Universitat Ramon Llull

DOCTORAL THESIS

Title	**Open nnovation: Organizational practices and policy implications**
Presented by	**Henry López Vega**
Centre	**ESADE Business School**
Department	**People management and organization**
Research Center	**Institute for Innovation and Knowledge Management**
Supervised by	**Dr. Jonathan Wareham** **Dr. Wim Vanhaverbeke**

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Esta tesis está dedicada a mis padres
Juan Carlos López y Maritza Vega
por todo el amor, coraje y luz de
esperanza que me han otorgado
durante todos estos años.

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Abstract

Over the last decade, open innovation has impacted and enhanced firms' collaboration strategies and public policy programs. This new 'paradigm shift' emerged from businesses' needs to recover from the dot-com crash and to adapt to changing circumstances in a global recession. In this new wave of innovation, companies refocused on organic growth and on their customers and consumer markets to enrich their business units and new corporate venturing initiatives. Also, open innovation gained importance in firms' innovation strategies as technology and idea markets became a path to commercialize undeveloped solutions via licenses and patents. Moreover, given the need for innovation systems that require the collaboration among firms both on local and international levels, governments are designing new programs and strategies to capture the benefits of investment in R&D programs. This doctoral thesis addresses the aforementioned issues and provides a multi-level research framework comprised of seven complementary research articles. These provide a broad perspective on open innovation, from the project level to the innovation system level of analysis, each analyzing a unique area in enough depth to provide a high level of insight, and guidelines which may be valuable to managers and policy makers in the future.

The studies include an exploration of different types of innovation intermediaries in Europe and the US and the analysis reveals the different approaches and value propositions adopted by innovation intermediaries. Two further studies focus on the business model of one-sided and two-sided innovation intermediaries and how these create and capture value for firms in technology and idea markets. These two independent case studies rely on archival information, interviews and surveys. A further in-depth case study of NineSigma – an innovation intermediary – reveals that innovation intermediaries are not only beneficial in capturing ideas from technology and idea markets but also in assisting firms in articulating and codifying their scientific problems. All these studies revealed that firms seek external knowledge to speed up their innovation process, as early results will enable them to launch faster products onto the market or to determine the commercial (un) availability of corporate venturing initiatives. The fifth study confirms that open innovation collaboration speeds up the innovation process but also that

collaboration with scientific partners does not help to speed up projects. Also, this study suggests that corporate venturing and core business units can often benefit from collaborating with the external market and scientific partners. The two final studies provide innovation policy guidelines for the European Union and the Mediterranean System of Innovation where open innovation, service innovation and business models represent novelty in a policy level study.

Overall, this doctoral thesis addresses the disconnection between open innovation studies and established streams of literature, in areas such as innovation intermediaries, dynamic capabilities, innovation speed, corporate venturing and innovation policy. The paramount academic contributions in this thesis include: a) an overarching business model typology of different innovation intermediaries, intended to be used to decide between collaborating with one-sided vs. two-sided innovation intermediaries; b) a contribution to Zollo and Winter's (2002) framework on how innovation intermediaries help firms to articulate and codify knowledge and the managerial tensions and benefits of an intermediated external knowledge acquisition strategy; c) empirical support to the claim that open innovation speeds up the innovation process as well as the most advantageous type of collaboration to accelerate the speed of technology transfer, from research labs to business units, for corporate venturing and core business units; d) the first publication on the Mediterranean System of Innovation; and e) new policy initiatives for the European Union, where insights into open innovation and business models have enlarged the common theoretical contributions on innovation systems.

In this thesis, the study of open innovation at different levels, multiple theoretical perspectives and the use of qualitative and quantitative data and different methods of analysis have all facilitated the discovery of future research opportunities. For this reason, this thesis concludes with recommendations for further scholarly research on open innovation, possible connections to established literatures and new methods and insights for managers interested in adopting open innovation in their own firms.

Resumen

Durante la última década, debido a la necesidad de recuperación económica después la crisis de Internet y recesión mundial, la innovación abierta ha emergido como la nueva estrategia de innovación para organizaciones en el sector privado y público. La innovación abierta ha ganado importancia en las estrategias de innovación de las empresas multinacionales debido al rápido crecimientos de los mercados de ideas y tecnologías, los mismos que son una alternativa para la comercialización de soluciones tecnológicas a través de licencias y patentes. Por otra parte, dada la necesidad de sistemas públicos de innovación que faciliten la colaboración entre empresas nacionales e internacionales, los gobiernos han diseñando nuevos programas y estrategias para capturar los beneficios en inversiones de I+D. La presente tesis doctoral está compuesta por siete artículos de investigación que abordan la innovación abierta desde diferentes niveles de análisis. Los mismos proporcionan un profundo estudio sobre la innovación abierta, desde el nivel de los proyectos hasta el nivel de sistemas regionales de innovación, proporcionando así una contribución única y suficiente para explicar científicamente el fenómeno de estudio y proporcionar recomendaciones valiosas para directivos y gestores de innovación en sectores públicos y privados.

Los estudios presentados en esta tesis doctoral incluyen una exploración de diferentes tipos de intermediarios de innovación en Europa y EE.UU., donde el análisis pone en evidencia la existencia de diferentes enfoques y propuestas de valor adoptados por los intermediarios de innovación. Primero, dos diferentes estudios se centran en el modelo de negocio de los intermediarios de innovación de una cara "one-sided" y dos caras "two-sided". Estos dos estudios de caso se basan en información obtenida mediante entrevistas, encuestas y documentación pública. Posteriormente, un caso de estudio más elaborado en la empresa NineSigma - un intermediario de innovación - revela cómo los intermediarios no son sólo útiles para obtener nuevas respuestas a problemas tecnológicos en los mercados de ideas y tecnologías, sino también para ayudar a las empresas en la articulación y codificación del conocimiento. Todos estos estudios han revelado que las empresas buscan el conocimiento externo para acelerar su proceso de innovación, ya que las soluciones obtenidas les permitiría comercializar más rápidamente los productos en

los mercados. Tercero, un quinto estudio confirma el uso de la innovación abierta, como estrategia de colaboración para acelerar el proceso de innovación. Sin embargo, la colaboración con socios científicos no beneficia ha acelerar proyectos de innovación tecnológica. Asimismo, este estudio sugiere que los proyectos de riesgo corporativo "venture capital" y de unidades de negocios establecidas ¨core Business" se benefician de la colaboración directa con socios de mercado y universidades. Finalmente, los dos estudios finales proporcionan directrices de política de innovación en la Unión Europea y en el Sistema de Innovación del Mediterráneo, donde la innovación abierta, la innovación de servicios y modelos de negocio representan la novedad en un estudio a nivel de la política.

En general, esta tesis doctoral intenta conectar los estudios emergentes de innovación abierta y las teorías de gestión de la innovación, tales como los intermediarios de innovación, las capacidades dinámicas, la velocidad de la innovación, riesgo corporativo y la política de innovación. Las principales contribuciones académicas en esta tesis son: a) una tipología del modelo de negocio de diferentes intermediarios de innovación; b) una contribución al modelo de Zollo y Winter (2002) sobre los mecanismos de aprendizaje a través del uso de los intermediarios; c) la confirmación empírica que la innovación abierta acelera la velocidad de los procesos de innovación; d) la primera publicación sobre el Sistema de Innovación del Mediterráneo; y e) nuevas políticas de innovación para la Unión Europea. Finalmente, el estudio de la innovación abierta a diferentes niveles, desde múltiples perspectivas teóricas, el uso de datos cualitativos y cuantitativos y los diferentes métodos de análisis han facilitado el descubrimiento de nuevas oportunidades de investigación las que son presentadas al final de esta tesis.

Resum

Durant la darrera dècada, a causa de la necessitat de recuperació econòmica després de la crisi d'Internet i la recessió mundial, la innovació oberta ha emergit com la nova estratègia d'innovació per a organitzacions en el sector privat i el públic. La innovació oberta ha guanyat importància en les estratègies d'innovació de les empreses multinacionals a causa del ràpid creixement dels mercats d'idees i tecnologies, els mateixos que són una alternativa per a la comercialització de solucions tecnològiques mitjançant llicències i patents. D'altra banda, atesa la necessitat de sistemes públics d'innovació que facilitin la col·laboració entre empreses nacionals i internacionals, els governs han dissenyat nous programes i estratègies per capturar els beneficis en inversions de R+D. Aquesta tesi doctoral està composta per set articles de recerca que tracten la innovació oberta des de diversos nivells d'anàlisi. Es tracta d'un estudi profund sobre la innovació oberta des del nivell de projectes fins al nivell de sistemes regionals d'innovació, que proporciona, així, una contribució única i suficient per explicar científicament el fenomen d'estudi. També ofereix recomanacions valuoses per a directius i gestors d'innovació en el sector públic i el privat.

Els estudis que es presenten en aquesta tesi doctoral inclouen una exploració de diversos tipus d'intermediaris d'innovació a Europa i als Estats Units, l'anàlisi de la qual posa en evidència l'existència de diversos enfocaments i propostes de valor que adopten els intermediaris d'innovació. En primer lloc, dos estudis diferents se centren en el model de negoci dels intermediaris d'innovació d'una cara, one-sided, i de dues cares, two-sided. Aquests dos estudis de cas es basen en informació obtinguda a partir d'entrevistes, enquestes i documentació pública. En segon lloc, un altre cas d'estudi, elaborat a l'empresa NineSigma –un intermediari d'innovació–, revela com els intermediaris no tan sols són útils per obtenir noves respostes a problemes tecnològics en els mercats d'idees i tecnologies, sinó també per ajudar les empreses en l'articulació i la codificació del coneixement. Tots aquests estudis han revelat que les empreses cerquen el coneixement extern per accelerar els seus processos d'innovació, ja que les solucions obtingudes els permeten comercialitzar els productes en els mercats més ràpidament. En tercer lloc, un cinquè estudi confirma l'ús de la innovació oberta com a estratègia de col·laboració per

accelerar el procés d'innovació. Això no obstant, la col·laboració amb socis científics no beneficia el fet d'accelerar projectes d'innovació tecnològica. Així mateix, aquest estudi suggereix que els projectes de risc corporatiu, venture capital, i unitats de negocis establertes com a core business es beneficien de la col·laboració directa amb socis de mercat i universitats. Finalment, els dos estudis finals proporcionen directrius de polítiques d'innovació a la Unió Europea i al sistema d'innovació del Mediterrani, en què la innovació oberta i la innovació de serveis i models de negoci representen la novetat en un estudi d'escala política.

En general, aquesta tesi doctoral intenta connectar els estudis emergents d'innovació oberta amb les teories de gestió de la innovació, com són els intermediaris d'innovació, les capacitats dinàmiques, la velocitat de la innovació, el risc corporatiu i les polítiques d'innovació. Les principals contribucions acadèmiques d'aquesta tesi són: a) una tipologia del model de negoci de diversos intermediaris d'innovació; b) una contribució al model de Zollo i Winter (2002) sobre els mecanismes d'aprenentatge a partir de l'ús dels intermediaris; c) la confirmació empírica que la innovació oberta accelera la velocitat dels processos d'innovació; d) la primera publicació sobre el sistema d'innovació del Mediterrani, i e) noves polítiques d'innovació per a la Unió Europea. Finalment, l'estudi de la innovació oberta a diversos nivells, des de múltiples perspectives teòriques, l'ús de dades qualitatives i quantitatives, i els diferents mètodes d'anàlisi han facilitat el descobriment de noves oportunitats de recerca, que es presenten al final d'aquesta tesi.

Chapter I Introduction

Open innovation strongly advocates knowledge inflows and outflows with external actors who are located outside the boundaries of the firm, because it is argued that knowledge sharing is more beneficial than hoarding. Over the last decade, scholars have established empirical evidence that firms collaborating with external partners can boost their performance, raise their revenues and speed up their innovation processes (Chesbrough, 2003). Further, well-known examples of open innovation initiatives are diffused through a) company practices, such as P&G's Connect & Development program and the Innovative Medicines Initiative (IMI) partnership; b) new actors and intermediaries such as NineSigma and Innocentive; and c) public policies such as open government. A remarkable example is the High Tech Campus in Eindhoven that changed from being the Philips monopolized Science Park into an open innovation arena where numerous firms exchange scientific knowledge and collaborate with Philips's research and test labs. Currently, Philips, like many other firms, is going beyond encouraging open innovation in its employees to adopt an open business platform that facilitates the inflow and outflow of scientific and technological knowledge.

Numerous scholars have suggested that the adoption of open innovation management practices and public innovation policies make R&D processes more heterogeneous, faster and more financially valuable (Chesbrough, 2003, Chesbrough and Vanhaverbeke, 2011, Laursen and Salter, 2006, Lichtenthaler, 2009). As a result, open innovation is currently part of many firms' corporate strategies and is an important pillar of national innovation policies. These ongoing activities, however, require a thoughtful and cross-divisional implementation of programs for private and public organizations. This doctoral thesis therefore sheds light on the following two research questions:

How can firms use open innovation strategies, i.e. the use of innovation intermediaries or external partners, to facilitate the acquisition of external knowledge?

How can policy makers embed this new paradigm in their policy frameworks?

Overall, the thesis explores the phenomenon of open innovation. It does so by analyzing the various organizational practices (in Part I – Chapter II to Chapter VI) and discussing possible policy implications (in Part II – Chapter VII and Chapter VII). In analyzing the different forms and practices of open innovation, multiple theoretical perspectives and multiple levels of analysis have been adopted and, subsequently, a number of different data collection and analysis tools have been used. The findings from the thesis will be relevant to researchers, practitioners and policy makers.

Open innovation: Organizational practices

Firms willing to adopt an open innovation environment require the development of new capabilities and business models to successfully acquire and integrate external knowledge (Chesbrough, 2006, Lichtenthaler and Lichtenthaler, 2009). Those firms starting with open innovation activities and lacking this capability, which is necessary to operate and benefit from technology and idea markets, could arrange assistance from external partners (Huston and Sakkab, 2006). Innovation intermediaries in various forms have demonstrated their ability to orchestrate and improve the inflow and outflow of knowledge (Chesbrough, 2006). Until now, innovation consultants, science and technology parks, incubators and regional innovation agencies were considered the most prevalent types of intermediaries (Howells, 2006). Recently, however, a new type of innovation intermediary has been helping firms to obtain technological solutions in two-sided technology and idea markets i.e. NineSigma, Innocentive, Yet2.com (Dushnitsky and Klueter, 2011, Jeppesen and Lakhani, 2010, Lopez-Vega and Vanhaverbeke, 2010).

Although the number and type of these two-sided innovation intermediaries has increased over the last decade (Diener and Piller, 2010), limited research has explained their business model characteristics and the nature of the support they provide to firms' technological needs in technology and idea markets. As a result, the first part of this doctoral dissertation starts with an exploration of the multiple types of innovation intermediaries in different countries, and gradually moves towards an explanatory study of the use of an innovation intermediary by client firms in the United States. This study explains how innovation intermediaries help firms with the difficult task of articulating

and codifying internal scientific challenges (Zollo and Winter, 2002) in order to quickly transgress the boundaries of the firm and acquire the necessary identified knowledge.

Firms also adopt open innovation strategies because these help their teams to speed up their internal innovation processes (Chesbrough et al., 2006). Previous research on innovation speed has only explored the impact of external collaboration at the New Product Development (NPD) level of analysis (Chen et al., 2010, Kessler et al., 2000). These insights are insufficient to underline the contingencies that accelerate the speed of research projects when collaborating with scientific, or market, partners.

Open innovation: Policy implications

Recently, open innovation policy has gained the interest of policy makers and academics, as national and regional governments are required to design policy instruments. For example, patent systems, education, and support to SMEs facilitate collaboration among companies (Chesbrough and Vanhaverbeke, 2011, De Jong et al., 2008). Until now, most research on innovation policy has been limited to the innovation system perspective at national, regional and sector levels (Bergek et al., 2008, Lundvall, 1992, Malerba, 2004, OECD, 1997). However, this type of research has not addressed recent changes in firms' practices on open innovation, open business models and the service sector in particular.

This thesis provides insights into new innovation policy for the European Union and the Mediterranean area. Here, I combine the established innovation system framework with emerging practices from open innovation practices in order to suggest to policy makers how open innovation could be embedded in future innovation programs. The first study (Chesbrough and Vanhaverbeke, 2011) encourages five areas of improvement intended to speed the transition from a closed innovation to an open innovation mindset, something which is necessary to increase Europe's competitiveness. A second study provides an overview of the Mediterranean System of Innovation (MSI) using the innovation system perspective, but it also includes analysis of the current challenges facing open innovation, business models and the service sector, the overcoming of which are fundamental to enabling collaboration between southern and northern Mediterranean countries.

Comparison of the different studies in the thesis

This section highlights the contributions of each study and identifies the differences and links between them. Each of the chapters addresses a specific aspect of the use of innovation intermediaries or external scientific and market partners. In a similar vein, I look at how innovation policies can enhance open innovation practices in general and with intermediaries in particular. First, the different levels of analysis used to examine open innovation (Vanhaverbeke and Cloodt, 2006) are presented as four layers to enrich understanding of open innovation practices, platforms and policies, and to avoid any common bias towards a firm level focus on the topic, which has hitherto been the dominant approach in the literature. This multi-level of analysis invokes diverse literature streams and research objectives, and the contributions of each study vis-à-vis these fields are subsequently detailed. Next, the different research designs are compared. Finally, the links between the studies are examined while also looking at how the results of each specific study feed into one another.

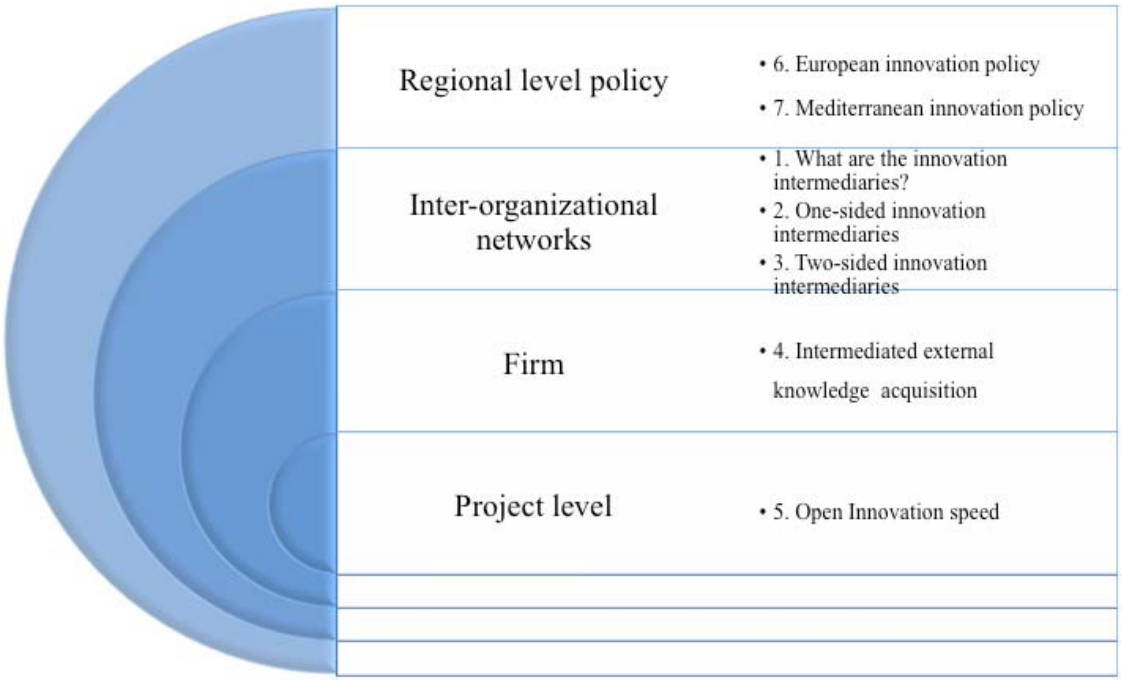
Multi-level analytical lens and object of focus

Most studies on open innovation are primarily focused at the firm level of analysis and, specifically, take a technological point of view. However, these findings need to be complemented with multi-level analyses, to deepen and strengthen our contributions to larger research streams, managerial practices and policy recommendations. As highlighted by Chesbrough et al. (2006 p. 287-301) “neither the practice nor the research on open innovation is limited to the level of the firm”. Further, Vanhaverbeke and Cloodt (2006 p. 276-278) encourage a multilevel categorization, from the individual to the innovation system level, to enrich the existing studies of open innovation and scientific insights. Following these recommendations, this doctoral dissertation explains the phenomenon of open innovation at four different and complementary levels of analysis. In this way, I explore the phenomenon of open innovation from multiple scientific perspectives and at multiple levels of study.

As illustrated in figure 1, on the next page, this doctoral thesis explores open innovation from the project level to the innovation policy level of analysis, through seven research articles. First, study #5, at the project level of analysis, focuses on the benefits of open innovation in innovation speed for a) corporate venturing and b) core business units. Second, at the firm level, study #4 explains how firms benefit from external knowledge through the use of an innovation intermediary and examines how innovation intermediaries help firms to deal with the tension involved in the articulation and codification of scientific challenges. For studies #1 - #3, the inter-organizational network is the focus of analysis, and, specifically, its manifestation through different forms of innovation intermediaries is examined. Study #1 provides a broad overview of multiple types of innovation intermediaries and explores their business model. Study #2 focuses on an emerging form of European innovation intermediary named Living Labs that are primarily publicly funded. In study #3 the focus continues on innovation intermediaries, via an examination of a specific type of innovation intermediaries who are operating as knowledge brokers in two-sided markets. Finally, studies # 6 and # 7 both provide policy recommendations, at the European and Mediterranean regional level, to enable more open and efficient innovation systems. Specifically, study #6 focuses on a subset of open innovation policies for the European Union (Chesbrough and Vanhaverbeke, 2011), while, still at the same level of analysis, study #7 is the first article to propose the concept of the Mediterranean System of Innovation (MSI) (Lopez-Vega and Ramis-Pujol, 2011).

Multi-level doctoral dissertations are limited to showing the relations between different studies rather than the relations between different levels and run the risk of failing to define the overarching link between the different parts of the thesis and demonstrating how different levels of analyses add strength to each other. This doctoral dissertation attempts to overcome this issue by studying, from the project level to the innovation system level, how firms are adopting open innovation practices from distinct theoretical perspectives. The relationships between the different studies is included, but is also used as a trigger motivating the researcher to move, with the conclusions, from one level of analysis to the next.

Figure 1: Level of analysis of each study



First, a project level study at one of the largest worldwide technological companies was useful in informing about managerial practices to acquire external scientific and market-related knowledge which could help to overcome an absence of internal scientific knowledge. This study provided valuable insights not only on the benefits of external knowledge for core business and corporate venturing units but also resulted in the first project level study confirming that open innovation accelerates the speed of innovation. Further, this study highlighted an emerging form of collaboration with multiple forms of innovation intermediaries or third-parties. This mechanism to acquire external knowledge seemed different than previously investigated forms of collaboration i.e. alliances, joint ventures or buyer-supplier relationships. So, as innovation intermediaries represent an unexplored phenomenon but are a prevalent business practice, a study on how firms acquire intermediated external knowledge and the tensions in this new form of collaboration was launched. On the one hand, this study confirmed that innovation intermediaries were a quick mechanism to identify potential external sources of technological and scientific knowledge to solve internal scientific and technological problems as well as presenting the tensions and stages present during an intermediated

external knowledge acquisition process. On the other hand, the study highlighted the need to further explore the distinct forms of third-parties and their complementary roles in the development of technological products from an inter-organizational level perspective.

Due to the complixity, novelty and newness of the innovation intermediary phenomenon, three different studies were launched. A first study was set up to explore the business model similarities and differences among a larger group of third-party organizations, i.e. science, technology and innovation parks, incubators, technology transfer offices and two-sided innovation intermediaries. This broader study included third-parties in California, Catalonia, southern Sweden and selected virtual knowledge brokers as these will allow an exhaustive comparison of different forms of innovation intermediaries. Although this study was principally descriptive and aimed to highlight the differences between one-sided and two-sided innovation intermediaries, it also provided motivation to explore, in greater detail and independently, these two distinct types of innovation intermediaries. Therefore, a first study explored in greater detail the role of one-sided innovation intermediaries, particularly the emerging European Living Labs, and their contribution to technology development. A second study was restricted to exploring the business model of different two-sided innovation intermediaries that are predominantly used by large technological global corporations.

Throughout the process of field research for these five academic articles and the continous interaction with policy makers, innovation managers and scientific scholars, a research gap between innovation policy and open innovation was identified and narrowed. For this reason, two indepent studies explored innovation policy from an open innovation perspective. The first study, at the Mediterranean Innovation System level, explored how different countries are designing open innovation policies and strategies in order to facilitate more collaboration and the exchange of knowledge among countries. Finally, at the European level, the last study explored the subject area in depth and suggested public open innovation strategies that would enable the exchange of scientific and technological discoveries within the European Union and globally. This final overarching study benefited from collaborating with numerous European policy makers and contributed to the overall conclusions on open innovation in this doctoral

dissertation. For example, it encourages the promotion of the use of innovation intermediaries to facilitate collaboration among European economies and the relevance of alternative methods to exchange patented knowledge or IP.

This multi-level doctoral dissertation is linked together by the researcher's curiosity and discoveries, throughout different academic articles, of the open innovation phenomenon. Here, the insights of each academic article add strength to a new scientific article and focus of analysis. This task requires a major effort to continously search for new and context-specific sources of data that could shed light on the new scientific research questions.

Literary approach and contributions

Given the interest in open innovation from academics, practitioners and policy makers, this thesis began with a critical examination of the literature on innovation intermediaries (Howells, 2006, Jeppesen and Lakhani, 2010, Verona et al., 2006). According to Huston and Sakkab (2006) Procter & Gamble's new model for innovation is based on the use of external sources of knowledge, where innovation intermediaries are key orchestrators of the science and technology markets. In this doctoral thesis, study #1 explores the activities and business model of broadly named innovation intermediaries (Howells, 2006) i.e. science, technology, and innovation parks, technology transfer offices and incubators. Following this, study #2 focuses on an emerging form of innovation intermediaries (http://www.openlivinglabs.eu/) that connects users directly with knowledge seeking firms (Almirall and Wareham, 2011). In contrast, study #3 focuses on two-sided innovation intermediaries, inspired by the work of Rochet and Tirole (2006) and Parker and van Alstyne (2005). Defined as platform providers, these actors operate in two-sided innovation markets and are created to co-ordinate the flow of innovation requests and solutions which occurs between and across distinct, distant and previously unknown innovation actors. This definition narrows the scope of innovation intermediaries and excludes other types, e.g. science parks, incubators, etc.

Table 1: Overview of separate studies composing this dissertation

No.	Study	Research framework	Audience	Contribution
1	What are the innovation intermediaries?	Innovation intermediaries (Howells, 2006), innovation systems (Klerkx and Leeuwis, 2008, Steward and Hyysalo, 2008), business models (Chesbrough and Rosenbloom, 2002)	Innovation intermediaries, open innovation	Shows different approaches and value propositions adopted by broad innovation intermediaries and details their contribution to the surge in the development of technology markets
2	One-sided innovation intermediaries	Living Labs (Almirall and Wareham, 2011, Folstad, 2008), innovation intermediaries (Hargadon and Sutton, 1997, Howells, 2006), technological innovation systems (Bergek et al., 2008, Carlsson and Stankiewics, 1991)	Living Labs, user innovation, innovation systems	Provides a typology of different innovation intermediaries and explores the entrepreneurial intermediary (the living labs) that presents a high level of involvement with users and enables the participation of external stakeholders, particularly during the early phase of new technological systems of innovation
3	Two-sided innovation intermediaries	Two-sided markets (Parker and van Alstyne, 2005, Rochet and Tirole, 2006), technology markets (Arora and Gambardella, 2010b), business models (Chesbrough, 2006, Zott and Amit, 2007), innovation intermediaries (Diener and Piller, 2010, Dushnitsky and Klueter, 2011, Jeppesen and Lakhani, 2010, Sieg et al., 2010)	Innovation intermediaries, open innovation, business models	Presents how a subset of innovation intermediaries create value in two-sided markets and how they capture part of the value as well as improve the effectiveness of technology markets, providing benefits for both sides of the market. Examines the managerial trade-offs with in-house innovation portals
4	Intermediated external knowledge acquisition	Dynamic capabilities (Zollo and Winter, 2002), open innovation (Chesbrough et al., 2006), innovation intermediaries (Jeppesen and Lakhani, 2010, Lichtenthaler and Ernst, 2008b), external knowledge acquisition (Cassiman and Veugelers, 2006, Vanhaverbeke et al., 2002)	Dynamic capabilities, innovation intermediaries	Proposes six phases in the innovation intermediation process, explains how innovation intermediaries assist clients through knowledge articulation and codification and argues that innovation intermediaries are more cost-efficient in organizing these learning processes
5	Open Innovation speed	Innovation speed (Chen et al., 2010, Kessler and Chakrabarti, 1996), ambidexterity (Gupta et al., 2006), open innovation (Chesbrough et al., 2006, Vanhaverbeke et al., 2008), corporate venturing (Burgelman, 1983, Covin and Miles, 2007)	Open innovation, corporate venturing, ambidexterity	Indicate that firms doing open innovation can speed up the innovation process. It also reveals market partners accelerate innovation speed while scientific partners decelerate it and highlights the most advantageous type of collaboration for corporate venturing and core business units
6	European innovation policy	Open innovation (Chesbrough et al., 2006, De Jong et al., 2008), innovation policy (Borras, 2003, Lundvall, 1992), patent systems (van Pottelsberghe de la Potterie and Mejer, 2010), open government (Fung and Weil, 2010)	Innovation policy in Europe, open innovation	Suggest five public policies that will address the innovation needs of the European Union: 1) pursue global market opportunities, 2) invite external innovators in to spur greater competition and innovation, 3) encourage circulation of ideas, 4) provide the proper institutional structures for innovation, 5) use government funds to stimulate greater SME formation
7	Mediterranean innovation policy	Innovation systems (Edquist and McKelvey, 2000, Lundvall, 1992, Nelson, 1993), functions of innovation systems (Bergek et al., 2008, Hekkert and Negro, 2009), Mediterranean innovation system (Lopez-Vega and Ramis-Pujol, 2011)	Innovation systems, Mediterranean studies	Sheds light on how activities conducted by public and private organizations influence the formation of different system functions and showed that R&D support is slightly changing to services and business models. This highlights the relevance of having innovation strategies for increasing the capabilities

Study #4 addresses the research gap on how innovation intermediaries help firms to articulate and codify knowledge before searching for solutions within the two-sided technology markets and contributes to the existing studies on dynamic capabilities and external knowledge acquisition (Zollo and Winter, 2002). As such, this study goes beyond merely describing the simple benefits of accessing innovation networks through innovation intermediaries (Dushnitsky and Klueter, 2011). Study #5 sheds light on the type of open innovation collaborations that speed up research projects, from research labs to development units for corporate venturing and core business units. This contributes to the ongoing discussion on ambidexterity and corporate venturing in open innovation studies (Gupta et al., 2006, Vanhaverbeke et al., 2008). Studies # 6 and # 7 contribute to the limited studies published thus far on innovation policy and open innovation. Specifically, #6 responds to the call to examine open innovation policy in Europe (Chesbrough and Vanhaverbeke, 2011) and # 7 provides the first research study of the Mediterranean System of Innovation (MSI) functions (Lopez-Vega and Ramis-Pujol, 2011). Each chapter in this thesis targets a specific audience and appropriate but distinct literature bases. Furthermore, within each specific respective stream of literature, these studies also respond to specific calls for research within that field. All of these research topics are summarized in table 1. I focus, for each topic, on the research framework, literature stream, the targeted audience and the rationale and intended contribution of the study.

Study designs

Different considerations impact the various study designs in each case, such as a) the emerging relevance of innovation intermediaries; b) open innovation management; and c) innovation policy. This doctoral dissertation includes both rigorous qualitative and quantitative methods to explore key areas of open innovation. The different data collection and analysis methods utilized are summarized in figure 2 overleaf, where the stars indicate the particular method used for the study.

Figure 2: Summary of study designs

No.	Study	Sample	Collection instruments					Analysis methods		
			Archival information	Interviews	Surveys	Ethnography	Panel data	Case study	Grounded theory	Event history Analysis
1	What are the innovation intermediaries?	22 long interviews and profle check of innovation intermediaries in USA, Sweden and Spain	★	★					★	
2	One-sided innovation intermediaries	17 interviews and 18 surveys from selected European living labs		★	★			★		
3	Two-sided innovation intermediaries	41 long interviews and profile check on 8 innovation intermediaries	★	★				★		
4	Intermediated external knowledge acquisition	2 months of ethnographic field research, interviews and archival information from 21 innovation managers from 18 different companies in Europe and the U.S. and 54 surveys		★	★	★			★	
5	Open Innovation speed	1 European technological company, 558 projets and 19531 observations		★			★			★
6	European innovation policy	12 interviews with corporate managers from 8 European firms and public institutions		★				★		
7	Mediterranean innovation policy	25 delegates from northern and southern Mediterranean countries, program directors and representatives from the European commission	★	★				★		

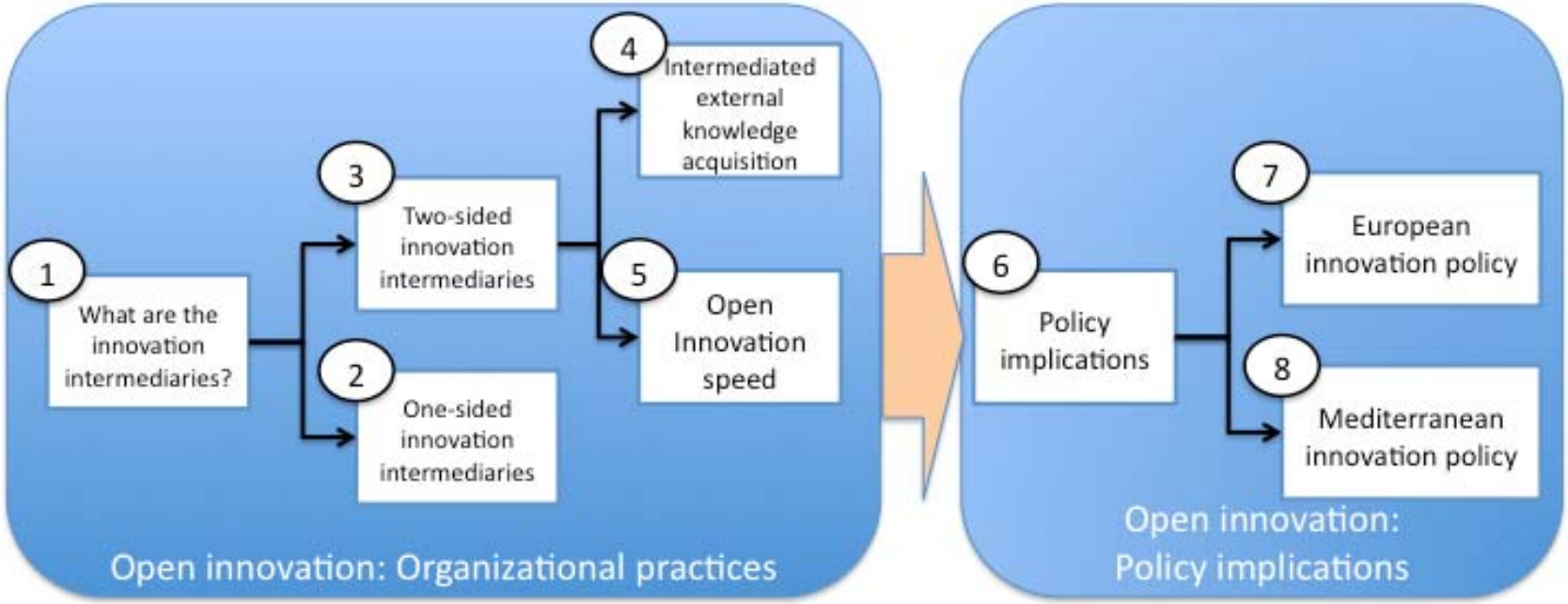
The research strategy for studies #1 through to #3 are exploratory, as these chapters explain the existing types of innovation intermediaries and business models and as they provide a typology for future studies. Study #4 is a confirmatory study that uses information from ethnographic techniques (during 2 months), resulting in 30 interviews and a questionnaire that was answered by 54 respondents. All data was then triangulated and analyzed using methods proper to grounded theory. Study #5 is a confirmatory study using panel data from a large European technological company, which analyzes the speed of innovation using event history analysis. Finally, studies #6 and # 7 represent two innovation policy studies that explain the current innovation situation in Europe and the Mediterranean System of Innovation (MSI). Overall, the thesis presents explanatory and confirmatory studies for the emerging phenomena of open innovation, innovation intermediaries and innovation policy. These choices were made in order to provide significant contributions to the literature. Also, this method enabled me to link organizational practices to innovation policy and other research fields.

Relationships between the studies

As observed in figure 3, in this doctoral thesis, each scientific study stands on its own and feeds a new field study. Furthermore, the different insights into open innovation practices also provided direction on innovation policy recommendations for the European and Mediterranean innovation systems.

The paper entitled "***From solution to technology markets: The role of innovation intermediaries"*** *(paper #1)* develops a theoretical typology concerning the function and business logic of predominant innovation intermediary types. Until now, different forms of innovation intermediaries have achieved increasing prominence in the technology sectors. This analysis focuses exclusively on common patterns which are surfacing and the mechanisms in innovation intermediaries' underlying business logic and value creation. This research coincided with the current expansion of technology markets that have become prominent in an era of abundant and widely distributed knowledge (Arora and Gambardella, 2010b). Given that technology transactions suffer from several market imperfections, innovation intermediaries are filling the gap and can help to overcome the boundaries between open and closed innovation markets.

Figure 3: Doctoral dissertation framework



1. From solution to technology markets: The role of innovation intermediaries
2. Intermediating and integrating knowledge: The role of the European Living Labs
3. An open innovation perspective on the role of innovation intermediaries in technology and idea markets
4. In search of innovations: intermediaries and external knowledge
5. Innovation speed: Does open innovation facilitates firm ambidexterity?
6. Policy implications
7. Open innovation and public policy in Europe
8. Connecting the Mediterranean System of Innovation

Based on an exploratory cross-case analysis, this study enhances our understanding of the operational practices of innovation intermediaries. A detailed analysis of the business model of 22 innovation intermediaries clarifies how these organizations improve the effectiveness of the technology markets, providing benefits both for large and medium size organizations. This study identifies three main types of innovation intermediaries. The connection group offers well-known functions, i.e. demand articulation and brokering from a broader class of two-sided platforms. Secondly, the collaboration group focuses on deep interaction through coordination and commercialization processes, providing boundary-spanning functions across disparate disciplines, vocabularies and institutional logics. Finally, the technological services group offers boundary spanning value, but with a greater emphasis on market execution and transactional relationships.

The next two papers (papers # 2 and #3) are designed to analyze the business models and provide the first typology of two distinct types of innovation intermediaries. First, paper #2 explores the role of an emerging type of innovation intermediaries, usually termed living labs (Almirall and Wareham, 2011). Next, paper #3 explores the business models of innovation intermediaries in the two-sided markets that are the most predominant in the open innovation literature (Chesbrough, 2006).

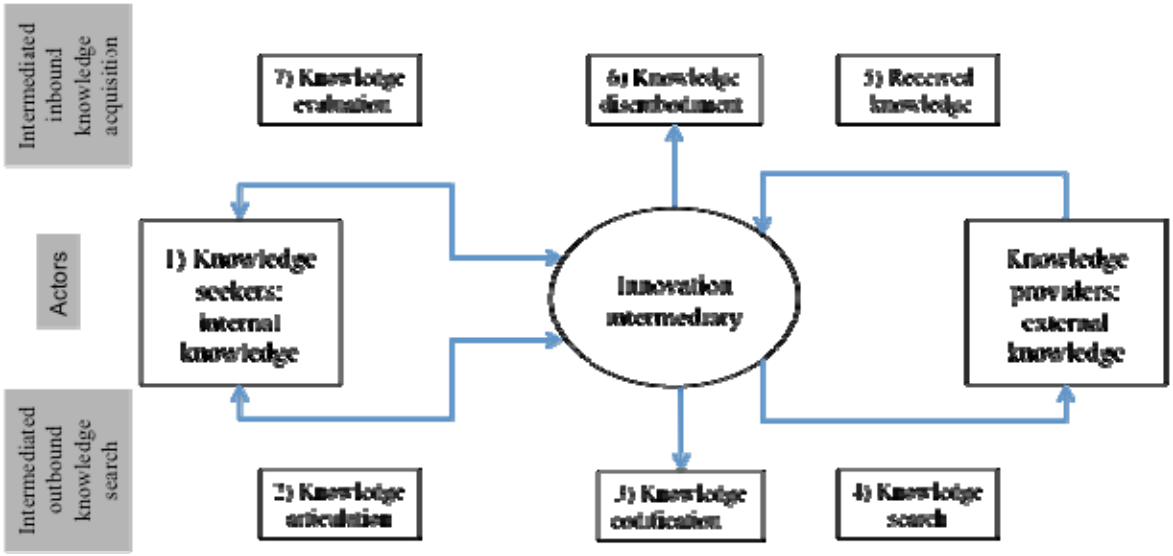
The paper entitled "***Intermediating and integrating knowledge: The role of the European Living Labs"*** (paper #2) is intended to contribute to the large discussion on open innovation intermediaries by providing a typology of these innovation intermediaries, based on a review of the literature. I also suggest a new structural type of intermediary, the entrepreneurial intermediary. The structural configurations of the intermediaries presented in this paper go beyond traditional categorizations and explore the uniqueness of intermediaries based on their business models, structures and flexibility towards contingent factors. This research provides evidence of this type of intermediary, with data cultivated from selected members of the European Network of Living Labs (ENoLL). The finding revealed that this type of intermediary presents a high level of involvement, develops new user-driven technologies, requires the participation of external stakeholders and produces technologies during the early phase of new technological systems of innovation. Furthermore, a comparison of the identified

typologies reveals that the role of Living Labs is paramount to orchestrating the development of new technologies, rather than only connecting different actors, as other innovation intermediaries might do.

Next, the paper "***an open innovation perspective on the role of innovation intermediaries in technology and idea markets"*** (paper #3) contributes to the discussion in the open innovation literature about innovation intermediaries (Jeppesen and Lakhani, 2010, Lichtenthaler and Ernst, 2008a). This paper studies how a subset of these intermediaries creates value in a two-sided market and how they capture part of the value. A detailed analysis of the business model (Chesbrough and Rosenbloom, 2002, Zott and Amit, 2007) of twelve innovation intermediaries clarifies how these organizations can improve the effectiveness of technology markets, providing benefits for both sides of the market. We also look at managerial trade-offs when choosing between the use of intermediaries' services and in-house innovation portals.

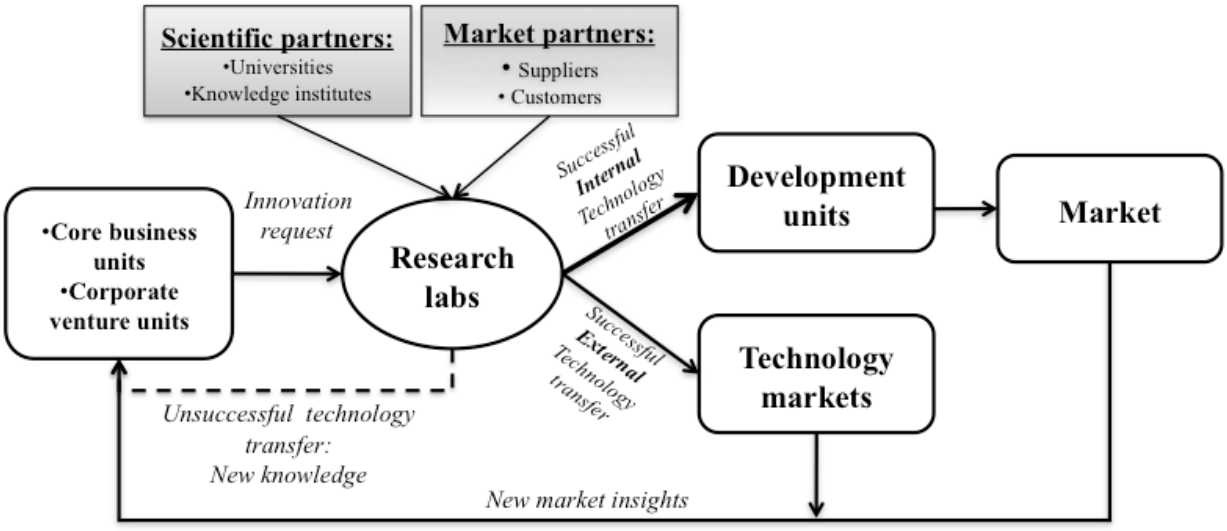
Following this paper, given the fact that technology markets have become prominent in an era of abundant and widely distributed knowledge and that technology transactions suffer from several market imperfections, I found that more and more innovation intermediaries are filling an identified gap and are acting as facilitators of external knowledge acquisition. Paper #4, named ***"Intermediated external knowledge acquisition: the knowledge benefits and tensions"***, conducts an ethnographic study of the business model of one innovation intermediary,NineSigma, that has emerged to assist firms' external knowledge acquisition in markets for technologies and ideas. The main findings of this paper are that: a) we propose that there are six phases in the innovation intermediation process; b) we suggest that innovation intermediaries primarily assist clients through knowledge articulation and knowledge codification (see figure 4); and c) we argue that innovation intermediaries develop capabilities to articulate and codify knowledge-seeking firms' knowledge that make them more cost-efficient (at least under some conditions) than the knowledge-seeking organizations themselves in organizing these learning processes. They are therefore better positioned to subsequently search in web-mediated communities.

Figure 4: Innovation intermediary process



Study #5, titled ***"Innovation speed: Does open innovation expedite corporate venturing?"***, presents an empirical analysis for corporate venturing and core business units about the innovation speeds of open and closed innovation projects executed by the central R&D labs of a large multinational corporation (see figure 5). The findings confirm that firms performing open innovation speed up their innovation process. Surprisingly, this effect is not observable for corporate venture units which tend to be slower than core business units when a research project is internally transferred from research labs to development units. Secondly, results reveal that market partners, i.e. suppliers and customers, accelerate innovation speed, but scientific partners, i.e. universities and research centers, do not speed up the innovation process. Further, this study provides greater clarity about the benefits and limitations of open innovation, with external scientific and market partners, on innovation speed for core business and corporate venture units. This manuscript brings together existing contributions from the literature on innovation speed (Chen et al., 2010, Kessler and Bierly, 2002), open innovation (Chesbrough et al., 2006, Gassmann et al., 2010, Van de Vrande et al., 2010) and ambidexterity (O'Reilly III and Tushman, 2011). Finally, this research provides corporate directors with a typology capable of identifying the most advantageous partners to use in order to accelerate their innovation transfer speed.

Figure 5: Ambidexterity and open innovation speed



The research conducted in the project using the inter-organizational network of analysis (papers #1 to #5) provided the insights to write two innovation policy papers. Paper #6, named "***Open innovation and public policy in Europe"*** (Chesbrough and Vanhaverbeke, 2011)**,** combines new research and analysis on open innovation, and includes focused interviews with major participants in the European innovation system. The result is a series of recommendations for public policies in Europe that could create a more conducive climate for open innovation in the European Union. The underlying argument in this paper is that previous innovation policies relied on large companies to act as the engines of innovation in the EU. While large companies remain relevant to innovation within the EU, they themselves report that their processes involve many more SMEs and other contributors outside their own walls. Therefore, innovation policy in Europe must also move outside the walls of these large companies and consider the impact in open innovation practices of human capital and its mobility, competition policy, measures to finance R&D, intellectual property and public data in promoting an environment which assists open innovation.

Finally, the paper titled "***Connecting the Mediterranean System of Innovation: A functional perspective"*** (paper #7) (Lopez-Vega and Ramis-Pujol, 2011) provides the first exploratory overview of the Mediterranean System of Innovation (MSI) and presents

the results of interactive work with innovation delegates from northern and southern Mediterranean countries. This study came at a turning point when the Union for the Mediterranean was designing future innovation policies and debating the best mechanisms to boost central activities. This research benefits from the established literature on systems of innovation (Lundvall, 1992) in studying the policy tools which Mediterranean countries use to advance their innovation capacity. The data sheds light on how activities conducted by public and private organizations influence the formation of different system functions. The results also indicate that R&D support in these countries is slightly changing with regard to services and the development of new business models. Finally, it highlights the relevance of having a defined innovation strategy, something which is necessary for increasing existing capabilities. The value of this chapter is that it represents the application of the highly accepted system of innovation functions perspective onto the Mediterranean system.

Contributions and highlights

Overall, this doctoral thesis contributes to the unfolding research opportunities which are being disentangled by open innovation scholars who have been trying to connect them to established organizational theories. Specifically, the contribution of this doctoral dissertation is threefold. The first underlying research contribution of this dissertation is to the large literature on innovation intermediaries. Here, I have provided a typology of the broad types of innovation intermediaries, classified by their business model and explained the characteristics of a new form of intermediary called Living Labs. These two contributions help to emphasize the uniqueness of two-sided intermediaries. Further, this thesis shows how intermediaries help firms by articulating and codifying knowledge before searching for it in technology, which makes it the first contribution which highlights the tensions and benefits of an intermediated external knowledge acquisition strategy.

Secondly, although previous research suggested that collaboration with external partners accelerates the innovation process, this thesis confirms that open innovation helps firms to speed up their innovation processes. Further, I identify the most advantageous type of

collaboration in accelerating the speed of technology transfer, from research labs to business units, for corporate venturing and core business units. As such, this contribution has become the first research contribution confirming: a) that open innovation accelerates the speed of innovation; b) that corporate venturing projects tend to be slower than core business projects; c) that research projects for corporate venturing units benefit from collaborations with scientific and market partners, and d) that only market partners help to offset the generally slow speed of corporate venturing projects; scientific partners do not have the same effect. As such, this theoretical contribution sheds some light which may guide future studies on innovation speed and corporate venturing.

Lastly, this doctoral thesis contributes to the literature of innovation systems by providing the first publication on the Mediterranean Innovation System where the insights of open innovation and business models are prevalent. Also, at a similar level, a European-level study manifests the relevance of numerous innovation system functions and the need to address some key policy issues, such as: a) a unique patent policy; b) the mobility of scientific personnel and c) the financing of entrepreneurial initiatives. Overall, these studies do not simply explore two distinct regional areas but they also enhance the state-of-the-art research on innovation systems by introducing an open innovation perspective.

Chapter II From solution to technology markets: The role of innovation intermediaries[1]

Technology markets have become prominent in an era of abundant and widely distributed knowledge. Given that technology transactions suffer from several market imperfections, ever more various innovation intermediaries are filling the gap and can help transgress the boundaries between open and closed innovation markets. Based on an exploratory cross-case analysis, this study enhances our understanding of the operational practices of innovation intermediaries. This manuscript develops a theoretical typology concerning the function and business logic of predominant innovation intermediary types. A detailed analysis of the business model of twenty-two innovation intermediaries clarifies how these organisations improve the effectiveness of technology markets, providing benefits for both large and medium size organizations. We also look at managerial trade-offs between the use of intermediaries' services and in-house innovation platforms. We identify three main classes of intermediation intermediaries. Connection groups offer well-known functions from a broader class of financial intermediaries or two sided platforms, including demand articulation and brokering. Collaboration groups focus on deep interaction through coordination and commercialization processes, providing boundary-spanning functions across disparate disciplines, vocabularies and institutional logics. Technological services group also offer boundary spanning value, but with greater emphasis on market execution and transactional relationships. Innovation Intermediaries have achieved increasing prominence in technology development sectors. This analysis focuses exclusively on intermediation intermediaries, surfacing common patterns and mechanisms in their underlying business logic and value propositions.

Keywords: innovation intermediaries, open innovation, business models, technology markets, two-sided platforms

Introduction

Open Innovation points to the need for a two-way traffic of information: into companies to strengthen the competitiveness in their existing businesses, and out of companies in order to find external business opportunities for monetising their own ideas (Chesbrough, 2003). Over the last few years, open innovation scholars have focused on identifying imperfections and opportunities in external technology markets, on companies' internal

[1] **Presented:** Economics and management of innovation, technology and organizational change (2009), DRUID-DIME Winter Conference, Aalborg University, Aalborg, Denmark

responses to these opportunities, the different options of external knowledge, and the need to create value for the firm for special issues see (Chesbrough et al., 2006, Dahlander et al., 2008, Enkel, 2009, Gassmann, 2006, Gassmann et al., 2010).

Extant literature on open innovation has emphasized the emergence of a particular form of innovation intermediation useful in bridging and coordinating a firm's innovation network (Chesbrough, 2006, Jeppesen and Lakhani, 2010, Lichtenthaler and Ernst, 2008b, Sieg et al., 2010). Innovation intermediaries actively connect organizations with access to unexplored external technological or non-technological providers relying on their extensive network of solution providers e.g. university research institutes, small technological firms (Jeppesen and Lakhani, 2010, Sieg et al., 2010). One example is Ninesigma, which has sent over 20,000 requests for proposals from its network of 1.5 million solution providers, in 135 countries, facilitating over 12 USD million in contract awards for well known companies such as Xerox, Philips, and Unilever. Another example is InnoCentive that has posted over 1,044 challenges and received over 20,000 innovation proposals, of which 685 received monetary awards (www.innocentive.com).

In an attempt to shed some light to broader group of innovation intermediaries, Howells put forward a broader definition as "an organization or body that acts as an agent or broker on any aspect of the innovation process between two or more parties (Howells, 2006) p. 720)". The consolidated and extended literature review explained how external forms of intermediation contribute to innovation (Bessant and Rush, 1995, Hargadon and Sutton, 1997, Steward and Hyysalo, 2008, Winch and Courtney, 2007). Although this line of research explains relevant activities used by innovation intermediaries to help firm's innovation process, a comprehensive understanding of the differentiating characteristics of existing innovation intermediaries such as NineSigma, InnoCentive, Yet2.com, YourEncore, Ocean Tomo, Innovaro is lacking. Related literature from other intermediaries and platforms suggests that substantial differences exist concerning their internal logic, value proposition and underlying business models (Klein and Wareham, 2008, Tang et al., 2011). In a similar vein, we suggest that it is useful to conduct an empirical survey of a cross section of innovation intermediaries specifically, and surface patterns concerning their underlying mechanisms. We do this with data cultivated from

twenty-two selected cases. The result of this paper represents the first attempt to integrate various forms of innovation intermediary studies such as consultants (Bessant and Rush, 1995, Hargadon and Sutton, 1997, Verona et al., 2006), science and technology parks (Yusuf, 2008), incubators (Hansen et al., 2000, McAdam et al., 2006) and innovation platforms (Jeppesen and Lakhani, 2010, Sieg et al., 2010), and contrast them from a perspective of open innovation (Chesbrough et al., 2006). More specifically, our analysis shows the different approaches and value propositions adopted by intermediaries for helping companies throughout the open innovation process. Our results offer a unique survey of innovation intermediaries and their underlying business models (Chesbrough, 2006), detailing their contribution to the recent surge in the development of technology markets (Arora and Gambardella, 2010a).

The chapter is structured as follows: In the next section we review the approaches contributing to a better understanding of innovation intermediaries. The third section discusses our research strategy. Section 4 gives the results of the data analysis. Section 5 discusses the implications of the new forms of intermediaries for firm's seeking advice through external sources of knowledge. The last section wraps up the chapter with the conclusions, a brief discussion of the implications of our work and suggestions for further research.

Literature Review

Scanning peripheral markets for technological developments is an established practice, where most firms with R&D centers rely on individual gatekeepers or boundary spanners (Allen, 1977, O'Mahony and Bechky, 2008) to appropriate useful technologies and knowledge, to keep abreast of scientific developments, or identify solutions to internal problems through access to informal networks (Cohen and Levinthal, 1990, Rothwell, 1992). The process could be defined as one that is conducted by scientific employees who are able to translate scientific and industrial information from opposing sides of organizational boundaries (Turpin et al., 1996, Tushman and Scanlan, 1981). A central drawback of gatekeepers, however, lays in either the limited extension of their innovation

network and ability to gather information from external sources or in channeling only intra-organizational conversations to their innovating sub-units (Tushman, 1977).

Organizations have decided to complement their internal activities to seek for external knowledge with the assistance of a broader group of external sources of technological knowledge, here named innovation intermediaries, and involve them in long-term relationships to perform functions beyond simple information retrieval and dissemination (Becker and Gassmann, 2006, Benassi and Di Minin, 2009, Sawhney et al., 2003, Steward and Hyysalo, 2008). Specially, this line of research has focused on the way consultancies exploit existing specialist solutions to come up with new managerial approaches to bridge the gap between technological opportunities and user needs (Bessant and Rush, 1995, Hargadon and Sutton, 1997).

The growth of the Internet ushered virtual innovation intermediaries based on technology platforms which gained attention due to their ability to cross geographic distance and scale large amounts of activity (Verona et al., 2006). Some examples represent IdeaConnection, Atizo or InnoGet. Chesbrough (2006) argues that these are two-sided platforms acting in technology markets. In addition to aggregating supply and demand, he suggests that innovation intermediaries must coordinate the integration of various knowledge sources, by translating specific needs into a more general scientific language, and advise firms on how to capture the benefits of external and/or internal knowledge flows. As such, most of these intermediaries are more than Internet platforms connecting large organizations with solution providers (Huston and Sakkab, 2006, Sieg et al., 2010). Other forms of intermediation facilitate the inward and outward dissemination of technologies, Intellectual Property (IP) and licensing (Benassi and Di Minin, 2009, Lichtenthaler and Ernst, 2008b). This form of innovation intermediary represents the building block of Burt's theory on structural holes, which sees intermediaries as “buffers” between two non-redundant contacts (Burt, 1992).

Finally, during the 90s, research provided evidence on new governmental mechanisms to help firms seek external know-how and access complementary assets (Shohert and Prevezer, 1996), which may include science, or technology parks (Kodama, 2008, Seaton

and Cordey-Hayes, 1993). These public or quasi-public intermediaries increasingly complemented the work performed by gatekeepers and were clearing the technology market for companies that were interested in sourcing technologies. Complementing this phenomenon is the emergence of private incubators fostering partnerships among start-up teams, facilitating the flow of knowledge and talent (Autio and Klofsten, 1998, Bergek et al., 2008, Hansen et al., 2000). Recently, firms have decided to establish independent incubators to screen the market for high-potential star-ups and build bridges from the star-up to the corporation and vice-versa (Becker and Gassmann, 2006). Consultants such as Accenture and Capgemeni have followed suit and furnish innovation labs for customers to help share ideas and highlight trends (Wolpert, 2002).

That innovation intermediaries have a variety of profiles and functions also suggests that their underlying business models also differ. If we take a traditional two-sided platform model, the choice of a business model must consider price structure as the central component in the revenue model because: a) cost and revenue come from both sides (Eisenmann et al., 2006); and b) breakdown and allocation of transaction fees matter to the success of a platform (Rochet and Tirole, 2003). Second, the design of business models has to identify ways of fostering network growth on both sides of the market simultaneously– posing a "chicken & egg" dilemma (i.e. platform success depends on having a large, diverse pool of solution providers but these are only interested in the network if it contains a large number of innovation seekers).

Based on a wide-ranging literature review and his field research, (Howells, 2006) came up with a list of the ten most common functions of innovation intermediaries. Five functions were identified from the literature: a) scanning and information processing; b) knowledge processing and combination; c) gatekeeping and brokering; d) testing and validation; and e) commercialization. The remaining five functions were identified from field research: f) foresight and diagnosis; g) accreditation and standards; h) regulation and arbitration; i) intellectual property; and j) testing, evaluation and training. We conducted a comprehensive literature review to identify unexplored functions, group them, and to link activities to each intermediation function. The results suggest demand articulation functions (Boon et al., 2008) and brokerage between science, policy and industry spheres

(Kodama, 2008, Winch and Courtney, 2007), neither of which were integrated in previous research. Furthermore, our review suggests innovation intermediary functions might be grouped under three general headings: a) connection; b) collaboration and support; and c) provision of technological services (Table 2).

The connection group covers intermediaries' three main innovation functions. The gatekeeping and brokering function goes beyond the internal and external translation, deal-making and contract finalization activities mentioned by Howells (2006). As table 2 shows, intermediaries foster innovation by playing a middleman role between groups of innovation seekers and innovation providers (Benassi and Di Minin, 2009). They also seek to link entrepreneurial initiatives to internal corporations (Becker and Gassmann, 2006, Hansen et al., 2000) and channel the flow of knowledge from science base to end-user firms (Tether and Tajar, 2008). Second, the innovation systems literature sees intermediaries as middle men between science policy and industry within a given technological system of innovation and as transforming relationships (Carlsson and Jacobsson, 1997, Klerkx and Leeuwis, 2008). This middle ground between policy and science may foster communication and the co-ordination of social-physical relationships (Piore, 2001), improving the chances of finding partners, pooling resources and joining research projects. Third, intermediaries help bridge the gap between companies and communities, furnishing valuable insights on customers' demands and needs (Steward and Hyysalo, 2008).

Intermediaries can also provide collaboration and support services (second group), advising customers on technological and managerial issues, and revealing market trends. Initially, innovation intermediaries use their knowledge-gathering and processing skills to help firms "compensate for a lack of capability" (Bessant and Rush, 1995). However, they can extend these basic capabilities to foster in-house research (Becker and Gassmann, 2006), provide marketing and sales support, and facilitate funding (Howells, 2006), commercialize firms' technological knowledge (Lichtenthaler and Ernst, 2009) and advise firms on how best to identify and satisfy market needs.

Table 2: Groups, functions and activities of innovation intermediaries

Group	Functions	Activities	Contributing literature
Connection group	Gatekeeping and brokering	Link innovation or patent providers and seekers; build bridges from start-ups to internal corporations; represent a single point of contact to several parties; enable the flow of knowledge generated in the science-base to end-user firms; build networks to overcome weaknesses; provide neutral spaces for innovation	Chesbrough (2006); Huston and Sakkab (2006); Benassi and Di Minin (2009); Becker and Gasmann (2006); Bessant a Rush 1995; Turpin et al. (1996); Winch and Courtney (2007); Hansen et al. (2000); Wolpert (2002)
	Middle men between science policy and industry	Facilitate communication in and co-ordination of social-physical relationships in an innovation system; provide the opportunity to find partners; resources and join research projects	Kodama (2008); Piore (2001); Stankiewicz (1995)
	Demand articulation	Provide interfaces between users and firms; use complementary market demand to provide services; narrow down demand options and furnish more information	Steward and Hyysalo (2008); Boon (2008); Smits (2002)
Collaboration and support group	Knowledge processing and combination	Integrate knowledge from stakeholders; generate in-house scientific and technical knowledge; benefit from the firm's network position and internal behavior; direct transfer of specialized knowledge; mobilize university research	Hargadon and Sutton (1997); Tether and Tajar (2008); Van der Meulen and Rip (1998); van Lente et al. (2003); Youtie and Shapira (2008); Becker and Gassman (2006)
	Commercialization	Support marketing, sales and funding activities; inward and outward technology commercialization	Lichtenthaler and Ernst (2009); Bessant and Rush (1995)
	Foresight and diagnosis	Align public research toward industry needs; provide an interactive model of technology transfer and reception	Van der Meulen and Rip (1998); Seaton and Cordey-Hayes (1993);
	Scanning and information processing	Technology intelligence; scoping and filtering; screen external markets	Howells (2006); Becker and Gassmann (2006)
Technological services group	Intellectual Property	Intellectual property advice; management and IP control	Benassi and Di Minin (2009)
	Testing and training	Testing, diagnostics, analysis and inspection; prototyping and pilot facilities; validation; training	Howells (2006)
	Assessment and evaluation	Technology assessment and technology evaluation	
	Accreditation and standards	Provision of advice on standards and standard-setting	
	Regulation and arbitration	Regulation; self-regulation; informal regulation; arbitration	

In addition, support functions involve anticipation and analysis of likely technological trends (Seaton and Cordey-Hayes, 1993) and screen information on external markets through technology intelligence and filtering mechanisms. Last (Howells, 2006) introduced five innovation functions associated with technological services. Technology services may be the least understood function offered by innovation intermediaries, although contributions from (Benassi and Di Minin, 2009) highlight the services such as licensing, patents, and infringement monitoring.

Exploring business model characteristics

The overall architecture, strategy and growth potential of business models can be studied in detail using the following six functions (Chesbrough and Rosenbloom, 2002).

- *Value creation* refers to the characteristic mechanisms or processes designed to satisfy customer demands. These are grouped under four value creation drivers (Amit and Zott, 2001). First, the novelty-centered business model design is associated with a firm's ability to link previously unknown parties through new transaction mechanisms (Zott and Amit, 2007)". Second, efficiency-centered design refers to mechanisms for cutting transaction costs. Third, called "lock-in" covers ways of ensuring external partners engage in repeated transactions through trust-based relationships with customers. Fourth, the complementary driver covers the gain to customers' from bundled products or services;

- *Value capture* or revenue architecture refers to managers' decisions and mechanisms for assigning prices and exacting payment;

- *Value chain* denotes the internal and external resources, competences and processes needed to meet customers' demands. Resources include people, technology, equipment, information channels, partnerships and alliances (Johnson et al., 2008);

- *Market segment* covers market size, matching the firm's goods and services to: market volume, current and future customer requirements, geographic and demographic characteristics;

- *Value network or ecosystem* refers to managers' identification of the main co-operative and complementary points of differentiation to enable sustainable, non-imitable arrangements among suppliers, customers and competitors;

- *Competitive strategy* refers to managers' decision regarding present and future activities for securing and sustaining competitive advantage over their competitors

We will use these six functions to describe the design/architecture of value creation, delivery systems, and value capture mechanisms in the business models of various innovation intermediaries. This should give us a more detailed picture of how they deliver value to customers on both sides of the market and how they generate profits by setting price and cost structure. Before we apply business models to these intermediaries, we shall explain in the next section how we selected the innovation intermediaries.

Data and Method

Research strategy

This research employs a deductive cross case study to explore different forms of innovation intermediaries. This approach was chosen because the underlying phenomenon of observation is still poorly understood. In-depth enquires were made into the business model functions used by twenty-two innovation intermediaries. The research design was based on multiple case studies where the authors interacted to ensure replicable findings (Yin, 2009) from the types of business model used by intermediaries. As suggested by (Eisenhardt, 1989b), the use of multiple investigators enriched the study and strengthened the convergence of perceptions.

Sample

The selection criterion for our twenty-two cases (see table 3) was based on a theoretical sampling strategy and unexplored forms of intermediaries. The sample only included those intermediaries engaging in innovation activities ranging from the provision of

infrastructure to commercialization phases. We decided to exclude intermediaries that did not address any of the intermediary functions presented in Table 2 or are internal to firm's business development e.g. gatekeepers, technology scouts.

Table 3: Interviewed companies

No.	Category	Name	Region/ Country	Expertise	Method
1	Incubators or technology centers	Plug&Play Tech center	Silicon Valley, CA, USA	ICT	Long-interview
2		ASCAMM	Barcelona, Spain	Industrial engineering	Long-interview
3		Venture Lab	Lund, Sweden	ICT	Long-interview
4		Idealab!	Pasadena, CA, USA	Renewable technologies	Long-interview
5	In-sourcing incubator	Siemens Technology to Business	Berkeley, CA, USA	Mechanical and physical engineering	Long-interview
6	Research Park	Stanford Research Park	Silicon Valley, CA, USA	Mechanical and physics	Long-interview
7	Science park	IDEON	Lund, Sweden	Telecommunications	Long-interview
9	Management Park	EsadeCreapolis	Barcelona, Spain	Innovation management	Long-interview
10	Technology Transfer Offices: University / Regional	OTL Stanford	Silicon Valley, CA, USA	Mechanical and physics	Long-interview
11		CONNECT	San Diego, CA, USA	Biotechnology	Long-interview
12		Lund Innovation System	Lund, Sweden	Mechanical and physics	Long-interview
13	Internet-based intermediaries	InnoCentive	Waltham, MA, USA	Multi sector	Profile check
14		IdeaConnection.com	Vancouver, BC, Canada	Multi sector	Long-interview
15		Innoget	Barcelona, Spain	Multi sector	Long-interview
16		Yet2.com	Needham, MA, USA	Multi sector	Long-interview
17		Creax	Leper, Belgium	Multi sector	Profile check
18		Big Idea Group (BIG)	Bedford, NH, USA	Multi sector	Profile check
19		Innovaro	Tampa, FL, USA	Multi sector	Profile check
20		YourEncore	Indianapolis, IN, USA	Multi sector	Profile check
21		Ocean Tomo	Chicago, IL, USA	Multi sector	Profile check
22		NineSigma	Cleveland, OH, USA	Multi sector	Long-interview

Data Collection

Two data-gathering methods were employed. First, we conducted face-to-face interviews with senior managers including CxOs and R&D directors of innovation areas and lasted at least an hour, providing respondents plenty of time to explain the various business model functions (McCracken, 1988). This part of the research began at the end of 2009 with interviews in California, Sweden and Spain to gather information on intermediaries' business models. Additionally, in 2010, we reviewed the business model categories from the 'new' type of innovation intermediaries and gathered detailed information from: a) telephone interviews; and b) publicly available sources, such as web sites, intermediary reports and articles. In both cases, interview guidelines were set for gathering information on each business model category.

Data Analysis

For this paper, we adopted techniques for cross-case analysis (Miles and Huberman, 1994, Yin, 2009) to explain the business model functions of innovation intermediaries. We used analytical techniques of pattern matching to connect the six business model functions with the collected data. This inferential approach was chosen for this research in the absence of any alternative approach for explaining and comparing business models. The aim was to bring forward business model functions and match our data to explain the characteristics and differences between various kinds of intermediaries. Finally, we triangulated and integrated the data and clarified the major categories of innovation intermediaries.

Analysis

Our initial inductive analysis of the business models employed led us to formulate four categories in which innovation intermediaries may fall (see table 4): a) open innovation intermediaries; b) incubators; c) parks; and d) mediators.

Open Innovation intermediaries

Here, our results reveal two value creation drivers (Zott and Amit, 2007) predominated in early-established innovation intermediaries e.g. NineSigma, InnoCentive, Ocean Tomo, and Yet2.com. We observed novel transaction mechanisms between innovation solvers and seekers that exploited two-sided innovation intermediaries in technology markets. By the same token, innovation intermediaries created value through the complementary services needed to identify and develop solutions for innovation seekers. However, innovation intermediaries could not establish 'lock-in' mechanisms because both innovation seekers and solvers were able conduct multi-homing and the intermediaries lacked market power.

We found that innovation intermediaries, as part of the value capture mechanisms, subsidize the participation of innovation solvers to boost the number and quality of solutions for innovation seekers. Although this price structure is a typical characteristic in two-sided markets, value creation for innovation intermediaries occurs mostly when successful innovation seekers acquire the proposed solution. These form of innovation intermediaries capture value from innovation seekers from: a) a percentage or a fixed fee from the contract awarded to winning innovation solvers; b) up-front posting fee to send an innovation challenges to external networks; and c) consultancy services. In most cases, innovation intermediaries do not capture value from the supply side because solvers' participation is subsidized to increase the likelihood of a successful solution for innovation challenges.

We observed that established innovation intermediaries have similar ongoing value chains to nurture their 'orchestrating' role in two-sided technology markets. First, strong network externalities are needed to engage large communities of innovation solvers capable of solving innovation challenges. Second, established innovation intermediaries may enlarge their internal resources to provide open innovation consultancy services to facilitate the identification, selection, development and market commercialization of technologies, whereas smaller innovation intermediaries outsource these services to other external firms.

Table 4: **Business model configuration of innovation intermediaries**

	Open Innovation Intermediaries	Incubators	Parks	Mediators
Value Creation	(a) Access to organized external networks of qualified solution providers to solve confidential innovation challenges or partnering for business development opportunities; (b) transfer or license opportunities of IP or technologies; and (c) services to develop external technologies and embed open innovation within organizations.	(a) Organizes hundreds of events per year to expose entrepreneurs to funding, rent spaces and offers complementary human, material and technological resources; (b) close monitoring of companies' operations	(a) Physical spaces close to universities researchers, students, VCs, early stage start-ups, testing facilities & training; (b) "Organic" interaction among companies, business and innovation networks, brand image	(a) Business development advice; (b) providing support to connect through research and consultancy services; (c) seminars on how to create an IP; (d) Springboards, gatekeeping for financing; (e) reviewing the novelty of ideas and market concepts
Value Capture	(a) A percentage or a fixed fee from the contract awarded to winning innovation solvers; (b) up-front posting fee to send an innovation challenges to external networks; (c) consultancy services	(a) Partially financed with public money; (b) affordable shared spaces	(a) Lease or rent	(a) Royalties from the technology transfer; (b) membership fees
Value chain	(a) Strong network externalities; (b) innovation consultancy services to facilitate the identification, selection, development and market commercialization of technologies	(a) Executives in residence; (b) incubator's consultancy & technical team; (c) facilitates brokering with large companies	(a) Access to have competent people to employ, networks of contacts, potential customers, investors and contacts	(a) Network of VC, business angels, service companies, domain experts; (b) help to find directors
Market Segment	(a) Blue Chip companies; (b) also large companies engaged in research and new product	New start-up companies	(a) Large companies with established R&D centers or emerging technological companies	(a) University researchers; (b) local entrepreneurs
Value network	(a) co-operative arrangements with foundations, large companies or public institutes; (b) broader range of innovation consultants, technology centers and other international innovation intermediaries	(a) Funding agencies; (b) universities, public agencies;(c) fast-track partnerships; (d) talent acquisition teams	(a) Relationship with the university through graduate students, research; (b) Medium companies profit from recruiting	(a) University faculty; (b) VCs and business angels; (c) advisors, domain experts

Competitive Strategy	(a) The size, commitment to provide solutions and qualifications of the innovation intermediaries' solver network in compare to other intermediaries; (b) Differentiation strategies for specific type of innovation seekers	(a) Brokering with established companies to advance the technological and business part of ideas and facilitate the exchange of knowledge	(a) Ability to scan market for competitors, (b) new technologies to buy in; (c) employee rotation, to employ high qualified people e.g. researchers and students.	(a) Appropriate provision of internal and external advisors; (b) identification of market opportunities

In two-sided technology markets, innovation intermediaries are driven to raise the size of innovation-solver and -seeker communities to foster cross-side network effects and create value for innovation processes. The innovation seekers' side of the market includes Blue Chip companies, taking in not only those in the S&P 500 and Fortune 500 rankings but also large companies engaged in research and new product launches in Europe and Asia. Innovation intermediaries continuously search for strategic alliances with new external actors on both sides of the market, as part of their value network strategy. On the one hand, strategic co-operative arrangements with foundations, large companies or public institutes encourage more innovation solvers to join the innovation-solver community. On the other hand, complementary arrangements with a broader range of innovation consultants, technology centers and other international innovation intermediaries enhance the service provided for innovation seekers.

Innovation intermediaries, to outcompete other competitors in markets for technologies, use competitive strategy mechanisms. Accordingly, the two major activities are: *The size, commitment to provide solutions and qualifications of the innovation intermediaries' solver network in compare to other intermediaries.* As demonstrated by Utek, with the acquisition of Pharmalicensing.com and TekScout to increase cross-side network effects, a strategy to maintain competitive advantage is to increase the network size by acquiring smaller innovation intermediaries. *Differentiation strategies for specific type of innovation seekers.* The competitive advantage of large cross-side network effects has been overcome with the emergence of a heterogeneous, smaller in size, innovation intermediaries.

Incubator

Innovation incubators provide infrastructures to facilitate internal and external exchange of ideas and knowledge among residents developing new science, technology or service activities. Generally, incubators create value for forms by facilitating over hundred facilitated events to expose residents' entrepreneurial ideas to Venture Capitalists and mentoring groups. This mechanism also benefits large companies that could benefit from faster and accessible external entrepreneurial talent located at incubators. Another form

of creating value is through education in sales, collaboration investment decisions, etc. For example, Plug&Play Technology Center manages to invite corporate managers to observe the emerging ideas from its incubators being the result a qualified advice for the development of the technology or the acquisition of the technology. A remarkable example emerging out of this incubator is PayPal that was initially allocated at this incubator and grew from 2 dedicated entrepreneurs to an international company. Also, incubators, such as idealab!, attempt to have communities of entrepreneurs and employees who could be relocated to other initiatives in circumstances where the technology did not have the expected impact.

Most incubators in Europe capture value not only through the reduced rent from residents but also from the public funding provided by local or national governments. On the other hand, in the U.S. incubators are privately owned and offer reduced prices by creating economies of scale. As previously defined, the value chain includes: financial services, maintenance of a network platform, leveraging external contacts and relationships; access to market and financial research.

Innovation parks

Innovation parks provide infrastructures to the use of knowledge coming from universities, R&D institutes to improve science, technology and business initiatives by co-ordinating and facilitating access to scientific and technological resources for innovation. This form of intermediation creates value for companies by facilitating an 'organic' interaction among companies and a broader sample of innovation networks. Also, science and technology parks try to forge trust with firms and governments in tackling scientific and technological challenges and in conveying companies' requirements to universities.

A similar form to science parks is named innovation parks e.g. EsadeCreapolis that seek complementarities among firms in terms of knowledge, resources and services in a physical setting. Although these form of innovation intermediaries are emerging and their contribution to innovation has yet to be explored, our study reveals their role in facilitating collaborative and open innovation.

Collaborative innovation involves: a) sector selection: identification of sectors that attract the interest of a larger number of residents; discovery of these needs includes a survey, individual interviews; profiling of their innovation needs and current capability to innovate; b) idea generation: screening of information and evaluation of existing market opportunities, with internal residents and external, around 80 possible ideas were initially identified; c) idea evaluation: scrutinizing market opportunities and filtering. Around 12 ideas are initially discussed through interdisciplinary workshops. Open innovation activities include: a) project selection: single or a group of residents selected initiatives to develop and commercialize them along the open innovation funnel. External advice from solution providers is enacted through collaborators e.g. research institutes, innovation intermediaries, innovation consultants; b) proof of concept: mentoring and support assists on the commercializing by providing advice on market identification, funding and crowd-sourcing; c) go to market: identification and selection of external partners includes advice in contacting and developing the external value network. Finally, IP advice is provided to secure and hinder the replication of developed products or services.

Innovation mediator

The last type of intermediary is the 'innovation mediator' provides innovation service or support, relying on its external innovation network, to facilitate market commercialization of entrepreneurial science, technologies or services. One used mechanism includes the innovation springboards that are mentoring programs to mentor early stage companies to present their initiatives and receive initial feedback or funding to continue with their project. For example, Connect ® recruits early stage companies allocated in San Diego, mentors them to present in front of highly qualified panel composed of domain experts and CxOs positions. The management of connect is responsible to match entrepreneurs with coachers, resulting on weekly presentations. On the other hand, a domain expert who provided advice over an eight-weeks period may decide to establish with the entrepreneur a longer collaboration agreement. On the one hand, these activities lower the pre-transaction costs and build trust and strength in the relationships for the entrepreneurs. On the other hand, the benefits for panelists include:

a) observing new stimulating business ideas; and b) have a high Return on Involvement (ROI) from other competitors, clients and partners.

Discussion

It may be valuable to relate our findings focused on innovation intermediaries to some of the broader work focused on a more generalized class of intermediaries. The traditional literature on intermediation subject has commanded most attention in the financial literature (Rousseau and Wachtel, 1998) where intermediaries are effectively 'middlemen', brokering transactions between buyer and seller (Rubinstein and Wolinsky, 1987). This classic literature argues that the main functions of intermediaries are to aggregate supply and demand, provide market transparency and liquidity, mitigate moral hazard and adverse selection by clearing transactions and providing trade financing, hold inventories to absorb variations in supply and demand, and re-bundle portfolios of goods and services across multiple suppliers (Rubinstein and Wolinsky, 1987, Spulbr, 1999). We certainly see these classical functions in our sample of intermediaries in the gatekeeping, brokering, demand articulation and other connection functions (see table 2).

In more recent literature, another key task of the intermediary is to develop social and intellectual capital to create interfaces allowing for inter-firm knowledge identification, knowledge-sharing, and knowledge-combination across institutional, disciplinary and even cultural boundaries (Mahnke et al., 2008). This literature suggests that the simple matching and other transactional functions that dominated the early work on intermediation remain present and important. However, many innovation intermediaries work in scientific or technical realm where processes of standardization and commoditization are elusive; that is, they promote innovation challenges that resist any easy form of easy "securitization" that is common in financial or commodity markets. In these instances, the boundary spanning literature is leveraged to understand entities that facilitate the sharing of expertise across two groups who hold different goals, values, and languages (Aldrich and Herker, 1977, Allen and Cohen, 1969, Tushman and Scanlan, 1981). Basic boundary spanning functions include information processing, but extend to the interpretation and translation of knowledge, to the negotiation common meanings

across heterogeneous parties with different conceptual vocabularies (Carlile, 2004). These boundary-spanning functions are clearly present throughout our sample, although in several different forms. For technology-based intermediaries that leverage Internet or other platforms to facilitate broadcast and search by problem owners and solvers, substantial capabilities are employed before that actual broadcast of the problem in formulating it in a common language and defining measurable success criteria. Here we see the need to take heterogeneous problems from a wide variety of participants and reformulate them in a standard vocabulary; an attempt to securitize and normalize syntax similar to financial markets.

For technology transfer entities, boundary spanning occurs through the translation between differing institutional logics. Where academic communities appeal to values of scientific knowledge creation and its diffusion into the public realm, commercial communities are premised on regimes of strict property right protection and economic value appropriation. Finally, our remaining two groups, research parks and incubators, combine a variety of services across the idea gestation, commercialization and organizational maturation processes. Depending on the target segment and spectrum of services offered, these entities negotiate across heterogeneous actors from a variety of commercial, legal and scientific disciplines. Here boundary spanning becomes synonymous with increased cohesion across an otherwise fragmented bundle of discrete services.

Finally, it may be useful to summarize these positions by considering intermediaries to the degree that they differ in their bridging and bonding capabilities (Tang et al., 2011). Intermediaries assuming the bridging position focus on developing capabilities that reduce search costs, coordination costs, and transaction risks for both solution seekers and solvers. These are the classic brokering functions described above and which are predominant in our connection group. By contrast, intermediaries assuming a bonding position focus on developing capabilities that enable the pooling and coordination of resources within a heterogeneous network of institutions, and the deployment of effective collective action and boundary spanning across disparate institutional logics. These

functions are more predominant in our collaboration and support and technological services group.

A temporal dimension emerges which suggests a key point of differentiation. Bridging or connection intermediaries typically have a shorter engagement with solution seekers and solvers, although it will typically be longer than a spot contract and involve developed phases of pre- and post- contractual intermediation (Mahnke et al., 2008). The means that the underlying business models will normally be based upon a higher volume of transactions, with commensurately lower transaction fees or commissions. Bonding intermediaries can also develop high volume platforms. However, the higher degree of complexity in their value propositions suggests relatively higher profit margins on fewer transactions.

Extant research suggests that intermediaries performing bridging or matching functions are subject to a logic of natural monopolies, where market forces will drive a market concentration towards a few dominant platforms (Tang et al., 2011). By contrast, the complexity of the bonding intermediaries that offer collaboration or technology services create natural barriers to entry, making these positions more resistant to the concentration seen in more transactional platforms. One open question is if this effect will be seen in innovation intermediaries to the same degree. It may well be that bridging across heterogeneous scientific communities and institutional logics is so difficult that it may resist concentration, and develop natural niches based upon geographic and disciplinary scope.

Conclusions, limitations and future research

Open innovation implies that companies make much greater use of external ideas and technologies in the development of their own products and businesses, while they let their unused ideas be used by other companies (Chesbrough et al., 2006). Open innovation offers the prospect of deploying firms' knowledge bases more effectively, shortening the time to market, and lowering R&D costs and risks. However, as more external ideas flow in from the outside and internally developed knowledge flows out, problems concerning the co-development and transfer of knowledge become greater than ever. This study has

focused on one particular problem, i.e. how companies seeking external technical solutions, IP, or other innovation-related resources can be helped in their search by innovation intermediaries. More specifically, this manuscript attempted to shed light on the business models of innovation intermediaries and relate to and extend literature on intermediation.

The focus of this paper was on comparing external and internal sources of value creation as well as the mechanisms and systems to capture value. This research presents examples of different forms of innovation intermediaries from a sample of 22, surfacing patterns in their underlying logic and mechanisms. We adopted insights from various literature streams such as the two-sided market literature (Eisenmann et al., 2006, Rochet and Tirole, 2003), one-sided innovation intermediaries (Howells, 2006) and open innovation (Chesbrough et al., 2006). Combining theoretical and empirical insights, we synthesized generalizable categories for innovation intermediaries and their value creations and appropriation mechanisms.

Particularly, we focused on the business models of two-sided innovation intermediaries to obtain a more accurate picture of how they generate benefits for a specific group of customers and how they profit in doing so. Our analysis reveals that two-sided innovation intermediaries contribute to open innovation by facilitating inter-organizational flows of knowledge in two-sided markets by providing a platform through which both sides can forge links. As predicted by the two-sided markets literature, innovation intermediaries typically subsidize the price-sensitive side of the market - especially when uncertainty is high, and hence, a large population of solution providers is needed to ensure a successful outcome. Since network externalities are important in two-sided markets, it is likely that innovation intermediaries will face fierce competition once market growth begins to slacken. It is a winner-takes-all competition and take-overs can be expected in the future. The consolidation trend will be further strengthened by the diversification strategies of larger innovation intermediaries. However, innovation intermediaries can differentiate, offer other kinds of services, specialize into different types of technology, or target other types of clients. As a result, new entrants may avoid head-on competition through

differentiation. In contrast, solution seekers may prefer companies offering bundled services.

As open innovation becomes more popular, companies face a growing number of competitors with equal access to non-proprietary knowledge. Open innovation has become a competitive necessity and it no longer automatically confers competitive advantage. Innovation intermediaries are a powerful force for putting external available knowledge within the reach of every company. To earn returns from open innovation, companies must ensure their collaboration with innovation intermediaries dovetails with an overall innovation strategy, selection of projects and corporate support. Firms' internal organizations should adapt to fast-changing services and the growing number of intermediaries offering them. The companies that profit from open innovation are those that adapt their innovation processes and organizations in line with the new opportunities offered by innovation intermediaries. In other words, open innovation in a company should be a dynamic process that co-evolves with changes in technology markets, which themselves are partly driven by the rapid growing possibilities offered by intermediaries.

Chapter III Intermediating and integrating knowledge: The role of the European Living Labs[2]

This research is mean to contribute to the large discussion on open innovation intermediaries by providing a typology on intermediaries, based on a review of the literature, as well as to suggest a new structural form named the entrepreneurial intermediary. The structural configurations of intermediaries presented in this paper go beyond traditional categorizations and explore the uniqueness of intermediaries based on their business model, structure and adoption to contingency factors. The comparison of the identified typologies revealed the lack of research to intermediaries developing new technologies, rather than only facilitating it. This research provides some evidence on this form of intermediary with data cultivated from selected members of the European Network of Living Labs. Our results revealed this type of intermediaries present a high level of involvement, develop new user-driven technologies, demand the participation of external stakeholders and produce technologies during the early phase of new technological systems of innovation.

Keywords: Open Innovation, intermediaries, typology, innovation systems

Introduction

Open innovation suggests firms should use external as well as internal ideas, and internal and external paths to market as they look to advance their technology (Chesbrough et al., 2006). This way for explaining the innovation process is built on the assumption that the results of sharing knowledge with the external environment exceed the benefit of hoarding it. Firms, however, may not recognize the relevance of external knowledge to its business the more distant from the firm's central concerns the knowledge encountered tends to be. Yet, once that relevance is demonstrated, the more valuable such knowledge is likely to prove, simply because others will not have made the connection and will take time to respond it. However, firms may lack the capacity to pursue knowledge sharing on their own. In some circumstances they may be too small to carry the heavy costs of maintaining and operating networks of interaction. Or, in the absence of an appropriate business model, they may simply not know how to profit from such interactions when they occur.

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Precisely, open innovation intermediaries smooth the connection of firms 'innovation seekers' with external sources of solutions 'innovation solvers' accelerating the creation of novel solutions as well as its appropriation by firms. According to Chesbrough (2006), this players create value for firms acting as innovation brokers, representing one side of the market, using a Web-mediated model to engage a large set of innovation solvers e.g. contract laboratories, retirees, university faculty, research institutes. Further, innovation intermediaries reduce the costs of generating unexpected solutions or new product concepts, creating new company connections outside the original technological challenge, and field of expertise and contributing to the creation of knowledge from a broad range of solution providers.

This form of intermediaries is studied under the umbrella of the brokerage literature (Burt, 1992) and explains how 'structural holes' occupy and profit from a position between two disconnected parties. Evidence suggesting innovation brokers play an important role for innovation range from diffusion, using a broadcast mode, to specific services connecting users and producers (Winch and Courtney, 2007). On the one hand, additional research exploring the business model, contingency and design factors of innovation brokers represents an opportunity for further analysis of the impact of intermediaries during the innovation process. On the other hand, other specificities on the discussion of innovation intermediaries demand further analysis. Firstly, how a broader range of innovation intermediaries e.g. technology parks, university incubators, public innovation agencies, contribute to the open or closed innovation processes. Specifically, how these a) create and develop scientific and technological knowledge; b) collaborate and engage in the innovation process; c) forecast and road map future technologies; and d) finance regional innovation activities. Secondly, how previous established theories and studies on intermediation contribute to explain the relevance of emerging innovation intermediaries. These could be drawn from the innovation market theory (Spulber, 2003) or intermediation studies (Howells, 2006, Obstfeld, 2005).

This paper sheds some light to the ongoing discussion on intermediary organizations, specifically a) the situations on which they may be more beneficial for earlier or later stages of innovation; b) their business models; c) structural configurations; and d)

influence of contingency factors. This paper addresses this gap, firstly theoretically, designing a typology of intermediaries that reviews different multidimensional configurations as well as connecting the emerging ones to existing theories of intermediation. The result of this typology identified four predominant intermediary configurations. Along a continuum, the "brokers" represent the type of innovation intermediaries described by Chesbrough (2006) that contribute to the innovation process providing new connections between innovation seekers and solvers. Whereas on the other side, the "pumpers" represent the intermediaries actively engaged in the innovation process e.g. technology parks (Becker and Gassmann, 2006).

Secondly, we address this gap with data cultivated from an emerging form of intermediaries named the Living Labs. In Europe, this form of intermediary organizations is unified in the European Network of Living Labs (ENoLL), which currently has 119 members in Europe and 10 associated members in Asia, South America and Africa. In Europe, Living Labs represent a form of R&D intermediation attempting to establish functional regions where a variety of stakeholders form a Public-Private-Partnership (PPP) of universities, firms, public agencies and people for creating, prototyping, validating, and testing new services, products and systems in real-life contexts. Accordingly, we propose the following research questions: How do Living Labs integrate knowledge from their external constituents, namely firms, governments, academia and users? And what phases of the innovation process are optimal for the knowledge orchestration by Living Labs? Do they excel in early phases of exploration and generation or are their processes better suited towards integration and commercialization? We address this question with data cultivated from Living Labs in Spain, Belgium and Finland as well as survey with members of ENoLL.

This paper is structured as follows; the second section presents a review of the literature on intermediation and brokerage, contributing to the innovation process. The result of this point is a theoretical typology of third party organizations. The third section explains our research method as well as the focus of study, the Living Labs. Following, our research questions and the business model of Living Labs, according to its typology, are analyzed

in the discussion part. The fifth point addresses the conclusions and future research lines towards taxonomy of innovation intermediaries.

Intermediary Organizations

A review of the literature details the continuous role of intermediaries, connecting, facilitating or collaborating with other organizations along the innovation process, since the middle of the 1980s (Carlsson and Stankiewics, 1991). Early studies referred to organizations focused on the transfer of technologies e.g. technology brokers (Hargadon and Sutton, 1997, Hargadon, 2002) or intermediary level bodies (Van de Meulen and Rip, 1998). Recent contributions (Howells, 2006, Winch and Courtney, 2007), however, presented a new set of functions grouped into a) facilitating collaboration; b) connecting science and policy initiatives; and c) providing services for stakeholders' activities.

Furthermore, as presented here, assorted studies on intermediaries have broadened our understanding of their relevance for the innovation process, specially from the following literatures: social networks (Burt, 1992), innovation management (Bessant and Rush, 1995), intermediation economic theory (Spulber, 2003), systems of innovation (Steward and Hyysalo, 2008), public policy (Callon, 1994, Fernandez and Gould, 1994), technology transfer (Youtie and Shapira, 2008) and information systems (Brousseau, 2002, Klein and Wareham, 2008).

From an astronomic perspective intermediaries contribute to innovation from three different angles. The first and largely researched line convenes on describing different organizational forms linking university research and firms technological products (Kodama, 2008). A second type represents the ones supporting the funding of innovation (Hellman and Puri, 2002) and, thirdly, attention has also been given to third parties facilitating management innovation processes, electronic markets and innovation agencies (Brousseau, 2002, Chesbrough, 2006, Piore, 2001). From a narrow perspective, a large range of heterogeneous forms of intermediaries are embracing different intermediation activities (for a review see Howells, 2006) as well as new specialized activities for pumping innovation such as user driven innovation (Boon et al., 2008, Smits, 2002) or design (Dell Era and Verganti, 2009).

These studies illuminated the functions of intermediary organizations, ideal or hybrid configurations, as well as the thematic elements of each form of intermediation have not been explored. Up to now, existing studies illuminate the functions of intermediary organizations but do not devote enough attention to different typologies, business models and structures.

Why a typology of intermediation? Now, rather than suggesting a new function of intermediation, particularly studying one new form of intermediation or demanding a hiatus until a taxonomy of the relevance of intermediaries can be supported by empirical data. It may be more revealing to inquire what type of ideal and hybrid configurations of intermediaries do exist, to comprehend the thematic elements/variables necessary for drawing distinctions and relationships of conceptual relevance. Certainly, the result will allow us to measure and predict organizational effectiveness of intermediaries.

Configurations of intermediaries

According to Meyer et al. (1993) organizational configurations "denote any multidimensional constellation of conceptually distinct characteristics that commonly occur together". This implies narrow, isolated and suggestive configurations are not: a) beneficial for reliable predictive or prescriptive analysis; and b) hinder integrating existing typologies, contributing to the noncumulative research (Miller and Friesen, 1984). Configurations are presented either in typologies, commonly developed conceptually, or taxonomies, commonly developed empirically. Typologies in management are used as a) devices for describing and classifying structures, organizations, strategies and environments; and b) mechanisms to create order out of a potential chaos, and predict relationships (Tiryakian, 1968). Commonly, these are well informed by theory, facilitate contrasts and the variables and elements explaining each type cohere in thematic ways (Miller, 1999). Some examples include the mechanistic and organic systems of management (Burns and Stalker, 1961), the structural configurations (Mintzberg, 1979) and the organizational adaptation forms (Miles and Snow, 2003). The aim of this section is to develop a typology of intermediaries, bearing in mind the limitations and characteristics discussed in the literature, for explaining how and why

different characteristics, attributes and parameters interrelate and complement. Following, this text describes the parameters framing each configuration. Then, each of the identified configurations is briefly explained trying to highlight logical arguments that result on specific predictions.

Parameters for intermediation

The first step for creating structural configurations is to search for orchestrating themes and networks of relationships and explore why and how these elements complement and interrelate each other (Miller, 1999). In this paper, these orchestrating themes are identified from previous studies on intermediation and brokerage. The analysis resulted in 19 themes, organized in the following three clusters: a) strategic; b) structural; and c) the contingency cluster.

The strategic cluster resembles an overall overview of the business model emphasizing the form intermediaries create, and capture value, the beneficiaries of intermediation and the coordination mechanisms. The structural theme provides a picture of the mechanisms and capabilities adopted by intermediaries to interact with external actors. Some of these activities include: required and created knowledge, the foresight and diagnosis of future market opportunities, the interrelation with external stakeholders, the existing integrative capabilities, the mechanisms for scanning and information processing of new markets and offered services. The last cluster explores the contingency factors shaping the formation and development of intermediaries. Although most studies on intermediation ignore these themes, the systems of innovation literature emphasize them as a relevant component for the formation and development of the Technological Systems of Innovation (TSI) (Stankiewics, 1995). Some of these themes include the scientific field; market or technology demands; innovation policy regulations; user demands; technical system of innovation; and the size.

Acknowledging, other themes may complement the different configurations presented here. We consider the selected themes cohere in thematic ways, may clarify existing

debates on intermediation as well as facilitate the study of intermediary configurations from a broader perspective.

A typology of intermediation

As previously observed, a typology of intermediation should provide a multidimensional analysis of different themes that advance scientific progress and resolve persistent debates and conflicts. Our review of the literature identified the existing discussion in the innovation literature between brokerage and intermediation requires further analysis. On the one hand, the brokerage literature emerged out of the social network approach and is widely studied in the structural holes literature (Burt, 1992). On the other hand, the later is roughly studied under the name of intermediary organizations (Seaton and Cordey-Hayes, 1993, Wright et al., 2008).

Although both areas of research arose from Simmel's (1902) working on third parties, these differ epistemologically. On the one hand, the theory on brokerage assumes two forms of third party organizations: firstly, the tertius gaudens or "the third who enjoys" is the one benefiting from establishing interchangeable occurrences between the parties and himself. This form of intermediation represents an ad hoc solution for both parties and usually sets an ambiguous reciprocity between the elements rather than establishing it. Secondly, the divide and conquer "divide et impera" is known as the intermediary benefiting from separating two conflicting parties. These two forms of third parties or intermediaries represent the building blocks of Burt's theory on structural holes that considers them as "buffers" between two non redundant contacts (Burt, 1992 p. 18-38). In this sense structural holes act as bridges of separated parts and benefit from two competing parties who themselves do not have a relationship but are related indirectly through a third party.

On the other hand, the other form of intermediary discussed in Simmel's work represents the mediator who is preconditioned by a non-partisan and subjective interest on the mediation. These two characteristics imply intermediaries are untouched by interests and opinions of other parties as well as maintain a personal detach from them. As noticed by (Khurana, 2002, Obstfeld, 2005 p. 103), Simmel's description attempts to secure

reconciliation in adverse scenarios through arbitration or consensus much different than existing organizational relations. Lately, this form of intermediation has been rediscovered under the concept of the *tertius iungens* and presupposed scenarios of coordination and collaboration, rather than adverse ones. Here, Obstfeld (2005) recognizes the role of intermediaries when parties may have common interests, tentative collaborative projects or may be indifferent to one another's interest. Whereas the tertius gaudens type of intermediary could be represented as a bridge of two disconnected parties, the tertius iungens or mediator could be represented as an anchor or pump type of intermediary.

Intermediaries may function as "anchors" when they coordinate and collaborate with other actors and purposefully have a subjective and non-partisan interest on the innovation process. This type of intermediaries is similar to the social intermediaries or market organizers described by Piore (2001) who smooth the technological transition processes by reducing ambiguity and uncertainty among innovation actors. This group of intermediaries has a dynamic function coordinating and assigning resources for scientific and technological innovations to different constituents of systems of innovation. Accordingly, this type of intermediaries proposes innovative reconfigurations linking together networks and public organizations (Callon, 1994).

In compare to "bridges" that link two disconnected parties and arbitrage the information flow (Kogut, 2000), intermediaries act as "pumps" when they interact and collaborate with other actors during the creation and generation of new knowledge. These differ from bridges by: firstly not having the need to fill-in a hole in any innovation network and secondly possessing the necessary technical or scientific knowledge for facilitating the development of innovations. Apparently, these intermediaries are observed in dense networks that lead to cooperative behavior (Coleman, 1988) where breadth and depth knowledge of the capabilities is required for exploiting group capabilities.

Until now, three different intermediary configurations were introduced. The first one aligned to the existing literature on structural holes presupposes intermediaries act as bridges of disconnected parties and are the architects of new unexpected connections

leading to innovation. The second and the third one, delineated from the tertius iungens, refer to the anchor and the pump. The former is drawn from research on the emerging social intermediaries (Piore, 2001) necessary for supporting innovation activities. Our review reveals these type of intermediaries are "hostess" of innovation and responsible for different activities. The third configuration is known as the pumps or the engineers of the intermediation process because of their active participation and coordination of innovative activities with other actors such as universities and industry. An example represents technology parks that purposefully not only try to bridge science and technology but also participate on some projects.

Finally, the "door" is considered as the traditional type of market intermediary, necessary for reducing market frictions using innovative business models that reduce transaction costs (Spulber, 2003). In this configuration intermediaries act as merchants between buyers and sellers that benefit from having returns on scale from transactions as well as advantages of information gathering. In this configuration, not only "brick and mortar" intermediaries are included (Hansen et al., 2000). Also, financial intermediaries (Hellman and Puri, 2002) and E-commerce intermediaries (Brousseau, 2002, Orman, 2008) are considered as the new forms for intermediation.

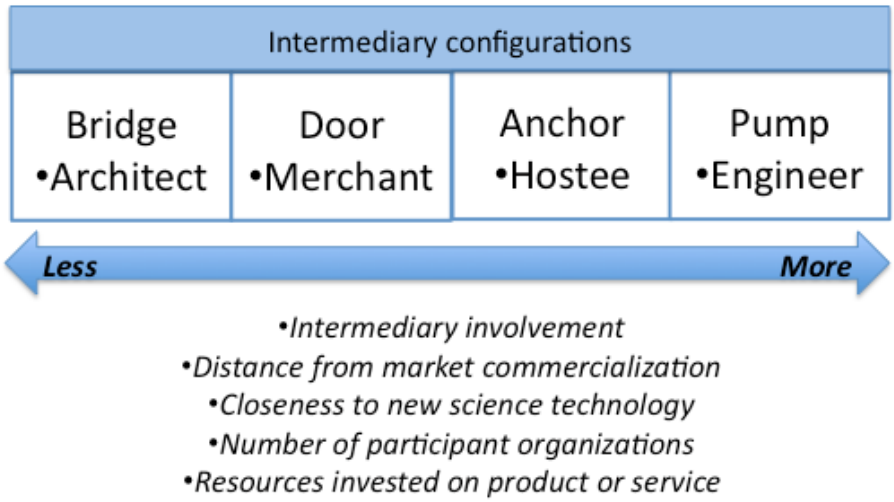
Summary and synthesis

An extensive review of scholarly contributions, on intermediation, confirms the four identified typologies, the bridge, door, anchor and pump, are the most scientifically studied. Further, each configuration is theoretically supported by established theoretical contributions (see table 5). This preliminary structural configuration assigns intermediaries along a continuum where each type is studied by the level of involvement, distance from market commercialization, closeness to new science, or technology, number of participant organizations and resources on the product or service (Figure 6).

The usefulness of the presented typology will demand additional research addressing: a) the validity of each type of intermediary measured by its effectiveness e.g. taxonomies; and b) the identification and additional configurations, missing in the presented typology. The second part of this paper follows the later. It elucidates how Living Labs recombine

different sources of knowledge, especially from end-users, to develop new innovations in different sectors. We call this structural configuration the "entrepreneurial intermediaries" because of their ability to recognize market opportunities and apply to commercial user-driven innovations in collaboration with a large set of innovation players.

Figure 6: A typology of intermediaries



Research approach and collected data

The analysis and interaction with Living Labs in Europe showed their external distinctiveness, in compare to other external forms of intermediation, but also its lack of internal homogeneity. This occurs because of the novelty of Living Labs as well as its current emerging stage. This scenario led us to purposefully select Living Labs with some level of maturity and volume, where specific methodologies have been developed. These Living Labs coincide with the regions in Europe where emerging Living Labs networks are being formed: Sweden, Belgium, Finland and Spain.

Table 5: A typology of intermediaries

Themes	*Bridge / Architect*	*Door / Merchant*	*Anchor / Hostess*	*Pump / Engineer*
		Strategic Cluster		
Value creation	a) Offer customized information; b) provide consultancy services; c) manage customer's identity; d) access and broadcast a two-sided-market; e) identify new opportunities	a) Reduce transaction costs; b) provide an augmented product for buyers; c) foster partnership and provide preferential access; d) provide liquidity	a) Identifying new directions and possibilities to link science to socio-economic objectives; b) Design new strategies; c) interact with various societal actors	a) Mediate, promote collaborative research between various actors; b) Provide commercializing mechanisms; c) facilitate knowledge transfer
Value capture	a) Transform ideas to fit new environments; b) accompany the selection, evaluation and negotiation process; c) provide successful transactions	a) Transform and customize data for customers; b) transaction securitization; c) problem solving; d) obtain resources and partnerships with large companies	a) Maintain and establish social relationships / communication; b) identify trends; c) invite supporters for new technologies	a) Transform research into commercial products; b) foster new relationships, entrepreneurial activities and knowledge sharing; c) analyze external markets; d) develop complementary technologies
Beneficiaries	a) Companies lacking expertise, staff, resources; b) companies trying to exploit their potential; c) distant innovation solvers; d) actors with different knowledge base	a) Buyers and sellers; b) VCs	a) Societies; or b) organizations in systems of innovation	a) Companies working with the intermediaries
Advantageous	a) New combination of knowledge is required; b) provision of a common ground is needed; c) light form of diversification; d) validation of new ideas; e) provide a neutral space for near-to-market research	a) Lower transaction or searching costs are required; b) transaction problems need to be solved; c) decrease of advertising, price, and competition; d) cooperative partnerships are necessary	a) Large groups of stakeholders are involved and new strategies have to be designed or implemented	a) Address opportunities for the region to generate and share new expertise, human capital, knowledge
Coordinating mechanisms	a) Organization's network position; b) licensing or selling patents; c) provision of a platform for near-to-market research and validation of new ideas	a) Web-enabled commerce; b) services; c) seller, buyer and independent alignment; d) financial support	a) Communication and specific coordination mechanisms	a) Boundary spanning offices; b) organizational practices
Creation	Private Initiative and VCs	Private initiatives	Public and PPP	Both public and private initiatives

Structural theme				
Knowledge created or transferred	a) Recombined knowledge to provide new services or products	a) Transactional knowledge about consumer's behavior to match demand and supply	--	a) New research and technologies; b) spin-off technologies; c) incremental improvements; d) human capital and competencies
Required Knowledge	a) Understanding of the market (clients and technologies); b) specialized and extensive knowledge in the market of expertise	a) Technological expertise; b) process capabilities; c) functional skills; d) information about preferences; e) triggering mechanisms	--	Ability to: a) leverage external sources of knowledge; b) develop, acquire and use codified knowledge; c) recombine tacit knowledge
Foresight and diagnosis of future opportunities	a) Exploiting its "Acquisition, storage and retrieval" model; b) new services to solver community	a) Improve organizational capabilities; b) change from existing lines of business; c) investments on physical assets and proprietary knowledge; d) portfolio strategy and network design; e) new services enabled by ICT	--	a) Explores technological knowledge through an in-sourcing process
Interrelation with other actors	Engagement of solvers from contract universities, research centers	--	--	a) Develops a complementary market knowledge through a market incubator
Scanning and information processing of new market opportunities	a) Flow of resources among dissimilar industries; b) identification of market for technologies; c) pursuing the intermediation between the sources and implementers of new ideas	Customers and sellers provide new information	--	a) Four-phase model: selection, structuring, involvement and exit
Integrative capabilities	a) Identify new relationships; b) shape research problems and practice the implementation	a) ICT technologies e.g. data warehousing and integration, sensor networks; b) collaborative filtering; c) time-and-place utility	a) Ensure communication; b) building of networks; c) develop and implement innovative opportunities	a) Access platform for various types of knowledge; b) interdisciplinary collaboration and c) financial and human capital resources

Funding / Resources	a) Privately owned; b) VCs; c) large companies; d) Public or PPP	a) Innovative transactions between buyers and sellers, matching and satisfying specific customer needs	a) Public funding	a) Public funding; b) service fees
Offered products / services	a) Development of engineering products/services; b) IP evaluation; c) licensing transaction; d) help definition of the problem; e) evaluation of outcomes; f) market identification	a) Bring buyers and sellers together; b) customize information to specific users; c) brokering transactions; d) coaching; e) provide funds	--	a) Advising; b) provision of resources e.g. knowledge and physical
Contingency factors cluster				
Science	Seldom relationship with universities	--	--	--
Market demands	a) Development of patent markets; b) competition of IP blindness; c) IP management	Use of ICT technologies may benefit the advancement of commercial and electronic intermediaries	--	--
Policy regulation	--	--		Facilitates the university-technology transfer
User demands	--	Through vertical market relationships or new demands from users	--	--
Technical systems	--	--		Changes on the innovation system prompt changes in the intermediary

This research employs a comparative case study analysis (Stake, 2000, Yin, 2003) focusing on multiple evolving elements and relationships to understand the complexities and dynamics of Living Labs. This exploratory method is best suited to investigating poorly understood processes (Eisenhardt, 1989b) and it provides an explanation of how events evolve over time (Langley, 1999). Due to the large amount of longitudinal multifaceted data which could create 'data asphyxiation' (Pettigrew, 1990), the mechanisms for collecting empirical evidence from a large set of Living Labs include: a) interviews with Living Lab representatives; b) surveys with ENoLL members; c) numerous European conferences focusing on living labs; and d) documents and reports on Living Labs (table 6).

Table 6: Sample data collection

Interviews	17
Surveys	18 out of 56
Coordination Activities	> 20
Conferences on LL	3
Duration	2 years

The European Network of Living Labs

The introduction of this paper mentioned the Living Labs as one type of intermediary that could act as system builders of a larger network of organizations. Living Labs were created in most cases as Public-Private Partnerships (PPP) to enforce regional advantage, in which user-driven innovation is integrated within the co-creation process of new services, products and societal infrastructures. The Living Labs movement grew in Europe around 2005, coming from experiences on real life experimentation in Nordic countries. On November 2006 under the Finish presidency, the European Network of Living Labs (ENoLL) was officially born. Since 2006, the European Commission launched several integrated programs from the Sixth Framework Program to support Living Lab activities through ENoLL. Currently, this community comprises 119 Living Labs in 21 different European countries as well as in Asia, South America and Africa.

Our, ongoing, empirical research reveals, in Europe, Living Labs represent a form of technological intermediation attempting to establish functional regions where stakeholders form a PPP of universities, firms, public agencies, institutes of technology and people with the aim to create, prototype, test new technological products in real-life contexts. The result of this continuous interaction of stakeholders is expected to: a) contribute to innovation and development process of different organizations; b) offer a platform for accelerating the innovation process; and c) provide medium or long-term services in large and small scale for the development of new technologies. At the micro level, Living Labs are defined as "environments for innovation and development where users are exposed to new ICT solutions in (semi) realistic contexts, as part of medium – or long term studies targeting evaluation of new ICT solutions and discovery of new innovation opportunities (Folstad, 2008)".

Certainly, testbeds or environments for ubiquitous computing also offer similar activities conducted inside Living Lab platforms e.g. users' validation or experience and experiment environments. Living Labs, however, distinguish by emphasizing early phases of the innovation process such as creation and ideation as well as offering innovation platforms for multi-stakeholder collaboration in the value chain of ICT production. The following description of the characteristics of Living Labs clarifies their distinctiveness.

- ***Facilitating collaboration for research.*** Chesbrough (2006) described innovation intermediaries as the one responsible to accelerate the process of open innovation by directly addressing the need of bringing new ideas into the pipeline and letting out the ones that do not seem relevant enough in the light of the firm's business model. In the same line, Living Labs act as catalyst of technologies around their research lines to accelerate the creation and development process. Firstly, it is observed that Living Labs act as connectors, looking for technological complementarities and materializing connections on that basis. Secondly, Living Labs enhance the collaboration of different organizations by: a) conducting medium or long term studies of possible groups of technologies with various

stakeholders; and b) involving users as co-creators during the R&D phase of technologies;

- ***Connecting science and policy initiatives.*** Living Labs were mainly established as university or public governmental initiatives to enhance the innovation outputs in local regions. Up to now, only a small group of Living Labs is established as private initiatives but this type of Living Labs is increasing. The majority of innovation policy initiatives, supporting Living Lab activities, aimed to connect basic "upstream" and downstream" [3] activities to accelerate the development of new technologies in the region. In this role they serve as public or quasi-public agencies that actively promote lines of research and create synergies between the regional actors. Living Labs address the two functions in their connection role between a) universities and private organizations; and b) policy and industry;

- ***Providing Services for Stakeholders.*** R&D centers are continuously enhancing their portfolio of offered services to also include complementary activities such as validation, testing, marketing analysis (Howells, 2008). Living Labs anticipated the need for complementary services, not only to technology creation and development, and strategically offer experimental platforms with large number of users who embrace a joint discovery process through the use of prototypes. Specifically, the services Living Labs offer for the creation and development of new technologies include: a) provide insight into the unexpected ICT uses and new service opportunities; b) experience and experiment with ICT solutions in contexts familiar to users or in real-world contexts; c) try out ICT solutions with large number of users; d) evaluate or validate new ICT solutions with users; and e) conduct technical testing in a (semi) realistic context of use;

[3] "Upstream" activities are concerned with the development of basic components of an industry. Whereas, "downstream" activities are concerned with the integration of basic technologies and components into complex systems (Stankiewicz, 1995).

Summary and Synthesis

In this summary part, we attempted to clarify the question what Living Labs really do, using primarily the information from three European Living Labs in Spain, Belgium and Finland (Table 7). This analysis phase involved a continuous comparison of the functions performed Living Labs with the intermediary activities described in the literature (Howells, 2006) and the Technological System of Innovation functions (Bergek et al., 2008).

The preliminary data showed Living Labs performed more actively on the following innovation functions: a) knowledge development; b) market formation; c) development of external economies; and d) resource mobilization. The first function was developed through new established interactions among academia, companies and users in the studied regions. Also, Living Labs encapsulated the created knowledge, for additional reuse, acting as knowledge hubs. Secondly, Living Labs contributed to market formation providing dissemination mechanisms that compile information from university research institutes, users, entrepreneurs and companies. This service provided an overview of the situation on the market, the consumers and their purchasing behavior. Thirdly, Living Labs contribute to the development of external economies by providing mechanisms for external human and financial capital coming from private and public initiatives as well as continuously enlarging the interaction with a broad range of SMEs and entrepreneurial initiatives. Finally, Living Labs mobilize resources that include entrepreneurs, a large group of users, local governments, public and private organizations and contribution of European commission through different projects addressing their emerging challenges.

Discussion

As presented above, Living Labs represent a distinct type of intermediary configuration where they use their absorptive capacity to recognize, assimilate and apply external knowledge, from users, universities, research centers, entrepreneurs and private organizations, to develop new innovations. Apparently, Living Labs do not represent

Table 7: Living Labs as intermediaries and system builders

Intermediaries functions (Howells, 2006)	i2Cat	Forum Virium	i-city
	Barcelona, Spain	**Helsinki, Finland**	**Hasselt, Belgium**
Facilitating the collaboration between organizations			
Knowledge processing, generation and combination	i2Cat provides a technology platform for companies, research centers and citizens as an attempt to conduct an innovation process of co-creation and validation of technologies, services in real life contexts	Aim to identify business opportunities of research conducted in universities to companies in the Helsinki area, created in cooperation between corporations, universities and users	Identify new business opportunities in collaboration with users to design, develop and validate new technologies as well as disseminate research conducted in universities
Foresight and diagnosis	i2Cat provides services for conceptualization, development and testing of wideband applications	Collaborates identifying trends in radio and television technologies, specially in digital services	Collaborates scanning market trends (focused on socio-economic objectives) in 5 groups of technologies: e-health, e-Environment, e-Government, media and mobile technologies
Scanning and information processing	Aims to transfer technologies as two-way process from universities to firms, from entrepreneurial initiatives to possible technologies in collaboration with external private and public companies	Collaborates providing specialized knowledge from university research institutes	Provides services of scientific knowledge from Leuven and Hasselt universities to company project and entrepreneurial activities as well as real life environments for idea generation
Commercialization of outcomes	Provide diffusion opportunities for university research as well as entrepreneurial initiatives for universities	Forum Virium acts as sales network supporting and planning possible adoption of technologies by private firms	Disseminate research conducted in universities to companies as well as select entrepreneurial initiatives in the specified sectors of interest
	Provide financial capital for new technologies comes from local government and the rest from the entrepreneur or company. Also, various local and international activities rise the possibilities for funding	-	One initiative is to organize public offerings for funding innovation (up to 50%) coming from the Flemish government (IWT) for attractive regional projects. Further, i-city offers other public mechanisms for local entrepreneurial initiatives
Connecting users, science and policy initiatives			
Gate keeping and brokering	i2Cat is considered as coordinator of the network of organizations linking not only governmental institutions with research institutions and organizations but also include users' perspective in the innovation	Provides private firms and research centers with the necessary methods and space for obtaining users' ideas to conceptualize and develop technologies between firms and research institutes. As well as the marketing	i-city provides in Hasselt an space to coordinate and exchange information for companies as well as for involving university researchers into the innovation process

	process	initiatives.	
Intermediaries among entrepreneurs, science, policy and industry	i2Cat and CATLAB (Catalonian Network of Living Labs) are coordinators of public funds, research projects, contractual research and provision of services	It is the linkage to the Network of Living Labs in Helsinki created as regional initiative to promote Living Lab's activities, with public collaboration from Tekes.	i-city is the coordinator of public initiatives and considered as knowledge repository and Liaison between innovation policies and the operational sector. It also receives Public funds for regional research initiatives, from contract research and the provision of services
Evaluation of outcomes	It enables other organizations to innovation measured by the no. of research partners, no. of new end-users and having success stories	It was created as a regional initiative to enhance innovative activities, measured by new research and industrial partners and success stories	It is considered as a liaison between public and private organizations to identify new research partners, new SMEs, firms, and having success stories
Demand articulation	Aims to design, develop and validate technologies with users (Currently between 100 and 500 active users)	An initiative called open co-operation aims to create new technologies in collaboration with public bodies, citizens and customers (between 30 and 1000)	It brings the demand site through different design, develop and validate technologies with an active pool of users (between 1000 to 3000) who are targeted to specific projects
Providing services for stakeholders			
Testing and validation	i2Cat provides the internal service for conceptualizing, developing and testing technologies in collaboration with users, entrepreneurs, universities and firms. However, it does offer yet to other companies		It validates and test developed technologies in real life environments. Also, provides consultancy services for technology development and validation
Providing services for stakeholders			
Intellectual Property: Protecting the results	-	-	-
Accreditation and standards	-	-	-
Validation and regulation	Does offer validation of technologies developed inside the Living Lab	Offer technology validation and testing methods in real life environments	It has a Laboratory (called i.Lab.o for open innovation) used to technically validating internal and external technologies

isolated cases, on the contrary similar forms of intermediation e.g. technology centers share the same business model as Living Labs. In our structural typology, this type of intermediaries is known as the entrepreneurs that are able to alternate disperse sources of knowledge to develop new innovations.

A definitive typology of entrepreneurial intermediaries

Cohen and Levinthal (1990) explained absorptive capacity represents the ability of firms to value and recognize new external knowledge, assimilate it and apply to commercial ends as well as the capability to predict the nature of future technological advances. This capability is build upon of prior related knowledge, which includes basic skills, shared language, and also knowledge on the latest insights on scientific and technological developments. Here, entrepreneurial intermediaries use their absorptive capacity to leverage their stock of scientific and technological knowledge not only to provide solutions to customers but also to recognize future technological advancements and introduce new products or technologies. They are continuously confronted with new technological challenges by interacting with customers, universities and public organizations. In this sense, they "alternate" between scientific, or market signals and market demands where they are likely to provide cutting-edge products. Apparently, the defining characteristic of this form of intermediary is its capability to leverage between depth of knowledge, in specific fields, and breadth of knowledge connecting different knowledge spaces.

Living Labs as entrepreneurial intermediaries

Are Living Labs an articulated structural configuration to be an entrepreneurial intermediary? Apparently, established Living Labs represent a prominent type of entrepreneurial intermediaries that can create and capture value by recognizing new external knowledge, assimilate it and apply it, in close collaboration with users, to commercial ends as well as identify emerging technology demands. As observed in table 8 this typology of intermediaries: a) requires an intensive level of involvement from participating organizations; b) it is distance from the market commercialization phase; c)

it is close to new science and technology, with high level of user participation; d) it invites universities, organizations, VCs, entrepreneurs and a large number of users to take part of the innovation process; and e) it requires a larger amount of resources during the innovation process.

Table 8: A definitive structural configuration of Living Labs

Themes	***Alternator / Entrepreneur***
Strategic Cluster	
Value creation	a) Provide platforms where users, organizations, research centers, entrepreneurs develop new technologies
Value capture	a) Create and develop early phase user-driven innovations in collaboration with companies
Beneficiaries	a) Users; b) entrepreneurs; and c) participant organizations
Advantageous	a) Early phase of new technologies / products; b) users technologies are needed
Coordinating mechanisms	a) Physical interactive platforms for interaction
Creation	a) Mostly PPP; b) few private (technology parks, foundations)
Structural theme	
Knowledge created or transferred	a) Recognize, assimilate and apply external knowledge for new user-driven technologies
Required Knowledge	a) Technological expertise; b) methods to include user knowledge
Foresight and diagnosis of future opportunities	a) Try to identify tentative user applications of new technologies
Interrelation with other actors	a) Interaction with VCs, entrepreneurs, innovation agencies
Scanning and information processing of new market opportunities	Not identified
Integrative capabilities	Not identified
Funding / Resources	a) Public local and EU; and b) private
Offered products / services	a) User-driven cooperative technology development; b) testing of technologies with users
Contingency factors cluster	
Science	a) Collaboration with universities for developing new technologies
Market demands	a) Not directly responsive to organizations' demands
Policy regulation	a) Policy is supportive but not regulatory
User demands	a) Close relation with groups of local users, possible adopters
Technical systems	a) Mainly active in new ICT e.g. e-health, e-mobile, e-government

Open Innovation defines a model where ideas can flow inside or outside the company been accepted solely because of their fit with the business model. However, the main

actors in this process are still companies and research institutions. Still open innovation does not provide many guidelines on how can it be effectively supported at the macro level in terms of policy. Parallel to this, we have seen a rise of a new actor in the innovation process - users. We find users auto-organized in open source communities, or playing an important role in shaping software products in the perpetual beta process.

Living Labs aim to provide structure and governance to the user participation. In this paper we have seen how they attempt to do it by maintaining user groups, providing services around user experience, supporting lead users and creating societal involvement. Also we described where they seem to be more effective: in customization exercises and in exploration, especially in interdisciplinary projects that involve organizational change, where they work as "entrepreneurial intermediaries".

Currently, Living Labs are still young and represent a large quasi-experiment in themselves, where validated methodologies are limited and methods to incorporate the participation of companies and generate start-ups are just emerging. Living Labs, however, are aligned with objectives of regional funding agencies and the rising importance of both individual users and society in general in the innovation process.

Conclusions, limitations and future research

Historically national and regional governmental organizations have been the largest amount of academic research funding. Recently, however, government's share declined and industry's share increased during the 1980s and 1990s. In Europe, the establishment of the European Research Council (ERC), the first pan-European funding agency for frontier research in all fields of knowledge, attempts to provide additional support to academic research but it recognized the "enormous demand for funding". In this highly demanding and decreasing scenario of public funding, the increasing industry's share of R&D investments seems to be insufficient. Currently, industrial R&D is increasingly becoming globally and performed collaboratively, requiring partners, resources and ideas outside the company. Intermediaries contribute to the innovation process fulfilling different innovation functions such as testing and validation, linking different groups of

organizations as well as, and perhaps more relevant, facilitating the transference of basic research to applied research and during the development phases of new technologies.

This research aimed to theorize the influence of one peculiar type of intermediation, Living Labs as entrepreneurial intermediary, within a broader group of intermediaries. Further, this research initiative constituted the first approach to explore the engagement of the demand site on innovation systems on the formation phase. Future contributions on intermediation literature should demand the validation of the discussed typologies and assessment of the activities performed by Living labs, using quantitative metrics such as taxonomies.

We consider the emerging evidence of this research could advance further research on intermediation, at the technological system level (Bergek, et al., 2008). This could provide tentative explanations of the role of intermediaries during the formation of new Technological System of Innovation and the possible dynamics encountered during the process. We suggest further studies should explore how intermediaries, both private and public, interact with groups of organizations and facilitate the process formation of technologies as well as the possible encountered problems.

Chapter IV An open innovation perspective on the role of innovation intermediaries in technology and idea markets[4]

Technology markets have become prominent in an era of abundant and widely distributed knowledge. Given that technology transactions suffer from several market imperfections, ever more innovation intermediaries are filling the gap and acting as facilitators. We analyze how a subset of these intermediaries creates value in a two-sided market and how they capture part of the value. A detailed analysis of the business model of twelve innovation intermediaries clarifies how these organizations improve the effectiveness of technology markets, providing benefits for both sides of the market. We also look at managerial trade-offs between the use of intermediaries' services and in-house innovation portals.

Keywords: innovation intermediaries, open innovation, business model, two-sided markets

Introduction

Open innovation addresses how firms integrate external and commercialize knowledge in technology markets to accelerate speed and minimize costs of innovation (Chesbrough, 2003). Numerous scholars have illustrated firms' benefits adopting these new practices (Huston and Sakkab, 2006). But firms' challenge is to design business models to reach beyond firm's innovation network (Chesbrough, 2006, Johnson et al., 2008, Lichtenthaler and Lichtenthaler, 2009, Teece, 2010) and become participants in technology and idea markets (Arora and Gambardella, 2010b). Although these markets provide numerous advantages, an issue for firms willing to benefit from the available knowledge is to reveal confidential and strategic initiatives that may result on IP contamination, losing a first mover advantage.

In response to this challenge, a new kind of innovation intermediary has emerged to help companies to transgress their own firm's innovation network and access external technological markets (Chesbrough, 2006, Sieg et al., 2010). These innovation intermediaries i.e. NineSigma, Innocentive, Yet2.com, YourEncore actively connect

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supply and demand sides in two-sided idea and technology markets forging links between firms searching for external ideas (innovation seekers) with communities of highly-qualified solution providers (innovation solvers). Yet, despite the substantial research on open innovation, scant attention has been paid to the content, structure and governance mechanisms of these emerging forms of innovation intermediaries.

This paper attempts to disentangle this particular innovation process by: a) connecting the broader literature about two-sided markets (Eisenmann et al., 2006, Rochet and Tirole, 2003); b) briefly reviewing the features of technology markets (Arora and Gambardella, 2010a); and c) open innovation (Chesbrough et al., 2006) to the underlying business models of innovation intermediaries (Chesbrough, 2006). More specifically, we are interested in the innovation intermediaries' business model and how it creates and captures value in two-sided technology markets. Our analysis reveals that innovation intermediaries contribute to open innovation by accelerating two-sided flows of knowledge in line with the theoretical insights developed in the two-sided market literature. Furthermore, this study shows the different approaches adopted by intermediaries for helping companies throughout the open innovation process. Therefore, this paper provides the first study of innovation intermediaries' business models and details their contribution to the recent surge in the development of technology markets.

The paper is structured as follows: the next section presents our theoretical approach to the study of innovation intermediaries in two-sided markets. Section 3 discusses how organizational characteristics of the innovation intermediaries are studied using a business model framework. Section 4 discusses our research design followed by the results of the analysis in section 5. Section 6 discusses the managerial trade-offs in using external or internal innovation intermediaries to capture external knowledge. The last section wraps up the main conclusions; we discuss some managerial implications and formulate suggestions for further research.

What are the characteristics of (open) innovation intermediaries?

In an era with abundant and widely distributed knowledge, technology transactions and partnerships with external partners became more prominent in firms' innovation

strategies (Chesbrough et al., 2006). For decades, various scholars have shown that technology transactions and markets are prone to different types of market imperfections (Arora et al., 2001, Arora and Gambardella, 2010a, Arrow, 1962). Over the last decade, companies have shown growing interest in transacting technologies with external partners. A rising number of cases revealed firms make use of services offered by innovation intermediaries. These, however, are ubiquitous and a clear definition of such innovation intermediaries would sharpen the focus of this paper but none is to be found in the literature to date.

Recently, in an attempt to shed some light to these studies, Howells put forward a broad definition of an innovation intermediary as "an organization or body that acts as an agent or broker on any aspect of the innovation process between two or more parties. Such intermediary activities include: helping to provide information about potential collaborators, brokering transactions between two or more parties; acting as mediator, or go-between, bodies or organization that are already collaborating; and helping find advice, funding and support for the innovation outcomes of such collaborations (Howells, 2006 p. 720)". Although this proposed definition embraces significant activities and forms of intermediaries, it does: a) not reveals differences among widely-studied groups of intermediaries; b) not explains the reason d'être and differentiating characteristics of emerging innovation intermediaries such as NineSigma, InnoCentive, Big Idea Group, InnovationXchange, IP Exchange and Ocean Tomo, etc. (Chesbrough 2006); and c) includes agent based intermediaries which are excluded from the analysis in this paper.

Empirical observations indicate that such intermediaries may speed the quest for possible solutions to a customer's problems or help firms license or sell internally-developed technologies that they cannot turn into products of their own. Innovation intermediaries do this by: drawing on an international network of potential innovation solvers and helping inventors find innovation seekers. Chesbrough (2006) explained this new breed of innovation intermediaries emerged in a "rich environment of abundant and widely distributed knowledge" that required third parties capable to overcome barriers conditioning the functioning technology markets.

Let us take NineSigma as an example of an open innovation intermediary. This firm was established in 2000 and has since helped over 300 organizations worldwide to find solutions from an external network of 2 million providers drawn from 16 industrial groups and 115 countries. Since its foundation, it has guided over 1,600 open innovation projects and successful technology development agreements, doing US $ 10 m of business in 2008.

Ninesigma's simplified innovation process entails six steps. The first one involves a series of activities between an innovation seeker (e.g. P&G) and the intermediary's representative to find a strategy to best meet open innovation i.e. convert a business challenge into a confidential request for a solution, assess technology landscape, identify success metrics. Next, a request is sent to the international network of solution providers (companies, technology centers, and individual scientists). Third, solution providers comb through their existing technologies and capabilities. If they think they can provide a solution, they submit an initial Proposal for Request (PFR) to the intermediary. NineSigma receives around 90 PFRs per challenge and around 40% of the submitters are new to the game. These submissions are then gathered together and sent to the solution seeker. Fifth, innovation seekers evaluate the technical, commercial and relational feasibility of received solutions. This process involves several ongoing meetings between selected innovation solvers and solution seekers' representatives (or innovation champions). During the last step, innovation seekers select one technological solution, agree future collaboration, IP acquisition or possible partnership with the innovation solver and settle the intermediation fees. Throughout these six steps, NineSigma may provide additional services to technology seekers wanting more from its network.

NineSigma is an example of an emerging group of innovation intermediaries (Chesbrough, 2006, Lichtenthaler and Ernst, 2008a, b) that create value by enabling and facilitating (technology based) transactions between players in a two-sided market. The innovation intermediaries' strengths are:

- The ability to facilitate collaboration across two sides of technology markets by creating innovation platforms that link companies match seekers with potential innovation solvers (the latter include scientific entrepreneurs, retirees, public and private research labs, etc.);

- Providing an attractive price structure for innovation seekers who only pay the innovation solver and the intermediary if and when they acquire, in-license the proposed solution. Innovation intermediaries do not pay solvers a monetary compensation for their time and effort. However, offer them valuable business access to potential end customers and allow solution providers to search business challenges through other intermediaries;

- Providing innovation seekers with complementary services, which include strategic advice, technology mapping, integration services, etc.

Most studies on intermediaries in two-sided markets have emerged from research on network externalities and multi-product pricing (Parker and van Alstyne, 2005, Rochet and Tirole, 2003). According to Rochet and Tirole (2006 p. 664-665) "a market is two-sided if the platform can affect the volume of the transactions by charging more to one side of the market and reducing the price paid by the other side … The market is one-sided if end-users negotiate away the actual allocation of the burden… ; it is also one-sided in the presence of asymmetric information between the buyer and the seller, if the transaction between buyer and seller involves a price determined through bargaining or monopoly". Two-sided markets, according to Parker and van Alstyne (2005), require the interaction of three groups of actors; a group of technology buyers, a group of sellers and an intermediation 'platform' that creates tools or mechanisms for helping both parties strike a deal.

Another literature stream has focused on the growing importance of the market for technology (Arora et al., 2001, Arora and Gambardella, 2010a), which is disembodied from physical goods. The focus is mainly on the efficiency of technology market transactions and the division of labor between those licensing their technology and firms seeking it to new products and businesses. However, this literature focuses strongly on

bilateral technology transactions such as R&D contracting and licensing between technology specialists and buyers. To the best of our knowledge, the role played by innovation intermediaries in bringing technology suppliers and technology buyers together in a triangular trading arrangement has yet to be discussed within this framework.

Research on open innovation not only stresses that knowledge is both plentiful and widely distributed across the globe (Chesbrough et al., 2006). The literature stream also acknowledges various challenges in accessing and acquiring external knowledge such as identifying useful external knowledge sources, efficient scaling, and establishing technology markets. These all pose hurdles to the management and organization of open innovation in companies, etc. Chesbrough (2006) provides in-depth analysis of several innovation intermediaries whose platforms help two-sided technology markets work. He describes innovation intermediaries as entities that harness the integration of various knowledge sources and advise firms on how to capture the benefits of external and/or internal knowledge flows. Following this line of thought, we narrowly define such innovation intermediaries thus: *"platform providers in two-sided innovation markets created to co-ordinate the flow of innovation requests and solutions across distinct, distant and previously unknown innovation actors"*. There are two merits to this definition. First, it acknowledges the existence of other innovation/knowledge intermediaries (Howells, 2006, Verona et al., 2006, Winch and Courtney, 2007)– for example incubators (Hansen et al., 2000), university science parks (McAdam et al., 2006, Youtie and Shapira, 2008) and consultancies (Bessant and Rush, 1995, Hargadon and Sutton, 1997). Second, it highlights the characteristics of innovation intermediaries, which act as platform providers in two-sided technology markets and which have been described in Lichtenthaler and Ernst (2008a), Chesbrough (2006) and Huston and Sakkab (2006).

We shall now look at several factors that determine the commercial success of this subset of intermediaries Eisenmann et al. (2006) derive a number of factors from theoretical models about two-sided markets as explained by Parker and van Alstyne (2005), Rochet and Tirole (2003, 2006) and others. Intermediaries are considered as platforms whose

infrastructure and rules facilitate transactions between two sides of the market. Innovation intermediaries provide value to companies in search of solutions, IP, other services or resources by taking away the expensive search processes. This is especially interesting when the supply side of the market is highly scattered. For individuals and groups at the supply side innovation intermediaries provide a window opportunity to successfully commercialize their invention, solution or technology.

Innovation intermediaries usually stimulate the growth of both innovation seekers and solvers because their interaction is not a zero-sum game but rather one in which adding value to one side fosters growth on the other. This cross-side network effect is crucial in explaining the commercial success of innovation intermediaries. Acquiring new participants on both sides of the market boosts the value offered by the innovation intermediary. The remorseless logic of increasing returns to scale means that two-sided markets are usually fiercely competitive and ones in which "the winner takes all".

This is also the case for innovation intermediaries. Early entrants can gain first-mover advantages. Late entrants are clearly at a disadvantage but they can adopt a differentiation strategy given that innovation seeker needs are varied and each intermediary can offer a different kind of service, focusing on other sorts of clients or specializing in different technological fields. As a result, innovation intermediary start-ups have boomed over the last 5 years. However, we can expect that the growth of networks will lead to growing consolidation in the industry as larger innovation intermediaries start to acquire smaller ones. UTEK's acquisition of Pharmalicensing, TekScout and Innovaro is a sign that the process is already underway.

The consolidation trend will be further strengthened by the diversification strategies of larger innovation intermediaries. Here, one should note that intermediaries offering different types of services often have overlapping customer bases and thus shared relationships could be leveraged if an innovation intermediary can bundle together what is only offered piecemeal by his competitors. Some intermediaries are already diversifying by offering kindred services to their clients but so far this has been the result of an organic growth strategy. One might expect that more and more intermediaries will diversify through acquisition.

In two-sided markets, pricing is more complicated than in one-sided markets, as intermediaries have to choose a price structure, taking into account that the growth on one side of the market increases the other side's willingness to pay. Innovation intermediaries often have a price structure to "subsidize" one-side of the market to boost demand and the other side's disposition to fork out. Frequently, innovation intermediaries may attract large numbers of (price-sensitive) innovation solvers by offering free membership. This is specially the case when large groups of solution providers are requested and the chance of providing a winning solution is low. This is the case for platforms such as InnoCentive and NineSigma, which need over 100,000 innovation solvers to constitute an attractive platform for major innovation seeker clients. This hit rate is a logical consequence of clients' highly specialist needs, which few solution providers are in a position to satisfy. In turn, more paying clients make the platform more attractive to solution providers. However, this is not always the case. Yet2.com charges both sides of the market because IP-trading may generate large benefits for both sides and a "membership fee" may also give companies greater incentives to use the platform.

"Same-side" network effects are usually not present among solution providers because most intermediaries thwart such links. Innovation solvers are not only isolated from innovation seekers but also from other solvers because anything else would threaten the middleman's position. Similarly, same-side effects do not exist among innovation seekers as they only establish bilateral transactions with the platform provider. Information leaks may constitute a serious problem and intermediaries have to observe the strictest confidence and secrecy (Chesbrough, 2006). As such, strategic information about innovation seekers should not leak to other innovation seekers using the same innovation intermediary services. In addition, firms' collaborating with innovation intermediaries face "Arrow's information paradox" (Arrow, 1962): that is, in seeking a solution firms are forced to reveal information but must conceal the firm's technological weaknesses to potential competitors. Researchers and engineers of competing companies who operate as solution providers might get wind of such weaknesses. Finally, innovation seekers should protect themselves from contamination: if a client firm receives a solution from a supplier through an innovation intermediary, then "any consequent internal development in a related area by the [...] [former] may be challenged by the supplier... (Chesbrough, 2006

p. 68)". Therefore, an intermediary has to insulate client firms "...from inadvertent exposure to external ideas, unless those ideas become paid solutions (Chesbrough, 2006 p. 143).

Understanding innovation intermediaries' business models

Although no consistent definition of business models can be found in the literature, most scholars emphasize the relevance of value creation and capture mechanisms. On the one hand, value creation (or value proposition, as it is also known) refers to the articulated logic, method or services offered to customers. On the other hand, value capturing refers to the design of the internal revenue and cost streams for delivering the created value (Chesbrough, 2003, Johnson et al., 2008, Morris et al., 2005). Value capturing is the process through which a firm generates profits by creaming off some of the value created. Besides value creation and value capturing, there are four other dimensions in a business model. We adopt the definition of business models proposed by Teece (2010). He defines business models as:

> "…the design or architecture of the value creation, delivery and capture mechanisms employed. The essence of a business model is that it crystallizes customer needs and ability to pay, defines the manner by which the business enterprise responds to and delivers value to customers, entices customers to pay for value, and converts those payments to profit through the proper design and operation of the various elements of the value chain (Teece, 2010)"

Recently, the design of business models has attracted scholars' attention because it entails highly complex entrepreneurial and managerial analysis of market opportunities. By the same token, early-established innovation intermediaries identified the opportunity created by the increasing technical capabilities of external suppliers and the need to rein in the soaring costs of technology development (Chesbrough, 2003, 2007). Innovation intermediary platforms were conceived as a way of tackling closed innovation problems through innovation networks for matching innovation needs from innovation seekers (e.g. P&G, Unilever) and capabilities embedded in innovation solvers.

Innovation intermediaries' business model

The literature on two-sided markets, technology markets and the few open innovation publications covering intermediaries have provided some interesting insights on their role and functioning. This section analyses the business model of these platform providers and will furnish a detailed picture of how innovation intermediaries create and capture value and how they can compete effectively.

Let's first have to look at some particularities of platform providers. First, the choice of a business model for innovation intermediaries takes into account price structure as the central plank in the revenue model because a) cost and revenue come from both sides (Eisenmann et al., 2006); and b) breakdown and allocation of transaction fees matter to the success of a platform (Rochet and Tirole, 2003). Second, the design of business models has to identify ways of fostering network growth on both sides of the market – posing a "chicken & egg" dilemma (i.e. platform success depends on having a large, diverse pool of solution providers but these are only interested in the network if it contains a large number of innovation seekers).

The rise and growth of technology markets not only drove the emergence of new innovation intermediaries but also fostered value creation for their customers and ways of creaming off part of this to build a profitable business. For example, in two-sided markets, intermediaries could create value by either offering an established community of solution providers (e.g. InnoCentive, NineSigma, IdeaConnection.com) or providing an IP merchant bank set-up between inventors and organizations (e.g. Ocean Tomo). According to Teece (2010), business models deserve more attention from both scholars and practitioners. Although remarkable contributions include research on contingency factors (Zott and Amit, 2007) or categories (Chesbrough and Rosenbloom, 2002, Johnson et al., 2008, Morris et al., 2005), scholars in organizational, strategic and marketing sciences still consider business models simply are not necessary to understand strategic management (Teece, 2010). This section highlights the relevance of research on business models through the discussion of breakthrough insights and major categories for comparing and analyzing business models.

Exploring business model characteristics

The overall architecture, strategy and growth potential of business models can be studied in detail using the following six functions (Chesbrough and Rosenbloom, 2002, Johnson et al., 2008, Morris et al., 2005).

- *Value creation* refers to the characteristic mechanisms or processes designed to satisfy customer demands. These are grouped under four value creation drivers (Amit and Zott, 2001). First, the novelty-centered business model design is associated with a firm's ability to link previously unknown parties through new transaction mechanisms (Zott and Amit, 2007)". Second, efficiency-centered design refers to mechanisms for cutting transaction costs. Third, called "lock-in" covers ways of ensuring external partners engage in repeated transactions through trust-based relationships with customers. Fourth, the complementary driver covers the gain to customers' from bundled products or services;

- *Value capture* or revenue architecture refers to managers' decisions and mechanisms for assigning prices and exacting payment;

- *Value chain* denotes the internal and external resources, competences and processes needed to meet customers' demands. Resources include people, technology, equipment, information channels, partnerships and alliances (Johnson et al., 2008);

- *Market segment* covers market size, matching the firm's goods and services to: market volume, current and future customer requirements, geographic and demographic characteristics;

- *Value network or ecosystem* refers to managers' identification of the main co-operative and complementary points of differentiation to enable sustainable, non-imitable arrangements among suppliers, customers and competitors;

- *Competitive strategy* refers to managers' decision regarding present and future activities for securing and sustaining competitive advantage over their competitors

We will use these six functions to describe the design/architecture of value creation, delivery systems, and value capture mechanisms in the business models of various innovation intermediaries. This should give us a more detailed picture of how they deliver value to customers on both sides of the market and how they generate profits by setting price and cost structure. Before we apply business models to these intermediaries, we shall explain in the next section how we selected the innovation intermediaries.

Research design

Sample selection

The literature review suggests innovation intermediaries are broadly understood as any organization acting as a broker in the innovation process (Howells, 2006) or offering services in the field of open innovation (Diener and Piller, 2010). This leads to the wrong assumption that third parties act as (open) innovation intermediaries in technology markets. Examples of the former kind of intermediaries include technology transfer offices, science parks and incubators. Although groundbreaking research (Becker and Gassmann, 2006, Hargadon and Sutton, 1997, McAdam et al., 2006) has explained how these third parties facilitate innovation, little attention has been paid to innovation intermediaries acting as two-sided innovation platforms (praiseworthy exceptions are Verona et al., 2006; Lichenthaler and Ernst, 2008).

Although we interviewed a large sample of the aforementioned intermediaries for this paper, we decided to include only those innovation intermediaries co-ordinating the flow of innovation requests and solutions between distinct, distant and previously unknown innovation actors. As such, our definitive sample included 12 innovation intermediaries (see table 9) that were analogous in facilitating innovation and not engaging in design or other non-innovation related activities. We not only drew upon a sample that excluded other kinds of intermediaries but also searched for sufficient heterogeneity regarding the

stage of the development, type of challenges solved, the provision of complementary services, and size (number of staff or size of network).

Table 9: Sample of innovation intermediaries

No.	Intermediary	Gathering
1	NineSigma (U.S.A.)	Long interview
2	IdeaConnection.com (U.S.A.)	Long interview
3	Innoget (Spain)	Long interview
4	Yet2.com (U.S.A.)	Long interview
5	InnoCentive (U.S.A.)	Profile check
6	BIG - Big idea group (U.S.A.)	Profile check
7	InnovationXchange (Australia)	Profile check
8	TekScout - UTEK (U.S.A)	Profile check
9	Pharmalicensing – UTEK (UK)	Profile check
10	Yourencore (U.S.A.)	Profile check
11	Ocean Tomo (U.S.A.)	Profile check
12	Creax (Belgium)	Profile check

Data Collection

Two data-gathering methods were employed. First, we conducted extensive interviews at 4 innovation intermediaries firms with senior managers including CxOs and R&D directors of innovation areas. All interviews were face-to-face and lasted at least an hour, providing respondents plenty of time to explain the various business model functions. Finally, interviews were transcribed via interview notes (McCracken, 1988). Second, we carried out a profile check on the remaining innovation intermediaries, checking from publicly available sources, including company websites and press reports on the firms' business activities. This information came from two sources: a) researchers explored and presented the business model functions from different innovation intermediaries; and b) they reviewed the analysis provided and validated the responses with further checking of additional information sources. This method improved the reliability of replicable findings (Yin, 2009) and strengthened the convergence of perceptions.

Analysis methods

For this paper, we adopted techniques for cross-case analysis (Miles and Huberman, 1994, Yin, 2009) to explain the business model functions of innovation intermediaries. We used analytical techniques of pattern matching to connect the 6 business model functions (Chesbrough and Rosenbloom, 2002) with the collected data. This inferential approach was chosen for this research in the absence of any alternative approach for explaining and comparing business models. The aim was to bring forward business model functions and match our data to explain the characteristics and differences between various kinds of intermediaries. Finally, we triangulated and integrated the data and clarified the major categories of innovation intermediaries.

Results

Innovation intermediaries help companies in search for technologies by taking away the expensive search process for solutions to their needs and facilitating managerial access to external technological solutions. For people or organizations with possible solutions they provide a window of opportunity to monetize their technology or idea. Our analysis of 12 intermediaries' business models reveals an ongoing evolution in their content, structure and governance mechanisms as well as their range of activities, customer segments and price structures. The results of our data analysis are presented in table 10 where the different functions of the business model are discussed.

Table 10: Business model functions

Name	Value Creation	Value Capture	Value chain	Market Segment	Value network	Competitive Strategy
NineSigma	*For seekers*: brings in external solvers to provide solutions on a confidential basis; supports selection and development of solutions	*From seekers*: fees for posting and solution finding. Consultancy services (deal brokering, training, development)	Large network of innovation solvers, open innovation consultancy services	Around 300 companies globally	Collaboration with industry associations and new solution providers	Network size: focuses on building a large innovation network and adds consultancy services
	For solvers: provides a platform for selling and adapting their current technologies	*From solvers*: no transaction or membership fees		2 mio. qualified solvers: industry, academia and govmt. labs & private research institutes.		
InnoCentive	*For seekers*: brings in external solvers to tackle challenges, licensing; supports selection, transfer and development of solutions	*From seekers:* fixed fee to post a challenge and variable fee for successful solutions to transfer IP; consultancy and training	Large network of innovation solvers and open innovation consultancy	Private and public companies seeking solutions in 60 scientific disciplines e.g. P&G, Unilever	New alliances with public & private companies, universities and foundations e.g. SAP, NASA, Rockefeller Foundation	Network size: focuses on building a large innovation network and adds consultancy services
	For solvers: A platform for solving a conceptual challenge and transferring their technologies	*From solvers*: No fees are requested		Over 200 thousand qualified solvers		
Yet2.com	*For seekers*: Platform to acquire or license-in technologies	*From seekers*: Fixed fee to post a tech. need and variable success fees, advice on IP licensing, acquisition and analysis	Large network of innovation solvers and seekers and virtual matching platform	Large (Fortune 500) and small companies seeking or selling technologies. Approx. 100 thousand subscribed users	Strategic partners and company relationships	Differentiation strategy: efficient IT matching platform
	For solvers: Platform for anonymously licensing out technologies	*From solvers*: fixed membership fee and variable commission				
Innoget	*For seekers*: a Spanish network of innovation solvers; idea pooling	*From seekers*: no fee for posting challenge but a percentage taken of awarded contracts	Problem in platform scalability and consultancy services	Spanish market and size growth through international alliances	Alliances with other technology transfer intermediaries e.g. Yet2.com & innovation consultants	Differentiation strategy: offers services in the Spanish innovation market
	For solvers: provides a platform to solve international innovation challenges	*From solvers*: No fees are requested		Engages Spanish scientists		

Pharmalicensing - Utek	*For seekers*: supports in-licensing, partnering search and business development	*From seekers*: business develop. services; other services i.e. portfolio intelligence, striking deals	Benefits from Utek's network of innovation seekers and solvers; efficient matching platform	Companies interested in: deal-negotiation; in-licensing, portfolio intelligence	Alliances and partnerships with established science specialist in new markets; Utek's support	Differentiation strategy: provides an efficient IT platform
	For solvers: supports out-licensing within scientific fields	*From solvers*: profiling variable payment or fixed fee; variable success fee		Companies out-licensing in different industry sectors		
TekScout - Utek	*For seekers:* advice on and screening of innovation challenges	*From seekers:* an up-front posting &variable success fee; consultancy services	Benefits from Utek's network of innovation seekers and solvers	Innovation solvers from scientific companies, over 2000 universities, national labs, UTEK's innovation network	Utek as principal corporate partner	Network size: focuses on building a large innovation network
	For solvers: outlet for technology entrepreneurs	*From solvers*: No fee				
Big Idea Group (BIG)	*For seekers*: receives a compilation of low-tech prototypes	*From seekers*: The price of acquiring a low-tech product	Network of solution providers; access to present ides to large companies	Companies in consumer products and technology devices	Collaboration with communities of heterogeneous inventors	Differentiation strategy: innovation process comes from innovation solvers' side
	For solvers: Evaluates, improves, protects inventions & match them with companies	*From solvers*: keeps a portion of royalties from sold or licensed solutions		International community of 13,000 innovation solvers		
IdeaConnection.com	*For seekers*: creates groups of innovation solvers to work on confidential inventions	*From seekers*: percentage of award from accepted solutions; fee for posting available technologies	Automated software platform to assign solvers to challenges	Few S&P 500 companies and SMEs	Coordination with external consultants and other open innovation intermediaries i.e. InnoCentive	Hybrid: size of its network is smaller than established intermediaries & differentiates with the process
	For solvers: Alternative mechanism to use their knowledge and expertise	*From solvers*: No fee for providing solutions; fixed fee for posting technologies on sale		'Thousands' of solvers with prior experience, distributed in Western Europe, U.S., India		
Innovation Xchange (IXC)	*For seekers:* receives tech. solutions from member partners to early-stage challenges	*From seekers & solvers:* charges an annual searching service fee	Tailored identification of existing solutions among network	Members of IXC are simultaneously seekers and solvers of potential solutions	Collaboration with American companies to create new	Differentiation strategy: method to solve innovation problems

	For solvers: offers opportunity to license or sell proprietary IP to other trusted network members		partners	for early-stage innovation challenges	market opportunities and economies of scale	
Creax	*For seekers:* offers a platform to solve problems by searching & filtering existing patent databases; provides insights on market potential & patent strategy	*From seekers:* up-front agreed amount based on number searching hours; software solutions for idea generation, knowledge transfer, etc.	Platform and support to match IP	Large and small manufacturing firms in 8 different sectors	Employees in India (70 ICT specialists responsible for restructuring and updating patent database, public institutions, universities	Differentiation strategy: IT to identify technological applications in market for technologies
	For solvers: identifies potential market or applications for new solvers' products, technologies and materials	*From solvers:* No transaction fee for giving solutions; up-front amount for market studies		6000 established private companies (300 blue chip, universities & research institutes		
YourEncore	*For seekers:* access to communities of solvers capable to work on specific projects; create forums to discuss questions, documents, etc.	*From seekers:* fixed amount for a challenge; complementary consultancy services	Efficient platform to match seekers' demands with solvers; large network of innovation solvers	A list of over 50 member companies i.e. P&G, Lilly, Boeing	Member companies as solvers and investors in Yourencore	Differentiation strategy: services offered by highly qualified retired innovation solvers
	For solvers: provides retirees to use their expertise on projects of their interest	*From solvers*: No fee is charged for solving problem		Around 6000 retired experts from over 800 companies, universities		
(ICAP) OceanTomo	*For IP buyers:* opportunity to obtain advice and acquire IP anonymously	*For IP buyers:* IP auctions demand a buyer's premium; no fee for brokerage transactions	Efficient platform to match IP technology requests from buyers and sellers	Investors or companies interested in acquiring IP	Strong relationship with ICAP and Ocean Tomo	Differentiation strategy: IT platform to exchange IP
	For IP sellers: offers liquid auctions to exchange IP; 'hands-on' approach to sell IP	*From IP sellers:* fixed listing fee; commission on transaction fee		Sellers of IP i.e. inventors, companies, govmt. agencies, etc.		

Value creation

One of the central functions of a business model is that it has to create value for a targeted customer group. A characteristic of innovation intermediaries is that they have to create value for customers on the two-sides of technology markets. On the one hand, value is created for innovation seekers by offering: a) access to organized external networks of qualified solution providers to solve confidential innovation challenges or partnering for business development opportunities; b) transfer or license opportunities of IP or technologies; and c) services to develop external technologies and embed open innovation within organizations. On the other hand, value is created for solvers when an innovation intermediary enables them to: a) apply their knowledge to technological challenges; b) sell or license proprietary technologies; and c) identify possible market applications for existing technologies.

Our results reveal two value creation drivers (Zott and Amit, 2007) predominated in early-established innovation intermediaries – e.g. NineSigma, InnoCentive, Ocean Tomo, and Yet2.com. We observed novel transaction mechanisms between innovation solvers and seekers that are exploited by two-sided innovation intermediaries in technology markets. By the same token, innovation intermediaries created value through the complementary services needed to identify and develop solutions for innovation seekers. However, innovation intermediaries could not establish 'lock-in' mechanisms because both innovation seekers and solvers are able conduct multi-homing and, as a result, innovation intermediaries lack market power.

The innovation intermediaries not only create value through enabling and managing the transactions between the two sides of the market. As a middleman they can offer other advantages to their customers. First, firms making use of the services of innovation intermediaries can stay anonymous to solution providers (and competitors active in the same innovation field). Firms seeking a solution may disclose their technological weaknesses to (potential) competitors when they search for external solutions. These weaknesses or white spots are difficult to conceal in bilateral relations between solution seekers and providers. This problem can be alleviated in triangular relations when a solution seeker works with an intermediary between. Similarly, (large) innovation seekers may prefer to stay anonymous in order to conceal their buying power. Next, innovations intermediaries may also help solution providers in guaranteeing a fair return and legal protection of their invention. Finally, as we

have mentioned before, innovation seekers should protect themselves from contamination: An innovation intermediary can insulate client firms from unintentional exposure to external ideas (Chesbrough, 2006).

Value capture

Innovation intermediaries have to capture part of the value they generate for their customers. We found that in most cases they subsidize the participation of innovation solvers to boost the number of solutions for innovation seekers. This is especially the case when the chance to find interesting solutions is small and, as a result, the number of solution providers has to be larger. Although this price structure is a typical characteristic in two-sided markets, value creation for innovation intermediaries occurs mostly when successful innovation seekers obtain results from their transaction with the innovation intermediary. Innovation intermediary platforms capture value from innovation seekers through: a) a percentage or a fixed fee from the contract awarded to winning innovation solvers; b) up-front posting fee to send an innovation challenges to external networks; and c) consultancy services. Table 10 showed that in most cases, innovation intermediaries do not capture value from the supply side because solvers' participation is subsidized to increase the likelihood of a successful solution for innovation challenges. Our results reveal, however, some intermediaries (i.e. Pharmalicensing, Yet2.com and ICAP Ocean Tomo) have price structure mechanisms for capturing value from innovation solvers (IP sellers) by: a) charging a success fee or fixed commission for licensed transactions to innovation solvers; b) posting their available technology offers or profile; and c) charging an annual membership fee.

Value chain

The value chain of innovation intermediaries denotes internal or external resources or processes needed to meet innovation seekers' and solvers' demands in two-sided markets. We observe that established innovation intermediaries have similar value chains to nurture their 'orchestrating' role in two-sided technology markets. First, strong network externalities are needed to engage large communities of innovation solvers capable of solving innovation challenges. Established innovation intermediaries draw on a large community of innovation solvers, which increases the likelihood of an innovation seeker getting a useful solution. Smaller intermediaries lack large networks of innovation solvers and have to make up for this through advertising or strategic alliances to receive innovation challenges from companies.

Intermediaries can increase the number and diversity of innovation solvers through free membership, offering training, a large pool of innovation seekers with deep pockets, exposure for winning inventors, etc. In its turn, a large network of solution providers will attract more solution seekers.

Second, established innovation intermediaries may enlarge their internal resources to provide open innovation consultancy services to facilitate the identification, selection, development and market commercialization of technologies, whereas smaller innovation intermediaries outsource these services to other firms. A typical service innovation intermediaries offer is the identification of an appropriate business challenge for intermediation and its transformation from a tacit problem into an explicit request that is independent of technological domains, applications or industries.

Innovation intermediaries' value chain also entails an efficient information channel to facilitate the matching of specialized technology offers and requests. Usually, this resource is complemented with a rich patent database and services related to patent analysis. Finally, our analysis of the 12 intermediaries also reveals innovation intermediaries' will make improvements on the value chain including: a) improvements in software matching and codifying mechanisms; b) provision of new innovation services; and c) internationalization of its operations through new subsidiaries or collaborative alliances.

Market segment

In two-sided technology markets, innovation intermediaries are driven to raise the size of innovation-solver and seeker communities to foster cross-side network effects and create value for innovation processes. The innovation seekers' side of the market includes Blue Chip companies, not only those ranked in S&P 500 and Fortune 500 but also large companies engaged in research and new product launches in Europe. In theory, SMEs can be clients to but the up-front posting fee is usually too high for them. We can expect that the market for SMEs will take off once the brokering processes can be standardized. The innovation solvers' side of the market includes: private organizations; university and government labs; private and public research institutes; retirees from various sectors from around the world. A characteristic of innovation-solver communities is their large number and ability to work for several innovation intermediaries at the same time. Innovation solvers work independently

from each other, but intermediaries can change the business model and enable solvers to get connected to each other to make teams and improve the average quality of the solutions.

Value network

Innovation intermediaries continuously search for strategic alliances with new external actors on both sides of the market. On the one hand, strategic co-operative arrangements with foundations, large companies or public institutes encourage more innovation solvers to join the innovation-solver community. On the other hand, complementary arrangements with a broader range of innovation consultants; technology centers and other international innovation intermediaries enhance the service provided for innovation seekers.

Competitive strategy

This section presents mechanisms used by innovation intermediaries to outcompete other competitors in market for technologies. Accordingly, the two major activities are:

- *The relative network size, quality of the solutions and services of an innovation intermediary in comparison with other intermediaries determines its competitive advantage.* The largest intermediaries have a competitive advantage because cross-side network effects increase when the networks at the two sides of the market increase. To the extent that network effects and increasing returns to scale play a role, it is important to develop a first mover advantage. As a result, innovation intermediaries will do all the necessary to expand. Utek demonstrates this with the acquisition of Pharmalicensing.com, TekScout and Innovaro: This intermediary increases its network size by acquiring smaller innovation intermediaries. However, smaller intermediaries can successfully compete through a differentiation strategy;

- *Differentiation strategies for smaller innovation intermediaries.* A smaller intermediary or late entrant can face the superiority of large cross-side network effects of the larger intermediaries by introducing new brokering services. The market for innovation intermediaries that work, as a platform in two-sided markets is quite heterogeneous since offerings can be differentiated easily. Moreover, solution providers and seekers are free to practice “multi-hosting”. Differentiation may however lead to a crowded and non-transparent market where innovation seekers will

look for bundle services. In that case, large diversified intermediaries will become dominant players in the future

Alternative one-sided innovation platforms

Any analysis of innovation intermediaries should take into account the innovation portals set up by several large companies such as Procter & Gamble (P&G), Unilever, Starbucks, Kraft, Pfizer, Lego and Dell. Their corporate websites connect them directly with external innovation partners and form part of a strategic decision. As a result, these large firms take a two-pronged approach: they are clients of several innovation intermediaries and they have their own portals targeting external innovation partners. We try to unravel why companies adopt this strategy. What are the advantages of working with innovation intermediaries and when does it pay to have one's own portal?

An advantage of corporate portals is that the firm is no longer forced to play a single role but instead can relate to many kinds of external innovators at the same time. P&G, for instance through Connect + Develop (C&D), not only seeks technical solutions to its needs but also allows website visitors to see those technologies that have applications outside P&G's core products and markets. Yet2.com provides the search engine used on the company's website. Thus this strategy allows P&G to access an external network of clients, through the C&D, and simultaneously co-ordinate part of their challenges with several kinds of innovation intermediaries.

Of course, a portal only works for large companies with very strong corporate brands. It is no surprise to find that the companies involved in B2C activities are large ones with worldwide reach. Their brand names are sufficiently well known to attract large numbers of potential external technology partners. B2B companies would find it much harder to set up a comparable network. Likewise, smaller firms would also find it tough if not impossible to create a network that was large enough to be worthwhile. The difference with communities of users established by many (small) companies is that a technological community has to be large and global in scope to be effective. By contrast, small regional user communities may still be viable.

Organizations with a portal also benefit from their direct contact with the innovation community. This is the case when an organization is looking for technologies for which no strategic information is revealed on its web site dissemination. It can search for solutions on a

permanent base instead of working on a project with an intermediary within a relatively small time frame. Similarly, it can advertise the technologies it wants to sell or license and shape the contract in a way that benefits both parties. However, this should not blind one to the advantages to working with intermediaries. First, companies have to rely on these where anonymity is required. Organizations seeking a technological solution or selling a technology do not want competitors or investors to zero in on them. Moreover, intermediaries can play a crucial role in solving the problem of contamination. An innovation intermediary may have a much larger network of solution providers or its network might differ in some important way from that furnished by the client's own portal. Hence a firm can still benefit from working with intermediaries even when it has its own portal. While the aforementioned companies aim to become the solution providers of choice, many potential partners are scared of contacting a large corporation that has many irons in the fire. Given that the company screening a proposal may also be the potential buyer, many solution providers opt to work only with neutral intermediaries. Some companies such as Dell and Starbucks use their portal mainly to get feedback from users. It is an interesting way of keeping in touch with users and gleaning direct feedback on the firm's products and ideas. It also generates ideas for new product launches.

Conclusions, limitations and future research

Open innovation implies that companies make much greater use of external ideas and technologies in the development of their own products and businesses, while they let their unused ideas be used by other companies (Chesbrough, 2006). Open innovation offers the prospect of deploying firms' knowledge bases more effectively, shortening the time to market, and lowering R&D costs and risks. However, as more external ideas flow in from the outside and internally developed knowledge flows out, problems concerning the co-development and transfer of knowledge become greater than ever. This study has focused on one particular problem, i.e. how companies seeking external technical solutions, IP, or other innovation-related resources can be helped in their search by innovation intermediaries. More specifically, we focused on the role of innovation intermediaries in two-sided markets (in contrast to agent-based intermediaries).

To analyze the role of innovation intermediaries described by Chesbrough (2006), we brought together various literature streams and applied the insights from each of them to explain the success of these innovation intermediaries in the open innovation landscape. We borrowed

insights from various literature streams such as the two-sided market literature (Eisenmann et al., 2006, Rochet and Tirole, 2003), technology markets (Arora and Gambardella, 2010b), and open innovation (Chesbrough et al., 2006). Combining these insights painted an interesting picture of the role played by intermediaries and how they create and capture value in two-sided technology markets. Ideas coming from the two-sided markets literature are useful to analyze the role of innovation brokers in greater depth. We also find that the literature on technology markets, which focused mainly on bilateral, IP-agreements should extend its attention into triangular IP-agreements where an intermediary mediates relations between sellers and buyers.

Next, we focused on the business models of 12 innovation intermediaries to get a more accurate picture of how they generate benefits for a specific group of customers and how they turn a profit in doing so. Our analysis reveals that innovation intermediaries contribute to open innovation by facilitating inter-organizational flows of knowledge in two-sided markets by providing a platform through which both sides can forge links. As predicted by the two-sided markets literature, innovation intermediaries typically subsidize the price-sensitive side of the market (usually solution providers) - especially when uncertainty is high and hence a large population of solution providers is needed to ensure a successful outcome. Since network externalities are important in two-sided markets, it is likely that innovation intermediaries will face fierce competition once market growth begins to slacken. It is a winner-takes-all competition and take-overs can be expected in the future. The consolidation trend will be further strengthened by the diversification strategies of larger innovation intermediaries. However, innovation intermediaries can differentiate, offer other kinds of services, specialize into different types of technology, or target other types of clients. As a result, new entrants may avoid head-on competition through differentiation. In contrast, solution seekers may prefer companies offering bundled services.

As open innovation becomes more popular, companies face a growing number of competitors with equal access to non-proprietary knowledge. Open innovation has become a competitive necessity and it no longer automatically confers competitive advantage. Innovation intermediaries are a powerful force for putting external innovation within the reach of every company. To earn returns from open innovation, companies must ensure their collaboration with innovation intermediaries dovetails with an overall innovation strategy. Firms' internal organizations should adapt to fast-changing services and the growing number of intermediaries offering them. The companies that profit from open innovation are those that

adapt their innovation processes and organizations in line with the new opportunities offered by intermediaries. In other words, open innovation in a company should be a dynamic process that co-evolves with changes in technology markets, which themselves are partly driven by the rapid growing possibilities offered by intermediaries and technology service companies.

Chapter V Intermediated external knowledge acquisition: the knowledge benefits and tensions[5]

In the wake of more distributed and open innovation models, innovation intermediaries have emerged to assist firm's external knowledge search in markets for technologies and ideas. This study argues innovation intermediaries also help firms to identify their specific innovation challenges and overcome the tensions of external knowledge search and acquisition. To support our framework, we interviewed innovation managers in Europe and the U.S. that have been using innovation intermediaries, conducted two months of field research and a survey directed to NineSigma's clients. The main findings are: i) the six phases and knowledge practices in the innovation intermediation process; ii) the intermediated knowledge practices that assist clients through the articulation and codification of knowledge; and iii) the capabilities innovation intermediaries develop to articulate and codify knowledge-seeking firms' knowledge that make them more cost-efficient than the knowledge-seeking organizations themselves in organizing these learning processes and therefore are better positioned to subsequently search in web-mediated communities.

Keywords: innovation intermediaries, open innovation, external knowledge acquisition, dynamic capabilities, process research

Introduction

Recently, the process of how firms acquire external knowledge became a central point of research (Caloghirou et al., 2004, Cassiman and Valentini, 2009, Cassiman and Veugelers, 2006). However, external knowledge acquisition not only requires internal learning mechanisms (Cohen and Levinthal, 1990, Zollo and Winter, 2002) but also capabilities to monitor external knowledge and overcome acquisition barriers in technology markets (Arora and Gambardella, 2010b, Graebner et al., 2010). Firms lacking these two capabilities are unable to identify and recognize knowledge that is applied in other contexts, disembodied from its technology (Gans and Stern, 2010) or may even risk being overloaded with large amount of sources of external knowledge (Laursen and Salter, 2006, Leiponen and Helfat, 2010).

Currently, in the wake of more distributed and open innovation models, innovation intermediaries have emerged to assist firm's external knowledge acquisition in technology and idea markets (Dushnitsky and Klueter, 2011, Jeppesen and Lakhani, 2010, Sieg et al.,

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2010). Such organizations connect the supply and demand sides of the market, forging links between firms searching for external knowledge (knowledge seekers) with communities of solution providers (knowledge solvers) (Chesbrough, 2006). For instance, NineSigma's business model is designed to create value for its customers in three ways: First, it rapidly connects innovation seekers with distant and valuable potential external sources of knowledge that have novel approaches to solve their technological challenge. Second, it creates value by facilitating the project selection, evaluation and integration of external knowledge to increase the success rate. Thirdly, and not explored yet, it helps clients to transform their specific 'tacit' technological challenge into an 'explicit' scientific document to be disseminated to external technological and scientific communities.

The interest of this research is on explaining the tensions and opportunities when acquiring external knowledge by presenting a setting where innovation intermediaries help firms to identify, articulate and codify external knowledge. This is an alternative explanation to principal frames such as alliances and partnerships, supplier relations and complementary to initial network benefits mentioned in the innovation intermediary literature. Hence, this multi-staged study investigates the following research questions: a) how do firms acquire external knowledge using an innovation intermediary?; b) what are the knowledge processes involved when companies make use of the services of an innovation intermediary?; and c) what are the cognitive tensions and benefits to the adoption of an intermediated knowledge process? To answer these questions, the researchers interviewed and received archival information from 21 innovation managers from 18 different companies in Europe and the U.S., conducted two months of field research at NineSigma in Cleveland, OH and launched a survey to verify the degree of the qualitatively collected information.

We respond to the first research question based on a longitudinal process study and describe the knowledge practices and actors involved in the six stages of the knowledge intermediation process. For the second question, we use Zollo and Winter's (2002) framework, and show how team's technological request is articulated and codified to facilitate firm's external knowledge search process. Finally, to answer the last research question, we disentangle the cognitive tensions and benefits of using an innovation intermediary in order to shed light on the determinants of the boundaries of the firm. We suggest that this in-depth study contributes to the literature by addressing calls for research on external knowledge acquisition and open innovation, where we propose that knowledge articulation and codification undertaken by

knowledge seekers, in collaboration with intermediaries, create opportunities for reduced scope of the boundaries of the knowledge-seeking firm.

This paper is structured as follows: the next section presents the previous literature on external knowledge sourcing and innovation intermediaries. Section 3 discusses our research design, followed by a detailed explanation of the intermediated external knowledge acquisition process (section 4). Section 5 discusses the knowledge processes and the implications of using an innovation intermediary. The last section wraps up the main conclusions; we discuss some managerial implications and formulate suggestions for further research.

Literature review

Intermediated external knowledge

Frequently, individual innovation scouts, gatekeepers or boundary spanners perform firms' external knowledge search in technology markets (Fleming and Waguespack, 2007, O'Mahony and Bechky, 2008). For example, Procter&Gamble encourages its technology scouts to participate in conferences and be active in innovation networks to look internationally for novel products and potential partners (Huston and Sakkab, 2006). Alternatively, firms might be involved in long-term relationships with external science parks, research centers, incubators and consultants (Hansen et al., 2000, Hargadon and Sutton, 1997, Winch and Courtney, 2007) to perform functions beyond simple information retrieval and dissemination (Benassi and Di Minin, 2009, Howells, 2006, Tran et al., 2011). A central drawback of internal gatekeepers or external innovation facilitators lays, however, in their limited ability to gather information from distinct technology and idea markets that are far from the locus of the problem's need or invention (Arora and Gambardella, 2010b, Gans and Stern, 2010). In the last decade, the relevance of markets for technology has grown as it improves the efficiency and division of labor between those licensing their technology and firms seeking to integrate it to new products or business (Arora and Gambardella, 2010b). Graebner et al. (2010) explained that searching for knowledge in technology markets involves unique features and challenges during pre-acquisition and post-acquisition phases i.e. information asymmetry, confidentiality and knowledge contamination.

Recently, Lichtenthaler and Ernst (2008a) and Benassi and Di Minin (2009) explained firms could use innovation intermediaries to complement firm's open innovation activities in

technology markets and remove managerial barriers such as searching and selecting external knowledge, information asymmetry. Further, numerous scholars raised the attention of an emerging kind of innovation intermediaries (e.g. NineSigma, Innocentive, YourEncore, Yet2.com, Innovaro) that apply a business model where they facilitate and orchestrate the interaction between firms searching for external knowledge and those offering it (Jeppesen and Lakhani, 2010; Dushnitsky and Klueter, 2011; Chesbrough, 2006).

This type of innovation intermediaries are beneficial for established technology and idea markets as they create value using a Web-mediated model to engage a large set of knowledge solvers e.g. contract laboratories, retirees, university faculty, research institutes and technology-base companies (Sawhney et al., 2003, Verona et al., 2006). Also, these guide firms – knowledge seekers– to acquire external knowledge from potential respondents – knowledge solvers– by using a proprietary process of external knowledge acquisition. It has also been suggested that these intermediaries reduce the costs and accelerate the speed of obtaining unexpected solutions or new product concepts, create new company connections outside the original technological problem, and field of expertise and contribute to the creation of knowledge from a broad range of solution providers (Huston and Sakkab, 2006).

Most studies on intermediaries in two-sided markets have emerged from research on network externalities and multi-product pricing (Eisenmann et al., 2006, Parker and van Alstyne, 2005, Rochet and Tirole, 2003). According to Rochet and Tirole (2006 p. 664-665) "a market is two-sided if the platform can affect the volume of the transactions by charging more to one side of the market and reducing the price paid by the other side … The market is one-sided if end-users negotiate away the actual allocation of the burden … ; it is also one-sided in the presence of asymmetric information between the buyer and the seller, if the transaction between buyer and seller involves a price determined through bargaining or monopoly". Two-sided markets, according to Parker and van Alstyne (2005), require the interaction of three groups of actors; a group of technology buyers, a group of sellers and an intermediation 'platform' that creates tools or mechanisms for helping both parties strike a deal.

To the best of our knowledge, the activities performed by innovation intermediaries in bringing knowledge seekers and knowledge solvers, together in a triangular knowledge trading arrangement, has yet to be discussed within the open innovation literature. Thus, here, we define such innovation intermediaries thus as *"platform providers in two-sided technology markets created to co-ordinate the flow of explicit innovation requests and non confidential*

solutions". This definition tries to encompass different forms of two-sided innovation intermediaries i.e. patent brokers (Lichtenthaler and Ernst, 2008) and idea market places (Dushnitsky and Klueter, 2011) and excludes one-sided innovation intermediaries (Howells, 2006). Although a similar type of intermediaries is extensively studied in the literature of network externalities and multi-product pricing (Eisenmann et al., 2006, Parker and van Alstyne, 2005, Verona et al., 2006), there is a shortage of explanations of their role during the external knowledge search and acquisition process for new technologies.

External knowledge acquisition and capability formation

According to (Fosfuri and Giarratana, 2010) the past two decades have shown a rapid increase in the number of exchanges of technologies, ideas and services that created benefits for firms in search for external knowledge e.g. quick scanning of external available solutions, more heterogeneity among firms sourcing external knowledge. However, scouting and acquiring external knowledge demands overwhelming negotiation tensions between buyers and sellers of technologies (Graebner et al., 2010, Monteiro, 2011). Recent research suggested that the possibility to independently identify a useful solution diminishes at less than a dozen of contacted sources (Laursen and Salter, 2006, Leiponen and Helfat, 2010). Also, research has devoted some attention to explain the process of designing an innovation strategy that focuses on building new internal capabilities to acquire knowledge (Caloghirou et al., 2004, Cassiman and Gambardella, 2009, Cassiman and Veugelers, 2006). Particularly relevant are the internal capabilities required to sense external opportunities to acquire external knowledge that will emanate in sustainable competitive advantages for firms (Teece, 2007).

Previous research has explored the outcomes and motivations to acquire external knowledge (Almeida and Kogut, 1999, Chesbrough et al., 2006, Grant, 1996, Katila and Ahuja, 2002) and the steps subsequent to the identification of external knowledge e.g. acquisitions and alliances (Kale and Puranam, 2004, Vanhaverbeke et al., 2002). A striking feature of these findings is however that they offer limited empirical evidence about the processes through which firms search for solutions, evaluate and build capabilities to acquire external knowledge (Arora and Gambardella, 2010b, Laursen et al., 2010). While the function and impact of experience accumulation, knowledge articulation and knowledge codification in dynamic capability formation has been discussed elsewhere (Teece, 2007, Zollo and Winter, 2002), the literature on external knowledge acquisition has so far paid little attention to the influence of these learning processes on firms' decisions to use external parties for knowledge

acquisition and which learning processes that are involved. In this research, we utilize the opportunity of exploring unique data on an innovation intermediary to examine such issues further.

Zollo and Winter (2002) introduced a framework for analyzing the evolution of dynamic capabilities in firms that hinges on three learning processes: experience accumulation (of tacit knowledge), knowledge articulation and knowledge codification. Using the idea of a learning investment function, i.e. that firms need to invest in learning to accumulate capabilities, but that there are different cognitive efforts associated with different learning processes, they argue that deliberative learning primarily involves knowledge articulation and knowledge codification, two processes that are more cognitively demanding than experience accumulation. This implies that there are trade-offs to be made regarding the costs of such learning investments and the benefits accruing to each learning process. The framework proposed by Zollo and Winter has for instance been used to analyze inter-project learning in project-based organizations e.g. (Prencipe and Tell, 2001), inter-organizational knowledge transfer e.g. (Mason and Leek, 2008) and knowledge integration in distributed new product development teams e.g., (Enberg et al., 2006, 2010). In the following sections we discuss some of the processes, benefits and costs associated with experience accumulation, knowledge articulation and knowledge codification.

Experience accumulation

The vantage point for much theorizing on capability formation in firms is the nature of experience accumulation through experiential learning into practical know-how, emanating in organizational routines see e.g., (Levitt and March, 1988, Nelson and Winter, 1982)). Evolutionary neurologists as well as philosophers (e.g. Polanyi, 1958, Searle, 1992, Wittgenstein, 1969) have argued for the important role of subsidiary awareness and tacit assent in the evolution of human knowledge. In perceiving and knowing our world, we are not passively learning it, but actually constantly drawing upon sub-conscious processes and predispositions, which make us actively, hypothesize about the states of the world we are encountering (see e.g. Nightingale, 2003). One argument regarding the processes involved in tacit knowing recognizes that an important function of subsidiary awareness ("indwelling" as Polanyi called it) is that it allows the executor of a specific task to direct his/her attention to something focal (which consequently is not subsumed). Experience accumulation processes involve the internalization and assimilation of knowledge by the knowing subject, creating

foundational and taken-for granted assertions that allows for focal attention and experimentation. These processes form capabilities, skills and connoisseurship, both senso-motorical and cognitive (Balconi et al., 2007, Nelson and Winter, 1982, Polanyi, 1958).

The benefits associated with experience accumulation are well known. Utilizing focal awareness provides high returns to specific attention and execution that leads to the formation of distinct capabilities. Such capabilities provide ample opportunities for specialization among economic agents such as individuals, groups/units, and firms (Richardson, 1972). Such specialization facilitates learning by trial-and-error, since it allows for error-detection in response to environmental feed-back (Levinthal and March, 1993). Nickerson and Zenger (2004) denoted such processes directional search, which are primarily apt to problem-solving in less complex (decomposable) situations. Another, related, benefit lies in the creation of routines that serves as low-cost integration mechanisms, as routines imply that individuals need not know what others know in order to coordinate their activities (Grant, 1996, Nelson and Winter, 1982).

Some costs pertaining to experience accumulation relate to the local character of experience-based learning, i.e. that it is closely related to existing routines. Building on previously formed sub-conscious dispositions, routines are essentially rigid and difficult to change. Moreover, learning by doing is based on experience from actions where actors may have difficulties in drawing inferences to causality, since there is no explicit model of causality at hand. The knowledge developed by organizations in such situations, thus exhibits certain elements of procedural rationality, lacking conscious volition, signified by processes involving feed-back rather than feed-forward (Gavetti and Levinthal, 2000). In the same vein, Levinthal and March (1993) suggested that organizations run the risk of myopia, such as capability traps and superstitious learning. Such learning disabilities stem from the tendency of organizations to execute existing operational routines in response to all problems encountered, and the restricted range of alternatives that search routines may select from.

Knowledge articulation

Although there are evolutionary advantages to relieving the brain from conscious deliberations to background knowledge, the articulation of knowledge may serve important purposes in the strategic management of organizations. Through agents' abilities to express opinions and beliefs (Zollo and Winter, 2002), the ability to develop visions and the creation

of metaphors and analogies (Gavetti, 2005), cognitive processes drawing more global inferences and determining causalities are triggered. Such processes where agents are using theory, codes (language and pictorial representations), and tools (embodied knowledge, instrumentalities, memory tools), the conversion of tacit into explicit knowledge, the creation of codes are aimed at knowledge articulation (Hakanson, 2007). Knowledge articulation involves a cognitive effort towards the establishment of some causal inference such as, for instance, explanations, interpretations, models, rules, schemas and theories. Knowledge articulation processes thus involve the collective identification of rules and codes for inter-subjective translation (Balconi et al., 2007).

One important benefit accruing to knowledge articulation is a "mindfulness effect i.e. an increased ability to change operating routines. The elements of substantive rationality or logic of consequence involved (March and Olsen, 1989), allow for 'reflection-in-action' (Schon, 1983). By collective dialogue and discussion knowledge can be articulated by organizational members and an arena can be created for double-loop learning (Argyris and Schon, 1978). Knowledge articulation may improve the understanding of action–performance relationships and enable the creation of agreed upon representations (Grant, 1996). Further, knowledge articulation result in representations that help in disentangling cause-and-effect relationships. It may therefore aid in developing heuristic search i.e., search that is theory driven and helpful for problem-solving in complex (non- or nearly decomposable) settings (Gavetti and Levinthal, 2000, Nickerson and Zenger, 2004). Furthermore, the creation of such shared representations facilitates communication and knowledge integration amongst the actors using the concepts embedded in such representations (Foray and Steinmueller, 2003), and may form the basis for efficient group-problem solving and decision-making that serve as an important coordination mechanism in complex situations (Grant, 1996).

The costs relating to knowledge articulation can be cognitive, representational and social. The cognitive cost pertains to the efforts involved in "breaking the spell" of subsidiary awareness. In addition to these demands on cognition, knowledge articulation involves investments in formulation of symbols, codes, rules, language and other representations (Hakanson, 2007). Since such achievements aim for abstraction and completeness there is a cost of decontextualization (Balconi et al., 2007). Finally, in order to facilitate collective endeavors and shared meanings, knowledge articulation may involve social costs pertaining to for instance overcoming socially embedded interpretative barriers, social acceptance, legitimacy, and justification (Dougherty, 1992, Tell, 2004, Zollo and Winter, 2002).

Knowledge codification

Zollo and Winter (2002) argued that knowledge codification requires even higher cognitive efforts than knowledge articulation. As emphasized by Zollo and Winter (2002), the cognitive efforts of creating codified knowledge from what has been (perhaps) tacitly known involves creative elements (cf. Hakanson, 2007, Nonaka and Takeuchi, 1995) as well as the establishment of internal selection processes. The process of codification involves inscription using symbols and explication of relations among symbols (e.g. expressed in rules) into declarative propositions. The codification of knowledge thus implies the creation of exosomatic memory, brought forward in material linguistic and symbolic representations. Furthermore, knowledge codification involves an aim for completeness (Balconi et al, 2007) and abstraction. Albeit decontextualized, codified knowledge is dependent upon subsidiary awareness, context and background knowledge for its interpretation, use and actionability.

There are arguably several benefits of knowledge codification. One benefit stems from the logical structure implied by codification, making such knowledge inferential and also testable. When knowledge is codified into ”codebooks” (Balconi et al., 2007, Cowan et al., 2000), the aim may be to reveal links between actions and outcomes and derived causality. Foray and Steinmueller (2003) accordingly distinguished between two functions of knowledge codification. The first function is that codified systems of symbols allow for storage and transfer across time and space. The second function of codification is to allow humans to rearrange, manipulate and examine symbols and symbolic relationships in order to transform the underlying knowledge represented in such systems. Hence, not only is there an aspect of inscribing what is tacitly known involved in codification, but also, a higher effect of changing and creating knowledge. This feature of knowledge codification implies a search process similar to the one implied in science (Fleming and Sorenson, 2001, 2004). In situations characterized by very high complexity such search process should be favorable to find re-combinatory solutions.

Codification processes are also associated with much effort and high costs. Some costs are associated with the creation of an inscription technology, that is, the system of symbols and rules and the format used to convey these, and allow for public scrutiny. Also, there is a cost of re-contextualizing most codified knowledge. Another cost associated with the creation of

explicit rules is the rigidity implied, which may cause cost pertaining to lack of flexibility. Our review of these three learning processes emphasizes the processes and economic benefits and costs involved. One important extension of the arguments presented pertains to the organization of innovative efforts. In particular, how do these learning processes relate to external knowledge acquisition and the use of innovation intermediaries? In this paper we purport to analyze primarily the implications for learning processes involved as well the economic rationale for this mode of organizing innovation, using a case study of NineSigma and its clients.

Research strategy

Due to the lack of previous theory and limited research regarding the process how firms go about moving from internal to external knowledge acquisition when contracting an innovation intermediary, this research approach use grounded theory-building (Strauss and Corbin, 1998). This method allows for a close correspondence between data gathering and theory, a process whereby the emergent theory is "grounded" in the phenomenon (Eisenhardt, 1989b, Glaser and Strauss, 1967).

Research setting

Following an exploratory analysis of different two-sided innovation intermediaries (Lopez-Vega and Vanhaverbeke, 2010), we purposefully selected NineSigma (www.ninesigma.com) as it is the largest innovation intermediary in technology markets. Since 2000, it has emerged as one of the leading innovation intermediaries employed by firms to help them understand, codify and broadly search for external scientific and technological solutions or to identify new market opportunities from a coordinated growing network of potential knowledge providers. Since its foundation, it has guided around 350 Fortune 500 companies worldwide to arrange over 2,500 technology development projects across different industrial sectors.

Although other authors have centered on investigating a different type of intermediaries that are stronger in idea or patent markets i.e. Innocentive, YourEncore, Yet2.com, Innovaro (Dushnitsky and Klueter, 2011, Jeppesen and Lakhani, 2010, Lichtenthaler and Ernst, 2008b, Sieg et al., 2010, Tran et al., 2011). The research design for this manuscript centers on an in-depth single-case study where we used an embedded design through which we decided to

explore the main external knowledge acquisition practices used by numerous American and European companies.

Data Collection

From January to December 2010, the data for the case study was collected through telephone interviews and an ethnographic field study in Cleveland, OH. Data collection included interviews with NineSigma Program Managers (PMs) and solution seekers, observations and a survey. All these three data sources did not only enable data triangulation but also the analysis of the knowledge intermediated process.

Interviews

The first author conducted multiple interviews with 30 people, totaling 32 interviews overall (Table 11). Those lasted approximately one hour and were primarily semi-structured (McCracken, 1988) to portray the external knowledge acquisition process. Eleven of the semi-structured interviews were conducted (see the interview guideline in Annex 2), with different European and American NineSigma Program Managers (PMs) and unit directors, to comprehend the intermediated process and the role of different actors involved in the process. Most of PMs have an average experience of 3 years advising clients to select, evaluate and acquire external knowledge. The 7 interviewed PMs are experienced scientists with PhD degrees and are familiar with product development processes, so, they are acquainted with different knowledge search processes in different scientific fields.

The analysis of these interviews helped the researchers to design a second open-ended interview guideline to be used with knowledge seekers acquiring NineSigma services. Specifically, the designed guideline aimed to explore clients': a) decision to search for external knowledge; b) selection of alternative sources of external knowledge; c) problem formulation with NineSigma; d) evaluation and selection of external potential partners; and e) experience of barriers limiting the success of the knowledge intermediated process. A total of 21 semi-structured interviews were conducted with open innovation directors, R&D directors or innovation managers from global American and European companies to obtain an overall and confirmatory understanding of the innovation services used by clients. All these interviews were recorded and transcribed and informants provided additional archival information i.e. diagrams, charts. Although many of these materials were labeled as

confidential, they reinforced the overall understanding of the various interactions. Necessary notes were taken to explore whether novel initiatives were replicated at multiple companies.

Table 11: Innovation intermediaries: Interviewed companies

No. of interv.	Name of the organization	Position	No. of interv.	Name of the organization	Position
1	L'Oreal	Open innovation manager	1	Xerox	Xerox Fellow and Manager Open Innovation
1	Carl Zeiss AG	Senior manager scientific affairs	1	Kraft Foods	Sr. Assoc. Principal Scientist
2	Hallmark Cards, Inc.	Product Innovation Manager; Senior Engineer II	1	Ferrero	Packaging development director
1	BP PLC, Refining Technology	Process Tools and Analytics	1	Sherwin Williams	Technology Scout
1	Sealy	Senior Process Engineer	1	The Goodyear Tire & Rubber Company	Senior R&D Associate
2	Philips	Director Open Innovation; Senior Engineer Metals and Ceramics, Cluster Process Technology	1	Kimberly-Clark Health Care	Product & Technology Development
2	Akzo Nobel Decorative Coatings	Paints research associate; Open innovation leader	1	Sealed Air	Research Scientist (Open Innovation Manager)
12	NineSigma	Chief Executive Officer; Vice President, Strategic Programs; Chief Sales Officer; Vice President, Technology Solutions; Director- Global Programs at NineSigma; Director Technology Solutions; Principal Program Architect; Consulting and Sales Executive; Program Managers	2	3M	Senior Laboratory Manager & Laboratory Head; 3M Display & Graphics Laboratory
			1	International Copper Association	Assistant Director of Technology
			1	Rheem Manufacturing Co.	Principal Engineer

Observations

Additionally, observations helped to illuminate the taken-for-granted and process related nuances that interviewees might not be able or willing to share in interviews. Although the length of a project takes at least 6 months, the first author "in the field" was granted status of non-participant observer for 8 weeks of different projects and allowed to observe, listen to confidential conversations and interact with employees for five days a week. This experience provided insights from the client, solution provider and NineSigma perspective on every stage of the knowledge intermediation process. Further, over lunch, breaks and corporate meetings, the first author observed and listened to contributions, discussed and received feedback on his

work and analysis. During all these interactions, notes were taken and NineSigma PMs clarified the meaning of statements, decisions and reactions from clients.

Survey

A survey (see the full survey in Annex 3) was used to confirm the construct validity of the interviews. This survey had a response rate of 21,6% from North America, Europe, Asia-Pacific and Latin America (54 out of 250 companies). Most of the respondents have more than USD10 Billion in revenues and come from the food and beverage, industrial and chemical industries. These firms have collaborated with NineSigma between 2002 and 2011 and acquired between 2 and 57 NineSigma's intermediation services. The survey was divided in 4 parts to capture a) the expectations and outcomes of an intermediated innovation challenge; b) the evaluation of external knowledge processes; c) the knowledge crafting and search processes of NineSigma; and d) tentative enabling mechanisms to facilitate external knowledge acquisition.

Analytical approach

Because research on how firms go about acquiring external knowledge through an innovation intermediary is limited, an inductive process approach to explain the 'process' was warranted (Langley, 1999, Poole, 2000). This research design responds to the need to use process methods to explore – in real time – our central research question*: what are the knowledge processes involved when companies make use of the services of an innovation intermediary?* This research question was formulated to explore the sequences of events that unfold while the external knowledge acquisition occurs and increase our chances to identify changes which are not easy to identify in retrospective studies (Pettigrew, 1990).

Mapping the knowledge intermediated process

In order to analyze the process of external knowledge acquisition with the use of an innovation intermediary, in the first phase of the analysis, the authors wrote vignettes (Miles and Huberman, 1994) of an intermediation process and the possible actors involved. Further, from these vignettes and with help of NineSigma, we drawn a process map of intermediated knowledge acquisition consolidated into six phases (see figure 7). We selected these phases because of a clear "continuity in the activities within each period and … certain

discontinuities at [their] frontiers" (Langley and Truax, 1994). For example, once a project team has encountered a scientific problem that cannot be solved internally and can only be solved using external knowledge, the project team decides to use external knowledge from its innovation network or an innovation intermediary. In each stage, we highlighted the recurrent knowledge related practices. This process map, validated by NineSigma, helped to understand the actors involved in the innovation intermediation process and at what points in time, what each party had at stake, and how earlier decisions and actions affected subsequent decisions and interactions.

Identifying and comparing practices

In the second phase of the analysis, we identify characteristics for each stage of the intermediated knowledge acquisition process. So, we entered all the transcribed interviews, observation field notes, videos, archival information and survey results into the qualitative software named Atlas.ti. Following, we begun an iterative process of developing grounded codes (Boyatzis, 1998) and exploring the emerging knowledge intermediated process and testing initial findings. We alternated between coding and validating our codes among the authors and with NineSigma's PMs, the codes reached a level of stability at which they were mutually exclusive and comprehensive. In order to confirm the reliability of our working practices and coding, first, in table 12 we include the number of identified quotations for each identified working practice. Furthermore, table 13 shows the results of our survey necessary to classify the activities for each working practice. All these four sources of data, interviews, archival information, observations and a survey, allowed us to obtain consistent results out of the triangulate data and confirm our innovation intermediation process (figure 7) and proposed framework for intermediated external knowledge acquisition.

Knowledge articulation, codification and the search process

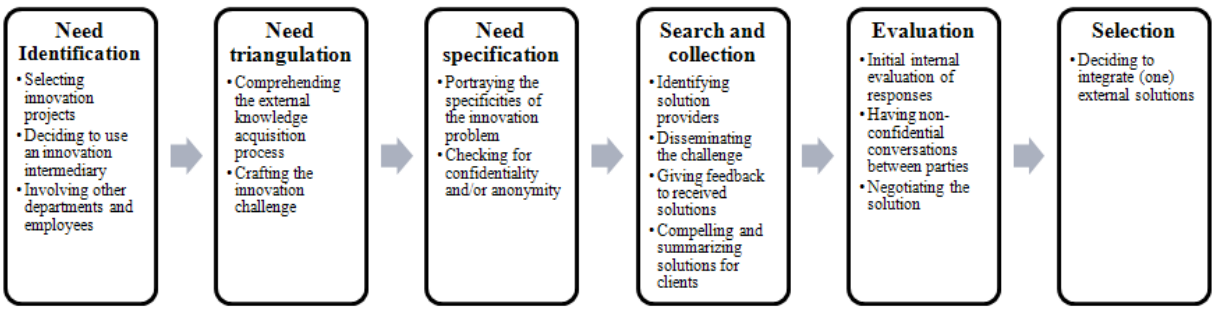
Relying on Zollo and Winter's (2002) established knowledge process model and the initial insights on the intermediation process (Jeppesen and Lakhani, 2010, Sieg et al., 2010), here, we developed a framework which shows the knowledge processes involved in the process of using an innovation intermediary. The review of previous practices allowed us to refine our understanding of the observed activities at the NineSigma and generate more abstract and generic categories and concepts. This analysis was then condensed into tables presented here. First, we identified the different practices of experience accumulation, knowledge articulation

and codification practices. As a result of this micro-level coding, we designed a process of external knowledge acquisition through an innovation intermediary, explaining the knowledge processes for the articulation and codification phases.

The knowledge intermediation process

Companies collaborate with NineSigma through its knowledge sourcing services like the Request for Proposal (RFP) to search novel solutions from a network of external solution providers interested in a collaborative partnership. Although in some circumstances this process (figure 7) is not completed for numerous managerial obstacles i.e. lack of an internal manager leading the knowledge acquisition process, we determined the success of a project will depend on carefully addressing different identified knowledge practices and six intermediation phases: 1) need identification; 2) need triangulation; 3) need specification; 4) search and collection; 5) evaluation; and 6) selection of solutions. Table 12 shows the substantiation of our analysis providing some of quotations emerging from the documents and the number of quotations. Further, table 13, shows the survey result for the identified working practices.

Figure 7: The intermediation process



Phase 1: Need identification

Prioritizing innovation projects

The underlying part of the intermediated open innovation process is the selection of projects to be advanced using external sources of knowledge. We observed that most knowledge seekers have predefined practices to select recurrent types of innovation projects that require the use of external sources of knowledge. The most common project selection methods correspond to the creation of a priority list based on ongoing demands from different business

units, the filtering of projects based on a set of established 'power' questions and the use of an unstructured discussion method among different departments. For example, an innovation manager commented " So, for a packaging research organization, I go out and talk to all our packaging leaders, technical leaders, … business units and assemble together a need list. We develop it in a non-confidential way and prioritize it". Less frequently used methods are internal rank and selection among previously filtered ideas or the use of an external consultant to facilitate with the screening of ideas.

Knowledge seekers try to identify scientific and technical problems that cannot be solved using the internal research or spelled out with the corresponding test-methodology or material and represent a priority for the company operations. At this stage, firms exclusively require the identification of a new knowledge provider to put the solution in place. For example, an innovation manager illustrated "I'd say that we use intermediaries for tactical problems where we know we've a particular need and we identified that internally. We don't have an expertise to deliver against that need ourselves. Then, we know that we need to partner with somebody externally to deliver on that, the question is how we find that external partner. We do various things to find an external partner, one of which is using an intermediary".

This stage is troublesome when firms avoid paying enough attention to the selection of the innovation projects or try to identify strategic products that are extremely complex – if not unrealistic. For example, a senior innovation manager says "Initially, we came out with 10 projects that we wanted to run through NineSigma and what happened was that it was done very quickly without care and the results were not that good, the first nine approximately. We made all the classical mistakes by starting out we were not realistic enough, too narrow, too much cost, a bunch number of classic things". Another senior manager at a technological organization explained "At the beginning, when [knowledge seeker] was hesitant of posting requests, we actually started with 'Holy Grail' questions that include things that were in people minds for years and impossible to solve … So, those request were already the ones that we knew it was almost impossible to reach and we did a few times".

Deciding to use an innovation intermediary

Once a firm decides to use innovation intermediaries to reach out solutions in unknown areas, accelerate the project timeline and have higher chances to close a contract with an external solution provider, the process continues with the selection of the most advantageous

innovation intermediary for the specific innovation challenge. For example, one of our respondents explained that when external solutions need to be identified "that is where all the tools come into play and discuss what specific need we have and try to match the [search] tool to that we need. So, if we are looking for a new technology we are not familiar with, I think NineSigma is a good choice because it gets a wide range of experts". Further, we observed that knowledge seekers familiar with the process tend to be more successful acquiring external knowledge as these have already an integrator mindset to combine ideas from different solution providers, draw attention and support from corporate management, promote the use of external technology, communicate open innovation successes and implement new directives. For this reason, experience with the intermediation process offers teams and business units the chance to understand the dynamics and embed the necessary practices to work with different innovation intermediaries.

An experienced fellow and manager of open innovation at one of the largest technological companies in US explained that "[the firm] has historically used intermediaries for a number of critical projects for something we don't know. It was run as a pilot to look around. So, one of the senior managers motivate us to engage in collaboration with NineSigma, then I had to do the due diligence to understand if we plan to spend resources, this is the right partner. So, we have meetings and we basically sign the contract for a fix amount and number of projects and we run the process". Thus companies with higher experience tend to be more organized when deciding to collaborate with innovation intermediaries and use them primarily when a successful outcome is deemed achievable. For example other manager explained "where we can define some very clear success criteria, we may use an innovation intermediary like NineSigma or other intermediary to help us identify potential vendors that have technologies that may of interest to us for the evaluation".

Involving other departments and employees

This part of the process attempts to involve personnel from other departments or business units i.e. legal, purchasing that could take part of the intermediation process and provide insights to reinforce the performance of the project. For example, one of our respondents told us "that means our marketing department has an equal voice on the type of projects that are brought to the end, so it develops different arguments for a project to reach the end and it's very difficult". In some organizations the project identification and selection occur at cross-departmental corporate levels. Other senior open innovation manager mentioned "so, we've

this executive group of innovation board which has a meeting, with marketing and R&D, to identify and prioritize problems and research projects. This is why we're doing OI [Open Innovation]. If we have 100 problems and if we're working on half of them inside, then people like me can begin to take the other half of the problems out to people outside [the firm] to begin to do a little bit of work. So, when we've space internally, we don't begin with an empty piece of paper."

Table 12: Innovation intermediation: Definitions and strength of evidence

Knowledge practice	Definition	Example	No. of quotations	Type of evidence
Phase 1: Need identification - Firm -				
Selecting innovation projects	Internal innovation challenges are selected to search for external knowledge	*The new projects we're identifying and seeking collaboration with NineSigma are the ones that we are working hard by ourselves and we through to the wall and cannot really solve the problem; it's a very specific area. We understand different things, basically we know what needs to be invented, but we don't know how to do it. We only go for projects high priority in our list* *We look for projects that have entry and exit milestones. What you expect achieve, how do you know you're succeeding or failing at this point. We've to know and need a clear understanding of the products we're funding*	45	PM, IS,SS
Deciding to use an innovation intermediary	From tentative types of innovation intermediaries one is selected to run the external knowledge search	*It's not a one size fits all when we select to work with them (NineSigma). I say, there are two instances to work with NineSigma. The first is to solve what I'm going to call long-term issues that we have. We have been working on problems and we are far from relevant avenues to look at. We approach NineSigma to see if they can provide us any new contacts that we need to look at or take us into a new area to solve that problem. That is one way; long-term issues that we have been working on and we look for fresh perspectives. Other way we utilize NineSigma or other technology services is if we know what we want and we just need a quick identification of a partner to help us to put into practice* *Open innovation seem to be a viable approach within an organization, it's been proven and NineSigma has demonstrated their efficiency and we decided to go with them. What NineSigma does is to go out there and through something –lots of bombs– and they identify the targets and allow us to hit them. We use NineSigma as a parallel process where we look our suppliers' chain, the trade organizations, universities and internally. We use NineSigma to expand our reach; again, NineSigma is a force multiplier because they allow us to use our existent resources and to amplify in cover a broader area*	28	PM, IS
Involving other departments and employees	Innovation champions create a cross-departmental team	*What you do internally has to be right before acting with other actors externally. What has to happen is: a) have the right people that are going externally who would be capable to do it internally, they have to have the money, technical expertise, the connections, enthusiastic, empower, everything that makes a project internally successful before you go outside. You can't imagine going outside to solve the problems if you didn't have first the ability to solve them internally. Going outside is a choice you made and you find something when you all the right things ... you cannot do things for those you don't have the internal capability to do. You've to have the good process and good people to do it* *External intermediaries are helpful but they can only help you up to certain level because there's a need for an appropriate internal infrastructure. Companies need to be successful, you've to have full engagement of internal resources and infrastructure, if you want to be successful*	14	PM, IS,SS
Phase 2: Need triangulation - Firm and NineSigma -				
Comprehending the external knowledge acquisition process	Includes explaining the roles, expectations and contributions of different partners	*They (project leaders) are helping me to formulate the questions; the challenge is a lot of the internal people expect the OI process to deliver the solution yesterday in a complete solution. So, it needs to be explained to them that we need to break the problem down and tackle the various bits of it and it may require a little bit of work to identify the solution and make it work. So, it's has been some work in explaining to people what the process is all about* *Each challenge that I work with NineSigma probably involves somebody who is new in the organization … so, I'll think, they teach them how to look for information and the one to use in a public sphere. I think the process itself is training our people. So, every challenge seems to engage new people*	16	PM, IS,ON

Crafting the innovation challenge	Iterative process to scientifically and technically narrow and broad the challenge	*The PM (Program Manager) was very useful because of her capability to translate the need as well as she was aware of the language that's been used. Then, she was able to translate it back to us, which then gave us a better means to write the RFP, detail the specific terminology or this specification because it's maybe confusing. She was able to interact with us and put the right words in a NineSigma solicitation because she was knowledgeable about what was going on in the field and to translate results to us. It was a two-way kind of thing* *I worked with NineSigma on 3 different Request for Proposals (RFPs) and, sometimes, all depends on how well your solutions maybe applicable to other projects. It's all about how you craft the RFP. When you write an RFP, you do not want to be too general that you get everybody to respond and you do not want to be too specific to get only few responses. The ideal combination is the mix of both characteristics. The financial incentive shows that you are serious and willing to spend money to solve a solution*	32	PM, IS,SS,ON
Phase 3: Need specification - NineSigma and Firm -				
Portraying the specificities of the innovation problem	Outlines 'clear', 'concise' and 'compelling' solutions that underline the business opportunity, tech. specifications, possible approaches, IP specificities	*We talk about, how to write the request in a language that is not industry specific and we focus on the fundamental science that way anybody who reads it can say ohhh!!, this seems as something I did for my discipline. So, it's a request for a food company but the solution comes from other some technical source. This particular project that we talked about, surface treatment and modification, is thought in a lot of different fields. We want to be specific about the need but we want to appeal to a broad audience. There is an element of translation, all of us speak English, but you know a customer that has been entrench in their industry tends to speak in their lingo, they use slang and terminology hat has specific meaning for them but the rest of the world may not understand. So, I try to clarify that kind of language and translated into something, the rest of the world may understand more clearly. It's more grounded in the fundamental chemistry or physics. The terminology of the fundamental disciplines as oppose to the slang that may be part of the specific industry that the client is part of.* *NineSigma has these core capabilities and our core capability is to articulate specific challenges, issues that clients have in a way that the external community can understand them and address them ... So, we take problems, we look at them apart into identifiable peaces but not necessary into the pieces they would be apply. So, we take the application out of it and look at the pure science and then we go and identify*	30	PM, IS,SS,ON
Checking for confidentiality and anonymity	Strip out away any confidential information to prevent IP problems	*It's partly to make things clear for a broader audience; it's partly to make the client anonymous. We can get away the lingo specific terminology to have an easier time, hiding their particular business. In this case, they've a particular problem and they don't want to tell the world that they have a problem with the product that tends to go sales to go down, you know. Or to have an increase in liability, from lawyers. In other cases they are thinking in a new product line, a new kind of product that nobody else is doing and they don't want to give it away before they make money with it* *We obviously take very carefully, the things we should look at and see if there are some minor problems of IP. We won't touch it … you need to make sure that you're legally covered. We're very nervous about that*	18	PM, IS, ON
Phase 4: Search and collection - NineSigma -				
Identifying solution providers	Identify adjacent networks of scientific communities	*That's the secret sauce. We don't give it!!! Again, there is a whole group of people who are working in different technical areas and we all can learn from each other, taking ideas on board to look for things. We also have a massive database, we add to those everyday. We look for those based on what we think, the client should be looking for. It's based on a number of keywords* *The other piece of our capability is that we can go and identify potential solvers. So, it's not passive, it is not posting on a chat, it is not having a website full of experts who accept every challenge, we look for specific capabilities in every single challenge. So, that is the core capability*	15	PM. ON

Disseminating the challenge	The use of an advance software system allows to spread the challenge to the identified potential solvers	*So, we connected over or nearly two million people over the last 10 years. Are they in our network, I guess theoretically they're within the database. We don't have a network per se. Our network is the world. You are either in our database or you're out there, and if you're out there we're going to find you anywhere. So, that is my database. But sometimes it's too big and you can't see it all, you may have enough connections but hopefully you have enough right connections to make the project successful* *When we use NineSigma, we found information about potential solution providers who we couldn't find any information in the website or writings. But NineSigma was able to identify them. By NineSigma's intermediaries route, they reach companies that may or may not be visible through the Internet or even in the scientific literature. This particular company we had no idea, this company was working in this field. We could have been searching forever and never found them*	5	PM. ON
Giving feedback to received solutions	PM clarify questions and help to articulate the response	*Now, we tick the solution provider community; however to tick them doesn't mean anything. Direct interaction with the solution providers is what it's important, again people skills are very important, it isn't just using the website, filling a form and set back a lot of things need to happen. Interacting, coaching answering phone calls, at the end my client wants the problem solved*	7	PM
Compelling and summarizing solutions for clients	Make sure clients receive the responses in an structured and easy to evaluate form	*Just on the number of solutions was useful but also NineSigma did a great job on summarizing the responses, by different categories. So, making judgments whether some platforms were mature or not mature. Distillation of responses and put them in a useful format ... easy views of result that enhances the use of an intermediary, it makes just easy to go through for especially new technologies where [the firm] is not aware of or strong*	13	PM, ON
Phase 5: Evaluation - Firm, NineSigma and solution providers -				
Initial internal evaluation of responses	A cross-departmental team evaluate the received responses	*The most interesting ones are from people that come from adjacent industries that have a way of understanding packaging and those are the ones most interesting, once in a while we've someone who is developer in an early stage research and that's often is a good source for us ... but the top ones are adjacent industries where people have solved similar problems* *Once we received 36 solutions for this project, we pull together a team composed of management and technologist, define with them a selection and evaluation criteria for those 36 potential vendors. We evaluate them based upon a matrix and enter in the potential availability rating. We gather further information and establish a second round matrix and re-evaluated the 5 based on the extensive matrix, based on the analys and narrowed the group to two, the most viable candidates. It was a mixture of qualitative and quantitative matrix that was used because somebody there was familiar with the decision support methodologies and was able to lead through that. That's is one of the things is missing in much of the small industrial management companies. They've to have something like this and many companies do not have this.*	30	PM, IS,SS, ON
Having non-confidential conversations	The program manager arranges 30 min. conversations with selected respondents	*So, NineSigma help us with the contact which will be 25 min. conversation with no confidentiality agreement, very, very quickly in these 10 we are going to find 6 that we'll require a confidentiality agreement* *So, sometimes there needs to be another step in the exchange of information, and we as PM would feel that. We may email some extra questions to them [solution providers] that won't look at anything confidential and/or we will bring the two parties to a teleconference. We will mediate the discussion, again, this is a non-confidential discussion and the reason is to keep things moving quickly*	1	PM, IS,SS, ON
Negotiating the solution	Critical step to explain how solutions can address the innovation problem	*In successful collaborations, it's necessary companies have a common understanding of each other business and win-win sharing scenarios of collaboration. Additionally, it's needed to build trust and transparency between clients and solution providers to successfully evaluate the potential of the provided technology* *The more data and the more knowledge that they've been interacting in the area that I'm looking at, that moves them up in the list who I want to work with as well as the assigned personal to work with my company*	19	PM, IS, ON

Phase 6: Selection - Firm -				
Deciding to integrate (one) external solutions	Teams decide to (not) acquire or license (one) received solutions according to pre-defined business terms	*It needs to be somebody who has a technology who has a technology that it's in the latest stages or reduce to practice and it has a prototype that meets my requirements to the best. It's a partner that's willing to work with us in terms of IP, exclusive rights in a particular area. You need to think about, the scale that you need to actually deliver on that, manufacturing capabilities, size, the need that we've. What's the technology we're looking for, what's their willing to sign-on for milestone payments? At that point, it comes to how well are we able to structure a deal* *We actually run an RFP with NineSigma where we kept bumping our heads against the wall and we put the RFP out there and we didn't discover anything new. That may be for some as a failure but for us it validated what we already know. So, we moved onto to something else and we don't spend anymore money on that matter until something changes in the world*	25	PM, IS, SS

Type of evidence: PM= Program manager interview; IS = Innovation seeker interview; SS = Innovation seeker survey; ON=Observation/Notes;

Phase 2: Need triangulation

Understanding the external knowledge acquisition process

The main objective of this stage is to explain NineSigma's PMs the technical expectations and specifications, possible agreement scenarios and roles and, responsibilities. We observed, this phase concludes after two weeks of training that familiarize project stakeholders on the knowledge intermediation process. For example, one of the project managers, at the knowledge seeker's organization, explained: "At the beginning, those aspects to understand how to achieve a successful project were missing and lagging behind … when we started, I was working with Frank [a NineSigma PM] to explain me the process, give me detail suggestions how to always be ahead of one small phase. I was very pleased that I received the insights, last minute changes and upcoming steps to screen the respondents".

Crafting the innovation challenge

Here, all project stakeholders meet with the assigned NineSigma PM to articulate the selected project, into a specific request but with broader scientific appealing. This stage involves reviewing the (non) technical information that could be shared in the Request-for-Proposal (RFP), as a wrong balance of sharing confidential information could result on revealing firm's strategy, technical weaknesses or not providing enough technical information to potential knowledge providers. Numerous respondents explained that "you don't want to be too broad and end-up with 120 responses but neither you want to go too narrow because you may end up negating somebody's interest to submit something for you. You are really looking for this diversity of collection of ideas".

Knowledge seekers with accumulated experience may have the capability to effectively identify and unwrap the specific technical challenges to make them understandable for external actors. For example, one respondent active in the painting industry explained, "So, the RFP is very useful in helping us to understand what is the real technical challenge, behind the problem. That's what I find, it's very useful in forcing us to understand what's the real technical problem we need to solve to be able to deliver this particular benefit … Also, the thing is that if the

solution to our problem resides in other paint companies, there's no way they're going to give us the solution. We need to look outside the paint field to identify a solution". The result of this collaborative effort serves as the input for the document named RFP to be disseminated worldwide.

Phase 3: Need definition

Portraying the specificities of the innovation problem

In the third phase, the specific technological challenge is detached from its company specific context into a formal request, called a RFP – a four-pages document – that is disseminated to broader scientific and technical networks to enable the exchange of non-confidential information with global research and innovation communities. In navigating this process, we observed the transformation process is not a one-step process because NineSigma needs to provide enough information about: a) the business opportunity (R&D contract, licensing, product acquisition, proof of concept, supplier agreement); b) project timing (anticipated timeline for the engagement, road map for the work to be done); c) financials (budget or financial opportunity for the respondent); and d) evaluation criteria (what needs to be included in a response for proper evaluation, and list approaches that might address the need or do not want to see). The end-result of this work is a clear, concise and compelling statement of a technical and business need that provides detailed information to understand what is needed for the technology to be evaluated. One of our respondents explained, "I'm really impressed with the PMs and the discussions we've with them in terms of describing what our need is. Usually, what I do is take the template and start to draft our version of the challenge and send it out to them. But they do a very good job of capturing the key message, then we've a discussion with the project leader, the PM and myself to kind let them ask questions and understand what we're doing. I'm impressed how quickly, they capture what is needed and then they do a good job of revising that need to make it work for their network".

Table 13: Innovation intermediary: Survey results

Knowledge practice	Survey questions - seekers - (N=54)	
	Survey question	**Likert scale from 1 (the lowest) - 7 (the highest)**
Need identification		
Selecting innovation projects	What types of Request For Proposal projects did your organization conduct with NineSigma?	1) New strategic initiatives (3.06) 2) New Product Development (3.76) 3) Cost or quality improvement (3.24) 4) Scanning the market for insights (2.65) 5) Technical gaps or implementation issues (4.73) 6) Fundamental scientific research (3.15)
Deciding to use an innovation intermediary	Does your company use an innovation intermediary?	1) As a 'complementary' source of external knowledge, to complement internal activities (4.33) 2) As the 'initial' source of external knowledge, prior to other knowledge bases (3.38) 3) As the 'final' source of external knowledge, after exhausting all other resources (3.57)
Involving other departments and employees	When deciding to embark in an open innovation project with NineSigma, did you	1) Assign a team to participate throughout the process (5.10) 2) Create an infrastructure to integrate selected solution(s) (3.69) 3) Encourage communication with solution providers (to maintain the momentum) (4.94) 4) Overcome confidentiality challenges in order to share information with external parties (5.04) 5) Participate or involve other departments throughout the process (4.98) 6) Provide a budget for the project (5.08) 7) Provide 'protected' time resources for the project (3.81)
Need triangulation		
Comprehending the external knowledge acquisition process	How effective is "NineSigma's" assistance in:	1) Advising your group in open innovation practices (5.00) 2) Providing the process to collaborate with external partners (5.79)
Crafting the innovation challenge	How effective was NineSigma's "Program Manager" in:	1) Facilitating project selection (4.58) 2) Coaching your group to craft the RFP (5.64)
Need specification		
Portraying the specificities of the innovation problem	In your experience, an RFP is valuable for:	1) Helping you to 'focus' the problem (5.42) 2) Explaining your 'technical' requirements to a broader audience (5.50) 3) Revealing your 'Relationship' expectations i.e. academic researchers, entrepreneurs, labs (4.57) 4) Revealing your 'Commercial' needs i.e. ability to scale up, long-term supply (4.78) 5) Clarifying your funding intentions for the external solution (4.43) 6) Clarifying your IP expectations (4.52)
Checking for confidentiality and/or anonymity	How effective is "NineSigma's" assistance in:	1) Maintaining your confidentiality for the selected project(s) (6.04)
Search and collection		
Identifying solution providers	How effective is "NineSigma's" assistance in:	1) Introducing you to new unexpected solution providers (5.31)
Disseminating the challenge	Did you benefit in collaborating with NineSigma by:	1) Discovering new product or process opportunities (4.98) 2) Accelerating the speed of partner identification (5.27) 3) Getting additional ideas (5.16)
Giving feedback to received solutions & Compelling and summarizing solutions for clients	–	–
Evaluation		
Initial internal evaluation of responses	When evaluating solution providers, how important are the following:	1) Quantifiable data i.e. measurements, models, pictures, etc. (5.58) 2) Initial non-confidential interaction (5.27) 3) Availability of samples or prototypes (4.92) 4) Intention to co-develop the solution, rather than buying it outright (4.33) 5) Experience and qualification of assigned personnel (5.62) 6) Offered business terms, including IP (5.25)

Having non-confidential conversations between parties	How effective was NineSigma's "Program Manager" in:	1) Facilitating your engagement with solution providers (5.38) 2) Assisting in reviewing received solutions (5.37)
Negotiating the solution	–	–
Selection		
Deciding to integrate (one) external solutions	When selecting solution providers, how relevant is it that they offer:	1) A mature technological solution (4.49) 2) Mid-stage technological solution (4.80) 3) Established IP (4.10) 4) A novel solution (5.21) 5) Capability to scale up i.e. logistic, manufacturing (4.49) 6) A solution that matches your budget (5.15) 7) Experience in proposed technologies i.e. credibility (5.50) 8) Resources (4.35) 9) Financial stability (4.24)

Checking for confidentiality and/or anonymity

The RFP is a text that is disseminated through a proprietary platform as a non-confidential and anonymous document. As such, NineSigma defines project-specific intellectual property procedures and policies. One of the NineSigma PM said about one of the largest worldwide sportswear and equipment supplier "I knew we had a business [with the solution seeker] because when we walk and meet for the first time, they done some homework and say what we really like is the fact that your process is non-confidential, that we can put a non-confidential need and you bring back non-confidential information. So, we can evaluate and decide how to move forward … you're having a non-confidential conversation and then you learn more, you put a confidentiality agreement to work forward ... So, when they say, we really like this non-confidential, I knew it is because they got it, they understood how it fits, I think that's the hardest thing".

A recurrent dilemma knowledge seekers encounter is to reveal their company name in the RFP. Although the major disadvantages include the disclosure of competitive knowledge, product weakness or reveal the industry application of the solution, the benefits of revealing the name for solution seekers include receiving detailed responses and have higher chances to work with a high quality companies.

Phase 4: Connection and collection

Identifying solution providers

This stage begins identifying generic 'terms' that will allow PMs to identify scientists, laboratories and companies with solutions to the scientific challenge. Those could come from the same, desired or potential unrelated scientific fields. This process is comparable with conducting a literature search where key words guide the process and bring researchers into unknown scientific fields that use different methods, have a different epistemology, etc. This stage of connecting unrelated scientific fields to a specific knowledge seeker's scientific problem requires the efficiently use of proprietary search tools and methodologies to develop a project search strategy. NineSigma's methodology has evolved over a decade to identify and contact people that might have solutions or who may know colleagues with expertise relevant to the project. As explained by a senior PM, "We've a bunch of search tools, databases, all kind of things and people who are very curious about it. We have a lot of noise people … the PMs, search and production team are all in the open space. So, we can hear, what each other is saying, you know we can pop-up with someone else questions because we know he's dealing with something of that. So, that's part of the organic [environment] and can't be replicable. You have to put it in place, you need to have it in nature".

Disseminating the challenge

In this stage the RFP campaign is broadcasted for 4-5 weeks to approximately 15,000 potential solution providers where interested parties can directly contact and engage NineSigma's PM or dedicated Help Desk for guidance and further project information. According to one PM, "we [NineSigma] sent RFP to over two million people over the years, some, more than once. How many people in total and that's a little bit more difficult to assess. It's a lot. We say that we don't have a network, we will develop a network accustomed to your project, we'll engage that network and hopefully we find a group of technical people". This network is developed making new arrangements with scientific communities, new provided contacts and, primarily, through the services of an external specialized company.

Giving feedback to received solutions

This stage occurs during the dissemination of the challenge and entails recommending knowledge providers about the form to structure their response, client expectations, the intermediation process and reassuring the relevance of the innovation challenge. This is relevant for the success of the whole innovation process because responses that include the requested non-confidential information are invited to explain the details of the solution during a non-confidential telephone conversation. One NineSigma PM explains that it is particularly relevant to portray "the 'what' and not the 'how', give us general ideas of the 'how'. The how does not matter if I [the knowledge provider] hold all the IP, they can include the patent number". Frequently, coaching to write a complete confidential response is complex with academic solution providers who are use to write academic papers and provide specifications and not making the solution commercially interesting for the solution seeker. Finally, NineSigma PMs are involved in responding questions that are out of the scope from the RFP or negotiating with the solution provider the type of information that could be additionally shared.

Compelling and summarizing solutions for clients

This stage involves providing an executive summary and overview of all the received responses as well as having a report out meeting with the solution seeker. Here, NineSigma PMs follow a methodology to plot and rank the responses in a so called "technology map" that will facilitate the evaluation and engagement with the knowledge solver by the knowledge seekers. Although it is an attempt by the PM to focus on the initial criteria emphasized during the 'crafting of the innovation challenge', the complete review and final decision is on solution seekers side. As one PM explained "Sometimes I'm right others I'm wrong and a lot of times, it depends on what the client told us upfront".

It is also important to portray that although other larger innovation intermediaries have comparable intermediation processes i.e. Innocentive, YourEncore, the delivery of the collected responses varies significantly. For example, one of our respondents explained "Because when someone replies to Innocentive questions, they've to abandon their knowledge and IP. For every reply you have, you've to document why you have (not) chosen it, which is enormous. You only

own the information about the solution that you choose and pay for. All the rest, you don't own. It's information that you don't have. Whereas with NineSigma is much more flexible, people aren't abandoning their IP at all and then, the information we receive from NineSigma is total. We know who the people are … that's why you have much more information with NineSigma … with Innocentive we've around 5% transformation rate".

Phase 5: Assess

Initial internal evaluation of responses

This stage involves a two-stage evaluation of collected solutions by the solution seeker's team and the initial selection of solution providers for non-confidential conversations. For one to three days, a project team conducts the initial evaluation, of a 300 pages document provided by NineSigma, as they have the expertise in the scientific field, know the boundary conditions and desire to have a complete overview of novel technological solutions. An open innovation manager explained "we look through independently, the list of solutions and identify which ones are potentially useful and then we'll talk and come to an agreement that says out of the 40, 5 are worth talking to. Then, my job is to go back and communicate our interest and need for further questions".

All proposals are reviewed for a) must have; b) must not have; and c) nice to have items according to technical, business and relationship needs i.e. the stage of technology development, performance, business terms, budgets and are shortlisted into preferred solutions which are further vetted. Firms contracting NineSigma's services revealed their satisfaction with the technological solutions as these cover a good range of known scientific and technological fields and provide new insights into unknown areas. For solution seekers, the number of useful responses directly measures the overall satisfaction. One of the open innovation managers explained "I'm running now 40% transformation, meaning the quality. The rest doesn't matter. I'm going to give you an example, we're getting an average of 17 replies per RFP and the spam is 4-6 replies. So, we've a very large spam when the bad questions are asked. We've for one RFP 25 replies and we are following up with 10 of them, which is enormous".

Having non-confidential conversations between parties

Since the RFP and proposed solutions offered against it may be lacking key pieces of information, a second evaluation is needed to properly vet the options. At this stage, the solution seeker engages shortlisted solution providers in non-confidential interviews, sample testing arrangements or even site visits to determine who they wish to negotiate a project plan. Here, NineSigma facilitates these interactions to keep the effort on track and to protect the interests of both sides and making sure information is shared only under confidentiality to minimize IP contamination. Ideally, the result is to "get them closer and closer to the point where they will talk and come to some kind of agreement". These meetings with potential solution providers attempt to have an open communication, understand the nuances of the scientific challenge and create a bidirectional learning, and opportunity assessment for all involved parties without the exchange of money.

Negotiating the solution

This stage involves having clear understanding and 'frank' meetings between the knowledge seeker and solution provider(s) to lay down the issues and success criteria for the innovation challenge: type of resources and personnel solution providers are willing to assign, deliverables, IP expectations and payment. As one senior OI manager mentioned "If you do those things upfront and do it well, you'll have success. Open [innovation] won't work if the company asks the solution provider to do the work because they pay the money and expect the results in a couple of months". Frequently, in these phases NineSigma is not included in the process, as both parties believe it does not create value to the negotiation. Besides being cleaner, a simple two-way interaction removes any semblance of possible conflicts of interest that may arise. Further, since NineSigma holds no stakes in and offers no expertise in developing or adapting the proposed solution, it is not involved to negotiate arrangements or length of technology development work. Thereby cleanly extricating itself from contractual issues and focusing on relationship building and project management. However, NineSigma may, at the request of either party, act as an intermediary to help manage the process and coach best practices to overcome possible stumbling blocks.

Phase 6: Selection

Deciding to integrate (one) external solutions

The last stage is the final decision to acquire or not an external solution. On those cases where knowledge providers fulfill all the requirements negotiated in the previous phase the integration is smooth. However, there are many circumstances where the knowledge seekers decide to not integrate any of the solutions as these "didn't bring us [knowledge seekers] any further than where we are now, for the money we were going to pay out, the responses are very vague, the divulged information was not properly crafted, the business and technical terms does not mach". Overall, we observed knowledge seekers are satisfied with the innovation intermediation process as they " learnt something on a much greater, cheaper rate than we'd have done normally [internally]".

Analysis

The previous section provided a detailed and complementary perspective of the activities and involved agents during an intermediated knowledge process and how these collaborate during the external knowledge acquisition. Following, we analyze data from section 4 and use Zollo and Winter's framework as discussed in the conceptual part to respond to the second research question that is *what are the knowledge processes involved when companies make use of the services of an innovation intermediary?* The constructs developed in the previous section give input to respond the third research question, that is, *what are the cognitive costs and gains to the use of an innovation intermediary?*

Knowledge search, and acquisition and learning processes

According to Zollo and Winter (2002) firm's accumulated experience could help to build new dynamic capabilities only when the learning mechanisms are appropriately enacted. Open innovation findings confirm firms require a dynamic capability to accumulate experience and be able to collaborate with external partners (Dahlander and Gann, 2010, Lichtenthaler and Lichtenthaler, 2009). However, learning to acquire external knowledge involves numerous tensions and developed skills (Graebner et al., 2010) that could be offset by innovation

intermediaries. Following, we present a framework that explains how innovation intermediaries help firms with the difficult task of articulating and codifying internal knowledge problems before the intermediary seeks for external solutions in technology and idea markets. This contribution goes beyond the previous view that innovation intermediaries are primarily beneficial to identify external knowledge sources (Dushnitsky and Klueter, 2011, Sieg et al., 2010)

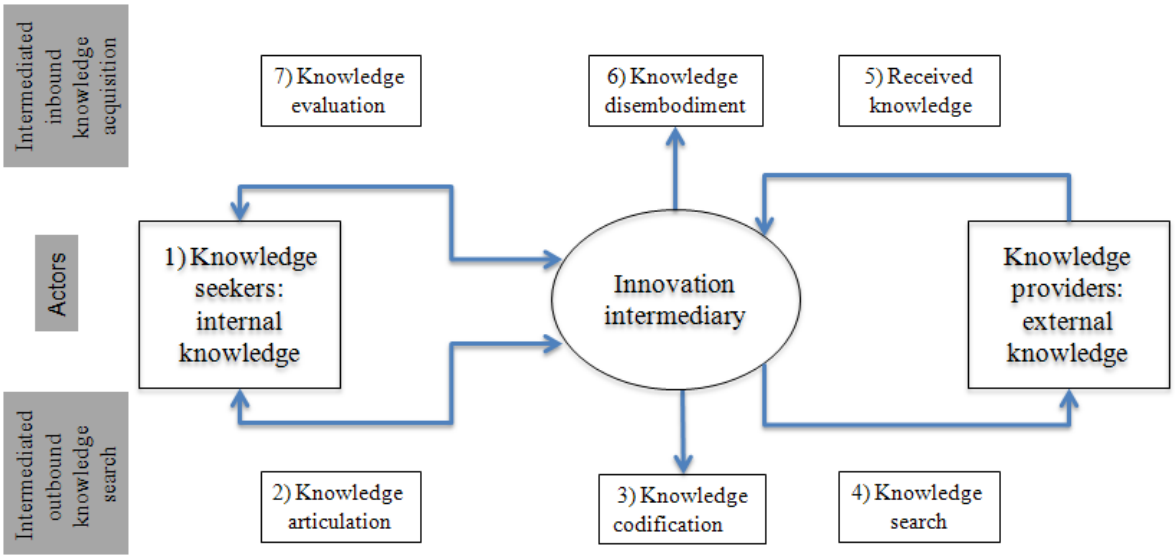
This process (see figure 8) begins with (1) using firm's accumulated experience to evaluate problems that cannot be solved internally or from current suppliers, alliance partners, etc. Here, the firm decides to seek external knowledge to address the technological challenge with the use of an innovation intermediary. It continues (2) with numerous meetings between the research team having the technological problem (knowledge seekers) with the innovation intermediary to disentangle and articulate the complexities and characteristics of the technological problem. In the third (3) stage knowledge is further articulated and codified by the innovation intermediary and reviewed and agreed by the knowledge seekers' team. Follows (4) the codified scientific challenge is searched in technology and idea markets. Then (5), the received knowledge is reviewed by the innovation intermediary's specialist to determine whether the received knowledge complies with the request and is non-confidential to initiate conversations with the knowledge seeker's team. In the following phase (6), the received knowledge is disembodied in a technological map that matches the knowledge seeker needs and received solutions. Following (7), the knowledge seeker reviews and engages in anonymous and non-confidential conversations to determine if any of the received solutions match their expectations. Finally (8), the knowledge will be integrated as in other buyer-supplier collaborations (this is not showed the in the framework).

Experience accumulation

In this research, we found that regardless if firms had established routines and accumulated research expertise to solve their technological problems, innovation intermediaries could help them to: a) obtain a contract with a solution provider; b) gain insight and perspective on the knowledge problem; c) accelerate the speed of projects; d) validate internal paths; e) re-direct projects; and f) kill projects using external insights. These findings reveal that the decision to use

an intermediary is an intended action to enact an intermediated outbound knowledge search routine. Furthermore, accumulated experience plays a role on the project identification and selection of an innovation intermediary.

Figure 8: Intermediated external knowledge framework



Knowledge articulation

As mentioned by Nonaka (1994) the conceptualization of knowledge is a contextualized, temporary and multifaceted process where teams build concepts and co-develop new ideas through interpersonal interaction and expression of their ideas. Until now, numerous scholars provided insights on the benefits of knowledge articulation for problem solving (Gavetti and Levinthal, 2000) and mechanisms for its articulation (Argyris and Schon, 1978). In an intermediated process, project teams developing this external knowledge search routine articulate knowledge through higher-level discussion sessions with members in different departments i.e. marketing, legal and purchasing and the innovation intermediary. This empirical instance allowed project teams to narrow down the specific technological problem into scientific challenge that could be comprehended from multiple scientific perspectives. The sessions between teams and PMs also involve the study of the characteristics of potential solution

providers and their response characteristics as these issues represent future barriers of technology integration (Graebner et al., 2010).

Knowledge codification

Firms going beyond knowledge articulation need to invest higher cognitive efforts to benefit from the available external knowledge that could address the technological demand (Zollo and Winter, 2002). So, teams outsource the knowledge codification process to innovation intermediaries as these possess structured organizational process, schemas and experience to codify and verify the articulated knowledge until it is sufficiently disentangled and achieve an expected level of business acumen to search among external scientific communities. We observed teams outsourced the knowledge codification process, as these did not possess experience to write the innovation challenge in a detached, confidential and anonymous format for worldwide potential network of innovation solvers. Whereas innovation intermediaries have an available set of scientific managers, with product development experience, who understand and could codify the innovation challenge using an established and proved scientific methodologies.

Finally, table 14 combines the learning mechanisms from Zollo and Winter (2002) and the intermediated external knowledge practices. This allows a better evaluation of how intermediaries help firms with activities of knowledge articulation and codification.

Implications of external knowledge search

Principally, research has explored two processes that allow firms to develop, solve and foresight technological challenges. For firms, the first alternative is to build strong internal R&D capabilities to develop new technological products using primarily an internal process (Teece, 2007). Second, a studied alternative is to exert for external knowledge that could shed light to the latest technological discoveries i.e. innovation alliances (Stuart, 2000, Vanhaverbeke et al., 2002), corporate venturing (Kelley et al., 2009, Rosenkopf and Almeida, 2003, Vanhaverbeke and Peeters, 2005) or innovation scouting (Fleming and Waguespack, 2007, O'Mahony and Bechky, 2008). The third alternative, suggested in this paper, is the intermediated external knowledge search that enables companies to efficiently search for specific technological request

in (non) related scientific fields, reduce the time of search and increase the number of potential partners in technology markets (Jeppesen and Lakhani, 2010, Sieg et al., 2010).

During knowledge accumulation, firms need to perform research activities to be able to assimilate and acquire external knowledge (Cohen and Levinthal, 1990) because this cognitive cost is necessary to build a core capability to generate innovations and operate in technology markets (Leonard-Barton, 1995). This learning process cannot be externalized to either innovation intermediaries or rely only on firm's knowledge search activities as it is a dynamic capability to be nourish.

Table 14: Knowledge intermediated practices

	Key challenge for solution seeker		
	Experience Accumulation	**Knowledge articulation**	**Knowledge codification + search**
Innovation seekers problems with the learning mechanism	Innovation seekers centralize technology requests, exhaust internal resources, show lack of coordination and do not possess search routines to move externally and identify solution providers to improve their products, cover technical gaps, or innovation strategy from idea and technology markets	Innovation seekers have unrealistic expectations about the innovation project outcomes, and limitations and don't involve the right personnel to provide insights in the project	Innovation seekers a) do not have an established process to codify their technological challenge; and b) cannot anonymously and confidentially search solutions in unknown idea and technology markets
Knowledge practice offered by innovation intermediaries	–	The innovation intermediary helps to define the a) technological requirements, and opportunity; and b) business and commercial relationship	The innovation intermediary uses its established processes and accumulated experience to adequately achieve a higher degree of understanding of the scientific challenge before searching among external potential solution providers
Observed knowledge practices to move to next phase	For the selection of technology projects, innovation seekers 1) have cross-functional / divisional: a) discussions by internal teams; b) vote to prioritize internal projects; 2) the internal OI or project manager follow a corporate or departmental directive	Articulating the innovation challenge requires collective debriefing sessions among project stakeholders and the assigned PM to focus on the scientific and technological problem	The innovation intermediary's methodology and PM experience help to codify the scientific challenge to detail the technological requirements, reveal commercial needs, IP expectations and clarifying funding intensions

Second, on the one hand, an intermediated knowledge articulation process requires the cognitive effort of firm's research team to explain the tacit scientific challenge through interactive

meetings and sharing of information. Here the innovation intermediary and the firm need to disentangle the complex technological problem into smaller and solvable scientific challenges, which could be addressed by external network of knowledge providers. In this scenario, firms benefit from using an innovation intermediary as it provides established techniques to trigger articulation. Although using a purely internal solution discovery process will not require knowledge articulation, as internal teams will 'tacitly' comprehend the scientific challenge, an internal driven process of external solution would involve cognitive costs of articulation. Here, firm's research teams would need to have meetings to provide and align the needs and requirements to a specific group of innovation technology scouts (Huston and Sakkab, 2006).

Third, the economic rationale lies in the capability of the innovation intermediary to codify the previously articulated scientific challenge in an anonymous and non-confidential format and use its innovation network to search for a solution in technology markets. Here, in compare to a purely internal process, firms' costs are the ones for the knowledge intermediation service and possible leakage of strategic information. The cognitive gain is, however, to leave to the intermediary the troublesome processes of codification and search of external knowledge. If firms decide to use an internal process of external knowledge search i.e. using an innovation scout these will not have a cost of codification because knowledge will be search tacitly. However, these will have the risk to externally reveal future strategic insights or internal technological challenges and possible cognitive costs of training scientific personnel to search and identify external partners and solutions.

Conclusions, limitations and further research

It is well known that in the current fast changing technological environment firms use number of strategies to acquire external knowledge (Arora and Gambardella, 2010b, Cassiman and Veugelers, 2006, Chesbrough, 2003, Leiponen and Helfat, 2010). This paper suggested firms could collaborate with innovation intermediaries not only to search (Dushnitsky and Klueter, 2011, Jeppesen and Lakhani, 2010, Sieg et al., 2010) and acquire external knowledge but most important to articulate and codify it. This activity help firms to increase the scope of solutions and reduce the time to spot them in unknown technology markets. This multiple perspective study was the first to focus on the knowledge intermediation process and explore the cognitive

benefits and costs of using innovation intermediaries to acquire external knowledge. In particular, the contribution to Zollo and Winter's (2002) framework shows further guidance for more confirmatory research.

There are several interesting conclusions to draw from this study. Although Sieg et al. (2010) and Dushnitsky and Kluter (2011) described the innovation intermediation process, they did not provided a detailed description of the knowledge practices between knowledge– seekers and –solvers. Here, we detailed: a) the six phases; b) explained innovation intermediaries are not only conceived as co-development partners for contextual R&D activities as suggested by Chesbrough and Schwartz (2007) but also for core or critical external technology acquisition. Here, we noted that firms use innovation intermediaries as an alternative to obtain insights about future scientific advancements and, thereby, reduce the time and costs of research. Also, NineSigma's business model, in compare to other types of intermediaries, provides more flexibility to acquire external technologies (Graebner et al., 2010) and higher changes to avoid problems of asymmetric information (Akerlof, 1970).

A second contribution is the delineation of an intermediated knowledge acquisition framework that is complementary to the firm's – internally driven – external knowledge search (Helfat et al., 2007, Teece, 2007, Zollo and Winter, 2002). Here, this paper focused on the learning practices of experience accumulation, knowledge articulation and codification when collaborating with an innovation intermediary to acquire external knowledge. Firms' decision to use an innovation intermediary is rational given that it presupposes a highly cognitive activity with potential benefits but also associated cognitive costs. When firms involve an innovation intermediary, although the cognitive costs and resources associated with the integration of external knowledge remain comparable and the problem remains purely internally, the central benefits are in clarifying the technological or scientific need, reducing the time to obtain alternative solutions and knowledge heterogeneity. As a result firms may reduce the scope of its internal knowledge boundaries and be conditioned to the opportunities conferred by the use of innovation intermediaries. However, the relationship tensions and cognitive cost for firms remain on collaboratively articulating the knowledge request with the innovation intermediary. As such, this suggests innovation intermediaries could become a significant mechanism to enable the 'search' dynamic capability discussed in Zollo and Winter's work.

This study offers number of opportunities for further research on knowledge acquisition, dynamic capabilities, boundaries of the firm, open innovation and innovation intermediaries. First, although it contributes to the dynamic capabilities theory, it does not address the last stage of managing threats and transforming part discussed in Teece (2007). Further, this paper does not center on the last stages of technology development and integration (Grant, 1996) or negotiation of the technological contract (Graebner et al., 2010). Finally, as this is an in-depth study, the objective was not to compare our findings with other type of innovation intermediaries such as Innocentive or YourEncore or one-sided innovation intermediaries i.e. innovation consultants, technology parks, business incubators (Becker and Gassmann, 2006, Hansen et al., 2000, Hargadon and Sutton, 1997). In this research, we observed the growth of two-sided innovation intermediaries, with creative business models, that aim to offer a variety of value-added services for firms i.e. evaluation of innovative capability, patent and technological vigilance, etc. So, future research should quantitatively map the advantages of two-sided intermediaries over their one-sided counterparts.

Future research could not only provide confirmatory research of the proposed framework but also explore the managerial barriers or enablers during the acquisition of external knowledge. For example, tentative research questions include: are externally identified solutions rewarded equally as internal developed solutions?; and what is the role of the firms actors to identification and integration of external knowledge? It is also interesting to determine differences among technological base of industries i.e. consumer products, pharmaceuticals, electronics that reflect differences in technological requests. This will give us a better understanding of the benefits of using an innovation intermediary for firms and have a better understanding of the knowledge acquisition and integration process.

Chapter VI Innovation speed: Does open innovation expedite corporate venturing?[6]

Open innovation has become an alternative framework to study how firms benefit from opening their boundaries and enable inflows and outflows of knowledge. Yet there is insufficient understanding of the factors that explain and predict differences in innovation speed when collaborating with external scientific and market partners. This paper is to our knowledge the first study presenting an empirical analysis about innovation speed of open and closed innovation projects executed by global research labs of a large multinational corporation for corporate venturing and core business units. Our analysis reveals that open innovation speeds innovation projects and it is particularly relevant to accelerate the offset the lack of innovation speed for corporate venturing projects. Further, market partners are beneficial to expedite the successful transfer of innovation projects from research labs to development units while scientific partners do not have an effect on the speed of innovation. All these contributions have implications for corporate venturing units, project managers and numerous academic communities.

Keywords: open innovation, innovation speed, corporate venturing, scientific knowledge and value-chain knowledge

Introduction

Chesbrough (2006) explains that "open innovation is the purposive use of inflows and outflows of knowledge to accelerate internal innovation … (and) assumes that firms can and should use external ideas as well as internal ideas, and internal and external paths to market, as they look to advance their technology". Until now, in the light of more research on the benefits of open innovation and external knowledge acquisition (Cassiman and Veugelers, 2006, Dahlander and Gann, 2010), a large project level study of open innovation speed is necessary to confirm when inflows of external knowledge speed up innovation projects. It would be naïve to accept open innovation consistently accelerates internal innovation due to the number of findings making reference to inhibitors such as knowledge integration and stickiness, coordination costs (Kessler and Chakrabarti, 1999, Leiponen and Helfat, 2010, Von Hippel, 1994).

Similarly, numerous scholars have highlighted the strategic relevance of innovation speed (Eisenhardt and Martin, 2000, Kessler and Bierly, 2002) on internal product development (Chen et al., 2010, Eisenhardt and Tabrizi, 1995), market internationalization (Ramos et al., 2011), R&D commercialization (Carbonell and Rodriguez-Escudero, 2009, Eisenhardt, 1989a) and market share and revenues (Kessler and Chakrabarti, 1999, Lieberman and Montgomery, 1998).

[6] **Presented:** Management culture in the 21st century (2011), Euram, Estonian Business School, Tallinn, Estonia

Gains in innovation speed, however, require ambidextrous firms to facilitate operations, engage in forward-looking debates and decentralize business units (Tushman and O'Reilly III, 1996). The literature refers to ambidextrous firms as the ones capable to overcome inconsistent demands for process management capabilities that, in the short run, speed exploitation and maximize efficiency and control (Benner and Tushman, 2003) as well as synchronously coordinate differentiated and weakly integrated exploratory business (Gupta et al., 2006). Recently, ambidexterity has been understood as a dynamic capability that allows firms to maximize efficiency in existing business units and explore opportunities into new areas by reconfiguring the organizational structure, strategy and culture (O'Reilly III and Tushman, 2011). Further, it has been related to the balance of orthogonal business units – explorative and exploitative – that are needed to address new threats and opportunities and obtain higher business performance and sales (Gibson and Birkinshaw, 2004, He and Wong, 2004).

On the one hand, core business or exploitative units are understood as "a potential reservoir of core competencies (Prahalad and Hamel, 1990)" that enables firms to produce products and generate profits. On the other hand, in the field of corporate venturing or corporate entrepreneurship, exploration units are seen as external sources of business ideas or R&D for firm's corporate strategy that are necessary to build new businesses and generate additional revenue (Narayanan et al., 2009). Although numerous examples are available on how innovative companies cope with balancing between corporate venture units while staying focused on company's core ones (Gibson and Birkinshaw, 2004), frequently, firms need to navigate an organizational and strategic tension (Tushman et al., 2011) while simultaneously incorporating open innovation strategies (Chesbrough and Garman, 2009, Vanhaverbeke et al., 2008) to accelerate product development. Research explained open innovation increases innovative performance, chances of market success (Cassiman and Veugelers, 2006, Chesbrough et al., 2006, Laursen and Salter, 2006, Leiponen and Helfat, 2010) but has not detailed the gains on speed up for exploitative and exploratory business units.

In this paper, we present empirical evidence on the transfer speed of open and close innovation projects from a global technology company. Benefiting from project level data from 558 research projects for the period 2003 to 2010, aggregated at the business level, this paper focuses on the benefits of collaborating with external partners on innovation speed from research labs to

business units. We break down open innovation in two possibilities: a) scientific partners i.e. universities, knowledge institutes; and b) market partners i.e. suppliers, customers. Also, as recommended by Chesbrough et al., (2006 p. 287-301) the analysis of open innovation needs to be complemented with analyses at other levels: "neither the practice nor the research on open innovation is limited to the level of the firm", the novelty of our empirical research is the micro-level longitudinal data from a large global technological corporation that allows us to measure the impact of open innovation, at the core business and corporate venture units, and provide corporate level recommendations. This detailed study allows us to systematically explain the type of partner leading to faster innovation for core business and corporate venture units.

Research on open innovation is burgeoning, yet our understanding of innovation speed, corporate venturing and most beneficial type of external partner remains unclear. First, although our results indicate that firms doing open innovation speed up the innovation process, we found corporate venture units tend to be slower than core business units when transferring a research project. Surprisingly, open innovation offsets this negative effect for corporate venture units and helps to accelerate the innovation process. Secondly, results reveal market partners accelerate innovation speed and the collaboration with market partners, for corporate ventures, counterbalances the negative effect on innovation speed. Finally, scientific partners do not speed up the innovation process. This research provides greater clarity about the benefits and limitations of open innovation, with external scientific and market partners, on innovation speed for core business and corporate venture units.

This manuscript connects the growing literature on open innovation (Chesbrough et al., 2006, Gassmann et al., 2010, Van de Vrande et al., 2010) with corporate venturing (Covin and Miles, 2007) and innovation speed (Chen et al., 2010, Kessler and Bierly, 2002). Further, it provides a guiding taxonomy of the most efficient combination of external sources of external knowledge to accelerate innovation projects for corporate venturing and core business units.

The rest of the paper is structured as follows: in the next section we review the literature explaining innovation speed, external knowledge sources and corporate venturing. The third section presents our hypotheses and the specific focus of study. The fourth section introduces the research methods, including the framework, variable definitions and measurements and the data utilized in this study. Section five presents the empirical results and discussions. The last section

wraps up the paper with the conclusions, discuss the implications for theory and managerial practice, limitations of this study and highlights suggestions for further research.

Literature review

Innovation speed

Innovation speed has become a cornerstone for firms innovation strategy (Eisenhardt and Martin, 2000, Kessler and Bierly, 2002) as it benefits a) faster internal product development (Chen et al., 2010, Eisenhardt and Tabrizi, 1995); and b) market internationalization (Ramos et al., 2011). Frequently, it is understood as the "(a) initial development, including the conceptualization and definition of an innovation, and (b) ultimate commercialization, which is the introduction of a new product into the market place (Kessler and Chakrabarti, 1996)". For an overview of the literature, table 15 presents the most relevant contributions and findings.

The New Product Development (NPD) literature studied the specific strategic, project, process and team characteristics and environmental activities to speed up the innovation process and increase competitive advantage (Chen et al., 2010, Henard and Szymanski, 2001, Pattikawa et al., 2006). Moreover, most recurrent approaches to speed up innovation include i.e. supplier intimacy, acceleration methods, project leader selection and cross-functional teams (Gerwin and Barrowman, 2002, Langerak and Hultink, 2005, McDonough, 1993, Millson et al., 1992, Schiele, 2010). Only limited research, however, investigated whether external partners could speed up the innovation process and generates larger market profit (Chen et al., 2010, Kessler and Chakrabarti, 1996, Langerak and Hultink, 2005, Stalk Jr, 1988, Vesey, 1992). For example, the NPD literature informs that early integration of suppliers increases quicker reaction to market opportunities, and development time, reduces manufacturing cost and improves quality and financial performance (Langerak and Hultink, 2005, Schiele, 2010). Although searching and acquiring external knowledge could be beneficial for speeding up projects during the research and development stages, Kessler et al. (2000) found the contrary for the idea generation stage.

Table 15: Previous research on innovation speed

General findings	Studied concepts	Source of data	Authors
a) More routine work is associated with faster development and radical work is associated with slower development and b) selection of project leader and team depends on the radicalness of projects	Project leader and team characteristics a) scientific background, b) project technology and c) type of work are associated with innovation speed	Questionnaire	McDonough III (1993)
Conceptual model of innovation speed highlighting the need for speed that is based on strategic orientation and organizational capability	Criteria-related factors, scope-related factors, staff-related factors and structure-related	Theoretical	Kessler and Chakrabarti (1996)
a) Product complexity increase development time, b) neither formal process nor project newness increase development time, c) cross functional teams are more significant for reducing new prod development time earlier in the process of prod development	a) Project strategy, b) process characteristics and c) team structure affect on cycle time for projects	Archival data & questionnaire	Griffin (1997)
Technology sourcing strategies a) increases time to complete projects (create problematic knowledge integration, more organizational barriers and lack of ownership and lack of a motivated project champion), b) decreases competitive advantage (coordination costs and longer time to complete)	Internal-versus-external sourcing, innovation speed, development costs and competitive success	Questionnaire	Kessler et al. (2000)
Dominant drivers of performance are: product characteristics, strategic R&D resources, marketplace characteristics, innovation process/launch characteristics	Review of predictor variables coded in 4 categories - product, firm strategy, firm process and marketplace characteristics	Meta Analysis	Henard and Szymanski (2001)
a) Incremental improvements reduce development time, b) product's technical complexity has impacts development time, c) broadening tasks does not reduce development time, d) cross-functional teams reduce development time and goal failure and e) project leader's organizational influence is effective in improving performance measures	NPD process, project definitions, teaming, organizational context	Meta Analysis	Gerwin and Barrowman (2002)
Faster innovation cycle is related to higher quality products (satisfaction of customer requirements), faster innovation is related to market success, innovation speed is more effective for more predictable innovations and environments	Innovation speed, development costs, product quality, project success, tech– and demographic– dynamism, project radicalness, internal sourcing	Questionnaire	Kessler and Bierly (2002)
a) Supplier involvement, lead user involvement, speeding up activities, training and rewarding of employers, simplification of org. structure speed up innovation and b) lead user involvement, training and rewarding of employees and emphasizing the customer have effects on profitability	Supplier & lead-user involvement, speeding-up activities, reduction of parts, training and rewarding employees, implementation of support systems, interfunctional cooperation, emphasis on customer, simplification of organizational structure	Questionnaire	Langerak and Hultink (2005)
Sizable relations predicting performance: a) Strategy (market orientation, product advantage, technology synergy and management skills), b) organizational category (project manager competency, degree of org. interaction and R&D/ Marketing interaction), c) process category (general proficiency, predevelopment activities, marketing & technical proficiency, launch activities, financial business analysis)	Study of 34 classes of variables in 4 categories -strategy, environment, process and organizational -	Meta analysis	Pattikawa, Verwaal and Commandeur (2006)
Main effects of innovation speed: a) strategy: top management support, goal clarity, b) process: formalization, concurrency, iteration and learning, c) team: leadership, experience, dedication, integration, external integration and team empowerment,	Four group characteristics: a) strategy, product, process and teams	Meta analysis	Chen, Damanpour and Relly (2010)

Scientific and market partners

Although research suggested collaboration with external partners could accelerate the internal innovation process and innovative performance (Laursen and Salter, 2006, Yun-Hwa and Kuang-Peng, 2010), firms have not yet developed an open innovation capability to benefit from external knowledge and overcome the disconnection of transferring projects from research labs to business units (Chesbrough, 2006, Lichtenthaler and Lichtenthaler, 2009). For instance, internal organizational barriers could decelerate the speed of collaboration with external partners due to the problem of specialization and division of knowledge (Katz and Allen, 1982, Kessler et al., 2000, Pavitt, 1998).

Open innovation research classifies external partners into scientific and market related partners. First, scientific partners range from universities, research centers, knowledge institutes (Cockburn and Henderson, 1998) to governmental research agencies (van Lente et al., 2003). This type of partners provide firms with: a) access to scientific knowledge i.e. patents, research outputs, scientific cooperation (Narin et al., 1997); b) opportunities to create patents and commercialize new technologies (Zucker et al., 2002, Zucker and Darby, 1995); c) support and validation from qualified scientific personnel i.e. consultancy (Cohen et al., 2002); d) higher innovative performance and outputs (Pekermann and Walsh, 2007); e) benefit from scientific networks (Zucker et al., 2002); and f) reduce the cost of in-house R&D (Cassiman and Veugelers, 2006).

Collaboration with scientific partners gives firms the advantage to better identify, understand and access external knowledge and advance internal technologies (Cohen and Levinthal, 1989, Gambardella, 1995). Also, it is argued that consultancy services, offered by scientific partners, help firms to faster identify, solve technical problems as well as ensure the validity of the technology under development (Cockburn and Henderson, 1998). Furthermore, universities and research institutions are frequently equipped with highly advanced scientific facilities, which are indispensible for conducting novel research. This advanced knowledge infrastructure enables firms to do experiments and test their technologies.

Second, collaboration with market partners allows to access a) latest market knowledge; b) assistance in market preparation; and c) application knowledge that is predominantly available at

firm's customers, high-tech startups, SMEs or other value chain partners. Market partners are not only firm's primary external source of technology (Cohen et al., 2002) but also these help firms to quickly re-distribute resources in a variety of areas along the value chain without having to invest on developing technologies by themselves Chesbrough (2003) p. 40).

Moreover, market partners provide firms with valuable knowledge and insights that the firm is hard to develop internally. Recent evidence indicates that technology users might represent a largely untapped source of creativity and offer considerable promise for the initiation of innovation (e.g. Von Hippel, 1988). By exposing a firm to consumer trends and sensitizing it to external developments, customer intimacy enhances a firm's ability to utilize external knowledge from downstream in the pursuit of innovations (Alcacer and Chung, 2007). Besides the knowledge and insights market partners provide, they also allow forms to better receive other kinds of external knowledge because they have a sharper focus on which technology they need.

Open business models in explorative and exploitative units

Chesbrough (2003 p. 40) suggests external partners i.e. universities, suppliers help firms to quickly re-distribute resources to accelerate the transfer of research projects to business development units along a porous innovation funnel. Along the innovation funnel, however, there is a risk of disconnection between research labs willing to push out research projects, as soon as patents and publications have been generated, and business units delaying the acceptance of technology projects that are not ready to be commercialized Chesbrough (2006 p. 28 - 30). Frequently a large portion of research projects "stays on the shelf" or do not generate a transfer until they are sufficiently advanced to be developed by firm's business development units.

For example, Xerox experienced this unbalance when most of its research projects contributed to the core business units i.e. PostScript, laser printers but radical research projects were not further funded by corporate venturing units. In the long-term, the latter research projects i.e. SynOptics, Adobe generated profits for firms outside Xerox business model (Chesbrough, 2006). Similarly, other companies did not quickly incorporated recommendations from corporate venturing units i.e. Kodak, HP. While firms like IBM, Google adopted the suggestions from corporate venturing units and enter in new business sectors. For example, in 2004, IBM's decided to sell its core personal computer business unit to keep focus and be more agile on new areas such as Linux

software, pervasive computing and consultancy. This suggests firms willing to achieve profitability need to balance between project transfers to existing core business and corporate venture units. So, faster internal technology transfers is of special relevance for corporate directors as it could reduce the risk to leave out many potential technologies on the shelf (Chesbrough, 2006 p.28) and not financially benefiting from investments in research.

Research has explained firms need to nourish business units focused on process and product improvements as well as on those on radical innovations to create new market opportunities and growth (Baden-Fuller and Volberda, 1997, March, 1991, Prahalad, 1993). Similarly, a recent literature stream called ambidexterity explained successful firms simultaneously focus on process management practices that increase exploitative innovation but do not dampen exploratory innovation (Tushman and O'Reilly III, 1996). Benner and Tushman (2003) explain "exploitative innovation involve improvements in existing components and build on the existing technological trajectory, whereas exploratory innovation involves a shift to a different technological trajectory". It is expected that exploitative innovation practices will improve performance and accelerate organizational responsiveness when technological environments are stable. However, in fast changing technological environments will fail to generate growth and business profit (Gibson and Birkinshaw, 2004). In contrast, explorative innovation is aimed to entering new product or service domains and entails a set of set of organizational systems, capabilities and new business within firms in existing or new fields (Burgers et al., 2009, Narayanan et al., 2009). As suggested by (Benner and Tushman, 2003) at ambidextrous organizations exploratory units tend to be small and decentralized and succeed by experimenting while exploitation units are larger and more centralized to maximize efficiency and control which is associated with process management efforts.

Exploration activities at the firm level are observed in corporate venturing units as these are focused on a new set of organizational systems, processes and practices meant to create new businesses in existing or new fields with the use of internal and external means (Narayanan et al., 2009). Moreover, these units are seen as sources of business ideas for the firm's corporate strategy (Covin and Miles, 2007) or as an external source of R&D for new business to generate additional revenue streams. Frequently, corporate venturing studies focus on locus of opportunity which refers to the origin of the venture idea, either inside or outside the boundary of the firm or

on the origin of the idea which could be generated internally i.e. business incubation or captured from external partners i.e. joint ventures, licensing, real options (Hill and Birkinshaw, 2008). For example, Vanhaverbeke et al., (2008) suggested open innovation practices could allow firms to become ambidextrous as it enables early involvement in new technologies or business opportunities without risking excessive time and financial resources.

Hypotheses

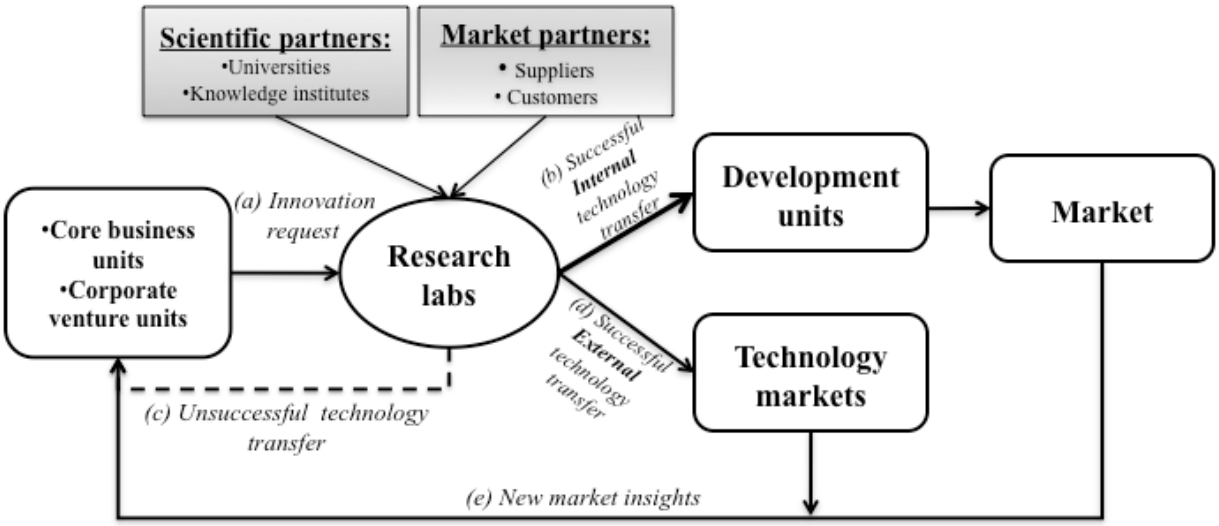
Open innovation scholars suggested firms should use external ideas and paths to improve the efficiency of innovation and accelerate internal innovation (Chesbrough et al., 2006 p.1). Yet, our understanding of the types of external partners that can speed up technology transfer from research labs to development units remains unclear. Even more complex would be the response confirming the most advantageous type of external partner for innovation requests from core business or corporate business units.

A simplified framework for firms (figure 9), based on Chesbrough's (2006 p. 29) budgetary disconnection between R&D and the business unit, shows how core business and corporate venturing units from a technological firm send innovation requests (a) to its research labs based on numerous insights and expectations from their own and external technology markets (e). Following, research labs, based on the novelty of the technology, internal knowledge availability, etc, determine whether the requested innovation should be advanced only internally or in collaboration with a) scientific partners; b) market partners; or c) both external partners. Once the research labs want to push a finished research project to development units numerous tensions emerge that delay the internal technology transfer (b) (see Chesbrough, 2006 p. 27-30). A practiced alternative is to commercialize the research results via patents, licenses to external technology markets (d) that compensate the research investments. A final alternative scenario is the unsuccessful technology transfer (c) that will only generate new scientific and technological knowledge for research labs and new insights for core business and corporate venturing units.

Maintaining the complexity of the presented framework, this paper focuses only the "successful internal technology projects (b)" and how innovation speed is affected by the collaboration with scientific and market partners. This empirical study, based on existing findings on open innovation has the potential to explain the underlying contingencies that accelerate the speed of

research projects to development labs. Furthermore, understanding open innovation contingencies leading to faster technology transfers is pertinent for firm's understanding of collaboration benefits with external partners. Results will advice managers how to generate first mover advantages, higher market share and protection from outright failure in fast changing technology markets (Robinson and Min, 2002).

Figure 9: Framework for ambidextrous and open firms



Collaboration with external partners: open innovation, market and scientific partners

On the one hand, until now research has explained gains in innovation speed is one of the expected benefits from doing open innovation (Chesbrough et al., 2006) as this give some advantage in fast changing industries (Gassmann and Enkel, 2004, Langerak and Hultink, 2005, Tessarolo, 2007). On the other hand, contradicting findings suggest collaboration with external partners slows down the innovation process and reduce firms' competitive advantage (Bierly and Chakrabarti, 1996, Kessler et al., 2000) because knowledge is 'sticky' and difficult to integrate (Grant, 1996, Von Hippel, 1994) and employees oppose to external technology sourcing i.e. the "not invented here" syndrome (Kessler et al., 2000). Since, until now, research has contradicting findings about the impact of external partners on open innovation speed, we suggest this as our first hypothesis.

H1: Open innovation speeds up innovation projects, compared to close innovation projects

Although some studies could not find strong evidence to confirm collaboration with market partners increases the speed of technology transfer (Gupta and Souder, 1998, Wagner, 2010) or could guarantee a reduction in the innovation cycle time in compare to customer integration and marketing efforts (Sherman et al., 2000), Chesbrough (2003 p. 40) suggested collaboration with market partners help firms to quickly re-distribute resources in a variety of areas along the value chain without having to invest on developing technologies by themselves. As a result, firms will move faster and address more market opportunities and accelerate research projects along the open innovation funnel. Further, Cohen et al., (2002) suggested firms relying on market partners, as their primary source of technical and market information, could accelerate product development time, address market opportunities and collect new market insights. Teece (1992) argued market partners are particularly relevant to speed up the innovation process when knowledge is complex and tacit. The NPD literature supports these insights and suggests early integration of market partners can boost financial performance, reduce manufacturing costs and quicker response to market (Langerak and Hultink, 2005, Schiele, 2010).

It is well known that firms' research labs invest large amounts of resources in high quality research but a large portion of it "stays on the shelf" when it is not attractive enough for development units to commercialize it (Chesbrough, 2006). Collaboration with market partners in the research phase may help to smooth the transition from research labs to development units. Long lags between invention and innovation may be caused because some of the conditions to commercialize the technology are lacking (Lichtenthaler and Ernst, 2007). For example, cooperation with customers helps to increase market acceptance and diffusion of product innovations (Kleinknecht and Mohnen, 2002). Further, market partners provide firms with better understanding of user needs, which is necessary for commercializing the technology. Consequently, they may contribute to the market acceptance for new technologies and accelerate innovation speed. Collaboration with market partners helps firms to get early feedback about their technology, which consequently accelerates the speed of innovation. Technologies are not developed and then left to their own (Koruna, 2004), rather, there is a continuous process of further improvement and development, and there are feedback loops from the performance. In

brief, collaboration with market partners helps firms detect technological problems quicker and enable them to act with higher efficiency. We hypothesize:

H2: Market partners speed up innovation projects, compared to non-market partners

Numerous authors (Fleming and Sorenson, 2004, Laursen and Salter, 2004, Mansfield, 1998) suggested firms that collaborate with scientific partners, during the research phase, could not only help to overcome fruitless experimentation, receive guidance to directly identify solutions for technical problems but also reduce the technology development and commercialization time. Further, collaborating with scientific partners could lead to new breakthrough discoveries, market opportunities, stronger patents and disembody scientific knowledge into formulas, patents or publications, which represent a strong predictor of firm's success (Cohen et al., 2002, Zucker et al., 2002). Now, although scientific knowledge is frequently tacit and difficult to share and close collaboration with scientific partners is a key driver to speed up internal innovation, numerous countervailing factors could decelerate the innovation process due to cost of coordination, combinative capabilities and integration of external scientific knowledge (Grant, 1996, Katz and Allen, 1982, Kessler et al., 2000, Kogut and Zander, 1992).

Extant studies have continuously show the superiority of universities and research institutions as external sources of knowledge which provide firms with the most advanced and comprehensive scientific and technological knowledge and a better understanding and command of such knowledge (Belderbos et al., 2004, Van Looy et al., 2004). It also compensates the knowledge deficiency of the firms, enable them to be better able responding to the risks and faster changes they face in the innovation process (Cassiman et al., 2008) and contribute to the better stability and higher quality of the product. The relevance of scientific collaboration in achieving business success of innovative projects is corroborated by several empirical studies. It is shown that 15% of new products, 11% of new processes representing about 5% of total sales in a sample of major firms in US could not have been developed in the absence of academic research (Mansfield, 1998), the Yale Survey (1983) and Carnegie Mellon Survey (1994) also confirm the relevance of university research for innovation for R&D active firms. Consequently, firms' innovation speed is likely to be accelerated with scientific partners, by having a more profound body of scientific

and technological knowledge to ensure higher level of product quality, and by better responding to technological change and reduced product life cycle. As such, we would expect collaboration with scientific partners speeds up innovation because they offer qualified scientific personnel, early results, etc. Thus, we hypothesize:

H3: Scientific partners speed up innovation projects, compared to non-scientific partners

Corporate venturing

While some studies explain exploratory innovation reduces the speed at which existing competencies are improved and refined He and Wong (2004), limited corporate venturing studies suggested internal venturing increases the speed of new venture introduction (Covin and Miles, 1999, Miles and Covin, 2002) or provided evidence about the length internal corporate venturing cycles (Burgelman, 1983). As results of corporate venturing benefits are primarily explored using economic or financial measures and researchers "must make judicial use of lag effects to incorporate the temporal nature of their subject of inquiry (Dess et al., 2003)". An early attempt to measure the length of internal corporate venturing with the financial performance showed that on average corporate ventures require 8 years before profitability is attained (Biggadike, 1979).

The study of the speed of innovation for corporate venturing compare to core business units, during the research phase, is central to achieve a balance product portfolio, assess the risk of corporate venturing projects and determine the average length of time until a project is ready to be transferred. Further, it is apparent to compare the differences in the speed of innovation for corporate venturing units and core business units, which diverge in their technological nature from radical to incremental, respectively.

H4: Corporate venturing projects have a slower successful internal technology transfer, compared to core business units

Open innovation and corporate venturing

Now, although open innovation is expected to accelerate firms' innovation process (Chesbrough et al., 2006), research has not investigated whether it equally benefits corporate venturing and core business units. Only limited contributions have highlighted the possible benefits of open innovation, through options, for corporate venturing units as a mechanisms to invest on exploratory technologies (Vanhaverbeke et al., 2008). As mentioned in Chesbrough (2000), unsuccessful short-term results will result on the closure of the corporate venturing research project or unit. So, open innovation is especially relevant to speed up firms' innovation process by providing faster access to proven results when firms lack internal absorptive capacity and building internal knowledge would require longer time to be developed or be too expensive. As such, we suggest:

H5: Open innovation helps to speed up innovation projects for corporate venturing units, compared to open innovation for core business units

Market partners, although Yang (2008) found that knowledge from them has a positive effect on product timeliness for core business units, are paramount for new explorative innovations i.e. disruptive innovations (Christensen, 1997). Knowledge from market partners does necessary needs to be a breakthrough, which is expected from top-class scientific research labs. Knowledge and information from users, customers, partners, and distributors provides firms with practical information on market needs for core business and corporate venturing units. Furthermore, such type of knowledge may take less time to be integrated, compared to developing something that is completely new (Tidd and Bodley, 2002) and bring a faster pace for harvesting financial return. Consequently, collaborating with market partners enables corporate venturing units with a more accurate focus on future market needs and avoids unnecessary waste in time to research something that may be commercially unattractive. Therefore, it may help corporate venturing units to find the market niche quicker, to accommodate user desires better and eventually to achieve business success faster.

The involvement of market partners is one of the crucial aspects in facilitating market acceptance of innovative products. Therefore, being open with market partners and inviting them into the

innovation process not only helps to align companies' offerings with users' needs, but also enables the corporate venturing unit to take more initiatives in innovation. In terms of organizational adopters, careful and specific targeting of an innovation towards selected potential adopters and collaborating with them can facilitate market acceptance (Frambach and Schillewaert, 2002). Also collaboration with suppliers not only creates market awareness but also influences potential customers' perceptions of future innovations, which indirectly affect potential adopters' propensity to adopt the innovative product (Frambach and Schillewaert, 2002). Further, Kambil et al., (2000) suggest the involvement of external equity partners, with experience to the firm's new venture, could reduce the speed of innovation when the new research project deviates from the focus of its corporate partners.

Not only the user needs, but also the fast changing consumer interests influence innovation speed for corporate venturing units. It is stated that, among other things, the pressure on achieving profits from innovation is alleviated by the ever faster changing customer interests (Han et al., 1998). It might be easier for a corporate venturing unit to learn about the general market needs than to stay well informed of the minor changes of customer interests and to precisely target at a profitable market niche. In such cases, firms need to proactively approach the market partners to better understand their interests and market trends for corporate venturing opportunities. In this process, market communication facilitates firms' understanding of users' interest (Frambach and Schillewaert, 2002), and keep them stay with the market trend. Taking into account of the above points, therefore, we hypothesize:

H6: Market partners help to speed up innovation projects for corporate venture units, compared to market partners for core business units

According to Santoro and Chakrabarti (2002) large firms could strength their skills and knowledge, in core business, from university collaborations through a) knowledge transfer i.e. research consortia, co-authoring of research papers; and b) research support activities i.e. financial and equipment contributions. The speed at which this type of distributed knowledge is accessed and integrated will depend on firms' absorptive capacity and will explain differences in product development performance, higher profits and stock market valuation (Carlile and Rebentisch, 2003, Grant, 1996). In contrast, cooperative research i.e. contract research,

consultancy and technology transfer i.e. patent or licensing services do not strength skills or knowledge gains for core business units but could help to quickly obtain external knowledge to accelerate the innovation process for corporate venturing units. Collaboration with scientific partners, for corporate venturing units, could speed up the innovation process for firms, since they can provide complementary knowledge, resources and skills (Chesbrough et al., 2006, Teece, 1986).

Knowledge from scientific partners is in most cases of an explorative kind (Belderbos et al., 2004) and could allow firms to develop radical innovations and differentiate their products from competitors. Scientific partners provide firms with closer to science findings and information that are necessary to correctly spot future market opportunities and successfully speed up the transfer of research projects to corporate venture units. Also, they participate in the early research of the new technological discoveries accelerating the innovation process of exploratory projects for corporate venturing units. Collaborating with scientific partners not only provide firms with better knowledge to cope with changes and risks and enhance product quality, it may also enable them to better absorb external knowledge to address market insights and make modifications and improvements faster. Firms with a better understanding of external scientific knowledge and continuously conduct research are better placed to introduce product and process innovations faster than competitors. Science base knowledge allows firms to gain competitive advantage over their competitors not only by addressing less intensive market competitions, but also by being first movers in new markets, which, in turn, may contribute to a faster speed to harvest financial returns for corporate venturing units. Considering the above three aspects, we therefore hypothesize.

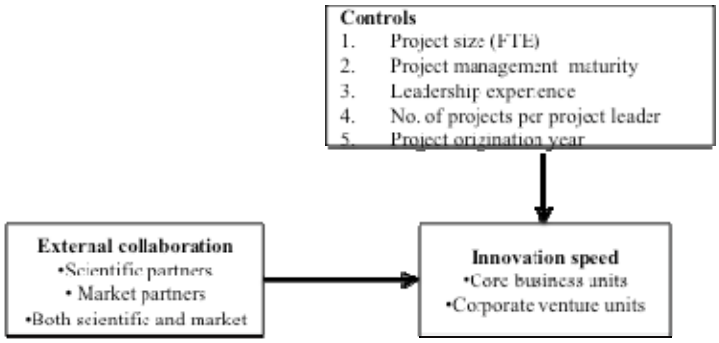
H7: Scientific partners help to speed up innovation projects for corporate venture units, compared to scientific partners for core business units

Research method

Conceptual framework

Figure 10 shows the conceptual framework investigated in this study. It indicates that external scientific and market partners affect innovation speed of a firm. In additional, several important control variables are included in the model to eliminate or reduce the bias arising from counteracting effects. This framework guides the definitions and measures of the major variables used in this study.

Figure 10: Analytical framework for studying ambidexterity and speed



Sample

The sample ranges from 2003 to 2010 and comes from a European base global technology company active in sectors such as healthcare, consumer products and lighting. Although the majority of projects do not generate technology transfers (77%), some projects are successfully transferred and generate multiple transfers from the research labs to the business units along with large revenues. In this paper, we only consider the 558 projects, 19,531 monthly records, which have been transferred from multiple global research labs to a) core business or b) corporate venture units. Once a research project is approved for execution and the date of origination is registered, it is assigned to a) a project leader, b) a beneficiary unit i.e. healthcare, incubators and c) a responsible department i.e. digital signal processing, biomolecular engineering. Here, each project is recorded and evaluated on a yearly basis and associated with unique information on the starting date of its originating project and the transfer date to its receiving business units (or to

the current year, if it is still running). Also, all projects present the information about the type of collaboration with external scientific or market partners.

Variable definitions

Dependent variable

The dependent variable in this study is the innovation speed, which is measured by the elapsed time from the start of a project, at a research lab, to its transfer to a business unit. Along the R&D phase, a research project may generate multiple transfers, thus, it is possible that this project may correspond to multiple transfers. Therefore, we examine the elapsed time of multiple transfers of each project as a measure of the innovation speed. This will be discussed in more details in the methodology section. Note that the definition of innovation speed adopted in this paper refers to the "initial development, including the conceptualization and definition of an innovation (Kessler and Chakrabarti, 1996)". The dependent variable tests the effect of collaborating with external partners on innovation speed, calculated at the project level of analysis, for: a) core business; and b) corporate venture units (Co Vent.). Here, we needed to develop a simplified categorization and aggregation of hundreds of business units where the authors received the support from executive managers and a later detailed review on the developed categories. First, core business units entail the accounts of lighting, healthcare, consumer lifestyle, semiconductors and components or any account that is active in the market. Second, corporate venturing units include professional research, intellectual property (IP&S), external and research and incubators. The difference between the two business units was captured using dummy variables.

Independent variables

The focus of interest in this study is the type of external collaboration accelerating the transfer speed from global research labs to development units. So, scientific leaders of research projects will select among three collaboration strategies to speed up the transfer to development units. Namely them will have to choose among collaboration with market and/or scientific partners or pure internally research (closed innovation). However, once a project receives some external

knowledge from a partner, its effect will influence the entire life of the research project. We adopt accumulated dummy variables with either 0 or 1 as our independent collaboration variables. The two independent variables used to measure the speed of innovation are: collaboration with market partners i.e. suppliers[7], partners and consumers who contribute with closer to market solutions and information. This is a dummy variable with value "1" if the project collaborates with market partners in the current year or in any of the previous years and "0" otherwise. The second one is scientific partners (Faems et al., 2005) i.e. universities, research centers that offer a type of knowledge that is closer to science and more determinant for new radical innovations. In line with the market collaboration variable, this is a dummy variable with value "1" when a research project team collaborates with scientific partners in at least one of the previous years or in the current year and "0" if it does not.

Control variables

As mentioned in prior sections, there are several factors that may influence NPD success (Cooper et al., 2004, Griffin, 1997). We develop a number of variables to control for the possible confounding effects. This paper has several control variables that help to appropriately determine the effect of open innovation on speed of transfers for core business and corporate venture units. First, It has been argued that projects with higher internal resource endowment perform better than the ones that do not (Cooper et al., 2004), a larger project may be considered to be more important and therefore embodies higher potential revenues or more management support, or it may be regarded as more complex to complete, therefore it faces more technical challenges. To control for such variance, we use full time equivalent researchers (FTE) working on the project as the proxy of project size and internal resource endowment, which is also a variable on yearly basis[8]. Second, in this paper we control for the Project Management Maturity (PMM) of the research project because the larger the number of partners the higher the coordination costs. Here, six indicators compose this variable: a) project ownership; b) project

[7] The "horizontal" type of partners, such as competitors, consultants, etc. is labelled as either market– collaboration or science– based collaboration according to the type of knowledge they provide in the innovation process. Nevertheless, such type of collaboration (particularly with competitors) is seldom adopted by research projects in our sample.

[8] There are some studies talk about project cost (Cooper et al., 2004) or innovation cost (Faems et al., 2010), we do not explicitly include project cost as a variable in our analysis because: 1) It is highly correlated with the present variable project resources (FTE). 2) We have more complete data on FTE than on project cost, therefore we opt to use FTE as the proxy of project resource endowment and leaving out project cost.

start-up; c) project planning; d) project monitoring and review; e) project rationale; and f) project closure/termination. These 6 indicators were evaluated on a yearly basis by the firm, using a scale from 0 to 5 (5 denoting better execution). In this paper, the average of these 6 sub-indicators was used and converted it into a percentage[9]. In the analysis of the paper, we use the average PMM value for each project across its history. We performed factor analysis to check whether these six factors refer to distinct aspects of project management, the result suggests that they can be integrated into one factor, denoting the overall level of project management for each project in a given year.

Third, the NPD literature put great emphasis on the role of project leaders in the final success of research projects (e.g. Cooper et al., 2004; Griffin, 1997). To control for this, two aspects of project leaders in research activities are controlled leadership experience (Proj. leadership) and the number of projects lead (Nr. Proj. lead) by a project leader. The first variable is proxied by number of projects the project leader has managed in the company before the investigated year while the second variable is measured by the number of projects that the project leader is managing in the given year. We expect project management experience to affect project speed because the more accumulated experience at the firm, the more established project management routines project leaders will have. Moreover, the variable that measure number of projects that the leader is managing in a given year might be corresponding to the managerial attention and project commitment for research projects. We assume the more projects a project leader manages in the same year, the lower the speed of transfers for research projects. These two variables are logarithm transformed in the regressions in order to control for the very skewed distribution. Finally, we control for the year of origination (Year orig.) of projects, from 2003 to 2009, as more recent projects (year 2009) will have less chances to show a project transfer. Further, the project-originating year may signal the macroeconomic situations at a particular point in time, it may also embody the effect of corporate level strategy on NPD projects in a given year.

[9] We exclude the 6th indicator "project closure/termination" from the construction of overall PMM score when the projects are still running.

Methodology

This paper uses event history analysis (also known as survival analysis) to measure the elapsed time from the initiation of a research project to its transfer to a development unit. Due to the firm data is detailed at the day level, in this paper was classified into monthly records in order to maximally preserve useful information while still keeping the data at an operational level. Compared to parametric models in survival analysis, the semi-parametric Cox model does not assume a specific shape of the survival curve, thus allowing for sufficient flexibility in the survival function, which has been mostly adopted by prior studies. Therefore, in this paper the Cox model is adopted as the model of analysis.

Moreover, because each record of the same research project shares a commonly unobservable random frailty we further use Cox model with shared frailty of records from the same project in this study. This allows the study to keep consistency for unobserved heterogeneity of results across the three performance dimensions. The econometric form of the analysis is as follows:

$$\mu(t, Z, X) = Z\, \mu_0(t) \exp(\beta^T X)$$

Here $\mu_0(t)$ denotes the baseline hazard function, assumed to be unique for all individuals in the study population. X is the vector of observed covariates and β the respective vector of regression parameters to be estimated. The hazard of an individual depends in addition to an unobservable random variable Z, which acts multiplicatively on the baseline hazard function μ. The frailty Z is a random variable varying over the population that lowers (Z<1) or increases (Z>1) the individual risk. Because the frailty is unobservable, the respective survival function S, describing the fraction of surviving individuals in the study population, is then given by:

$$S(t|Z,X) = \exp(-Z \int_0^t \mu_0(s)ds \exp(\beta^T X))$$

Where S(t| Z,X) can be interpreted as the fraction of individuals surviving the time t after begin of follow-up given the vector of observable covariates X and frailty Z.

Analysis

Descriptive statistics

The degree of openness of the firm is relatively high, with a mean of 85.90%, which corresponds to 474 distinct projects in our sample. The majority of projects have collaborated with either scientific-based (71.92%) or market-based partners (67.38%) while 315 projects (56.45%) in our sample have collaborated with both types of partners during their life course. We have dichotomous information on the collaboration activities of projects, the indicators take value "1" if there is collaboration going on with a certain type of partners (science base, market base or both of them), while value "0" if otherwise. Furthermore, accumulated FTE has a mean of 8.46 and the average PMM has a mean of 77.19%. The correlation among the independent variables is low and confirms the reduced concern about multi-collinearity among variables.

Now, whereas table 16 provides the descriptive statistics and correlation results, the analysis results are shown in table 17. In table 17, the baseline model for all presented models is close innovation in core business unit projects. Here, we control for unobserved heterogeneity, at the project level, by including a shared frailty term and assuming a gamma distribution across projects. This means, we imposed a gamma-distributed latent random effects that affect the hazard multiplicatively (the logarithm of the frailty enters the linear predictor) as a random offset, which resembles random effect panel data regressions in Cox model.

Broadly, model 1, 2 and 3 detail the individual effect of each type of external collaboration on project innovation speed while model 4 shows the pure effect of corporate venturing projects in project innovation speed. Model 5, 6 and 7 show the interaction effects of conducting each of the open innovation strategies for corporate venturing projects on project innovation speed. When assuming shared frailty among projects, doing open innovation is significant and positive (Model 1). So, we confirm hypothesis 1 that open innovation speeds research projects. Market partners show to speed up the innovation process of research projects and such effect is significant and positive (Model 2). Therefore, hypothesis 2 is supported. However, we did not find a significant effect for collaborations with scientific partners that shows these kind collaborations do not significantly speed up project speed and cannot confirm hypothesis 3 (Model 3). Finally, our

results informed corporate venturing units are slower than core business units (Model 4). Model 5, 6 and 7 show the relation between R&D collaboration types and project innovation speed in corporate venturing units (interaction effects). First, research projects, from corporate venturing units, that collaborate with both types of external partners (open innovation) speed up project transfer and such effect is significant and positive (Model 5). So, we accept hypothesis 5. Similarly, market partners are beneficial for accelerating innovation speed for corporate venturing projects (Model 6). Although the coefficient for the interaction effect is 0.15 and not significant as such, the result shows collaborating with market partners, for corporate venturing units, help to offset the negative speed of innovation projects. Therefore, hypothesis 6 is supported. Our results, however, did not find any significant effect on collaborating with scientific partners on the innovation speed in corporate venturing projects (Model 7) and cannot support hypothesis 7.

Furthermore, when probing into details, the coefficients of the regressions show that conducting open innovation helps projects to be 73.84% quicker (refers to Model 1: exp (0.553)-1= .7385). Corporate venturing projects, however, themselves delay project innovation speed to be 42.54% slower (Model 4: exp (-0.554)-1=-0.4254) compared to closed innovation projects for core business units. When doing open innovation for corporate venturing projects these tend to be 11.95% slower than the closed innovation projects for core business units (Model 5: exp (0.391)*exp (-0.953)*exp (0.434)-1= -.11945) but still quicker than if these do not conduct any collaboration activities. Collaboration with market partners tends to be 70.40% quicker (refers to Model 2: exp (0.533)-1= .7040) while working with scientific partners helps research projects to be 16.766% quicker (refers to Model 3: exp (0.155)-1= .1677) but such effect is insignificant. Furthermore, collaborating with market partners for corporate venturing units makes research projects to be 6.70% slower than closed innovation projects in core business units (refers to Model 6: exp (-0.656)*exp (0.437)*exp (0.150)-1= -0.067). Nonetheless, market partners still help corporate venturing projects to speed up the innovation process. Collaboration with scientific partners, for corporate venturing research projects, shows to be 32.73% slower (refers to Model 7: exp (-0.610)* exp (0.153)*exp(0.071)-1= -0.3207). Further, collaboration with scientific partners delays even more the speed of innovation for corporate venturing projects compared if a collaboration is absent.

Table 16: Correlation Matrix for innovation speed

(n= 20,088)

No	Variable	Descrip. Statistics				Variables																	
		Mean	S.D.	Min.	Max.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
1	Open Innov.	0.86	0.35	0	1	1																		
2	Mrt. part.	0.67	0.47	0	1	0.582	1																	
3	Scien. part.	0.72	0.45	0	1	0.648	0.235	1																
4	Co Vent.	0.64	0.48	0	1	-0.019	-0.147	0.039	1															
5	Open Innov*CoVent.	0.55	0.50	0	1	0.444	0.127	0.337	0.824	1														
6	Mrt part*CoVent.	0.40	0.49	0	1	0.329	0.565	0.154	0.611	0.741	1													
7	Scien. part*CoVent.	0.47	0.50	0	1	0.38	0.019	0.586	0.705	0.856	0.548	1												
8	sum FTE	8.46	6.85	0	66.00	0.229	0.269	0.278	0.026	0.135	0.206	0.191	1											
9	AVG PMM	0.77	0.14	0	1	0.094	0.216	0.032	0.21	0.129	0.007	0.136	0.133	1										
10	Proj. Leadership	4.05	0.95	0.69	5.55	0.115	0.073	0.127	0.021	0.068	0.042	0.093	0.203	0.092	1									
11	Nr. Proj. lead	3.30	0.79	0	4.54	0.115	0.062	0.138	0.019	0.074	0.045	0.099	0.204	0.065	0.709	1								
12	Year orig. 2003	0.21	0.40	0	1	0.002	0.045	-0.054	-0.039	-0.052	-0.002	-0.074	0.061	-0.033	-0.426	-0.377	1							
13	Year orig. 2004	0.12	0.32	0	1	-0.016	0.03	-0.01	-0.113	-0.093	-0.048	-0.058	0.122	0.009	-0.19	-0.169	-0.186	1						
14	Year orig. 2005	0.18	0.39	0	1	0.028	0.061	0.07	0.036	0.065	0.09	0.068	0.073	-0.017	-0.086	-0.08	-0.242	-0.174	1					
15	Year orig. 2006	0.17	0.38	0	1	0.088	-0.058	0.089	0.04	0.075	-0.03	0.088	-0.007	0.013	0.126	0.048	-0.23	-0.166	-0.215	1				
16	Year orig. 2007	0.12	0.33	0	1	-0.087	-0.02	-0.083	0.099	0.029	0.048	0.002	-0.045	0.006	0.168	0.11	-0.188	-0.136	-0.176	-0.168	1			
17	Year orig. 2008	0.09	0.29	0	1	-0.015	-6E-04	-0.006	-0.002	0.001	-7E-04	-0.002	-0.084	0.002	0.221	0.196	-0.165	-0.119	-0.154	-0.147	-0.12	1		
18	Year orig. 2009	0.08	0.27	0	1	-0.013	-0.044	-0.02	-0.004	-0.017	-0.041	-0.022	-0.12	-0.003	0.248	0.344	-0.146	-0.105	-0.137	-0.13	-0.107	-0.093	1	
19	Year orig. 2010	0.03	0.17	0	1	-0.02	-0.065	-0.008	-0.043	-0.044	-0.071	-0.031	-0.108	0.061	0.199	0.205	-0.089	-0.064	-0.083	-0.08	-0.065	-0.057	-0.051	1

Table 17: Open innovation: project innovation lack of speed

VARIABLES	Model (1)	Model (2)	Model (3)	Model (4)	Model (5)	Model (6)	Model (7)
Open Innov.	0.553***				0.391*		
	-0.182				-0.224		
Co Vent.				-0.554***	-0.953***	-0.656***	-0.610***
				-0.118	-0.325	-0.216	-0.188
Open Innov*CoVent.					0.434*		
					-0.241		
Mrt. part.		0.533***				0.437***	
		-0.144				-0.185	
Mrt part*CoVent.						0.15	
						-0.246	
Scien. part.			0.155				0.153
			-0.142				-0.1686
Scien. part*CoVent.							0.071
							-0.225
sum FTE	0.0522***	0.0484***	0.0506***	0.0550***	0.0540***	0.0507***	0.0527***
	-0.014	-0.0139	-0.0141	-0.0136	-0.0137	-0.0137	-0.0138
AVG PMM	3.242***	3.054***	3.350***	2.875***	2.741***	2.601***	2.865***
	-0.601	-0.6	-0.598	-0.581	-0.589	-0.589	-0.586
Proj. Leadership	-0.085	-0.0829	-0.0834	-0.111	-0.115	-0.114	-0.116
	-0.0911	-0.0907	-0.0905	-0.0906	-0.0913	-0.0909	-0.0908
Nr. Proj. lead	0.609***	0.604***	0.618***	0.624***	0.613***	0.609***	0.623***
	-0.11	-0.11	-0.109	-0.109	-0.11	-0.11	-0.109
Year orig. 2003	2.449***	2.381***	2.451***	2.410***	2.439***	2.370***	2.444***
	-0.523	-0.524	-0.521	-0.511	-0.515	-0.515	-0.513
Year orig. 2004	2.125***	2.057***	2.118***	2.007***	2.019***	1.964***	2.018***
	-0.522	-0.523	-0.519	-0.51	-0.514	-0.514	-0.511
Year orig. 2005	1.099**	1.030**	1.124**	1.223**	1.189***	1.130**	1.218**
	-0.503	-0.504	-0.501	-0.492	-0.496	-0.497	-0.494
Year orig. 2006	1.429***	1.434***	1.468***	1.541***	1.514***	1.535***	1.549***
	-0.478	-0.478	-0.476	-0.469	-0.472	-0.473	-0.471
Year orig. 2007	0.926*	0.849*	0.924*	1.044**	1.061**	0.991**	1.058**
	-0.497	-0.497	-0.495	-0.487	-0.491	-0.491	-0.489
Year orig. 2008	1.256***	1.178**	1.223**	1.205**	1.223**	1.170**	1.215**
	-0.483	-0.484	-0.481	-0.472	-0.476	-0.477	-0.474
Year orig. 2009	0.577	0.557	0.607	0.602	0.584	0.569	0.609
	-0.481	-0.482	-0.479	-0.471	-0.475	-0.476	-0.473
Observations	19,531	19,531	19,531	19,531	19,531	19,531	19,531
Number of groups	558	558	558	558	558	558	558
Log Likelihood	-3220	-3217	-3224	-3214	-3208	-3207	-3213

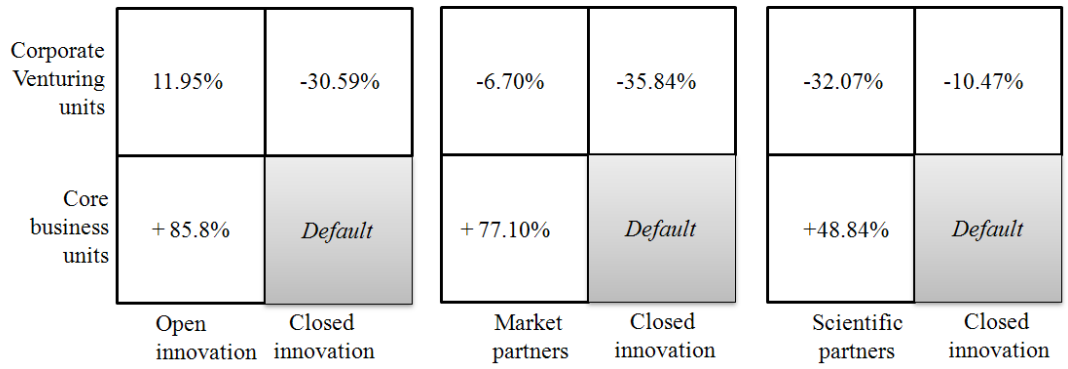
Finally, it is also interesting to look at our control variables, while both additional scientific resources (FTE) and project efficiency (PMM) can significantly accelerate innovation process. The standard approaches of project management (e.g.: stage-gate, milestones, regular monitoring & reviewing, etc.) seem to indeed help project proceed faster than the ones without such approaches. Additionally, project leaders' experience does not seem to be positively related to innovation speed. However, an interesting finding is that number of projects that project leader is managing in the same year also positively influences innovation speed. At the first glance, it may be because the more projects the project leader is managing in the same year, the smaller or less radical these projects might be. Also, these projects could benefit from cross-projects fertilization and accelerate the transfer speed.

Discussion

Along with the results from the event history analysis figure 11 summarizes our findings and shows the gains on innovation speed for closed and open innovation projects. First, compared to closed innovation projects in core business units (the default model), open innovation projects on itself are 73.85% quicker and research projects performed for corporate venturing units tend to be 42.54% slower. However, doing open innovation for corporate venturing projects is only 11.95% slower than closed innovation research projects for corporate venturing units (-30.59%). As predicted, compared to closed innovation, open innovation enables corporate venturing projects to be quicker by 26.85% ((1-11.95%)/(1-30.59%)-1). This finding provides evidence to confirm open innovation speeds up innovation projects (Chesbrough et al., 2006) and relinquish contradicting findings e.g. external sourcing creates problematic knowledge integration, more organizational barriers or lack of motivation (Kessler et al., 2000) that suggest external knowledge slow down the innovation process. Furthermore, we corroborate Vanhaverbeke's et al. (2008) finding that open innovation is an effective alternative to search for new technologies or business opportunities for corporate venturing units without risking excessive time and resources. Also, this paper gives a new innovation speed insight to Hill and Birkinshaw's (2008) corporate venturing configuration as it

matches the strategic logic and source of knowledge of a large technological company and shows possible gains in innovation speed.

Figure 11: Comparing innovation speed in ambidextrous firms



Similarly, compared to closed innovation projects in core business units, corporate venturing projects that collaborate with market partners are -6.70% slower which is better than in the absence of collaboration with market partners (-35.84%). Therefore, collaboration with market partners speeds up research project process by 45.42% ((1-6.70%) / (1-35.84%)-1), compare to those external projects with no collaboration. This results confirm previous findings that suggest collaboration with market partners speeds up the innovation process and increases quicker reaction to market opportunities (Langerak and Hultink, 2005). Moreover, this manuscript suggests collaboration with market partners speeds up innovation projects for corporate venturing units and extends the current knowledge on innovation speed and corporate venturing (Miles and Covin, 2002).

On the contrary, compared to closed innovation in core business, collaboration with scientific partners for research projects speeds up research projects by 16.76% and collaborations with scientific partners for corporate venturing projects slow down the speed by 32.73%. Now the results confirm scientific partners decelerate the speed of innovation projects for corporate venturing projects by 24.13% ((1-32.07%) / (1-10.47%)-1). These results suggest that scientific knowledge neither helps to speed up the innovation process nor shortens the speed of research projects for corporate venturing initiatives. These results suggest openness to scientific partners involves continuous

control and realignment of scientific goals, verification of results and IP regulation that extends the time before the technology is ready to be transferred. This finding is contradictory to the previous studies suggesting collaboration with scientific partners speeds up the innovation process (Mansfield, 1998) but supports the numerous countervailing factors such as the difficulty to integrate external knowledge (Grant, 1996, Katz and Allen, 1982). Furthermore, although open innovation and collaboration with market partners help to offset the low speed of corporate venturing projects, scientific partners tend to decelerate the gain in speed that could be obtained from closed innovation or internal technological skills. This suggests corporate venturing units should primarily rely on market related partners to quickly identify the potential of future technologies.

Conclusions, limitations and future research

In the current fast changing technological environment, firms need to expedite their innovation process to keep pace with competition and benefit from the latest technological discoveries. For this reason, firms have adopted open innovation strategies to collaborate and search for valuable knowledge among scientific and market partners. There are several interesting conclusions to draw from this study. Indeed, open innovation projects move faster from research to development units than close innovation projects (Chesbrough et al., 2006). Second, in contrast to scientific partners, only collaboration with market partners expedites the speed of innovation. This finding reveals that different counterbalancing issues influence innovation speed. Third, corporate venturing projects are slower than core business projects. Fourth, open innovation helps to offset the negative effect of corporate venturing projects compare to closed innovation projects for corporate venturing units. Fifth, only market partners offset the negative of corporate venturing projects and expedite the speed of innovation from research labs to development units.

These results extend previous open innovation contributions that refer to external search strategies (Leiponen and Helfat, 2010). First, although Laursen and Salter (2006) conclude in exploratory stages of the product life cycle firms need to deeply collaborate

with a small number of key sources of knowledge, this study concludes exploratory innovations should use market partners to speed up the innovation process. Broadly, this manuscript the effect of external collaboration and innovation speed with coordination costs (Kessler et al., 2000, Zander and Kogut, 1995) and broadly to the coordination and appropriation literature (Gulati and Singh, 1998). This study is, to our knowledge, the first study exploring external collaboration with scientific and market partners at the project research level within a multinational technological multinational firm. In particular, we focused on the effect of collaboration with scientific and market partners on the time to transfer a research project from research labs to business units.

In this study, we offer the first longitudinal analysis of innovation speed, at the project level and for core business and corporate business units, for one of the largest Technology Company in the world. These insights allowed us to capture and control for the micro-level variables affecting innovation projects i.e. scientific resources, project management maturity, project leader experience, number of projects lead by a project leader and the year of origination of the project. Until now, most research on innovation speed was based on survey data that has numerous limitations to reveal detailed innovation insights. Together, these contributions provide an excellent opportunity to connect and extend the research on open innovation and innovation speed.

Finally, this study has its limitations but also offers a number of opportunities for research. First, we focus only on the speed of the transfers while it may be interesting to determine whether open innovation projects generate more transfers to business units (and licensing arrangements with other firms) than closed innovation projects. Second, it is necessary to determine whether projects collaborating with external partners could generate larger market sales and improve firm's financial performance compared to projects that do not involve any type of external collaborations. Another future challenge is to determine whether collaboration with external partners improves over time as suggested by Chesbrough (2003). It is also interesting to determine differences among technological base of industries i.e. consumer products, pharmaceuticals, electronics that reflect differences in the time to transfer technologies. Further, future research could reveal whether endogenous factors could decrease the speed of innovation i.e. market

dynamism and uncertainty, market potential (Carbonell and Rodriguez, 2006, Guimaraes et al., 2002, Mansfield, 1988). Until now, these results reflect antagonistic effects and inconclusive findings on the benefits for the speed, for internal technology transfers from research labs to corporate venturing units, of combinatory sources of external knowledge. All this will give us a better understanding of the benefits of open innovation for firms and allow for the integration of research on new product development, dynamic capabilities and external search.

Policy implications

Numerous scholars highlighted the need to study innovation systems from an open innovation perspective (Cooke, 2005, Vanhaverbeke and Cloodt, 2006) as these combination will contribute to reinforce the relevance, improve the effectiveness and diversify of existing networks for future innovation policies (Wang et al., 2012).

In this thesis, the last two articles are meant to highlighted the weakness in two large innovation systems and suggest future innovation policies to strength Europe's and the Mediterranean's innovation systems. As observed, in table 18 these two articles are connected by overarching and already established innovation policies and activities to avoid the suggestion of difficult to implement initiatives.

Chapters VII and VIII suggest four areas where the European Union and the Mediterranean Innovation System should design new innovation policies to accomplish and open innovation system. Furthermore, for the European Union, a necessary intellectual property policy has been designed because this area needs special and immediate attention to facilitate the exchange of knowledge in technology markets. These two articles benefit from the collaboration with two different institutions, first Science|Business (http://www.sciencebusiness.net/) facilitated the access to corporate directors from large European firms and, second, IEMED (http://www.iemed.org) invited representatives from numerous Mediterranean countries for a general meeting. All the insights on open innovation, explored in the presented studies in this thesis, facilitated the recommendation of polices to enable more open innovation in two large innovation systems.

Table 18: Innovation policy implications

Linking innovation activities and policy	Open innovation and public policy in Europe		Connecting the Mediterranean System of Innovation
	Policies	**Programs**	**Activities**
Provision of knowledge inputs to the innovation process	Education, Development and the diffusion of human capital	Human capital creation	Provision of R&D and Competence Building
		Knowledge diffusion	
Provision of markets-demand site factors	Open government	Open government and open data	Articulation of quality requirements
		Extending the idea of open government	Formation of new product markets
Provision of constituents inputs to the innovation process	Promoting cooperation and competition	SME formation and growth	Creating/changing organizations needed for the development of new fields
		The locus of innovation is in the network	Networking through markets and other mechanisms
		-	Changing institutions that provide incentives or obstacles
	Financing open innovation: The funding chain	-	Financing of innovation activities
Support services for innovation firms	Adopt a balanced approach to intellectual property	a) Open innovation fostered by high quality patents; b) open innovation hampered by the high costs of the European IP system; c) Aligning incentives of researchers and industry; d) Activating unused IP in large companies; e) large scale technology collaboration; f) opening broader channels of collaboration; g) promoting intermediaries to facilitate the diffusion of knowledge; h) extending the IP scope beyond patents	a) Incubating activities; b) provision of consultancy services of relevance for innovation processes

Chapter VII **Open innovation and public policy in Europe**[10]

Industrial innovation processes are becoming more open. The large, vertically integrated R&D laboratory systems of the 20th century are giving way to more vertically disintegrated networks of innovation that connect numerous companies into ecosystems. Since innovation policy ultimately rests on the activities and initiatives of the private sector, it is vital that policy follows this evolution. Previous innovation policies relied on large companies to act as the engines of innovation in the EU. While large companies remain quite relevant to innovation within the EU, they themselves report that their processes involve many more SMEs and other contributors outside their own walls. Therefore, innovation policy must also move outside the walls of these large companies and consider the roles of human capital, competition policy, financing, intellectual property, and public data in promoting an environment of open innovation. In this report, we combine new research and analysis on open innovation with focused interviews of major participants in the European innovation system. The result is a series of recommendations for public policies that could, if implemented, improve the climate for open innovation to take place in the European Union – and thereby improve the competitiveness of the European economy overall. Taken together, these recommendations comprise an informal 'charter' for EU open innovation policy.

Keywords: Innovation policy, open innovation, innovation systems, intellectual property, financing innovation

Introduction

Open innovation is a rapidly spreading paradigm for business research, development and innovation. As outlined in Chesbrough 2003: *The distribution of knowledge has shifted away from the tall towers of central R&D facilities, toward variegated pools of knowledge distributed across the landscape. Companies can find vital knowledge in customers, suppliers, universities, national labs, consortia, consultants and even start-up firms. Companies must structure themselves to leverage these distributed pools.* Open

[10] **Published** by Chesbrough and Vanhaverbeke (2011) in collaboration with Henry Lopez-Vega and Tuba Bakici as a research report commissioned by ESADE Business School & The Science|Business Innovation Board
Full reference: Chesbrough, H., and Vanhaverbeke, W., (2011). Open innovation and public policy in Europe, ESADE Business School & the ScienceIBusiness Innovation Board, Brussels
Presented at The Innovation Convention 2011, 5th – 6th December, Square – Brussels Meeting Centre, Brussels, Belgium

innovation relies heavily upon the availability of external knowledge that companies assimilate and integrate into their businesses. Yet, the stock of available knowledge and its availability to firms cannot be taken for granted. This knowledge is the result of numerous, and often unconnected, public policies regarding science, technology, intellectual property (IP), and education within society. In this report, we will bring these background elements to the fore, and ask how governments can craft policies that support innovation in a world of widely dispersed knowledge, mobile workers, and venture capital (VC).

Many current public policy measures have their roots in the closed innovation era. They stem from a logic focused on developing large national or regional markets, protecting local companies, restricting foreign workers and students, and subsidising large local firms to keep them innovating. These prescriptions assume economic autarky, where national economies operate largely independently of one another. Yet, science and technology are nowadays widely diffused across the world. Most technologies are, nowadays, developed through a global network of technology partners. The number of technologies (even those that are thought to be crucial for national security) that can be developed and exploited within national borders is decreasing rapidly. Currently, no national or European government can reasonably hope to exclude a hostile government or interest group from having access to these technologies.

A similar reasoning applies to national procurement in EU member states for military and other technologies. Most national procurement regulations – especially those with military or national security applications – were born in a mindset of closed innovation. The increasing globalization and rapid proliferation of open innovation implies that governmental agencies cannot effectively exclude others from accessing widely available technologies. The same erosion factors that have caused private firms to move away from the closed innovation mindset are also forcing innovation policies to change. In the United States, for instance, experiments along these lines came from the CIA when it contributed financial capital to start a venture firm, InQTel. This VC firm is chartered with finding innovative start-ups to commercialise important software and communication technologies. Importantly, InQTel does not need to follow any federal

procurement regulation guidelines, and provides the CIA access to technologies that were previously difficult to access. In the UK, Qinetiq represented during its first years a similar initiative to set up commercial applications for military technologies. These initiatives make far better use of today's knowledge environment than policies based on a closed innovation logic.

Chesbrough 2003 examined several erosion factors that led to the decline of closed innovation. They included:

- Increasing mobility of trained engineers and scientists
- Increasing importance of venture capital
- Greater dissemination of knowledge throughout the world
- Increased quality of university research
- Increased rivalry between companies in their product markets.

These factors help to enable a new division of labor in the funding, conduct, and focus of research and development (R&D) in innovation systems. This new division has caused businesses to shift the focus of their internal efforts from more basic research discoveries towards more external sources of knowledge, and has caused businesses to seek new uses for their knowledge more aggressively than in the recent past.

However, one important difference between the perspective of a firm and the perspective of a society is that a firm benefits from a single clear and coherent business model, while knowledge-intensive societies benefit from a multiplicity of business models competing to create value out of ideas. Venture capital has become an integral part of the innovation system in leading OECD countries, and combined with increased labor mobility, the result has been a larger role for small and medium sized enterprises (SMEs) in the industrial innovation systems of these countries. These SMEs offer society a variety of possible business models vying to create value out of knowledge.

Starting up new companies and growing them into global businesses is crucial for the economic growth of an economy. The US economy has spawned new global players in industries that were embryonic or non-existent 20 or 30 years ago; examples include

Microsoft, Dell Computer, Cisco Systems, America Online, Genentech, Amgen, Millennium, eBay, Google, and Facebook.

Both the American and European economies have lost market share in manufacturing to the more efficient and responsive manufacturing systems of Japan and some other emerging Asian economies. The difference is that the European innovation system has been unable to copy the dynamism of the American innovation system over the last 20 years. Much of the American resurgence came from the ability of new firms to discover new industries, and of society's ability to redirect human, financial, and technological resources to these new firms and away from distressed industries. Moreover, this change went hand in hand with a more fundamental change in how innovation systems functioned. Internal R&D within large businesses became less important and gave way to external sourcing of technology, as SMEs and universities became strong technology players.

If Europe wants to keep or improve its competitive position in the globalising knowledge economy in the next decade, then public policy has to develop some basic guidelines that are in line with the imperative of open innovation. We will develop some suggestions for these policy guidelines in the following sections. Firstly, we focus on education and human capital development and diffusion. We then analyse how the transition from closed to open innovation requires new funding systems. Thirdly, we tackle policy issues related to intellectual property. Fourthly, we look at how open innovation encourages policy makers to look at networks rather than individual firms – and to promote competition and rivalry in product markets. Finally, we look at some topics related to open government. We finalise this report by drawing some conclusions that can be considered a charter for open innovation policies in Europe.

Education, development and the diffusion of human capital

Open innovation can only thrive in a society when two key conditions of human capital are fulfilled: the educational system must systematically create highly qualified labour; and knowledge workers must be highly mobile. There is a general consensus (in Europe) that the government has to play a role in fostering the creation and diffusion of high

quality knowledge within society. To realise this objective a society's educational system has to take a central role in innovation policymaking. Related to issues of creating a skilled workforce, are policies that facilitate the mobility of that workforce. Pensions, social security, healthcare, and other aspects of compensation are typically tied to employment, and this effectively constrains mobility. Making these benefits portable, or severing their tie to a specific employer, would enable workers to seek the best opportunities to use their skills.

Human capital creation

Top level research and technology development hinges on the availability of excellent scientists and researchers. Universities play a key role in educating new generations of researchers and scientists, and in generating new knowledge through research. Yet, a quick look at the worldwide ranking of EU universities compared to American universities in terms of publications and citation indices, Nobel prizes, valuable patents, and university spin-offs shows that the Americans do better in academic research. The relative position of Europe is also worsening as several non-Western countries rapidly upgrade their educational and knowledge infrastructures and quickly climb in the international rankings.

One reason: There is no transparency in the European educational system. It is not easy to compare universities in the same country, and international comparisons within Europe are much harder. It is crucial that European policy makers set up a ranking system for universities in Europe against which all institutions can be benchmarked (as the European Commission is currently considering.) Any metric is simplistic. But better rankings would offer students information about how much value they can expect for their money. As a result, good students would look for good universities, and so offer Europe much better researchers. When rigorous research assessments were introduced in the UK, university administrators began to think about their strengths and weaknesses. As a result, they either addressed their weaknesses or started differentiating their offerings from other universities by building on their strengths.

As well as educating new students and researchers as a key resource, universities and related research institutes also play an important role in advancing basic research. Only two decades ago, large industrial companies had enormous corporate R&D centres where research was oriented towards the mission of the company and each centre had greater scientific and technological capabilities than most universities. The majority of these central labs were dismantled – especially during the 1990s – because large companies were forced by shareholders to focus on short-term profits, or just plain survival. At the same time, the governments (especially in the US) were investing in research systems, national labs, and major universities. In this way, the incentives weakened for large companies to tackle (basic) research themselves, rather than working with major universities and, more generally, the innovation ecosystem existing in different countries. In consequence, as companies focused on applied sciences and the development and commercialisation of technologies, universities became the major (and maybe only) institutions driving basic science research. As a result, governments have to make investments in fundamental science – which, if managed appropriately, is a major source of new technological developments. The success of the Defense Advanced Research Projects Agency (DARPA) in funding basic research in the US in information technologies is a demonstration of how government funding, directed to decentralised research institutions, can yield cumulatively important research outcomes.

During our interviews with leading R&D managers in major industrial companies in Western Europe, there was a surprising unanimity that research in Europe is not 'in good shape' because of institutional inhibitors. While there is great research in Europe, getting more of it hinges on top researchers working in top institutes. Large manufacturing companies are interested in accessing the fundamental research capabilities of top-performing universities and research labs, but not second-tier universities. Hence, what counts is the presence of world leading research labs. Top researchers will work in universities and research institutes that can offer leading edge knowledge infrastructures, interesting connections or collaboration opportunities with other top researchers, and large, long-term projects (5-10 years depending on the technological field). The latter is necessary as it enables researchers to build a faculty that is large enough to cope with

important scientific problems and there is enough time to move the scientific frontier through scientific publications.

Europe faces problems in generating sufficient top-level research that can compete with universities and research institutes on a global scale. Unlike agricultural funding, R&D budgets are still mostly a national matter; 93% to 95% of all public-sector research spending in Europe is funded nationally. Of course, the European Commission has launched a number of central initiatives such as the European Research Council (ERC); but budgets are limited in comparison with those of the US National Science Foundation (NSF), the National Institutes of Health (NIH), and a number of private American foundations. As a result, there is no pan-European competition between universities as in the US. What provides the drive at American universities to have the best researchers and labs? Every lab must be funded every four to five years through national competition. Permanent competition is the best way to match budgets to the best technology. To this end, the European Commission should convince member states to transfer more of their R&D budgets to the ERC, provided that the basis for resource allocation is meritocratic and not political.

The current system used in the rest of the EU's Seventh Framework Programme (FP-7) projects, is not really a contribution to pan-European competition between universities/research labs. The requirement in many FP-7 projects that research partners collaborate with many different universities and many different companies adds cost and slows the pace of work. Participants lose their competitive edge, or seek funding elsewhere where administrative procedures are quicker and grants are usually larger. In sum, research programmes should be made competitive on a pan-European scale and universities should collaborate only if it actually improves the proposition.

Knowledge diffusion

Diffusion of knowledge is as important as creation to spur innovation within society. Yet many European countries have long-standing policies that constrain the diffusion of knowledge from universities to industry. For example, university lecturers in many European countries are civil servants, prohibited from working with and for private

companies while drawing a public salary. Consequently, universities cannot learn from management practices in industry. Graduate students in many of these same countries are effectively indentured servants of the lecturers they work for, and cannot seek out the best places to apply their cutting edge knowledge. Lack of mobility has other unintended side effects. When faculty members select their next research initiative, they do so in ignorance of the burning issues that need to be addressed in other areas, including industry. This ignorance multiplies when university staff reviews the research proposals of their peers to allocate funding, or oversee the training of their students. Research by Van Looy et al. (2004) demonstrates that researchers who work closely with companies doing applied research achieve higher quality rankings for their fundamental research than peers who do not collaborate with industry. Therefore, contrary to the traditional thinking, academics do not face a trade-off between collaborating with industry and doing fundamental research. Both activities are highly complementary.

Diffusion of knowledge between universities and business would be dramatically improved if academics could temporarily be employed in private companies, and vice versa. But at present, if an academic researcher leaves to work in a company and later returns, he or she cannot be promoted because they will not have published any papers during their absence from the university. A similar pattern emerges when managers take an academic post. However, there is some flexibility in this area. Some companies are sending managers to academia as part of their career development. This requires that the courses be adapted for the transition and that industry has a model of career development that deliberately advances the capabilities of managers.

There are other barriers to mobility of knowledge workers. Pensions, social security, healthcare, and other aspects of compensation are typically tied to employment. Making these benefits portable would enable workers to seek out the best opportunities to use their skills. Moreover, social legislation in Europe is largely determined by national authorities, which implies that labour movement between member states involves plenty of complicated paperwork. Further, there is an urgent need to develop a European economic immigration policy that lowers immigration barriers for a highly qualified labour force. This has proven to be a useful strategy for the US, where a continuous

inflow of highly qualified labour has supported American scientific, technological, and economic strength for decades. The EU could also learn from mobility policy in China, which has adopted a number of initiatives to encourage Chinese citizens who were working abroad to return to China later in their careers. These so-called 'sea turtles' bring a wealth of international business and scientific expertise with them, and help to rejuvenate the culture of the organisations in China that they join upon their return. However, this policy can only work when the research conditions in Europe are similar (or better) than those abroad. Top researchers will not return to their home country when the conditions for research are worse than those abroad. Finally, another area for EU reform is policy toward retirees. Yet with the continued progress in healthcare, longer life expectancies, and an aging population in most EU countries, there is too much valuable knowledge residing in the minds of retirees to be neglected. The time has come to tap into this source of 'seasoned' knowledge – whether it is through coaching, mentoring, teaching, project work, or other less-than-full-time employment.

In sum, labour mobility eases the tacit knowledge flow between organisations. Mobility also induces networking between organisations and knowledge spillovers (Cohen and Fields, 2000). Therefore, the productivity of a skilled workforce is determined by the quality of the skills as well as the mobility of the workforce. A fast flow of ideas generates more value than ideas that are locked into the boundaries of a single company.

Financing open innovation: The funding chain

The European Commission must consider new ways to channel financial resources to promising new ideas and business models. While education produces knowledge, it requires financial capital to take those ideas to market. Many traditional innovation policies erroneously provide direct incentives to companies (usually large companies) to undertake R&D. Such incentives take no account of the erosion factors confronting the recipients of these incentives, and under-serve small and medium sized enterprises (see Chesbrough, 2003, 2006). While companies will surely pocket incentives for research, their willingness to undertake additional research internally is offset by the problems of diffusion, of being able to profit from the technology they develop. As these problems

grow, more incentives will be required to stimulate the same level of R&D within the firms.

Thus, direct incentives for R&D are ill-advised; they require public managers to make judgments about the prospects and merits of innovation at private companies. These judgments are inherently subjective, and are best left to private equity suppliers, who compete to supply capital to promising opportunities. Competition enables a diversity of innovation approaches to be funded, and elicits greater investment in governance by the suppliers of this capital. These owners will also be able to adapt much more readily to new information than public servants.

If highly innovative companies drive economic growth, then the EU focus should be on the economic world and *the funding chain*. The funding chain conceptualises the need to have appropriate types of financing for *all* stages – from research to the establishment and growth of a new venture. In each stage, the type of funding has to change and different funding partners will be involved. Compared to the traditional innovation policy guidelines in Europe, more attention should be paid to the appropriate funding of the commercialisation of new ideas into real business opportunities. A smoothly working VC market is a crucial element in the funding chain.

The size of the venture capital market in Europe is about one quarter that in the US. The role of VCs is to finance ventures for a number of years. These ventures then need to grow and become competitive. Accordingly, in areas where technology cycles are long (especially in biopharmaceuticals, and aerospace) a venture cannot grow into a large company in just five years; 10 or 20 are needed. If there is no strong stock market, as at present, then VCs often have to sell the company prematurely to established companies. Acquisition by large companies is fine if economic reasons (such as complementary assets and global reach) drive it. But acquisitions that occur because VCs have run out of money lead to suboptimal solutions from a welfare point of view. Moreover, when the main acquirers are American companies in biotech for instance, the result limits economic growth in Europe. It is thus a matter of encouraging more investments into these start-up firms.

Unfortunately, new regulations for banks and insurance companies are reducing their investments in the stock market; and this damages new ventures. Europe needs proactive reform. Five to seven percent of savings could, for instance, be channelled into rapidly growing and innovative companies. Europe has among the highest saving rates in the world, but these funds are invested in low risk and under-productive areas. There is plenty for corporate and government bonds, but very little for growing companies. While fiscal policy is not directly in its legal authority to control, the European Commission could use its coordinating and exhortatory powers to have member-states provide new incentives for investment in R&D-based ventures. To do so, it could clearly define the target companies. They should be independent, not subsidiaries of larger companies. They should be spending 15% to 20% of their overall budgets on R&D. They should not be more than 10 years old. With the right investments, European high-tech ventures could create more economic growth in Europe.

Adopt a balanced approach to intellectual property

A government that wants to promote open innovation should provide private firms with enough protection to induce them to invest in creating new IP. At the same time, a government has an over-riding interest to ensure that technology is commercialised in as many ways as possible and disseminated widely throughout society. Policy makers should remain concerned with this apparent trade-off between incentives to innovate and ease of diffusion. But recent shifts in the R&D strategies of private firms may suggest that markets for technology can play a more important role in promoting diffusion than in the past (Arora and Gambardella, 2010b). As companies look to make greater use of their IP outside of their own businesses, the supply of knowledge available in the market should increase. Thus, governments should clarify the ownership of IP, and provide the institutional and legal support for its purchase and exchange.

However, this clarification of IP ownership should be limited in scope. In open innovation, firms invest in R&D to extend their current business models, and occasionally to search for new models. These firms cannot and do not make every conceivable use of their ideas within their own walls. Innovation policies for the

protection of ideas must accept the limits of what any single firm can do with its ideas and technologies, and promote the recombination and reuse of the available knowledge in other companies. Direct expropriation of such ideas without compensation would be a terrible policy. But granting wide-ranging ownership rights to ideas that are not strictly controlled in their novelty, usefulness, and non-trivial nature is equally problematic. The first realisation of an idea is often incomplete. Granting broad ownership rights could strangle the follow-on innovative work that enhances the value of that idea. For similar reasons, granting ownership rights to ideas for very long periods of time can be problematic. A balance must be struck between invention and diffusion. And that balance is disturbed by several factors in Europe, from the cost of patent application to the local nature of the IP market.

Open innovation fostered by high quality patents

The European Patent Office (EPO) has the reputation of high quality, according to our interviewees. When the EPO grants a patent, it signals some embedded value when the inventor wants to license the technology, or when the start-up receiving the patent seeks external financing. The EPO approach also prevents companies becoming easily blocked (in developing or producing new products) by poor quality patent families owned by other companies or non-practicing entities (e.g. patent trolls) as was the case in the US until recently (the strategy of the US Patent and Trademark Office has changed in the last few years in this regard).

Clear legal protection of high quality patents is not in contradiction with an open innovation policy that strives to provide adequate incentives to undertake research and diffuse these discoveries widely. In fact, open innovation would literally be impossible without IP protection, as firms would resist sharing their ideas for fear competitors would steal them. Indeed, it can be argued that open innovation increases the need for robust IP protection. In developing a new medicine, for instance, the separate tasks of research, development, trials and marketing may be conducted by different companies or groups – yet the overall financial return still needs to cover the costs of each step plus produce profit margins for each participant. So, there is a need to generate the same or greater

returns to sustain all the parts of the R&D ecosystem – and this depends in part on robust IP. Within an open innovation framework, IP is not a fence preventing others from making use of a protected technology; but rather a bridge to collaboration with other firms and organisations. Indeed, leading scholars say a solid patent system provides opportunities for firms to overcome Arrow's (1962) 'disclosure problem'. However, there are still significant transaction costs in transferring technologies. Selling technologies in the marketplace is not fully leveraged and according to Gambardella, Giuri and Luzzi (2007) the market for technology could be 70% larger if transaction costs could be further reduced. The high percentage of unused but patented inventions could provide a ready supply of technology to the market if these costs could be addressed.

Open innovation hampered by the high costs of the European IP system

Europe has been working for almost half a century on its IP system (van Pottelsberghe de la Potterie and François, 2009). However, the current system remains overly complex, opaque, and unpredictable; and it constitutes a heavy financial burden for small companies or start-up companies. The European IP system is the most expensive and complex in the world due to its high level of fragmentation and translation requirements. Moreover, once a patent is granted by the EPO it must be enforced (i.e. translated, validated, and renewed on a yearly basis) by the national jurisdictions of the countries in which the patent is applied. The London Agreement, which intends to reduce the translation requirements for patents when they are validated at national patent offices in 15 out of 34 states, has led to a reduction in the cost of patenting by 20% to 30% (van Pottelsberghe de la Potterie and Mejer, 2010). Despite these savings, the relative cost of a European patent validated in six countries is still five times higher than in the US. These costs have a major impact on the number of potential patents that are not submitted (or withdrawn). The difference in price between the US and Europe partly explains why the USPTO attracts four times as many patent filings as the EPO (van Pottelsberghe de la Potterie and François, 2009).

IP is increasingly embodied in business strategies; and an efficient IP system is crucial in the development of more R&D collaboration and technology transfer. A bold shift to a

single European patent would drastically reduce the costs and complexity of the current system. This needs to be matched to a centralised litigation process via a single court. It is fundamental that this Pan-European Patent Court (known as the European and EU Patent Court or EEUPC) has clear rules of procedure and is run by a highly qualified group of IP judges. Otherwise, the perspective of a single patent being invalidated in any one of 27 member states after a trial of variable quality would be a significant step backwards.

There is room for improvement in other areas. The EPO is currently working to reduce the time to grant a patent (currently 49 months) that compares unfavourably to the JPO (31 months) and the USPTO (27 months). And van Pottelsberghe de la Potterie (2011) suggests a "50% reduction in entry fees for a well-defined group of young innovative companies up to the sixth year (the average duration of the examination period). A pay-back process (of the 50% reduction) could be scheduled for companies that keep their patents enforced for more than six years." Generally, open innovation should encourage European policy makers to invigorate the European patent system. Therefore, it is interesting to notice that the EU in the last 12 months has made progress on a unified patent system.

Aligning incentives of researchers and industry

Researchers at universities and other public labs carrying out research for companies always face tension between their desire to publish early and the requirements of the contracting companies to keep inventions secret until a patent is filed. Currently, a patent application will be rejected in Europe if the invention has become publicly available before the application was filed. This includes selling the invention, giving a lecture about it, showing it to an investor without a non-disclosure agreement (NDA), or publishing it in a scientific journal. The US, by contrast, has a one-year grace period. This means that the inventor there can freely publish without losing patent rights. The European patent system would benefit from the introduction of a similar grace period. In general, IP discussions between research institutes (or universities) and companies can troublesome if:

- Academic centres over-value their IP and over-estimate the odds of making a profit, leading to elevated expectations of royalty payments that make projects untenable; or
- Academic centres attempt to patent their work but do so badly, leading either to a lack of protection in key global markets or – worse still – creating 'prior art' that invalidates patents on more useful developments of the same technology.

These collaboration problems in research institutes or universities require professional IP management.

Activating unused IP in large companies

Multinationals have vast portfolios of patents. To protect their inventions a company such as Philips files, via its Intellectual Property and Standards organisation (IP&S), an average of 1600 patent applications annually. It owned 55,000 patents in 2009, and employed 500 IP professionals and support staff worldwide. However, about 85% of all patents of large companies are never used in new products, or are used to deter potential competitors. From a public policy point of view, unused patents represent a large untapped source of knowledge that could create new companies and economic growth if there were an efficient way to 'activate' these unused patents in other companies.

To be sure, major companies with large patent portfolios can monetise unused technologies. Patents are frequently used as tickets in cross-licensing negotiations (mostly) with other large companies. However, licensing technologies from large companies to small firms, or creating new ventures based on the IP of large companies, is not common practice everywhere. Licensing out technology or spinning off ventures requires time and energy. And the return is likely to be small, as SMEs and start-ups generate insufficient revenues to seriously interest a large company that wants to monetise its unused IP. There are exceptions, however. Microsoft, for instance, has established a unit called IP Ventures, which partners with start-ups, venture capitalists, and government agencies to take inventions created by Microsoft Research and put them in the hands of entrepreneurs and small companies. Microsoft is working closely with government economic development agencies such as Enterprise Ireland and the Finnish

National Fund for Research and Development (Sitra) to transfer technology and spur the growth of small businesses. Licensing out IP is also an increasing trend in pharmaceutical and chemical companies.

Large scale technology collaboration and IP agreements

IP transfers can take more complex forms than bilateral agreements between two organisations. The growing complexity of technologies is forcing companies to team up with various types of partners in broad consortia. Examples include the IIAP programmes of IMEC, CTMM, and IMI. In IMEC's Industrial Affiliation Programmes, IMEC invites partners to collaborate on precompetitive research on nano-electronics and uses the so-called fingerprint IP-model to deal with background IP in collaborative research and IP-ownership and the use of jointly developed technologies (Helleputte and Reid, 2004). The Centre for Translational Molecular Medicine (CTMM) develops medical technologies that enable the design of new and 'personalised' treatments for the main causes of mortality and diminished quality of life (cancer and cardiovascular diseases and, to a lesser extent, neurodegenerative and infectious/autoimmune diseases). It is a public-private consortium that comprises universities, medical centres, medical technology firms, and chemical and pharmaceutical companies. CTMM is using a similar IP model as IMEC to distribute the benefits of the joint research among the participants (including those that cannot generate patents, such as hospitals).

The Innovative Medicines Initiative (IMI) is a partnership between the European Union and the European Federation of Pharmaceutical Industries and Associations (EFPIA). The aim of IMI is to support the faster discovery and development of better medicines for patients and to enhance Europe's competitiveness by ensuring that its biopharmaceutical sector remains dynamic. Participants in the IMI (research institutes, SMEs, and large pharmaceutical companies) generate IP which is owned by the participant(s) who generated it (or when no individual participant can be identified the IP is jointly owned by those who have carried out the work). Participants have access to the knowledge developed in IMI before completion of the project and they have access to IP for research

purposes after the project. Beyond the research, participants may use, sublicense, or commercialise the foreground they own.

These complex forms of joint research require careful thinking about ownership and the use of commonly developed IP. The pressure on universities to generate revenues from their research can exacerbate problems in some IP negotiations. In the IMI, for example, competing pharmaceutical companies agree that results of pre-competitive research can be made freely available, but some university technology transfer offices want ownership over any IP generated by their work. The idea of academic centres being worried about appropriating returns, while industry at times accepts free access, runs counter to many public expectations; but it represents an important trend. These complex forms of multi-partner collaboration are shaping the future of European research; therefore, it is desirable that policy makers help in encouraging collaborative IP rules based on good practices. The current FP7 IP rules are not adapted to these complex forms of collaboration.

Opening broader channels of collaboration

Open business models have proven very effective in different parts of industry. In many cases, firms with considerable IP assets have decided to open specific parts of their IP portfolio to communities of practitioners or users. For example, IBM's IP Collaborative Innovation initiative pledged 500 patents to Open Source communities, launched an Open Innovation Network, and established an American university summit for open collaboration. Similarly, Sony and Nokia have decided to share a portion of their patent portfolios to stimulate innovation in green technologies. Another successful collaboration is the GreenXchange, a breakthrough concept for sharing IP among companies that are working on sustainability issues in the footwear sector. And Microsoft is increasingly cooperating with major Linux software providers to enhance the interoperability of Windows and Linux through joint technology development. As customers want to use both systems to work together seamlessly and efficiently, Microsoft and Novell created an IP bridge between the worlds of Open Source and proprietary software.

Promoting intermediaries to facilitate the diffusion of knowledge

Recently a new form of third party – innovation intermediary or 'innomediary' - has emerged around the world. NineSigma, InnoCentive, Yet2.com, YourEncore are a few. These intermediaries facilitate collaboration across technology markets by providing innovation platforms that link companies with potential problem solvers, and facilitate the diffusion of knowledge or technologies.

There are significant transaction costs in transferring technologies. Selling technologies in the marketplace is not fully leveraged and according to (Gambardella et al., 2007) the market for technology could be 70% larger if transaction costs were reduced. These new intermediaries are shaping the market for technologies, and they help make the market for knowledge and IP more transparent; EU policy makers should take note. The intermediaries have been mainly focused on major companies as clients, but there is enormous potential for using their expertise to solve problems for universities, research labs, and SMEs. These cannot currently afford these innovation intermediaries; and so policy makers could analyse how costs could be lowered to an acceptable level for these groups.

Extending the IP scope beyond patents

Patents are only one form of IP protection and are very good for protecting IP that is related to a broad range of technologies. For instance, in the pharmaceutical industry patents are used for protecting the molecular structures of medicines. But the industry has always sold more than that; value is also determined by knowledge about how these medicines can and should be used. The knowledge is generated in clinical trials, which now account for around 60% of the R&D costs (up from 50% a decade or so ago). Moreover, drug manufacturers are being asked for ever-greater amounts of data by regulators and reimbursement agencies, and this data is costly to produce. Thus, Data Exclusivity (DE) is another important form of IP protection for pharmaceutical companies; it is generating incentives for companies to collect data (particularly clinical data) on a medicine to investigate its value in treating new indications. Hence, it is

important in the context of open innovation that policy makers pay attention to the increasing heterogeneity of data and information.

Similarly, trademarks, copyrights, trade-secrets and industrial design rights are important in the discussion of an open innovation policy. The emergence of the Internet is changing and will continue to change the business models that are used in many service industries (Chesbrough, 2011). Policy measures can have a considerable impact on the speed and direction of these changes – as we have seen in the music industry – but the European Commission could play a major role in proactively ensuring that IP regulation supports the conditions for business model changes in several services industries that rely on these types of IP protection.

Promoting cooperation and competition

Open innovation can only prosper when policy makers avoid monopoly and promote rivalry within the economy. If market competition is strong within an industry, firms will be motivated to find ways to exploit their ideas as fully as possible. If market leaders are in a position to enforce monopolies in their markets, then the open innovation process can easily break down. Monopolistic firms could attempt to hoard their ideas and technologies and exclude them from rivals. In the process, other ways of using these ideas in society could also be thwarted. In an open innovation era, a narrow focus of policy on large companies is no longer effective. Policy makers must focus on the innovation ecosystem and pay more attention to start-ups and SMEs. That focus requires greater attention, as well, on the regulatory barriers and problems of coordination, which can slow the uptake of new technologies – a problem that the European Commission has noted in its recent Innovation Union strategy.

The locus of innovation is in the network

Nowadays, knowledge is abundant and the technology landscape is scattered. Therefore, policy makers have to shift their support from single firms to the innovation ecosystem that is creating and commercialising technologies. They have to look at the different nodes in the 'food chain,' from science to commercially viable product introductions.

Innovation policy can play a crucial role in stimulating innovation systems in which universities, labs, start-ups, and large companies jointly create new market opportunities. The locus of innovation is no longer in the firm but in the network (Powell et al., 1996). An analogous shift in policy making should redirect the policy focus from single large companies towards networks or ecosystems in which innovation partners jointly create new business opportunities.

Pharmaceutical companies, for instance, experience quick changes in their innovation process. Industry officials say their R&D productivity has declined in recent years. Attrition rates in development have remained high. At the same time, spending has increased to cover the rising demands for clinical data from regulators and payers. As a response to declining research productivity, these companies have adapted their R&D organisations. More and more stages of the R&D process are undertaken through collaboration or out-sourcing. At the research level, companies deploy many different models for creating effective collaborations: contractual research agreements for specific research tasks; bilateral agreements with individual universities and research groups; collaborations with other companies on areas of pre-competitive research; bi-lateral agreements with other companies to progress specific research areas or specific high-cost development projects. Some companies have a venture fund and external research experts dedicated to finding partners and generating new deals and collaborations.

SME formation and growth

This shift to the network also implies that innovation public policy should seek to cultivate and strengthen small and medium sized firms. Their vitality will infuse a greater dynamism into the economy, as those companies that survive will embody new combinations of knowledge, and new business models to commercialise that knowledge. These companies will also spur greater innovation from larger companies. They provide large companies with demonstrations of the commercial viability of new approaches to commercialising ideas, and their success confronts incumbent firms with hard facts that they ignore at their peril. Incumbents will respond to the demonstrated success of new firms with new combinations of knowledge far more rapidly than they will respond to

any direct government programme targeted to support them. Start-ups often have new technologies or are highly creative in developing new business models to commercialise knowledge; therefore, they are also great sources for large companies to in-source new technologies and business models for commercialising technologies.

To spur open innovation, policy makers should facilitate the creation of start-ups and encourage entrepreneurship in the European economy. They must also spur cooperation between SMEs and large companies to discover knowledge about the functioning of technologies and enact new technological ecosystems as system integrators. Finally, a new breed of managers is needed in large companies with the skills to set up new ventures such as spin-offs based on unused but patented technologies.

European VC-backed ventures should be able to grow into fully developed businesses that can compete on an international or global scale. There should be different financing schemes all the way from seed to late stage; otherwise too many European high-tech ventures will be acquired by large American and Chinese companies. If there is sufficient money available in the VCF market then start-ups can develop new manufacturing and distribution assets. The composition of the boards also plays a role in stimulating high-tech start-ups. These companies need directors who know the industry very well. In Europe, executives from large companies do not usually want to 'waste their time' being board members in small companies. However, large companies that do encourage their directors to sit on small boards (such as Microsoft, Novartis, GE, BP, Pfizer and DSM) generate two effects. Firstly, board membership gives early access to new technologies with considerable business opportunities. Secondly, the directors bring their experience to the start-up company. Let's take, for instance, the Novartis venture fund. When Novartis invests in start-ups it shares its views on the industry with the start-up, and brings a great deal of expertise from the pharmaceutical industry. This is of enormous value for the start-up because, while a small company may have vision and new technologies, it will probably also lack many managerial skills necessary to avoid obvious mistakes. A good board significantly increases the economic viability of start-ups. Governments should incentivise large companies to encourage their directors to become board members in start-ups.

The way in which VCs are managed is also very important. In America, VCFs are mostly managed by former entrepreneurs and former executives of large technology companies who have become investors. This approach is the right way to do it. Growing new ventures is not about how to analyse profit and loss accounts – investors have to know the field, the technology, and understand the value proposition that will create competitive advantage for the venture. Too often in Europe venture capital firms are headed by people with a financial background, and no experience in industry or academia. Consequently, there is a high risk of making mistakes or making overly conservative decisions – creating followers instead of leading ventures. Therefore, it would be good in Europe to stimulate the formation of independent VCs that are led by people with a strong research, clinical, or industrial background. The EC could, for example, launch a programme through the European Investment Fund to stimulate the creation of new funds – provided there is a new team with a broad, international background.

A final note: more than funding is required if SMEs are going to be able routinely to launch major medicines again. Regulatory and market reforms are also essential (these would benefit big and small companies). Growing needs for deep scientific knowledge, increasing sensitivities to risk (and liability), ever-greater demands for data from regulators and payers, and the need to globalise revenues to generate ROI have made launching medicines a difficult game for all, large or small. The Commission's attention to these issues – for instance, in its proposed European Innovation Partnership on healthy ageing – is needed.

Expanding open government

Governments are the owners of the largest databases in the world with unprecedented possibilities for new and functional technologies and information for commercial and other uses. To establish a transparent, accountable, and innovative management system, governments are transforming their public services into more open, accessible, and collaborative structures. However, the most powerful information sources are nowadays not in the hands of the governments, but in hands of large corporations like Google (De Jong et al., 2008). The rapidly growing global distribution of information via internet is

an important driver of open innovation. But the uncontrolled growth of online knowledge repositories can also hamper open innovation. Easy access to these repositories is considered critical to open innovation. Thus governments have to be vigilant and monitor the evolution of online repositories to ensure that private companies do not have a monopoly over information that is useful for society.

Open government and open data

Recently, there have been several 'open data' initiatives around the world promoting interactive sharing of information between the government and the public. Open data refers to a practice of making data freely available online in a standard and re-useable format for everyone to use (Fung and Weil, 2010). City halls collect extensive data about residents and the city. 'Data' in this case refers to everything from electoral statistics to the location of schools or parking lots.

As governments realise the benefits, open data has emerged as an essential movement across the world. Many local and national governments have created their own 'data portals' to list data (such as 'data.gov.uk' in the United Kingdom). These open data portals allow citizens to access all public information obtained during public affairs management in standard and re-useable formats. Thus open data is the key foundation of an open government initiative. The social benefits of open government vary from citizen engagement to increased transparency and accountability, or enhanced communication channels. For instance, citizens gain greater insights into how their taxes are spent. Real time availability of information also increases the potential to create extra services.

Open government also supports public sector innovation through diminishing bureaucracy and friction in data exchange and demolishing competitive advantages gained by proprietary access to data. Innovation is most likely to occur when data is available online in open, structured, computer-friendly formats for anyone to download (Robinson et al., 2009). Excellent examples include the USPTO and EPO databases about patents that are applied for and issued in the US and Europe respectively. These databases have been used by thousands of researchers and have advanced our

understanding of the role of innovation in creating competitive advantage at the firm level and wealth creation at the macro-economic level.

To foster innovation, government entities often use 'contests' to encourage citizens to collaborate. 'Apps' contests are common (such as 'Apps for Democracy') to build web applications and services with open data. US government agencies have also launched challenges such as Challenge.gov or NASA Centennial Challenges Program for citizens to provide and share their solutions and innovations with the government. Other platforms for communication include 'Blue Button,' an online health portal where people can download their health information securely and privately; or 'Federal Register 2.0,' an attempt to organise articles into news sections for readers to browse by topic and by government agency, and which enables citizens to submit comments on regulatory actions.

Since government data is important for both government and citizens, a clear policy on how governments should open and distribute their data is required. Open data projects use the following principles: data should be complete, original, available online (such as in HTTP format) or in structured formats such as XML, uniquely addressable, machine readable, license-free without limitation for anyone or anything, and offered in a timely manner (Robinson et al., 2009). Furthermore, governments should develop a central online portal so that data can be browsed and downloaded by citizens. There should also be a commitment by the government to regularly update data.

But there remains a number of areas where details must be worked out. Much government data is dispersed and some is still not fully disclosed. Deciding which data should be published is an important decision. Today many politicians strongly believe in the public's right to access all information – even information that is directly related to national security and privacy issues. To accomplish this, there are certain guidelines for how to ensure disclosure while protecting national security and individual privacy. Thus governments should strike a balance between the requirements of openness and considerations calling for non-disclosure.

Extending the idea of open government

The idea of open government can be extended to areas where the government is a monopolist. Public procurement drives demand for innovative goods and services – as analysed previously (Aho, 2006). Examples where public purchases play a crucial role in driving top technology are defence, aerospace, road and railway infrastructure, and specific ICT applications. These purchases of innovative products encourage suppliers to generate top technologies that also represent interesting but untapped sources of innovations in commercial applications. There are numerous examples of how military technologies can successfully lead to commercial applications. The same holds for aerospace technology, which even leads to new products in low-tech industries – see, for example, Quilts of Denmark's functional quilts, based partly on NASA technology.

However, the commercialisation of technologies developed in these industries does not come automatically. On the contrary, companies that develop high-tech products for governments usually have priorities and capabilities other than those required to develop commercial products. Usually, other types of organisations handle commercialisation. A few examples include MILCOM Technologies (now part of Arsenal Venture Partners) and (the early) Qinetic. Both organisations search for interesting technologies that have been developed originally for military purposes and turn them into commercial applications through licensing deals or new ventures.

Starting with the 1958 National Aeronautics and Space Act, some US federal agencies such as NASA have been required to facilitate the transfer of technology to other sectors. NASA has established 1700 spin-offs and has organised itself to actively pursue market opportunities. The transfer, application, and commercialisation of NASA-funded technology occurs in many ways – knowledge sharing, technical assistance, intellectual property licensing, cooperative research and technology projects, and other forms of partnership (such as the NASA Open Government Plan). Similarly, the Space Foundation is a national non-profit organisation in the US that is certifying products that originate from space-related technology or use space-derived resources for consumer benefit.

Governments can further stimulate the commercialisation of these technologies through funding. In the US, the Small Business Innovative Research (SBIR) programme distributes $2.5 billion per year in R&D grants across 11 federal agencies, including $1.2 billion distributed by the Department of Defense. Companies whose products have high transition potential are eligible for 'commercialisation' funding.

In conclusion, to encourage collaboration and innovation, the old top-down model of government data management must be changed into a networked model. The scope of open data should also be expanded. Publishing data in bulk must be a government's first priority as an information provider. By publishing data in a form that is free, open, and reusable, governments will empower many innovative ideas. However, the provision of data alone will not lead to the goals of open government. Governments need to design effective legislation and policies to support this collaborative approach with citizens. Data must be processed and an open government ecosystem should be created. Open government, if implemented effectively, can improve the accountability of government, as well as boosting innovation in and beyond the public sector.

Public policy makers can also play a role in encouraging the commercialisation of technologies that have been developed in industries where the government is the sole customer. Examples include the defence industry, aerospace, road and railway infrastructure, and national security. Many of these technologies have the potential to be commercialised; but this does not happen automatically. The development of commercial applications for these technologies requires the help of specific organisations that are specialised in detecting and developing commercial applications. Governments should look at good practices and accelerate the search for commercial applications for these captive technologies.

Summary of policy recommendations

Many past and present innovation policies stem from a logic that is reminiscent of a closed innovation mindset. These may have been appropriate a generation ago, but are no longer appropriate to the innovation needs of the EU in the 21st century. Instead, an open innovation mindset is required.

We have summarised our recommendations in five areas:

Education and human capital development

The EU is fortunate to have tremendous human capital resources at its disposal. Nonetheless there are some important changes to be made that would strengthen the excellence of research that emanates from this pool of human capital.

Increase meritocracy in research funding – Too many research programmes within the EU sprinkle money across all the member states, with insufficient competition for these resources. The result is politically popular; but economically, the funded programmes lack the excellence and scale to produce world-class research and technology. Research funding competitions should move to the EU-level wherever possible, to reward excellence and promote the promising ideas of new scholars. The European Research Council is a good step forward – and should be enlarged.

Support enhanced mobility during graduate training – EU graduate training is world class in some fields in some countries, but not in others. While this condition will not change quickly, individual researchers can be given world class training if they are supported in conducting part of their training outside the EU and at the world's leading centres. In turn, EU graduate schools can broaden training by inviting the most promising scholars from outside the EU. A better ranking system for European universities would help inject much-needed transparency into the system, allowing students to make informed choices as they move. Likewise, more flexible immigration policies would also increase Europe's available brain power.

Financing open innovation: the funding chain

Funding open innovation requires a broader set of funding tools, reflecting the different financial needs at each stage of the process in which new ideas move from research and development into full commercial exploitation.

Introduce the funding chain concept: Growing ideas into profitable businesses require appropriate types of funding at each stage of the development and commercialisation

phase. A narrow focus on public subsidies for R&D inputs by firms is not in accordance with open innovation. The EU could start by encouraging member-states to grant tax incentives for small, R&D based companies.

Increase the pool of funds available for VC investment: The availability of VC funding is crucial to oil the innovation engine based on the establishment and growth of new ventures. Europe's VC market is dwarfed by the American market and this fact is slowing the growth and dynamism of the European economy.

Support the formation of spin-offs to commercialise research discoveries: Great technical ideas do not get commercialised because they are early-stage and too risky to be privately funded. Reflection is needed on how policy can help providing funding to early-stage ventures.

A balanced approach to intellectual property

One of the most powerful levers government has to stimulate innovation is to design intellectual property policies that reward innovative initiatives while also stimulating the diffusion of innovations throughout society. Ironically, in an open innovation world strong IP protection is vital, to permit firms to share knowledge; but at the same time a balance must be struck to ensure rapid flow of ideas.

Reduce transaction costs for intellectual property. Current IP policy is anchored in each member country of the EU, fostering multiple filings, multiple language translations, and creating much high costs for EU patents. We need to move to a single EU patent, backed by a unified judicial process, to lower the costs of patent protection to those of rival regions. Current costs are particularly onerous for SMEs.

Foster the growth of IP intermediaries. There is a growing market for IP, and the EU should encourage the expansion of this market. In addition, it should fund research into the functioning of IP markets so that future policy can be based on new and better evidence.

Rebalance EU policy towards universities with publicly funded research. Too many universities are focused on maximising the royalty income they receive from publicly funded research. The focus on royalty income, encouraged by governments trying to capture as much value as possible from their funding, may limit the flow of knowledge to industry which, in turn, hampers the technological progress and competitiveness of the industry. A more balanced approach would be to give greater weight to the overall social and economic impact of publicly funded research, with particular emphasis on broadly diffusing the research output within society.

Promoting cooperation, competition, and rivalry

Competition is vitally important to innovation. It enhances the willingness of firms to take the risks that advance new thinking, new processes, and new markets in an innovative society.

Shift support from national champions towards SMEs and start-up companies. SMEs are powerful agents of innovation diffusion within a society. Even when large firms remain at the top, the presence of striving SME firms in their industries forces large firms to innovate more rapidly to keep ahead. Policies should support SME formation, expansion, and exports outside the EU.

Promote spinoffs from large companies and universities. Many innovative ideas start small, too small to be of interest to large companies. Many other ideas start inside a university lab, but require risk capital and entrepreneurial management to move into the market. Government can help facilitate these spin-offs by encouraging the transfer of IP to these spin-offs (perhaps providing tax incentives for large companies) and supporting the invested risk capital.

Focus on innovation networks. The locus of innovation is no longer in single large companies; but in innovation networks involving a mix of partners: universities, labs, start-up companies, multinationals, and governments. The relationship between these players largely determines the overall performance of an innovation system. The success of large firms hinges increasingly on their ecosystem.

Expanding open government

Government is not a bystander in the innovation system. It possesses a wealth of information distributed through a myriad number of databases that are often difficult to access. Government also buys innovation from many suppliers in society, and its opportunities to foster innovation through its procurement activities also deserve more attention.

Accelerate the publication of government data wherever possible. Citizens and companies can often spot wonderful innovation opportunities if given the necessary information. This has already been demonstrated through mashing data from different sources, and developing applications to analyse and interpret public data.

Utilize open innovation in government procurement. When buying new technologies, create and employ open innovation intermediaries to seek out solutions from anywhere in the world, vs. the usual suppliers to the government. The U.S. Department of Homeland Security, for example, has created a government organisation, SECURE, to procure defence and security-related technologies using open innovation.

Foster commercial application of technologies developed for the government. Public policymakers should encourage the commercialisation of technologies that have been developed for military, aerospace, road and railway infrastructure, and national security. Many of these technologies can be turned into interesting commercial applications, but this process will not happen automatically without government incentives.

Chapter VIII Connecting the Mediterranean System of Innovation: A functional perspective[11]

This paper provides a first exploratory overview of the Mediterranean System of Innovation (MSI) and presents the results of an interactive work with 25 different innovation delegates from northern and southern Mediterranean countries. The study comes at the turning point where the Union for the Mediterranean is designing future innovation policies and debating the mechanisms to boost central activities. This research benefits from the established literature on Systems of Innovation to study the means Mediterranean countries use to advance its innovation capacity. In collaboration with IEMed, this research invited delegates from northern and southern Mediterranean countries, program directors and representatives from the European commission to discuss national and regional activities in their own countries. The data shed light on how activities conducted by public and private organizations influence the formation of different system functions as well as showed that R&D support is slightly changing to services and business models. Finally, it highlighted the relevance of having a defined innovation strategy necessary for increasing the existing capabilities. The value of this research represents the application of the highly accepted system of innovation functions perspective to the Mediterranean System of Innovation and the description of existing enabling and blocking mechanisms.

Keywords - Mediterranean System of Innovation, innovation systems, innovation intermediaries, system functions, Union for the Mediterranean

Introduction

In the last years we have witnessed in Europe a change in the factors that provide competitive advantage to regions, nations and continents, from policies supporting economic growth to ones fostering innovation. The later are concerned with connection, collaboration and coordination of research, education, industries and public policies (Etzkowitz and Leydesdorff, 2000, Leydesdorff and Meyer, 2006). Currently, the Mediterranean region is experiencing similar institutional changes as a result of recent programs and agreements under the initiative "Union for the Mediterranean" that attempt to establish a long lasting and stronger collaboration among Mediterranean countries. However, two large distinct scenarios represent the initiation of this turning point. On the

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one hand, successful experiences emerge out collaborations between the Mediterranean countries and Europe that consummated on the advancement in economic and social fields. On the other hand, sustainable and long-lasting programs in the Mediterranean region remain vague. Apparently, reasons justifying this juxtaposing scenario lay out in: a) the lack of strengthened structures and the low capability of creating new ones; and b) the absence of systemic governmental programs for cooperation between Europe and the Mediterranean.

An established framework to study this phenomenon in Mediterranean area and give advice to policy makers is Systems of Innovation (SI) that could be interpreted as the study of continuous institutional arrangements providing connectivity among economic actors (Carlsson, 2007). In this respect, the SI framework provides researchers with sufficient theoretical instruments to explain the performance of the SI grounded on: a) the dynamics of learning processes; b) historical and evolutionary perspectives; c) emerging inter-organizational interdependencies; and d) the role of institutional arrangements to promote innovation (Edquist, 2006). On the other hand, policy makers are using this framework to accelerate and increase market interactions to stimulate the generation and transfer of knowledge, skills and competences necessary for the formation of spillovers and economic growth.

Research on systems of innovation has progressively expanded its focus of study, traditionally at the national level (Lundvall, 1992, Nelson, 1993), to explain innovation at the continental (Freeman, 2002), regional (Cooke et al., 2004), sectoral (Malerba, 2004) and technological levels (Bergek et al., 2008). Further, it contributed to other theoretical fields such as innovation, and social networks (Assimakopoulos, 2007, Dodgson et al., 2008), knowledge and learning (Lorenz and Lundvall, 2006) and innovation policy (OECD, 1997). Furthermore, recent contributions suggested a ‘functional’ approach (Bergek et al., 2008, Chaminade and Edquist, 2006) suitable to comprehend structural components, and dynamic relationships as well as influencing the creation, diffusion and exploitation of innovation.

Previous research on continental systems of innovations has been conducted for Europe (Arundel et al., 2007) and Scandinavia (Lundvall, 2008). A review of the literature, however, revealed no single contribution has made the effort to comprehend the dynamics and components of the Mediterranean System of Innovation (MSI)[12]. The relevance of studying the Mediterranean area is due to major agreements to consolidate the 'Union for the Mediterranean' that will not only influence the formation and development of the MSI but also a Mediterranean solar energy plan, the inauguration of the Euro-Mediterranean University, and the Mediterranean Business Development Initiative focusing on micro, small and medium-sized enterprises, the de-pollution of the Mediterranean sea, the establishment of maritime and land highways, civil protection initiatives to combat natural and man-made disasters.

This paper is concerned with the study of the dynamics of the Mediterranean System of Innovation through the lenses of the systems of innovation framework. We asked ourselves the following research questions: *could the innovation systems functional framework explain the Mediterranean System of Innovation?* And *what are the central enabling and blocking mechanisms?* We respond to these questions with data cultivated from 25 selected innovation actors including politicians, project managers and academics from various Mediterranean countries in collaboration with the Institut Europeu de la Mediterrània IEMed (European Institute of the Mediterranean). Our analysis suggests the MSI has addressed different innovation functions but these still are on an emerging phase, particularly for southern Mediterranean countries, and are less focus on scientific or technological discoveries. Secondly, it suggested the design of system of innovation strategies and creation of intermediary organizations as two fundamental activities for the development of the system. In summary, the novelty of this contribution is twofold: a) an exploration of the structural components and dynamic relationships of the MSI and b) the perceived relevance of innovation intermediaries and innovation strategies as two lacking activities in the Mediterranean area.

[12] Our analysis is based on the Social Science Citation Index (SSCI) of Thomson-ISI available on the on-line database and consistent with the aim of our focus of study.

The remainder of this paper is structured as follows. The next section reviews the literature on systems of innovation and the systems functions described in the literature. The third section presents our research strategy and section fourth presents the results of the data analysis. Section five discusses our presented framework of the MSI seeking to increase the connection, collaboration and coordination among Mediterranean countries. The last section wraps up the paper with the conclusions, offers a brief discussion of the policy and theoretical implications of our work and suggests further research.

Literature Review

During the last decade, studies on National Systems of Innovation (NSI) blossomed providing not only academic research but also policy-oriented reports (Borras, 2003). Academic contributions included longitudinal explanations of national systems (Fagerberg and Srholec, 2008, Freeman, 2001, Nelson, 1993) that covered a wide range of organizations, institutions in both developed countries (Arundel et al., 2007) and catching up ones (Hu and Mathews, 2005). Recently, this framework benefited from the 'functional' approach to describe the overall dynamics of actors and institutions at different spatial levels. This section synthesizes existing research on systems of innovation.

Systems of Innovation

National Systems of Innovation are: a) defined as "the network of institutions in the public and private sectors whose activities and interactions initiate, import and diffuse new technologies"; and b) used to explain "how technological infrastructure differs between countries and how such differences are reflected in international competitiveness (Freeman, 1987, 2004)". The NSI literature differs from others such as Triple Helix (Etzkowitz and Leydesdorff, 2000) and Mode 2 (Gibbons et al., 1994) because it recognizes innovation as a process where: a) firms do not innovate in isolation but interact with others through complex relations; b) system components and relationships influence the outcomes; c) policies benefit the collective underpinning of organizations;

and d) the learning process to create new knowledge is fundamental for the system (Chaminade and Edquist, 2006).

Edquist (1997) suggest studies on systems of innovation should include "all important economic, social, political, organizational, institutional, and other factors that influence the development, diffusion and use of innovations" and, particularly, the careful study of embedded relationships between institutions and organizations. On the one hand, institutions are understood as sets of common habits, routines, established practices, rules or laws that regulate relations and interactions between individuals, groups and public, and private organizations and reduce the uncertainty by providing information or incentives. On the other hand, organizations include firms, universities, industry associations, scientific and professional societies, regulatory agencies and intermediaries that represent the main vehicles for the creation, development and diffusion of technologies (Edquist and Johnson, 1997).

According to Dodgson et al. (Dodgson et al., 2008), additional research on NSI is required to study emerging organizational forms in which learning emanates from new institutional practices and innovation network. Similarly, Lundvall (2002 p. 222) encourages further research should search for "collective solutions where firms collaborate and create technology centers and other forms of inter-firm clearing houses for the exchange of innovations". These form of organizations are recognized as intermediaries and are a central plank in the learning process in production and innovation system settings (Lundvall et al., 2002) and for co-ordinating activities between users and producers (Smits, 2002). Steward and Hyysalo (2008 p. 306) suggest intermediaries are necessary at the system level to facilitate, configure and broker social learning.

The functional approach for Systems of Innovation

An established contribution to the study of systems of innovation represents the 'functional' approach (Chaminade and Edquist, 2006, Liu and White, 2001) that is used to explain how an innovation system works in comparison to how it is structured

(Markard and Truffer, 2008). According to Jacobsson and Bergek (2004) and Hekkert et al., (2007), the fundamental reasons that justify the use of the functions approach are: a) it allows researchers to conduct comparisons between innovation systems with different institutional set-ups; b) it enables a more systematic method for mapping the determinants of innovation cycles and feedback loops; and c) it makes possible to deliver a clear set of policy targets as well as instruments to meet these targets. Table 19 presents selected contributions to the functions perspective, the four groups of innovation activities to be considered by policy makers and the suggested indicators that describe the overall dynamics of innovation systems.

Provision of Knowledge inputs to the innovation process

This function, provision of R&D and competence building, emerged out of the perspective of interactive learning proposed by Lundvall (1992) and has evolved: a) on studies on how knowledge is created, transferred and exploited (Lam and Lundvall, 2006); and b) the learning capability of individuals, organizations and regions related to human resource development and competence building (Lundvall et al., 2002). This activity has been carried out mainly by public research centers and financed by public agencies. However, recent policy instruments promote a change towards more interactive involvement coming from private organizations towards either developing already basic research or co-investing in new lines research for producing basic research.

Provision of market-demand site factors

The functions involved in the provision of market-demand side factors include: a) articulation of quality requirements; and b) the formation of new product markets. The former one refers to the institutional mechanisms public and private organizations use to influence the direction of search for new technologies. This function involves an interactive match of visions, expectations and beliefs in growth potential, regulations and policy and demand articulation.

Table 19: Overview of the functions of innovation systems

Linking innovation activities and policy	Edquist (2006)	Bergek et al. (2008)	Gali and Teubal (1997)	Indicators for innovation systems
Provision of knowledge inputs to the innovation process	Provision of R&D and competence Building	Knowledge Development and Diffusion	R&D activities and supply of scientific and technical services to third parties	R&D projects, network size and intensity; size and orientation of R&D projects; learning curves; development of a new technology
Provision of markets-demand site factors	Articulation of quality requirements	Influence on the direction of search	Policy making by governmental entities	Targets set by governments; no. press articles; incentives from taxes; regulatory pressure
	Formation of new product markets	Market formation	Diffusion of scientific culture through science centers	No. of niche markets; lead users; customer groups; actor strategies, market size; purchasing processes
Provision of constituents inputs to the innovation process	Creating/changing organizations needed for the development of new fields of innovation	Entrepreneurial Experimentation	-	No. of new entrants and diversifying established firms; no. experiments; no. of diversifying activities of incumbents; breath of technologies used
	Networking through markets and other mechanisms	Development of positive external economies	Diffusion of information, knowledge and technology between suppliers and users	Specialized intermediaries, information flows, political power, pooled labor markets
	Changing institutions that provide incentives or obstacles to innovation	Legitimation	Professional coordination through academies, professional associations, etc.	Rise and Growth of interest groups and their lobby actions; visions and expectations; alignment with current legislation
Support services for innovation firms	a) Incubating activities; b) Financing of innovation activities; c) Provision of consultancy services of relevance for innovation processes	Resource mobilization	Implementation of institutions e.g. laws. Functions usually performed by intermediary organizations	Volume capital and VC, volume and quality of human resources, complementary assets

Secondly, systems of innovation request the creation of complementary assets (Teece, 1986) and an articulated market demand that will determine adoption of new technologies and price/performance relationships. The relevance of this function is to determine the mechanisms driving and hindering market formation, firm strategies to create new markets, role of users on adopting new technologies and public regulations and subsidies to accelerate the development of technologies.

Provision of constituencies

The provision of constituents to the system involve: a) creating and changing organizations; b) networking through markets and other mechanism; and c) changing institutions. The first function, creating and changing organizations, supports the deployment of new technologies through the creation of new start-ups or entrepreneurial initiatives. Besides experimentation, the creation and development of new technologies benefits the SI through new forms of learning and knowledge creation in different scenarios with consumers, competitors and suppliers.

Secondly, as mentioned by Edquist (1997) systems of innovation demand a continuous interaction among firms, universities, public organizations, association and users that are present on networks or clusters naturally organized to facilitate the exchange of information (Carlsson and Stankiewics, 1991). This system function studies existing mechanisms that facilitate the formation of learning relations among organizations and the emergence or entry of positive externalities i.e. new entrants, specialized intermediaries and service providers. Finally, the function of changing institutions is a matter of social acceptance and compliance with relevant institutions of existing and disruptive technologies. It is considered as a conscious iterative process between public, private organizations and individuals that are aligned to existing and new institutional regulations such as incentives or obstacles to innovation.

Support services for innovation firms

Finally, the formation and development of systems of innovation depends on the support services provided by private and public organizations that include: a) incubating activities; b) financing innovation processes; and c) provision of consultancy services (Edquist, 2006). The first one involves the provision of infrastructures and administrative support for innovation projects. The second involves the activities necessary for accelerating the development and commercialization of early stage technologies and R&D. Finally, the last activity involves the provision of consultancy advice for the commercialization and appropriation of technologies. Previous studies reveal the formation of new techno-economic paradigms involves "a new 'best practice' set of rules and customs for designers, engineers, entrepreneurs and managers (Freeman, 1987 p. 57)". In this sense, the emergence of innovation systems requires the existence of intermediary organizations providing support services to avoid the possible mismatch between the emergence of new technologies, organizational structures and institutional frameworks.

Lately, the relevance of intermediary organizations influencing different network of agents at the technological, national or continental level is becoming determinant for accelerating industrial development and economic growth (Howells, 2006). In particular, intermediaries have a role addressing policy issues at technological or industry levels as well as increasing the connectivity of the system facilitating the share of knowledge and influence the diffusion of technologies.

Research Design

This research was carried in collaboration with the European Institute of the Mediterranean (IEMed) as part of the first study on innovation for the Union for the Mediterranean. This process initiated with a formal meeting in Barcelona on the 12th of February at the IEMed workshop "Innovation as a Motor of Development in the Euro-Mediterranean Region" where 25 selected innovation actors such as politicians, project managers and academics from various Mediterranean countries were invited to presented

their national projects and provide comments in four different work-sessions: a) Promotion of business innovation through the structuring of National Innovation Systems (NIS) and the creation of national agencies for the promotion of innovation; b) funding mechanisms and promotion of innovation; c) technology transfer; and d) promotion of innovation through international technology cooperation. Secondly, the major themes were identified by the researchers and commented with 5 representative attendees from Turkey, Egypt, and Spain and members from IEMed.

During the data analysis, we applied techniques for both within and cross-case analysis displays (Miles and Huberman, 1994, Yin, 2009) as well as triangulated, and integrated all the data from the aforementioned sources and studies the seven system functions. Finally, in this research we are aware of the differences between the northern and the southern Mediterranean countries and carefully consider them on the analysis and conclusion of this paper.

The Mediterranean System of Innovation (MSI)

This section provides the analysis of our study on the MSI using the 'functional' perspective as well as a brief overview of its current situation.

Current situation in the MSI

Up to now, the lack of collaboration and coordination in the Mediterranean region has remained as the principal blocking apparatus. Before 1995, the lack of collaboration between Europe and Mediterranean countries was considered to be the consequence of cultural misunderstanding. Following Mediterranean countries, even though took actions to smooth cultural differences, rapidly discovered that the real problem had laid out principally on the economic and social differences. The Barcelona process, initiated in 1995, carried out some institutional actions to overcome existing economic and social differences as well as increase the number and quality of collaborations. According to Senén Florensa, General Director of IEMed, now after 14 years of continuous interactions the Mediterranean region is encountering a new major "turning point". It is the result of recent programs and agreements, under the initiative named "the Union for

the Mediterranean", to establish a long lasting collaborations between Europe and Mediterranean countries.

Until now, the two central short-term institutional reinforcement mechanisms contributing to the process of transformation and cohesion represent: a) the second summit for the Union for the Mediterranean to structure new relationships, under the Spanish European presidency in the first semester of 2010; and b) the possibility of having a co-presidency, of the Union for the Mediterranean, in one southern Mediterranean country. Apart of these political initiatives, the priority is to have innovation policies that have an impact on Mediterranean countries through bilateral programs, both intra-Mediterranean and with Europe as well as help the Mediterranean region from its interior. These initiatives might include new structures, facilities, radical investments in fields of energy and the continuation of the modernization of Mediterranean economies.

The Mediterranean region, however, is experiencing a decline of market growth and employment, partially, agreed as the consequence of the global economic and financial crisis. Apparently, innovation activities could give Mediterranean countries a boost on market development and economic growth. As suggested by the General Director of IEMed, *" we could use a new wave innovation that results in prosperity in the societies and countries. Innovation is the engine that may push our (Mediterranean) economies out of the tramp of the crisis. But the problem is as always we have extremely urgent activities that may result in benefits in the medium term or long-term."*

System functions in the Mediterranean System of Innovation

This point provides the analysis for each system function and illustrates with some examples (table 20) opinions emerging from our data.

Provision of R&D and Competence building

Apparently, in the MSI the provision of R&D and competence building is supported as part of specific national programs such as the "programme National de Recherche

d'Innovation (PNRI)" in Tunisia or the Industrial Innovation Programs in Italy. Further, Mediterranean economies are changing their perception from strict support to R&D initiatives to the service sector and entrepreneurial initiatives. Indeed, currently, in the Mediterranean region a few number of innovations emerge out of basic scientific research and successful technologies and products are closely interacting with latent market opportunities coming from the demand side.

Articulation of quality requirements

Currently, the issue of the innovation strategy is of high relevance because most innovation programs do not have an impact on innovation and do not enforce the development of capabilities. The Italian and Moroccan innovation strategies represent two observed cases of broad innovation strategies. Italy supports various types of innovation opportunities and broad demands coming from SMEs and diverse sectors. Further, Morocco offers support to a large number of priority sectors as well as innovation initiatives in new industrial sectors. These two examples show the lack of an enduring Mediterranean innovation strategy that may benefit the long lasting development of capabilities and collaboration in the Mediterranean region. A different scenario was observed on other Mediterranean countries that carefully designed and implemented strategies that embraced common and long-term innovation objectives in collaboration with a diverse number of actors.

Formation of new product markets

The formation of new product markets is scarcely initiated through new collaboration agreements between Mediterranean countries and national technology agencies in Europe. Currently, the programs addressing the formation of new product markets are observed coming from subsidized programs such as Eureka or Medibtikar.

Table 20: Current situation on Mediterranean System of Innovation (MSI)

Linking innovation activities and policy	Activities (Edquist, 2006)	Mediterranean System of innovation
Provision of Knowledge inputs	Provision of R&D and Competence Building	"Innovation is not research. Half of innovation is done without research. Mediterranean countries lack the capability to transform knowledge on business models for the service sector"
Provision of markets-demand site factors	Articulation of quality requirements	"When I listened to the last presentation and went through different actions, I thought where is the strategy? And the strategy came last. I would have thought the strategy has to come first. This is something; we observe rather often that we are lost in details. I believe there are too many programs in support of innovation, research and clusters. There are just too many and most the programs have no impact"
	Formation of new product markets	"Nowadays, the only programs addressing the lack of collaboration, between the Mediterranean region and the European region, are the Eureka and Medibtikar"
Provision of constituents inputs to the innovation process	Creating/changing organizations needed for the development of new fields	"In the Mediterranean region the only existing program of collaboration is Medibtikar that is designed to a) increase the efficiency of incubators and technological parks across the region; b) increase and enable technology transfer; c) find early stage financing to increase innovation; d) innovation management and e) support for specific sectors"
		"Our experience with textiles is that it is much easier to do this in the private sector. Businessmen and women everywhere can change the way they do things very quickly if assured a financial return on their efforts"
	Networking through markets and other mechanisms	"Medibtikar facilitates the establishment of innovation networks through its five axes of operation a) Services to incubators and technology parks; b) development of technology transfer; c) financing innovation, d) innovation management; and e) sectoral support). Other local initiative is the one from ACC1Ó that has the initiative to create networks of innovation support to narrow interactions between universities and firms"
		"Enterprise networks represent coordinated actions between companies targeted at increasing their critical mass and at strengthening their presence on the market without necessarily having to merge"
		"In the Mediterranean region, Medibtikar, had the supporting role to set-up TTOs to facilitate the membership of Mediterranean countries to the Enterprise Europe Network (EEN). Up to now, five Mediterranean countries have already the partnership and other five are receiving help to write a proposal for acceptance"

	Changing institutions that provide incentives or obstacles	"A definitive and unique Mediterranean legal framework is apparently too complex and specialized that might encounter not only legal discrepancies but also cultural differences. Furthermore, it apparently represents a low priority for private companies collaborating with the research sector"
Support services for innovation firms	Incubating activities	"Technology Transfer Offices (TTO) are relevant actors for the innovation process because these have the role to promote the generation, transfer or commercialization of the knowledge that may be applied to business activity" . "TTO are responsible to design, coordinate and manage a framework of technology transfer between university and companies"
	Financing of innovation activities	"Most people qualify innovation support as a vitamin that helps to make the economy more robust, healthy. You could also qualify it as an aspirin if some people have some headache…The question is whether you can tackle the current economic and financial crisis with vitamin pills and aspirin. I doubt!"
		Three funding levels of innovation support: a) Specific support for innovation initiatives (innovation vouchers); b) Specific innovation funds (Early stage funding through a business angel network); c) General funds (Scientific and technological research investment, fund, competitive fund, Competitiveness and Development Fund and Enterprise Financing fund)
	Provision of consultancy services of relevance for innovation processes	"Two forms of consultancy facilitate the innovation process: a) innovation agencies; and b) innovation intermediaries". a) Innovation agencies financing innovation activities for the system of innovation and acting as facilitator of companies willing to unlock their potential to innovate; and b) Public-Private-Partnerships (PPP), private organizations, or programs collaborating with the innovation process, from a non-technological perspective.

Creating and changing organizations needed for the development of new fields

The system of innovation function "creation and change of organizations needed for the development of new fields" was observed at the Mediterranean, national, cluster and sectoral level. At the Mediterranean level, an existing program of collaboration is Medibtikar that is designed to a) increase the efficiency of incubators and technological parks across the region; b) increase and enable technology transfer; c) find early stage funding; d) facilitate innovation management; and e) support for specific sectors.

Collaboration at the regional and cluster level has been more predominant in the Mediterranean region. For example, the Barcelona city council has as objective to: a) boost the role of Barcelona in terms of innovation; b) link national and international innovation activities to the territory; and c) be recognized as an engine of innovation and research. A similar alternative represents the meta-districts in Italy that are scattered throughout the entire territory to increase sectoral synergies by a) aggregating networks of SMEs; b) facilitating collaboration with the research system; and c) intensifying the exchange of know-how between companies.

At the sectoral level, collaboration was feasible through the identification of companies' problems and future opportunities. An example is the ICT sector in Egypt that emerged out of a small group of private investors and policy makers, both having a common understanding of market needs and mutual interest. Following, once the system was on its emerging phase, it became institutionalized by governmental entities. The success factor in this case was the informality and collaboration among companies.

Networking through markets and other mechanisms

In the MSI innovation and enterprise networks were considered as highly relevant for the diffusion of research and commercial activities among organizations. On the one hand, innovation networks represent initiatives to improve the connection of universities, entrepreneurs, companies and technology parks engaged in the innovation process. An

actor facilitating the formation of innovation networks is Medibtikar through continuous activities in five axes of operation a) services to incubators and technology parks; b) development of technology transfer; c) financing innovation; d) innovation management, and e) sectoral support). The deployment of innovation networks was also observed at regional levels e.g. ACC1Ó (the Catalonian Innovation agency) is creating new networks of innovation through narrow and distinct interactions between universities and firms.

On the other hand, enterprise networks are designed to support the connection of companies, particularly for SMEs, requiring advice to establish new alliances, develop their business model and find the appropriate business partner. An existing mechanism in the Mediterranean region, coordinated by Medibtikar, is to involve Technology Transfer Offices (TTO) that could facilitate the membership of Mediterranean countries to the Enterprise Europe Network (EEN). Up to now, five Mediterranean countries have already the partnership and other five are receiving help to write a proposal for acceptance. The relevance of EEN is on the provision of a platform where SMEs propose a technology offer to a large network of firms in 60 countries. By the same token, they can write a technology request and express their specific need for a technology in a particular area.

Changing institutions that provide incentives or obstacles

Certainly, a common Mediterranean legal framework represents a relevant institutional mechanism to enhance collaboration and the development of the MSI. However, up to now, mechanisms to successfully achieve remain vague and not discussed.

Incubating activities

Currently, three activities are conducted to improve the technology transfer process and incubation in the Mediterranean area. The first initiative is the establishment of long lasting partnerships and mergers and acquisitions with foreign companies. The second initiative involves an increase of technology transfer initiatives on the Mediterranean service sector. Finally, Mediterranean countries are searching to establish new alliances between specialized southern Mediterranean agencies and European ones.

Financing of innovation activities

Up to now, innovation funding has been broadly spread through out unplanned industries, sectors and technologies, without analyzing and measuring their impact. In the short-term, this strategy to distribute the scare funding resources should change or may run out of resources.

Currently, in the Mediterranean region the mechanisms for funding innovation include: Firstly, general funding initiative that is focused on fertilizing: a) basic and industrial research; b) competitive development and innovation; and c) the development of new productive systems. The second level involves specific innovation funds for defined entrepreneurial or company activities. This initiative could be coordinated by public or private initiatives and usually the funding is lower and more targeted, in compare to the upper level. Thirdly, an emerging form of specific support for innovation initiatives represents the innovation vouchers, early adopted in the Netherlands, France and Finland. Innovation vouchers assist individual companies with their innovation ideas or activities. However, the use of them could vary on the amount and exigencies.

Provision of consultancy services of relevance for innovation processes

Innovation intermediaries offering managerial, technological or scientific support facilitate the development of the MSI by providing personalized advice to organizations, entrepreneurs and scientists. In the Mediterranean area two types of intermediaries were identified. On the one hand, public innovation agencies were necessary to: a) finance innovation activities for the system; b) act as facilitator of companies willing to unlock their potential to innovate; and c) provide coaching and information activities for companies. On the other hand, innovation intermediaries represent public, Public-Private-Partnerships (PPP), private organizations collaborating with the innovation process, from a non-technological perspective through services including business and funding networking, coaching and valorization instruments.

Discussion

In the Mediterranean region, the ongoing collaborative activities towards an innovative society are expected to enhance the number of research and technological outputs. However, results the achievement of this objective will depend on addressing the innovation system functions, the re-examination of institutional programs, research funding and business activities. At the beginning of this paper, we formulated the following research questions: could the innovation systems functional framework explain the Mediterranean System of Innovation? And what are the central enabling and blocking mechanisms? Following, we extensively respond to these questions.

Firstly, the functional perspective (Edquist, 2006, Bergek et al., 2008) represents a useful framework to comprehend the structural component and dynamic relationships between organizations and institutions in MSI. As observed in the previous section, our analysis contributes to previous research using the 'functional' perspective by suggesting the indicators in the Mediterranean countries. Secondly, our research contributes to the literature on Systems of Innovation by emphasizing the need of having a 'function' for the national innovation strategy. Our data revealed the lack, in Mediterranean countries, to have a long-term strategic innovation policy necessary to guide investments, research and business activities. Similarly, the role of intermediary organizations, to connect different actors within countries and across the Mediterranean area, was extensively requested. Apparently, this actors brokering policy, research and business have a role beyond incubating and advising to be more engaged on the internal commercialization and coordination with other European actors.

Conclusion, limitations and further research

The contribution of this paper has both a theoretical and empirical implications to the Systems of Innovation literature (Arundel et al., 2007, Carlsson, 2007). On the one hand, it represents the first exploratory study of the Mediterranean System of Innovation using the functional systems perspective (Bergek et al., 2008). Our analysis suggests that the functional perspective is an appropriate instrument to conduct a systematic method for

exploring the enabling and blocking mechanisms in the MSI as well as to propose policy initiatives. However, existing measures provide partial guidance to observe the activities conducted by organizations and influence of public institutions. For example, Mediterranean countries have far less R&D investments on new technologies but invest resources on services and new business models. This research also confirmed the relevance of intermediary organizations facilitating the formation and development of systems of innovation (Howells, 2006). On the other hand, the result of this research highlights some drawbacks on the MSI that devotes limited emphasis to the innovation strategy.

The policy implications of our paper reveal the cohesion of MSI could be stimulated through: a) having a clear and adapted definition to the Mediterranean reality that includes not only technological innovations but also non-technological ones; b) aligning the system of innovation reality, at the local, national or Mediterranean level. It includes the careful mapping of existing capabilities, the design of the system of innovation strategy and the legal framework; c) selecting and implementing funding mechanisms and innovation programs that foster not only R&D activities but also help to launch basic research to markets; d) considering a broader range of innovation intermediaries for the untapped connections between science and markets; e) strengthening intra- and inter – Mediterranean collaboration through stronger agreements with Europe as well as new programs to ease collaboration among companies from different areas in the Mediterranean; f) advancing the use and tentative association to EEN and resemble the same structure for the Mediterranean region. Narrow the interaction between research and markets through the use of innovation networks; and g) through the creation of new structures that connect demands from different Mediterranean institutions and unify them towards a common initiative.

Our research represents the first attempt to shed light on the Mediterranean System of Innovation based on the seven system functions. Although more differences than commonalities exist in social aspects in Mediterranean countries, apparently organizational and institutional activities supporting innovation share a common ground. In our work, we carefully selected representatives from northern and southern

Mediterranean countries to have a broader overview of its similarities and differences. However, our understanding of specific systems of innovation was limited to the information provided by attendees. Further, the results are generalized to the Mediterranean level from specific cases and do not represent a detailed analysis of each country. We suggest more research should attempt to explore: a) the northern and southern Mediterranean System of Innovation separately; b) explain the relevance of institutional mechanisms ‘ the Union for the Mediterranean’ enabling the formation of a new continental system of innovation; c) the functions public and private innovation intermediaries have on establishing new connections for the MSI; and d) we encourage the study of non-technological innovations in the Mediterranean systems e.g. services because of their relevance and increasing growth in most Mediterranean systems.

Chapter IX Final framework and conclusions

Based on the empirical contributions presented in the seven research articles, this last chapter discusses the general conclusions, contributions and suggested future areas for research arising from the study as a whole. First and foremost, it must be pointed out that over the last decade the hype attached to the terms 'open innovation' and 'business models' has become accentuated, used in designing new external knowledge acquisition strategies and they are often referenced superfluously by academics, practitioners and policy makers. This doctoral thesis provides scientific findings, upon which future (multi-level) studies on open innovation, business models and open innovation can build. My approach to this study of open innovation encompasses an empirical analysis of organizational and policy strategies, ranging from descriptive to explicative studies.

Framework elements and conclusions from the empirical research

The two overarching questions in this research are: How can firms use open innovation strategies i.e. the use of innovation intermediaries or external partners to facilitate the acquisition of external knowledge? and how can policy makers embed this new paradigm in their policy frameworks? Throughout this multi-level doctoral thesis, I have shown how, through thorough exploration of possible sources of external knowledge and innovation systems, these questions can be answered.

In the second chapter of this thesis, I look at different forms of innovation intermediaries that could provide access to technology and idea markets. More specifically, I analyze the underlying business logic and value creation strategies among these intermediaries. The results revealed details of the different services offered by different European and American innovation intermediaries.

From this research, I endeavoured to explore an emerging type of one-sided innovation intermediary, Living Labs, which demonstrates a high-level of participation from end users during the establishment of new technological systems of innovation. Here, I also develop a theoretical typology of innovation intermediaries that helps to classify and differentiate innovation intermediaries into five different segments: a) intermediary

involvement; b) distance from market commercialization; c) closeness to new science/technology; d) number or participant organizations; and e) resources invested in new products or services.

In Chapter 3, my goal is to provide an external and detached evaluation of the business model of a selected group of two-sided innovation intermediaries and to explain how they help firms create and capture value in the growing technology and idea markets. This research was necessary to comprehend the similarities and differences among well-known intermediaries such as NineSigma, Innocentive, Yet2.com and YourEncore when they access and deal with external knowledge partners. The following study (Chapter 4) aims to explain the benefits and tensions for firms when acquiring external knowledge with the use of an innovation intermediary. Based on ethnographic research at NineSigma, this study details the knowledge practices for each innovation phase, provides an alternative framework to external knowledge acquisition, and explains that innovation intermediaries are not limited simply to providing network benefits but are, perhaps, more important for articulating and codifying knowledge.

In Chapter 5 examines the effect of open innovation on the speed of internal technology transfers for corporate venturing and core business research projects. This study is the first to use project level data highlighting that: a) open innovation expedites innovation projects; b) open innovation helps to offset the naturally low speed of corporate venturing projects; c) market partners speed research projects and are useful to counterbalance the lack of speed from corporate venturing projects; and d) scientific partners do not help to speed research projects. In doing so, this study provides several academic contributions to the existing research on open innovation and corporate venturing and confirms the relevance of open innovation in speeding up innovation processes.

Finally, I examine the innovation policy implications of open innovation and business modes within two different innovation systems – the European and the Mediterranean. Firstly, I compare the existing innovation system frameworks and highlight, where needed, the design of new European policies for enacting in the areas of innovation and new business models. The need for a balanced approach to intellectual property and financing SMEs is significant, especially in Europe. Secondly, I published the first article

on the Mediterranean System of Innovation which sheds some light on emerging patterns i.e. service innovation and business model innovations within the emerging Mediterranean System of Innovation. These two contributions are current policy strategies which, I argue, are ways to embrace the relevance of open innovation in innovation systems and which represent a prosperous area for academic research.

Contributions to theory and practice

In a nutshell, the essential purpose of this doctoral thesis has been to contribute to a better understanding of how private and public organizations design and adopt open innovation strategies to facilitate the inbound and outbound flows of knowledge, with multiple sources of partners. Throughout this multi-level thesis, specific theoretical and practical answers have been provided towards this overarching research question. Now, this last section presents these theoretical contributions from the project level to the innovation system level of analysis in order to highlight the multi-level contributions of the work as a whole.

Firstly, until now, scholarly research could not confirm, with large scale and longitudinal project level data, that open innovation activities did indeed accelerate the speed of innovation. Broadly, this doctoral dissertation confirms that open innovation activities expedite innovation projects from research labs to development units as well as explaining that open innovation represents an efficient practice with which to counterbalance the lack of speed observed from corporate venturing projects. As such, this scholarly contribution represents the first confirmatory finding on innovation speed contributing to the open innovation literature by: a) informing that market partners such as suppliers, partners and customers accelerate the speed of innovation projects and improve the lack of speed in corporate venturing projects; and b) proposing that collaboration with scientific partners such as universities, research centers and science parks does not have an effect on the speed of innovation projects and does not improve the lack of speed from corporate venturing projects. This study of hundreds of research projects and close collaboration with Philips Research gave an impetus to study those hybrid collaboration strategies where collaborations with scientific and market partners

occur through the use of an innovation intermediary. Following, the clear strategy was to further investigate why firms decided to use distinct forms of innovation intermediaries to expedite the search for, and acquisition and integration of, technological knowledge which has been internally unavailable within the firm itself.

Secondly, in order to provide a profound evaluation of the benefits and challenges of collaborations with innovation intermediaries, I researched: a) firms' innovation processes with innovation intermediaries; and b) one-sided, and two-sided innovation intermediaries' business models. On the one hand, within the boundaries of the firm, this doctoral dissertation provided numerous theoretical contributions, such as: a) inductively providing the knowledge practices at every intermediated knowledge acquisition stage; b) deductively explaining the learning process of experience accumulation, knowledge articulation and knowledge codification during the external knowledge acquisition process; c) illustrating the intermediated knowledge acquisition tensions of generality vs. specificity, depth vs. breath and closure vs. disclosure.

On the other hand, multiple forms of innovation intermediaries have been investigated to extend previous studies of one-sided and two-sided innovation intermediaries, disentangling the differences and similarities of their business models. This research responded to an identified research gap to sharply differentiate heterogeneous innovation intermediaries' benefits during the acquisition of, and process of gaining access to, external knowledge from international innovation networks. An initial study aimed to compare the differences and similarities between one-sided and two-sided innovation intermediaries. Following this, a study of one-sided innovation intermediaries explored an emerging type of intermediary, named Living Labs, which orchestrates public and private actors in emerging technological systems of innovation. In this thesis, I have highlighted the novelty of this type of intermediary through its ability to engage users during the early stages of new product development. Additionally, a detailed study of two-sided innovation intermediaries presents the business models of selected two-sided innovation intermediaries and analyzes how they compete in the technology and idea markets.

Thirdly, the findings at the project, firm and network level of analysis contribute to describing how policy makers facilitate open innovation within the European and Mediterranean systems of innovation. At the European level of analysis, this thesis recommends that future innovation policies should devote specific attention to the funding chain and intellectual property in order to help transcend national boundaries. This thesis theoretically contributes at the Mediterranean level of analysis with the inclusion of the first study on the innovation functions and highlighting the differences with other more technology-driven systems of innovation. These two innovation system research contributions highlight the conditions necessary to the facilitation of open innovation, at a larger level of analysis, and offer a contribution to a policy-oriented audience.

Throughout my doctoral research period, the research contributions presented (as well as others not included in this thesis) not only provided new scholarly theoretical contributions but, most importantly, shed light on new avenues for future research, possible research strategies and data sources to cover these areas. As such, this multi-level effort has allowed me to continuously discover new avenues for future research and provide a cohesive theoretical framework for scholars on open innovation.

Future research and concluding remarks

While this doctoral thesis has been greatly influenced by the empirical phenomenon of open innovation and the role of intermediaries, I believe that my findings, combined with current developments in the field, open up a number of interesting avenues for future research. For example, the rapid growth of new, two-sided innovation intermediaries, such as IdeaConnection, Innoget, TekScout and Creax, has gained momentum. These firms attempt to replicate the knowledge search services offered by established intermediaries like NineSigma, Innocentive, Yet2.com, YourEncore, and Ocean Tomo. Frequently, these newcomers have the advantage of operating in national markets where physical proximity, a shared language, and lower priced services represent an advantage over internationally recognized innovation intermediaries. However, the market for innovation intermediaries is not a winner-takes-all competition and takeovers can be

expected in the future. On the one hand, I foresee that in the coming years, the consolidation trend will be further strengthened by diversification strategies of established innovation intermediaries. On the other hand, offering other types of services, specializing in different R&D stages or targeting other types of clients will be ways for emerging innovation intermediaries to differentiate themselves from their competitors. Also, newcomers might avoid head-on competition by differentiating their products, or by establishing new alliances with one-sided innovation intermediaries, e.g. incubators, research parks and/or technology centers, or with established two-sided innovation intermediaries; the collaboration between Yet2.com and Innoget is a good example of this. This will allow emerging innovation intermediaries to offer knowledge seekers bundled services of higher overall quality. Consequently, research exploring how the dynamics among the different actors changes and how the business models of these actors develop offer very interesting directions for future research.

Furthermore, although innovation intermediaries are a powerful force in launching open innovation activities, since they put external knowledge within the reach of every company, open innovation is already an established innovation strategy among incumbent companies and has conferred equal access to non-proprietary ideas and technologies upon competing companies. Consequently, open innovation activities have become a competitive necessity which no longer immediately results in a competitive advantage. Currently, to maximize returns from open innovation, companies must ensure that their collaboration with innovation intermediaries dovetails with an overarching innovation strategy and an established external knowledge acquisition capability. Also, companies' internal practices should adapt to more tailored services and the growing types of innovation intermediaries who offer them. In the near future, the companies profiting from open innovation will be those which have adapted their innovation processes and collaboration modes with innovation intermediaries to the new opportunities offered by technology and idea markets. In other words, open innovation in companies should be a dynamic process that co-evolves with changes in technology and idea markets, which themselves are partly driven by the rapid growing possibilities offered by intermediaries and technology service companies. Consequently, the close

analysis of the development of firms' abilities to adapt to changing collaboration modes offers another interesting avenue of future research.

Since most firms using innovation intermediaries to acquire solutions from technology markets do not always end up integrating them in their products or processes, the challenge for companies is to select innovation intermediaries who provide services that will help to identify, articulate and codify the companies' specific internal scientific problems. This means that the main problem is not in identifying external knowledge, but, rather, in the correct selection of projects and their later integration. We still do not know whether the knowledge acquired through an innovation intermediary is more easily integrated through established alliances or joint ventures. Also, most research to date has only centered on the network benefits of innovation intermediaries. More research is needed to find out the following: how intermediated external knowledge could be quickly integrated into firms' innovation process; how to overcome internal barriers e.g. NIH syndrome; when intermediaries are more beneficial than other sources of external partners; and what are the characteristics of those projects which are more likely to be integrated. These questions are all extremely important, as most companies have not yet developed a capability that would allow them to recognize the value of technologies and ideas from distant scientific fields and in so doing, simultaneously avoid possible problems of knowledge contamination and information asymmetry. Hopefully, new research will provide a better understanding of the benefits of using innovation intermediaries for external knowledge acquisition and integration.

Finally, while there is agreement that open innovation is beneficial in accelerating firms' innovation processes, it would be myopic to believe that two-sided innovation intermediaries are the only, or even definitely the most effective, mechanism available to search for external knowledge in technology and idea markets. Further research is needed to explore how other forms of intermediation, such as universities, incubators and science parks provide similar services and valuable technological solutions. Also, it would be interesting to explore the future role of innovation parks or design schools e.g. EsadeCreapolis and the Art Center College of Design, as physical platforms that foster innovation and creativity. Future research could provide validation of the presented

business models, typology and framework presented in this thesis and a careful assessment of the identified activities. The evidence emerging from this research could provide more tentative explanations for the role of innovation intermediaries in innovation systems and the possible dynamics encountered during the process. Moreover, I suggest that this could provide further insights towards exploring how intermediaries, both private and public, interact with groups of organizations and facilitate their R&D policies.

The findings from this thesis show evidence that firms adopt open innovation strategies in order to accelerate their innovation processes and to quickly launch their products onto the market. In this thesis, I have shown that open innovation speeds up innovation transfers from research labs to business units and that market partners are a good source of knowledge to accelerate the process. It is surprising, however, that scientific partners delay the speed of transfers for research projects. Future research should determine whether projects demanding collaboration with scientific partners are more radical or disruptive, generate more profits, or, perhaps, are in earlier phases of development than projects with market partners. It has also become evident that there is a lack of research on open innovation at the business unit and project level, on the nature of those partners speeding up transfers, and on which units should conduct more open innovation to strengthen their open innovation strategies.

The numerous issues addressed in this thesis offer a great opportunity to connect up future research on corporate venturing and open innovation. Initial settings could focus on appropriate strategies to simultaneously accelerate the speed of innovation processes, increase market sales, provide more transfers to business units (and licensing arrangements with other firms) and impact core business and corporate venturing units. The findings could, additionally, be compared to projects that do not involve any type of external collaborations.

Another future challenge is to determine whether collaboration with external partners improves over time. For example, some researchers argue that trust built over time should contribute to smoother interaction and, therefore, better performance over time. Moreover, the different compositions and the differing natures of competition within the

industry are likely to influence any willingness to share knowledge and engage in open innovation. Therefore, it would be interesting to determine differences among technological base industries, e.g. consumer products, pharmaceuticals, electronics, and among other industries, e.g. pharmaceuticals, Information and Communication Technologies (ICT), in order to explore the role these factors play in the open innovation process. Further research on innovation speed should also reveal whether other factors could affect the speed of innovation, e.g. market dynamism and uncertainty, market size or access to resources. The insights up until now in this thesis reflect antagonistic effects and provide inconclusive findings on ways to encourage for innovation speed. The previously mentioned future research possibilities could shed light on the growing literature of open innovation and allow for the integration of research on new product development, dynamic capabilities and external knowledge searches.

Open innovation and business model innovation has also gained the interest of policy makers, who have implemented new innovation policy programs and requested the means to improve their innovation systems. Broadly, this thesis has highlighted some areas where policy makers need to design new instruments to ease the flow of knowledge and collaboration among European research centers and support scientists across Europe and to provide financial support to SMEs. Future research needs to shed light on the structural differences between protectionist or close innovation systems and more open and collaborative ones, propose new measures to explain the effectiveness of new, more open innovation policies and relate the emerging research on open data and open government to open innovation. It could also explore the benefits of knowledge sharing, gained from new European patent enforcement laws and requirements for patent translation, and the current role of, and schemes for, funding in Europe.

Moreover, studies at the innovation system level have emphasized the differences and similarities between the northern and southern Mediterranean Systems of Innovation, and the ways in which new open innovation and business model strategies could help to support these systems. It has become clear that open innovation cannot afford to neglect the extensive findings coming from the innovation systems literature but further studies could, rather, provide an open innovation and business model perspective. I suggest that

further research should attempt to explore the northern and southern Mediterranean Systems of Innovation separately and explain the relevance of institutional mechanisms, e.g. 'The Union for the Mediterranean', in enabling the formation of a new system of innovation. Future research could also explore how public and private innovation intermediaries function in establishing new connections among Mediterranean countries. I would encourage the study of non-technological innovations in the Mediterranean systems, e.g. services or textiles, because of their relevance and increasing growth within most Mediterranean systems. Finally, now that the Union for the Mediterranean has become an established political institution, further research should quantitatively and qualitatively study emerging collaboration modes in order to develop new technologies, products and services.

Final summing up

This thesis is comprised of a compendium of seven original research articles through which the organizational practices and policy implications are explored from an open innovation perspective. For each academic article, I relied on different qualitative and quantitative data sources and considered multiple theoretical perspectives in order to shed some light on the question of why private and public organizations design open innovation practices to acquire external knowledge. The seven research studies, when taken together, form a coherent thematic unit which is tightly bound by the theme of open innovation research. This research also suggests new ways to enhance our scholarly knowledge of open innovation and to connect it with other fields of literature. It is important to recognize that open innovation is becoming the new paradigm for external knowledge acquisition and integration and a key pillar of future innovation policy making. For this reason, it has now become the function of the academic community to further connect it to established streams of literature and research its benefits, tensions and limitations. This thesis provides alternative links to some of these literatures, i.e. dynamic capabilities, two-sided platforms, innovation speed, corporate venturing and innovation systems, though there is also potential to extend and make connections to innovation networks, leadership and entrepreneurship.

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Annex 1: Articles: Co-authorship, publication, presentation and awards

Chapter II: From solution to technology markets: The role of innovation intermediaries with Jonathan Wareham and Wim Vanhaverbeke
Presented: Economics and management of innovation, technology and organizational change (2009), DRUID-DIME Winter Conference, Aalborg University, Aalborg, Denmark

Chapter III: Intermediating and integrating knowledge: The role of the European Living Labs with Jonathan Wareham
Presented: Passion for Creativity and Innovation: Energizing the study of organizations and organizing, EGOS Conference (2009), ESADE Business School, Barcelona, Spain; Inclusive Growth, Innovation and Technological Change: education, social capital and sustainable development (2009), Globelics UNU-Merit & CRES,UCAD, Dakar, Senegal

Chapter IV: An open innovation perspective on the role of innovation intermediaries in technology and idea markets with Wim Vanhaverbeke
Presented: Dare to Care: Passion & Compassion in Management Practice & Research (2010), Academy of Management Meeting, Montreal, Canada

Chapter V: Intermediated external knowledge acquisition: the knowledge benefits and tensions with Fredrik Tell and Wim Vanhaverbeke
Presented: Formal organizations meet social networking (2012), Organization Science Winter Conference, Steamboat Springs, Colorado; Social Innovation for Competitiveness, Organisational Performance and Human Excellence (2012), Euram, Rotterdam School of Management, Erasmus University, Rotterdam, Netherlands; Open Innovation: New Insights and Evidence (2012), Imperial College Business School, Imperial College, London

Chapter VI: Innovation speed: Does open innovation expedite corporate venturing? With Du Jinshu and Wim Vanhaverbeke

Presented: Management culture in the 21st century (2011), Euram, Estonian Business School, Tallinn, Estonia

Chapter VII: Open innovation and public policy in Europe as a collaboration with Henry Chesbrough, Wim Vanhaverbeke and Tuba Bakici

Published: A research report commissioned by ESADE Business School & the Science|Business Innovation Board AISBL

Presented: to Máire Geoghegan-Quinn, EU Commissioner for Research, Innovation and Science and at the Innovation Convention 2011 in Brussels

Chapter VIII: Connecting the Mediterranean System of Innovation: A functional perspective with Juan Ramis

Published: EuroMed Journal of Business, Vol. 6 Iss: 1, pp.46 - 62

Presented: 2nd EuroMed Conference of the EuroMed Academy of Business (2009), University of Salerno, Salerno, Italy

Award: 2008/2009 Emerald/EMRBI business research award for young researchers 'Highly commented'

Annex 2 Interview guideline

A) Collaboration with Ninesigma

- Why has [client's name] decided to collaborate with innovation intermediaries?
    - Ninesigma in particular
- How does [client's name] select projects for external collaboration?
- When you seek for external solutions, do you simultaneously: Use other intermediaries, contact suppliers, develop the technology internally, use your stakeholders' network?
- Could you describe me the collaboration process with Ninesigma?
- When do you feel satisfied with the received responses?

B) Interaction with solution providers

- What requires your team to communicate your needs e.g. NPD, ready products, basic research through an RFP?
    - How useful is the RFP mechanism to leverage confidentiality and seek for wide novel sources of solutions?
- What are the reasons [client's name] believe its negotiations worked out and not worked out with solution providers?
- What innovation seekers' attributes/services are necessary to successfully engage with them during development phases?

C) Internal structural and cultural change

- How have you changed your organizational practices to select, evaluate and incorporate external sources solutions?
- How have you tried to change your organizational culture to be more receptive to external solutions as well as increase cross-departmental inertia around projects?
- As a project manager, how do you deal with the collaboration between your employees and external solution providers to achieve your initial technological challenge?

- What does internally stop the process of integrating external solutions?

Annex 3 Intermediary survey

About the NineSigma Challenge

1. What types of projects did your organization conduct with NineSigma?
    i. New strategic initiatives
    ii. New Product Development
    iii. Cost or quality improvement
    iv. Scanning the market for insights
    v. Technical gaps or implementation issues
    vi. Elemental scientific research
    vii. Other

    1) Never……2)……3)…….. 4) Sometimes…..5)…….6)……. 7) frequently

2. When you engage with NineSigma, what outcomes did you believe were possible to achieve?
    i. Accelerate the project timeline
    ii. Re-direct the project
    iii. Kill the project, using external insights
    iv. Contract with the solution provider of the RFP
    v. Validate our internal path
    vi. Gain insight and perspective
    vii. Other

    1) not important in any case 4) relevant for some projects but not others7) always relevant

3. Did the proposals that you received meet your expectations in terms of:
    i. ***'Variety of expertise'***
    ii. ***'Depth of knowledge'***
    iii. ***'Quality'***
    iv. ***'Quantity'***
    v. Alignment with your '***needs'***

    1) not true at all…2)…3)…. 4) some what true…5)….6)…. 7) very true

4. How did you '***select*** ' your open innovation projects?
    i. ***'Ranking or Voting'*** by an internal cross-functional / divisional evaluation team
    ii. ***'Ranking or Voting'*** process conducted by an individual (innovation champion, project leader)

iii. Discussion, by an internal cross-functional / divisional evaluation team (no formal process)
iv. 'Corporate or Departmental' directive
v. Facilitated by ***'NineSigma'*** selection process
vi. Facilitated by an ***''External consultant' selection*** process

1) Never……2)……3)…….. 4) Sometimes…..5)…….6)……. 7) frequently

5. After you received proposals, how did you '***evaluate'*** them?
   i. 'Ranking or Voting' by an internal cross-functional / divisional evaluation team
   ii. 'Ranking or Voting' process conducted by an individual (innovation champion, project leader)
   iii. Discussion, by an internal cross-functional / divisional evaluation team (no formal process)
   iv. 'Corporate or Departmental' directive
   v. Facilitated by ***'NineSigma'*** evaluation process
   vi. Facilitated by an ***''External consultant'*** evaluation process
   1) Never……2)……3)…….. 4) Sometimes…..5)…….6)……. 7) frequently

6. Did the outcome of the project(s) meet your expectations related to:
   i. Your ***'Open Innovation'*** experience
   ii. Your ***'Project Specific'*** experience
   iii. Your ***'collaboration'*** with NineSigma
   iv. Other:

   not true at all…2)…3)…. 4) some what true…5)….6)…. 7) very true

Solution Providers Characteristics

1. When selecting solution providers, how relevant is it that they offer:
   i. A mature technological solution
   ii. Mid-stage technological solution (proof of concept)
   iii. Established IP
   iv. A novel solution
   v. Capability to scale up i.e. logistic, manufacturing
   vi. A solution that matches your budget
   vii. Experience in proposed technologies i.e. credibility
   viii. Resources
   ix. Financial stability
   x. Other

1) not important in any case 4) relevant for some projects but not others7) always relevant

2. When evaluating solution providers, how important is/are the following:
    i. Quantifiable data i.e. measurements, models, pictures, etc.
    ii. Initial non-confidential interaction
    iii. Availability of samples
    iv. Intention to co-develop the solution, rather than buying it outright
    v. Experience and qualification of assigned personnel
    vi. Offered business terms, including IP
    vii. Other

1) not important in any case 4) relevant for some projects but not others7) always relevant

NineSigma Open Innovation Facilitation Services

1. In your experience, how ***valuable*** is NineSigma's assistance in:
    i. Providing the process to collaborate with external partners
    ii. Introducing you to new unexpected solution providers
    iii. Maintaining your confidentiality for the selected project(s)
    iv. Advising your group in open innovation practices
    v. Other

1) not necessary…2)…3)…. 4) somewhat necessary…5)….6)…. 7) very necessary

2. In your experience, how ***effective*** was NineSigma's service delivery in:
    i. Providing the process to collaborate with external partners
    ii. Introducing you to new unexpected solution providers
    iii. Maintaining your confidentiality for the selected project(s)
    iv. Advising your group in open innovation practices
    v. Other

1) not effective…2)…3)…. 4) somewhat effective…5)….6)…. 7) very effective

3. In your experience, how ***valuable*** was NineSigma's Program Manager in:
    i. Facilitating project selection
    ii. Coaching your group to craft the RFP
    iii. Assisting in reviewing received solutions
    iv. Facilitating your engagement with solution providers

1) not necessary…2)…3)…. 4) somewhat necessary…5)….6)…. 7) very necessary

4. In your experience, how ***effective*** was NineSigma's Program Manager in:
    i. Facilitating project selection
    ii. Coaching your group to craft the RFP
    iii. Assisting in reviewing received solutions

iv. Facilitating your engagement with solution providers

1) not effective…2)…3)…. 4) somewhat effective…5)….6)…. 7) very effective

5. In your experience, an RFP is valuable for:
   i. Helping you to ***'focus'*** the problem
   ii. Explaining your ***'technical'*** requirements to a broader audience
   iii. Revealing your '***Relationship***' expectations i.e. academic researchers, entrepreneurs, labs, etc.
   iv. Revealing your ***'Commercial'*** needs i.e. ability to scale up, long-term supply
   v. Clarifying your funding intentions for the external solution
   vi. Clarifying your IP expectations
   vii. Other

   1)not true at all…2)…3)…. 4) some what true…5)….6)…. 7) very true

7. Did you benefit in collaborating with NineSigma by:
   i. Getting additional ideas
   ii. Discovering new product or process opportunities
   iii. Accelerating the speed of partner identification
   iv. Reducing the cost of product or technology development
   v. Challenging your team to think outside the box
   vi. Confirming previous internal research
   vii. No benefit
   viii. Other

   1) no benefit …2)…3)…. 4) some benefit …5)….6)…. 7) high benefit

6. Is your company using other innovation intermediaries besides Ninesigma?
   i. Yes / No
   ii. Why?

Internal Open Innovation Activities

1. How often do you encounter the following internal obstacles when you engage in open innovation?
   i. Reluctance from internal research personnel "Not Invented Here syndrome"
   ii. Difficulty aligning open innovation needs with relevant business objectives
   iii. Lack of experienced personnel to lead and implement open innovation initiates
   iv. Insufficient cooperation from legal department

v. Insufficient cooperation from purchasing department
vi. Lack of budget to initiate or advance collaboration
vii. Insufficient executive support
viii. Other:

1) Seldom ……2)……3)…….. 4) Sometimes…..5)…….6)……. 7) frequently

2. How does your organization encourage employees to initiate new external collaboration practices?
    i. Communicating open innovation successes
    ii. Rewarding teams for successful open innovation initiatives
    iii. Promoting the use of external technology
    iv. Implementing new OI strategic directives
    v. Demonstrating the relevance of external solutions to researchers or scientific personnel
    vi. Other

1) Seldom ……2)……3)…….. 4) Sometimes…..5)…….6)……. 7) frequently

3. Does your company use an innovation intermediary?
    i. As a ***'complementary'*** source of external knowledge, to complement internal activities
    ii. As the ***'initial'*** source of external knowledge, prior to other knowledge bases
    iii. As the ***'final'*** source of external knowledge, after exhausting all other resources

1) Seldom ……2)……3)…….. 4) Sometimes…..5)…….6)……. 7) frequently

4. When deciding to embark in an open innovation project with NineSigma, did you:
    i. Assign a team to participate throughout the process
    ii. Create an infrastructure to integrate selected solution(s)
    iii. Encourage communication with solution providers (too keep the momentum going)
    iv. Overcome confidentiality challenges in order to share information with external parties
    v. Participate or involve other departments throughout the process
    vi. Provide a budget for the project
    vii. Provide 'protected' time resources for the project

1) Seldom ……2)……3)…….. 4) Sometimes…..5)…….6)……. 7) frequently

Company Characteristics

1. Identify your company's primary sector?
    a. Consumer products
    b. Retail

c. Final services
d. Automotive and motor vehicles
e. Industrial goods and manufacturing
f. Pharmaceuticals
g. Biotechnology
~~g.~~h. Health care
~~h.~~i. Technology and telecommunications
~~i.~~j. Entertainment and media
~~j.~~k. Energy
~~k.~~l. Travel, tourism and hospitality

2. Indicate your region
   a. North America
   b. Europe
   c. Asia-Pacific
   d. Latin America
   e. Other

3. Indicate your approximate company's sales revenue over the last year in US Dollars ?
   a. < 500 Million
   b. 0.5 - 1 Billion
   c. 1 billion – 5 Billion
   d. 5 Billion – 10 Billion
   e. > 10 Billion
   f. N/A

4. Indicate your approximate company's number of employees?
   a. < 5000
   b. 5,000 – 15,000
   c. 15,000 – 50,000
   d. 50,000 – 100,000
   e. > 100,000

5. How long have you been coordinating NineSigma initiatives?
   a. Less than 1 year
   b. Between 1 year and 3 years
   c. Between 3 years and 6 years
   d. More than 6 years

6. Position
   a. Within a R&D unit
   b. Within open innovation unit
   c. Other business or product units

Name (optional):

Company (optional):

Email (optional):