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Innovación de Base Científica-Tecnológica desde las Universidades de Iberoamérica

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En los últimos años, la acumulación del conocimiento científico-tecnológico ha experimentado un crecimiento dramático, lo que ha generado continuas y relevantes innovaciones. Esto se puede apreciar en el número de patentes que anualmente conceden los países a inventores de todo el mundo. Su incremento ha sido especialmente relevante en las pasadas 3 décadas donde, por ejemplo, Estados Unidos pasó de conceder 60 mil patentes en 1985 a 325 mil el año 2015.

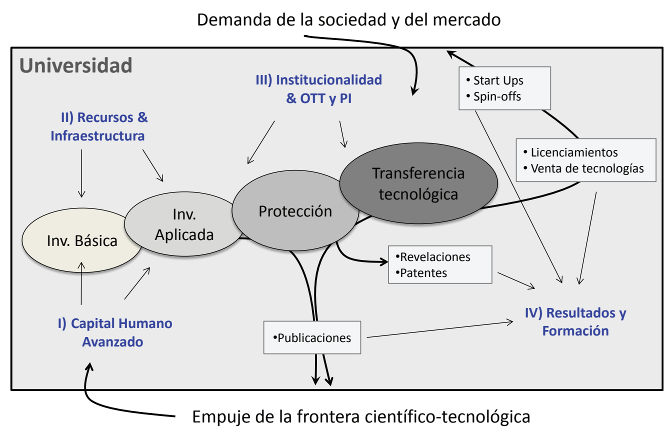
En los países industrializados el conocimiento es el factor más relevante en la producción de nuevos bienes, servicios y procesos; sobrepasando al capital y al trabajo (Arrow, 1962; Lucas, 1988). Lo anterior, ha transformado a las actividades de creación y transferencia del conocimiento en factores esenciales para el desarrollo económico y social de las naciones (OECD, 2010).

En este contexto, las universidades han adquirido un rol fundamental por tratarse de instituciones creadoras de conocimiento. Ellas tienen el potencial de impactar en la sociedad, las industrias y los mercados; transfiriendo sus avances científico-tecnológicos, generando nuevo valor e incrementando la productividad basada en innovación (Jiménez, 2016). Sin embargo, los procesos de creación y transferencia de conocimientos son complejos, no lineales y resultan de una diversidad de interacciones entre los diferentes actores involucrados (Boni & Emerson, 2005), todo lo cual es difícil de medir.

Disponer de información fidedigna sobre las actividades de investigación, desarrollo, innovación y emprendimiento (I+D+i+e) se ha vuelto indispensable para diseñar políticas universitarias y públicas efectivas. En este contexto, es que en el año 2012 junto a un equipo de representantes de 17 destacadas universidades iberoamericanas (2 brasileñas, 1 colombiana, 1 chilena, 9 españolas, 2 mexicanas, 2 portuguesas), comenzamos un estudio en esta materia. Su objetivo central fue caracterizar el estado y evolución de los principales procesos, recursos y resultados de los sistemas de I+D+i+e en 17 instituciones de educación superior.

Para ello, elaboramos un modelo de análisis empírico de los sistemas de I+D+i+e a nivel de universidades con cuatro actividades centrales: 1) investigación básica; 2) investigación aplicada; 3) protección del conocimiento; y 4) transferencia tecnológica (ver Figura 1). Asumimos que dichas actividades —lejos de seguir un proceso secuencial— actúan más bien como un sistema no lineal en donde existe una permanente interacción entre la investigación básica y aplicada. Por otra parte, dependiendo de la naturaleza y tipo de conocimiento generado, varía la forma y oportunidad de su protección y transferencia a la sociedad.

Figura 1. Modelo del sistema de I+D+i+e universitario utilizado en el análisis empírico



Para que el sistema opere se requiere de un conjunto de insumos, servicios e infraestructura que identificamos a través de cuatro ejes: i) Capital humano avanzado; ii) Recursos e infraestructura; iii) Institucionalidad y servicios; y iv) Formación de capacidades y resultados en I+D+i+e.

En nuestro modelo actúan a su vez dos fuerzas externas relevantes. Por un lado, el "*empuje de la frontera científico-tecnológica*" para la creación de nuevos conocimientos y, a través de ellos, innovaciones que se transfieren a la sociedad (Dogson, 2000). Por otro lado, la "*demanda de la sociedad y del mercado*" de innovaciones, mediante nuevas tecnologías, productos y soluciones (Salter & Martin, 2001). Luego, identificamos 15 variables y 42 indicadores, con los cuales elaboramos una encuesta estructurada que nos permitió caracterizar y medir el sistema de I+D+i+e en las 17 instituciones iberoamericanas de educación superior entre los años 2007 y 2010.

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Entre nuestras conclusiones podemos afirmar que:

Hay avances significativos y sostenidos en el desempeño de los sistemas de I+D+i+e del conjunto de las instituciones estudiadas

Se observaron mejoras significativas y generalizadas del conjunto de instituciones en las diferentes dimensiones de sus sistemas de creación y transferencia de conocimientos y tecnologías durante el período 2007-2010. Hay un aumento promedio del 20% en publicaciones y citas WOS, un 60% en revelaciones de invención y un 28% en solicitudes de patentes. Hay un incremento de un 114% en los contratos de licenciamiento por institución y un 25% en la creación de empresas *spin-off*.

Todas las universidades estudiadas poseen Oficinas de Transferencia y Licenciamiento (OTL) e incubadoras de empresas. La mayoría dispone de un centro de emprendimiento activo. A su vez, todas tienen o están terminando de institucionalizar procesos orientados a regular la propiedad del conocimiento generado, el licenciamiento de tecnologías y la creación de empresas *spin-off*.

Lo anterior da cuenta de los avances relevantes y sistemáticos en el conjunto de universidades analizadas y de los esfuerzos que se están desplegando para fomentar la innovación y el emprendimiento de base científico-tecnológico.

En este contexto, las universidades iberoamericanas deben continuar con sus esfuerzos sistemáticos y de largo plazo si quieren asemejarse a las universidades líderes (tanto anglosajonas, europeas como asiáticas). Además, deben apurar el paso en I+D+i+e y hacer partícipe a la comunidad universitaria (y a la sociedad) de la importancia que tienen este tipo de actividades para el desarrollo de los países. Es clave formar y reclutar el mejor capital humano y dotarse de la infraestructura necesaria para fortalecer la I+D+i+e.

Se observa una gran heterogeneidad en sus políticas y mecanismos de apoyo para la creación y transferencia de conocimiento

Las 17 universidades estudiadas presentan altos y persistentes niveles de heterogeneidad en sus sistemas de I+D+i+e, los cuales se manifiestan incluso en instituciones de un mismo país con contextos nacionales comunes (por ejemplo, las españolas, mexicanas y brasileñas). Las universidades tienen una alta diversidad de estrategias y políticas de desarrollo de largo plazo, que derivan en distintos comportamientos y desempeños organizacionales.

La alta heterogeneidad se manifiesta en diferencias significativas entre instituciones en los diversos indicadores utilizados en el estudio. Es el caso del gasto en I+D, el número de alumnos de doctorado, el número de publicaciones indexadas o el número de patentes o contratos de licenciamiento, entre otros. A modo de ejemplo, las universidades estudiadas tuvieron un gasto total directo promedio en I+D de €74 millones el año 2010, con un presupuesto máximo (€211 millones) que llega a superar en 30 veces al mínimo (€7 millones). Además, en promedio, el 21% de este gasto es financiado con recursos privados externos, con una variación que va desde un máximo del 54% hasta un mínimo del 7%.

Una diferencia relevante se puede apreciar en instituciones como el Instituto Tecnológico de Monterrey (ITESM), fuertemente orientado a la formación para el emprendimiento y a la creación de empresas *spin-off*. El año 2010 el ITESM creó 25 empresas, cifra cuatro veces superior al promedio. Por su parte, la Universidad de Sao Pablo tiene una marcada orientación hacia la investigación básica y a la formación de alumnos de doctorado, que suman más de 13.000 (cuatro veces la media de las universidades analizadas). El alto dinamismo de la Universidad Politécnica de Valencia en materia de patentamiento internacional y transferencia tecnológica es otra singularidad destacable. También el fuerte énfasis de la Universidad de Barcelona por la formación de magíster en innovación y emprendimiento, contando con ocho especialidades diferentes.

La alta y persistente heterogeneidad a nivel de universidades está documentada por la bibliografía y es objeto de interesantes estudios. Su dinámica no se ajusta con lo que ocurre en muchos sectores en donde se observa una tendencia a la convergencia. Esto significa que las diferentes organizaciones de una industria tienden a aumentar su similitud y reducir su heterogeneidad a lo largo del tiempo —fenómeno que en la educación superior no ocurre o sucede en menor grado y más lentamente—. Esta constatación es relevante, ya que nos indica que las instituciones de educación superior tienden a ser persistentemente distintas en sus estrategias de largo plazo.

Como recomendación a lo anterior, debemos distinguir dos niveles de políticas o acciones para tener en cuenta: medidas de carácter general o común a todas las instituciones estudiadas y medidas de carácter local o particular a instituciones específicas. Así, las de carácter general hacen referencia a fomentar buenas prácticas que se pueden incorporar en todas las instituciones con la idea de mejorar los procesos de creación y transferencia de conocimiento. En este sentido, algunos ejemplos de medidas ya implantadas han sido la institucionalización de los reglamentos de propiedad intelectual y transferencia tecnológica —que progresivamente se han ido extendiendo entre las instituciones—. Así como la creación de oficinas de transferencia y licenciamiento (OTL) y la creación de centros de emprendimiento, entre otras.

Por otra parte, las medidas de carácter local, responderán a la orientación estratégica específica de cada institución. Lo anterior implica también, la aplicación de estrategias diferenciadas. En esta línea, los responsables de cada universidad —una vez realizado el diagnóstico de su situación en I+D+i+e y su benchmarking con respecto a otras instituciones similares y/o de referencia— deberían establecer un plan estratégico con los objetivos que desean alcanzar señalando los aspectos a fortalecer y corregir.

Las universidades iberoamericanas se orientan principalmente a la investigación básica y en menor medida a la aplicada

El conjunto de 17 universidades estudiadas posee un marcado énfasis hacia la investigación básica o fundamental y una menor orientación hacia la investigación aplicada. Por ejemplo, tienen un promedio de 46 solicitudes de patentes por cada 1.000 publicaciones científicas indexadas en el período 2007-2010. Sin embargo, esta cifra varía enormemente desde un máximo de 321 solicitudes de patentes por cada 1.000 publicaciones científicas del ITESM y un mínimo de 9 en el caso de las Universidades de Valencia y Autónoma de Madrid.

Como recomendación, es conveniente que las universidades mejoren sus indicadores en investigación aplicada de modo que cubran todo el espectro que va desde la investigación básica pasando por la investigación aplicada y el desarrollo tecnológico. Cuando las universidades tienen bajos niveles de investigación aplicada significa que no están aprovechando las oportunidades que derivan de la investigación básica que desarrollan. Tampoco aprovechan las oportunidades de atraer nuevos recursos —tanto de fuentes públicas como privadas— orientados al financiamiento de la trasferencia tecnológica (TT) y generar así, nuevo valor para la sociedad.

Básicamente se proponen dos ámbitos de acción: 1) Generar y desarrollar ideas potencialmente aplicables; y 2) transferir dichas ideas de modo que logren tener un positivo impacto en la sociedad. Las actuaciones en el primer ámbito buscan incentivar a los investigadores para producir conocimiento y tecnología potencialmente transferibles a la sociedad. Dichas acciones tienen un carácter general y habitualmente conllevan un cambio en la mentalidad de la comunidad académica. Algunas medidas concretas serían la consideración de los esfuerzos y resultados en materia de creación de propiedad intelectual del investigador en los criterios que determinan la promoción en su carrera académica —tal y como ya se viene haciendo en algunos países—. Otra medida posible es el establecimiento de sistemas de incentivos dentro de las universidades que permitan a los académicos percibir un porcentaje de los royalties que se derivan de las patentes o de los contratos de licenciamiento generados.

Por su parte, en lo que se refiere a las actuaciones en el ámbito de la transferencia de ideas, si bien los investigadores desarrollan la tecnología, el personal de la OTL suele tener un mejor conocimiento de su potencial de comercialización. En este sentido, la experiencia de la OTL es fundamental para asesorar a los investigadores en los procesos de protección y transferencia de su invención.

Por otra parte, queremos puntualizar que cuando se recomienda la conveniencia de incrementar el peso de la investigación aplicada no se hace a costa de reducir o restar recursos a la investigación básica. Por el contrario, significa ampliar el espectro de la investigación desde el perfil fundamental hasta el desarrollo de aplicaciones reales. Así, todo el sistema crece y se producen flujos de conocimiento en ambos sentidos.

Las acciones de gestión de la propiedad intelectual (PI) están más avanzadas que las de trasferencia tecnológica

Dentro del avance sostenido y relevante de las universidades en materia de I+D+i+e, se aprecia que las iniciativas relacionadas con la gestión de la propiedad del conocimiento generado están más avanzadas y desplegadas que las de transferencia tecnológica (que son más recientes y seguramente por ello están menos sistematizadas y son menos intensas).

Así, en el año 2010, el conjunto de 17 instituciones estudiadas solicitó un promedio de 45 patentes de invención (entre nacionales, en el extranjero y vía PCT) y les fueron concedidas un promedio de 22. A su vez, la media de patentes concedidas en el período 1990-2010 fue de 114 por institución. Las anteriores cifras contrastan con resultados significativamente menores en materia de transferencia de estos conocimientos. En efecto, en el año 2010 las universidades tuvieron un promedio de solo 8 contratos de licenciamiento de tecnologías y los ingresos medios por licenciamiento se situaron en torno a €153.000 por institución anualmente, es decir muy bajos y esporádicos en el contexto internacional. Con respecto a los ingresos por participación en empresas de tipo *spin-off*, la situación es aún más incipiente. De hecho, son muy pocas las universidades que reportaron haber obtenido ingresos por participar en este tipo de empresas. Las cifras son también muy pequeñas en materia de ingresos obtenidos por venta de tecnologías.

Como recomendación, se debe avanzar hacia etapas más evolucionadas y sistemáticas de transferencia de los conocimientos generados. Esto pasa por promover relaciones más estrechas con el sector productivo que, en definitiva, es el demandante último de las invenciones desarrolladas en las universidades. Para incrementar dicha colaboración se podrían crear mayores incentivos para la incorporación temporal de doctores a las empresas que tengan capacidades de absorción de nuevo conocimiento. Por su parte, los investigadores debieran de ampliar sus líneas de investigación a las necesidades de nuevo conocimiento y soluciones que la sociedad demanda, así como la celebración de encuentros y jornadas específicas entre investigadores y empresas.

En este estrechamiento de relaciones entre universidad, sector productivo y sociedad en su conjunto, es recomendable que las universidades se abran a incorporar con mayor contundencia un enfoque en la demanda de I+D (market pull). Sin duda resulta más fácil transferir una nueva tecnología diseñada para solucionar un problema existente, que crear un nuevo conocimiento tecnológico para después buscar potenciales interesados en adquirirlo (technology push). Esta medida facilitaría la transferencia tecnológica y mejoraría el impacto y los retornos económicos y no económicos de los esfuerzos de la I+D en las universidades iberoamericanas.

En resumen, el estudio plasmado en el libro "Análisis de las actividades de investigación + desarrollo + innovación + emprendimiento en universidades de Iberoamérica" (Cruz, 2014); nos ha permitido conocer los avances que las 17 universidades están teniendo en su capacidad para crear y transferir conocimiento pertinente hacia la sociedad. También nos semana, las principales debilidades y carencias que deben ser atendidas para profundizar y consolidar lo avanzado.

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Relation Analysis of Knowledge Management, Research, and Innovation in University Research Groups

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Abstract: Knowledge is a competitive advantage for companies. Knowledge Management helps to keep this competitiveness. Universities face with challenges in research, innovation and international competitiveness. The purpose of this paper includes studying Knowledge Management Models, and Innovation Models apply to Research Groups of Universities, through an analysis of relation in inter-organizational level. Some researchers and leaders of research groups participated in a survey about knowledge management and innovation. Here we show the relationship between knowledge management, innovation and research, including processes and operations performed by universities around these. We organize the results in three dimensions: Knowledge Management perception, the relationship between Knowledge Management and Innovation, and Strategic Knowledge organization. Too, we identify a generality of good practices, challenges, and limitations on Research Groups for Knowledge Management.

Keywords: knowledge management; innovation; research; research group; University.

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Introduction

Universities support innovation and science development with their scientific and technological capacities. Universities make efforts on research, knowledge production, and solutions for society problems in addition to teaching (Dalmarco, Dewes, Zawislak, & Padula, 2011; Gillian Ragsdell, Rathi, Given, & Forcier, 2016). Accordingly, universities play an essential role in the transformation process of society, because these are institutions that take place on a public stage for the advancement of knowledge which modifies and transforms the socio-economic dynamics (Ovallos-Gazabon, De-La-Hoz-Escorcia, & Maldonado-Perez, 2015). Education sector and universities face with knowledge production requirements, high-quality teaching, research, innovation, and extension. Researchers and professors work to fulfill these aims. Universities focus its efforts on projects development, research development, and products generation to fulfill high requirements on teaching, research, and innovation. However, in some cases, universities achieve success by sacrificing what they consider low-impact activities, such as Knowledge Management. According to Azagra-Caro (Azagra-Caro, 2004), universities have low participation in the socialization of knowledge management experiences. Knowledge Management accelerates the knowledge production and research results, especially for "higher-learning institutions in which the environment is essentially a collection of individual experts who constitute an accepted body of knowledge for many degree-granting areas" (Wei Chong, Yen Yuen, & Chew Gan, 2014).

In a broader context, Knowledge Management is "the organization and structuring of processes, infrastructures, and organizational mechanisms to create, store and reuse organizational knowledge" (Huang, Lee, & Wang, 1998). Knowledge Management provides answers to the needs of production, competitiveness, financing, and innovation to an organization in the business and industrial context (Honarpour, Jusoh, & Md Nor, 2012; Liao & Wu, 2010); also knowledge management enables the change of data and simple information into data with useful value to improve and increase competitive advantage (Lopes Ferreira & Pilatti, 2013). In this context, university role is to produce and disseminate knowledge. Also, studies show their necessity of Knowledge Management and its effect on innovation (Devi Ramachandran, Chong, & Wong, 2013). Campos et. al. (2003) concluded that knowledge and intellectual capital is a riches for universities and research groups. Knowledge management and innovation factors are "actually specific to the characteristics of a particular context and system". The same applies in the academic and research context (Matayong & Mahmood, 2013), hence in this study we show some dimensions and factors for Knowledge Management and Innovation in universities.

This paper includes the analysis of the relation between knowledge management, innovation, and research in the university context and inter-organizational level perspective, which are two important factors to investigate in Knowledge Management. In fact, there is little research on the subject (Patil & Kant, 2014). We identify good practices, challenges, and limitations of Knowledge Management in Research Groups. The paper is a contribution to fields of Knowledge Management and Education; here we enlarge the analysis into three variables: knowledge management, innovation, and research.

We organize the results in three dimensions: Knowledge Management perception, the relationship between Knowledge Management and Innovation, and Strategic Knowledge organization. The results show the relationship between knowledge management, innovation

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and research, including processes and operations performed around these by universities. The perception of researchers and the actions that they perform corroborates the relationship between knowledge management and innovation. However, it is necessary to have accurate and consistent strategies to ensure successful communication between all those involved in the research development. Results evidence the need to define and improve knowledge management policies, processes for storage and transfer of knowledge.

The structure of the remainder of the article is: the first section covers state-of-the-art models of Knowledge Management and Innovation. The second section describes the methodology. The third section presents the results and analysis. And finally, conclusions of the study are presented.

Definition of Knowledge Management and Innovation

Knowledge is a set of cognitive beliefs. These cognitive beliefs are experienced, confirmed and contextualized. Knowledge is often present in documents and databases but is also within routines, procedures, practices and standards of the organization. Likewise, knowledge is related to the processes of creation, transmission, use and information management (Ikujiro Nonaka, Kodama, Hirose, & Kohlbacher, 2014).

Knowledge-management discipline emerged around 1995 and since its inception has been many definitions found in the literature. L. Chen & Mohamed (2007) state that knowledge management is "a process that focuses on knowledge-related activities to facilitate knowledge creation, capture, transformation, and use, with the ultimate aim of leveraging organizations' intellectual capital to achieve organizational objectives". Knowledge Management is the process of identifying, acquiring, using, and creating data, information, and knowledge, with internal and external organizational-relevance, to improve both efficiency and effectiveness of the company, and ensure their permanence in the competitive scenario. These definitions indicate that knowledge management is mostly related to its application in the business sector organizations.

Also according to (Groff & Jones, 2012) "Knowledge management (KM) refers to a set of organizational activities to achieving organizational objectives by making the best use of knowledge". Knowledge Management is essential for organizational learning. The knowledge management processes (i.e., knowledge capture, sharing, and apply) can support organizational processes involving collective learning and individual learning in university research groups.

Moreover, considering the university as a company into the concept of Nonaka & Takeuchi (1995), knowledge management is the capacity to create new knowledge, disseminate it within the research groups and incorporate it in all research processes.

The innovation and technological change are associated, however, Schumpeter (1934) referred to the innovation of all kinds. Innovation "represents a new way of doing things resulting in a positive change". Innovation includes any transformation based on knowledge that creates or adds value in a market. The innovation processes revolutionize economic structure from within, renewed by the destruction of old, and continuous creation. This process called creative destruction "is the essential element of capitalism" (Joseph A. Schumpeter, 2013). According to OECD Frascati Manual (2002), innovation is the transformation of an idea into a marketable product or service, a manufacturing process or operational distribution, new or improved, or a new method of providing a social service.

Models of Knowledge Management and Innovation

There are multiple models of knowledge management in the state of the art (Coukos-Semmel, 2003). Each with common characteristics and particular emphasis.

The Wiig Model identifies conditions and organizational elements: businesses, customers, resources, and skills. It consists of four steps: Construction, storage, disposal and application. The Wiig model is composed of elements and activities and is applicable in business organizations where resources are significant, as people and capital.

Gopal and Gagnon Model is a transformation model of knowledge from tacit to explicit, organized into three areas: knowledge admin, information admin, and learning admin. But, it is limited to the transformation of knowledge from tacit to explicit.

The KPMG model is divided into four phases: a) purchase, b) indexing, filtering and bond, c) distribution, and d) application. The KPMG model aims at improving customer service in financial organizations. However, other contexts show that it can extend its application (Lindenhall, Väisänen, Soriano, & Miguel, 2014).

Another model, KMAT, has four factors: leadership, culture, technology, and measurement. KMAT has seven stages: capture, identify, create, share, apply, organize, and adapt. The KMAT model allows evaluation and diagnosis of knowledge management model. The KMAT model used for diagnostic and evaluation of knowledge management models.

The Meyer and Zack Knowledge Management Model bases on the physical products development cycles. This model divides into five stages: acquisition, refining, storage and retrieval, distribution, and presentation. Meyer and Zack define a model according to Knowledge Management elements. It recognizes as a generic model with the potential to be adapted to different types of organizations.

The Model of McElroy set up with knowledge production and knowledge integration processes, feedback loops to the organization's memory, claims or incidents, and environments business process. The McElroy Model makes a clear description of knowledge evaluation and support decision-making. It focuses on identifying knowledge with value to an organization and its members.

The 10-Steps Road Map Model organizes in four phases and ten steps. It aims to implement a knowledge management model in business organizations. It is a life cycle for the implementation of a knowledge management model in a business organization. It is an explicit model and therefore extensive.

Recently, Nonaka, Kodama, Hirose, & Kohlbacher (Ikujiro Nonaka et al., 2014) established a knowledge management model that integrates the exploration and exploitation of knowledge dynamically; this model is named dynamic fractal organization. They state that "there are no pure forms of exploration and exploitation, just as there are no pure forms of tacit or explicit knowledge and knowing". According to them, the dynamic fractal organization is a "new organizational model to foster innovation through sustained knowledge creation". Indeed, the dynamic fractal organization shows an apparent relationship between the innovation and knowledge management.

Also, in the field of innovation models, a set of recognized models is observed. Among these, some similarities with knowledge management models are appreciated.

The Linear Model of Innovation starts with basic research, continues with the applied research phase, technological development and finally, the marketing. However, this model can be considered rigid with an absence of feedback. On the other hand, the Demand-Pull Model is based on the Linear Model, sets market needs or customers as the first stage, and Inherits most of the limitations of the Linear Model of Innovation (Godin & Lane, 2013).

The Triple Helix model integrates university, industry, and government. This model is the key to improving innovation conditions in a knowledge-based society. It describes the interaction between the helix in society but not describes an innovation processes or phases (Leydesdorff & Etzkowitz, 1998).

The Marquis model establishes the idea as a fundamental point of innovation. The idea can come from any part of the organization, not only of demand or basic research (Myers & Marquis, 1969). However, the Marquis Model can be considered a rigid model, and lacks flexibility for real innovation processes.

The Kline Model: Chain Linked Model consists of three innovation areas: research, knowledge, and innovation as the central process allowing interaction among areas. It maintains linearity in innovation area and is very complete. However, it can take a long time to apply. The Chain Liked Model focuses on innovation description, without addressing inside knowledge about processes and research (Kline & Rosenberg, 1986).

This analysis of knowledge management models and innovation models supports the determination of variables, dimensions, and indicators of interest. Next, the methodology section describes them.

Method

This study is a survey with a predominantly quantitative approach. A population sample of researchers and leaders of research groups in a university on Colombian Caribbean Region participate in the study.

Table 1. Population and non-probability sampling for research.

Item	Quantity
Colombian research groups on Engineering and Technology	650
Engineering Research groups in Barranquilla, Colombia	24
Engineering Research groups included in study	5
Total researchers included in study	16

The target population corresponds to twenty-four engineering research groups in Colombian Caribbean Region. A non-probability sample was selected. A multistage sampling driven by roles, group member, researching expertise, among others.

The instrument consists of interest variables, dimensions, and indicators, which was peer reviewed. The dimensions and indicators base on literature review and analysis of the research problem.

Table 2. Variables, dimensions and indicators of survey design.

Variable	Dimension	Indicator	Total Items
Knowledge Management	Knowledge Management Perception	Understanding of knowledge management. Commitment to knowledge management. Perception of knowledge management work.	9
	Relationship between Knowledge Management - Innovation	Implementation of a knowledge management plan. Maturity and control of knowledge management plan.	7
	Strategic Knowledge Organization	Storing knowledge Knowledge socialization Use of Information and communications technologies (ICT) Strategic knowledge organization Information quality	19
Innovation	The relationship between Knowledge Management - Research - Innovation	Relations with the business environment. Innovative leadership Perception of knowledge management Innovation relationship	8

Results and discussions

The results are in Table 7. It uses the following Likert scale for the response options:

Table 4. Likert scale used in the survey.

5	4	3	2	1
Totally agree	Moderately agree	Neither agree nor disagree	Mildly disagree	Strongly disagree

The analysis of variables, dimensions, and indicators uses descriptive statistics. The interpretations of measures and variability are defined as follow:

Table 5. Scales for responses category.

Range	Interval	Responses category	Interpretation
5	4.21 < x ≤ 5	Very High	Respondents agree highly with the item statement
4	3.41 < x ≤ 4.2	High	Respondents agree with the item statement
3	2.61 < x ≤ 3.4	Middle	Respondents do not disagree or agree with the item statement
2	1.81 < x ≤ 2.6	Low	Respondents disagree with the item statement
1	1 < x ≤ 1.8	Very Low	Respondents disagree highly with the item statement

Table 6. Scales for dispersion category.

Range	Interval	Dispersion Category	Interpretation
5	1,60 < DE ≤ 2,00	Very High Dispersion	Respondents have very different opinions regarding the item statement
4	1,20 < DE ≤ 1,60	High Dispersion	Respondents have different opinions regarding the item statement
3	0,80 < DE ≤ 1,20	Mid Dispersion	Respondents have different but similar opinions on the item statement
2	0,40 < DE ≤ 0,80	Low Dispersion	Respondents have similar views on the item statement
1	0,00 < DE ≤ 0,40	Very Low Dispersion	Respondents have the same views on the item statement

Table 7. Survey results.

Variable	*Dimension*	*Indicator*	*Average*	*Category*	*Standard deviation*	*Category*
Knowledge Management	Knowledge management perception	Understanding of Knowledge Management	3,94	High	1,10	Mid dispersion
		Commitment to Knowledge Management	3,55	High	1,17	Mid dispersion
		Perception of Knowledge Management work	3,75	High	1,09	Mid dispersion
		Variable	3,75	High	1,13	Mid dispersion
Knowledge Management - Innovation	Relationship between Knowledge Management and Innovation	Implementation of a Knowledge Management plan	3,25	Middle	1,15	Mid dispersion
		Maturity and control of Knowledge Management plan	3,51	High	1,19	Mid dispersion
		Variable	3,36	Middle	1,17	Mid dispersion
Knowledge Management	Strategic knowledge organization	Storing knowledge	3,00	Middle	1,15	Mid dispersion
		Knowledge Socialization	3,47	High	1,23	High dispersion
		Use of Information and communications technologies (ICT)	3,04	Middle	1,27	High dispersion
		Strategic knowledge organization	3,76	High	1,11	Mid dispersion
		Information quality	3,82	High	1,01	Mid dispersion
		Variable	3,42	High	1,21	High dispersion

Dimension: Knowledge management.

59% of researchers have clarity about what is knowledge management and apply some action to them in their processes. Additionally, knowledge management processes are considered a fortress to innovation. Though, there is no consensus on an exact knowledge management concept. Similarly, multiple concepts of knowledge management are in the state of the art.

Unlike small and medium-sized enterprises, academic institutions and research groups have greater clarity about the concepts involved in knowledge management and a better perception of the benefits of knowledge management.

There is a research center running some knowledge management strategies. However, research groups lack a plan or program for the implementation of projects and budgets for knowledge management.

Researchers say that the commitment of the organization with knowledge management is high. However, an average of 3.55 shows that many aspects need to be improved. Obeidat, Masa'deh, & Abdallah (2014) establish that high levels of knowledge worker commitment are critical to knowledge creation.

Strategies and knowledge management work become more important in different contexts such as small and medium enterprises, education, and medical. In universities and research groups, activities of knowledge management work are typically carried out by researchers individually. Researchers do not perform collaborative work in knowledge management. The success of knowledge management strongly depends on the acceptance and commitment of people involved in this process. At this end, research team collaboration and participation is required to underpin an efficient knowledge transfer.

The relationship between Knowledge Management and Innovation.

Some economic domains such as the service sector, have studied the relationship between knowledge management with different business objectives, like competitiveness, innovation, among others (Farzin, Kahreh, Hesan, & Khalouei, 2014). From the perspective of multinational companies, innovation requires the acquisition of knowledge and highlight the participation of leaders in innovation. The results show a strong relationship between knowledge management and innovation, particularly in research groups and academia.

Researchers apply some knowledge management activities independently, to organize documents related to projects. However, there are no institutional knowledge management plan neither strategies to provide previous knowledge to new members. Define a knowledge management plan is critical for involving research and innovation into a dynamic convergence in university research groups. In fact, a growing demand for researchers with skills in knowledge management is expected.

Research groups have tacit strategies for control, monitoring, and availability of information. They lack knowledge management indicators because they have an early plan documented. The level of efficiency increase when a knowledge management plan exists. The relationship with innovation is the product of a knowledge management plan with maturity. Oliveira & Pedron (2014) define three strategic benefits of maturity models for knowledge management: absorptive capacity, innovation, and organizational performance.
Strategic knowledge organization.

The researchers make use of technological resources individually, as computer equipment and cloud computing to store organized documents. However, they lack information systems to storage their knowledge, and a budget for knowledge management (implementation of repositories, storage, etc.). Repositories is an essential tool for systematic storage of knowledge, especially to transform tacit knowledge.

Research Groups socialize knowledge and result internally among themselves. There are gaps of knowledge socialization among research groups: lack internal reporting, communication ways or strengthening of knowledge acquired, developed project information, and other research actions. Jabbary and Madhoshi (2014) state that "organizations with innovation-supporting cultures are more likely to implement Knowledge Management system, so that information sharing is facilitated through internal norms, which encourages individuals to share their knowledge". However, "many faculty members consider knowledge as proprietary and something that is not shared freely" (Wei Chong et al., 2014).

Researchers used available and easily accessible resources. Organization should ensure continuity of services such as electricity, the internet, information repositories and other technological tools for knowledge management.

The advances in Knowledge Management based on Information and communications technology (ICT) provide important means to increase productivity and achieve the effectiveness of the research team since it provides methods and tools for sharing, understand, reuse, and facilitate knowledge access by research team to create. ICT can be used to systematize and enhance knowledge management in organizations such as university research groups.

As for the organization, groups are strategically organized to generate knowledge and provide solutions. It should expand the organization to higher levels, involving the deanship, its researchers, and groups.
Researchers ensure the quality of the information used and generated by their research. There are no indicators or a system for monitoring and evaluating of information quality. There is no information platform to record companies with partnership opportunities.

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Conclusions

Without a Knowledge Management Model, incorporation of new teachers and researchers is more difficult because the lack of guidelines to provide knowledge of the institution and previous researchers to the new team. Further disadvantages are due to the absence of procedures regarding communication protocols, internal disclosure, knowledge strengthening, research projects developed, or products obtained. Consequently, locate historical information on projects is difficult, especially project leader left the institution. On these conditions, Knowledge production is slow down.

There are many Knowledge Management Models and Innovation Models, most of them aimed at business organizations. On theoretical grounds, this study is a contribution to the knowledge management literature concerning to Research Groups and Colombian Researchers. Research groups accept the importance of knowledge management and its relationship with innovation. However, the processes of Knowledge Management is nascent and weak in the research groups studied, its effect on innovation is small in practice.

In institutions with immature Knowledge Management processes a strong management commitment is required. This commitment is on a Budget Plan, Knowledge Management projects, and a system supporting them. We suggest the analysis of integrated models Knowledge Management and Innovation.

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Mechanisms and Functions within a National Innovation System

*Joseph Gogodze**

Abstract: In modern society, the competitive success of countries is increasingly dependent on the effective management of their national innovation system (NIS). Therefore, understanding the mechanisms behind NISs has become essential. After reviewing the current understanding of the NIS concept and the existing measurement models, this study proposes to consider the NIS as an intangible (underlying) asset of a specific kind and identifies its seven fundamental components, which are extracted with a new measurement model, the Global Innovation Index (GII). This study employs the Structural Equation Modeling (SEM) techniques to analyze the relationships among the components of an NIS. Our results support the existence of a causal link between the constituents of an NIS and provide several perspectives regarding NIS management opportunities. In particular, we find that the efficient management of institutional capital is a key determinant of innovation success for non-high-income countries.

Keywords: National Innovation System; Intangible Asset; Structure Equation Model; Global Innovation Index (GII).

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Introduction

In today's world, fostering innovation is essential to improving economic growth and competitiveness across countries (see e.g. Freeman and Soete, 1997; Gregersen and Johnson, 1997; Klenow and Rodriguez-Clare, 1997; Jaffe and Trajtenberg, 2005; Verspagen, 2005; Fagerberg and Srholec, 2008). However, the literature seems to focus very little on the determinants of innovation and how innovation systems function in different countries. This study attempts to clarify how various countries develop and manage their innovative capacities.

Innovation capability of nations and its measurement

The OECD/EUROSTAT (2005) provides the following definition of innovation: "An innovation is the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organizational method in business practices, workplace organization or external relations" (p. 46). However, innovation is only a part of a more general process through which new technologies enter the market. According to Schumpeter (1942), this process comprises three stages: invention, innovation, and adoption. Inventions are usually the product of R&D processes and represent only general ideas that may be commercialized in the innovation stage and then distributed on the market in the adoption stage.

The sequence "invention-innovation-adoption" can function efficiently only in the appropriate enabling environment, namely the country's innovation system. According to Gregersen and Johnson (1997), "The main idea of the concept of innovation systems is that the overall innovation performance of an economy depends not only on how specific organizations like firms and research institutes perform but also on how they interact with each other and with the government sector in knowledge production and distribution" (p. 5).

Innovation systems may operate at the regional (sub-national), national, or international level. A National Innovation System (NIS) determines the innovation capability of a country. In other words, an NIS can be seen as a socio-economic system where different actors, such as companies, research and academic organizations, public administrations, professional mediators, and other formal and informal institutions interact. NISs necessarily exploit all available resources in a country, such as human, financial, infrastructural, and institutional resources. Moreover, an NIS requires the generation and dissemination of knowledge, in addition to the utilization of innovation. Finally, the results obtained by NISs can help achieve economic development. An NIS can also be seen as an intangible asset characterized by a set of interacting, underlying (or latent) components able to contribute to a country's economic growth, value creation and wellbeing. At the same time, considering an NIS as an intangible asset requires an appropriate measurement model for it.

The measurement of an NIS (and the corresponding country's innovative capabilities) requires the construction of special instruments to address the complex and multidimensional nature of NISs and adequately reproduce them. Composite indicators are instruments of this type. Various organizations and researchers have developed a number of composite indicators for the measurement of a country's innovative capability, such as the ArCo Index (Archibugi and Coco, 2004), Innovation Capability Index (UNCTAD, 2005), TechAchv Index (UNIDO, 2005), Knowledge Economy Index (Chen and Dahlman, 2005), Global Innovation Scoreboard (European Commission, 2007), European Innovation Scoreboard (European Commission, 2008), TechRead Index (WEF, 2009), BCG/NAM Innovation Index (BCG/NAM, 2009), Economist Intelligence Unit Index (EIU, 2009) and Summary Innovation Index (INNO Metrics, 2011. See also Archibugi and Coco, 2005; Archibugi at al., 2009; Tijssen and Hollanders, 2006; Gogodze, 2013 for other composite indicators and their use).

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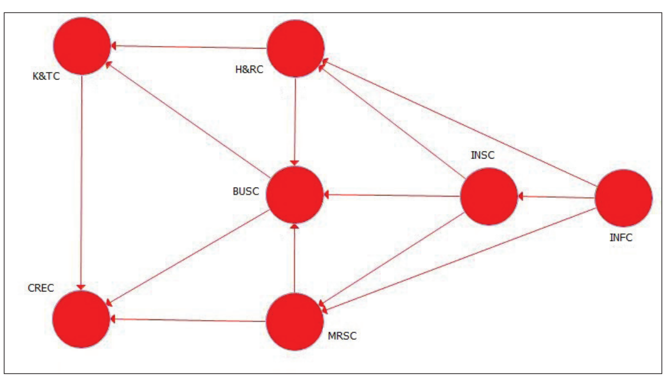
The Global Innovation Index (GII, see (INSEAD, 2011-15) for further details) is used in this study. The GII is built on a hierarchical basis and includes two sub-indices composed of seven underlying constructs, named pillars. Each pillar is divided into sub-pillars, and each sub-pillar is the product of individual indicators. This study used the GII data for the period 2011-2015, at the pillar level. Note that we decided to use the GII because it reflects the extensive experience of previous studies and the current understanding of NISs and the mechanisms behind their functioning. In addition, the GII uses well-defined measurement tools, both the primary data and final indicators of the GII are subject to multiple external and internal tests, and the GII is regularly published and contains detailed data on more than 100 countries.

Theoretical assumptions and aims of the study

On the basis of the above considerations, we introduce the following definition: an NIS is an intangible (underlying) asset (capital) of a country and represents the resources and values of the NIS actors, and the current and potential sources of a country's future economic growth, value creation and wellbeing. Due to the lack of a global theory of NISs, there is currently no clear and full understanding of a country's NIS constituents. However, based on the measurement method introduced by the GII, we can suppose that an NIS contains seven components: Infrastructural capital (INFC), Human and Research capital (H&RC), Institutional capital (INSC), Market Sophistication capital (MRSC), Business Sophistication capital (BUSC), Knowledge and Technological capital (K&TC), and Creative Ability capital (CREC). These constituents of NISs should also be considered as intangible assets. We propose to understand them as hidden values of the corresponding NIS actors, and current and potential sources for a country's future development, measured by the respective GII constructs (i.e., GII pillars). We are also assuming that the above-mentioned components of NISs form an interaction network, which defines the NIS functioning mechanism and its effectiveness. The aim of the present study is to investigate the channels through which different components of NISs interact with each other.

Figure 1. Conceptual model of NIS sub-systems interactions



This study develops and explores a conceptual framework for the relationships among NIS components (see Figure 1), and with the hypotheses described below. Specifically, we are assuming that Infrastructural capital (INFC) directly and positively affects Human and Research capital (H&RC), Market Sophistication capital (MRSC), and Institutional capital (INSC). Consequently, we introduce the following hypotheses:

H1a: INFC positively affects H&RC.

H1b: INFC positively affects MRSC.

H1c: INFC positively affects INSC.

On the other hand, Institutional capital (INSC) has a direct and positive impact on Human and Research capital (H&RC), Market Sophistication capital (MRSC), and Business Sophistication capital (BUSC). Accordingly, we introduce the following hypotheses:

H2a INSC positively affects H&RC.

H2b: INSC positively affects MRSC.

H2c: INSC positively affects BUSC.

Human and research capital (H&RC) has a direct and positive impact on Business Sophistication capital (BUSC) and Knowledge and Technological capital (K&TC). At the same time, Market Sophistication capital (MRSC) has a direct and positive impact on Business Sophistication capital (BUSC) and Creative Ability capital (CREC). Moreover, Business Sophistication capital (BUSC) directly and positively affects Knowledge and Technological capital (K&TC) and Creative Ability capital (CREC). Finally, Knowledge and Technological capital (K&TC) has a direct and positive impact on Creative Ability capital (CREC). Accordingly, we introduce the following hypotheses:

H3a: H&RC positively affects BUSC.

H3b: H&RC positively affects K&TC.

H4a: MRSC positively affects BUSC.

H4b: MRSC positively affects CREC.

H5a: BUSC positively affects CREC.

H5b: BUSC positively affects K&TC.

H6: K&TC positively affects CREC.

Both the proposed conceptual framework and research hypotheses have been empirically tested in this study, using GII data.

Method

Data

The GII is built on a hierarchical basis and includes two sub-indices: the Innovation Input Sub-Index, composed by five input indexes (pillars), and the Innovation Output Sub-Index, composed by two output indexes. On the next level, each pillar is divided into sub-pillars, and each sub-pillar is the product of the relevant individual indicators. In this study, we used the values of the GII pillars for the period 2011-2015. To give an intuition about the GII pillars' underlying concepts, in Table A1[1] we present the GII structure up to the sub-pillar level, with the corresponding names, as well as the notations used for them in this study. Details about the composition of individual indicators, data sources, processing techniques and country selection methods can be found in (INSEAD,2011-15) and are briefly discussed below.

The GII is the simple average of the above-mentioned input and output sub-indices. Sub-indices are also the simple average of the underlying pillar scores. We compute ach pillar score as the weighted average of its sub-pillar scores, and we derive each sub-pillar score as the weighted average of its individual indicators. The latter are obtained from various sources (their number and composition changes from year to year, and range between 79 and 84 in the GII, for the period 2011-2015). The GII is audited annually by the European Commission Joint Research Centre, which checks the conceptual and statistical consistency of its structure, and the impact of the crucial modeling assumptions on the GII scores and ranking.

In this study, we also use the World Bank classification of countries by income group, as it is presented in the above-mentioned GII publications. The distribution of the GII countries by income group is shown in Table A2.[2] Based on the World Bank classification, in this study we use the following categorization: "high-income" countries (corresponding to the World Bank classification for high-income countries) and "non-high-income" countries (which include low-income, lower middle-income, and upper middle-income countries, according to the World Bank classification). The sub-samples of GII countries belonging to the high-income and non-high-income countries are named H-sample and nH-sample, respectively.

Analytical procedures

We used the Structural Equation Modeling (SEM, henceforth) analysis to assess the direct and indirect relationships among the components of an NIS. The core purpose of the SEM is to explain the pattern of a series of interrelated relationships of dependence within a set of latent (or unobserved) variables, measured using manifest (or observed) variables. There are two different techniques to perform SEM analyses: variance and covariance-based SEM. In this study, the variance-based partial least squares (PLS) method was used to evaluate the proposed theoretical model. This decision takes the following circumstances into account: the PLS method can deal with complex models, with a high number of variables and relationships; it allows working with small sample sizes and makes less strict assumptions about the variable distributions, as PLS is primarily intended for causal-predictive analysis of models not backed by strong theory (see Esposito Vinzi at al., 2010).

The analysis of the structural model proposed in this study involves the identification of causal relationships among latent variables, as presented in Figure 1, and the assessment of the explained variance. We used the SmartPLS software (Ringle at al., 2015) to perform the SEM analysis. We carried out a bootstrap analysis in the SmartPLS framework to assess the significance of different statistical characteristics. No less than 5000 sampling generations were performed using a bootstrapping procedure to obtain the final statistical estimations. To investigate the homogeneity of the various groups of data, we used the SmartPLS procedure for Multi Group Analyses (MGA). We utilized the software G*Power 3.1.9 (Faul at al., 2007) to estimate the minimum sample size[3]. Our estimates showed that the minimum sample size to evaluate the model presented in Figure 1 is 77.

Results

Table 1 shows the descriptive statistics and correlations for the complete sample, as well as for the H-sample and nH-sample. As expected, Table 1 shows statistically significant differences between the H and nH sub-samples. For example,

the mean value of the I11 indicator is 80.23 and 52.95 in the H and nH sub-sample, respectively; the correlation between the I12 and I14 indicators is 0.09 in the nH sub-sample, while the same correlation is 0.57 in the H sub-sample. Thus, a separate consideration for the two sub-samples seems needed. We return to this point below.

(1) see Annex.
(2) see Annex.
(3) For the estimation, we used the following parameters: the test power P=0.8, the Cohen's indicator $f^2 = 0.15$, the significance level $\alpha=0.05$, and the maximum number of predictors N = 3 (see Figure 1), under the G*Power 3.1.9 options: "Linear multiple regression: Fixed model, R^2 deviation from zero," "F test," "A priori: Compute required sample size" (see Faul at al., 2007).

Table 1. Descriptive statistics and correlations

Variable	Mean	Std Dev.	Std Err.	Correlation Matrix						
				I11	I12	I13	I14	I15	I21	I22
Complete sample (N=692)										
I11	61.98	16.95	0.64	1.00						
I12	33.97	14.62	0.56	0.75***	1.00					
I13	33.79	13.20	0.50	0.59***	0.59***	1.00				
I14	46.04	12.87	0.49	0.72***	0.59***	0.55***	1.00			
I15	36.31	11.66	0.44	0.68***	0.73***	0.53***	0.57***	1.00		
I21	28.59	12.86	0.49	0.64***	0.73***	0.56***	0.63***	0.69***	1.00	
I22	33.85	12.67	0.48	0.73***	0.67***	0.58***	0.61***	0.63***	0.62***	1.00
H-sample (N=229)										
I11	80.23	9.85	0.65	1.00						
I12	49.33	10.60	0.70	0.63***	1.00					
I13	44.12	14.78	0.98	0.23***	0.24***	1.00				
I14	56.82	11.98	0.79	0.66***	0.57***	0.27***	1.00			
I15	46.78	10.73	0.71	0.65***	0.69***	0.28***	0.56***	1.00		
I21	40.17	12.63	0.83	0.55***	0.63***	0.30***	0.58***	0.67***	1.00	
I22	45.27	10.24	0.68	0.62***	0.47***	0.32***	0.50***	0.50***	0.48***	1.00
nH-sample (N=463)										
I11	52.95	11.62	0.54	1.00						
I12	26.37	9.46	0.44	0.33***	1.00					
I13	28.68	8.58	0.40	0.40***	0.40***	1.00				
I14	40.71	9.52	0.44	0.46***	0.09*	0.40***	1.00			
I15	31.14	8.08	0.38	0.26***	0.38***	0.28***	0.12**	1.00		
I21	22.87	8.32	0.39	0.18***	0.40***	0.36***	0.26***	0.31***	1.00	
I22	28.20	9.57	0.44	0.44***	0.32***	0.42***	0.30***	0.32***	0.28***	1.00

Notes: notation for GII pillars given in Table A1, Annex. ***-p<0.01, **-p<0.05, *-p<0.1.

Table 2 reports the results of the standardized path coefficients (or β coefficients) estimation for the proposed model. All path coefficients are statistically significant at the 1% level in the complete sample. The phase MRSC→BUSC is not significant, and all other phases are statistically significant at the 1% level in the nH sub-sample. In the H sub-sample, the phase MRSC→BUSC is statistically significant only at the 10% level, while the phases INFC →H&RC, INFC→MRSC, and K&TC→CREC are statistically significant at the 5% level, and all other phases are statistically significant at the 1% level.

Table 2. Estimation of the standardized path coefficients

Phase	Complete sample			H-sample			nH-sample		
	β	STDEV	T	β	STDEV	T	β	STDEV	T
BUSC→CREC	0.321	0.046	6.996***	0.244	0.086	2.823***	0.246	0.052	4.698***
BUSC →K&TC	0.339	0.038	8.837***	0.449	0.063	7.115***	0.177	0.049	3.603***
H&RC→BUSC	0.504	0.038	13.263***	0.445	0.062	7.168***	0.333	0.047	7.108***
H&RC→K&TC	0.480	0.037	13.040***	0.315	0.065	4.844***	0.337	0.042	8.077***
INFC→H&RC	0.227	0.039	5.828***	0.107	0.051	2.097**	0.321	0.043	7.409***
INFC→INSC	0.586	0.037	15.711***	0.226	0.070	3.213***	0.402	0.034	11.652***
INFC→MRSC	0.191	0.038	5.038***	0.128	0.053	2.422**	0.260	0.042	6.237***
INSC→BUSC	0.214	0.046	4.616***	0.305	0.063	4.832***	0.135	0.051	2.635***
INSC→H&RC	0.613	0.037	16.745***	0.601	0.045	13.435***	0.203	0.047	4.286***
INSC→MRSC	0.609	0.033	18.536***	0.631	0.035	18.214***	0.357	0.041	8.623***
K&TC→CREC	0.212	0.042	5.101***	0.159	0.076	2.100**	0.145	0.045	3.221***
MRSC→BUSC	0.118	0.036	3.279***	0.102	0.060	1.698*	0.028	0.050	0.559
MRSC→CREC	0.292	0.038	7.713***	0.267	0.066	4.022***	0.234	0.046	5.112***

Note: ***-p<0.01, **-p<0.05, *-p<0.1.

The explained variance (or Pearson's coefficient, R^2) of the dependent variable is a key indicator of the quality of a model. Table 3 reports our estimates of R^2 for the dependent variables in the proposed model.

Table 3. The variance explained

Variable	Complete sample			H-sample			nH-sample		
	R^2	STDEV	T	R^2	STDEV	T	R^2	STDEV	T
BUSC	0.583	0.026	22.797***	0.564	0.042	13.411***	0.165	0.033	5.032***
CREC	0.513	0.025	20.419***	0.330	0.053	6.248***	0.189	0.032	5.870***
H&RC	0.590	0.025	23.206***	0.402	0.050	8.087***	0.197	0.035	5.689***
INSC	0.343	0.044	7.866***	0.051	0.033	1.563	0.162	0.028	5.840***
K&TC	0.584	0.027	21.956***	0.497	0.048	10.360***	0.190	0.032	5.892***
MRSC	0.544	0.023	23.237***	0.451	0.041	11.038***	0.270	0.034	7.996***

Note: ***-p<0.01, **-p<0.05, *-p<0.1.

For each endogenous variable, the portion of variance explained by the independent variables in the model is sizeable ($R^2>0.26$)[4] in the complete sample. The pattern is the same in the H sub-sample, except for the INSC variable, whose variance is explained by the IFSC variable only to a small extent ($0.02<R^2<0.13$), and is not statistically significant. In the nH sub-sample, the portion of the variance of the MRSC variable explained by the INSC and IFSC variables is large ($R^2>0.26$), but for all other endogenous variables, the portion of variance explained by the model's exogenous variables is rather modest ($0.13<R^2<0.26$).

In addition, Table 4 reports the estimates of the magnitude/strength (or Cohen's indicator, f^2) for each structural path in the proposed model. The size effect assesses the magnitude/strength of the relationship between the variables in the model and shows how much an exogenous latent variable contributes to an endogenous variable's R^2. Therefore, size effect is another key indicator of the quality of the proposed approach. Table 4 reports the results for the complete sample: the phase MRSC→BUSC has negligible and statistically insignificant strength ($f^2<0.02$); the phases BUSC→CREC, BUSC→K&TC, INFC→H&RC, INFC→MRSC, INSC→BUSC, K&TC→CREC, and MRSC→CREC have small strength ($0.02<f^2<0.15$); the phases H&RC→BUSC and H&RC →K&TC have medium strength ($0.15<f^2<0.35$), and the phases INFC→INSC, INSC →H&RC, and INSC → MRSC have large strength ($0.35<f^2$).

Table 4. Assessment of the effect size

Phase	Complete sample			H-sample			nH-sample		
	f^2	STDEV	T	f^2	STDEV	T	f^2	STDEV	T
BUSC→CREC	0.104	0.033	3.144***	0.045	0.036	1.248	0.067	0.031	2.189**
BUSC→K&TC	0.127	0.031	4.045***	0.208	0.074	2.811***	0.033	0.020	1.693*
H&RC→BUSC	0.267	0.049	5.431***	0.257	0.087	2.968***	0.118	0.037	3.156***
H&RC→K&TC	0.256	0.048	5.340***	0.102	0.047	2.192**	0.120	0.033	3.608***
INFC→H&RC	0.082	0.027	3.082***	0.018	0.019	0.965	0.108	0.033	3.271***
INFC→INSC	0.523	0.104	5.018***	0.054	0.038	1.415	0.193	0.040	4.834***
INFC→MRSC	0.052	0.020	2.609***	0.028	0.025	1.112	0.078	0.027	2.848***
INSC→BUSC	0.036	0.016	2.230**	0.101	0.041	2.465**	0.015	0.012	1.256
INSC→H&RC	0.602	0.111	5.436***	0.574	0.133	4.304***	0.043	0.022	1.994**
INSC→MRSC	0.535	0.089	6.030***	0.689	0.123	5.610***	0.146	0.039	3.787***
K&TC→CREC	0.041	0.016	2.513**	0.018	0.018	1.005	0.022	0.014	1.538
MRSC→BUSC	0.016	0.010	1.570	0.012	0.017	0.739	0.001	0.004	0.170
MRSC→CREC	0.099	0.027	3.613***	0.065	0.037	1.779*	0.063	0.026	2.387**

Note: ***-p<0.01, **-p<0.05, *-p<0.1.

(4) In this study, we also used threshold values (or rules of thumb) for the Pearson's coefficient, R^2, and Cohen's indicator, f^2, usually employed in the standard practice: $R^2<0.02$ (negligible), $0.02<R^2<0.13$ (weak), $0.13<R^2<0.26$ (medium), $0.26<R^2$ (large); $f^2<0.02$ (negligible), $0.02<f^2<0.15$ (small), $0.15<f^2<0.35$ (medium), $0.35<f^2$ (large).

In the H sub-sample, we observe that the phases INFC→H&RC, K&TC→CREC, and MRSC→BUSC have negligible and statistically insignificant strength ($f^2<0.02$); BUSC→CREC, H&RC→K&TC, INFC→INSC, INFC→MRSC, INSC→BUSC, and MRSC→CREC have medium strength ($0.15<f^2<0.35$); the phases BUSC→CREC, INFC→INSC, and INFC→MRSC also have statistically insignificant strength, and the phases BUSC→K&TC and H&RC→BUSC have a large strength ($0.35<f^2$). In the nH sub-sample, the phases INSC→BUSC and MRSC→BUSC have a negligible and statistically insignificant strength ($f^2<0.02$); only the phase INFC→INSC has large strength ($0.35<f^2$); all other phases have a medium strength ($0.15<f^2<0.35$), and the phase K&TC→CREC has statistically insignificant strength.

Table 5. Phase differences comparison for sub-samples across time

Phase	H-sample vs.					nH-sample vs.				
	H_2011	H_2012	H_2013	H_2014	H_2015	nH_2011	nH_2012	nH_2013	nH_2014	nH_2015
BUSC→CREC	0.183	0.282	0.178	0.144	0.111	0.252	0.049	0.194	0.140	0.019
BUSC →K&TC	0.057	0.006	0.100	0.025	0.205	0.050	0.202	0.022	0.084	0.079
H&RC→BUSC	0.107	0.133	0.149	0.154	0.073	0.095	0.021	0.090	0.164	0.174
H&RC→K&TC	0.070	0.010	0.042	0.091	0.114	0.083	0.005	0.028	0.160	0.147
INFC→H&RC	0.478	0.011	0.035	0.043	0.045	0.192	0.060	0.143	0.359	0.269
INFC→INSC	0.456	0.146	0.151	0.101	0.194	0.033	0.053	0.014	0.111	0.166
INFC→MRSC	0.362	0.082	0.056	0.040	0.056	0.042	0.103	0.054	0.172*	0.160*
INSC→BUSC	0.040	0.041	0.005	0.006	0.065	0.205*	0.180*	0.065	0.270	0.217
INSC→H&RC	0.422***	0.055	0.061	0.049	0.069	0.124	0.005	0.021	0.209*	0.185*
INSC →MRSC	0.327**	0.064	0.023	0.028	0.073	0.055	0.018	0.088	0.004	0.098
K&TC→ CREC	0.073	0.027	0.099	0.108	0.057	0.044	0.079	0.182*	0.135	0.163
MRSC→BUSC	0.202	0.149	0.143	0.139	0.057	0.392	0.224	0.157	0.036	0.065
MRSC→CREC	0.090	0.366	0.104	0.191	0.087	0.139	0.159	0.001	0.167	0.106

Note: ***-p<0.01, **-p<0.05, *-p<0.1.

Let us consider now the issue of homogeneity across time, which is one of the fundamental assumptions of this study. To this end, we split the H and nH sub-samples into smaller sub-samples, by year, and conduct the relevant comparisons for the phase coefficients for each sub-sample, and for the H and nH sub-samples, respectively. Our results are reported in Table 5. Almost all differences in the coefficients are statistically insignificant at the 5% level. The only exceptions are the differences in the phase INSC→H&RC coefficients (significant at the 1% level) and phase INSC→MRSC coefficients (significant at 5% level) for both the H sub-sample and the H–2011 sub-sample. This observation allows us to conclude that our assumption of homogeneity over time seems acceptable. To investigate the main features of NIS functioning in both high- and non-high-income countries, we have also compared the path coefficients of the H and nH sub-samples. Our results are reported in Table 6.

Table 6. Phase differences comparison for the H and nH sub-samples

	Phase difference	T-value by Parametric Test	T-value by Welch-Satterthwait Test
BUSC → CREC	0.002	0.019	0.018
BUSC→K&TC	0.272***	3.286***	3.395***
H&RC →BUSC	0.112*	1.411	1.444
H&RC→K&TC	0.022	0.296	0.288
INFC→H&RC	0.214	2.966***	3.162***
INFC→INSC	0.176	2.537**	2.243**
INFC→ MRSC	0.132	1.878*	1.957*
INSC →BUSC	0.170**	1.991**	2.073**
INSC→H&RC	0.398	5.442***	6.153***
INSC→MRSC	0.274***	4.280***	5.010***
K&TC→CREC	0.014	0.175	0.166
MRSC→BUSC	0.074	0.907	0.950
MRSC→CREC	0.034	0.421	0.420

Note: ***-p<0.01, **-p<0.05, *-p<0.1.

The differences between the path coefficients for the H and nH subsamples are statistically significant at the 10% level for the following phases: BUSC→K&TC, INFC→H&RC, INFC→MRSC, INFC→INSC, INFC→MRSC, INSC→ BUSC, INSC→H&RC, and INSC→MRSC, (i.e., for 7 over 13 phases). The above-mentioned results suggest that the proposed model of NIS functioning is satisfactory regarding quality, as it relevantly shows the direction and magnitude of the interactions among the components of NISs.

Discussion

The model developed in this study provides empirical support for the proposed research hypothesis. Moreover, our results showed that the magnitude of the NIS components' interactions considerably depends on the level of economic development in a country. Our results also show that Institutional capital (INSC) is a fundamental constituent of NISs. Although Institutional capital (INSC) does not directly impact a country's innovation output (while other components, such as K&TC and CREC, do), it has a positive and significant impact on innovation capability through Human capital and Research, and Business and Market Sophistication (measured by the H&RC, BUSC, and MRSC constituents of NISs). Therefore, the quality of a country's political, regulatory, and business environment indirectly, but fundamentally, affects its innovation capabilities. In particular, the efficient management of a country's Institutional capital helps establish fruitful relationships with the other components of a country's NIS. Institutional capital's direct impact on H&RC, BUSC, and MRSC is noticeably weaker for non-high-income countries. Therefore, the non-high-income countries should focus on improving their Institutional capital to increase their innovative capabilities.

Institutional capital (INSC) is directly and positively influenced by Infrastructure capital (INFC), but the impact is weaker for high-income countries. The same can be observed for H&RC and MRSC, which are also directly and positively affected by INFC, probably because infrastructure capital has reached a level of saturation in high-income countries. Hence, non-high-income countries should focus on improvements in infrastructure capital. Human and Research capital (H&RC) directly and positively affects Business Sophistication and Knowledge and Technology capital (BUSC and K&TC, respectively). Note also that the impact of Market Sophistication (MRSC) on Business Sophistication (BUSC) is very small, but its impact on Creative Ability (CREC) is significant. Business sophistication (BUSC) has a direct and positive impact on Knowledge and Technology (K&TC) and Creative Ability (CREC). The effect of Knowledge and Technology capital (K&TC) on Creative Ability (CREC) is also direct and positive. To summarize, Table 7 presents the assessments of the overall effects of the NIS components' interactions.

Table 7. Total effects of interactions

	H-sample			nH-sample		
	Mean	**STDEV**	**t-Values**	**Mean**	**STDEV**	**t-Values**
BUSC→CREC	0.315	0.073	4.320***	0.272	0.049	5.556***
BUSC→K&TC	0.448	0.063	7.080***	0.177	0.049	3.613***
H&RC→ BUSC	0.445	0.062	7.176***	0.333	0.047	7.148***
H&RC → CREC	0.190	0.041	4.671***	0.139	0.023	5.953***
H&RC →K&TC	0.515	0.054	9.467***	0.395	0.037	10.694***
INFC → BUSC	0.207	0.052	3.913***	0.201	0.030	6.670***
INFC→CREC	0.152	0.041	3.661***	0.170	0.024	7.046***
INFC→ H&RC	0.245	0.064	3.812***	0.404	0.040	10.196***
INFC → INSC	0.228	0.071	3.194***	0.402	0.034	11.816***
INFC → K&TC	0.170	0.044	3.800***	0.172	0.025	6.777***
INFC → MRSC	0.272	0.066	4.090***	0.405	0.037	11.026***
INSC →BUSC	0.635	0.036	17.533***	0.213	0.044	4.791***
INSC → CREC	0.400	0.040	10.026***	0.152	0.023	6.473***
INSC → H&RC	0.600	0.045	13.298***	0.203	0.046	4.390***
INSC → K&TC	0.475	0.037	12.747***	0.106	0.021	5.046***
INSC →MRSC	0.630	0.036	17.615***	0.356	0.041	8.613***
K&TC →CREC	0.158	0.074	2.148**	0.144	0.044	3.271***
MRSC →BUSC	0.099	0.061	1.673*	0.028	0.049	0.564
MRSC→ CREC	0.298	0.066	4.558	0.241	0.046	5.246*
MRSC→K&TC	0.044	0.028	1.610	0.006	0.010	0.515

Note: ***-p<0.01, **-p<0.05, *-p<0.1

This study proposes to consider the NIS as an intangible asset of a particular kind and identifies its seven fundamental constituents. These components are extracted through a modern NIS measurement model, the Global Innovation Index (GII), and are named conventionally: Infrastructural capital, Human and Research capital, Institutional capital, Market Sophistication capital, Business Sophistication capital, Knowledge and Technological capital, and Creative Ability capital. Based on empirical data and applying the Structural Equation Model (SEM) analysis techniques, this study establishes the existence of a causal relation between the proposed NIS components and the assessed magnitude of their interactions.

The results of this study on the NIS functioning can serve as a basis for several practical applications, potentially leading to new management capabilities of NISs. We found that a country's ability to efficiently manage its own Institutional capital's quality and its interaction with other NIS components is a key determinant of successful innovation. The transformation of infrastructural capacities into effectively functioning human, research, market, and business constituents of NISs is entirely determined by Institutional capital and, as showed in this study, is significantly affected by the innovation output of a country (i.e., Knowledge, Technological and Creativity Ability). The proposed model, as well as our parameter estimates, may enable researchers and practitioners to rank the relative importance of different managing practices to enhance NIS effectiveness.

The results of this study also highlight the following areas of future research: an additional analysis for a clear understanding of NIS as a transformation mechanism for economic development; classification issues and detailed analyses of NIS functioning, considering other factors (e.g., cultural characteristics, geographical location, stocks of mineral resources and/or others); modeling the spatiotemporal evolution of NIS distribution.

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Annex

Table A1. GII composition (first 3 levels) and weights

GII Index	Sub-index	Pillar	Sub-pillar	Name	Weight 2011	2012	2013	2014	2015
I				Global Innovation index	1	1	1	1	1
	I_1			Innovation Input	1/2	1/2	1/2	1/2	1/2
		I_{11}		Institutions	1/5	1/5	1/5	1/5	1/5
			I_{111}	Political environment	1/3	1/3	1/3	1/3	1/3
			I_{112}	Regulatory environment	1/3	1/3	1/3	1/3	1/3
			I_{113}	Business environment	1/3	1/3	1/3	1/3	1/3
		I_{12}		Human capital & research	1/5	1/5	1/5	1/5	1/5
			I_{121}	Education	1/3	1/3	1/3	1/3	1/3
			I_{122}	Tertiary education	1/3	1/3	1/3	1/3	1/3
			I_{123}	R&D	1/3	1/3	1/3	1/3	1/3
		I_{13}		Infrastructure	1/5	1/5	1/5	1/5	1/5
			I_{131}	ICT	1/3	1/3	1/3	1/3	1/3
			I_{132}	General infrastructure	1/3	1/3	1/3	1/3	1/3
			I_{133}	Ecological sustainability	1/3	1/3	1/3	1/3	1/3
		I_{14}		Market Sophistication	1/5	1/5	1/5	1/5	1/5
			I_{141}	Credit	1/3	1/3	1/3	1/3	1/3
			I_{142}	Investment	1/3	1/3	1/3	1/3	1/3
			I_{143}	Trade & competition	1/3	1/3	1/3	1/3	1/3
		I_{15}		Business sophistication	1/5	1/5	1/5	1/5	1/5
			I_{151}	Knowledge workers	1/3	1/3	1/3	1/3	1/3
			I_{152}	Innovation linkages	1/3	1/3	1/3	1/3	1/3
			I_{153}	Knowledge absorption	1/3	1/3	1/3	1/3	1/3
	I_2			Innovation Output	1/2	1/2	1/2	1/2	1/2
		I_{21}	Knowledge & technology		1/2	1/2	1/2	1/2	1/2
			I_{211}	Knowledge creation	1/3	1/3	1/5	1/3	1/3
			I_{212}	Knowledge impact	1/3	1/3	2/5	1/3	1/3
			I_{213}	Knowledge diffusion	1/3	1/3	2/5	1/3	1/3
		I_{22}	Creative outputs		1/2	1/2	1/2	1/2	1/2
			I_{221}	Intangible assets	1/3	1/2	1/2	1/2	1/2
			I_{222}	Creative goods & serv.	1/3	1/4	1/4	1/4	1/4
			I_{223}	Online creativity	1/3	1/4	1/4	1/4	1/4

Note: Pillar I_{21} "Knowledge and technology outputs" and Sub-pillar I_{123} "Ecological sustainability" were named "Scientific outputs" and "Energy," respectively, in the GII 2011. Sub-pillar I_{223} "online creativity" was not introduced in the GII 2011.

Table A2. GII samples by year

Year	Number of countries by income level				Total
	H	UM	LM	L	
2011	43	35	31	16	125
2012	44	40	35	22	141
2013	45	40	36	21	142
2014	49	38	33	23	143
2015	48	38	34	21	141

Note: **H**- High-income countries; **UM**- Upper-Middle-income countries; **LM**- Lower-Middle-income countries; **L**- Low-income countries.

Digital Technologies for Social Innovation: An Empirical Recognition on the New Enablers

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Abstract: Even though scholars' attention has been placed on Social Innovation (SI), little evidence has been provided with regards to which tools are actually used to address social needs and foster Social Innovation initiatives. The purpose of the article is twofold. Firstly, the article offers empirical recognition to SI by investigating, on a large-scale, social and innovative activities conducted by start-ups and small and medium-sized enterprises (SMEs) across the world between 2001 and 2014. Secondly, the article intends to capture SI core businesses and underlying complementarities between products, markets, and technologies and show in which way digital media and IT are essentially tracing innovation trajectories over a multitude of industries, leading the current industrial patterns of SI, and continually fostering its cross-industry nature.

Keywords: Social Innovation; Start-up, SMEs; Digital Tools; Network analysis

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Introduction

Social Innovation (SI) has acknowledged in the last decades a rapid growing both for scholars and policy makers (Adams and Hess, 2010). According to Mulgan (2006), Social Innovation (SI) refers to innovative activities that are motivated by a social need. Innovation is "social" to the extent that it may not necessarily be "good", but it is socially desirable (Howaldt and Schwarz, 2010) and satisfies a social need not perceived as relevant by the market (Mulgan et al., 2007). Auerswald (2009: 52) defines SI as "*a novel solution to a social problem that is more effective, efficient, sustainable, or just than existing solutions and for which the value created accrues primarily to society as a whole rather than private individual.*"

In other words, SI is related to all social and societal demands or challenges where any sort of innovation can procure an improvement based on newness and progress (Mulgan, 2006; Dawsond & Daniel, 2010). Hamalainen and Heiskala (2007) define SI as a way to address needs or resolve problems identifying new ideas or new social structures. This description induces a shift towards a demand-pull model where solutions are adopted by a large number of individuals who participate in its development (Eikins et al., 1992; Guida and Maiolini, 2013), with an explicit focus on social interactions (Marcy and Mumford, 2007; Maruyama et al., 2007).

An extensive debate is emerging in the literature about the meaning of Social Innovation (SI), while empirical studies are relatively few (Caulier-Grice et al., 2012; Bulut et al., 2013; Howaldt and Schwarz, 2010). Nowadays, a large percentage of innovative solutions come from information technology (IT) applications and tools. Bulut et al. (2013) investigate the emergence of SI from a social perspective and examine the causal relationships between SI and technological innovation. Moreover, they shed light on the "relativity" of SI, and the fact that it is oblique to different geographical and socio-economic activities (which suggests it is important to understand how SI initiatives develop and grow based on cross-industry flows of opportunities and cross-scale processes).

The purpose of the article is twofold. Firstly, the article offers empirical recognition to SI by investigating, on a large-scale, social and innovative activities conducted by start-ups and small and medium-sized enterprises (SMEs) across the world between 2001 and 2014. Secondly, we empirically explored the phenomenon using metadata to build a network analysis to capture SI core businesses' categories and identify complementarities between products, markets, and technologies in order to show how digital media are actually tracing innovation trajectories over a multitude of markets. The analysis provides info about the current industrial patterns of Social Innovation, fostering the SI cross-industry nature. This evidence is remarkable since literature investigating the key role that digital tools and IT play in changing the way individuals interact, providing few indications with regards to which digital tools are actually used to address social needs.

The article is organized as follows. The literature review section focuses on the role of digital tools (and more in general IT tools) as enablers of SI, facilitating the emergence and dissemination of social and innovative ideas.

The third section describes the dataset (data selection criteria), identifying the main economic figures, and trends related to the population of SI companies.

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In the methodology section we propose a network analysis to highlight emerging core businesses, market and technological complementarities, identifying mobile, social networks and platforms, social media, and the web as relevant SI drivers. The metrics of the resulting networks, at both node and network level, are discussed from an economic point of view. The paper concludes with suggestions and some directions for future research.

Social Innovation and the role of enabling technologies

Since the interplay among individuals is multifaceted, especially in case of a large number of players (West and Lakhani, 2008), digital tools and IT play a key role in changing the way individuals interact (Hinds and Kiesler 2002): such technologies helps in making information explicit and allows participants to keep in touch and resolve social and societal issues more quickly and effectively. Katz and Rice (2002) emphasize the ability of IT to sustain the collective dimension in decision-making and knowledge flows, while Pisano and Verganti (2008) illustrate how digitalization and IT reduce the cost of accessing innovative ideas. According to Fink (2007), a well-designed IT architecture is crucial in increasing the level of knowledge dissemination and developing new processes and products, especially as a way to foster knowledge generation (de Souza and Júnior, 2013).

Thanks to the emergence of an extremely large set of digitalized Tools, it is possible for many individuals to actively participate in the generation and implementation of new ideas (Hutter et al. 2011). So far little evidence has been provided with regards to which digital tools are actually used to address social needs (Smith and McKeen, 2011). To sum up, digital tools ensure the tools by which SI players interact and the present article aims at identifying current digital devices, channels and platforms enabling new SI initiatives.

This particular branch of literature is strictly connected to the digitalization of social issues, particularly linked to how social connectivity matters (Shih, 2009). As argued by Vaccaro and Madsen (2009) Internet-based technologies can assist firms to increase relationships between individuals and business practices, in relation to ethical issues and social challenges. With our research we would like to focus on hi-tech organizations (start-ups and SMEs) tracing social innovation trajectories over a multitude of markets.

Dataset

Data were collected from the web and CrunchBase. This latter is the world's most comprehensive database on innovative companies, freely accessible via an application-programming interface (API). It began in 2007 and included information on the profiles of more than 200,000 innovative companies, and is maintained by on-line contributors. The companies listed are active in several innovative industries including biotech, clean-tech, e-commerce, education, finance, health, hospitality, medical, nanotech, and software. For most of the companies the database includes information on a number of employees, category codes, total money raised, number and timing of financing rounds, tags and keywords related to markets, products, and technologies, city of registration, operating offices, and so on. Data from CrunchBase are used increasingly in research (Block and Sandner, 2011; Marra et al., 2015).

The choice to employ information from CrunchBase is based on the acknowledgment that current SI initiatives rely heavily on innovation and new technologies, and on the need for a large and homogeneous set of data that allow detailed examination with no limitation to industrial classification codes.

In the present work, 30,824 companies represent the SI population, a subset of all innovative companies listed in CrunchBase (the Crunch population).

The identification of the Si population was a long exercise. First, we collected the metadata for each company included in the database, ordered them, and deleted duplicates. Second, from the over 140,000 unique tags in CrunchBase, we manually selected around 7,000 tags (5% out of the total), also in light of potential tags' combinations, according to the operating schema of social and innovative activities provided by the European Commission (2013). The authors of the present study performed this step independently. The results were compared (more than 97.2% of the identified tags were selected independently by all the authors), checked and approved by two SI industry experts, and combined into a dataset. The resulting SI population includes some well-known innovative companies and many not recognized social and innovative companies including: a start-up promoting creativity and entrepreneurship to build livable and sustainable cities; an e-democracy platform that utilizes crowd-sourcing for collaboration to determine the most effective solutions, and organize action to oversee change through to implementation; a non-profit organization which is at the forefront of a new movement based on the belief that children and families deserve the help of technology tools; a start-up that provides a well-designed, easy to digest blog in the M2M environment; a platform and active media for creating SI through crowd-funding, petitions, and open democracy; a new company developing a SI platform that enables organizations to solve business problems by crowd-sourcing from the pool of global talent.

Social and innovative activities are a fragmented phenomenon in the United States: according to the Great Social Enterprise Census (2013) by Pacific Community Ventures only 20% of social enterprises are larger than the US $ 2 million in budget, just 8% employ more than a 100 people, and 60% were founded since 2006. Our investigation allows drawing useful insights into some figures and trends related to SI start-ups and SMEs.

Firstly, the tendency in the number of firms by year of foundation is increasing, and surpassed the 4,000 units' level in the period 2010-2012. Observing at both SI and Crunch companies per year of foundation we notice that their ratio increases between 2001 and 2013 from 29.5% to 44.2%, with a peak (47%) in 2012. Moreover, comparing the total number of employees for the entire period, is evident that the SI subset 621,440 is different from the Crunch dataset 1,357,727 (45.7%). Additionally, the total volume of money raised by the SI population is the US is $ 82,6 billion v.s. the total raised by the Crunch Companies US $ 241.8 billion that is 34.2% of the total amount in the Crunch dataset refers to SI start-ups. Information on the amount of funding per year of investment is available for many companies, but lack of detailed data on amounts and year for every single investments' round does not allow to propose a total amount per year of investment that is consistent with the above figures. The total quantity of money raised by observed companies per year of funding is US $ 60.8 billion for the SI subset and US $ 179.8 billion for the Crunch dataset. Observing the trends for both SI and Crunch funding per year of investment since 2007 we notice a ratio of 36% on average, with relevant spikes in 2008 (51%), 2009 (38%), and 2011 (43%). These data on funding are reliable compared with other estimations, at least since 2006 when SI activities gained real momentum: The Center for Venture Research (2011) at the University of New Hampshire reports that angel investments augmented from US $ 17 billion to US $ 20 billion between 2009 and 2010.

Looking at the cities with the majority of SI start-ups that operates in a specific urban area, Chicago displays the greater percentage with 47.5% of SI start-ups, followed by Berlin (45.3%), San Francisco (42.4%), New York (39.6%), London (39.3%), Austin (37%), Los Angeles (36.6%), Paris (36.2%), Palo Alto (35.8%), and Mountain View (33.5%).

As known, SI companies favour urban areas where new ideas spread more quickly and find matching users' needs, where markets can grow rapidly, entrepreneurial activities with non-profit origins can evolve and transform the underlying business model (Mulgan, 2006; Bulut et. al, 2013).

Cities mentioned above have a strong presence in some innovative industries, such as mobile, software, web development, advertising, and enterprise services. The technology industrial structure in Chicago is diversified (seven industries present percentage values above 5%) with high values for advertising (19%), software (15%), web (10%), enterprise services (10%), e-commerce (9%), analytics (5%) and mobile (5%). The concentration in software and web is well below the levels in New York and San Francisco. New York has a diversified economy, similar to Chicago, with the Web (17%), software (16%), advertising (13%), mobile (7%), e-commerce (6%), and enterprise services (5%) as the most relevant sectors. San Francisco has a more specialized urban economy: values above 5% are found for social (6%), software (42%), and the Web (27%).

As well known, SI has strong implications for education (college and schools), access to news and information (blogs, university, research), poverty, health, climate change (green, energy), unemployment (recruiting, workplace), discrimination, welfare, social networking (collaboration, community, learning, sharing), crowdsourcing, training, small business, security, charity, urban regeneration, social economy. Looking at these areas and activities, it is clear that an investigation of SI could not be circumscribed to the assessment of too general category codes: this fact suggested to concentrate our efforts on metadata, tags and keywords related to companies' markets, products, and technologies.

The SI subset is sorted by ranking of tags, counting the times that a specific tag appears in the SI dataset; at the top of the ranking are located: mobile (2,261), social-media (2,082), social-network (2,006), big data (570), analytics (503), music (490), video (575), and marketing (1,049).

This first range of tags confirms the universal scope of SI across different businesses. Also, in the top 100 tags there are businesses that are close to the common understanding of SI, like education (1,031), healthcare (826), community (719), food (349), news and entertainment (respectively 339 and 336), sharing (306), sports & Training (269 and 255), crowd-funding (235), art (232), college (222) and learning (200), etc.

Methodology

We used as a methodology network analysis that it is strongly recognized and used into economic and managerial disciplines such a long time (Jackson, 2011). As seen, SI is "oblique" to several markets, products and technologies (Auerswald, 2009) and this induced looking for an alternative way to visualize the extent of the SI phenomenon. The proposed network analysis using metadata allows capturing SI markets, products and technologies, and underlying complementarities between them.

A network node symbolizes the co-occurrence of a tag within two companies: for example, tags A and B are linked in the network if these coexist in the same company. A second measure is provided with the weight of the nodes: it is heavier if the number of companies in which the two tags coexist is greater. Consequently, for tags A and B, the weight of the edge A-B is five since these tags concur in five diverse firms, and the weight of the edge A-C is two because these tags coexist in two different firms, and so on (Table 1).

Table 1. Row data (example)

	Name	Tags
1	Company_1	A, B, C, D
2	…	A, B, E, F
3	…	A, B
4	…	A, B, C, G, H, I
5	Company_n	A, B, L, M, N

More weighted edges represent actual links between markets, products, and technologies through which social and innovative companies drive their research, production and marketing efforts.

The analysis is established using a network of Social Innovation tags (where the links between tag_i and tag_j is calculated from the co-existence of tag_i and tag_j in the same firm), which is based on a two-mode matrix X_t, where the rows are tags and the columns are firms. The square matrix representing the number of links a_{ij} among tag_i and tag_j is the adjacency matrix A_t, which again is calculated as the product of X_t and X'_t. according to Bastian et al. (2009), the open-soruce software Gephi has been used to visualize data as a picture of network analysis.

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Results

The network linking SI initiatives includes 58,478 nodes (tags) and 640,833 edges (connections between tags based on their co-occurrence in the same company). Several descriptive statistics are defined below along with their economic interpretation (Table 2). The density *D* of the network is defined as the ratio of the number of edges and to the maximum number of edges possible within the network. *D* varies between 0 and 1; the closer to 1, the denser the network, otherwise it is sparse. The observed SI network is very low density, which means that the graph is large and diversified and, hence, is informative about the variety of SI activities and initiatives involved.

Table 2. Descriptive statistics of the SI network

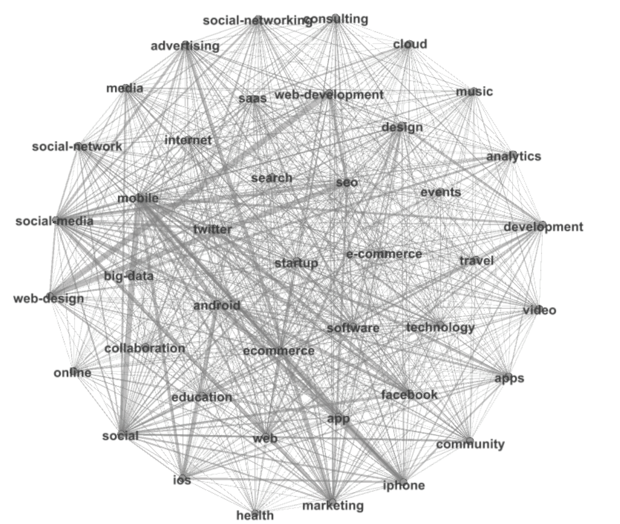
Metrics	
Number of nodes	58,478
Number of edges	642,824
Avg. Degree	21,9
Avg. Weighted Degree	29,4
Graph Density	0.01
Modularity	0.463
Avg. Clustering Coefficient	0.873
Modularity	0.463

Closely related to network density are the average degree, where degree *k* of a node is the number of edges connected to it, and weighted average degree which is the summation of the weights of the total of links attached to node *i*.

Centrality indices produce rankings to identify the most central nodes in the network. Intuitively, a node is central if it has the highest number of edges with other nodes. This concept of centrality is limited to direct links (links directly connected to that node). Centrality can also be related to indirect links (links not directly connected to the specific node). For instance, in a network with a star structure in which all nodes have ties to one central node, the centrality of the central node is equal to 1 (normalized value). According to degree, the most important nodes are mobile (5,166), social-media (4,734), social (4,256), e-commerce (4,246), software (3,533), social-network (3,232), saas (software as a service; 3,210), marketing (3,055), iPhone (2,790), and education (2,730). Whereas the former concept of centrality is meant in terms of the number of nodes to which a node is linked, the latter concept is in terms of the distances among the various nodes: two nodes are associated by a path if there is a chain of distinct links interconnecting them, and the length of the path is the number of edges that comprise it. Betweenness centrality measures the extent to which a particular node lies "between" other nodes in the network, and establishes the relative connotation of a node by measuring the fraction of the paths connecting all pairs of nodes, and holding the node of interest: a node with only a few edges might play as a bridge and so be very central to the graph. Central nodes are IT devices, channels and platforms such as mobile, social media, media, social network, e-commerce, marketing, community, and education.

Modularity is a measure of the network. Networks with high modularity show dense connections between nodes within modules, but sparse connections between nodes in different modules. The value (0.2) is low and indicates the absence of very strong aggregates within the network, which emphasizes the fertilization nature of SI. The reduction of the network helps in identifying some relevant aggregates of nodes. In Figure 1 the network has been limited by degree (the minimum degree has been set at 1,500, with the maximum value at 5,167) to get a preliminary view of the diffusion of SI through markets, products, and technologies. The resulting network has 42 nodes and 853 edges (respectively, 0,07% of total nodes and 0,13% of total edges), and parameters are: average degree 40.6, average weighted degree 1,425, graph density 0.991, modularity 0.19, network diameter 2, and average path length 1.009. In such a restricted network, four modularity classes or aggregates emerge: the smallest class represents the 4,76% of the network and links basically big data, analytics, and other relevant areas; the second aggregate is given by the 19% of the network and includes all social media activities, web-development and web-design; the third modularity class equals 26,2% of the network and mainly interconnects central nodes such as mobile, software, web, and the two mobile operating systems; the largest aggregate covers the remaining 50% and includes all other nodes and edges across the network. As seen, aside from the weight or centrality of the single node, some insights derive once each node is positioned in relation to every other node. We find the most robust connections between: mobile and social; mobile and social-media; mobile and software, and social-media and social network (Figure 1).

Figure 1. A restricted view of the SI network



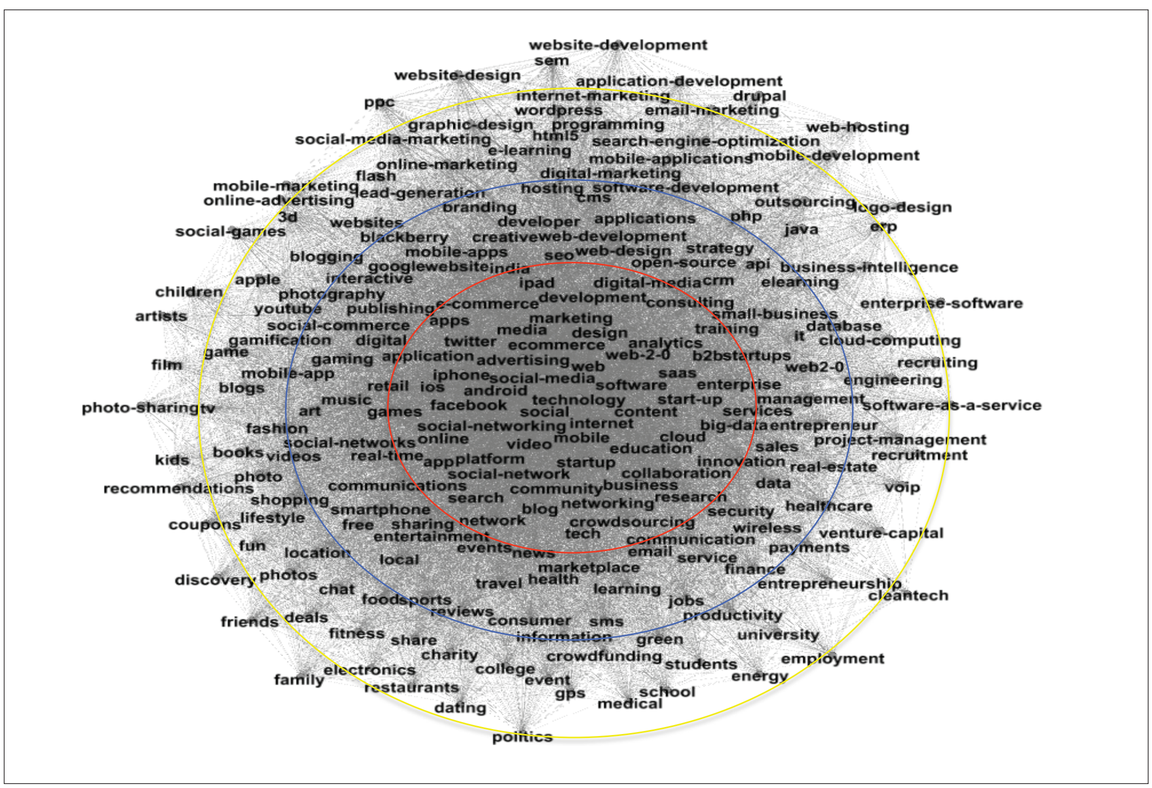
Source: Own elaboration on CrunchBase (2014)

Some major patterns and SI trajectories emerge from non-trivial associations between tags. First, social and innovative activities are associated with certain communication channels (mobile, web, internet, media), software development (web-design and development, apps, search engine optimization), operating systems (Android, IOS), specific devices (iPad, iPhone), major social platforms (Facebook and

Twitter), technologies and services (cloud, saas, analytics) and industries (advertising, e-commerce, social-network, education). These can be grouped into three sets of drivers: (a) mobile as a device; (b) web and social as channels/platforms; (c) marketing, education, and e-commerce as relevant businesses. It should not be surprise to find out the scope for marketing, advertising and e-commerce in SI: digital tools and IT enable a higher level of personalization and targeting, crucial for the full understanding of individuals' needs, than more traditional approaches (Millard and Carpenter, 2014). Since the increasing diffusion of social marketing sees the common attempt to influence social behaviour, not to the marketer's benefit, but to benefit the target audience and the general society. Moreover, one of the key factors for SI companies is to adopt a marketing approach, which is needed to reach large audience at early stages. To maximize the impact of SI initiatives, entrepreneurs need to look for the highest adoption rate on the market and strong marketing campaigns (e.g., leveraging the online community through social media, blogs, forums and online publications) are crucial. In this respect, also e-commerce can be argued to represent an SI initiative, since it brings change in the way individuals communicate, create wealth, entertain, work, and shop.

Digitalization enables and supports SI, increasing the magnitude of social and innovative activities, creating totally new social, business, and governance models and new value chain forms. IT is used to create new content, serves to identify new social needs, and contributes to solve the matching between assets and needs, identify new solutions, address circumscribed social needs. Figure 2 provides a wider view of the SI network (with the setting of a lower minimum degree, 1,000) and distinguishes among three different tiers of significance, defined by relevance, closeness, and relation. The first tier includes all items that are "core" to SI since these represent areas where social and innovative activities are relevant, and are represented by all the tags within the red boundary such as education, social networking, mobile, cloud, big data, social media, collaboration, community, research, blog, crowdsourcing, training, and so on. Together with relevant SI industries and areas, digital tools lead the patterns. The second tier includes all items that are close to SI (i.e. reliant on social and innovative activities) but where the underlying connection is less strong such as music, games, healthcare, finance, travel, interactive, open source, small business, security, learning, information, entertainment and sharing (outside the red perimeter and within the blue circle). Also, in this case, digitalization and IT produce relevant implications as long as it impacts on all above businesses. The third tier in the network (between the blue and yellow boundaries) is an amalgam of activities that have some kind of relationship, which is difficult to classify and systematize, with the SI core businesses, and include, among many others, tags such as outsourcing, clean-tech, green, energy, university, school, college, books, e-learning, recruiting, employment, venture capital, politics, charity, social and digital marketing, and so on. In this last tier, the IT influence is weaker and less direct (aside from e-learning and social and digital marketing).

Figure 2. A wider view on the SI network (three tiers by relevance, closeness and relation)



Source: Own elaboration on CrunchBase (2014)

Conclusions

The purpose of the article was twofold. Firstly, the article offered empirical recognition to SI by investigating, on a large-scale, social and innovative activities conducted by start-ups and small and medium-sized enterprises (SMEs) across the world between 2001 and 2014. Then, the article planned to capture SI core businesses and underlying complementarities between products, markets, and technologies, through a network analysis of metadata. The analysis demonstrates in which way digital media are essentially tracking innovation trajectories over a multitude of industries, controlling the current industrial patterns of SI, and constantly advancing the SI cross-industry nature.

Some major patterns and SI trajectories emerge from the network analysis. First, social and innovative activities are associated with certain communication channels, software development, operating systems, specific devices, major social platforms, technologies and services and industries. These can be grouped into three sets of drivers: (a) mobile as a device; (b) Web and social as channels/platforms; (c) marketing, education, and e-commerce as relevant businesses.

The study contributes to debate on SI, offering an original view of the phenomenon and identifying economic figures, trends and industry patterns.

A focus on start-ups and innovative SMEs is useful because SI is often disruptive and increasingly the domain of new and young companies, which makes it difficult to paint a complete picture.

The article shows that digitalization plays a key role in shaping SI sector boundaries, continually fostering its cross-industry nature, and constantly changing the SI phenomenon, which is not easy to define regarding markets, products, and services. The understating of SI implies an increasing emphasis on the role of communities in creating and disseminating innovation and the way new technologies can support these (West and Lakhani, 2008; Smith and McKeen, 2011). A holistic interpretation of SI underlines the interaction between agents operating in different fields and using specific technologies as innovation enablers (Millard and Carpenter, 2014). In particular, digital media provide new solutions and alternative ways to solve problems: Millard and Carpenter (2014) suggest that IT and new technologies facilitate connectivity and simplicity, enhance user experience, and enable new forms of SI based on different combinations of platforms, devices, networks and communities, and change the rules and roles of actors within communities. The study results provide information for innovation managers, social innovation strategists and all of them (entrepreneurs, local policy makers) interested in understanding the most suitable technologies that can be used within a social innovation project.

The identification of the main digital technologies used infra sectors is a strong information that can be used to increase the social contribution of technical products under development. The role of different digital technologies can be used also to understand actual direction of SI development and possible future scenarios. This paper's findings open numerous new opportunities for further research. Next studies can concentrate on deeper understanding how different technologies impact on different industries or look to the phenomenon from a longitudinal perspective and monitor the evolution of the technological trajectories founded in this research. Other comparative contexts, such as CSR, could be included in future research, making, for example, a comparison among different typologies of sustainable innovation. We hope that our research will incite and motivate other academics to undertake research in this area. It could be also very interesting to understand what kind of companies are the primary drivers of such innovation, and explore what practices do they use in order to reply to specific social needs, or the level of success of that specific technologies to reply to social challenges.

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Beyond 'Innocents Abroad': Reflecting on Sustainability Issues During International Study Trips+

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Abstract: With ecosystems and populations in many regions threatened by rapid development, sustainability is a critical component for businesses in mature markets and emerging economies alike. The International Association of Jesuit Business Schools notes that global sustainability involves a broad set of interconnected issues ranging from environmental preservation to social justice to desirable production and consumption patterns. Jesuit business schools are uniquely positioned to address sustainability issues with their focus on teaching managerial content in tandem with corporate social responsibility. Further, the Ignatian Pedagogy Paradigm of experience, reflection, and action would suggest that business students may benefit from reflective observation in support of learning about sustainability.

In this paper, we examine the international study trip as an opportunity for students to learn about sustainability, with results suggesting that student understanding about the broad sustainability domain may be enhanced through the study abroad experience. We discuss how two classes of primarily American MBA students traveling to emerging markets (one class to Santiago, Chile and one class to Johannesburg, South Africa) were able to connect local business practices with economic and social as well as environmental sustainability issues, enhancing both student engagement and learning outcomes. Further, these students' sustainability experiences while in an unfamiliar environment provided the opportunity to apply the potentially transformative experience, reflection, and action components of the Ignatian Pedagogy Paradigm. Compared to similar graduate business students enrolled in regular classes, we argue that these students discerned deeper connections with the economic, social, and environmental issues of sustainability.

Key words: Sustainability; Study Abroad; Emerging Markets; Ignatian Pedagogy

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Beyond 'Innocents Abroad': Reflecting on Sustainability Issues during International Study Trips

With ecosystems and populations in many regions threatened by rapid development, sustainability is a critical component for businesses in mature markets and emerging economies alike. The International Association of Jesuit Business Schools proposes that global sustainability involves a broad set of interconnected issues that range from achieving environmental conservation to social entrepreneurship, poverty eradication, social justice, desirable production and consumption patterns, species preservation, and supporting spiritually rich lives across the planet. Measuring sustainability performance in any domain requires consideration of multiple stakeholders, a concept integral to Jesuit values (Beabout & Wilson, 2014). Jesuit business schools are thus particularly qualified to teach business content integrated with corporate social responsibility, and including a sustainability dimension in their curricula is a growing trend (Reilly, 2013; Rusinko, 2010; Van Marrewijk & Were, 2003). Prior research (e.g., Cordano, Ellis, & Scherer, 2003) suggests that adding these topics to business classes can sensitize students to sustainability-related issues as well as heighten their interest in this important area of management.

In this paper, we add two dimensions to student learning about sustainability: study abroad and reflective learning. In particular, we ask, When paired with a conscious awareness of—and reflection about--the people-planet-profit dimensions of sustainability, are the learning outcomes in a study abroad class different from a 'standard' course? The Ignatian Pedagogy Paradigm of experience, reflection, and action would suggest that students engaged in study abroad experiences may benefit from reflective observation as both a critical learning style and in adapting to new perspectives. As noted by Peter-Hans Kolvenbach, S.J. (former Superior General), "Students, in the course of their formation, must let the gritty reality of this world into their lives, so they can learn to feel it, think about it critically, respond to its suffering, and engage in it constructively" (2000, address at Santa Clara University). Drawing on observations collected during two MBA study trips (one for ten days to Santiago, Chile and one for five weeks to Johannesburg, South Africa), we found enhanced student understanding about the broad spectrum of sustainability issues through participating in the international study experience. Compared to similar graduate business students enrolled in regular classes, we argue that these students discerned deeper connections with economic, social, and environmental issues, as reflected both in their informal classroom discussions and their formal written assignments.

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Linking Sustainability to Study Abroad

The Jesuit mission of educating students to respect the needs of the environment and the global community provides a compelling impetus for integrating a sustainability dimension within the international study experience (Reilly, 2013). Indeed, the emphasis on the common good underlying Jesuit education may help to support a deeper student awareness of sustainability's complexity as well as potentially stronger learning outcomes (Morris & Grogan, 2015). Witnessing first-hand the impact of rapid development on an emerging nation's social infrastructure is a very powerful learning tool (Tellis, 2011), as is having to cope with local conditions such as air pollution and smog (Stephenson, 1999). For example, during the Johannesburg five-week trip, the region was in the midst of a drought. While residents (including our students) were encouraged to monitor water use carefully, the depleted reservoir was unable to support local needs, creating sporadic water outages and pressure drops.

Study abroad provides an opportunity to explore sustainability beyond the classroom, offering a broader perspective of the triple bottom line. First, students may be introduced to environmental sustainability technologies that they had not experienced in the United States. For example, their first impression of Johannesburg included the thousands of solar powered water heaters on the roofs of tiny individual houses, and local restaurant owners told of the competition to purchase their used cooking oil for biodiesel fuel. Real-life examples of interconnected sustainability elements can help students better understand the complexities of managerial decision making about resource allocation (Cordano et. al., 2003; Beabout & Wilson, 2014). Second, given the scope of the study abroad experience, environmental topics are more likely to spill over into the economic and social sustainability dimensions (Lewis & Niesenbaum, 2005; Tellis, 2011). For example, one student in our Chile course began her paper by considering the land degradation caused by copper mining in Chile and closed with a discussion of the impact of natural resource extraction on indigenous peoples. Another student paper positioned the damming of a river for hydroelectricity within the realm of policy change, addressing the social costs of opening public land for private development as well as environmental concerns. By combining environmental sustainability problems with their interconnected social and economic issues, students can better understand the concept of 'net impact' in real-world situations.

This deeper knowledge is consistent with the model of work-based learning proposed by Raelin (1997) and linked to action learning by Raelin and Coghlan (2006). These pedagogical approaches emphasize the powerful learning that may occur in a group setting and in real time, using actual rather than simulated problems. The study abroad experience merges classroom training with management-related developmental experiences, and thereby "acknowledges the intersection of explicit and tacit forms of knowing" (Raelin, 1997:574). Raelin and Coghlan's (2006) emphasis on integrating conventional classroom learning with reflective problem-solving in practical contexts align with the experience—reflection—action framework of the Ignatian Pedagogy Paradigm (IPP).

Reflective Practice, the Ignatian Pedagogy Paradigm, and the International Study Trip

Reflective practice may support learning by developing critical thinking skills through the analysis of one's life experiences. The impact of reflection in the learning process has been recognized for decades (Dewey, 1938; Schon, 1983), and reflective practice is found in many disciplines. In the management and leadership domain, prior literature has noted that developing management competencies may be linked to managers' ability to reflect socially on action and experience (Segon, Booth, O'Shannassy, & Thompson, 2010). Hedberg (2008) argues further that the capacity for reflective thought should be intentionally added to the learning repertoire of management students. As Kolb and Kolb (2005) note, one means to deepen students' understanding of organizational processes is through reflective practice, which may further result in a higher level of personal purpose (Pavlovich, Collins, & Jones, 2009).

While students in any domain of study may benefit from reflective practice, business school students may encounter special challenges in learning reflective practice (Gosling & Mintzberg, 2004). Business school curricula include a plethora of quantitative-based courses that require linear, convergent problem solving--classic "left brain" activities, rather than intuitive, divergent "right brain" thinking. Further, many business schools measure organizational effectiveness solely by bottom-line profits. In contrast, the Jesuit perspective emphasizes interests of multiple stakeholders and motives beyond financial gains, thus providing an excellent context for reflective practice. Complicated and thorny issues experienced during study abroad, such as business-related environmental degradation and subsistence marketing, offer opportunities for Jesuit business students to assess current business practices and to consider different options for the future (Beabout & Wilson, 2014). Thoughtful, reflective practice informed by the Ignatian Pedagogy Paradigm encourages students to engage in more holistic, creative approaches to critical thinking and analysis.

The study abroad experience provides an opportunity to apply the three basic tools--experience, reflection, and action--of the Ignatian Pedagogy Paradigm. Students benefit from the opportunity to discern and reflect on paradigms that may be outside their prior experiences. Morris and Grogan note, "The IPP describes the Jesuit educational goal as one that develops learners to habitually think and act with competence, conscience, and compassion, always seeking the greater good" (2015:56). Prior literature has illustrated that actual experiences (e.g., study abroad) followed by reflection and application (e.g., a sustainability assignment) can measurably enhance student learning (Smart & Csapo, 2007). Reflecting on personal experience is a form of experiential learning (Kolb & Kolb, 2005), and it represents an important means of deepening student understanding and engagement (Raelin & Coghlan, 2006). Dehler and Edmonds (2006) note that reflective practice offers an opportunity to challenge accepted beliefs and assumptions, clearly a fundamental issue in the study abroad environment.

Studies have found that study abroad classes can have a positive impact on the overall development of students' cross-cultural sensitivity (Anderson, et al., 2005). Study abroad brings students away from the distractions and demands of campus life, providing an opportunity for deeper, more purposeful learning about complex issues such as sustainability. Indeed, it affords a similar positive opportunity for the participating faculty, who often assume the juxtapositional role of fellow student in addition to instructor and program leader (Festervand & Tillery, 2001). For many students, the international study trip may be transformational in affecting their personal development, including their attitudes about the world and its diverse inhabitants. In her study of 16 business leaders who championed sustainability initiatives, Rimanoczy (2014) found similarities in their development of social sensitivity and a sense of personal mission based on some form of "awakening" or transformative experience as adults. Corresponding results were reported by Schein (2015) in his interviews with 65 senior corporate sustainability leaders. The first of five major themes Schein noted was that his respondents' personal experiences, including "seeing poverty and environmental degradation in developing countries" (2015:10), shaped their ecological worldviews. Thus, gathering 'real-world' data about sustainability outcomes—both positive and negative--may foster the experiential learning consistent with the Jesuit ideal of transformative education.

Study abroad has a long history of encouraging students to become global learners as well as gaining hands-on familiarity with new cultures. The opportunity to meet people from different backgrounds may enhance cross-cultural awareness and foster respect for varying religions, races, and cultures. Over two decades ago, Carlson and Widaman (1988) found increased levels of international political concern, cross-cultural interest, and cultural cosmopolitanism for students participating in study abroad. We shared a similar experience in Santiago, where the free-ranging population of stray dogs is visible throughout the city streets. One student searched for an explanation and commented,

> Chileans often feed and take care of [200,000+] strays…which like many unspoken problems in Chile go back to politics. During the General Pinochet dictatorship, many dogs were killed by lethal injection. Since then there has been a backlash towards any interference from the government or even NGOs in terms of animal control.

These study experiences may contribute to this global, multi-cultural focus; Lewis and Niesenbaum (2005) reported an increased interest in interdisciplinary studies and more awareness of globalization among their study abroad students. The opportunity to gain a broader perspective of the world helps students build self-confidence, create varied connections and friendships, and gain an understanding of international business that will be beneficial in their future careers.

In addition, learning from a cross-cultural experience usually improves interpersonal communication skills (Peppas, 2005). While traveling outside their home country, students interact with local people daily, often without the benefit of foreign language expertise. In her 2005 study abroad research, Williams found that exposure to varying cultures was the greatest predictor of intercultural communication skills. These skills may contribute to increased global cooperation and fluency when engaging in international business. Further, study abroad experiences may force monolingual students to rely on observational research, encouraging them to broaden their framework for analysis and interpretation. Exploring sustainability issues may encourage students to participate directly in eco-friendly initiatives such as public bike-sharing programs, and learn that the economics—and the demographics--of urban bicycling vary significantly across nations. Students who participate in study abroad programs thus may gain a better understanding of how global corporations function on a multi-cultural level, and must address the challenges of sustainability differently in different places.

Implementing a Sustainability Focus in a Study Abroad Experience

The sustainability dimension described in this paper is an addition to the co-authors' ongoing study abroad course repertoire. We added a sustainability focus to the required course assignments, and this article discusses our findings from that addition. To provide some comparative data, we also contrast the study abroad course outcomes with similar sustainability-focused coursework completed over a four-year period in standard class format. All three co-authors have prior involvement with study abroad. During the past two decades, both the first and second authors have led multiple undergraduate and MBA short-term study abroad courses to a variety of locations, including Rome, Beijing, Santiago, and Johannesburg. In addition, the second author lived in Shanghai for two years, where she worked as a faculty member in an international university, and she has served as director for an international full-time MBA program that included longer-term cultural immersion in multiple overseas locations. The third author, a recent Jesuit university graduate, participated in summer study abroad courses in Greece and Rome.

Learning about Sustainability in Chile

Our first study abroad and sustainability example draws from an advanced-level MBA elective course entitled "International Dimensions of Cross-Cultural Management and Marketing" (cross-listed to maximize enrollment options for students). It was a quarter-long course that included a 10-day intensive learning trip to Santiago, Chile and its environs. In addition to daily course meetings, the class included complementary visits to the Santiago corporate offices of both local Chilean multinational companies and the Latin American headquarters of U.S.-based firms. The students were typical graduate students in a part-time evening MBA program based in a major, ethnically-diverse, Midwestern metropolitan area and business center.

In addition to other standard course requirements (e.g., an exam and a group project), this class included an individual written assignment focused specifically on sustainability. 0The assignment asked students to:

> Choose any topic related to environmental sustainability. Investigate and do a comparative assessment of the planning, policies and execution of this topic in the U.S. and in Chile. The topic should be one that stimulates your interest and curiosity. Some examples are the recycling of a specific item, water, air pollution, car emissions, LEED building certification, energy saving appliances, hospital or human waste, farming chemicals, etc.

Students were encouraged to do preliminary research on their topic at home before leaving for the study abroad trip, with the dual objective of preparing for the cross-cultural experience and beginning the reflective practice exercise (Smart & Csapo, 2007). Also (as with the standard course), the instructors included (before the trip) the same two-hour lecture and discussion module about sustainability, the triple bottom line, and metrics about sustainability performance. The students chose their topics, summarized in Table 1 below. Figure 1 presents the grading rubric for the assignment.

Table 1. Sustainability Projects from Chile Study Abroad Class (n= 16 projects)

Project Focus	Environmental	Economic	Social
Public Transit and Reducing Air Pollution	X		
National Energy Infrastructure/Grid	X		
Energy Sector and Alternative Energy Sources	X	X	X
Nuclear Energy	X		
Automobiles: Planet-Profit-People *(two projects)*	X	X	X
Automobiles: Air Pollution and Affordability	X	X	
LEED-Certified Buildings	X		
Construction: LEED-Certified and Seismic Safety	X		X
Green Construction	X		
Youth Activism		X	X
Higher Education Quality and Accessibility		X	X
Immigration (Legal and Illegal)		X	X
Innovation and Economic Development		X	X
Deforestation: Environment and Economy	X	X	
Stray Dogs			X
Totals	**11**	**9**	**9**

Figure 1. Grading Rubric for U.S./Chile Assignment

The assignment: Short individual paper

Choose any topic related to environmental sustainability. Investigate and do a comparative assessment of the planning, policies and execution of this topic in the U.S. and in Chile. The topic should be one that stimulates your interest and curiosity. Some examples are the recycling of a specific item, water, air pollution, car emissions, LEED building certification, energy saving appliances, hospital or human waste, farming chemicals, etc.

The context: MBA course in Santiago, Chile

The outcome: Project grading rubric (100 points)

Relevance of Topic for Comparison ______/5

U.S. Topic
- Planning and Policies ______/15
- Execution ______/15

Chile Topic
- Planning and Policies ______/15
- Execution ______/15

Comparative Assessment ______/20

Connection to Course Content ______/15

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Although the Chile course assignment specifically referenced environmental sustainability, Table 1 shows that 4/16 (25%) student papers did not examine the "planet" aspect of sustainability, while 9/16 (56%) included an economic focus and 9/16 addressed social sustainability issues. These results provide an interesting comparison to the Table 3 topic summary from the standard courses, in which only 30% of the student projects addressed either economic or social sustainability, while 100% of the student projects addressed environmental sustainability—even though this dimension was neither specified nor required. One conclusion could be simply that these students did not follow the assignment instructions. A different conclusion—and our proposition—is that their personal experiences in Chile yielded a transformative experience, in that these students discerned other significant elements of sustainability beyond environmental concerns. While the sample is small and common method bias is present, we argue that these results do suggest that the study abroad experience encouraged students to adopt a broader view of sustainability and the triple bottom line of planet-profit-people.

Learning about Sustainability in Johannesburg

The second author also incorporated a sustainability dimension in her five-week study abroad trip to Johannesburg, South Africa. The method of inquiry differed somewhat in this setting, as students were formally assigned to a specific non-governmental organization (NGO) for their group projects. In addition, this longer residency required students to adjust to daily life in an unfamiliar country, and much time was spent informally exploring and comparing differences between their native culture and their new setting.

Students connected with one of five NGOs that they were charged to investigate and assist, in the format of an unstructured business service project. Prior to the students' arrival, each organization had submitted a list of specific desired deliverables, most of which were marketing tactics. The student groups spent five half days with their focal organizations, observing business practices, reviewing policies and data, and working towards a set of recommendations. To provide structure to this ambiguous business environment and to assist in analyzing the existing situation, students used a business plan template as a guideline.

Although a few environmental issues arose in their project analyses (predominantly a move to paperless transactions and communications), the primary foci of their formal written assignments were upon economic and social sustainability. Since the five NGOs were non-profits, depending heavily upon volunteer help and donor contributions, these two aspects dominated when assessing their continued viability and potential growth. Table 2 summarizes the NGOs studied, with their main sustainability foci. As shown, all five written student analyses included both social and economic dimensions, while three of the five also had elements of environmental sustainability.

Table 2. Sustainability Projects from South Africa Study Abroad Class (n= 5 projects)

Project Focus	Environmental	Economic	Social
NGO preparing 18-year-old high school graduates for employment		X	X
Paleontology Museum	X	X	X
Anglican Diocese	X	X	X
Distance Learning Continuing Education Institute		X	X
Catholic Institute for Education	X	X	X
Totals	**3**	**5**	**5**

The Johannesburg results may be skewed by the focus of the assignment (an organization with not-for-profit status), and the sample size (n=5) is small. Nonetheless, these outcomes do reinforce our findings from the Chile experience: student experiences in the novel environment of study abroad contribute to broader discernment and analysis in the sustainability domain.

Learning about Sustainability in a Regular Course

As discussed earlier, we also wanted to examine how our experiences with these international study courses compared with similar assignments in 'regular' courses. The first author has taught an MBA elective class about organizational change for over twenty years. Several years ago, she added a sustainability-focused assignment to the course requirements, as an illustration of an organizational change initiative. A brief description of the assignment is as follows:

> *Field Study of a Strategic Change involving a Corporate Sustainability Initiative*
> This project is designed to allow your group to analyze a change situation involving sustainability, using the organizational change concepts and frameworks we will be using in class. The in-class presentations will also illustrate the variety of organizational development (OD) interventions being used by organizations to implement sustainability initiatives. In addition, the project will let you apply the research and data collection methods we will be studying.

To prepare the students for the project, the instructor provided a two-hour lecture and discussion module about sustainability, the triple bottom line, and metrics used to assess the net impact of sustainability performance. Classroom lecture and dialogue emphasized the broad nature of sustainability, with many examples of initiatives in the three different domains of environmental, economic, and social sustainability.

Table 3 summarizes the project topic choices for four different sections of this course taught during the past four years. As shown, all 20 projects addressed a sustainability issue with an environmental dimension. Six of the 20 project topics (30%) also considered economic aspects of sustainability, while another 5/20 (25%) included social sustainability issues in their analysis. The sample size is small and limited to one instructor's courses, but the default choice seems clear: without a transforming experience, students 'think green' first when they consider sustainability.

Table 3. Sustainability Projects from 4 Standard MBA Classes (n= 20 projects)

Project Focus	Environmental	Economic	Social
University Biodiesel Fuel Lab	X	X	
University Water Bottle Ban	X		X
City Neighborhood Curbside Recycling	X		X
Keurig K-Cup Disposal	X		
Computer Retailer Cardboard Recycling	X	X	
Commercial Printer Recycling Paper, Soy-based Inks	X		
Hospital Pharmaceutical Waste Disposal	X		
Hospital Repurposing Surgical Instruments	X	X	
Toyota Hybrid Cars	X		
Target's In-Store Sustainability Initiatives	X		X
Nike Sustainable Business and Innovation	X		X
Empire State Building LEED Retrofit	X	X	
Real Estate Management Firm's Tenants-Go-Green	X		
Manufacturer Reducing CO2 Emissions	X		
CDW beGreen Warehouse Initiatives	X	X	
Grainger & Carbon Disclosure Project	X		
Residential Recycling in New York City	X		X
Keurig Water & Product Sustainability Initiative	X	X	
Back 2 MAC Cosmetic Container Recycling	X		
Waste Management's Think Green Initiative	X		
Totals	**20**	**6**	**5**

Learning Outcomes

This paper explores how linking sustainability, study abroad, and the opportunity for deeper reflection may positively impact student learning about sustainability. Using observations and student projects from two MBA study trips (one to Santiago, Chile and one to Johannesburg, South Africa), we found that learning outcomes about the broad spectrum of sustainability issues may be enhanced through participating in the study abroad experience. Students experienced an enriching learning environment while immersed in another culture and country (Tellis, 2011; Schein, 2015), and through careful observation, they often unpeeled layers to reveal underlying causes beneath the surface. For example, in Johannesburg, students who witnessed people scavenging through trash, trying to salvage plastic and glass bottles to redeem for small amounts of cash, could easily connect environmental, economic, and social sustainability.

Critical thinking skills were also enhanced through the opportunity to visit a variety of business organizations, ranging from multinationals to entrepreneurs and traditional craft markets, to see firsthand the methods of sustainability at work. Compared to business students enrolled in regular classes, we argue that these students displayed deeper connections with economic, social, and environmental issues, as reflected both in their informal classroom discussions and their formal written assignments. This outcome supports the learning fostered by the Ignatian Pedagogy Paradigm of experience, reflection, and action (Beabout & Wilson, 2014).

As noted above, Tables 1 and 2 illustrate that in both the Chilean and South African classes, students chose a broad array of topics for their written papers. But almost all included at least two dimensions of the triple bottom line, compared to the predominantly environmental focus of the standard classes summarized in Table 3. In addition, those students who did focus upon environmental impact were also able to connect it with other related effects. For example, one student in the Chile course examined air pollution and its link to transportation, noting, "Santiago made a strategic choice to invest its infrastructure budget in building and strengthening its public transportation system, over building new roads." Another perceptive student explored the link between innovation and sustainability. She stated,

> The world is looking to Chile's mineral resources to fuel growth and to support the tech[nology] industry. The question is whether Chile can use the economic engine from mining demand to create a sustainable, diversified economy to support its long-term political stability.

Similar student reactions were evident in South Africa. Students discussed the jump to cellular phone technology, smart phones, and 4G technology, at a level more advanced than the U.S., in a developing country that never had landlines for its telephone service. Another example: the class visited a private school in Soweto in the process of building a new facility projected to be completely off the electrical grid. The facility will use solar power hand pumps to extract water from its reservoir, geothermal heating and cooling, and hydroponic gardening to assure a supply of fresh food to the students and the local community. This advanced sustainability thinking is happening in one of the poorest areas of Johannesburg.

Indeed, the discovery that emerging markets such as Chile and South Africa may be ahead of the United States in implementing sustainability initiatives was an unexpected lesson learned for (potentially ethnocentric) American students. In Santiago, we saw office buildings that were not just LEED-certified but were truly green: covered with panels of native moss that served as natural insulation. In Johannesburg, the prevalence of solar energy for people's homes provided a concrete example of how major environmental initiatives may be rolled out at the individual level. The innovative mindset needed to move the sustainability agenda forward (see Nidumolu, Prahalad, & Rangaswami, 2009) may be especially suited to the rapid economic development of emerging nations. A recent global survey found that "Developing countries and emerging markets had the highest rate of innovation and profiting from sustainability" (MIT/Sloan, 2012).

Implications and Conclusion

Multi-cultural mindsets are critical to improving business practices and diversity awareness, both in students' home countries and abroad. According to Orahood, Kruze, and Pearson (2004), business students who study abroad are more open to international careers. This experience helps to strengthen their content knowledge and employability. Peppas noted,

Globalization is here to stay, and companies across the world are realizing the importance of having employees with a global mindset. As companies cut costs, many provide little or no on-the-job training to hone employees' cross-border skills. It is thus the task of colleges and universities to prepare students to function and excel in the new and challenging global business environment of the 21st century (2005, p. 143).

Through widening their perspective on global business, students with study abroad experience may serve as constructive critics of cultures and business practices (Stephenson, 1999), including the sustainability domain. As an illustration, when discussing higher education opportunities in Chile, one student observed,

> [T]he greater concern is social sustainability, particularly in terms of equity and equal opportunity…the socioeconomic homogeneity of the [upper class only] university populace means that diverse viewpoints are not being shared, which has negative effects on both academic knowledge creation and practical knowledge transfer.

As Rimanoczy (2014) notes, developing a new sustainability mindset has a direct impact on shaping the next generation of leaders, and Schein's results (2015) provide further support for the impact of direct personal experiences on ecological worldviews.

By living and learning in a different country, students can experience facets of life abroad that would not otherwise be included in a standard course. By utilizing a "green" public transportation system, using electricity saving key cards in hotel rooms and being exposed to water shortages and power outages, students become more aware of sustainability in action. Reflecting on and learning to adapt to these daily examples of sustainability measures helps to integrate class content within the cultural context, with the potential for a transformative experience through the use of the IPP's experience—reflection—action framework. Dwyer's (2004) study demonstrated that study abroad may have a significant impact for students with respect to language ability, academic attainment, intercultural and personal development, and career choices. Most importantly, the study showed that the impact can be sustained over the long-term (50 years). Linking sustainability and study abroad is thus one means of bridging the gap between content and context, and helps students integrate these experiences for long-term learning and application. These experiences provide the opportunity to apply the potentially transformative experience, reflection, and action elements of Ignatian pedagogy.

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Tax Incentives for Innovation in Brazil: Obstacles for Use of the Good Law (Law 11.196/2005)

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Abstract: Brazil has a mix of instruments to support research and development activities, including grants and tax incentives. Among these policies, it is referred to the Law 11.196/05. According as the historical series, since the implementation of the law, the number of companies using the benefits has grown exponentially, but the number of beneficiaries is still very low. This article presents the results of the study with a group of 100 companies. The objective was to verify the innovation management practices used by these companies, as well as the main obstacles encountered by them to make use of tax incentives of the Good Law. The results showed that the biggest obstacle for use of the Good Law is the profile of the innovation projects. Companies need to actually differentiate improvement projects of the innovation projects. The minority of companies develop projects that exceed scientific or technological boundaries or having aspects out of the company's development scope.

Keywords: Tax incentive; Good Law (Law 11.196/2005); Innovation.

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Introduction

Companies mostly use their own resources to invest in research and development. According to Industrial Research of Technological Innovation, in Brazil, 87% of innovative companies use their own resources to carry out activities for innovation (IBGE, 2013). Mainly due to the risks involved and the return time, which tend to be larger. Thus, fiscal incentives such as those offered by Law 11.196/2005 (Good Law) should be more attractive for companies, having in mind that the company reduces from the income tax up to 100% of investments in research, development and innovation (RD&I). With this kind of incentive, the company reduces the risk of acquiring a debt to develop a technology that may ultimately fail in the marketplace.

However, according to the report released by the Ministry of Science, Technology and Innovation - MCTI (2015), in Brazil, in 2013, only 0.7% of companies with tax adequacy use the benefit. According as the historical series, since the implementation of the law in 2006, it is observed that the number of companies using the benefits of the law has grown exponentially, but the number of beneficiaries is still very low compared to the number of companies choosing for real profit tax (one of the prerequisites to enjoy the tax incentive).

This scenario refers to some research questions:

- Why do just few companies use the benefits of the Good Law?
- Do the companies opting for real profit tax know the Good Law?
- Do the requirements for adequacy and use of the Good Law are exclude?
- Do the companies opting for real profit tax do not use the Good Law because they do not present innovative projects?

It was observed in the literature the lack of studies to further investigate these issues from the point of view of businesses with tax adequacy to the incentives of the Good Law. Studies that support the analysis of the use of tax incentives in the business perspective do this without restrict the companies opting for real profit tax (Bueno, Torkomian, 2014; Bergamaschi, 2009).

The existing literature on the subject is divided basically into two lines:

(i) analysis of the group of companies that already use the incentives of the Good Law and its relationship with economic performance and investment in RD&I (Zittei, et al, 2016; Fabiani, Sbragia, 2014; Chaves, 2016; Calzolaio, 2011; Formigoni, 2008).

(ii) studies that analyze the profile of tax incentives for the innovation in Brazil (Bueno, Torkomian, 2014; Pacheco, 2011).

This article aims to answer these questions by bringing a piece of the data collected under the project "Program of Incentives for the Use of Tax Benefits of Good Law" The project coordinated by Euvaldo Lodi Institute of Santa Catarina (IEL/SC), supported from the Ministry of Science, Technology and Innovation (MCTI), aimed to raise awareness among companies of the taxable income to make use of tax incentives of Law 11.196/2005. This article presents the results of the study with a group of 100 companies opting for real profit tax. The objective was to verify the innovation management practices used by these companies, as well as the main obstacles found by them to make use of tax incentives of the law.

Innovation

Innovation is what promotes long-term growth of an economy and ensures its competitiveness globally. Technological innovation, according to Schumpeter (1988, p. 76), creates a break in the economic system by changing patterns of production and providing differentiation for the company.

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The definition of innovation used in the Oslo Manual (2005, p.55 §146) is more lenient on the break in economic systems. The impact of innovation can only be for the company and not to the market. "An innovation is the implementation of a product (goods or services) new or significantly improved, or a process, or a new marketing method, or a new organizational method in business practices, workplace organization or external relations". Indeed, the Oslo Manual is intended to guide and mainly standardize concepts, methodologies, in order to provide a common language to build statistics and RD&I indicators of industrialized countries and Organization for Economic Co-operation and Development - OECD.

In Schumpeter's view, innovation is an aspect of business strategy or part of a set of investment decisions to create product development capacity or to improve the company's efficiency. Innovation should lead to broad and extensive changes to restructure industries and markets (Oslo Manual, 2005, §80).

As the Oslo Manual is quite comprehensive and flexible as their definitions and methodologies of technological innovation, it has been one of the main references for innovation activities in Brazilian industry (Canto in Presentation Oslo Manual, 2005).

In Brazil, the law 10.973 / 2004 (art. 2 IV), known as the Innovation Law, provides measures to encourage innovation, scientific and technological research in the production environment. This law defines innovation as "the introduction of novelty or improvements in the production and social environment that results in new products, services or processes or knowledge the addition of new functionality or features to the product, service or existing process that can result in improvements and effective gain in quality or performance".

Conforming to Drucker (2013), innovation involves economic value, i.e. innovation is the ability to create wealth through features. The feature does not exist until man finds a use and thus contemplates the economic value. This definition is used by the author for both social and technical sphere.

For the authors Tidd, Bessat and Pavitt (2008), innovation is not static, and is not always related to something that is already part of the competencies of a company. In this case the innovation involves taking risks and exploring normally scarce resources on projects that may fail.

But despite the risks, breaking projects (with disruptive innovation) bring the greatest financial returns for the company in medium and long term (Nagji, Tuff, 2012).

As reported by Calzolaio (2011) the most developed countries began to use fiscal policy as an important tool to support innovation. OECD countries used it as a true development policy instrument. It is applied vertically to encourage small business sectors in particular and specific regions and companies without taxable income.

Incentive to Innovation

Brazil has a mix of instruments to support research and development activities, including grants and tax incentives. The main reason of these incentives is to leverage private investment and support increased productivity of the economy. The Government's support to innovation and RD&I activities in private sector have increased since the creation of the Sectorial Funds. Considering all the instruments, Government's support puts Brazil among the countries that most support the private effort in RD&I (Pacheco, 2010).

The big difference between Brazil and the countries of the OECD group is the low investment in RD&I performed by the private sector. When compared to public investment, it is observed that the 0.59% of the Gross Domestic Product (GDP) is very close to the 0.69% invested by all the OECD countries (Cruz; Chaimovich, 2010).

According to Chaves (2016) Brazil has sought to adopt public innovation policies to stimulate business investments in research, development and innovation. Among these policies, it is referred to the Law 11.196/05, aim of this article.

The Brazilian government published a provisional measure (MP) 694/2015, as part of the fiscal adjustment that announced the suspension of the tax benefit provided for in Chapter III of Law 11.196 / 2005. However, on March 8, 2016 ended the deadline for conversion of MP 694/2015, which fell by lapse of time, and consequently, the Good Law has effectiveness again. Thus, the incentives for Research, Development and Innovation for Brazilian companies (Chapter III) remain valid.

The Good Law and Incentive to Innovation

Law 11.196/05, also known as the Good Law, is an incentive granted by the Federal Government, through tax breaks for companies of any segment that invest in research, development and innovation.

The activities of research and development are self-declared by the companies and they take the responsibility, business risk, management and control of the use of the results of the expenditures.

The Table 1 shows the requirements for adequacy of the company and the main benefits granted by the Government.

Table 1. Requirements and benefits of the Good Law.

Requirements for adequacy	Main benefits
· Be opting for real profit tax. · Have obtained tax profit for the year that held investments in RD&I. · Conduct research, development and innovation in Brazil. · Fiscal Regularity. · Fill and send the form to the MCTI with information about the project.	· Income tax and social contribution of exclusion: 60% to 80% of expenditures in research and development. · 50% reduction of the IPI: Acquisition of equipment for RD&I. · Depreciation and accelerated amortization: 100% year acquisition - Exclusive RD&I. · Complementary exclusion - income tax and social contribution: 20% RD&I expenditures, patent object or cultivate. · Reduction to 0% withholding tax: Remittances abroad for the maintenance of trademarks and patents cultivars.

Data from Law 11.196/2005.

To grant the benefit, the evaluation committee MCTI analyzes the innovation projects by three criteria: (i) technologically new elements; (ii) barrier or technological challenges; (iii) used methods.

Conforming to Tininis (2015) it is in these three items that companies have more difficulty. It is an open field on the form in which the company has up to 500 characters to describe each item. The difficulty is not the restriction of text size, but the difficulty in characterizing innovation in the activity. The projects have little technological risk and are more characterized as engineering problems than RD&I projects. In fact, according to Longo and Silva (2016), the concepts of improvement/modernization and innovation are often confused, invalidating excellent opportunities for companies seeking financial support. The innovation projects are characterized by the exploration of new methods or processes, exploring new paths, features and materials. The main focus is the development, and it is precisely at this stage that operates the tax incentives of the Good Law. The incentives act in a phase that occurs technological risk.

The Good Law mainly operates in the following phases:

a) directed basic research: purpose of gaining knowledge about the understanding of new phenomena, with a view to developing products, processes and innovative systems;

b) applied research: the objective of gaining new knowledge, with a view to the development or improvement of products, processes and systems;

c) experimental development: systematic work outlined from pre-existing knowledge, in order to prove or demonstrate the technical or functional viability of new products, processes, systems and services, or even an obvious improvement of already produced or established.

With this kind of incentive the company ceases to run the risk of acquiring a debt to develop a technology that may ultimately fail in the marketplace. Most of the activities related to research and development project are eligible. Table 2 shows the types of eligible and ineligible expenditures in the Good Law.

Table 2. Types of eligible expenditure.

Eligible expenditures	Ineligible expenditures
Human Resources.	Individuals or legal entities located abroad.
Consumption material / Equipment.	Administrative and financial management of RD&I projects.
Travel for execution of the project.	BackOffice RD&I.
Third-party services (Institutions of Science, Technology and Innovation, Micro and Small Enterprises).	Rental and maintenance of assets.
Specific training for the project.	Charges for depreciation and amortization.
	«Outsourcing» of RD&I.

Data from Good Law (11.196 / 2005).

Chaves (2015) investigated the effectiveness of the Good Law on the profitability of companies. The author measured the effect of the Good Law on Return on Assets (ROA) of publicly traded companies. The sample consisted of 173 companies, including companies that use and do not use the incentives of the law. The study results support the conclusion that the Good Law is a government mechanism that causes positive results in the economic performance of companies. According to the author, the transfer of government values to private sector through the Good Law has caused actual results in the economic performance of companies, which suggests that this instrument meets its objectives. This profitability impacts not only on increasing benefits company's competitive to the market, but also in the economic development of the country.

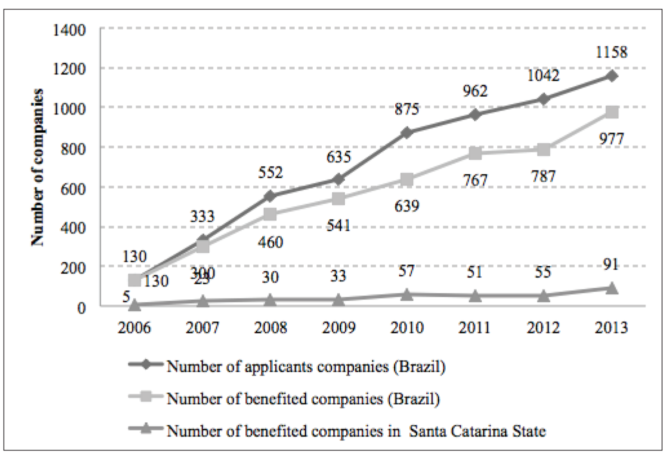
Calzolaio (2011) examined whether the companies using the Good Law intensified its research and development activities after receiving the tax incentives of the law. The study showed that the Good Law strengthened innovation, i. e. the companies that have used it spent on RD&I as never since 1998. There was efficient in reducing the cost of innovation activities and the expansion of innovation plans already in place. The Good Law not expanded the base of innovative companies, but intensified RD&I activities of companies that were already veterans in innovation. The tax incentive is an appropriate tool to induce greater amounts of innovation activities that are being performed.

However, Zittei et al (2016) concluded that the amounts spent on innovation by companies that enjoy the Good Law do not influence the nations competitiveness index. The relationship is between the number of companies investing in RD&I and not on the amount invested. This reinforces the importance of raising awareness among a larger number of enterprises to use the tax benefits of the law.

According to Pacheco (2010) the difficulty for increases the use of the Good Law is that the benefits focus on a small number of companies. The incentives of the Good Law are limited to companies opting for real profit tax. However, even if the benefit is restricted to such companies, the number that enjoys these benefits is extremely low.

In Chart 1 are illustrated the historical data with the number of companies requesting benefit since the creation of the Good Law. As can be seen, despite having increased the number of the companies using incentives over the years, this amount is still small.

Chart 1. Historical series with the number of companies that applied for and used tax incentives of the Good Law (Law 11.196 / 2005).



Adapted MCTI (2015).

In Santa Catarina, a Brazilian state, where the study was conducted, in 2013 only 91 companies received the benefit of the Good Law. The state has 9175 companies opting for real profit tax. Only 1% of these companies requested benefit. The state has an important industrial park, representing the 6th largest economy in Brazil, and the 4th state in number of manufacturing industries (IBGE, 2016).

In a survey conducted by the Public Leadership Centre (2015), Santa Catarina occupies the 3rd position in the ranking of the competitiveness of states. The study analyzes 10 categories: market potential; infrastructure; human capital; education; social sustainability; public security; fiscal sustainability; public machine efficiency; innovation; and environmental sustainability. In the innovation category, which analyzes public investment in RD&I (the number of patents applied and academic production) the state also occupies the 3rd position in the ranking. In this pillar, the average utilization of Brazil was 24%, while Santa Catarina got 62%. In the number patent applications, the state had 100% success.

These results show that the state has companies with the ability to RD&I and also has infrastructure installed for conducting research and development.

Methodological procedures

This article provides a cut of the data collected under the project "Program of Incentives for the Use of Tax Benefits of Good Law ". The project was coordinated by Euvaldo Lodi Institute of Santa Catarina (IEL/SC) and was supported by Ministry of Science, Technology and Innovation (MCTI), aimed to raise awareness among companies of the taxable income to make use of tax incentives of Law 11.196/2005.

One of the project phases was conduct a survey about innovation practices and the adequacy of companies opting for the real profit tax with requirements of the Good Law. The objective was to verify the reasons why companies do not use the tax benefits of the Good Law. This article presents the results of this survey.

To meet this goal we carried out a search of mixed methods. According to Creswell (2007, p.27) research mixed methods "is a research approach that combines or associates qualitative and quantitative ways." They are two approaches with antagonistic characteristics, so the analysis of the data was combined in a complementary way. The choice of this technique has mainly for two reasons:

i) Because it is a descriptive study, the executing agency of the project - Euvaldo Lodi Institute of Santa Catarina - had to have statistical information that allowed propose actions to promote the industry competitiveness of the state. Thus, a survey was the most suitable method.

ii) However, as the survey addresses issues related to the adequacy for RD&I projects to the tax incentive of Good Law, it was necessary to analyze in more detail the specificities of each company. For the kind of detail needed, conducting in-depth interviews with semi-structured script was the most appropriate technique.

Thus, the study was conducted in two stages. The first consisted in the survey with a group of companies opting for real profit tax. The objective was to verify if companies knew the Good Law, had innovation practices, and adequacy to the minimum prerequisites for using the tax incentives of the Good Law. In the second stage of the study were conducted in-depth interviews with 30 companies in order to check the composition of RD&I projects to the law incentives and analyze the perception of the company related to the law.

Frame 3. Methodological description. Data from authors.

	Kind of research	Objectives	Sample size
Step 1	Quantitative	· Verify whether the companies opting for tributary of the taxable income regime know the Good Law. · Explore whether the group of companies have practices that promote innovation, and conduct research and development activities. · Analyze whether companies meet the minimum requirements framework for using the incentives of the Good Law. · Examine the management controls of expenses incurred in RD&I.	100 companies
Step 2	Qualitative	· Observe the adequacy for RD&I projects to the incentives of the Good Law. · Examine the perception of the company in relation to the law.	30 companies selected in step 1.

Below are detailed the techniques used at each stage of the research.

Procedures Step Quantitative

Data collection instrument

The data collection instrument was developed from instruments already validated and widely used to evaluate the innovative practices in Brazilian companies. It was used as a reference the questionnaires used by ABDI (2015); Souza and Ruthes (2013); and IBGE (2012). On the questions that assessed the adequacy of the companies to the Good Law requirements, it was used as basis the own Law 11.196/2005, and the form used for MCTI to analyse the investiments in RD&I.

To evaluate the innovation practices and the adequacy of the Good Law were developed two indexes. We used Cronbach's alpha to measure the reliability and internal consistency of the scale (Curtain, 1993). The test results validated the two indexes, Innovation Practices obtained 0.84 and Adequacy with the Good Law obtained 0.87.

The pre-test questionnaire was conducted with a group of eight companies, four users of the tax incentives of the Good Law, and four non-users. The purpose of the pre-test was to determine whether respondents understood the questions and see whether the questions really differentiated companies. The user companies of tax incentives of Good Law obtained the best results in indexes of Innovation Practices and Adequacy with the Good Law.

The questionnaire was developed for self-administrated and the form of data collection was carried out online, by Survey Monkey tool. The consistency of all responses was verified by the research team after the full completion of the questionnaire. If inconsistencies were noted in the answers, respondents were again contacted to verify the validity of the answer.

Population and Sample definition

The study population are all industries with headquarters in Santa Catarina opting for real profit tax. The Microsoft Dynamics CRM (Customer Relationship Management) was used to access the contact information of the industries. This software is used by the Industry Federation of Santa Catarina State - FIESC. In the data collection period - between the months of July 2015 and March 2016 - had been 2.346 (N) industries by the real profit tax.

All industries received invitation, either by email or phone contact, to participate in the survey. Invitations were addressed to those responsible for areas: accounting; financial; engineering; development; or marketing. At the end of the data collection period, 100 (n) companies had responded to the questionnaire. Considering the level of confidence of 95%, the survey error margin was 10%. The actual practice, these studies, in general, it does not have a purely probabilistic analysis. That is, with a random sample. In this study, it is a representative purposive sample.

Qualitative stage procedures

The relationship between the levels of innovation practices and the adequacy of the Good Law allowed positioning of the companies in areas of expertise. Those with better positioning in both indexes received a free consultancy to check the composition of innovation projects to the requirements of the law. During the consultancy there were conducted in-depth interviews.

The qualitative stage provided greater understanding regarding the research and development activities undertaken by the company. The purpose of this step was to observe the adequacy of RD&I projects to the incentives of the Good Law. The interviews in-depth guide was designing by three consultants specialized in the Good Law. The guide of interview had questions about insecurity, bureaucracy, governance issues and knowledge of the law.

The interview lasted approximately two hours. For confidentiality reasons, since it dealt with issues related to RD&I projects, interviews were not recorded.

The interview was conducted by two consultants specializing in the implementation and management of incentives provided by the Good Law. At the end, information interviews were transcribed and tabulated in order to measure the results.

Results

All companies in the study are opting for real profit tax and they operate in different segments of the economy, such as: food industry; machines and equipment; technology of information and communication; textile; chemicals - plastics; and construction.

The sample was composed by companies of different sizes, but with a predominance of medium-large companies (Table 1). The rating of the BNDES (National Bank of Development) was used to categorize the size of the companies. This rating considers the revenue of the company.

Table 1. Business Size (classification by revenues).

Company size (BNDES rating)	Percentage
Large company (revenues exceeding R$ 300 million)	8.0%
Average large company (revenues exceeding R$ 90 million and less than R $ 300 million)	26.0%
Medium business (revenues exceeding R$ 16 and less than R $ 90 million)	41.0%
Small business (revenues exceeding R$ 2.4 and less than R $ 16 million)	19.0%
Microenterprise (lower revenues of R$ 2.4 million)	4.0%
Uninformed	2.0%
Total	100.0%

Source: primary data - Survey of 100 companies.

Although the researched companies self-reported as innovative, over half (54%) of companies do not have a formalized area of RD&I (Table 2).

Innovation processes must permeate throughout the organization. The activities should not be restricted to one area. However, for the management of innovation, is needed to monitor indicators, monitor actions, etc. The RD&I area is responsible for monitoring these processes and propose improvements. The absence of a formalized area of RD&I hinders the systematization of innovation management.

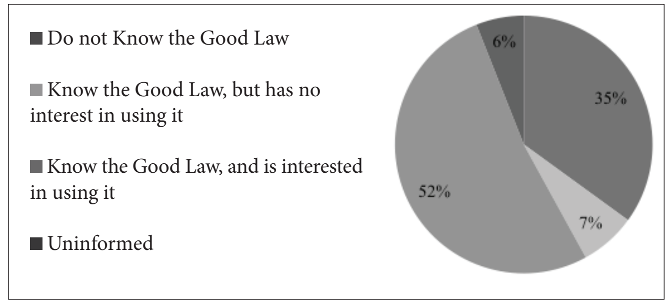
Table 2. The company has formalized area of RD&I.

Formalized area of RD&I	Percentage
It does not have RD&I area formalized	54.0%
Yes, it has RD&I area formalized	44.0%
Uninformed	2.0%
Total	100.0%

Source: primary data - Survey of 100 companies.

It appears that a significant number of businesses unaware of the Good Law. Approximately four of ten company's surveyed claim to ignore the incentives granted by Law 11.196/2005. Just over half (55%) claim to know the law and have an interest in using it (Chart 2).

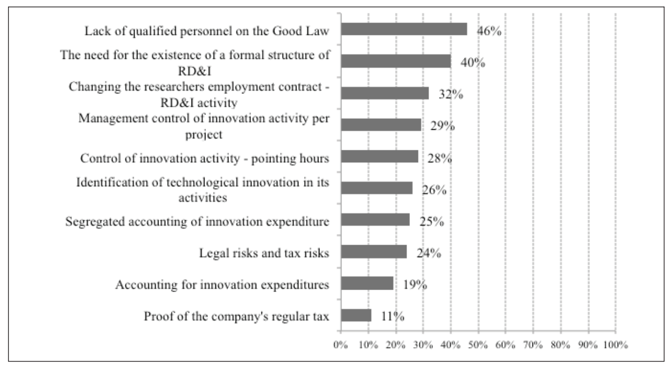
Chart 2. Knowledge of the Good Law.



Source: primary data - Survey of 100 companies.

When asked about the aspects that hinder the use of tax incentives of the Good Law (Chart 3), it appears that the major obstacles are the lack of professionals with sufficient knowledge of the law and the need for a formal structure for research, development and innovation. Proof of tax compliance was an item mentioned by the minority of companies.

Chart 3. Aspects that hinder the use of incentives of Good Law.

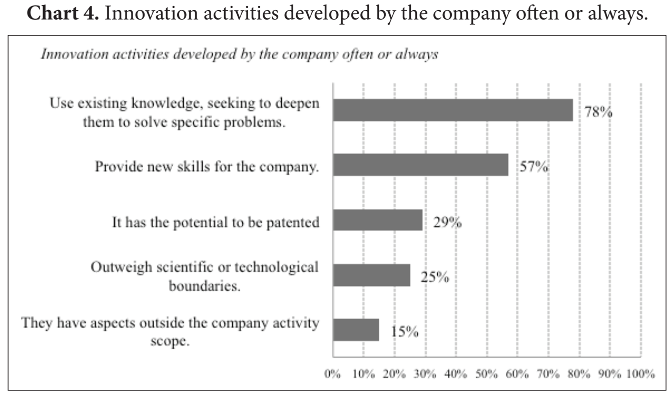


Source: primary data - Survey of 100 companies.

When analyzing the types of knowledge and novelty of research and development projects conducted by the company (Chart 4), it appears that the projects have low potential adequacy in the Good Law. The minority of companies develop projects that exceed scientific or technological boundaries or having aspects out of the company's development scope.

The projects, mostly, are limited to deepen existing knowledge in the company, seeking to solve specific problems.

Chart 4. Innovation activities developed by the company often or always.



Source: primary data - Survey of 100 companies.

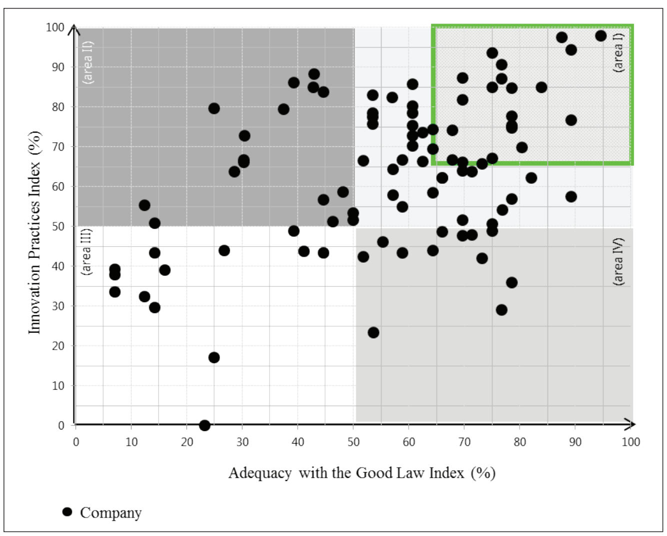
The scatterplot (Chart 5) presents the position of the 100 companies regarding the indexes of the practices of innovation and adequacy to the Good Law (on the horizontal axis contains the position of the adequacy to the Good Law, and the vertical axis shows the position in the innovation practices index).

Companies with higher performance in the indexes of innovation practices and adequacy to the Good Law are positioned well in the green area. Approximately 29% of companies have performance in index of innovation practices and adequacy to the Good Law above 65%. Theoretically, these companies have the potential to benefit from the tax incentives of the Good Law. However, you must check the eligibility of the projects according to the risk and technological challenge that claim to overcome.

Companies in the area II (dark gray), despite their good performance in the index on innovation practices, lack adequate to Good Law because they do not have structured innovation area with formal researchers, appointment of hours per project and expenses innovation escrowed apart. These companies need to "organize the house" if they want to resort to any kind of financial subsidy for innovation projects.

Companies positioned in the area IV (light gray) have innovation practices still "shy", but are already structured related to the management controls of expenditure on innovation.

Chart 5. Results innovation index versus adequacy of the Good Law.



Source: primary data - Survey of 100 companies.

The Good Law benefits the innovation projects. About that, a company may have more than one project with adequacy with the law. Then, for analyze the adequacy of the projects in the Good Law was necessary to visit the company. This brought more security for the company exposes their projects and, especially, gave the opportunity to clarify the main doubts of the company to fill out the MCTI form. So, 30 best performing companies in the indexes of Adequacy with the Good Law and Innovation Practices received a free consultancy with a specialist at Good Law.

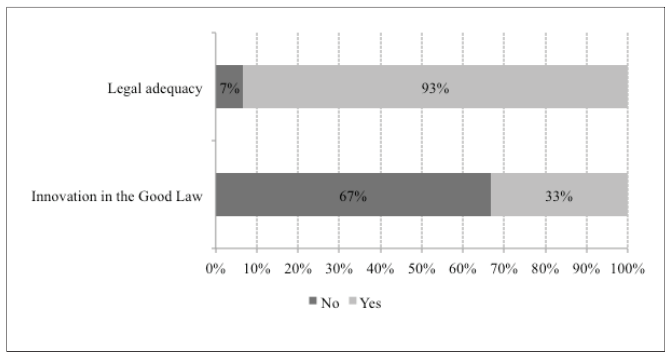
The main objective of the consultancy was to analyze the adequacy of the company's innovation projects to the main analysis criteria used by MCTI evaluators (technologically new element; barrier or technological risk; used methods).

Results of the consultancy – adequacy of projects in the Good Law

Companies that have received consultancy have the legal adequacy required to use the incentives of the Good Law (invest in innovation in Brazil, are opting for tributary of the taxable income regime, have regular tax and presented tax income in the base year). However, when analyzing the adequacy of innovation projects regarding new technological elements and barriers or technological challenges, it appears that innovation projects are, in most part, restricted to incremental innovations or product improvements/process.

Of the 30 companies that received the consultancy, only 1/3 had innovation projects with adequacy to requirements of the Good Law (Chart 6). That is, in fact present to gain competitiveness in the market.

Chart 6. Legal adequacy and Innovation in the Good Law.



Source: primary data - depth interviews 30 companies.

In addition to the adequacy of the projects, during the in-depth interview conducted in the consulting stage, was analyzed the perception of innovation team as (Chart 7): insecurity in using the benefits; bureaucracy to manage the resources invested; existing governance structure in the company to conduct activities of research and development; and knowledge about the law.

· Insecurity - this construct evaluates how the company has understanding about the Good Law and about the adequacy of their projects in the law. In the 30 companies visited, this construct was perceived as the greatest obstacle to the use of incentives of the Good Law. Companies have some uncertainty to the project adequacy according to the evaluation criteria of MCTI.

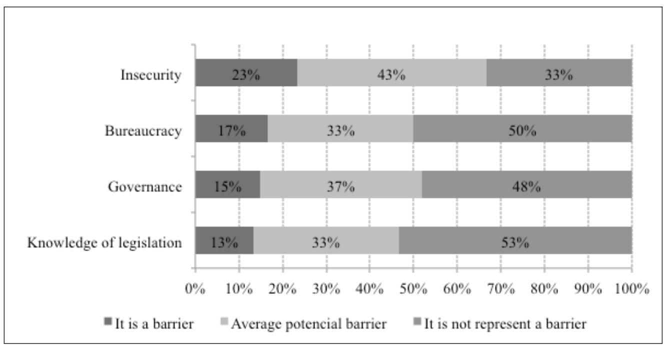
· These results corroborate those found by Fabiani and Sbragia (2014). The authors analyzed a group of 26 companies that use tax incentives of the Good Law. The main obstacles to use incentives the law are uncertainty in identifying the innovation process.

· Bureaucracy - this construct evaluates how the management of innovation expenditure can be seen as bureaucratic for the company (notes of hours per project, bookkeeping from innovation expenditure and project team of Research and Development formalized). It is noticed that few companies understand the controls as something bureaucratic. In fact the visited companies already have implemented these practices.

· Governance - make use of the Good Law involves different areas of the company. Therefore, it is necessary to establish governance in the company, involving different sectors of the organization. The visited companies do not observe the creation of a governance structure as an obstacle. The companies already have governance formed for the innovation projects or quality programs.

· Knowledge of legislation - this construct measures how the lack of knowledge of the law can be a hindrance. For the companies visited, knowledge of the law is not considered an obstacle.

Chart 7. Perception of potential barriers.



Source: primary data - depth interviews 30 companies.

Conclusion

It is known the growth of the country through the investment in research, development and innovation. In Brazil, the Federal Government, through MCTI, uses the mechanism of Good Law to encourage investment in innovation by the private sector. It seeks to approach companies from universities and research institutes, enhancing the results in RD&I. Companies need to take advantage of these tax incentives to be more daring in innovation projects, having in mind that almost 100% of the costs of the project can be reduced from income tax.

The group of companies that participated in the study is very diverse regarding the practices of innovation and adequacy to the requirements of the Good Law. The results of the survey with the group of 100 companies it can be concluded that most companies have projects with low potential of innovation to overcome technological boundaries - that provide greater gain in competitiveness. Most innovation projects use existing and dominated knowledge by the company, seeking only deepen them.

It was observed in the group of 100 companies surveyed, that the main reasons for non-use of tax incentives of the Good Law are the little knowledge about the law. It was found that both professionals working in accounting as research and development do not know the types of incentives granted and the type of project adequacy. Another important aspect presented in the study was the lack of a formalized structure for research and development activities.

It is not the kind of taxation that restricts the use of incentives of the Good Law, but the profile of the innovation projects. To increase the number of companies using the incentives of the law is not just a matter of extending the benefits for the companies deemed income. Companies need to separate improvement projects from innovation projects.

The results of this study showed that only 1% of the taxable income of the companies use the incentives of the Good Law. In other words, there are a significant number of companies opting for real profit tax that still need to be sensitized to the implementation of innovative projects that overcome technological barriers.

One recommendation is to encourage the rapprochement of businesses with science and technology institutions for the development of research projects and innovation. Such investment is also supported by the Good Law, provided that the activities are carried out in Brazil. This is a first step for companies that do not have installed structure of RD&I, or qualified professionals, to initiate the activities in this area.

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Country Competitiveness Relationship with Higher Education Indicators

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Abstract: This paper reports the performance of global competitiveness and higher education competitiveness between two groups of countries. The first group is formed by four Asian countries; the second one by four Latin American countries. Indicators from the World Economic Forum 2007-2015 are compared. The indicators with the nearest proximity were found in the management quality of the universities, where there was only a five-point difference in favor of the Asian group. The indicator with the widest gap came from the quality of math and sciences education where we found a difference of 104 points. This is congruent with the results of PISA 2012, which showed a difference of 152 points in math.

Keywords: higher education; competitiveness; Asian countries; Latin-American countries; quality in higher education; indicators of higher education; World Economic Forum; rankings of countries; competitive advantages; higher education systems.

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Introduction

This paper reports the competitiveness of the higher education system in two groups of countries. The first group includes four countries that Gregory and Stuart (2014) classify within the Asian development model because of their development styles. This model states that to achieve fast economic growth, "The government promoted universal education and investment in human capital, such as public health. The high levels of human capital at the start of growth contributed substantially to the rapid economic growth." (Gregory & Stuart, p. 348)

According to the World Economic Forum (WEF), these countries are in the third stage of competitiveness, which include the most competitive or developed countries. The second group is comprised of four Latin American countries that are in transition from stage two to stage three, i.e. they are moving from the stage of intermediate competitiveness to high competitiveness.

The theoretical framework was built by reviewing the categories of competition and competitiveness, which have been introduced in the economics of education studies, since they are processes with high influence in higher education institutions and for being theoretical dimensions that have been widely discussed from the last quarter of the twentieth century.

By analyzing the Global Competitiveness Index data (developed by the WEF), in particular the pillar number 5, also called *higher education and training,* we found out that from its eight components, Asian countries have achieved the best indicators in two components: *quality of the education system* and *quality of math and science education*. On the other hand, the Latin American countries of Group II observed a better performance in *quality of management schools* and *availability of specialized training services or local capacity for research.* We compared the performance of both groups regarding their competitiveness in the eight components and then we were able to determine the strengths and weaknesses of each educational system.

The main hypothesis of this research is that the performance of the fifth pillar and its components equally influence global competitiveness in both groups of countries. A secondary hypothesis is that the performance of the eight components shows a similar trend in their contribution to competitiveness for both groups.

To prove these hypotheses we used data from international organizations, such as the WEF, the United Nations Development Program (UNDP), and the Program for International Student Assessment (PISA).

Theoretical Frameworks

There are different models to analyze competitiveness within the countries. The first model is the one proposed by the German Institute for Development, which is known as "Systemic Competitiveness" and is founded in four levels: meta-economic, macroeconomic, meso-economic, and Microeconomic. In this model, higher education and all the government levels are part of the meso-economic level.

The Institute for Management Development (IMD) proposes a second model. This institute sponsors the World Competitiveness Center that presents an annual ranking of competitiveness, and in 2015 ranked sixty-one countries. Competitiveness is analyzed considering four primary factors: Economic performance, Government efficiency, Business efficiency, and Infrastructure

Each of those factors is divided into five sub-factors. The twenty subfactors are assessed considering 300 criteria. Education is the fifth sub-factor within the factor of infrastructure, which is evaluated using 18 criteria.

Considering Porter's theories and his Single Diamond (SD) model, in 2013 Cho and Moon developed other models with a higher number of variables, such as the Generalized Double Diamond (SD), the Nine Factors Model (NFM) and the Dual Double Diamond (DDD).

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Introducing an international variable in the existing domestic model SD creates the GDD model. The NFM is formed by introducing a diamond of human factors to the existing diamond of physical factors. The integration of these two extensions and the incorporation of international human factors into the single framework produce the DDD model (Cho and Moon, 2013, p.172).

Cho and Moon designed four rankings considering sixty six countries; the first one belongs to the simple model of Porter SD, the second one to the NFM, the third one to the GDD and the last to the DDD. Comparing the last three rankings to the SD, we found out that by introducing the variable of human capital, countries moved 3.27 positions on average. Likewise when the variable 'international' is considered (3.4 positions). Although, the greater variation in the positions happened when we introduced the variable 'international human capital' (5 positions on average). This means that the introduction of this variable in the DDD ranking, completely modified the original SD model by Porter, which agrees with Lane's opinion (2012) who states that Porter did not consider the institutions that form human capital in his analysis of competitiveness.

The WEF defines competitiveness "as the set of institutions, policies and factors that determine the level of productivity of an economy, which in turn sets the level of prosperity that the country can earn." (Sala-i-Martin, et. al, 2015, p. 4)

WEF assess competitiveness within the countries through the Global Competitiveness Index (GCI), which includes 144 indicators grouped in twelve pillars. The interest of this work is focused on pillar five of higher education and training.

The GCI includes statistical data from internationally recognized agencies; notably the International Monetary Fund (IMF), the United Nations Educational, Scientific and Cultural Organization (UNESCO), and the World Health Organization (WHO). It also includes data from the World Economic Forum's Annual Executive Opinion Survey to capture concepts that require a more qualitative assessment (Sala-i-Martin, et al, 2015, p. 5). 160 partner institutes from all over the world participate in the administration of the surveys and interviewed business executives.

In 2015, WEF ranked the competitiveness of 140 countries. They are ranked from 1 to 140 with 1 being the highest rank.

Moreover, there has been a considerable increase in studies regarding economics of education, economics of innovation and in general economics of knowledge and information. That is because these variables are strategic elements for promoting competitiveness in the countries.

Mongkhonvanit (2014) states that two forces have fostered the participation of the universities in the economy and consequently in the competitiveness of the regions. These forces are the rise of knowledge-intensive economic activities and globalization. Consequently, higher education system has experienced three main changes: *1)* a stronger linkage between government funding and economic policy with academic research; *2)* the development of more long term relationships between firms and academic researchers; and *3)* the increasing direct participation of the universities in commercializing research.

Slaughter and Rhoades (1996) pointed out that it was until the eighties of the twentieth century when public policies that promote education as a factor of competitiveness started to be implemented and competitiveness started to be understood through the concept of knowledge economy. Competitiveness begun to be part of the political agenda during the administrations of Reagan and Bush Sr. By that time, new narratives emerged related to the involvement of universities in the economies of emerging nations; governments and companies also started considering knowledge as an important factor of production; hence the promotion of policies that led the integration of universities to the productive world, which has been intensified by the globalization processes.

Carnoy (1995, p. 212) points out five changes that have been observed in the economies where education plays an important role: *1)* higher productivity is increasingly created from knowledge and information applied to production, and such knowledge is increasingly science-based; *2)* in the advanced capitalist societies production shifts from material goods to information processing activities; *3)* the organization of production and the economic activities in general change from mass standardized production to flexible customized production; *4)* the new economy is global; and *5)* these changes have been taking place in the midst of one of the most significant technological revolutions in the human history.

The commitment of science and education with the economy has increased, in particular with the productivity and competitiveness of countries. But competitiveness not only depends on scientific technological advances, "competitiveness depends increasingly on the coordination of, and synergy generated among, a broad range of specialized industrial, financial, technological, commercial, administrative, and culture skills which capacities can be located anywhere around the world." Mongkhonvanit (2014, p. 8).

Globalization processes combined with the global development model that is sustained by knowledge economy has resulted in the phenomenon of the pursuing global competitiveness, influencing policies and higher education decision and actions, which has also entered in a process of competitiveness in the global context. This is confirmed by Portnoi, Bagley and Rust (2010), who point out that competition among universities takes different forms, it can occur in the institutional, local, regional, national and global level.

The increase in the amount of works that address competition among universities has been remarkable. Marginson (2006) says that most universities aspire to achieve the best qualifications in the various quality indicators; their concern to be ranked in the higher positions of world-class universities lists have increased; institutions compete for funding research, and to enroll the best and brightest students and integrate its academic staff with academically distinguished professors. As Cabrera and Le Renard (2015, p. 12) say “The best research universities attract the best talents, perpetuating their presence and contributing to the country’s competitiveness.” Moreover, van Vught (2008) notes that universities are engaged in a race to achieve the best reputation. Levin & Aliyeva (2015, p. 540) states that: “Institutions compete for funds, faculty, students, and national and international rankings.” Higher education institutions are in a constant struggle to stay in the market, they strive to improve their status and prestige. The growing competition for higher status, prestige and financial resources has created a deepening stratification among the institutions (Levin & Aliyeva, 2015). The most common expression of competition can be seen in the emergence of a large number of university rankings.

Altbach (2016) states that the rankings are the inevitable result of the widespread growth of higher education, and the increase of competition and commercialization worldwide. Rankings have an increasing influence in the decision-making processes and in the implementation of higher education policies.

Production, dissemination and application of knowledge and information taken together constitute what is called knowledge economy. This economy, in several areas, overlaps with financial economy and the economics of production, which through various mechanisms such as innovation, participate in global competition, a process that defines and accelerates the knowledge economy, hence the integration of universities and research centers to global competition (Marginson, 2010). The old idea of universities integrated to national systems of innovation, coming mainly from the thinkers of economic evolution, has been undermined by the growing interdependence between nations and universities, as a result of the global flow of technologies, people, finance, languages and the transmission of ideas and data in real time (Marginson and Sawir, 2006).

In the search for a positive relationship between the quality of universities and the competitiveness of countries, Cabrera and Le Renard (2015) perform an econometric test, which found a strong correlation between the number of world-class universities in a given country with the level of competitiveness of such country. To reduce the possible impact that may be brought by the size of each country, the effect is normalized considering the number of inhabitants.

Higher education not only helps to improve innovation processes, it is also a critical factor to increase the competitiveness of developed countries economies (Ilon, 2010). By analyzing various countries, the same author reaches the conclusion that it is certain that higher education it is shifting from being just a service to the society to become a competitiveness factor for the industry.

The concept of competitiveness of the countries was introduced by Porter in 1990, with his book *The competitive advantage of nations* where he states that economic competitiveness of the nations in the 21st century would be created and not inherited, and he was right about it, because as Lane (2012) properly stated the pillars of competitiveness have been significantly transformed. Lane says that, twenty years ago the debate regarding the role that universities had in the increasing of competitiveness was minimum.

Porter focused his analysis almost exclusively on the firms and their role in the creation of factors that lead the economy and directed the activities within the universities, which were looking to satisfy the necessities of the industry. Comparative studies in higher education emerged in this context.

Since 1998, Altbach noted that these kinds of studies consider the contemporary university within an international analysis framework and developed four topics that were considered important by that time:

1. The development of Western Universities and their influence on the rest of the world.
2. Students and professors roles in the contemporary university.
3. The relationship between the academic systems worldwide, particularly the increasing international exchange of students and professors and its influence in the academic and scientific international community.
4. The recent emergence of the academic power of the industrialized countries.

In 2006, Forest and Altbach made a comparative analysis between regions and countries in the international context, and determined that the topics studied in this type of analysis are related to: demand and access mechanisms to College; diversification and privatization of higher education institutions; universities interconnection and interconnectivity, and the increasing use of technology.

Methods and Data

Data was collected from the annual reports of competitiveness published by the WEF from 2007 to 2015. Particularly, we observed the performance of the fifth pillar that corresponds to higher education and training. This organization evaluates higher education in the international context through eight components, which are: *1)* Secondary education enrollment, *2)* Tertiary education enrollment, *3)* Quality of education system *4)* Quality of math and science education., *5)* Quality of management schools, *6)* Internet access in schools, *7)* Availability of specialized training services, and *8)* Extent of staff training.

For this research, two groups of countries were selected; the first group consists of four countries from the Asian model of development: Japan, Hong Kong, Singapore, and Republic of Korea, which are classified in stage 3 by the WEF. Those are the countries with the higher competitiveness. The second group are four Latin American countries: Argentina, Brazil, Chile, and Mexico, which are in transition from stage 2 to stage 3 according to WEF classification. Table 1 shows the first group of countries with their corresponding indicators of competitiveness in higher education, while the second group of countries is listed in Table 2.

Table 1. Performance of the components of the fifth pillar from the Global Competitiveness Index (GCI) for the countries of Group I (2007-2015)

		YEARS									
Country	INDICATOR	2007	2008	2009	2010	2011	2012	2013	2014	2015	Av.
JAPAN	Competitiveness	8	9	8	6	9	10	9	6	6	8
	Pillar 5	22	23	23	20	19	21	21	21	21	21
	Secondary education enrollment	22	22	24	21	22	22	27	25	24	23
	Tertiary education enrollment	32	29	32	34	35	36	37	39	40	35
	Quality of education system	28	31	31	35	36	43	50	33	27	35
	Quality of math and science education	29	33	25	28	24	27	34	21	9	26
	Quality of management schools	68	82	77	65	57	80	86	72	51	71
	Internet access in schools	26	25	33	40	39	43	37	37	37	35
	Availability of specialized training services	6	12	13	13	12	12	12	9	19	12
	Extent of staff training	4	5	5	6	6	5	4	2	6	4
HONG KONG	Competitiveness	12	11	11	11	11	9	7	7	7	10
	Pillar 5	26	28	31	28	24	22	22	22	13	24
	Secondary education enrollment	63	72	73	81	84	85	93	73	37	73
	Tertiary education enrollment	61	63	66	67	37	37	34	43	30	49
	Quality of education system	9	22	28	25	21	23	22	20	20	21
	Quality of math and science education	4	6	11	12	11	11	10	9	8	9
	Quality of management schools	17	28	28	24	21	17	14	14	10	19
	Internet access in schools	7	10	14	9	14	16	14	16	10	12
	Availability of specialized training services	19	25	20	15	17	10	7	16	15	16
	Extent of staff training	28	29	25	27	26	24	21	26	23	25
SINGAPORE	Competitiveness	7	5	3	3	2	2	2	2	2	3
	Pillar 5	16	8	5	5	4	2	2	2	1	5
	Secondary education enrollment	32	21	17	15	17	15	18	16	17	19
	Tertiary education enrollment	36	31	29	30	27	19	20	10	9	23
	Quality of education system	1	2	1	1	2	3	3	4	3	2
	Quality of math and science education	1	2	1	1	1	1	1	1	1	1
	Quality of management schools	7	7	5	6	8	6	6	6	4	6
	Internet access in schools	9	9	5	5	6	5	4	6	2	6
	Availability of specialized training services	17	13	14	19	19	16	14	12	8	15
	Extent of staff training	7	3	2	4	4	3	6	7	4	4
KOREA	Competitiveness	11	13	19	22	24	19	25	26	26	21
	Pillar 5	6	12	16	15	17	17	19	23	23	16
	Secondary education enrollment	48	35	31	34	38	43	47	48	48	41
	Tertiary education enrollment	1	3	1	1	1	1	1	2	2	1
	Quality of education system	19	29	47	57	55	44	64	73	66	50
	Quality of math and science education	10	11	18	18	12	8	20	34	30	18
	Quality of management schools	26	30	44	47	50	42	56	73	59	47
	Internet access in schools	4	5	4	12	10	7	13	10	19	9
	Availability of specialized training services	14	20	35	39	39	31	31	36	48	33
	Extent of staff training	5	10	29	42	41	42	51	53	36	34

Source: World Economic Forum. The Global Competitiveness Report (annual reports 2007-2015)

Table 1 shows the performance of the four countries in Group I regarding their total competitiveness and the components of the fifth pillar. The information given is for nine years and the final column shows the average for each indicator.

Japan ranks 8th in competitiveness, whereas in Pillar 5 is in 21st place. Its best performance is shown in the component *extent of staff training*, since in average it is in 4th place. But on the other hand, it ranks 71st in the indicator *quality of management schools*, being surpassed by the four countries of Group II. In this country, the competitiveness of higher education shows a lower performance than the indicator of global competitiveness. The correlation between these two variables is lower than 0.2.

Hong Kong's global competitiveness ranks 10th, while the competitiveness of the higher education sector ranks 24th and despite their positions these variables are highly correlated. This country has its best qualification in the component *quality of math and science education* ranking in position number 9, while the component *secondary education enrollment* ranks 73rd, which is the lowest position among the countries of both groups.

The most relevant case is that of Singapore, which in average ranks 3rd in competitiveness and 5th in higher education, although just in the year of 2015 it ranked 1st. It is also number 1 in *quality of math and science education,* and number 2 in *quality of the education system*. On the other hand, the component *tertiary education enrollment is* its worst place in position 23rd. It is noteworthy to mention that Singapore shows the higher correlation between higher education and global competitiveness.

The Republic of Korea is better ranked in higher education than in global competitiveness, in places 16th and 21st respectively. Contrary to the other countries, Korea's *tertiary education enrollment* is ranked in first place, although the component of *education quality system* is in 50th position. Korea also observed a high correlation between higher education and global competitiveness.

In average, Group I is in a better position in global competitiveness that in higher education, since competitiveness is ranked in 10th position, whereas fifth pillar appears in 17th place; In average, they perform better in *math and science education* which is ranked in 14th position. On the other hand, their worst performance is in *secondary education enrollment* in place 39th and in *quality of management schools* in place 36th. They generally have a high correlation between global competitiveness and higher education, except for Japan.

Table 2. Performance of the components of the fifth pillar from the Global Competitiveness Index (GCI) for the countries of Group II (2007-2015)

		YEARS									
Country	INDICATOR	2007	2008	2009	2010	2011	2012	2013	2014	2015	Av.
ARGETINA	Competitiveness	85	88	85	87	85	94	104	104	106	93
	Pillar 5	51	56	55	55	54	53	49	45	39	51
	Secondary education enrollment	67	75	80	76	74	73	69	65	18	66
	Tertiary education enrollment	19	22	20	19	21	20	15	15	11	18
	Quality of education system	105	105	94	90	86	89	104	113	108	99
	Quality of math and science education	95	98	98	106	113	115	116	112	113	107
	Quality of manage schools	30	26	23	16	22	34	33	34	35	28
	Internet access in schools	85	90	89	111	106	87	79	76	75	89
	Specialized training system	45	60	57	42	44	60	60	65	53	54
	Extent of staff training	75	86	81	79	76	78	100	95	88	84
BRAZIL	Competitiveness	72	64	56	58	53	48	56	57	75	60
	Pillar 5	64	58	58	58	57	66	72	41	93	62
	Secondary education enrollment	21	14	25	22	23	17	20	37	35	30
	Tertiary education enrollment	75	76	73	65	68	80	85	85	84	78
	Quality of education system	120	117	103	103	115	116	121	126	132	113
	Quality of math and science education	117	124	123	126	127	132	136	131	134	123
	Quality of manage schools	66	58	66	73	61	52	49	53	84	63
	Internet access in schools	70	67	64	72	86	88	98	98	97	82
	Specialized training system	32	26	29	36	36	34	38	47	101	41
	Extent of staff training	45	46	52	53	33	33	44	44	61	49

CHILE	Competitiveness	26	28	30	30	31	33	34	33	35	31
	Pillar 5	42	50	45	45	43	46	38	32	33	42
	Secondary education enrollment	53	54	57	56	61	75	70	71	72	63
	Tertiary education enrollment	41	41	38	43	38	38	21	20	19	33
	Quality of education system	78	86	107	100	87	91	74	71	86	87
	Quality of math and science education	107	107	116	123	124	117	107	99	107	112
	Quality of manage schools	19	19	17	15	14	14	16	13	21	16
	Internet access in schools	39	41	38	42	45	48	48	42	49	44
	Specialized training system	34	46	41	31	33	36	42	46	36	38
	Extent of staff training	40	48	39	33	37	38	46	52	52	43
MEXICO	Competitiveness	52	60	60	66	58	53	55	61	57	58
	Pillar 5	72	72	74	79	72	77	85	87	86	78
	Secondary education enrollment	80	67	64	61	64	71	67	85	84	71
	Tertiary education enrollment	73	74	75	80	79	78	79	81	78	77
	Quality of education system	92	109	115	120	107	100	119	123	117	111
	Quality of math and science education	113	127	127	128	126	124	131	128	126	126
	Quality of manage schools	49	53	49	52	49	51	65	70	68	56
	Internet access in schools	62	76	77	89	82	82	90	93	90	82
	Specialized training system	52	55	53	55	41	44	50	60	59	52
	Extent of staff training	65	87	78	84	80	67	72	74	79	76

Source: World Economic Forum. The Global Competitiveness Report (Annual Reports 2007-2015)

Table 2 shows the performance of the four countries in Group II regarding their global competitiveness and the components of the fifth pillar.

Argentina's global competitiveness ranks 93rd, while higher education is in 51st position. Outperforming Japan, Hong Kong and Singapore, the component of tertiary education enrollment in Argentina is in 18th place. But, on the other hand, the main weakness of this country is in *quality of math and science education* which in average ranks 107th. It is observed a negative correlation between competitiveness and higher education, meaning that while higher education improves considerably the country loses competitiveness.

Brazil's best indicator is *secondary education enrollment*, which is positioned in 30th place, while its worst indicators are *quality of math and science education* in 123th position and *quality of education system* in 113th position. In average, fifth pillar ranks 62nd, while global competitiveness ranks 60th, with a correlation of 0.6 between these variables.

Chile's best indicator is *quality of management schools* in 16th position, outperforming Japan, Hong Kong and Korea of Group I. Although, its main weakness is in the component of *quality of math and science* which is ranked 112th place. The global competitiveness of this country is in 31st place, while fifth pillar is in 42nd place. There is a negative correlation between higher education and competitiveness, as an improvement in the first one; there is still a small decline in the second one.

Mexico's best indicator is the *availability of specialized training services* in 52nd position. However, its biggest weakness is quality, since the component of *quality of math and science education*, in average, ranks 126th while *quality of education system* ranks 111th. Mexico's competitiveness is ranked in 58th position while higher education in 78th, with a low correlation between these variables.

In summary, Group II performs better in the component of *quality of management schools* which is in 41st position, but they are very bad positioned in the concept of quality of the education system which ranks 103, and even worse, in quality of math and science which is in 116th position. Low correlations are observed for the four countries and there are negative correlations in the cases of Argentina and Chile.

Analysis and discussion

Comparing global competitiveness, Group I ranks 10th, while Group II ranks 60th. Regarding the competitiveness of fifth pillar, Group I is in 17th position while Group II is in 58th position; there is a gap of 41 positions. If the classification were made by deciles, the first group would belong to the second decile and group II to the fifth decile.

The smallest gap between both groups is in the component of quality of management schools, where Group I is in 36th place and Group II in 41st, in this case both groups are in the same decile. On the other hand, the biggest gap is found in quality of math and science education, since Group I ranks 13th, while Group II ranks 117; there is a gap of 104 positions among them. Comparing by deciles, countries of Group I are in the top decile and Group II falls to the ninth decile. They are positioned in the extremes of the whole series of countries.

A similar situation can be observed in the results of the PISA test, although the results shows greater differences: in 2012, Group I achieved 556 points, while Group II achieved 404 points; there is a gap of 152 points. But comparing Singapore with Argentina, the gap is bigger, 185 points, while the first one achieved the highest score with 573 points; the second one achieved the lowest score with 388 points.

Another aspect of comparison is the correlation between global competitiveness and the fifth pillar; among Group I the countries of Singapore and Korea have a correlation above 0.9, Hong Kong is up from 0.7 and Japan has a weaker correlation. The correlation above is calculated based on the positions achieved by the group and each country.

Investment in education has improved the competitiveness of these countries, which is consistent with the work of McMahon (2008, p.49), who concludes: "Heavy initial investment in human capital by households and governments...is largely responsible for the high per capita growth in East Asia ".

East Asian countries have managed to define a development model which Gregory and Stuart (2014) have called Asian model of development, which has a great influence on education as one of its five policies focuses on promoting universal education and investment in human capital. Regarding the same model, Mathews & Hu (2007, p. 93) state that these countries are considered late comers with a development model focused on "catch-up efforts, industry by industry and technology by technology, drawing on the knowledge accumulated in the leading countries". This model was first developed by Japan, quickly adopted by Korea and then by Singapore. Initially, at least during the first fifty years of the catching- up process, the latecomers did not see the universities as agents of innovation, rather they considered these institutions as agents of human capital formation; they were seen as institutions to provide advanced training. For this reason Japan's best performance is in the component *extent of staff training*, but Singapore and Korea indicators are focusing on the quality of education. During the post-war, Japanese universities mainly focused on training students for corporations and to be employed by the government (Mongkhonvanit, 2014). Later, the universities of Singapore focused on raising talents that were recognized by the ability of researching, commercialization of technology, creation of high-tech spin offs, attraction of scientific talent from abroad and the boost of entrepreneurial ideas among graduates (Wong, 2007).

By analyzing the correlations within Group II, it can be observed that Argentina and Chile have negative coefficients, as they tend to lose competitiveness at the same time they improve higher education. In the cases of Brazil and Mexico, although they have positive correlations, they are very low and they lose competitiveness in both variables.

Higher education systems in Latin America have expanded quantitatively and observed improvements in the administration of the universities, but have been criticized for their inefficiency and their growth has resulted in distrust in their quality (Balán, 2013). The indicators that reflect developments in higher education in Latin America are the management of universities and research, the first one because the evaluation model for quality improvement has been focused on the management of institutions at different levels and functions, and research and scientific production have been enhanced by the attention given to this function. Latin American public universities have integrated strong research groups by the pressure of internationalization. Research centers that are the window to the world science in different fields of knowledge (Schwartzman, 2008) can be found in the four countries of Group II.

A very important element revealed by the indicators is that, as Wong (2007) says, in the newly industrialized countries higher education becomes more important for the economy competitiveness. This suggests that the decisions of the government to invest in education in order to improve human capital are appropriate, since education has become the motor of endogenous development (McMahon, 2008). This can be seen in the cases of Singapore and Korea.

When analyzing the indicators, it was found that neither group had a good performance in the secondary education enrollment component; Group I was placed in 39th position and Group II in 57th position. Hong Kong has the worst performance in 73rd position and is surpassed by the four Latin American countries. Singapore has the best position in 19th place.

As for the tertiary education enrollment component, Group I ranks 27th, while Group II is positioned in 51st place. Korea holds the first place worldwide and Mexico ranks 77th holding the worst position among the eight countries.

Korea has increased education coverage as the result of policies that started to be implemented since the 60s, when private universities were saturated and the government began the construction of public schools, then in 1981 when the Fifth Republic was formed, laws were changed and an increase of 30% in the admission of students was established, but in 2000 the amount of young population began to decline and the country had an ample higher education structure.

The biggest problem for Latin American countries is in the field of quality of education system, as Group II ranks 102nd, while Group I ranks 27th, that is a gap of 75 positions. Regarding this component, Singapore is in second place, while Korea is ranked in the 50th position, although any country of Group II does not surpass it. The biggest gap is in quality of math and science education, since Group I is the best ranked in the 13th position, while Group II is the worst ranked in 117th position. Besides, the four countries of Group II tend to obtain worse results in this component, while only one country of Group I follow this tendency.

But in the field of quality not everything is bad for Group II, since the quality of management schools component shows that there is only a gap of 5 positions between Group I and II. This is the best indicator for Group II, ranked in 41st position, although the good performance of Chile in place 16th surpasses Japan, Hong Kong and Korea.

Countries of Group II are ranked in 74th position regarding the component of Internet access in schools; from the group, Argentina is in the worst position 89th position. On the other hand, countries of Group I are ranked in 16th position, which represents its second best indicator after the component of quality of math and science education. Singapore is the best ranked in 6th place with a rapid improvement, while Korea is in 9th place and is tending to lose positions.

As for availability of specialized training services, Japan is the best ranked in 12th position. The countries of Group II also show a good performance, since Brazil is ranked in place 41st, although it still does not surpass Group I, its indicators are not very dispersed and after the component administration of universities, this indicator has shown the best performance of the group.

Last, countries of Group I show good results in the component extent of staff training, being ranked in 17th position, while Japan and Singapore stand out in 4th position. Group II ranks 63th where Argentina has the worst performance in 84th place.

The differences in the competitiveness of education can be confirmed through the observance of other indicators, such the ones developed by the United Nations Development Program (UNDP). One of the indicators to consider is the mean years of schooling. In 2012, Group I reported 10.875 years of schooling and Group II reported 8.825 years, which represents a 2 years gap in schooling. In Group I, Korea stood out with 11.8 mean years of schooling, while Hong Kong only achieved 10 years, although none of the countries of Group II achieved this last number. From Group II, Argentina and Chile reported 9.8 years of schooling, while Brazil 7.2 years. See Table 3.

Another indicator of the UNDP is the expected schooling years, where the difference between both groups is less than a school year, which implies that a child from any of the eight countries, who gets to be enrolled in a school, has the same probability to accomplish, in average, 15 years of schooling.

Table 3. Human Development Index, Education Indicators (2012)

	Japan	H.K	Singapore	Korea	Argentina	Brazil	Chile	Mexico
I	11.5	10	10.2	11.8	9.8	7.2	9.8	8.5
II	15.3	15.6	15.4	17	16.4	15.2	15.1	12.8

I= Mean years of schooling II=Expected years of schooling
Source: Own elaboration with data from the Human Development Reports. United Nations Development Program, 2014.

Conclusion

The analysis of the data demonstrates that the two groups of countries are different in terms of competitiveness of their higher education systems. On the one hand, the countries of the Asian group show a better performance in the indicators, but also their competitiveness is based on the quality of their higher education system and their high rankings on teaching math and science; Group II is in great disadvantage regarding this last indicator, since there is a gap of 104 positions compared to Group I. PISA scores also show a big difference of 152 points in favor of Group I. This indicator certainly represents a major weakness in higher education in the countries of Group II.

Group II shows good performance in the component quality management of the universities, and this indicator remains nearly equal for Group I. This behavior is explained by the kind of assessment that is practiced in these countries, which it is an assessment of the processes of the academic programs and institutions in general.

Countries of Group I observed a high correlation between the components of the fifth pillar and global competitiveness, which implies they have performed similar policies in these areas during the nine years that were analyzed. Group II observed a very low correlation; Argentina and Chile show negative correlations since they have improved their higher education competitiveness but they have descended in the ranking of global competitiveness.

In the case of Asian countries, Japanese universities show a greater strength in training, because in the second half of last century, they were mainly devoted to such type of activities; in the case of Singapore and Korea, which are more newly industrialized countries, their strength lies in the teaching of mathematics and science, the improvements in their education systems and the use of internet in schools. But also, the latter two countries observed a strong correlation between higher education and global competitiveness.

Studies of competitiveness together with competition among the education systems and the levels of competitiveness that these achieve through various components, is a field of work where the research of economics of education can be successfully applied. These works can be done from the perspective of comparative research and facilitate the understanding of the dynamics driven by each of the nations.

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Innovación Tecnológica en Empresas Chilenas: Un Estudio Empírico Basado en Patentes

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Resumen: La literatura ha centrado sus esfuerzos en estudiar las patentes en determinadas industrias, subsectores o empresas, principalmente en países desarrollados. Por otra parte, el nivel o cantidad de patentes en Chile durante el periodo 2007-2012 en promedio alcanzó las 12 familias triádicas, países como Argentina y México presentaron medias de 12 y 15 familias triádicas respectivamente. La media total para el mismo periodo en la OCDE asciende a 48.242 familias de patentes triádicas. Lo anterior muestra, por una parte el interés de la comunidad científica por estudiar el fenómeno de la creación de patentes, y por otra, la gran brecha tecnológica entre países desarrollados y en vías de desarrollo. Proponemos estudiar los determinantes de la creación de patentes en las empresas chilenas, como un caso de país en vías de desarrollo. Utilizamos un modelo probit en donde la variable dependiente toma valor uno si la empresa tiene o está en proceso de obtener una patente de invención (tecnológica) y cero en caso contrario. Nuestra base tiene datos de 4.338 empresas chilenas, es de corte transversal y corresponde a un extracto de la Octava Encuesta de Innovación en Empresas 2011-2012. Los resultados muestran que la antigüedad de la empresa, la base de conocimiento existente y la utilización de instrumentos gubernamentales de apoyo a la I+D tienen un efecto positivo en la creación de patentes.

Palabras claves: Innovación tecnológica; patentes; empresas y probit.

Abstract: *Technological Innovation in Chilean Firms: An Empirical Study Based on Patents.* Literature has focused on studying patents in particular industries, subsectors or firms, mainly in developed countries. The level or quantity of patents in Chile during the period 2007-2012 on average reached 12 triadic families, while in countries like Argentina and Mexico presented averages of 12 and 15 respectively. The overall average for the same period amounted to 48,242 OECD triadic patent families. This shows the interest of the scientific community to study the phenomenon of patent creation, and, on the other hand, the large technological gap between developed and developing countries. We propose to study the determinants of patenting in Chilean firms, as a case of a developing country. We use a probit model where the dependent variable takes value one if the firm has or is in the process of obtaining an invention patent (technological) and zero if not. Our database has 4,338 Chilean firms, is cross-sectional and corresponds to an extract of the Eighth Survey of Innovation in Firms 2011-2012. The results show that the age of the firm, the base of existing knowledge, and the use of governmental instruments to support R&D have a positive effect on creation of patents.

Keywords: Technological innovation, patents, firms and probit.

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1. Introducción

La literatura se ha centrado en estudiar las patentes de invención solo en determinados sectores o rubros específicos. Salmi y Torkkeli (2009) estudian patentes relacionadas con sistemas navegación (GNSS/GPS) en la industria ferroviaria, la base considera 173 datos relacionados a ese subsector. Las patentes van del año 1989 al 2008 y considera principalmente países desarrollados como Japón, Estados Unidos, China, Gran Bretaña entre otros. Respecto a los principales resultados, el número de aplicaciones basadas en GNSS/GPS en la industria ferroviaria es considerablemente menor que para otros medios de trasporte, la actividad de patentamiento fue más alta en el año 2002 (con 24 aplicaciones) y pero ha ido decreciendo en los años recientes. Respecto al país de origen de los inventores, la mayoría (44%) pertenecía a Japón, demostrando la importancia del tren como medio de transporte y de las investigaciones e innovaciones relacionadas a este.

Hernandez y González (2013) estudian la evolución tecnológica de la industria de celulares a partir de 3 estudios de caso de las empresas Nokia, Huawei y ZTE. Se destaca la actividad de patentamiento como un indicador tangible de la actividad de investigación y desarrollo (I+D). De los principales resultados se destacan dos. Una buena correlación entre las ventas de las empresas y la generación de patentes, sin embargo, no necesariamente esto garantiza el éxito. Por ejemplo Nokia, que a pesar de invertir en I+D no tuvo utilidades en los últimos periodos. Segundo, si una empresa sigue el comportamiento del líder (patentamiento), sería factible que llegue a ser líder en el futuro, como es el caso de ZTE.

Tseng y Raudensky (2014) analizan la actividad de patentamiento en las oficinas de transferencia tecnológica de las 20 mayores universidades de EE.UU. De los principales resultados se destacan dos. Primero, que la innovación en el sector universitario e industrial es clave para el incremento de la competitividad. Segundo, la transferencia tecnológica en ha conducido a un crecimiento económico en EE.UU y de seguro conducirá a un próspero futuro en el país.

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Se puede apreciar como la literatura se ha centrado en estudiar las patentes focalizando sus esfuerzos en determinadas industrias, subsectores o empresas y principalmente en países desarrollados. Nuestro trabajo estudia las patentes para el caso chileno, que es un país en vías de desarrollo, e incluimos variadas industrias en nuestra base de datos.

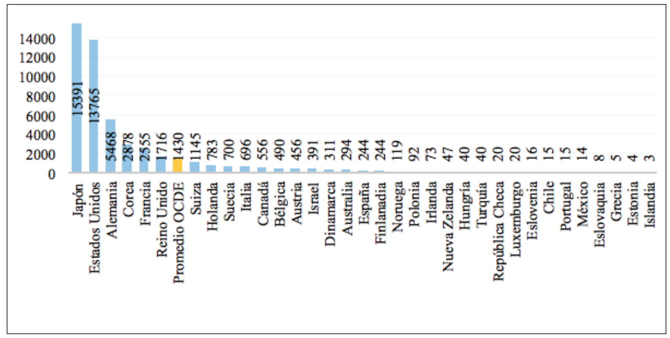
El objetivo de nuestra investigación es determinar que variables influyen en la creación de patentes para el caso chileno. En la sección 2 exponemos las principales motivaciones y contexto del tema. Luego, en la sección 3 presentamos una revisión de la literatura principalmente focalizada en las variables que influirían en la creación de patentes según diversos autores. Posteriormente, en la sección 4, mostramos la metodología utilizada. En la sección 5, presentamos los datos usados, éstos provienen de la Octava Encuesta de Innovación en Empresas (en adelante encuesta de innovación). En la sección 6 estimamos un modelo probit que nos permite estimar la probabilidad de que una empresa decida inscribir una patente de invención y relacionarla con el conjunto de variables que la literatuera sugiere que influyen en este tipo de decisión. En la sección 7 se expone una discusión de los resultados comparando nuestras estimaciones con la litertura revisada. Finalmente, en la sección 8 algunas recomendaciones.

2. Motivación y contexto

El uso de patentes es una de las maneras en que las empresas se apropian de los beneficios de una invención (Juliao, Barrios, Schmutzler, & Sánchez, 2013). Las patentes en Chile, durante el periodo 2007-2012, en promedio alcanzaron las 12 familias triádicas, por su parte países como México y Argentina presentaron medias de 15 y 12 familias triádicas respectivamente. Por otra parte la media total para el mismo período en la Organización para la Cooperación y el Desarrollo Económico (OCDE) asciende a 48.242 familias de patentes triádicas (OCDE, 2015). Lo anterior muestra, la gran brecha tecnológica entre países desarrollados y en vías de desarrollo.

En cuanto al modo de contabilizar las patentes por la OCDE, estas son medidas mediante familias de patentes triádicas, que son un conjunto de solicitudes de éstas licencias que se presentan ante la *European Patent Office* (EPO), la *Japan Patent Office* (JPO) y concedidas por la *United States Patent and Trademark Office* (USPTO). El motivo de contabilizar este tipo particular de patentes es que permite mejorar la comparabilidad internacional de los indicadores basados en patentes (se comparan sólo entre las solicitudes en un mismo conjunto de países), además que el valor de las patentes suele ser mayor, dado que ampliar la cobertura a las demás naciones presupone un mayor costo, que no retribuiría si la licencia no es lo suficientemente ventajosa (OCDE, 2009).

Gráfico 1. Número de patentes triádicas miembros de la OCDE, año 2012



Fuente: Elaboración propia en base a datos de OCDE, 2015.

Tal como se observa en el gráfico anterior, Latinoamérica presenta un evidente rezago frente al resto de las naciones miembros de la OCDE, en la generación de innovación y nuevas tecnologías. Se puede deducir que la mayoría de las firmas a nivel latinoamericano, basan sus procesos de innovación en la imitación, adaptación e ingeniería inversa de métodos y tecnologías de empresas foráneas (Forero, Laureiro, & Marín, 2011).
La búsqueda del desarrollo es una cuestión importante, es por esto que la innovación, como fuente de crecimiento económico toma un rol fundamental, debido a que sin avance en ciencia y tecnología las naciones se estancan y pierden competitividad frente a otras que sí progresan. Existen investigaciones que buscan entender mejor las variables que influyen en estos procesos, tales como los de Buesa & Molero (1996), Vega, Fernandez, Gutiérrez, & Manjarres (2005), y para el caso chileno Benavente (2005), entre otros, los cuales serán profundizados más adelante.

3. Revisión de literatura

Las patentes son instrumentos que están vigentes en nuestro mundo desde el siglo XIX, particularmente desde el año 1833. Es en la ciudad de París donde se comienza a resguardar de manera sólida el conocimiento de las personas de ciertas regiones, las cuales ahora cuidarían de sus ideas frente a otros seres que pudieran sacar ventaja de lo ajeno, todo esto sellado en el Convenio de París. La patente es por tanto la forma más antigua de protección a los activos intangibles (Díaz, 2008).

Con el paso de los años surgen en todos los países nuevas y más formas de patentamiento de ideas o invenciones de propiedad industrial como patentes asociadas a procesos, mecanismos, nuevos fármacos, procedimientos, productos, entre otros, las que están relacionadas a muchas áreas tales como, minería, agricultura, pesca, silvicultura, entre otras.

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Hoy en día la competitividad entre las distintas firmas es cada vez más fuerte en el mundo, presentando un escenario hipercompetitivo. Frente a esta situación el patentamiento es primordial, con el fin de protegerse de la copia o la imitación.

Los problemas del cambio tecnológico han ocupado un lugar importante en el análisis económico, una de las preocupaciones básicas ha consistido en buscar indicadores claves para medir las actividades tecnológicas y su relación con la eficiencia económica. Una de estas mediciones se hace a través del número de patentes generados por las empresas (Buesa & Molero, 1992). Es así como durante el siglo XX y hasta nuestros días la patente se considera un factor determinante de la innovación.

3.1 Evidencia Empirica

En este apartado, se recogen en diversas contribuciones teóricas y empíricas para establecer el marco de análisis del patentamiento en las empresas de la industria chilena. La búsqueda de los factores detonantes de la innovación no es algo nuevo, desde Schumpeter a comienzos del siglo XX la innovación ha sido un objetivo de análisis de múltiples autores.

Martínez & Pérez (2001), identifican que las patentes están relacionadas con la aglomeración de actividades tecnológicas. Esto se refiere a las relaciones que establecen las empresas con instituciones de investigación como las universidades, para acceder a instalaciones de I+D y mano de obra calificada pertenecientes a éstas. Se estima que esta relación es importante en fases iniciales, pero pierde relevancia con el tiempo y el avance de la empresa. Los mismos autores anteriores, definen el uso de tecnologías de la información como la creación de redes o nexos que desarrollan ciertas empresas ya sea dentro de la misma o con otras formando *clusters* para traspasar información o recursos entre estas. Estos recursos son necesarios para invertirlos conjuntamente en la creación de nuevos conocimientos (I+D, diseño, ingeniería), y para la introducción externa de nuevo conocimiento mediante la adquisición, adaptación e implementación de innovaciones (Belussi & Arcangeli, 1998).

Por otra parte, la relación entre el gasto en I+D realizado por la empresas y las patentes es un tema ampliamente estudiado por la literatura, la que permite hacer ciertas conclusiones con respecto a esta. El gasto en I+D está estrechamente relacionado a las actividades de patentamiento, y además, esta inversión tiene un efecto casi inmediato en la innovación y por tanto en la generación de patentes (Buesa & Molero, 1992).

De igual forma (Buesa & Molero, 1992), establecen que el origen del capital o propiedad de la empresa es un factor que incide en la generación de patentes de manera indirecta. Estos autores establecen que empresas de propiedad foránea tienden a importar tecnología por medio de pagos de asistencia técnica y regalías, promoviendo de manera indirecta el patentamiento.

El tamaño de la firma es una variable que ha despertado cierto nivel de interés en la literatura (Rothwell & Dogson, 1994). Las investigaciones han decantado en dos áreas de debate. La primera estipula que el tamaño de la firma afecta positivamente el desarrollo de patentes, dado que las grandes empresas tienen mayor capacidad para conseguir financiamiento, gestionar la información, mantener grandes instalaciones de I+D y atraer a los mejores técnicos y científicos. La segunda área de debate establece que las pequeñas empresas, en especial las de alta tecnología presentan una ventaja en el proceso de cambio técnico debido a su mayor flexibilidad para adaptarse a los cambios en el entorno exterior (Martínez & Pérez, 2001). Dentro del análisis realizado por Buesa & Molero (1996), se observa que la probabilidad de que las empresas emprendan actividades innovadoras aumenta junto con el tamaño de esta, asociado al volumen de ventas. Pese a esto ambos autores acotan que la probabilidad de innovar es infravalorada en empresas pequeñas que pueden realizar distintas actividades en I+D, dimensión de la cual no recogen datos.

La edad o antigüedad de una empresa es otra dimensión que se ha relacionado con la innovación. Buesa & Molero (1996), señalan que los procesos tecnológicos son acumulativos, la disponibilidad de experiencia constituye un factor favorable para la obtención de resultados innovadores que pueden traducirse en patentes, por lo que la edad de la firma sería un factor a favor del patentamiento.

Sancho (2002), habla sobre los indicadores de ciencia y tecnología dentro de los cuales distingue dos conceptos relacionados a los recursos humanos e I+D, el primero es personal dedicado a la I+D, es decir, el número de personas total o parcialmente dedicadas a I+D. Mientras que el segundo es más general y se refiriere a la reserva de personal en I+D incluyendo al personal real, como al potencial. En los estudios de Vega, Fernández, Gutiérrez & Manjarres (2005) se observa una relación positiva entre la base de conocimiento existente en la organización y la capacidad de absorción de esta, o capacidad de reconocer el valor de una nueva información y asimilarla con fines comerciales. La base de conocimiento es entendida por los autores mencionados como el conjunto de habilidades, conocimientos, y experiencia del que dispone la organización. Puede ser medida en dos dimensiones, la primera se refiere a las competencias del recurso humano y la experiencia de la organización, factor que se puede relacionar con el nivel de formación académica de los trabajadores. La segunda dimensión se refiere a aspectos relacionados con la infraestructura de la organización, específicamente la existencia de un departamento I+D o similar. En un estudio realizado por Álvarez & García (2012) se encontró que las competencias o habilidades del recurso humano si son significativas en cuanto a la decisión de innovar, por otro lado no encontraron una relación significativa entre la innovación y la presencia de un departamento de I+D.

Otra variable estudiada son las exportaciones (asociadas a las ventas, y por lo tanto al tamaño de la empresa), para Murillo & Hill de Titto (2006), una empresa que realiza exportaciones tiene mayores incentivos a innovar, dado que tiene contacto con tecnologías extranjeras y debe satisfacer exigencias de otros mercados. Ambos autores consideran también como variable los apoyos gubernamentales, los cuales contribuyen de manera directa al crear y financiar centros de investigación, subsidiar la investigación privada y proteger las leyes de propiedad intelectual. Cohen y Levin (1989) mencionan esta variable como una de las más estudiadas e importantes asociadas a las oportunidades tecnológicas. En numerosos sectores económicos, los gobiernos han contribuido a reducir el costo de la innovación por medio de sus propias investigaciones o subsidiando la investigación en el sector privado. Teubal (1996) hace la distinción de dos fases en la empresa, fase infante y fase madura. Él postula que los subsidios debieran ser la forma de implementar políticas de incentivos a la I+D, durante la fase infante de la firma, en dónde se debiera subsidiar la mitad de los costos del proyecto. En el caso de la fase madura Teubal (1996), menciona la posibilidad que el estado reduzca el apoyo. También existen los programas de exención tributaria, que autorizan a las firmas a decidir libremente qué proyectos de investigación y desarrollo desean financiar.

Benavente (2005), menciona que este tipo de fomento a la innovación debe aplicarse a empresas más grandes con importantes portafolios de proyectos en I+D, dado que empresas pequeñas pueden poseer bajos niveles de ingreso imponible y, aun cuando la exención tributaria sea máxima, no dispondrán de recursos suficientes para invertir en I+D. Bronwyn & Van Reenen (2000), establecen que en conjunto hay pruebas sustanciales de que el impuesto tiene un efecto en la I+D realizada, mencionando a grandes rasgos que un dólar dedicado a un incentivos fiscal estimula un dólar invertido en I+D. Hay que mencionar que en Chile existe la Ley Incentivo al I+D (Ley N° 20.570) la cual tiene por objetivo impulsar la inversión en I+D de las empresas, fomentando la innovación y por ende aumentado la productividad de estas.

La última variable identificada es la localización o la región de origen de la entidad. En un estudio sobre el desarrollo de patentes en universidades españolas (Fernández, Otero, Rodeiro, & Rodríguez 2009), establecen que la localización de la universidad en una región activa puede conferirle ventajas en el desarrollo de propiedad intelectual. Viendo a las universidades como una representación de las empresas se puede extrapolar esta variable a la división regional chilena. La localización o dimensión geográfica dentro del sistema en que está inserta la firma ha sido un importante factor de análisis, en dónde una cantidad no menor de teorías fueron postuladas con el objeto de explicar el desarrollo de la innovación industrial traducida en patentes, centrándose en la arista geográfica del fenómeno, en especial en su concentración y difusión espaciales (Vilalta & Banda, 2008). Dichas teorías se pueden clasificar en dos clases, aquellas que aplican un enfoque interdisciplinario geográfico-económico y las que aplican una visión netamente geográfica (Vilalta & Banda, 2008). Dentro de las teorías que aplican un enfoque interdisciplinario geográfico-económico, la más destacable es la que mencionan Vilalta & Banda (2008), dentro de su investigación sobre esta área en México, encontraron importantes antecedentes, donde establecen que el crecimiento de las inversiones no se da de manera uniforme, sino que se concentra en diversos polos de dedesarrollo e industrias impulsoras. Además, las teorías existentes respecto a la difusión espacial de la información se divide en cuatro tipos: contagio, expansión, relocalización y difusión jerárquica. La primera se refiere a la manera directa, con contacto entre individuos o instituciones. La difusión por expansión se da cuando la propagación de una idea comienza en un lugar de origen y se traslada a otros lugares, pero sin dejar de usarse en el lugar inicial. Por otro lado, la difusión por relocalización es similar, pero en este caso la propagación sí deja el lugar de origen. Finalmente, la difusión jerárquica sucede cuando la difusión va desde lugares más grandes a lugares más pequeños (Vilalta & Banda, 2008). En este contexto, Hägerstrand (1953), establece que la difusión de innovaciones tecnológicas tiende a ser contagiosa. En otras palabras, la difusión de innovación tecnológica es un efecto sujeto a la proximidad física entre instituciones. Vilalta & Banda (2008), mencionan dos reglas de difusión espacial: la innovación tecnológica se difunde de manera contagiosa en función de la distancia y se encuentra concentrada en ciertos lugares.

A continuación presentamos una tabla resumen de la literatura revisada.

Tabla 1: Principales variables identificadas

Dimensión	Variables	Autor(es)
Tamaño	Tamaño	(Buesa & Molero, 1996); (Martínez & Pérez, 2001)
	Exportaciones	(Murillo & Hill de Titto, 2006)
Edad	Antigüedad	(Buesa & Molero, 1996)
I+D	Personal en I+D	(Sancho, 2002)
	Gasto en I+D	(Buesa & Molero, 1992)
Forma de propiedad	Forma de propiedad	(Buesa & Molero, 1992)
Región geográfica	Región	(Fernández, Otero, Rodeiro, & Rodríguez, 2009) ; (Vilalta & Banda, 2008)
Capital humano	Base de conocimiento	(Vega, Fernandez, Gutiérrez, & Manjarres, 2005); (Álvarez & García, 2012)
Apoyo gubernamental	Instrumentos gubernamentales de apoyo al I+D	(Cohen & Levin, 1989); (Murillo & Hill de Titto, 2006); (Benavente, 2005)
Uso de información	Uso de tecnologías de la información	(Martínez & Pérez, 2001)
	Nexo con instituciones educacionales y aglomeración de actividades tecnológicas	(Martínez & Pérez, 2001)

Fuente: Elaboración propia con base en la literatura revisada.

4. Metodología

Probit es un modelo de elección discreta o de respuesta cualitativa, que surge para explicar una variable dependiente binaria (0 y 1), se decide respecto a un sí o un no. Este es aplicado para estimar la probabilidad de que ocurra un acontecimiento dados los valores de las variables explicativas. Al utilizar una función de distribución normal se da lugar al modelo probit

$$Prob(Y = 1) = \int_{-\infty}^{\beta'} \phi(t)dt = \Phi(\boldsymbol{\beta}'\mathbf{x})$$

Donde la función de distribución normal estándar se representa como, $\phi(.)$,β' representa los parámetros de las variables explicativas, finalmente el último parámetro de la ecuación es , que representa el vector de variables explicativas (Salgado & Chovar, 2010).

El modelo de probabilidad (Greene, 1999) es un modelo de regresión donde:

$$Prob(Y=1) = \int_{-\infty}^{\beta'} \phi(t)dt = \Phi(\boldsymbol{\beta}'\mathbf{x})$$

Para estimar los parámetros los modelos de elección binaria utilizan el método de máxima verosimilitud, donde cada observación se considera como la realización individual de una variable aleatoria con distribución Bernoulli (es decir, binomial con n =1). La probabilidad conjunta, o función de verosimilitud, de un modelo con probabilidad de éxito $F(\boldsymbol{\beta}'\mathbf{x})$ y observaciones independientes es:

$$\text{Prob}(Y_1 = y_1, Y_2 = y_2, \dots, Y_n = y_n) = \prod_{y_i=0}[1 - F(\boldsymbol{\beta}'\mathbf{x}_i)] \prod_{y_{i=1}}[F(\boldsymbol{\beta}'\mathbf{x}_i)]$$

Se puede reescribir esta fórmula como

$$L = \prod_{y_i=0}^{n}[F(\boldsymbol{\beta}'\mathbf{x}_i)]^{y_i}[1 - F(\boldsymbol{\beta}'\mathbf{x}_i)]^{1-y_i}$$

Esta es la función de verosimilitud para una muestra de observaciones. Tomando logaritmo se obtiene:

$$\ln L = \sum_{i=1}^{n}[y_i \ln F(\boldsymbol{\beta}'\mathbf{x}_i) + (1-y_i)\ln(1 - \ln F(\boldsymbol{\beta}'\mathbf{x}_i))]^6$$

Las condiciones de primer orden del problema de maximización requieren que:

$$\frac{\partial \ln L}{\partial \boldsymbol{\beta}} = \sum_{i=1}^{n}\left[\frac{y_i f_i}{F_i} + (1-y_i)\frac{-f_i}{(1-F_i)}\right]\mathbf{x}_i = 0$$

En esta última ecuación y lo que sigue usaremos el subíndice i para indicar que la función se evalúa en $\boldsymbol{\beta}'\mathbf{x}_i$. . Al seleccionar una forma concreta para F_i se obtiene el modelo. A menos que se utilice el modelo de probabilidad lineal, las ecuaciones contenidas en la anterior serán no lineales y habrán de resolverse con un método iterativo.

Para probit, al utilizar la función de distribución normal la función de verosimilitud logarítmica resultante es:

$$\ln L = \sum_{y_i=0} \ln[1 - \Phi(\boldsymbol{\beta}'\mathbf{x}_i)] + \sum_{y_i=1} \ln \Phi(\boldsymbol{\beta}'\mathbf{x}_i)$$

Al maximizar (calcular las derivadas respecto al vector $\boldsymbol{\beta}$) se obtiene que las condiciones de primer orden son:

$$\frac{\partial \ln L}{\partial \beta} = \sum_{y_i=0} \frac{-\phi_i}{1-\Phi_i}\mathbf{x}_i + \sum_{y_i=1}\frac{\phi_i}{\Phi_i}\mathbf{x}_i = \sum_{i=1}^{n}\left(\frac{q_i\phi(q_i\boldsymbol{\beta}'\mathbf{x}_i)}{\Phi(q_i\boldsymbol{\beta}'\mathbf{x}_i)}\right)\mathbf{x}_i \sum_{i=1}^{n}\lambda_i\mathbf{x}_i = 0$$

Donde $q_i = 2y_i - 1$. . En este modelo los estimadores de los parámetros pueden calcularse sin ningún problema utilizando el método de Newton. En el modelo probit el cálculo de estos se hace utilizando $\lambda(\mathbf{x}_i, \boldsymbol{\beta}'\mathbf{x}_i) = \lambda_i$, , donde las segundas derivadas pueden obtenerse para cualquier z,

$$\frac{d\phi(z)}{dz} = -z\phi(z)$$

Con ello se obtiene

$$\text{H}=\frac{\partial^2 \ln L}{\partial \boldsymbol{\beta}\, \partial \boldsymbol{\beta}'} = \sum_{i=1}^{n} -\lambda_i(1_i + \boldsymbol{\beta}'\mathbf{x}_i)\mathbf{x}_i\mathbf{x}_i'$$

Esta matriz es negativa sea cual sea el valor de $\boldsymbol{\beta}$. Basta con darse cuenta de que la parte escalar de la sumatoria es $1 - \text{Var}[\epsilon|\epsilon < \boldsymbol{\beta}'\mathbf{x}]$ cuando y = 1 y $1 - \text{Var}[\epsilon|\epsilon > -\boldsymbol{\beta}'\mathbf{x}]$ cuando y = 0 . En los dos casos, la varianza está entre 0 y 1, por lo que también su complemento estará en este intervalo (Greene, 1999).

La matriz de covarianzas asintótica del estimador de máxima verosimilitud puede estimarse a partir de la inversa del hessiano evaluada en el estimador de máxima verosimilitud.

Por otro lado, es importante observar que los parámetros del modelo, como los de cualquier modelo no lineal, no coinciden con los efectos marginales (Greene, 1999). En general los parámetros son calculados como

$$\frac{\partial E[y|x]}{\partial y} = \left\{\frac{dF(\boldsymbol{\beta}'\mathbf{x})}{d(\boldsymbol{\beta}'\mathbf{x})}\right\}\boldsymbol{\beta} = f(\boldsymbol{\beta}'\mathbf{x})\boldsymbol{\beta}$$

Donde $f(.)$ la función de densidad asociada a la utilizada, en caso de un probit, la distribución normal $\phi(.)$

$$\frac{\partial E[y|x]}{\partial y} = \phi(\boldsymbol{\beta}'\mathbf{x})\boldsymbol{\beta}$$

5. Base de datos

Utilizamos la Octava Encuesta de Innovación, que tiene por objetivo proporcionar información sobre la estructura del proceso innovativo en Chile y mostrar las relaciones entre este proceso y la estrategia de innovación de las empresas, el rendimiento económico, la capacidad de innovar y los factores que influyen en su capacidad para innovar. El diseño del formulario y la metodología que la encuesta utiliza sigue los parámetros generales sugeridos por la OCDE y aplicados por sus países miembros, también utiliza los lineamientos de la *Community Innovation Survey* (CIS) plasmados en el Manual de Oslo.

La población objetivo se compone de empresas naturales o jurídicas que desarrollen actividades dentro del país, las ventas anuales de estas deben ser superiores a 2.400 UF, razón por la cual no se incluyen microempresas. A nivel sectorial son consideradas las actividades más importantes que se desarrollan en Chile, sin embargo, la base utilizada no permite individualizar el sector de cada una de las empresas encuestadas. Los sectores considerados son: energía, minería, industria manufacturera, servicios de salud y sociales, hoteles y restaurantes, actividades inmoviliarias y empresariales, agricultura, construcción, comercio, pesca, transporte e intermediación financiera.

La encuesta de innovación es de corte transversal, se estudian los años 2011 y 2012, y con la totalidad de sus datos es representativa a nivel nacional. El tamaño de la muestra asciende a un total de 4.614 empresas. En tanto el total de empresas utilizadas en la investigación se reduce a 4.338 que son las empresas resultantes luego de verificar sus respectivos datos.

Realizamos diversos filtros a la base de datos de manera que el número total de empresas disponibles incialmente se redujo, en concreto, para la base utilizada en nuestra investigación eliminaron un total de 276 empresas, las cuales poseían errores en la digitación de datos. Específicamente 10 en el año de inicio de la empresa. 24 contaban con error en el monto de las exportaciones, donde estas eran superiores a las ventas totales del periodo. 219 empresas poseían ventas al 2012 inferiores a las 2.400 UF especificadas por la metodología de la encuesta, de este total 46 cuentan con ventas igual a cero. Finalmente 24 empresas fueron eliminadas por no poseer año de inicio de la producción y por ende la falta del dato de antigüedad de la firma. Hay que mencionar que las firmas de la muestra pertenecen a distintos sectores económicos y tienen distintas procedencias regionales. Dado el número de la muestra total se puede establecer que esta otorga resultados significativos y representativos estadísticamente. Se debe mencionar que los datos son de corte transversal y no representan una evolución o seguimiento a través de un periodo determinado de tiempo.

Del total de las observaciones analizadas, se observa que alrededor del 4% de las empresas tiene o es titular de algún derecho de propiedad intelectual o patente. Mientras que el 96% restante no ha solicitado ningún instrumento de propiedad en Chile ni en el extranjero. A continuación se muestran una tabla que presenta las principales características de las las empresas que sn sujeto de estudio.

Tabla 2. Descripción de las variables utilizadas

Variable	Descripción	Empresas sin patentes			Empresas con patentes		
		4.169			169		
		Media	**Máximo**	**Mínimo**	**Media**	**Máximo**	**Mínimo**
Ventas	Ventas locales 2012 en millones de pesos chilenos	33.616	6.747.117	0	114.170	7.171.004	24,94
Antigüedad	Años de la empresa en base al 2012	18	185	0	26	269	1
Exportaciones	Exportaciones 2012 en millones de pesos chilenos	3.618	1.775.937	0	8.914	544.936	0
Personal capacitado	Promedio de trabajadores universitarios, año 2012	37	3962	0	51	997	0
Personal en I+D	Promedio de trabajadores dedicados al área I+D, año 2012	2	726	0	5	117	0
Gasto en I+D	Gasto en I+D en millones de pesos chilenos al año 2012	228	213.479	0	5.267	718.806	0
		Características			**Características**		
Forma de propiedad	Origen de la propiedad de la empresa, la cual puede ser privada nacional o extranjera, mixta o estatal	91,7% es privada nacional			82,3% es privada nacional		
Región	Región de origen de la empresa asociada a un valor numérico del 1 al 15	44,42% están en Región Metropolitana			59,76% están en Región Metropolitana		
Departamento I+D	0: No posee	5,2% posee			33,1% posee		
	1: Posee						
Excepción tributaria	1: Utiliza	1% utiliza			3,6% utiliza		
	0: No utiliza						
Financiamiento público	1: Utiliza	4,7% utiliza			18,3% utiliza		
	0: No utiliza						
Nexo con instituciones educacionales	1: Utiliza	38,5% utiliza			74% utiliza		
	0: No utiliza						
Uso de tecnologías de la información	1: Utiliza	15,5% utiliza			39,6% utiliza		
	0: No utiliza						

Fuente: Elaboración propia en base a datos de la encuesta de innovación 2011-2012.

6. Estimaciones

Los resultados de las estimaciones se pueden observar en la tabla 3. Del total de las variables estudiadas, 7 presentan significancia. Personal capacitado, medido como el número de profesionales sobre el total de trabajadores de una empresa, Departamento I+D y Nexo con instituciones educacionales son estadísticamente significativas al 99%, la Antigüedad, Uso de TI y Fondo público al 95%, y finalmente la variable Región de los Ríos presenta significancia al 90%. El resto de las variables no ha presentado significancia en sus coeficientes por lo que, para esta estimación, no influirían en la decisión de patentar en las empresas. Se observa que todas las variables que presentan significancia poseen un coeficiente con signo positivo, excepto la variable Región de los Ríos. Además, la significancia observada para las variables Nexo con Instituciones Educacionales y Uso de TI indican la relevancia que tienen los vínculos que puedan existir entre las empresas e instituciones de educación y/o tecnologías de la información, y como este vínculo influye en la creación de patentes.

En cuanto a las variables significativas, y considerando tanto el coeficiente como los efectos marginales de estas se puede aseverar que si la empresa posee un año más de antigüedad verá aumentada su probabilidad de poseer patentes en una proporción bastante pequeña. En tanto, al aumentar en uno la proporción de trabajadores capacitados (con profesión, magister o doctorado) sobre el total de trabajadores de la empresa aumenta la probabilidad de innovar en una proporción mayor. En cuanto a las variables dicotómicas, si la empresa utilizó fondos públicos su probabilidad de poseer patentes también aumenta. Asimismo, la variable relacionada al departamento I+D es la que posee el efecto marginal más importante de las variables analizadas, demostrando su importancia en el aumento de la probabilidad de patentar. El mismo caso anterior se repite tanto cuando la empresa posee nexos con entidades educacionales y si la empresa utilizó nuevas prácticas de organización de procesos (reingeniería de procesos, gestión de calidad etc.) como tecnologías de información pero con un efecto marginal menor. Por otro lado la variable Región de los Ríos presenta significancia, pero con un coeficiente y un efecto marginal negativo. Podemos interpretar esto diciendo que las empresas ubicadas en dicha región, por diversas razones o variables no observadas en este estudio, ven en desmedro su capacidad de innovación solo por el hecho de ubicarse en dicha Región. No obstante hay que considerar que los datos son variables dicotómicas, lo cual entrega información limitada, y dificulta una interpretación mayor. En relación a esto queremos señalar además que el foco de nuestro trabajo no es profundizar sobre diferencias espaciales.

Tabla 3. Coeficientes, significancias y efectos marginales de las variables

Dimensión	Variable	Coeficiente[1]	3dy/dx
Tamaño	Ventas locales 2012	5,18E-08	3,17E-09
	Exportaciones 2012	-3,99E-07	-2,45E-08
Edad	Antigüedad	0,0040023**	0,0002452
I+D	RRHH en I+D 2012	-0,000959	-0,0000588
	Gasto en I+D	3,53E-06	2,16E-07
Forma de propiedad	Propiedad nacional	-0,3649418	-0,0299417
	Propiedad extranjera	-0,1932427	-0,010007
	Propiedad mixta	-0,4175191	-0,0176454
Región geográfica	Región de Tarapacá	-0,214838	-0,0108515
	Región de Antofagasta	-0,3308421	-0,150886
	Región de Atacama	-0,3327891	-0,0150758
	Región de Coquimbo	0,0749469	0,0049141
	Región de Valparaíso	-0,1425328	-0,007751
	Región O'Higgins	-0,2429941	-0,0120303
	Región del Maule	-0,2302869	-0,0115401
	Región del Biobío	-0,3873302	-0,0173516
	Región de la Araucanía	-0,2669446	-0,0129454
	Región de los Lagos	-0,0504207	-0,0029584
	Región de Aisén	-0,4116559	-0,0172461
	Región de Magallanes	-0,3765633	-0,016425
	Región Metropolitana	-0,1149965	-0,0069739
	Región de los Ríos	-0,7728221*	-0,242683
Base de conocimiento	Departamento I+D	0,6987536***	0,0219949
	Personal capacitado	0,3590284***	0,0761969
Apoyo gubernamental	Exención tributaria	0,0836733	0,0055475
	Fondo público	0,3306041**	0,0269454
Uso de información	Uso de TI	0,2079681**	0,0146066
	Nexo con inst. educacionales	0,291981***	0,019068
Constante = -1,754555		**y = 0,02644641**	
Pseudo R2 = 0.1393		**Chi2 = 196,30**	

Fuente: Elaboración propia en base a los resultados del análisis.

7. Resultados y discusión

El tamaño de la empresa no presentó significancia para nuestro caso. Recordemos que Buesa & Molero (1996) señalaron que el tamaño de una firma está positivamente relacionado con que la empresa emprenda actividades innovadoras, ellos utilizaron también una base de datos de corte transversal, pero considerando una menor cantidad de variables en su estudio. Nosotros no podemos corroborar aquello con nuestros resultados, pero podemos explicar las diferencias entre ambos debido a la disparidad de variables utilizadas.

Murillo & Hill de Tito (2006) establecen que una empresa que exporta se ve influenciada a cumplir con estándares más altos y por ende a innovar, podemos mencionar que su estudio se centra en un determinado sector industrial, no considerando a todos los sectores en su conjunto. En nuestro caso, nuestra base considera variadas industrias. Nuestras estimaciones no tuvieron efectos significativos respecto al nivel de exportaciones.

[1] Donde *p<0.1 **p<0.05 ***p<0.01.

La antigüedad de la empresa posee significancia y un efecto positivo, por lo que podemos comprobar lo expuesto por Buesa & Molero (1996) quienes postularon que la edad de la firma aumenta la capacidad innovadora de la empresa.

En tanto, las variables relacionadas a la forma de propiedad, éstas no presentaron significancia en ninguno de sus tipos, por lo que no es posible comprobar en nuestro estudio que las empresas que poseen propiedad extranjera poseen mayores influencias para patentar, lo que ha sido expuesto por estudios de Buesa & Molero (1992) y Álvarez & García (2012), para este último estudio podemos acotar que sólo se considera el sector manufacturero.

No pudimos comprobar que la localización de la empresa influya en la probabilidad de patentar. Reconocemos que nuestra base de datos no es idónea para aislar este efecto espacial. Recordemos que medimos la localización como la ubicación de una empresa en una determinada región del país, esta medida es poco precisa dado que no nos permite conocer coordenadas de varias empresas dentro de una misma región. El 2,4% (0,04*0,6) del total de empresas patenta y se encuentra en la Región Metropolitana.

Respecto a la base del conocimiento, podemos explicar esta por dos variables profesionales sobre el total de trabajadores de la empresa y la existencia de un departamento I+D. Los resultados van en la línea de los estudios de Vega et al (2005), observando una relación positiva entre estas variables y la innovación de la empresa. En este contexto, Álvarez & García (2012) encontraron una relación positiva entre las competencias del recurso humano y la innovación, pero no encontraron evidencia de la misma relación para la existencia de un departamento de I+D y su relación con la innovación. Es importante mencionar que en dicho estudio, la innovación es medida en base a dos variables distintas; la primera es una variable binaria que toma valor 1 si la firma gasta en innovación, mientras que la segunda se refiere al esfuerzo innovador, el cual es medido como el logaritmo de la inversión promedio por trabajador que realiza la empresa en adquirir tecnologías de capital, gestión, capacitación tecnológica e I+D.
Otra variable significativa se refiere a los instrumentos gubernamentales de apoyo a la I+D. Nuestros resultados indican que el financiamiento público es significativo y su efecto es positivo, por lo que podemos comprobar la importancia dada por Teubal (1996) a este instrumento y el beneficio que genera en la innovación empresarial.

Por otro lado, no comprobamos que los incentivos tributarios sean determinantes para las actividades innovadoras de las empresas. Esto no necesariamente se debe a que esta no influya en la innovación, sino que puede ser explicado por el desconocimiento de esta ley por parte de las empresas y/o porque su efecto puede estar subvalorado. De acuerdo a datos obtenidos de la encuesta de innovación, el 29% de las empresas conoce la ley, y sólo el 1,2% de empresas la utilizan.
El uso de tecnologías de la información presentó significancia y un signo positivo en su derivada, lo que va en una misma línea que lo expuesto por Martínez & Pérez (2001), demostrando la importancia de dicha variable para el patentamiento de las empresas.

8. Recomendaciones

A nivel empresarial la innovación es baja, en la muestra solo el 4% de las empresas posee patentes, por lo que para mejorar esta situación es de suma importancia que surgan políticas públicas orientadas a la generación de conocimiento y tecnologías en las firmas. Considerando los resultados de nuestro estudio podemos desarrollar posibles líneas de actuación, tales como el desarrollo de nuevos y mayores incentivos gubernamentales, y la masificación de las exenciones tributarias de manera que una mayor cantidad de empresas accedan. En definitiva, es recomendable el desarrollo de nuevos formas de apoyo que estimulen a las empresas a crear patentes de invención.

Respecto a la proporción de personal capacitado, actualmente el Estado otorga distintas becas para que profesionales se especialicen, política que es coherente con los resultados obtenidos en la investigación, sin embargo no es una práctica lo suficientemente masificada, quizás debido el alto costo asociado. Es por esto que una posible alternativa es que el Estado incentive a que las propias empresas capaciten a sus trabajadores, por medio de las mismas excenciones tributarias, lo que disminuiría en gran cuantía el costo directo que el Estado desembolsaría.

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Características del Gerente General Relacionadas con Investigación y Desarrollo en Empresas de Chile

Gustavo Barrera Verdugo [1], Eugenio Bisama Castillo [1]*

Resumen: El CEO o gerente general tiene incidencia en las principales decisiones estratégicas y de inversión en las empresas. Investigaciones previas han reconocido condiciones en el gerente general como edad, experiencia, género, participación en la propiedad de la empresa y rango de estudios alcanzados, relacionadas con participación de su organización en investigación y desarrollo. En la presente investigación, se ha utilizado la metodología regresión logística para reconocer si estos patrones son extrapolables a empresas chilenas incluidas en la Encuesta Longitudinal de empresas 2015 del Ministerio de Economía de Chile. Los resultados muestran que la edad, la experiencia, y la condición de único dueño del gerente, se relacionan negativamente con I+D, y que el rango educacional y el género masculino tienen impacto positivo. Los hallazgos obtenidos son relevantes, pues se reconocen condiciones que se vinculan con la investigación y desarrollo en empresas en Chile, país que integra el grupo de economías emergentes.

Palabras clave: Investigación y desarrollo; innovación; CEO; gerente general; características gerenciales.

Abstract: CEO's features related to Research and Development in Chilean companies. The CEO or general manager has an impact on the major strategic and investment decisions in business. Previous research recognized features of general manager as age, experience, gender, ownership of the company and level of studies achieved, related with R&D. In the present investigation, we used logistic regression to recognize whether these patterns are valid in the Chilean companies using as a tool the Business Longitudinal Survey 2015 the Ministry of Economy of Chile. The results show that age, experience, and the manager status as sole owner, impact negatively on R & D, also, that the educational status and male gender have a positive impact. The findings are relevant because conditions are linked to research and development in companies in Chile, which is part of the group of emerging economies are recognized.

Keywords: Research and development; innovation; CEO; general manager; management characteristics.

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Introducción

La investigación y desarrollo empresarial apoya a las organizaciones a adaptarse a cambios en su entorno, al apalancar los recursos y capacidades empresariales con su ambiente externo (Ettlie, 1998). También se reconoce que la investigación y desarrollo es fuente primaria de innovación, concepto que a su vez apoya la competitividad y crecimiento de empresas (O'Brien, 2003).

Las principales decisiones de una empresa, entre ellas las actividades de investigación y desarrollo, son determinadas por el chief executive officer (CEO), definido como máxima autoridad operacional de una organización. Las decisiones del CEO determinan la asignación de recursos organizacionales vinculados con investigación y desarrollo (Cazier, 2011; Lin et al., 2011). En Latinoamérica este cargo, tradicionalmente, ha sido denominado gerente general.

En relación con el CEO de una organización, se ha considerado que sus valores y actitudes respecto de la investigación y desarrollo, pueden tener incidencia significativa en las actividades realizadas en este ámbito (Hambrick y Mason 1984), adicionalmente, se ha estimado que aspectos como la edad del CEO, su experiencia, género, nivel educacional y el grado de propiedad que posee sobre la empresa, se vinculan con sus decisiones respecto de investigación y desarrollo en su empresa (Barker y Mueller 2002; Cazier, 2011; Lin et al., 2011).

Esta investigación busca relacionar características del gerente general de empresas chilenas, con participación de su organización en actividades de investigación y desarrollo. En términos específicos, pretende estimar si la participación en propiedad, nivel educacional, edad, años de experiencia profesional y género del gerente general, se vinculan con la ejecución de actividades de investigación y desarrollo en empresas en Chile.

La selección de Chile como país de análisis se pertinente, pues, por más de una década, el gobierno chileno ha promovido la investigación y desarrollo, y ha sido reconocido como poseedor de economía emergente junto a países latinoamericanos como Brasil, México y Colombia (MSCI World Index Stock, 2016). Por tanto, los resultados pueden ser considerados como referente para países latinoamericanos emergentes.

Reconocer relación de las características mencionadas con investigación y desarrollo se considera relevante, pues, bajo una perspectiva teórica, permite estimar si condiciones en los gerentes identificadas en investigaciones previas, explican la participación en actividades de

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I+D en empresas chilenas, o si existen diferencias en este país latinoamericano; adicionalmente, desde la perspectiva de la gestión de empresas, ayuda a orientar la selección y formación de gerente generales para facilitar la participación de empresas en I+D; finalmente, desde la perspectiva de políticas públicas, la investigación aporta criterios para la asignación de recursos gubernamentales, al reconocer características del gerente general vinculadas con mayor potencial de I+D.

Marco teórico

Investigación y desarrollo

La Organización para la Cooperación y Desarrollo Económicos (2015), indica que investigación y el desarrollo experimental (I+D) "comprende el trabajo creativo llevado a cabo de forma sistemática para incrementar el volumen de conocimientos, incluido el conocimiento del hombre, la cultura y la sociedad y el uso de esos conocimientos para crear nuevas aplicaciones". Respecto de la relevancia de I+D, durante las últimas dos décadas la literatura académica ha entregado evidencia crucial del rol de estas actividades en el desempeño, generación y sustentabilidad de la ventaja competitiva en una organización (O'Brien, 2003; Hsu, C. W., Lien, Y. C., & Chen, H., 2015).

En relación con el estudio de variables que afectan la actividad de investigación y desarrollo en una empresa, trabajos previos han examinado diversas variables de incidencia. Se han considerado significativas las características de la industria (e.g. Sujit y Mukherjee, 2005) y la estrategia de diversificación corporativa de las empresas (e.g. Lopez-Sanchez et al., 2006), también, se ha estimado la estructura de propiedad de la empresa como factor que incide en el I + D (e.g. Chen y Hsu, 2009), en último término, las características del CEO han sido reconocidas como variables que afectan las participación de las organizaciones en I + D (e.g. Habrick y Mason 1984; Barker and Mueller, 2002; Cazier, 2011; Lin et al., 2011).

Vínculo de I + D con cargos directivos

El CEO es una función fundamental en la elección de estrategia y nivel de desempeño de la empresa (Minnick y Noga, 2010; Ting, 2013), sus decisiones son relevantes para implementar investigación y desarrollo que facilita la innovación (Chen et al., 2016). Se ha estimado una conexión entre decisiones de administración de los gerentes y sus características (Hambrick y Mason, 1984), y evidenciado que ciertas características demográficas de los gerentes como edad (Barker and Mueller, 2002), educación (Lin et al., 2011) y experiencia (Kor, 2006), inciden en decisiones vinculadas con investigación y desarrollo en las empresas.

En relación con la edad del CEO, Hambrick y Mason (1984) encontraron evidencia de que los CEOs de mayor edad tienden a ser más conservadores, pues presentan mayor conformidad con su posición y seguridad. Del mismo modo, Marshall et al. (2006) sugieren que los gerentes con mayor edad se vuelven más confiados en sus propios recursos de información para tomar decisiones, más conservadores y menos propensos a tomar riesgos. También se ha mostrado, que CEOs más cercanos a la edad de retiro exhiben mayor aversión al riesgo (Matta y Beamish, 2008; Serfling, 2014)

En concordancia con estos estudios, se estima que la edad CEO tendería a impactar negativamente en la participación de la organización en actividades de investigación y desarrollo en Chile.

Respecto de la incidencia de la propiedad del CEO sobre la empresa, Jensen (1993) plantea que la inversión en investigación y desarrollo puede no ser objetivo primario, pues los CEOs prefieren ganancias de corto plazo en vez de incrementar el valor de largo plazo de la empresa a través de investigación y desarrollo. De igual forma, Hirshleifer y Thakor, (1992) afirman que los pagos inciertos provocados por proyectos de investigación y desarrollo, incentivan a los gerentes a evitar participar en ellos. Adicionalmente, se ha reconocido que las empresas familiares presentan menor intensidad de participación en I +D por su mayor aversión al riesgo (Block, 2012; Massis, Frattini, y Lichtenthaler, 2013).

Por el contrario, Barker y Mueller (2002), afirman que la alta participación de los CEOs sobre la propiedad de la empresa, permitiría alinear los intereses de estos con los accionistas, por ello, tendrían mayor incentivo de participar en I + D para aportar al crecimiento de la empresa en el largo plazo.

En general, el efecto esperado de la concentración de propiedad y el gasto en investigación y desarrollo es ambiguo, lo que ha sido confirmado en estudios han concluido la existencia de relación diversa entre la concentración de propiedad del CEO y el gasto en investigación y desarrollo (Ghosh et al., 2007).

A pesar de que la evidencia previa no es concluyente, se estima que la propiedad del CEO tendería a impactar negativamente la participación de la organización en actividades de investigación y desarrollo en Chile, pues la mayoría de empresas en Chile son pequeñas y medianas empresas con vínculo familiar, por tanto, la conducta de sus gerentes debe ser similar a la presentada por directivos de empresas familiares.

En relación con la formación del CEO, Wu, Levitas, y Priem (2005), señalan que existe relación positiva entre capacidad para procesar información, complejidad cognitiva y capacidad para gestionar actividades de investigación y desarrollo, también, Barker y Mueller, (2002) reconocen que el nivel educacional es factor relevante en la orientación cognitiva del CEO, Farag, H., y Mallin, C. (2016) indican que los CEOs postgraduados presentan mayor propensión hacia decisiones riesgosas, adicionalmente, Lee, W. S., & Moon, J. (2016) estiman relación positiva entre educación del CEO y decisiones riesgosas en la industria aérea, y Lin el al. (2011) evidencian relación positiva entre nivel educacional del CEO gasto en I + D.

De acuerdo con lo planteado, se estima que la formación CEO tendería a impactar positivamente la participación de la organización en actividades de investigación y desarrollo en Chile.

Finalmente, investigaciones previas estiman que el género del CEO puede afectar las decisiones financieras de la empresa. Barua et al. (2010) indican que las empresas que incorporan mujeres en la alta dirección, presentan decisiones financieras más conservadoras, Huang y Kisgen (2013) encuentran evidencia que las mujeres CEOs son menos propensas a realizar adquisiciones de empresas y tomar deudas, también, y Faccio et al. (2016) proponen que las mujeres CEOs toman menores riesgos en financiamiento de inversiones. En forma complementaria, se ha reconocido que la investigación y desarrollo es una actividad riesgosa, asociado con retornos inciertos y tardíos (Bromiley, P., Rau, D., y Zhang, Y., 2016), por tanto, las empresas con gerentes de género femenino, debiesen presentar menor propensión a efectuar investigación y desarrollo.

En coherencia con lo anterior, se estima que el género femenino del CEO tendería a impactar negativamente la participación de la organización en actividades de investigación y desarrollo en Chile.

Método

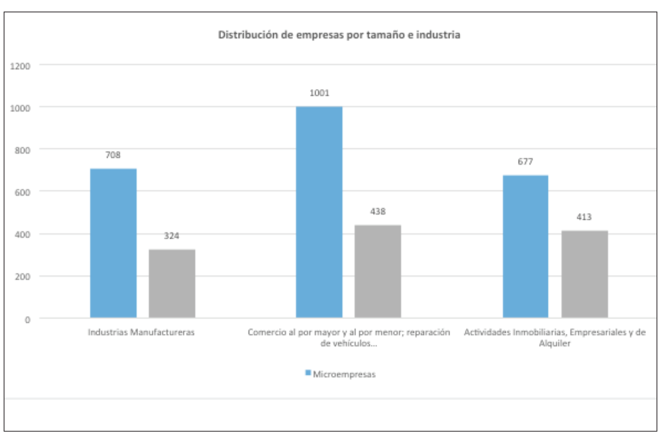
Muestra

Se ha utilizado como marco muestral, la tabulación de resultados de Tercera Encuesta Longitudinal de Empresas (ELE3), realizada por el Ministerio de Economía, Fomento y Turismo de Chile (2015). La unidad de análisis son empresas formalizadas con operaciones en Chile.

La Encuesta Longitudinal de Empresas 2015, incluye 7.267 empresas, clasificadas en 12 industrias en forma estratificada, es decir, representa la proporción, según su tamaño y actividad. Para la investigación han sido seleccionadas 3.560 encuestas, considerando tres industrias por su relevancias en el PIB de Chile, están son Industrias Manufactureras; Comercio al por mayor y al por menor; reparación de vehículos automotores, motocicletas, efectos personales y enseres domésticos; y Actividades Inmobiliarias, Empresariales y de Alquiler. Estás 3 industrias se analizan en 2 tamaños diferentes, que son microempresas, y pyme y grandes empresas. La clasificación de tamaño de empresas, es efectuada por monto de facturación de la empresa, según clasificación de Servicios de Impuesto Internos de Chile.

Esta organización de empresas busca controlar la incidencia del tipo de industria y el tamaño de la organización sobre las variables de estudio. Las pymes y grandes empresas son reunidas en 1 categoría, para conformar un número suficientemente numeroso en la muestra. El gráfico 1, muestra la distribución de empresas incorporadas en el análisis.

Gráfico 1. Distribución de empresas por tamaño en industria



Diseño y procedimiento

Con el fin de estudiar la participación de una empresa en actividades de investigación y desarrollo, fue seleccionada la pregunta número 1 del módulo F de la encuesta, que consulta "¿Su empresa ha realizado trabajos de desarrollo experimental o tecnológico con el objetivo de introducir nuevos productos, procesos, dispositivos, materiales, incluyendo la prueba de prototipo e instalaciones experimentales?", esta pregunta tiene respuesta dicotómica (sí, no).

A través de regresión logística, se estima la probabilidad de que la empresa realice trabajos de desarrollo experimental o tecnológico, es decir, obtener "sí" como respuesta a la pregunta 1 del módulo F, en función de las características del gerente general de la empresa.

El perfil del gerente general fue diferenciado por género, edad, años de experiencia laboral, nivel de propiedad en la empresa que administra y nivel de estudios alcanzados. Para evaluar la formación profesional del gerente general, son considerados los niveles universitaria completa, magíster o doctorado incompleto y magíster o doctorado completo, los encuestados responden sólo una categoría. Las variables independientes son mayoritariamente categóricas de tipo Dummy, sólo la edad y la experiencia del gerente (expresada en años) corresponden a variables escalares. En la siguiente tabla son presentadas las variables incorporadas en análisis de regresión.

Tabla 1. descripción de variables incluidas en modelos de regresión

Dependiente	Independientes
La empresa realiza actividades de investigación y desarrollo	Edad de gerente general
	Años de experiencia del gerente general
	Género del gerente general
	Gerente general es único dueño
	Gerente general es socio o accionista
	Gerente general ha alcanzado estudios universitarios completos
	Gerente general ha alcanzado magíster o doctorado incompleto
	Gerente general ha alcanzado doctorado o magíster completo

La metodología de análisis utilizada es regresión logística a través de presentación de resultados en 2 modelos. En Modelo 1 propone una regresión global incluyendo las 3.560 empresas, y regresiones por tamaño de empresas, incluyendo microempresa y Pymes y Grandes empresas. En el Modelo 2 se desarrollan regresiones por tamaño de empresas y tipo de industria.

Resultados

Descripción de frecuencias porcentuales

El análisis descriptivo de variables estudia frecuencias porcentuales, media aritmética y desviación estándar. La tabla 2, muestra que 18,3% de las empresas encuestadas declaran realizar trabajos de desarrollo experimental o tecnológico, el 13,5% de los gerentes son únicos dueños de la empresa y el 39,5% de los gerentes generales indicar tener propiedad sobre la empresa.

Tabla 2. Frecuentas porcentuales de variables

	Global	Industrias Manufactureras				Comercio al por mayor y al por menor; reparación de vehículos automotores...				Actividades Inmobiliarias, Empresariales y de Alquiler			
	Todas	Microempresas		Pymes y grandes		Microempresas		Pymes y grandes		Microempresas		Pymes y grandes	
	(n=3560)	(n=707)		(n=324)		(n=1001)		(n=438)		(n=677)		(n=413)	
		Sí	No	Sí	No	Sí	No	Sí	No	Sí	No	Sí	No
¿Su empresa ha realizado trabajos de desarrollo experimental o tecnológico?	18,3%	37,9%	62,2%	10,8%	89,2%	13,9%	86,1%	4,6%	95,4%	21,71%	65,5%	10,2%	89,8%
¿Gerente general es el único dueño de la empresa?	13,5%	1,4%	98,6%	35,2%	64,8%	5,0%	95,0%	49,5%	50,5%	1,3%	98,7%	19,1%	80,8%
¿Gerente general es socio o accionista de la empresa?	39,5%	1,4%	98,6%	46,3%	53,7%	43,4%	56,6%	29,7%	70,3%	32,9%	67,1%	52,8%	47,2%
¿Gerente general género masculino?	87,2%	79,8%	20,2%	96,6%	3,4%	91,2%	8,8%	97,3%	2,7%	79,9%	20,1%	91,8%	8,2%
¿Gerente general ha alcanzado educación universitaria completa?	49,4%	1,4%	98,6%	31,8%	68,2%	51,4%	48,7%	25,3%	74,7%	56,7%	43,3%	53,8%	46,2%
¿Gerente general ha alcanzado magíster o doctorado incompleto?	1,4%	1,3%	98,7%	0,9%	99,1%	1,6%	98,4%	0,7%	99,3%	1,9%	98,1%	1,7%	98,3%
¿Gerente general ha alcanzado magíster o doctorado completo?	15,9%	19,5%	80,5%	2,8%	97,2%	16,6%	83,4%	2,7%	97,3%	27,9%	71,1%	12,6%	87,4%

Respecto del nivel educacional de los gerentes generales, el 49,4% ha alcanzado educación universitaria completa, un 1,4% responde disponer de estudios de magíster o doctorado incompletos, y un 15,9% ha finalizado educación de magíster o doctorado.

En relación con el tamaño e industria de la empresa, las microempresas en industria manufacturera presentan mayor participación en actividades de investigación y desarrollo (37,9%), baja participación de los gerente generales como únicos dueños (1,4%), y menor porcentaje de estudios universitarios y de magíster y doctorado que en grandes empresas. La industria con mayor participación de gerentes como únicos dueños o accionistas es Comercio al por mayor y al por menor; reparación de vehículos automotores, motocicletas, efectos personales y enseres domésticos, esta industria también presenta el menor porcentaje de participación en actividades I+D para microempresas (13,9%), y pymes y grandes empresas (4,6%). La descripción de muestra presenta que las pymes en general participan en mayor medida en actividades I+D.

En relación con la edad y experiencia del gerente general, se aprecia que la edad promedio del gerente general es menor en microempresas, considerando todas las industrias, también, que la edad promedio del gerente general es 51,7 años y la desviación estándar 10,7 años. La Tabla 3, presenta resultados de media y desviación estándar de edad del gerente general por tamaño de empresa e industria.

Tabla 3. promedio de edad y experiencia de gerente general

	Global		Industrias Manufactureras				Comercio al por mayor y al por menor; reparación de vehículos automotores…				Actividades Inmobiliarias, Empresariales y de Alquiler			
	Todas		Microempresas		Pymes y grandes		Microempresas		Pymes y grandes		Microempresas		Pymes y grandes	
	(n=3560)		(n=707)		(n=324)		(n=1001)		(n=438)		(n=677)		(n=413)	
	Media	D.Est.	Media	D.Est.	Media	D.Est.	Media	D.Est.	Media	D.Est.	Media	D.Est.	Media	D.Est.
Edad gerente general	51,7	10,7	51,7	10,1	55,1	11,8	51,2	10,6	53,1	12,0	52,0	10,3	54,6	12,3
Años de experiencia gerente general	20,6	11,9	20,3	12,2	23,9	12,5	21,0	12,1	21,0	12,3	20,7	12,2	22,6	12,8

Análisis de correlación

Al desarrollar matriz de correlación de variables estudiadas, se obtiene que la mayor correlación positiva con variable dependiente se presenta con la variable "alcanzar estudios de magíster o doctorados completos" con correlación 0,124, y la mayor correlación negativa de variable dependiente se presenta con la variable "gerente general es único dueño de la empresa" con correlación -0,123.

También se encuentra alta correlación entre la edad y los años de experiencia del gerente general. Esta relación es predecible, dado que los ejecutivos con mayor edad tienden a disponer de un mayor número de años de experiencia. Al calcular Alpha de Cronbach para comprobar la consistencia de medición de estas variables se obtiene valor 0,81, este resultado evidencia que ambas variables podrían ser definidas bajo un concepto.

Modelo 1

El Modelo 1 de regresión logística presentado en Tabla 4 muestra que, al considerar las 3560 encuestas, el género masculino del gerente general incrementa la probabilidad de investigación y desarrollo en la empresa, también, que las empresas con gerentes generales como únicos dueños tienen menor probabilidad de realizar actividades de investigación y desarrollo. Los valores P>/Z/ son 0.000, lo que valida los Odds Ratio de estas variables con 99% de confianza.

La educación universitaria completa y de magíster y doctorado completa e incompleta, también obtienen Odds Ratio mayor a 1 y valores valores P>/Z/ significativos, esto indica que a mayor estudio del gerentes general, aumenta la probabilidad de que la empresa realice actividades de investigación y desarrollo. El coeficiente Odd Ratio mayor se vincula con el logro de estudios magíster o doctorado completo por parte del gerente, expresado en un valor 3,018. A transformar este valor a probabilidad a través de la formula Probabilidad= ((Odds Ratio/(Odds Ratio + 1)), se obtiene que la probabilidad que una empresa con gerente general con estudios de magíster o doctorado completos realice investigación y desarrollo es 75,11% mayor frente a una empresa sin esta condición. La Tabla 5 presenta probabilidades incrementales de coeficientes significativos al considerar la muestra global.

Tabla 4. Coeficientes de regresión Modelo 1

	Global			Microempresas			Pymes y grandes empresas		
	(n=3560)			(n=2385)			(n=1175)		
	Odds Ratio	P>[z]		Odds Ratio	P>[z]		Odds Ratio	P>[z]	
Género del gerente general	1,697	0,001***		1,480	0,057*		1430	0,230	
Edad de gerente general	0,998	0,828		1,010	0,137		0,960	0,005***	
Años de experiencia de gerente general	0,992	0,164		0,983	0,008***		1,020	0,155	
Gerente general es único dueño	0,446	0,000***		0,713	0,366		0,961	0,908	
Gerente general es socio o accionista	1,011	0,908		1,140	0,233		1,313	0,311	
Gerente general ha alcanzado educación universitaria completa	1,463	0,075*		1,260	0,370		1,666	0,198	
Gerente general ha alcanzado magíster o doctorado incompleto	2,033	0,000***		1,701	0,001***		2,038	0,010**	
Gerente general ha alcanzado magíster o doctorado completo	3,018	0,000***		2,286	0,000***		4,917	0,000***	
Constante	0,100	0,000		0,430	0,000		0,188	0,002	
	Prob>chi2 = 0,000			Prob>chi2 = 0,0000			Prob>chi2 = 0,0000		

*** Coeficiente significativo con 99% de confianza, **Coeficiente significativo con 95% de confianza, *Coeficiente significativa con 90% de confianza.

Tabla 5. Probabilidad incremental de variables con coeficientes significativos

	Odds Ratio	Probabilidad de realizar investigación y desarrollo
Gerente general de género masculino	1,697	Probabilidad mayor en 62, 97% si gerente general es de género masculino
Gerente general es único dueño de la empresa	0,998	Probabilidad mayor en 49,94% si gerente general no es único dueño
Gerenta general ha alcanzado magíster o doctorado incompleto	2,033	Probabilidad mayor en 67,02 % si gerente general ha alcanzado magíster o doctorado incompleto
Gerenta general ha alcanzado magíster o doctorado completo	3,018	Probabilidad mayor en 75,11% si gerente general ha alcanzado magíster o doctorado completo

Al dividir las encuestas por tamaño de empresas, se aprecia que la diferencia de género sólo es significativa en el grupo de microempresas, es decir, la probabilidad de realizar actividades de investigación y desarrollo en una empresa con gerente general con género hombre es mayor sólo para este estrato. También en el grupo de microempresas, se aprecia que a mayor cantidad de años de experiencia del gerente general, menor el probabilidad de que la empresa realice actividades de investigación y desarrollo, y que al alcanzar educación de magíster y doctorado completa e incompleta, incrementa la probabilidad de que la empresa efectúe actividades I+D.

Para el caso de las grandes empresas, los coeficientes significativos son similares, sin embargo, la edad del gerente general sustituye a los años de experiencia como variable con coeficiente significativo.

Modelo 2

El Modelo 2 de regresión logística, muestra los resultados de análisis de 3560 encuestas divididos por industria y tamaño de empresas. Los resultados son presentados en Tabla 6.

En la industria manufacturera sólo los años de experiencia del gerente general, en el estrato de microempresas, muestra relación negativa con actividades I+D con coeficiente significativo.

En la industria de comercio al por mayor y al por menor; reparación de vehículos automotores, motocicletas, efectos personales y enseres domésticos, dentro del estrato de microempresas, mayor experiencia del gerente general se relaciona con menor actividad I+D, también, alcanzar niveles de educación o magíster incompletos y completos incrementa la probabilidad de realizar investigación y desarrollo en la empresa. En el estrato pymes y grandes empresas de esta industria, el género masculino del gerente general se relaciona en forma positiva con participación en I+D, la edad del gerente general presenta relación negativa, y los estudios de magíster o doctorado completos e incompletos relación positiva.

La industria Actividades inmobiliarias empresariales y de alquiler refleja coeficientes positivos sólo en el estrato de pymes y grandes empresas. En este grupo, la edad del gerente presenta relación negativa con I+D, y los años de experiencia del gerente general relación positiva. Adicionalmente, la condición gerente general es dueño o accionista presenta relación positiva con I+D, y alcanzar educación de magíster o doctorado completo relación positiva.

Tabla 6. Coeficientes de regresión Modelo 2

	Industrias Manufactureras				Comercio al por mayor y al por menor; reparación de vehículos automotores, motocicletas, efectos personales y enseres domésticos				Actividades Inmobiliarias, Empresariales y de Alquiler			
	Microempresas (n=707)		Pymes y grandes (n=324)		Microempresas (n=1001)		Pymes y grandes (n=438)		Microempresas (n=677)		Pymes y grandes (n=413)	
	Odds Ratio	P>[z]	Odds Ratio	P>[z]	Odds Ratio	P>[z]	Odds Ratio	P>[z]	Odds Ratio	P>[z]	Odds Ratio	P>[z]
Género del gerente general	1,033	0,93	2,024	0,220	1,965	0,100	3,038	0,094*	1,257	0,537	0,773	0,557
Edad de gerente general	1,012	0,28	0,995	0,815	1,004	0,785	0,953	0,096*	1,002	0,873	0,919	0,004***
Años de experiencia de gerente general	0,976	0,012**	0,991	0,640	0,977	0,058*	1,010	0,739	1,005	0,636	1,063	0,028**
Gerente general es único dueño	0,240	0,182	0,518	0,204	1,473	0,457	1,676	0,456	2,071	0,317	1,114	0,867
Gerente general es socio o accionista	1,184	0,361	0,524	0,152	1,279	0,240	1,510	0,523	1,391	0,100	2,087	0,083*
Gerente general ha alcanzado educación universitaria completa	0,723	0,436	1,453	0,515	1,582	0,342	3,186	0,115	1,713	0,296	1,210	0,832
Gerente general ha alcanzado magíster o doctorado incompleto	1,153	0,561	1,470	0,374	2,587	0,002***	3,307	0,04**	1,125	0,719	2,554	0,100
Gerente general ha alcanzado magíster o doctorado completo	1,483	0,178	2,345	0,337	4,211	0***	2,962	0,364	1,622	0,167	8,410	0,001***
Constante	0,421	0,153	-0,143	0,074	0,430	0***	0,731	0,046**	0,126	0,002	0,592	0,640
	Prob>chi2 = 0,0319		Prob>chi2 = 0,3938		Prob>chi2 = 0,0000		Prob>chi2 = 0,0850		Prob>chi2 = 0,3897		Prob>chi2 = 0,0001	

*** Coeficiente significativo con 99% de confianza, **Coeficiente significativo con 95% de confianza, *Coeficiente significativa con 90% de confianza.

Para comprobar la ausencia de multicolinealidad en las variables independientes, se ha realizado Análisis de Tolerancia (TOL) y de Factor de Inflación de la Varianza (VIF). En este análisis se obtienen valores TOL cercanos a 1 y de VIF menores a 2 con promedio 1,35. No se encuentra evidencia de alta multicolinealidad entre las variables independientes.

Conclusiones

La presente investigación busca estudiar la relación de: participación en propiedad, nivel educacional, edad, años de experiencia profesional y género del gerente general, con actividades de investigación y desarrollo en empresas en Chile. Los hallazgos obtenidos, muestran que los resultados de investigaciones previas se replican parcialmente en empresas en Chile, según tamaño de empresa y tipo de industria.

Se evidencia que un mayor nivel educacional alcanzado por el gerente general se asocia con mayor propensión a realizar investigación y desarrollo, considerando algunas industrias y tamaños de empresas, esta idea es respaldada por Lin el al. (2011). También, que empresas con gerentes generales que son únicos dueños, presentan menor probabilidad de realizar investigación y desarrollo, premisa coherente con lo planteado por Hirshleifer y Thakor, (1992) y Massis, Frattini, y Lichtenthaler, (2013). Adicionalmente, se observa como tendencia, que la experiencia y edad del gerente incide en forma negativa en participación de empresas en I+D, resultado consistente con lo planteado por Marshall et al. (2006), Por último, que existe relación entre el género masculino y una mayor probabilidad de realizar investigación y desarrollo en la empresa, resultado coherente premisas de Huang y Kisgen (2013), y Faccio et al. (2016).

Los resultados obtenidos muestran que la condición de alcanzar estudios de magíster o doctorado completos, al considerar la muestra global, presenta la mayor incidencia sobre la variable dependiente, incrementando la probabilidad de realizar I+D en 75,11%. Según este resultado, incrementar la formación de postgrados en los gerentes generales impactaría positivamente la participación de empresas en actividades de investigación y desarrollo, y con ello a contribuir a la competitividad de empresas.

Desde la perspectiva de asignación de recursos públicos, la evidencia obtenida facilita el proceso de diagnóstico y evaluación de empresas postulantes en programas de apoyo a la investigación y desarrollo. La propensión hacia la innovación y las capacidades de I + D, pueden ser estimadas a través de las características del gerente general, por tanto, algunas de estas condiciones, por ejemplo, la formación del gerente general, son pertinentes de evaluación en el proceso de adjudicación de fondos, como los otorgados por la Corporación de Fomento y la Producción de Chile a través de concursos FICr o FDNr. Adicionalmente, las empresas dirigidas por gerentes generales con condiciones relacionadas en forma negativa con I+D pueden ser objeto de programas especiales financiados con fondos nacionales o regionales.

Bajo la visión de dirección de empresas, los resultados aportan a la selección de gerentes generales con condiciones facilitadoras para investigación y desarrollo, también para el desarrollo de programas de formación gerencial, de incentivos financieros para el gerente y de financiamiento de postgrados.

Respecto de la evidencia que relaciona experiencia del gerente general con menor participación de empresas en I + D, es pertinente implementar incentivos para la incorporación de directivos con menor experiencia en las empresas, y desarrollar convenios entre universidades y empresas para facilitar la incorporación de egresados en cargos de alta dirección.

La relación negativa entre participación en propiedad y participación I+D de las empresas, puede ser abordada a través de entrega de subsidios para I+D, que prioricen a empresas con alta concentración de propiedad, o por medio de programas de formación que busquen fomentar beneficios de I+D en empresas concentradas, y que presten apoyo en su implementación.

Para la relación negativa entre género femenino y participación en I+D en la empresa, se propone el desarrollo de programas de formación y difusión orientado a gerentes de género femenino y la aplicación de subsidios a la innovación dirigido a empresas dirigidas por estas gerentes.

Las propuestas descritas, apoyarían la participación de organizaciones en investigación y desarrollo, y con ello, a la competitividad y crecimiento de empresas, según lo planteado por (O'Brien, 2003). Adicionalmente, las propuestas pueden ser consideradas por países latinoamericanos con economías emergentes, como Brasil, México y Colombia.

Se reconocen como limitaciones del estudio la inclusión de sólo 3 industrias, también, que las pymes y grandes empresas son estudiadas en conjunto, y que la edad de la empresa, variable con relación inversa a actividades I+D (Hansen 1992), no ha sido utilizada como variable de control. Adicionalmente, para evaluar actividades de investigación y desarrollo, sólo se incluye una pregunta en la encuesta, sin incorporar monto de inversión, número de patentes, número de productos diseñados o cantidad de publicaciones realizas, variables recomendada por Brown y Svenson (1998) para medición de outputs de I+D. Por último, la formación del gerente general no es estudiada por área disciplina, factor que puede ser relevante, pues podrían ser reconocidas disciplinas asociadas con mayor propensión a I+D en las empresas. A pesar de estas limitaciones, la cantidad de empresas incluidas en la muestra permite representar la participación de organizaciones con características diversas.

Futuras investigaciones pueden incorporar la variable edad de la empresa, mayor número de industrias y reconocer diferencias en organizaciones dirigidas por gerentes con formación en diferentes áreas de especialización. Además, utilizar nuevos indicadores para medir participación de empresas en actividades I+D.

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Factors Hampering Innovation Activities – Case Study from the Czech Republic

Josef Krause [1*]

Abstract: The article looks at the importance of innovation in company strategy. It presents paths to a formulating strategy focused on innovation and approaches to value. It also introduces the main barriers to an enterprise's innovative activities and their types. It gives the key results of research undertaken in the Czech Republic by the Czech Statistical Office on the topic of innovation.

Keywords: strategy; innovation; blue ocean strategy.

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Introduction

Innovation is significant for the competitiveness of the whole economy (Scholleova and Necadova, 2012; Necadova and Brenova, 2009). Innovation and innovation strategy are considered one of the ways to achieve a successful strategy and build up competitive advantages (Grant, 2013; Johnson et al. 2011, 2012; Drucker 2015; Wit et al. 2014; Christensen, 2015; Jones, 2012). Rasheed (2012) for example writes "Innovate or perish!" There is a whole range of reasons why innovating businesses are successful. Johnson et al. (2011), for example, give the following advantages: Businesses can benefit from the experience curve; compared to followers, they have the profit of greater experience and contact with production; returns to scale as a result of larger production volume. These returns to scale allow them to achieve lower costs than their competitors. Another benefit of being first on the market is the opportunity to secure a supply of rare inputs which will be difficult for other businesses to acquire. Another reason is the innovator's good reputation amongst customers. The aim of this paper is present the main world and Czech authors emphasizing the importance of innovation for business strategy. The another goal of the article is to introduce chosen results of research realized by the Czech Statistical Office in the Czech Republic focused on the innovation activities in the Czech enterprises.

Innovation strategy

The topic of the presented article corresponds to the relatively new approach to building a successful strategy formulated by authors Kim and Mauborgne (2004, 2005a, 2005b). They have named this concept the 'blue ocean strategy.' The essence of the blue ocean strategy is creating own industry. Your company will not be competing with anyone else within this new industry. The creating own industry contrasts to a 'red ocean strategy' in which a company competes in industries where there already are competitors. Kim and Mauborgne propose several paths to formulating a blue ocean strategy. These ways should increase the customer value.

The authors reject the traditional dilemma between basic generic strategies formulated by M. E. Porter (1998a, 1998b). These generic strategies include the necessity for differentiation or concentration on lower costs or on the niche. Kim and Mauborgne (2005a) create a systemic framework of four actions (active measures) which are meant to help break this decision-making dilemma. This ambit is defined by the words: eliminate, reduce, create and raise. Businesses must identify factors which the industry takes for granted but can be reduced. Businesses must further identify factors which the industry considers standard but which can be reduced to a lower level. In contrast, factors must be identified which must be raised to a higher standard than is common in the industry. The final action businesses must take to find factors which until now have not been offered in the industry, and these must be created. The basis for successfully creating a blue ocean strategy is value innovation.

The differences between a blue and red ocean strategy can be defined as follows. Typical for a red ocean strategy is (Kim and Mauborgne, 2005a):

- Compete within an existing market space.
- Beat your competitors.
- Exploit existing demand.
- Choose between value and cost.
- Align the whole of your company's activities with its strategic choice of differentiation or low cost.

The characteristics of a blue ocean strategy are (Kim and Mauborgne, 2005a):

- Create an uncontested market space.
- Make the competition irrelevant.
- Create new demand and capture it.
- Break the value-cost trade-off.
- Align the whole of your company's activities in pursuit of differentiation and low cost.

Also, other authors emphasize the importance of innovation for the company success. For example Vlček (2005, 2006, and 2008) has

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looked in detail at innovation strategies and the importance of value innovation. Vlcek (2008) considers the pair stimuli for product and process innovation in the needs of external customers, and the needs of business units as market participants. He sees incentives for process innovation mainly in the requirements of external purchasers, the needs of business units as producing entities and the needs of some other stakeholders.

We can compare this with Drucker's approach (2015), which differentiates the seven most significant sources of innovation. The first four sources come from within a business:

- unexpected events,
- the discrepancy between reality and what had been anticipated,
- innovations which arise from process changes,
- shifts in the industry for which no-one is prepared.

The sources of innovation which come from outside the business are:

- demographic changes,
- changes in opinions and moods,
- new knowledge both scientific and non-scientific.

Drucker (2015) further formulates the successful competitive strategies: "fastest with the moistest," "hit them where they are not," "ecological niches" and "changing values and characteristics."

Also, Bartes (2011, 2010, 2006), who promotes an approach to formulating a business strategy which is not based on direct competition with rivals, for example, is in agreement with the above-detailed approaches which stress the importance of innovation.

Case study - Czech Statistical Office research – innovation activities of enterprises in the Czech Republic

According to a survey of the Czech statistical office (2014), the most innovating businesses are in the information and communication technology industry (65 %), the manufacturing industry (48 %) and Wholesale (42 %). Those industries with a pair level of innovating activities include architectural and engineering activities, research and development and others (39 %), electricity, gas, heat and air-conditioning production and supply (36 %) and water storage and activities related to sewage, waste, and sanitation (34 %). Those industries with the lowest level of innovation include mining and quarrying (23 %) and transport and storage (19 %).

Factors hampering innovation

According to Oslo Manual (2005), there are several factors hampering innovation activities. There are five groups of these factors: cost factors, knowledge factors, market factors, institutional factors and other reason for not innovating. Cost factors are for example lack of funds within the enterprise, lack of finance from sources outside the company, excessive perceived risks. Knowledge factors include for example innovation potential insufficient, lack of information on technology, lack of information on markets, difficulty in finding cooperation partner, organizational rigidities within the enterprise. Market factors include uncertain demand for innovative goods or services and a potential market dominated by established firm. Intuitional factors are a lack of infrastructure, weakness of property rights, legislation, regulations and others. Other reasons for not innovating are no need to innovate due to earlier innovations and no need because of lack of demand for novelty.

Factors hampering innovation activities for enterprises in the CR in 2010 – 2012 are (Czech Statistical Office, 2014):

Innovations not required 33 %,
Prior innovation means further innovation not necessary 20 %
Uncertain demand for new products 43 %,
Monopolised market 32 %
Problems finding a co-operating partner 18 %,
Lack of information on markets 14 %,
Lack of information on technology 8 %,
Lack of qualified workers 34 %,
High innovation costs 52 %,
Lack of funding outside the enterprise 24 %,
Lack of funding within the enterprise 56 %.

The most common factor hampering innovation activities for companies was a lack of financing within the business (approx. 56 %). This factor also relates to high innovation costs (approx. 52 %). For 43 % of firms, the hampering factor is uncertain demand for new products, for 34 % a lack of qualified workers, for 33 % the problem is the fact that innovations are not required. For 32 % of innovating enterprises, the hampering factor is the fact that the market is controlled by established companies. A lack of external sources of funding (24 %) and problems finding a suitable partner with whom to innovate (18 %) can be said to be relatively less important factors for innovation. A lack of information on markets and technology are amongst the least important factors hampering innovation. For about a fifth of enterprises, their prior innovation activities are an obstacle to new development.

Another field of interest of the research was aimed at the most significant factors hampering innovation activities for enterprises in the Czech Republic during period 2010 – 2012 (Czech Statistical Office, 2014). These factors are:

Innovations are not required 12 %
Prior innovation means further innovation not necessary 5 %

Uncertain demand for new products 11 %
Monopolised market 8 %
Problems finding a co-operating partner 1 %
Lack of information on markets 1 %
Lack of information on technology 0 %
Lack of qualified workers 10 %
High innovation costs 13 %
Lack of funding outside the enterprise 4 %
Lack of financing within the company 34 %.

For 34 % of innovating firms, the biggest obstacle is a lack of financing within the business. The other factors looked at follow on with a relatively large gap. For 10 to 13 % of companies, the biggest obstacles are high innovation costs, a lack of demand for novelty uncertain demand for new products and a lack of qualified workers. For 4 to 8 % of businesses, the most significant factor is a monopolized market, prior innovation and a lack of external sources of funding. An almost negligible number of enterprises (approx. 1 %) said that the most significant factor was a problem finding a partner and a lack of information on markets or technologies.

Table 1 gives information on the differences in barriers to innovation according to enterprise size. A business with 10 – 49 employees is considered a small firm. A business with 50 – 249 employees is considered a medium firm. A business with 250 or more employees is considered a large firm.

Table 1. Most significant factors hampering innovation activities according to enterprise size

Enterprise size	Small enterprises	Medium enterprises	Large enterprises
Innovations not required	14%	10%	10%
Prior innovation means further innovation not necessary	5%	4%	4%
Uncertain demand for new products	10%	13%	15%
Monopolised market	8%	8%	5%
Problems finding a co-operating partner	1%	1%	1%
Lack of information on markets	0%	2%	2%
Lack of information on technology	0%	0%	1%
Lack of qualified workers	8%	14%	16%
High innovation costs	12%	16%	18%
Lack of funding outside the enterprise	4%	4%	3%
Lack of funding within the enterprise	38%	29%	24%

Source: Source: Czech Statistical Office, 2014

The most significant factor hampering innovation activities was insufficient funding for all types of firm. This problem was seen the most amongst small companies (38 %). For large businesses, this factor was the most significant hurdle for just 24 % of enterprises. High costs was a most important factor for 18 % of large firms (18 %) and for 12 % of small companies. Relatively significant differences in assessments can be found for lack of qualified workers. This factor is the most relevant for 18 % of large enterprises, but just for 12 % of small firms. An uncertain demand for innovative products is also assessed relatively differently for various types of enterprise. It is termed the most significant factor for 15 % of large businesses, but its significance falls with the size of the company. For small enterprises, it comes to just approx. 10 %. There are no major differences in the assessment of innovation barriers for the other factors between different size groups of the firm.

Innovation categories

The basic kinds of innovations are technical and non-technical innovations. Technical innovations are divided into product and process innovation (Herman et al. 2008; Theodor, 2008; Ahmed et al. 2010).

Table 2. gives information about types of innovation activities.

Table 2. Types of innovation activities

Type of innovation activities	Small enterprises	Medium enterprises	Large enterprises
Innovative enterprises in total	38%	58%	79%
Technically innovative enterprises	30%	49%	72%
Non-technically innovative enterprises	27%	42%	58%

Source: Source: Czech Statistical Office, 2014

The biggest innovation activity (total) report large enterprises. The medium enterprises have the second positon, and the small enterprises have the lowest innovation activities. All three groups of enterprises are more active in the area of technical innovation in comparison with their activities in the area of the non-technical innovation.

The results of product innovation activities are (Czech Statistical Office, 2014):

Products range extension 45 %,
Entrance into new markets 20 %,
Replacement of the existing range of products 15 %,
The improvement of products quality 15 %,
Market share increases 4 %,

Negative impacts on the environment were reducing 3%.

Z most important effect of innovation is the product range extension (45 %). The other factors have the significantly less impact. Entrance into new markets was evaluated by 20 % of firms. For 15 % of companies, the result of product innovation is a replacement of an existing range of products and the quality of improvement. The last two facts – market share increase and negative impacts on the environment reducing – are relevant for approximately 7 % of enterprises.

The most significant result of process innovation activities are (Czech Statistical Office, 2014):

Improvement of manufacturing flexibility 57%
Labour costs reducing 15%
Negative impacts on the environment decreasing 13%
Expansion of production capacity 8%
Material and energy consumption reducing 3%
The health and safety of workers improving 5%

The most major effect of product innovation activities is an improvement of manufacturing flexibility. This result is most important for 57 % of enterprises. The second most important result is labor cost reducing (approximately 15 %) and the third most crucial factor is reducing of negative impact on the environment. The other three factors – expansion of production capacity, material, and energy consumption reducing and the health and safety of workers improving have less than 10 % of enterprises.

Conclusion

Innovation is the world and also in the Czech literature recognized as one of the sources of competitive advantage. According to review of the literature, the foundation of this strategy understands customer needs and value analysis. There are many barriers to the innovation development and implementation of the enterprises. The most important barrier to innovation for companies in the Czech Republic is the lack of funds.

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A Framework for the Strategic Management of Science & Technology Parks

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Abstract: Science and technology parks (STPs) have been playing an increasingly influential role in the stimulation and growth of the knowledge economy. However, the spread of STPs faces relevant challenges, such as the development of robust performance management systems, able to demonstrate results and indicate improvement opportunities. Thereby, this paper proposes a theoretical model of performance management, which combines premises of the Service-Dominant Logic (S-D Logic), the Balanced Scorecard (BSC) and the General Hierarchical Model (GHM). Based on a multiple-case exploratory and qualitative study, relevant information about the strategic planning and management of these projects were extracted and paved the way for the construction of a performance hierarchical model composed of five perspectives, according to the BSC. Considering the outcomes, it is expected that the proposed model provide useful insights for the consolidation of a framework for the strategic management of science and technology parks.

Keywords: science and technology parks; service-dominant logic; balanced scorecard; general hierarchical model; performance management model.

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Introduction

There is an increase of evidence, in different economies, that science and technology parks (STPs) promote the construction of a new model of economic and social development, adhering to the knowledge economy. Based on the interaction between academia, business and government, these ventures seek to act as regional economic development catalysts, by facilitating the creation and development of new technology-based firms and technology transfer from universities to companies (Vilà & Pagès, 2008).

In Brazil, the movement of STPs is recent and had its biggest boost only from the 2000s (Vedovello, Judice, & Maculan, 2006). Data from the Ministry of Science, Technology and Innovation of the Brazilian government (MCTI, 2013) indicate the existence of 94 STPs initiatives in all five regions of the country, in different stages of development (planning, implementation and operation). As a whole, in the 28 ventures in operation, 939 companies are installed, generating more than 32.000 skilled jobs and significant impacts in terms of revenues and taxes.

Nevertheless, the dissemination of STPs in Brazil faces relevant challenges such as the scarcity of resources for expansion and improvement of infrastructure, the difficulty of attracting companies and to promote the alignment between institutional partners and the establishment of better management practices (Fundação CERTI, 2013). It is observed over the past few years the absence of more robust performance evaluation systems able to prove the achieved results, indicating opportunities for improvement and supporting the effectiveness of parks as a public policy instrument (Bigliardi, Dormio, Nosella, & Petroni, 2006; Dabrowska, 2011; Monck & Peters, 2009; MCTI, 2015; Phan, Siegel, & Wright, 2005; Vedovello, Judice, & Maculan, 2006).

Recently, some proposals have emerged for the elaboration of more detailed performance assessment systems that can be deployed relatively easily and are accepted by the main stakeholders (Andreevna, 2013; Dabrowska, 2011; Fernandes, 2014; Rodeiro-Pazos; Calvo-Babio, 2012). However, there is no consensus on what is a successful science and technology park and on what metrics should be employed to evaluate and compare different parks systematically (Dabrowska, 2011).

In order to contribute to the understanding of these issues, this paper suggests the use of the conceptual basis of the Service-Dominant Logic (Vargo & Lusch, 2004), an innovative paradigm in the Marketing Theory for analysis of exchange between economic and social actors, as a theoretical support for the understanding of phenomena and processes of science and technology parks. Specifically, the article aims to reflect on the actions of the actors involved in these ecosystems, especially universities, business and government, with regard to the integration of resources and value cocreation.

Aiming to consubstantiate the analyzes and to contribute to the evaluation theme of STPs performance, it was developed a theoretical model based on the Balanced Scorecard (Kaplan & Norton, 1997, 2000, 2004) and in the premises for the construction of scales and models elaborated on the General Hierarchical Model (Mowen & Voss, 2008). The proposed model has as its central feature the expansion of the assessment results focus to the performance management view. Thus, development is aimed at identifying strategic resources for value cocreation in STPs, as well as the understanding of the relationship between these resources and the best known performance indicators of these innovation environments.

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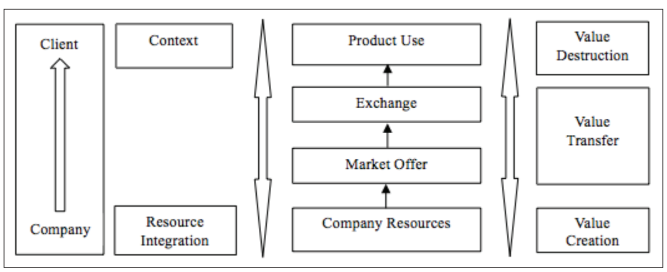
Initially, the work presents the theoretical background, which describes the fundamentals of the Service-Dominant Logic (S-D logic), science and technology parks, the Balanced Scorecard performance management model (BSC) and performance assessment approaches in STPs. The literature review is concluded with a discussion of the relationship between the S-D logic and the BSC and the explanatory power of the S-D logic against the phenomenon of science and technology parks, especially about value cocreation and resources integration practices. Then it is presented the research method, the proposed hypothetical-conceptual model and the suggestion of indicators to operationalize the constructs. At the end of work, considerations are made on the issues discussed, indicating the limits of this research and suggestions for future studies on the subject.

The Service-Dominant Logic

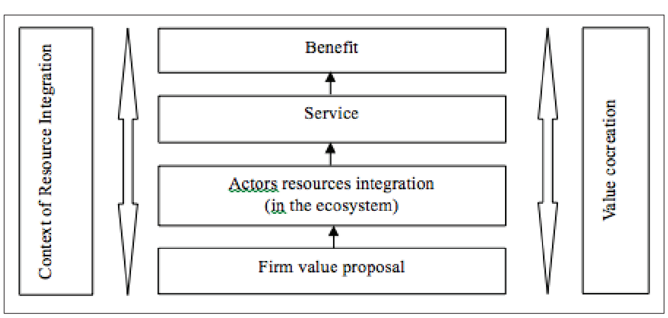
The Service-Dominant Logic (S-D logic) is a proposal for a paradigm change, from the dominant current "Goods-Dominant Logic" (G-D logic) for a Service-Dominant Logic, in which the term Service means the application of competences (knowledge and skills) for the benefit of another party and/or yourself (Lusch & Vargo, 2006). According to the G-D logic, values are constantly created and destroyed following the principle set out in the diagram of Figure 1 (Bettencourt, Lusch, & Vargo, 2014):

Figure 1. Diagram of value creation in the Goods-Dominant Logic. Data from Bettencourt, Lusch e Vargo (2014).



For Lusch and Vargo (2006), the S-D logic rejects the premise that only the firm can create value at the time of production of goods or services. According to the authors, any product, tangible or not, is only part of the provision of a service, that is, what is actually being exchanged is always service by service. The exchange value emerges in the use and it is cocreated by the actors involved in a service ecosystem, from integrated resources. In S-D logic values can be constantly cocreated, following the principle set out in the diagram of Figure 2:

Figure 2. Diagram of value creation in the Service-Dominant Logic. Data from Bettencourt, Lusch e Vargo (2014).



The theoretical framework from the S-D logic can be presented through its eleven foundational premises, five of which are considered more basic or axioms, as shown in Table 1.

Table 1. Axioms and foundational premises of the Service-Dominant Logic. Data from Vargo and Lusch (2016, p. 8).

A1 (FP 1)	**Service is the fundamental basis of exchange.**
FP 2	Indirect exchange masks the fundamental basis of exchange.
FP 3	Goods are distribution mechanisms for service provision.
FP 4	Operant resources are the fundamental source of strategic benefit.
FP 5	All economies are service economies.
A2 (FP 6)	**Value is cocreacted by multiple actors, always including the beneficiary.**
FP 7	Actors cannot deliver value but can participate in the creation and offering of value propositions.
FP 8	A service-centered view is inherently beneficiary oriented and relational.
A3 (FP 9)	**All economic and social actors are resource integrators.**
A4 (FP 10)	**Value is always uniquely and phenomenologically determined by the beneficiary.**
A5 (FP 11)	**Value cocreation is coordinated through actor-generated institutions and institutional arrangements.**

Notes: Abbreviations: A = Axiom; FP = Foundational Premise. In bold, the axioms.

These fundamental premises provide a framework to review and possibly increase the knowledge of the exchange process and its role in society (Lusch & Vargo, 2006). Essentially, S-D logic provides a more holistic, dynamic and realistic perspective of value creation, through exchange, among a wider, more comprehensive (than firm and customer) configuration of actors (Vargo & Lusch, 2016).

In S-D logic, the traditional firm-customer view must be overcome for a systemic approach of networks of actors interacting in a service ecosystem, in which all actors integrate resources and engage in service exchange, in the process of cocreating value (Vargo & Lusch, 2016). It is thus necessary to conceptualize important elements from the lexicon of S-D logic, such as ecosystem, value and resource. This is the content developed in the following subsections.

The service ecosystem

The service ecosystem, in the S-D logic, is defined as a system of direct and indirect exchange relationships between the actors involved. It is then necessary to abandon the producer-consumer dyad and to adopt the premise that in service exchange, resource-integrating actors "are connected by shared institutional logics and mutual value creation" (Lusch & Vargo, 2014). So, in the service ecosystem, all participants, directly and indirectly involved in the exchange are actors, and there is not, at first, separation between suppliers and consumers.

The ecosystem term is chosen to indicate a dynamic adaptation of the system. The systems are dynamically self-adjusting, while acting and reconfiguring the resource integration process and value creation aiming to increase the chance of survival and the ecosystem´s viability. The system's view differs from the network view by the fact that in the system, at each resource integration, service provision and value creation, there is a change to some extent of the context for the next iteration and determination of value creation (Wieland, Polese, Vargo, & Lusch, 2012).

Within the service ecosystem actors perform amongst themselves exchanges that can be of three basic types: strict, general and complex (Lusch & Vargo, 2014). The type of restricted exchange corresponds to the dyad in which an actor "A" exchanges service with an actor "B. In the type of general exchange, at least three actors perform indirect exchanges. The complex changes, in turn, are characterized by the presence of at least three actors, connected by a network of relationships in which each actor involves in a direct exchange at least once. This service exchanges allows the cocreation of value by the actors, as discussed below.

Value and value propositions

In the traditional view from the Goods Dominant Logic, value is created only by the producer organization of goods or services, leaving the client to consume this value function (Bettencourt, Lusch, & Vargo, 2014). In the Service Dominant Logic, however, the organization, with its resources, offers a value proposition to be exchanged with a customer. The integration of resources from the organization and other actors (government, family and other organizations) brings benefits to the consumer, which then becomes a beneficiary who cocreates value.

In this sense, the cocreated value can be measured as a perceived benefit. This value needs to be analyzed within a specific context of interactions and social structures. These social structures, in turn, are the ones that make it available to actors both the rules and the resources that can be employed in the activities and interactions. Following, it is presented the concept of resource in the S-D logic.

Resources and integration of resources

The integration of resources refers to organizations, families and individuals that transform micro specialized competences in complex services demanded in the market, which performs specific functions of the service system to a beneficiary or specific actor in the system (Peters *et al*., 2014). It is noticed that the integration of resources is not possible if these are limited to physical materials, such as raw materials. In S-D logic resources are the tangible and intangible entities available used to create value, being the service the result of the application of operant resources such as knowledge and skills on operand or tangible resources.

Another important concept related to resources is the density. Briefly, density is a measure of the amount of information, knowledge and other resources accessible to the actor at a given time and place, to solve a certain problem. To create or increase density in a particular situation, companies can separate and recombine resources. The higher the density, the higher the integration of resources and therefore the greater the potential value that can be cocreated (Lusch & Vargo, 2014).

Either service and value cocreation result from the resource integration (operant and operand) of multiple actors, which requires communication and coordination. The cocreation of value is necessarily a joint activity, which depends on the establishment of mutual understanding (instructions) so that different entities achieve common goals. On the other hand, mutual understanding is also cocreated because it is achieved through shared institutional logics, such as experiences, context and information, as well as other shared resources as a language specifically created by a group that facilitates the connection between its members (Maglio & Spohrer, 2008).

This proposed change in the concepts of value, value cocreation, resources, and how to see the relationships between the actors in the market, expanding the relationships pertaining to the dyad business-consumer to relationships in a broader service ecosystem, provides a new perspective to analyze more complex interaction phenomena as, for example, social and technological phenomena involved in the science parks ecosystems.

Science and technology parks

The concept of a science park originated in the United States in the 1950s, in Stanford, California. Based on the co-evolution of science and technology, science parks aim to promote technical infrastructure, logistics and administration to help small businesses develop their products, increase their competitiveness, promote technology transfer and the creation of an environment conducive to innovation (Bakouros, Mardas, & Varsakelis, 2002; Phillimore, 1999).

The importance of science parks can be seen by its spread in developed and developing countries and the emergence of a growing research literature, especially from the 1980s (Fiates, 2014; Phan, Siegel & Wright, 2005). The interest in these innovative environments, based on the Triple Helix model, has increased as government, academic and business actors realize its potential as a catalyst for innovative entrepreneurship and technological and socio-economic development.

In Brazil, according to the Brazilian Association of Science Parks and Business Incubators (ANPROTEC) a science park is:

> a productive industrial complex and scientific-technological base services, planned, with formal character, concentrated and cooperative, which aggregates companies whose production is based on technological research developed in R&D centers linked to the park. It is a promoter of the enterprise culture of innovation, competitiveness, increasing business skills, based on the transfer of knowledge and technology, with the aim of increasing the production of wealth of a region (ANPROTEC, 2015, s/p).

That way it is observed that a science park is a planned and cooperative space, in which technology based companies interact with themselves and with educational, research and development institutions. It is up to the park the offering of value-added services to promote the culture of innovation, competitiveness and increased business capacities, which will foster wealth creation in the region.

In a more systematic approach, the main actors involved in science parks, their contributions and the expected results by these stakeholders can be seen in Table 2.

Table 2. Science Parks: key stakeholders, contributions and expected results. Adapted from Vedovello, Judice and Maculan (2006).

STAKEHOLDERS	KEY CONTRIBUTIONS	EXPECTED RESULTS
Universities and research institutes	• Scientific basis: human capital, technology infrastructure and organizational capital. • Capacity to attract companies and talents.	• Commercializing academic research results expanding the sources of financial resources. • Expand the institutional mission. • Expand the labor market for researchers and students.
Entrepreneurs and academics entrepreneurs	• Entrepreneurial culture, technical and market knowledge.	• Use results of academic activities and research in order to boost their own R&D business. • Boost financial returns. • To access qualified human resources.
Financial agents and venture capitalists	• Availability of financing and technical and managerial support to companies.	• Investing in new technology based companies with high and fast economic growth potential and financial returns.
Government and development agencies	• Political support, public resources for the structuration and operation of parks and attractive financing to boost business.	• Support innovative activities in businesses. • Revitalize economically depressed regions. • Generate jobs.

Considering the context presented, we can see that the proposition of an evaluation and performance management mechanism in these ecosystems is a complex task due to the variety of actors involved, expectations and value propositions. In this sense, the use of a multidimensional model of performance, such as the Balanced Scorecard, adapted to the Science Parks context, can contribute to the understanding of the integration of resources and cocreation of value in these ventures.

Balanced Scorecard

In the early 1990s, the belief that the methods traditionally used to measure business performance were becoming obsolete because they consider only accounting and financial indicators, led to the creation of a new management tool called the Balanced Scorecard (BSC). As a differential, the BSC promoted and integrated important aspects related to value creation for organizations, such as human capital, the critical internal processes and the value proposition to customers or target audience, which would be intrinsically related to the achievement of financial results and fulfillment mission.

The Balanced Scorecard name (Balanced Measurements System) was chosen because the model reflected the balance between short and long term objectives, between financial and nonfinancial, among trend indicators and results and between internal and external perspectives of performance. This way the BSC proposes the integration of objectives, indicators, targets and initiatives in four interrelated categories of performance: financial, customer, internal processes, and learning and growth (Kaplan & Norton, 1997).

The financial perspective is responsible for defining the expected financial performance of the strategy and to provide the main targets for the objectives and measures of all other perspectives of the scorecard. Financial performance measures tangible results of the strategy, which show whether the organization is heading for success. Two main themes guided this perspective: revenue growth and increased productivity (Kaplan & Norton, 2004).

According to the logic of the BSC, the improved financial performance is closely related to the success in meeting the desires and target customer needs. Thus, it is necessary to carefully establish the organization's value proposition, which will clarify the context for intangible assets and internal processes to create value. The success of the customer's perspective can be measured by indicators of results such as satisfaction, retention and growth of success with customers.

While the financial and client perspectives describe the expected results of the implementation of the strategy (constitute external sides of the performance), the size of internal processes identifies the critical few processes that must exert the greatest impact on strategy (Kaplan & Norton, 2004, p. 32). These are the processes that will create and fulfill the value proposition for customers and indicate improvement trends that will impact on the target audience and financial results.

On the basis of the BSC, the learning and growth perspective is responsible for defining the most important intangible assets for strategy. The objectives in this perspective identify which jobs (human capital), systems (information capital) and type of climate (organizational capital) are needed to support the internal processes of value creation. These assets must be coherently connected with each other and aligned to the critical internal processes (Kaplan & Norton, 2004). Furthermore, "the improvements in the results of learning and growth are trend indicators for the internal processes, customers and financial performance" (Kaplan & Norton, 2004, p. 7).

The four perspectives mentioned, present in most applications of the BSC, can be complemented by other dimensions, as long as these are considered strategic in the organization's context (Kaplan & Norton, 1997). Thus, public sector institutions and non-profit organizations also make use of the BSC. The difference is that in this case, the ultimate criteria of success is not financial performance, or the creation of sustainable value for shareholders, but the performance in fulfilling the mission obtained through the creation of sustainable value for two interest groups: contributors and beneficiaries (Kaplan & Norton, 2000; 2004).

Throughout research and applications, the BSC has evolved from an optimized performance measurement system for a strategic management system, capable of promoting alignment and focus. Its use has been encouraging the development of principles of action in organizations such as the mobilization of change through executive leadership, the conversion of strategy to a continuous process, the transformation of strategy task of all organizational stakeholders, the organization's alignment to the strategy and translation of strategy into operational terms (Kaplan & Norton, 2000).

The BSC has also been improved and complemented by a management tool called "Strategic Map", used to describe strategy through goals interconnected in cause and effect relationships in the four perspectives (Kaplan & Norton, 2004). The strategy map provides further details about each perspective, improving the clarity and focus of the strategy.

Recently, the issue of evaluating science parks' performance, which is typically based on the comparison of results from technology-based companies located inside and outside these environments or in the monitoring of innovation and financial outcomes of parks, is being reinvigorated by more robust techniques based in consolidated references, able to bring new elements for a more consistent analysis of science parks' performance.

Performance Evaluation of Science and Technology Parks

Performance evaluation of science and technology parks is becoming an increasingly relevant issue for the actors involved (Bigliardi *et al.*, 2006; Dabrowska, 2011; Rodeiro-Pazos & Calvo-Babio, 2012), as there is a real demand for transparency and effective results in terms of local development, innovation and revenue for companies (Bigliardi *et al.*, 2006; Monck & Peters, 2009).

According to Fernandes (2014), the need to assess the effectiveness of science parks arose due to the expansion of the concept and the creation of new parks. It can be understood as a result of the maturing of the mechanism as a promotional policy to technological entrepreneurship. Indeed, the assessment shows stakeholders and managers improvement opportunities for the future.

In fact, the importance of this issue was highlighted in the study of MCTI (2015), which involved the development of suggestions for the improvement of support policies for science parks in the country. Among these, it can be included the definition of framework criteria for different stages of development (planning, installation and operation) and performance indicators for the investment of public resources; the development of services and support mechanisms to promote the interaction between innovation actors (companies and universities); and the development of a performance evaluation system for science and technology parks.

Typically, the performance of these ventures has been analyzed by comparing results of technology-based companies within parks versus outside parks. Several studies investigated the existence of statistically significant differences in indicators such as number of jobs created, sales volume, R&D results, new products and/or services and business survival rate (Dabrowska, 2011; Monck & Peters, 2009).

Some studies showed that companies located in parks have better performance of research and innovation and greater propensity to develop joint projects with universities (Fukugawa, 2006; Siegel, Westhead & Wright, 2003; Squicciarini, 2008). There is also evidence of positive impacts of science parks in the growth and image of the universities involved, with highest number of publications, patents and technology transfer and better allocation of graduated (Link & Scott, 2003). However, in general, the evidence of superior performance of tenant companies in parks compared to companies outside the parks are assessed as weak (Dabrowska, 2011; Monck & Peters, 2009).

At the same time, another common way to measure the performance of science and technology parks is the monitoring of general information, such as the number of tenant companies, the occupied area, the jobs created (Dabrowska, 2011), the level and type of investments made, the tenant company's revenues, the number of startups, patents and new products created (Bigliardi *et al.*, 2006; Dabrowska, 2011; Rodeiro-Pazos e Calvo-Babio, 2012).

Even though these evaluations provide important information on the results achieved, they are limited as they do not explain how to improve science parks' performance. Therefore, there is a need to develop more systematic approaches, supported by consolidated analytical frameworks, that can deal with the resources and expectations of the actors involved and be applied in a practical way by managers and stakeholders concerned with science parks.

Recent researches have used the Balanced Scorecard as a theoretical and methodological framework to propose a more consistent system for performance management in science parks (Andreevna, 2013; Dabrowska, 2011; Rodeiro-Pazos & Calvo-Babio, 2012). In these studies, contributions are pointed at the subject, especially in suggesting lines of analysis and indicators for measuring the effectiveness of these ventures. However, a common limitation is the lack of a methodology to integrate the dimensions and indicators in cause and effect relationships, in order to highlight the most strategic resources and the connections underlying value cocreation in science and technology parks.

Methods

This research can be characterized as exploratory and qualitative. According to Gil (2006), exploratory researches have as its principle to develop, clarify and modify concepts and ideas, through the development of more precise problems or searchable hypotheses for further studies. Given that the proposed work is rarely studied in the literature, there was an exploratory research to deal with aspects of a performance management model of science parks, considering key success factors, services and results of these ventures.

The qualitative character of the research is due to the emphasis given to the processes and meanings (Sale, Lohfeld, & Brazil, 2002). In this sense, the multicases study was used as a methodological strategy. According to Yin (2005), the case study applies as an empirical investigation of a contemporary phenomenon within its real-life context, especially when the boundaries between phenomenon and context are not clearly defined. For Gil (2006), one of the purposes of the case study is to explain the causal variables of a given phenomenon in very complex situations that do not allow the use of surveys and experiments. In fact, the multicases study allowed obtaining a wider knowledge of the planning, management and performance of science parks, which contributed to the proposition of a theoretical model grounded in the reality of these environments.

For this research, there was collected primary and secondary data. Initially, the literature review on Service-Dominant Logic, Science and Technology Parks and Balanced Scorecard provided material to elaborate semi-structured questions covering planning and strategic performance management of STPs. After the elaboration, ten semi-structured interviews were made with strategic and operational level managers of three STPs in operation in Brazil: tecnoPARQ (Viçosa – MG), BH-TEC (Belo Horizonte – MG), and Sapiens Parque (Florianópolis – SC).

These parks are in different stages of maturity and regional contexts, allowing a broader spectrum of analysis of management practices, important for the construction of reference models. Even though they are all in operation, the tecnoPARQ and BH-TEC are younger, with about five years of activity. Sapiens Parque, on the other hand, is a more mature venture with about ten years of operation. In addition, the BH-TEC and Sapiens Parque are located in large urban centers (capitals), while tecnoPARQ has the challenge of being successful out of large cities, in the up-country.

For the analysis of data obtained through the interviews, direct observation and analysis of institutional documents, content analysis technique was used, more specifically thematic analysis. According to Bardin (2000, p. 106), "the answers to open questions, [...] can be and are, often, analyzed with the theme as a basis". In this sense, related information from the interviews were grouped and four thematic categories have been formulated, addressing: (i) critical success factors; (ii) service portfolio; (iii) performance indicators, positioning and strategy; and (iv) strategic objectives of the parks. It followed this analysis the proposition of the research conceptual model, the development of hypotheses and the constructs' operational definition.

Following, it is presented the discussion that led to the research hypotheses, the suggested conceptual model and the indicators to measure the constructs.

Discussion of results

The Service-Dominant Logic, the Balanced Scorecard and Science and Technology Parks

In this research, both the Service Dominant Logic and the Balanced Scorecard were used for the analysis of resource integration and value cocreation in science and technology parks. Service-Dominant logic approach is holistic and integrative, and its key concepts, such as service, actor, resource, value and ecosystem, are consistent with the context of science parks. Besides, the BSC is recognized as an important strategic management system, able to associate objectives and performance indicators and to provide organizational alignment and focus. In addition, both S-D logic and BSC emphasize the relevance of intangible assets or operant resources (such as knowledge, skills and competences) for value creation. Essentially, this research assumes that these theories can be used together for the analysis of the science park ecosystem, supporting the proposal of a performance management model adapted for these innovation environments.

According to S-D logic, strategy success depends on the company's ability to effectively develop collaborative relationships which will promote the integration of resources and the creation of new resources. By definition, science parks must work to enhance institutional cooperation between university-industry-government (Giugliani, Selig, & Santos, 2012). Therefore, the proximity, the exchange of experiences and complementarity of competences between these actors (resource integration) are fundamental to the generation of synergies and consistent results.

The adoption of S-D logic also involves assessing the performance of science parks based on cocreated value by government actors, universities and companies. The direct and indirect benefits created by these ventures serve the different stakeholders and are represented by employment opportunities, increasing number of patents and technology transfers and the strengthening of entrepreneurship (Dabrowska, 2011). Thus, the cocreated value would result of combined efforts from different stakeholders and from the effective integration of resources.

Taking up the five basic axioms of S-D logic, it is possible to relate them to the context of science parks in the following way:

A1 - service is the fundamental basis of exchange: based on the definition of ANPROTEC (2015, sp), it can be inferred that the park management service is "to promote the culture of innovation, competitiveness, increasing business skills, based on the transfer of knowledge and technology". In other words, the main benefit generated by science parks to tenant companies consists in providing a planned and cooperative environment with high value-added services that facilitate the flow of knowledge, technology and resources between actors and lead to the development of new products and services. But the service offered by tenant companies is the generation of positive externalities such as jobs, new products, revenues and encouragement for the innovative entrepreneurship culture. The government, by its turn, offers the service in the form of political/institutional support, through investment, financing, innovation policy and regulatory framework. And universities provide the service in the form of intellectual capital, knowledge and research and development infrastructure.

A2 - Value is cocreacted by multiple actors, always including the beneficiary: in this work's view, the actors involved are the academy (universities), the government, the financial agents, the community around the park and the entrepreneurs (companies). In this ecosystem, one actor only can cocreate value (receive benefit) if different kinds of resources (operand and operant) are available: entrepreneurial culture, public policies supporting technological innovation, financial resources and facilities. If the beneficiary is represented by the tenant companies, the benefit received is the environment provided to accelerate technological innovation or the introduction of solutions, new products or services on the market successfully (Fiates, 2014). Tenant companies cocreate value in its operation when they integrate their knowledge resources with other actors, creating benefits as community socioeconomic development.

A3 - All economic and social actors are resource integrators: all actors involved in the innovation processes in science parks are resource holders (operant and operand). The government, for example, has resources for funding; the universities, resources in the form of knowledge and infrastructure; and businesses in the form of entrepreneurship and innovation. All these actors, while interacting, integrate their resources maximized in a higher density to increase the viability of the ecosystem.

A4 - Value is always uniquely and phenomenologically determined by the beneficiary: in the case of this study, the focus beneficiary is the tenant companies. Therefore, the model will seek to measure the most important benefits for these players, that is, the value cocreated. The same benefits can generate different values for different actors, as well as each tenant company can realize a different value for each resource to it offered.

A5 - Value cocreation is coordinated through actor-generated institutions and institutional arrangements: as described earlier, value cocreation depends on the establishment of mutual understanding and instructions to guide different entities towards common goals. This mutual understanding is improved if institutional logics, such as information, and other shared resources that facilitates the connection between its members (Maglio & Spohrer, 2008) are available. In this study, these connections facilitators are represented by factors such as the level of cooperation culture, entrepreneurial culture and encouraging entrepreneurship policies.

As seen above, each actor in the science and technology park ecosystem can cocreate different values, since the integrated resources differ from actor to actor. In this study, these values will be expressed in the definition and implementation of the model constructs. Another important point concerning this research is the assumption that the key success factors of science parks and the best known performance indicators of these ventures are also represented in the conceptual model.

Interviews analysis and the proposal of an analytical model

The thematic analysis of the interviews revealed what science parks managers consider the main goal of the parks: to increase economic development. All interviewers agreed at this point. They also agreed that this development depends on the availability of operand resources such as spaces, facilities and financial credit. Operant resources are indispensable too, such as management capacity of the science park team, public policies to encourage entrepreneurship, human capital and entrepreneurial culture of the tenant companies.

In order to overcome barriers and achieve this context of development, each park interviewed adopted different strategies. They are different due to the different maturity stages in which they are. The relative geographical position (central/peripheral) impacts too, along with the availability of resources coming from government and universities. The parks' strategies for development involve aspects such as the attraction of startups, big companies' R&D departments and anchor business, partnerships within the science parks net and the search for public and private financial resources.

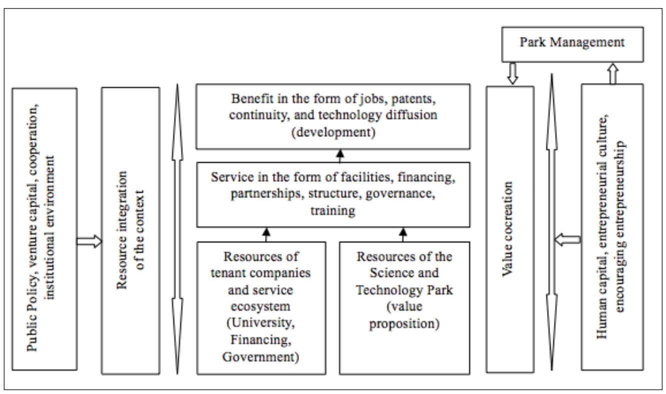
In fact, the interviews have shown that the strategies adopted aim to overcome difficulties concerning lack of financial, human and material resources, and this search for resources has left no room to prospect a path to increase the future performance of the park. For instance, in the BH-TEC the challenge now is to raise financial resources to build another facility, to admit new companies. And in tecnoParq, most of the human resources are composed by fellows' trainees who stay for a short time and cause a high turnover.

On the other hand, even with all the restrictions, all respondents agreed that the parks have brought benefits to the tenant companies and the community around the park. The companies receive services (in the SD-L sense) like management support and commercial advice and when integrate their resources (as knowledge and technology) the value is cocreated. In the community case, the benefits come as employment and income. The University (in the cases where its resources are properly integrated) receives the benefit of increase and diffusion of knowledge.

From the Service Dominant Logic point of view, the interviews reveal a lack of resource density. The relationship between government and academy and between academy and Science Park, and Science Park and government seems to be not properly set to an optimum result. So, an analytical model is proposed to help to analyze and propose solutions to the problem identified. The analytical model that integrates key success factors, services and results of science parks in the theoretical framework of the S-D logic is shown in Figure 3.

According to the proposed analytical model, the benefits are generated by the integration of resources of the actors that in this process are influenced by several factors, such as the government's public policies, cooperation of universities, entrepreneurial local culture. The park management also impacts the value cocreated, because it is directly linked to the coordination of resources towards higher density. According to the above, the S-D logic approach is valid to the understanding of relationships and parks phenomena. From this analytical model, based on the assumptions of S-D logic, the science parks literature and the context of the science parks interviewed, it is suggested a hypothetical conceptual model for measuring the relationships among the strategic resources of the actors, the technological, scientific and socioeconomic progress brought by these ventures (benefits), and the value cocreated for tenant companies, universities and government.

Figure 3. Analytical model of value cocreation in the ecosystem of the science park in the perspective of S-D logic. Data based on Bettencourt, Lusch and Vargo (2014).



Once defined the elements involved in the value cocreation process of the science parks in Brazil, the next step is to create a way to quantify the relation between each of these elements. This quantification demands a conceptual model, research hypothesis, scales and a framework to analyze the effect and significance (existence) of the relationships. In the following topic these aspects are addressed.

Conceptual model, research hypothesis and scales

Based on a review of literature on S-D logic, BSC and science and technology parks, as well as the analysis of the multicases study, a hypothetical-conceptual model for performance management of science and technology parks was proposed. The model consists of an adaptation of the BSC management tool to the context of strategic management of parks. Considering the theoretical proposal of S-D logic, developed in this work, the main actors present in this ecosystem are represented: park management, tenant companies, universities and government. Each of them has different resources that must be assessed. In order to perform these assessments, some dimensions are suggested.

The performance of the team management and the government, with regard to the provision of support bases for the performance of companies, is directly covered in the dimensions of Learning & Growth and Internal Processes. The value proposition cocreated by these stakeholders will be assessed from the perspective of Tenant Companies, defined as the focal actors in this model. In the Science, Technology and Innovation dimension, the intensity and the university-company relationship results are discussed. Finally, a more holistic contribution of the park to the region where it operates is handled through the dimension of Sustainable Socioeconomic Development. Therefore, the perspectives/constructs and their concepts are synthetically presented in Table 3.

Table 3. Model dimensions

Perspective / Construct	Concept
Learning & Growth	It refers to the critical success factors or to the intangible and tangible assets (operant and operand resources) required for the venture's success.
Internal Processes	Refers to activities related to the organization, the coordination and the most relevant services provided by the park, aiming at the growth of businesses and the organization itself.
Tenant Companies	It refers to the proposed park value for tenant companies. It consists of evaluating the performance of the park as a facilitator of technological innovation and business development, as well as its effectiveness in providing value solutions for companies.
Science, Technology & Innovation	It refers to the work of the park as a promoter of the university-business relationship, aiming results of scientific and technological development.
Sustainable Socioeconomic Development	It refers to more holistic results of the project in the region where it is located, contemplating benefits of socioeconomic and environmental nature.

For the construction of the hypothetical conceptual model, by its turn, the General Hierarchical Model (GHM), proposed by Mowen and Voss (2008), was used as a reference. This model provides a framework in which the constructs are distinguished not only by conceptual differences but also by level of abstraction. In a hierarchical model, the constructs have prior relationships and are fully interrelated. Thus, applying the GHM in the proposed model based on the BSC, the process starts from more intangible constructs such as learning and growth, to reach more tangible constructs such as science, technology, innovation and sustainable socioeconomic results. The Hypothetical Conceptual Model is shown in Figure 4.

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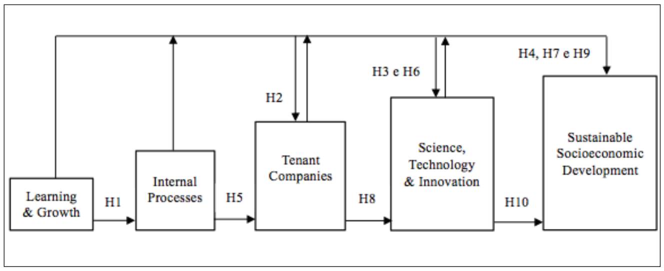
Figure 4. Hypothetical-conceptual model proposed, based on BSC



Thus, the research hypotheses arising from the model were constructed, as shown in Table 4. These hypotheses will be tested:

Table 4. Research model hypotheses

H1	The perspective of Learning and Growth has a positive effect on the perspective of Internal Processes.
H2	The perspective of Learning and Growth has a positive effect on the perspective of Tenant Companies.
H3	The perspective of Learning and Growth has a positive effect on the perspective of Science, Technology and Innovation.
H4	The perspective of Learning and Growth has a positive effect on the perspective of Sustainable Socioeconomic Development.
H5	The perspective of Internal Processes has a positive effect on the perspective of Tenant Companies.
H6	The perspective of Internal Processes has a positive effect on the perspective of Science, Technology and Innovation.
H7	The perspective of Internal Processes has a positive effect on the perspective of Sustainable Socioeconomic Development.
H8	The perspective of Tenant Companies has a positive effect on the perspective of Science, Technology and Innovation.
H9	The perspective of Tenant Companies has a positive effect on the perspective of Sustainable Socioeconomic Development.
H10	The perspective of Science, Technology and Innovation has a positive effect on the perspective of Sustainable Socioeconomic Development.

Regarding to the operationalization of the constructs, the indicators need to provide consistency with both the BSC and the context of science and technology parks. In this sense, the following considerations are presented:

- **Learning & Growth:** reflecting the emphasis on human capital, technological infrastructure and information and organizational capital, suggested by the BSC, it is intended to approach key success factors such as the ability to attract and retain talent, the work in strategic and effective networks, the quality of the scientific and technologic basis, the entrepreneurial culture of the region, among others.

- **Internal Processes:** with reference to the central themes presented in the Strategic Map (resulting tool from BSC), it is suggested to analyze the main value-added services to tenant companies, the activities of prospecting and attracting companies (including anchors) and seeking capital for investments.

- **Tenant Companies:** starting from the value proposition concept, highlighted in both S-D logic and BSC, it is indicated to approach which aspects of the park service are considered more important by tenant companies, such as the reputation of the park, the availability of value-added services, the opportunity of interaction with the university and with other companies, among others.

- **Science, Technology and Innovation:** reflecting one of the main motivations of a science park, it is suggested to approach items like the generation of successful innovations, intellectual property and scientific publications, among other concerns.

- **Sustainable Socioeconomic Development:** with reference to the regional development objectives of science and technology parks, it is suggested to approach themes such as income generation and quality jobs, attracting investment and integrated actions for sustainable development.

The hypothetical-conceptual model proposed here, with the definition of indicators to measure the aforementioned constructs, should be tested and validated with tenant companies in Brazilian science parks.

Conclusions

Science and technology parks are ventures that seek to promote regional sustainable development through innovation, coordinating the resources of several strategic actors involved in these initiatives. The integration of these resources is complex and the success of this ecosystem depends on a number of factors such as the presence of a strong scientific and technological base, entrepreneurial culture, public and private resources, anchor companies, networking, real estate development and production chains, among others.

The movement of science and technology parks is recent in the world and especially in Brazil, where the most significant growth ventures occurred only from the 2000s. Nevertheless, the challenges and opportunities that arise for these ecosystems are global. Currently, for example, begins the discussion of the Areas of Innovation concept, in which science and technology parks operate more holistically, integrating in a more effective way to cities and their demands.

As seen throughout this work, an issue also relevant in this context is the development of a more robust management system that can be deployed and that assist the understanding of the resources integration and value cocreation in these ecosystems. Given this opportunity, it was used the S-D logic approach to the understanding of relationships and parks phenomena, as well as the BSC management tool, as a model of strategic performance management that can be adapted to the science and technology parks' context. By its turn, the General Hierarchical Model was applied due to the model's exploratory nature, being a way of dealing with the difficulty of establishing, at this time, more accurate and assertive cause and effect relationships between constructs.

With the proposed model, it is expected to create a management tool that effectively contributes to the development of innovation ecosystems, indicating the strategic resources and the parameters considered most suitable for monitoring and improving performance. It is understood that this model may be useful for science and technology parks managers and public and private stakeholders interested in this mechanism, as it assists the clarification of priorities for the alignment and focus of the players in the Triple Helix and criteria for the conduct of public investment, for example.

The choice of tenant companies as focal actors of the model is justified by the fact that they are the responsible for the integration of resources provided by the ecosystem and at the same time the production/catalyzing results as increase in the number of patents, technology transfer, creation of goods and high value-added services and generation of employment and income opportunities. In this sense, the model emphasizes the resources involved in the value perception of tenant companies, as well as the value proposition of these in the form of scientific, technological and socioeconomic benefits. For future studies, it is suggested to carry out a 360º empirical evaluation involving the other players in the Triple Helix (Science, Technology and Innovation Institutes and Government) in order to raise their expectations and value propositions in relation to the Science and Technology Park mechanism.

Finally, considering that the S-D logic provides a promising new theoretical framework for the analysis of science parks ecosystem, an attempt was made to demonstrate the feasibility of the development and validation of a performance management model for these ventures, based on the Service-Dominant Logic and the Balanced Scorecard. It is expected therefore that this research can open ways for new studies to discuss the identification and integration of strategic resources that will enhance the success of these ventures.

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