costo de exportación por contenedor en USD.

Además, en la ecuación 1 se incluyen variables ficticias indicadas como ($\Sigma_h \delta^h P_{ij}$). Así, el estimador MCO entregará separadamente los β de estos efectos. Dichas variables ficticias asumirán valor 1 en caso de presentarse el evento o valor cero en caso de no presentarse el evento, las variables ficticias son:

F_{ij} : Frontera común entre el país y el país.
IC_{ij} : Idioma en común entre el país i y el país j.
$Mercosur_{ij}$: Exportador e Importador miembros del Mercado Común del Sur (Argentina, Brasil, Paraguay, Uruguay y Venezuela desde 2014).

SA_i: : País exportador con salida al Océano Atlántico.
SP_i : País exportador con salida al Océano Pacífico.
Chile : País exportador Chile.
Argentina : País exportador Argentina.
NAFTA–CL : Intercambio comercial entre países miembros del Tratado de Libre Comercio de América del Norte (NAFTA, Estados Unidos, Canadá y México) y Chile.

MERCOSUR–CL: Intercambio comercial entre países miembros del Mercado Común del Sur (Argentina, Brasil, Paraguay, Uruguay y Venezuela desde 2014) y Chile.

China–Cl : Intercambio comercial entre China y Chile.
UE-CL : Intercambio comercial entre países miembros de la Unión Europea y Chile.

2009 : variable tiempo que representa el periodo de crisis *subprime*.

La variable índice de facilidad para hacer negocios (IFNE) se incluye en la ecuación gravitacional (1) para determinar el impacto que puede tener la reglamentación y facilitación comercial en el volumen exportado de estos bienes creativos. Mientras más cercano a 1 mejor son las reglamentaciones para facilitar el comercio y la creación de nuevos negocios, destacándose a Dinamarca con 3; Hong Kong con 5 y Reino Unido con 6. Chile presenta un indicador de 48 y Argentina de 117 en el 2014 (Banco Mundial, 2016), observándose que en ambos países la reglamentación vigente dificulta la creación de nuevos negocios y la comercialización.

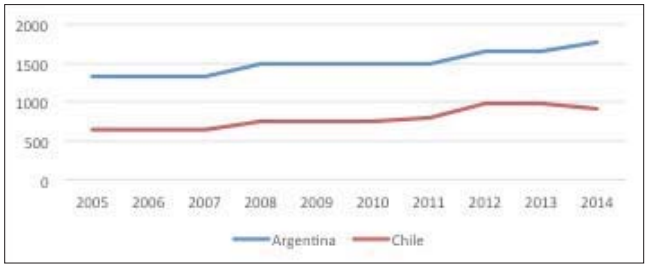
Además, se incluye en la *Ecuación 1* el índice de fortaleza de los derechos legales y medidas regulatorias (*IFDLE)* con el propósito de evidenciar algún efecto en el comportamiento exportador de estos bienes creativos, principalmente con el derecho de autor y propiedad privada. Este índice cuando está más cercano a cero son más débiles los derechos legales y medidas regulatorias, mientras que, más cercano a 12 son más fuertes. Para el 2014, el promedio mundial de este indicador es 5,1, destacándose Nueva Zelanda con 12 y Australia y Camboya con 11, mientras que Yemen, Timor, Eritrea y Bolivia son los países que presentan un indicador igual a cero. Argentina y Chile se encuentran por debajo del promedio mundial con 2 y 4, respectivamente (Banco Mundial, 2016).

El costo de exportación por contenedor ha ido aumentando progresivamente en el mundo de 1213,66 USD en el 2005 a 1559,8 USD en el 2014. Por ello, esta variable de costo se constituye en un importante y estratégico elemento de estudio, dado que puede estar perturbando negativamente el proceso exportador al afectar el precio competitivo de mercado y los tiempos de entrega. En el Gráfico 1, se puede observar que Argentina presenta costos de exportación mayores que el promedio mundial (1770 USD, 2014), mientras que Chile menores (910 USD, 2014).

(1) Las bases de datos que se utilizarán son: bases de datos de Trade-Map y Aduana de Argentina y Chile, montos exportados en millones de dólares FOB; *www.wcrl.ars.usda,gov/cec/java/lat-long.htm*, distancia en kilómetros entre capitales de los países en estudio; Banco Mundial, datos estadísticos en línea (*http://datos.bancomundial.org/*).

Las variables ficticias incluidas en la *Ecuación 1* permiten medir ciertos aspectos cualitativos, como son: a) Los acuerdos comerciales firmados entre Argentina y Chile con sus principales socios comerciales. El estudio de Valenzuela-Klagges y Espinoza-Brito (2015) concluye que el comercio intrabloque (MERCOSUR, NAFTA, CAN) ha tenido un efecto positivo y consolidado en América sobre el flujo del comercio bilateral entre los países que se integran; b) Frontera en común que busca diferenciar los efectos fronterizos del comercio con países vecinos del resto del comercio bilateral argentino y chileno, siendo además, una variable que medirá el uso mayoritario del transporte terrestre con estos países; c) Idioma en común es una variable que frecuentemente se incluye en la estimación del modelo gravitacional, principalmente porque se ha observado que socios comerciales con el mismo idioma tienden a tener mayor flujo comercial entre ellos. Por ejemplo, el estudio de Benavides, Olascoaga y Cuello (2015) concluye que el idioma en común entre socios afecta positivamente en las exportaciones del sector textil-confección de Colombia; d) Se incluye, además, la variable ficticia de tiempo que permite capturar el efecto temporal del año 2009 y las variables que representan la salida a los diferentes océanos para medir el efecto geográfico.

Gráfico 1. Costos de Exportación de Contenedor en USD: 2005-2014.



Fuente: Elaboración propia, según datos del Banco Mundial.

Para este estudio, se incluirán 37 países importadores, según zona geográfica, considerando los siguientes socios comerciales: 14 países pertenecientes a Europa; 1 a África; 4 a Asía; 2 a Medio Oriente; 3 a Norteamérica; 3 a América Central y el Caribe; 8 a Sudamérica y 2 a Oceanía. Dichos países constituyen el 96% promedio de los destinos de exportación de estos bienes creativos de Argentina y Chile durante el período de estudio. La exclusión de algunos países se debe a la escasez o ausencia de intercambio durante uno o más años consecutivos en el período de estudio. El total de observaciones por año son 72, constituyéndose un total de 1008 observaciones.

En relación a las observaciones cero, Santo-Silva y Tenreyro (2006) exponen un problema relacionado con la analogía entre la gravedad newtoniana y el comercio. Al respecto, señalan que la fuerza gravitacional puede ser muy pequeña, pero nunca es cero, mientras que, el comercio entre varios pares de países puede alcanzar valores cero, siendo un problema adicional el uso de logaritmos en la forma lineal de la ecuación gravitacional. Frente a esto y los posibles métodos de enfrentamiento a este problema, los autores plantean que sumarle 1 a la variable dependiente o usar estimador tobit puede generar estimadores inconsistentes. En este estudio, se siguió una de las recomendaciones expuestas por Santo-Silva y Tenreyro (2006), optando por dejar una muestra de 37 países en que el flujo de comercio bilateral con Chile y Argentina no presentaba observaciones cero para el período en estudio, alcanzándose el 96% de las exportaciones totales de obras de arte, colección, antigüedad, editorial e industria gráfica. Para determinar los montos totales de exportación, se utilizó los datos suministrados por la base de información Trade-Map y se complementó con datos e información entregada por las Aduanas de Argentina y Chile que especificaron, en algunos casos, los montos registrados menores a mil dólares.

Además, en esta investigación se cumple con la sugerencia de Roodman (2009), al usar una base de dato con un número de individuos mayores que 100 y por un período de tiempo (t) no mayor a 15 años.

La *Ecuación 1* se estimará mediante datos de panel estático con efectos aleatorios, siendo el intercepto de la regresión aleatorio (β_0) y que se considera como $\beta_0 = \beta + u_i$. Es decir, en vez de considerar a β como un intercepto fijo, se proyecta como una variable aleatoria con un valor medio β y una desviación aleatoria u_i de este valor medio.

La *Ecuación 1* es adaptada para la estimación con datos de panel estáticos con efectos fijos (*Ecuación 2*). En la *Ecuación 2* se excluyen todas las variables fijas que se mantienen a través del período en estudio, lo que permite observar intersecciones para todos los pares de socios comerciales, descartando una constante en común.

$$\ln(E_{ijt}) = b_j + m_1 h\ y_i + m_2 h\ y_j + x_1 h\ IFNE_i + x_2 h\ IFDLE_i + h_1 h\ Cose_i + u_{ijt}$$

(Ecuación 2)

Donde β_{ij} es un número fijo para cada par de socios comerciales.

Adicionalmente a las estimaciones estáticas en datos de panel y dado lo expuesto por Baldwin y Venables (1995) y BID-Intal (2000), es conveniente adaptar y estimar la *Ecuación 1* mediante datos de panel dinámicos. Baldwin y Venables (1995) plantean que los beneficios estáticos de procesos de integración y apertura comercial pueden ser cuantitativamente menores que los devengados de beneficios dinámicos, como los derivados de efectos escala y de producción. BID-Intal (2000) exponen que el comercio permite un avance en la especialización según las ventajas comparativas y aprovechamiento de economías de escala, disminuyendo gastos en actividades improductivas y mejorando continuamente la eficiencia de las empresas exportadoras hacia "*best practices*", evidenciando positivamente estos efectos en el comportamiento exportador de Colombia.

Por otra parte, Arellano y Bover (1990) exponen que uno de los aspectos en que el uso de panel resulta positivo y decisivo respecto a una muestra de corte transversal, es la posibilidad de modelizar respuestas dinámicas con microdatos. "…Ecuaciones con retardos de variables endógenas y exógenas pueden ser especificadas permitiendo la posibilidad de explicar procesos de ajustes" (pp. 5).

Dada esta posible endogeneidad del fenómeno exportador y su dinamismo, se recomienda incluir la estimación de datos de panel con

efectos dinámicos y verificar el efecto y su significatividad del retardo de la variable dependiente. La ecuación 1 es adaptada para la estimación con datos de panel dinámicos (*Ecuación 3*).

$$\ln(E_{ijt}) = \beta_0 + \beta_1 \ln(E_{ijt-1}) + \mu_1 \ln y_{it} + \mu_2 \ln y_{jt} + \xi_1 \ln IFNE_{it} + \xi_2 \ln IFDLE_{it} + \alpha_1 \ln D_{ij} + \eta_1 \ln Cose_{it} + \sum_k \delta_k P_{ij} + u_{ij}$$

(Ecuación 3)

Siendo, E_{ijt-1} el primer retardo de la variable dependiente. La *Ecuación 3* se estimará mediante el estimador de Arellano y Bond (1991) y **Blunder** y Bond (1998) conocido como *System GMM* ya que utiliza las diferencias de los retardos, conformando un sistema de ecuaciones.

4. Resultados

En la Tabla 5 se puede observar los resultados con datos de panel estáticos con efectos aleatorios y fijos *(Ecuación 1 y 2*, respectivamente) y dinámico (*Ecuación 3*) para toda la muestra, corregida la heterocedasticidad. Con el propósito de comparar las diferencias entre el coeficiente de efectos fijos y aleatorio, se aplica la prueba de Hausman, obteniendo Prob> Chi2=-5.4. Al ser negativo el test y siguiendo las instrucciones de Motero (2005), se lleva este valor negativo a valor cero de la prueba de Hausman, por lo que se valida el efecto fijo. Por consiguiente, se ratifica que el método de efectos fijos es más conveniente que el efecto aleatorio para explicar el comportamiento exportador chileno y argentino en objetos de arte, colección, antigüedades, editorial e industria gráfica hacia los países en estudio. Sin embargo, el coeficiente de determinación alcanzado en la estimación mediante efectos aleatorios (0.11) es muy bajo. No se observa autocorrelación de variables, dado los resultados de autocorrelación de Wooldridge. Debido al bajo coeficiente de determinación, y que el test de Durbin Wu Hausman, detecta endogeneidad, se recomienda utilizar datos de panel dinámico (*Ecuación 3*).

Tabla 5. Resultados Estimación Ecuación 1, 2 y 3, Muestra Completa.

Variables	*Efectos Fijos Ecuación 1*	*Efectos Aleatorios Ecuación 2*	*Efectos Dinámicos Arellano-Blunder Ecuación 3*
Ln (Exp -1)			*0.26***(0.04)*
Ln (PNB Exportador)	*2.2***(0.49)*	*2.59***(0.45)*	
Ln (PNB Importador)	*1.59 **(0.70)*	*1.4***(0.3)*	*4.5***(1.1)*
Ln (Distancia Geográfica)		*-1.02***(0.33)*	*-21.3***(5.2)*
Ln (Costo de Exportación)	*-2.7***(0.62)*	*-1.8***(0.6)*	*-2.4***(0.8)*
Ln (IFNE)			*-8.9 * (4.6)*
Ln (IFDLE)		*2.6***(0.8)*	
Chile			*-22.8***(6.8)*
Mercosur-Chile			*-20.5***(6.9)*
NAFTA-Chile		*2.4***(1.1)*	*-2.6 ***(1.2)*
China-Chile			*-2.7 ** (1.4)*
UE-Chile			*52.1***(12.2)*
ID			*-20.9***(7.4)*
FC			*-12.2***(6.1)*
SP			*8.7***(6.9)*
Crisis			*-0.2 *(0.8)*
Constante	*30.6 (29.2)*	*-21.2***(4.8)*	*268.2 ***(64.9)*
R^2	*0.11*	*0.38*	
Número Observaciones	*1008*	*1008*	*930*

Nota 1: Valores con heterocedasticidad corregida.
Nota 2: Nivel de significancia: *** = 0% error; ** = 0% < P ≤ 2.5%; * = 2.5% < P ≤ 5%
Nota 3: Valores entre paréntesis es estándar de error.

En la Tabla 5, se observa los resultados de la estimación de la *Ecuación 3* mediante datos de panel con efectos dinámicos con un retardo de la variable dependiente, utilizando la técnica de Arellano-Blundell. De acuerdo a los coeficientes estimados mediante datos de panel con efectos dinámicos (*Ecuación 3*, Tabla 5), es posible concluir que la endogeniedad disminuye y concuerda con lo teóricamente esperado. Los resultados indican que el primer retardo de la variable dependiente tiene signo positivo y significativo al igual que los coeficientes del producto nacional bruto real del importador y la salida al océano Pacífico de Chile. Los coeficientes de la distancia geográfica,

costos de exportación por contenedor e indicador de facilitación para hacer negocios son negativos y significativos. El acuerdo UE-Chile afecta positivamente en el comercio bilateral chileno, mientras que el acuerdo Mercosur-Chile, China-Chile, Nafta-Chile presenta efectos negativos. El bloque regional MERCOSUR no presenta efectos significativos en el comercio de este tipo de bienes para Argentina al igual que la salida al océano Atlántico. Las variables ficticias Chile, idioma en común, frontera en común y crisis *subprime* presentan coeficientes negativos.

En la tabla 6, se puede observar los resultados por separado de Argentina y Chile al estimar la *Ecuación 3* mediante datos de panel dinámico. Se observa entre países un efecto semejante a lo observado en la tabla 5, destacándose que en Argentina el efecto positivo del primer retardo de la variable dependiente el efecto es mayor que lo observado en Chile, mientras que los efectos negativos de distancia y costos de exportación por contenedor son menores en Chile; los coeficientes del indicador de facilitación para hacer negocios, idioma en común y frontera en común son negativos y significativos para los dos países, sin embargo, en el caso de Chile este efecto negativo es mayor.

Tabla 6. Resultados Estimación Ecuación 3 para Argentina y Chile.

Variables	*ARGENTINA Efectos Dinámicos Ecuación 3*	*CHILE Efectos Dinámicos Ecuación 3*
Ln (Exp -1)	*0.28***(0.06)*	*0.19***(0.03)*
Ln (PNB Importador)	*4.4***(1.0)*	*4.7***(1.2)*
Ln (Distancia Geográfica)	*-22.3***(5.4)*	*-15.3***(4.8)*
Ln (Costo de Exportación)	*-2.8***(0.9)*	*-2.2***(0.8)*
Ln (IFNE)	*-5.5 * (2.6)*	*-7.9 * (4.2)*
Mercosur-Chile		*-20.5***(6.9)*
NAFTA-Chile		*-2.6 ***(1.2)*
China-Chile		*-2.7 ** (1.4)*
UE-Chile		*52.1***(12.2)*
ID	*-17.9** (5.4)*	*-21.9* (7.8)*
FC	*-8.2* (6.1)*	*-14.2* (6.1)*
SP		*8.7** (6.9)*
Crisis	*-0.2 *(0.8)*	*-0.2 *(0.8)*
Constante	*180.2 ** (32.9)*	*190.2 ***(54.9)*
Numero Observaciones	*465*	*465*

Nota 1: Valores con heterocedasticidad corregida.

Nota 2: Nivel de significancia: *** = 0% error; ** = 0% < P ≤ 2.5%; * = 2.5% < P ≤ 5%

Nota 3: Valores entre paréntesis es estándar de error.

5. Conclusiones y recomendaciones

Debido al alza sostenible de la demanda mundial por bienes creativos, este mercado es una oportunidad para diversificar las exportaciones de Argentina y Chile y una estrategia económica para fomentar la creación de empleo, promover la cultura y economías creativas y el desarrollo de habilidades artísticas en la población, garantizando un crecimiento económico con inclusión. A pesar de su importancia, no se observa en Argentina y Chile una política cultural específica de apoyo directo a la exportación de bienes creativos y que potencie el desarrollo emprendedor en estos países, con facilitación comercial, asesoría de procesos exportables, información de ferias, convenios, subastas e instituciones internacionales especialistas en compra de estos bienes creativos.

Se observa que las exportaciones de Chile y Argentina en objetos de arte, colección, antigüedad, editorial e industria gráfica presentan una tendencia a disminuir su nivel de exportación y diversificación de destino, con un máximo de destino correspondiente a 37 países a través del tiempo, en contraposición con el aumento progresivo del mercado mundial en estos bienes creativos.

Los principales resultados indican que el comportamiento exportador de objetos de arte, colección, antigüedad, editorial e industria gráfica de estos países está explicado por un modelo dinámico, confirmando que existe un efecto positivo por el uso de mejores prácticas en el proceso de exportación de estos bienes, aprendidas en procesos anteriores. Probablemente, al romper el obstáculo fronterizo y formalizar contactos y redes internacionales, el artista o emprendedor artístico nacional logra desarrollar economías de escala dentro de un mercado de competencia imperfecta y ampliar su mercado externo. Además, se confirma que a mayor crecimiento económico del país importador y mejor facilidad reglamentaria y legal para hacer negocios en Chile y Argentina mayor será la exportación de estos bienes. Mientras que, a mayor costo de exportación por contenedor y distancia geográfica entre importador y exportador menor será el monto total exportado, afectando principalmente a Argentina, debido a que presenta elevados costos de exportación por contenedor. En este sentido, se sugiere para ambos países promover una legislación que facilite la creación de negocios, su comercialización y exportación, como también, mejorar la infraestructura portuaria, viabilidad y conexión de transporte a puertos y aeropuertos y servicios logísticos con el propósito de disminuir los costos de exportación por contenedor. Esto es congruente con el estudio de Rodríguez (2013) que, refriéndose al libro chileno como producto de exportación, enfatiza que es fundamental enfrentar la logística y todos sus desafíos pendientes y mejorar la colaboración público-privada para facilitar la exportación del libro chileno.

En este estudio se concluye que los destinos de exportación de estos bienes no se centran en países fronterizos ni en países con idioma español y se evidencia una mayor factibilidad para exportar estos bienes a países no hispanoamericanos. Esto sugiere al gestor artístico la importancia de dominar un segundo idioma, como es el inglés que ha sido declarado idioma universal y es el idioma oficial para todas las plataformas digitales.

También, se sugiere prestar asesoría a pequeños emprendedores artísticos independientes o agrupaciones en relación a los procesos de exportación, derechos y licencias para facilitar procesos de exportación, puesto que aunque exista una legislación adecuada para la facilitación comercial, no siempre es de conocimiento y manejo práctico del artista, coleccionista, diseñador y escritor. Adicionalmente, se sugiere reforzar la conectividad a internet con capacitación para trabajar en

redes de plataforma que promuevan internacionalmente estos bienes creativos. Como lo afirma Delgado-Cantú (2016) el acceso a internet, el uso generalizado de aparatos móviles y otros medios de plataformas digitales han contribuido al crecimiento de las industrias creativas, mejorando la comunicación y acortando los tiempos y distancias entre importador y exportador.

Las exportaciones chilenas de estos bienes creativos se benefician, además, por la salida al Océano Pacífico y por el acuerdo con la Unión Europea, aunque Chile presenta una evolución más débil e inconstante en este mercado que Argentina. Por otra parte, los acuerdos de Chile con China y países miembros del NAFTA afectan negativamente en el proceso exportador chileno de estos bienes creativos.

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