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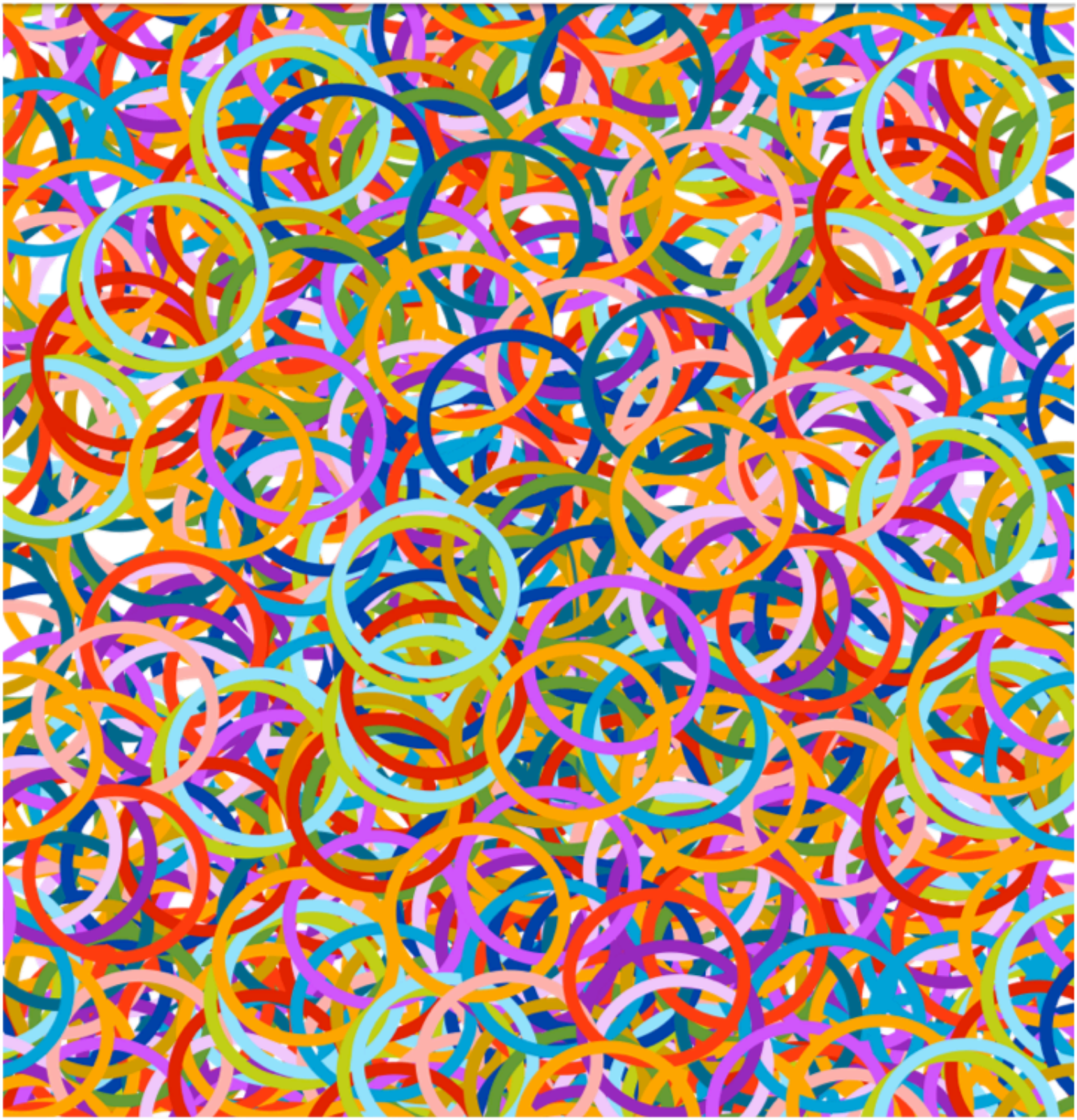

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Table of Contents

Editorial

Letters

Articles

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http://www.open-jim.org

Journal Editors

Economic and Social Science Areas

Editorial

The expansion of human knowledge in all areas is largely the outcome of the activity of academic institutions and the result of their mission to contribute to the cultural, intellectual and economic development of the society, involving education, research and university extension activities. For many years, the academic community has been organizing itself in all different ways to respond to current and future needs, ensuring research integrity and recognition, and building on successive generations of peers to validate and support the launching and development of novel research streams. We owe the current state of research and development of our society to generations of scholars and scientists that have brought all of us here.

The Journal of Innovation Management aims at contributing to the worldwide endeavor of new knowledge creation in the ever-increasing "multidisciplinary" contexts on which innovation strives. What does "multidisciplinary" mean? According to the Oxford Dictionary, "multidisciplinary" refers to "combining or involving several academic disciplines or professional specializations in an approach to a topic or problem". But what are we combining? Which academic disciplines or professional specializations are supporting these ambitions? It is widely accepted that "Science, Technology, Engineering and Math" (STEM) are key competencies for achieve and sustain economic economic leadership. In fact, these competencies play a major role in driving innovation and in conducting research and development. These competencies are also a major concern for governments, as less K-12 (Kindergarten to Form 12, i.e. Kindergarten, Middle and Upper School) students tend to take university STEM studies. This concern is justified as "STEM graduates are particularly well placed to use their technical and entrepreneurial skills to develop new innovations within their own or an existing organization", Abbott S. and Coles N. (2013). This is a fact that may be verified by observation upon a visit to a University Business Incubator. More recently, the "Arts" were brought into the equation and the acronym was revised to "STEAM" as the abbreviation of "Science, Technology, Engineering, Arts and Mathematics". The new STEAM seems to be getting a broad consensus "though many see art and science as somewhat at odds, the fact is that they have long existed and developed collaboratively", says Pomeroy S. R. (2012).

We are really witnessing a most interesting shift towards a broader and multidisciplinary understanding of the world, and one that you can actually observe at school, K-12. In fact, children are now more likely to have drama and art classes along with math, sciences and technology and project-based learning than they did some years ago. As we move towards higher education, however, the multidisciplinary approach is no longer that evident and the discipline centered education is back with rare opportunities for the integration of concepts. This discipline-centered organization is definitely tied to the professorship and to the way research careers are organized.

Research careers are tightly connected to the need for scientific publication in established peer-reviewed journals', mostly oriented to a particular discipline. This is as well the dominant logic for tenure positions. On the other hand, the promotion and rewarding of multidisciplinary research is somehow far from reality in this environment. However, it is our strong belief that, in spite of the traditional

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conservative academic environment, the sheer value of multidisciplinary research will emerge naturally. The fact is that, despite some doubts and uncertainty for the new boundary spanners, research opportunities are huge as one starts crossing frontiers and combining concepts and theories stemming from multiple disciplinary areas.

It is in this context that we would like to see JIM, as a modest contribution to this greater goal of promoting multidisciplinary research in academia and, through its promotion, the creation of new opportunities to the so-called boundary spanners. The way ahead is not an easy one, as crossing boundaries has its own challenges. We do believe Richard P. Feynman when he said: "I can live with doubt and uncertainty. I think it's much more interesting to live not knowing than to have answers which might be wrong." We are indeed going into uncharted territory and expect many different hurdles along on the way. Among those, the fact that different disciplines will have different views, different research methods and different languages, and this creates some difficulties that have to be overcome along the peer-review process, while ensuring that valid and valuable research is not bluntly rejected. This was, in fact, one of the difficult tasks we had to overcome upon the Journal launching and, we believe, we will be learning along the way. As they say "paths are made by walking" and we will have to ensure that we will walk the talk! To this end a careful peer review process was set-up. In the process we ensure that any multidisciplinary contribution is reviewed by at least one expert from each discipline, while being aware we will not have the same in-depth treatment of both disciplines. However, as time goes by, we believe new multidisciplinary research areas will emerge on their own right, thus creating new opportunities for academics and practitioners alike. This is also about talking the same language and, as soon as researchers, particularly those from more technical areas, start speaking the language of value creation, we will see amazing things happen.

This issue includes three letters, reflecting the multi-stakeholder perspective of JIM. Adopting a policy perspective, the first letter by Salmelin provides an overview of the Europe 2020 flagship initiative to implement the Innovation Union and support its competitiveness and growth. Salmelin further elaborates on the role of Open Innovation 2.0 and on the crucial relevance of ecosystems. In his academic letter, Hannon opens the debate on the challenges faced by universities in fostering the development of an entrepreneurial mindset within a traditional yet evolving educational context. Bagaria illustrates this entrepreneurial mindset and provides pragmatic insights on mobile banking alongside with the wealth of opportunities offered by technological change, ranging from new service development to customer engagement and improved user experience.

Following Bagaria's practitioner letter, Teixeira and Ferreira open the academic part of this second issue with an in-depth bibliometric analysis concentrating on entrepreneurship and adopting an original approach of identifying linkages among the most influential authors in the area and highlight the diversity of disciplines contributing to the understanding of entrepreneurship and its dynamics. In their conceptual contribution, De Smet et al. discuss the role of absorptive capacity for the co-creation of services in financial services. Klimontowicz also focuses on the financial services industry and unveils the results of a recent survey regarding traditional versus innovative payment instruments, uncovering customers preferences, drivers as well as diffusion barriers for such innovation in the Polish context. Relying on a survey of more than 200 firms in a leading emerging economy, Podmetina and

Smirnova open the debate on the role of R&D cooperation with domestic and international partners for implementing inbound, outbound and coupled processes of open innovation. Kortelainen et al. explore the variety of technological portfolios in the mobile phone industry, unveil their variation over time and elaborates on the firms' ability to dynamically adapt their portfolios in rapidly changing environments. In their empirical contribution, Indarti and Postma uncover the role of tie intensity and diversity as well as the quality of the interaction, multiplexity, on innovation performance, measured in terms of product novelties in two different industries in South East Asia.

João José Pinto Ferreira, Anne-Laure Mention, Marko Torkkeli
Editors

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Policy Letter

The Horizon 2020 framework and Open Innovation Ecosystems

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Abstract. Horizon 2020 will be the financial instrument implementing the Innovation Union, a Europe 2020 flagship initiative aimed at securing Europe's global competitiveness. Planned to run from 2014 to 2020 with an €80 billion budget, the EU's new Programme for research and innovation is part of the drive to create the conditions for new growth and jobs in Europe. It has been approved on 3rd December 2013, with many interesting new initiatives supporting the whole innovation process. Interlinking the new Horizon 2020 actions with the findings of the Dublin Open Innovation 2.0 conference findings and the Dublin Declaration for new European narrative for innovation we end up with very interesting new opportunities for all stakeholders in the innovation, including the societal dimension. In this short article I will elaborate some of the findings from Dublin Declaration and interlink those to the responses we see in the Horizon 2020 Programme.

Keywords. EU policy, competitiveness, innovation

1 Horizon 2020: background

Horizon 2020 is a totally new type of research programme for the EU that has been designed to deliver results that make a difference to people's lives. Built on three pillars it will fund all types of activities, from frontier science to close-to-market innovation.

Horizon 2020 is built around three pillars:

1. Support for "Excellent Science" – including grants for individual researchers from the European Research Council and Marie Skłodowska-Curie fellowships (formerly known as Marie Curie fellowships);
2. Support for "Industrial Leadership" – including grants for small and medium-sized enterprises and indirect finance for companies through the European Investment Bank and other financial intermediaries;
3. Support for research to tackle "societal challenges". During negotiations between the European Parliament and Council it was decided to support research towards meeting seven broad challenges:

    - Health, demographic change and wellbeing
    - Food security, sustainable agriculture and forestry, marine, maritime and inland water research, and the bioeconomy
    - Secure, clean and efficient energy
    - Smart, green and integrated transport

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- Climate action, environment, resource efficiency and raw materials
- Inclusive, innovative and reflective societies
- Secure & innovative societies

In addition, part of the Horizon 2020 budget goes towards funding the European Institute of Innovation and Technology (EIT), research activities carried out under the Euratom Treaty and non-nuclear research carried out by the Joint Research Centre, the European Commission's in-house science service.

In the following I will elaborate the Horizon 2020 programme from DG Connection Networks, Contents and technology (DG CONNECT) perspective, focusing on the industrial part of the programme as well on the societal challenges part where ICT is one of the critical technological enablers.

2 Open Innovation 2.0

Open Innovation 2.0 is a new innovation approach formulated by Martin Curley et al in their paper "Open Innovation 2.0: A New Paradigm", published in conjunction with the Irish Presidency conference Open Innovation 2.0 held in Dublin in May 2013. The paper identifies critical elements in the new approach clearly differing from the past understanding of open innovation.

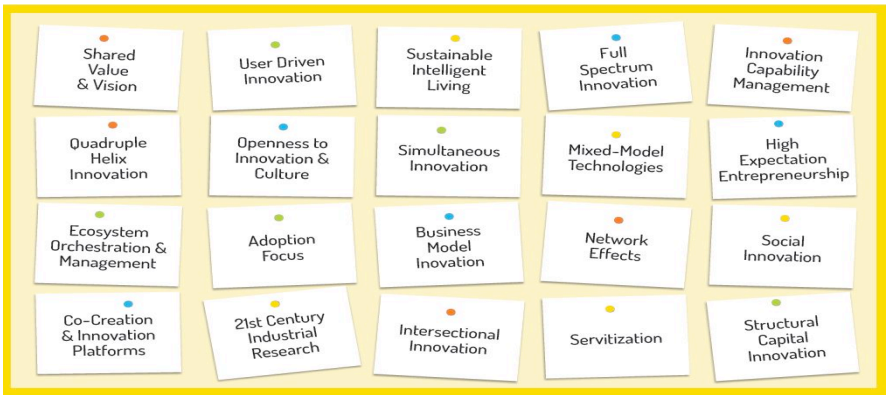

Fig 1: Components characterising Open Innovation 2.0

The key components are based on twenty interlinked elements from which I in this context want to highlight the following:

OI2 is a mash-up parallel process where the public policy maker needs to create the framework for this interaction (mash-up) to happen. OI2 is genuinely intersectional as innovation often happens in crossroads of technologies and applications and is not linear extrapolation of past.

To speed up the scalability all stakeholders need to co-create the solutions/find the innovations together, in real world settings. Only then we have a strong driver to create new markets and services, and are able to scale up successes fast. There is inherent buy-in in this kind of innovation environments. On the other hand by involving end users as co-creators upfront and seamlessly we see very fast the less successful experiments and prototypes failing; "failing fast, scaling fast" is actually one of the strongest advantages of Open innovation 2.0.

All this is leading to quadruple helix innovation model where the triple helix one

(research, industry, public sector) is complemented with the people component. Actually in this model the citizens are not seen as passive objects of new products or services but as active agents contributing in the whole innovation process seamlessly.

Importantly, taking both the quadruple helix approach as well as the interdisciplinarity into account we enter the innovation ecosystem model. The cluster model for innovation is outdated because it is still reflecting the sectorial approach. We see in many regions of Europe how the cluster approach has been successful in industrial sectors, e.g. in Germany and Northern Italy. However the cross-fertilisation beyond traditional value chains to value networks and further value constellations is increasingly important.

The paradigm change from closed innovation to open innovation and furthermore to Open Innovation 2.0 can be illustrated by the following table:

Closed innovation	**Open innovation**	**Open Innovation2.0**
Dependency	Independency	Interdependency
Subcontracting	Cross-licensing	Cross-fertilisation
Solo	Cluster	Ecosystem
Linear	Linear, leaking	Mash-up
Linear subcontracts	Triple Helix	Quadruple Helix
Planning	Validation, pilots	Experimentation
Control	Management	Orchestration
Win-lose game	Win-win game	Win more-Win more
Box thinking	Out of the Box	No Boxes!
Single entity	Single Discipline	Interdisciplinary
Value chain	Value network	Value constellation

In summary,

- Open stands for openness, curiosity, interlinking of different stakeholders, technologies and challenges.
- Innovation is making things happen, beyond ideation; scalability, and creating entirely new approaches. Innovation speed and success attracts talent and inwards investment, both intellectual and financial.
- Ecosystems would mean involving all stakeholders in quadruple helix manner, in order to build interdependencies and dare to drive a common agenda. It goes beyond sectors, clusters or PPP, involving all the ingredients needed in a mash-up process.

3 Open Innovation 2.0 and the Horizon 2020

Open innovation is present in many sections of the new H2020 programme and can be used systematically to create new (open) innovation ecosystems and environments. A lot of how strong the impact of these new instruments will be in real world depends on how the research, development and innovation projects are designed to complement and match and thus reinforce each others.

What is important is that there is a culture built enabling seamless interaction between the projects and the actors in ecosystems, that regionally new co-creative culture is created and that also new kind of courage is fostered in experimenting and bringing the results into real world.

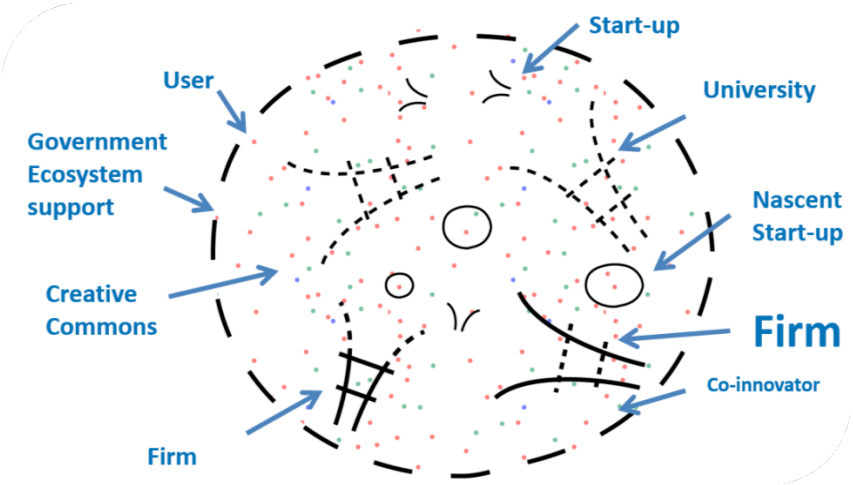

Fig 2: Open Innovation Ecosystem

In Fig 2 the heterogeneity of competencies are shown by different colours of the dots, combining together into competencies, more or less organised. A firm is an example of well organised form of collaboration, but increasingly we have expertise (or problem ownership; quadruple helix in mind!) regrouping project by project, based on their competencies.

Public support for the ecosystems is important not only in funding (and e.g. precommercial procurement of innovative solutions) but also as one important participant to create the rules in the ecosystems, to increase trust, and to increase the open mind sets of all participants in their various, simultaneous roles. As example, a citizen can be professional, distributing his skills towards several problem solvers, but at the same time he can be a problem owner longing for some solutions, etc. Each of us have multiple simultaneous roles in these ecosystems, which roles can be simultaneously public and private, problem owner or solver (contributor).

The H2020 programme is designed to cover the innovation aspects in the actions, bringing the research, development and innovation actions into the same basket. What is also interesting is that regional funding is now very strongly interlinked to the H2020 programme. The "smart specialization" is one of the elements in focusing the RD&I towards impact –provided that the smart specialization strategy goes beyond the buzzwords to share and solve the real issues.

This new thinking is reflected directly not only in the Horizon 2020 programme structure supporting demand-orientation but also in linking interdisciplinary thinking to problem solving. The science –driven innovation part of the programme supports the growth of new science and technology based results to be harvested in the other parts of the programme.

This holistic approach for research and innovation shapes the programme fundamentally.

Besides the "normal" projects there are quite a lot of new instruments bridging the gap between research and deployment. What is however very important, is that the RD&I actors themselves are doing the design of their own projects to match and complement each others, to create a sustainable (open) innovation system feeding continuously to the economical and societal development in these innovation hubs, attracting talent and leading to welfare, wealth and well-being.

Regarding traditional project approaches the H2020 is not defining the research and development method in general. However the partners are free to use the methodical approach; e.g. Experimental and Application Research method in real world settings. This would lead to upscaling of successful pathways and cutting the less successful ones. Of course then the design of the project needs to be done accordingly, which leads to new approaches in most cases. In the programme the applicants will see a drive towards prototyping, experimenting, and all happening in real world settings.

In some of the industrially driven research areas as well as in those addressing socio-economic challenges there is a clear requirement to develop and verify the outcome in real world, not in laboratories as usual. What is fostering the modern quadruple helix innovation model is to involve the users, e.g. citizens actively early and seamlessly the innovation process in co-creation of the results as then we are not only verifying the research at the final phase of the project, but also creating new markets, and even new solutions based on the real world interlinkages.

Open innovation environments call for a RD&I methodology based on courage to experiment, trial, scale-up and daring to fail small, but not big.

Regarding the new instruments for the H2020 there will be interesting new openings for prototyping and feasibility studies of ideas. The Open and Disruptive Innovation scheme (ODI) together with the SME-instrument allows ideas to be brought to the programme to be verified and prototyped in very light manner. If the prototype or feasibility phase show that the idea is worthwhile it can be brought forward with our more normal schemes. The risk level of this initiative is rather high, but by dividing the process to phases the risk is managed, at the same time maintaining the openness and incentive in the scheme.

One of the targets of the scheme is to create new markets by disruptive approach, which very often involves also strong presence of the problem owner (clientele, citizens) in the project execution, enabling at its best co-creativity for innovative solutions.

The public sector has an important role to play in creating innovation and bridging the research to successful applications. By procuring innovative solutions and investing on this bridging the public sector cannot only achieve better results but also directly encourage new entrepreneurship. If in these procurement processes quadruple helix innovation models are used also the co-creativity for the solutions means faster and more successful take-up, even creating new service models for enterprises and the public sector itself.

Importantly also inducement prizes will be proposed. They drive real solutions which are often application oriented. Prizes attract new constituency which not usually is involved in EU projects and highlights well also in public the issues to be solved. Prizes ideally bridge research results to commercialization without predetermining the structure or technology of the solution. There is clear evidence that prizes mobilise much wider constituency to solve the problem, and thus has a very strong impact on the innovation culture.

SME funding has been discussed thoroughly. One of the issues is to see clearly that one size does not fit all; that the focus needs to be on growth-hungry and even atypical SME's and even entrepreneurs. SME-enablers are critical also from the perspective of SME's often being very dynamic and knowledgeable players in business ecosystems, bringing agility and focused solutions to specific problems. It is important to realise that the (ICT oriented) SME's do not have "children's" tickets as they are immediately exposed to global competition. This is especially true for the new generation web entrepreneurs. Particularly interesting is that in specific SME schemes only one SME can be the sole participant, provided that the problem has a

European dimension. Also innovation vouchers are to be used to bring the SME:s digital. This part will be funded by ERDF.

One component of the holistic approach is also the use of loan instruments to cover parts of the innovation process close to the market.

4 Conclusion

The new innovation drivers (Open Innovation 2.0) call for new type of mind setting where key is the involvement of all stakeholders into a collaborative, co-creative culture. The quadruple helix model where the research community, industry, public sector and citizens are all active actors create a win-win situation as it is targeting to create new markets and fast upscaling of the successful solutions.

Having the Open Innovation Ecosystem as goal to attract talent, financial resources and ideas to be experimented and prototyped in real world leads to the need to engineer and design the portfolio of activities to create a winning game by sharing, not closing. Open Innovation Ecosystems create strong interdependency and a drive to make things happen. It has the possibility to drive the change by merging the technology enablers like ICT with the societal change.

Now it is up to the quadruple helix innovation community to tackle the challenge, and experiment the future; to scale up successes. Horizon 2020 together with the smart specialization creates a lot of new opportunities to build the portfolio upon. I urge you to have a close look at the new opportunities the research and innovation framework creates for you, and how you can together with relevant stakeholders jump into the new impactful innovation paradigm.

Disclaimer:

The views expressed in this article are those of the author and do not necessarily reflect the official European Commission view on the subject.

Letter from Academia

Why is the Entrepreneurial University Important?

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Abstract. Entrepreneurship in higher education is now recognized as important as a major driver to underpin innovation. It is also viewed as an appropriate response to succeeding in highly turbulent and unpredictable environments. However confusion remains over its conceptualization, meaning and value as institutional leaders seek ways to understand where this strategically fits within the organization and educational leaders seek to understand how best to embed entrepreneurship within its education and learning opportunities. This paper highlights the challenges faced by universities in becoming entrepreneurial and in creating environments within which entrepreneurial mindsets and behaviors are developed. The author builds on work undertaken in his previous role as CEO of the National Centre for Entrepreneurship in Education in the UK, current work with the European Commission and highlights practices undertaken in his new role to build an entrepreneurial university.

Keywords. Knowledge economy, entrepreneurship, higher education, university, teaching curriculum, innovation.

1 The Entrepreneurial University

The concept of the entrepreneurial university is not new. However it does have many meanings and identities including, inter alia, notions of enterprise, innovation, commercialisation, new venture creation, employability and others. It can also reflect organisational leadership and governance structures. It can be seen as an organisational response to external challenges and pressures (Gibb and Hannon, 2006).

Within an academic context and environment, entrepreneurialism can be perceived as the development of a set of individual behaviors, skills and attitudes as characterised by the entrepreneur (Gibb and Hannon, 2006). The same characteristics can be applied to the intrapreneur, the social entrepreneur, the technopreneur and across many other contexts.

But why is this important? Why is entrepreneurship important in higher education? Why are these concepts of relevance to higher education institutions? What role should an HEI play in stimulating entrepreneurship across its campus? Why does a university need to be entrepreneurial?

Clearly change is not new to the higher education sector. For decades institutions have been adapting to reflect the changing environments in which they operate and seek to succeed. Across the globe the pressure on institutions to change is increasing: globalisation, social mobility, online technology developments, competing nation states and geopolitics, demographics and of course economic pressures on governments to re-evaluate their investments in state funded services have all contributed to a highly uncertain and unpredictable environment for higher education (Gibb et al., 2012).

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It is when faced with precisely these types of environments that entrepreneurial responses are appropriate responses for organisations to tackle and exploit the challenges and opportunities that emerge. When the future is predictable and you know what is likely to happen and how organisations and individuals behave and respond, then you do not need to be entrepreneurial in what you do, how you do it and who you do it with.

In his seminal work 'Innovation and Entrepreneurship' Drucker stated 'Entrepreneurs innovate' (Drucker, 1985). Taking this further, it is entrepreneurial individuals that drive innovation. Innovation is enhanced by those who can think, behave and act in an entrepreneurial manner. In other words, innovation is underpinned by entrepreneurship.

There is a significant imperative to develop entrepreneurial capacities across a broad spectrum of students/graduates and those employed in small and innovative firms if we are seeking to enhance innovation. There is then a clear role for education and training and an educational imperative for universities in designing learning environments and providing learning opportunities that stimulate entrepreneurial mindsets, thinking and action.

We know that graduate entrepreneurs make an immense contribution to the economy. An assessment undertaken by the National Council for Graduate Entrepreneurship (NCGE) in the UK showed that, through an analysis of Top 100 listed firms, over 80% of Top 100 high-growth firms and Top 100 high-tech firms were founded and/or managed by university graduates.

Who are these university graduates? When an analysis of graduate start-ups was undertaken by the Kauffman Foundation in the USA, it was found that 89% of these start-ups did not emanate from university business studies and management programmes but from across a broad range of non-business disciplines.

This clearly has implications for how universities position entrepreneurship across their campus structures. In the UK the NCGE, (now the National Centre for Entrepreneurship in Education), has been conducting national surveys of the provision and engagement in enterprise and entrepreneurship offerings at British HEIs (see for example, Hannon et al., 2006; Hannon, 2007; Rae et al., 2010). Over a number of surveys the entrepreneurship provision offered by universities has hovered at around 60%+ from business and management schools. In recent surveys there has been a slight upward trend from non-business areas but there is clearly an opportunity for much higher levels of provision from the sciences, applied sciences, arts and humanities and other non-business subject areas.

2 The Need for the Entrepreneurial University

As well as arguing that Universities need to create environments conducive for the development of entrepreneurial mindsets and behaviors it is further important that universities can themselves think and behave in a more entrepreneurial strategic mode for addressing the multiple pressures they face (Gibb et al., 2012), such as:

- Governments wanting more from less; wanting solutions now to current economic crises; wanting new sources of employment to counter losses in the public and corporate sectors; and seeking solutions to combating growing youth and graduate unemployment;
- Employers wanting more than knowledge and basic skills from the graduate recruits as they seek new ways to enhance innovation and competitiveness;
- HEIs being perceived as engines of innovation and technological progress;

hence, HEIs are seen as driving forces for economic growth;

- Parents wanting the best opportunities for their children as they strive to find meaningful opportunities in an uncertain future;
- Students wanting value for money and expecting a good job and salary to pay off their education debt; believing that university education offers them a route to better (and guaranteed) employment opportunities;
- The potential impacts and opportunities arising from the substantial growth in the provision and take-up of MOOCs (Massive Online Open Courses);
- The competitive threats and opportunities as a result of the growth in private sector providers and to a much lesser degree, corporate providers;
- Knowledge no longer being the unique domain of universities. Kweik (2012) cites Williams (2012) highlighting that:

  '… as the emerging economies, particularly in Asia, build up their higher education systems, "knowledge" in itself is unlikely to ensure the earnings premium it enjoyed during the 20th Century.'

- Kweik (2012) further argues that institutions are becoming more 'socially embedded' as they respond to ever growing expectations:

  'The consequence is that both the higher education institutions and national governments are facing a growing multitude of expectations. As knowledge is sought for as the solution for everything, demands of the environment are penetrating higher education. Typically, the institutions respond by additive solutions. They are appending new layers of academic specialties, study programmes, services, and administrative units to the organization in order to meet the challenges.' (citing Arbo and Benneworth, 2006)

Universities are continuing to change and need to change, and some would argue at a faster pace. Kweik (2012) proposes that institutional change can take different courses – incremental; radical; accidental:

- For some institutions, change happens to them; it is accidental and can reflect a close symbiosis with their stakeholder environment;
- For other institutions, change is incremental where fundamental principles remain in place; a strong sense of purpose and identity is maintained; and new innovations and change management processes are introduced as part of a longer-term 5 or 10 year strategic plan;
- For a few institutions, change can be radical, a point of complete renewal in purpose and identity, in organisational governance and structures, in strategic relationships and in how the institution contributes to social and economic development on a local and global stage. Mergers and acquisitions are another example of radical change;
- Kweik (2012) refers to these approaches as an 'academic revolution'.

And what is the concept of the entrepreneurial university? This can firstly be presented in its simplest form through two key dimensions:

1. As an organisation taking an entrepreneurial response to addressing the pressures and challenges it faces as described above; an organisation that renews itself to better align with its environment; an institution that inculcates entrepreneurial thinking through its governance structures and managerial policies and practices.
2. An institution that creates an environment, within which the development of entrepreneurial mindsets and behaviors are embedded, encouraged, supported,

incentivised and rewarded.

Shattock (2009) provides a similar viewpoint:

> *'entrepreneurialism in a university setting is not simply about generating resources – although it is an important element – it is also about generating activities, which may have to be funded in innovative ways either in response to anticipated and/or particular market needs or driven by the energy and imagination of individualism, which cumulatively establish a distinctive institutional profile. Entrepreneurialism is a reflection both of institutional adaptiveness to a changing environment and of the capacity of universities to produce innovation through research and new ideas.'*
>
> *'We should not see entrepreneurialism simply or even necessarily in relation to research, or in the exploitation of research findings …… entrepreneurialism involving innovation and academic and financial risk can be found in regional outreach programmes, in economic regeneration activities, and in distance learning ventures, as well as in investment in spin out companies, the investment of overseas campuses and the creation of holding companies to house different sets of income-generating activities. For many universities, entrepreneurialism can be found in various innovative forms of teaching either to new clientele at home or embodied in programmes of internationalization (themselves often involving both financial and reputational academic risks)'.*

3 Challenges in Becoming an Entrepreneurial University

Universities face numerous challenges and obstacles on the journey to becoming more entrepreneurial, (for a detailed discussion see, for example, Clark, 1998; Etzkowitz, 2004; Thorpe and Goldstein, 2010; Gibb et al., 2012; Kweik, 2012), inter alia:

- Perceptions of relevance and meaning of entrepreneurship for higher education; and hence developing a shared institutional vision, identity and consensus
- Organisational transformation and re-organisation of knowledge and people and opportunity
- Ideological threats, notions of capitalist tendencies and the demise of academic autonomy through utilitarian approaches to modern university education
- Curricula controls on content and assessment through internal structures, external agencies and professional bodies
- Lack of academic career pathways for those pursuing entrepreneurship in higher education institutions, especially research-intensive institutions and hence perceptions of personal risk
- Perceptions of weak academic rigor against other more established disciplines
- Strong links with commercialisation and income generation rather than with education and learning
- Positioning within an institutional structure either inside or outside or academic faculties or colleges and the associated flows of income and related kudos.

For over two decades academics have been exploring this concept identifying key factors, developing a rationale and key arguments, assessing policy and practice and

creating frameworks and tools to aid institutional leaders and academic staff to build successful entrepreneurial universities and address the types of challenges and obstacles highlighted above.

Although there are challenges in understanding the why and what of the entrepreneurial university, more and more universities recognise both its importance for a 21st Century higher education institution and the need to enhance organisational flexibility and adaptability. However the greatest challenge remains in 'how' universities become entrepreneurial institutions and how they create effective environments for developing entrepreneurial capacities in their staff and students.

In the UK this has been approached initially through the creation of exemplars and role models in the sector. NCGE (now the National Centre for Entrepreneurship in Education, NCEE) has been running annual 'Entrepreneurial University of the Year' Awards with the Times Higher. Each year one university is selected from six finalists that best exemplify achievements during the past year in growing entrepreneurship. The framework behind this award emphasises the importance of an entrepreneurial environment, an entrepreneurial and innovative faculty, an engaged student community, and a resulting impact on the institution, its stakeholders and its environs.

4 An European Model

In Europe, the European Commission working with OECD have built an online self-assessment tool, HEInnovate (access at www.heinnovate.eu), as a guiding framework for the entrepreneurial university. This framework focuses on 7 key pillars identified through a thorough review of existing research and thinking and with a group of experts from across Europe. The tool aims to provide higher education institutions with the opportunity to reflect on their perceptions of strengths and weaknesses in each key area thereby helping to identify institutional development needs. The 7 pillars are:

- Leadership and governance
- Organisational Capacity, People and Incentives
- Entrepreneurship Development in Teaching and Learning
- University-Business/External Relationships for Knowledge Exchange
- The Entrepreneurial HEI as an Internationalised Institution
- Pathways for Entrepreneurs
- Measuring the Impact

Creating an environment for the enhancement of entrepreneurial thinking and behaviors across all subject areas also creates challenges. The UK has been investigating this and the Quality Assurance Agency published a guidance note (QAA, 2012) for embedding enterprise and entrepreneurship in higher education. This document aims to provide examples of how entrepreneurial learning opportunities can be provided within formalised curricula and through extra-curricula provision. The framework also proposes a learner journey that begins with raising awareness, progressing to the development of entrepreneurial mindsets, on to enhancing entrepreneurial capacities and finally to enhancing entrepreneurial effectiveness.

The challenge is for universities to review what they do and how and the effects on the enhancement or inhibition of the development of entrepreneurial capacities that will underpin innovation capacity. How often are the institution's structures and policies, all curricula, business and industry collaborations, internationalisation

activities reviewed? There is much the can be changed in an institution: conceptualisations of entrepreneurship; strategies for embedding entrepreneurship across the campus; opportunities for entrepreneurial learning; new combinations of multidisciplinary knowledge (Gibb, 2005).

Travelling the journey towards an entrepreneurial university is not a lone activity. There needs to be a number of actors stimulating change, for example: visionary and transformative leaders at all levels in the organisation; entrepreneurial staff acting as inspiring role models; students empowered to act and take risks; mentors and coaches who can inspire and support entrepreneurial development opportunities; education activists and critical friends who will lead innovation in the curricula and learning; learning technologists; dynamic and effective entrepreneurial ecosystems; a diversity of stakeholders from all key communities of practice; celebrators of learning from failure.

5 A Multi-layered Approach to Becoming an Entrepreneurial University

I have recently joined Swansea University to help stimulate more entrepreneurship across the institution. The university has already been on its own journey toward becoming an entrepreneurial university for a couple of years and much has been achieved. For example, below are highlights of a number of activities and initiatives that are stimulating entrepreneurship across the campus. This demonstrates the multi-layered approach necessary in creating a dynamic entrepreneurial institution.

- The creation of Swansea Employability Academy and associated Entrepreneurial University Development Group at a strategic level under the guidance of a Pro-Vice Chancellor
- The creation of the Institute for Entrepreneurial Leadership to enhance culture change and build institutional capacity
- New cross-campus entrepreneurship courses and modules to increase access to entrepreneurial learning opportunities
- Employment Directors established in all Colleges on the campus as champions and change agents in their own disciplinary areas
- Dedicated entrepreneurship webpages to coordinate all opportunities and activities and provide a coherent and cohesive approach
- Student enterprise suite within the School of Management as a hub for action
- A dynamic student entrepreneurship club as a peer-to-peer model
- A new 'Donate a day' scheme to engage local small firms in supporting students and provide real-life experiences of entrepreneurship in action
- A new staff CPD programme working with 150 staff to implement the QAA guidance and build institutional capability and confidence
- The first global start-up market and week-end in Wales to enhance the profile of Swansea as an active start-up environment
- £250 challenge to stimulate student team projects to engage in risk-taking behavior
- Canadian challenge to support students to work with Sir Terry Matthews, a high-profile Welsh multi-millionaire
- Senior university staff attending national leadership programmes to embed deeper understanding at a strategic level in the institution
- Entrepreneurial research group and Working Paper Series to provide research

interests across disciplines

- Student and staff start-ups and spin outs supported through the Dept of Research and Innovation
- Engagement with SMEs through LEAD Wales, a national leadership and business development programme to stimulate growth
- New Swansea Bay campus development focused on science and innovation and underpinned by entrepreneurship, as a significant flagship and major institutional commitment to becoming a leading entrepreneurial and innovative university

6 Summary

In summary, the role of the entrepreneurial university is increasingly being seen as important for finding new ways to compete and succeed in uncertain and unpredictable environments and for finding new solutions to the multiple challenges that need to be addressed for the public good, whether local or global.

How universities create the pathways and strategies for successfully travelling this journey are contingent on many factors. However, 'HEInnovate' and other such frameworks and tools enable universities in all contexts and across all countries to explore where they have opportunities to further develop. The most challenging change, as in many complex organisations, is the realignment of organisational values and culture and changing the mindsets of individuals.

The journey has begun in many universities across Europe and beyond and is likely to increase in pace during the current decade as institutions reflect and respond entrepreneurially to their changing environments.

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Letter from Industry

Inspiring mobility for banking enterprises

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1 Introduction

Mobile banking is taking the world by storm, accounting for over 590 million users worldwide, which is expected to double to exceed 1 billion by 2017. Today consumers will not bank with a Bank that does not have internet banking. Tomorrow consumers will not bank with a Bank that does not have mobile banking.

In order for banks to create a successful mobile banking strategy, banks need to do more than just provide their internet banking on the mobile phone. They have to focus on innovation and user experience to deliver leading edge mobile banking applications.

This article describes how banks in Asia Pacific have leveraged innovation and user-experience to differentiate themselves from their competitors.

2 Mobile Banking Landscape

Mobile technology is forcing banks to rethink how they engage with their consumers. While this technology provides a tremendous opportunity for banks to enhance their interactions with their customers, it has also given rise to a number of new competitors like Telco's and direct banks, which continue to leverage the ubiquitous presence of mobile phones to offer financial services directly to customers.

In recent years, a number of banks in Asia Pacific have invested in mobile in the race for a mindshare among increasingly technologically savvy customers. The mobile channel ranks as the number one priority for most banks.

In mature markets like Japan, Korea, and Singapore, banks are active in driving more innovative services to the mobile channel to differentiate themselves, while in emerging markets like the Philippines and Indonesia, the focus is more on capturing a larger customer pool by offering remittance and payment services.

There have been mixed results in mobile banking deployments in Asia, from highly successful initiatives like DBS Singapore, that was ranked number 1 by MyPrivateBanker in its Mobile Apps for Banking Report 2013, Axis bank that was voted "Best Financial Services Mobile Application" at the 2013 Mobile Web Awards and United Overseas Bank (UOB) that that took top honors for its mobile app at this year's Asia Banking & Finance Retail Banking Awards, to others in the region, offering only basic mobile banking apps to complete their channel offering.

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3 Innovation helps banks stand out from the crowd

When Banks think of mobile banking services, the important thing to keep in mind is that it is the consumer that is "mobile" not the phone, i.e. the consumer who is on the move and that mobile services have to be contextual to where the consumer is and the phone becomes a means of engagement with the consumer.

It's important then, that banks look at what relevant services can they provide to consumers on-the-move. These could include services like location-based marketing that offers the right deal to the right customer at the right time, mobile payments at retail outlets or innovative financial transactions services like mobile cash that allows consumers to withdraw money from ATM's using their mobile phone. By leveraging the power of mobile phone, banks have an opportunity to provide innovation in their financial products and services.

Using lending as an example, although many banks provide basic loan calculators on their mobile apps, some banks have gone the extra mile to innovate. For instance, the Commonwealth Bank of Australia (CBA) in their mobile banking app allows consumers to use the camera on their phone to point to a property, to see if it is for sale, get more details on it and calculate whether they can afford it or not. The beauty of this app is that it allows the bank to be an active part of the consumer's financial decision process to buy a property, rather than after the fact when they have made a decision and are out hunting for the lowest rate loan.

Banks are also integrating social media in their mobile strategy. Asia has a very high social media adoption rate with countries like Thailand, Indonesia and Philippines ranked with a higher index than the worldwide reach of social networking sites, according to digital analytics company, comScore. Consumers, especially young people, use social media apps on their phone extensively. This presents an opportunity for banks to become part of consumers' digital lifestyles, by offering services like social payments, to help build relationships with consumers early on in their banking lifecycle.

Beyond services, Banks are effectively using the mobile for new customer acquisition – both for retail and business customers. While banks invest heavily in marketing to new customers, opening an account can often be a tedious process that must be done at a branch leading to a low conversion rate even for customers that are interested in the banks' services. Banks are now leveraging the mobile to ease the account opening process by allowing submission of all necessary documents as images and filling all necessary forms through their mobile app. This is a game changer for foreign banks in a country that may not have the same branch and distribution network as the local banks of that country.

4 Improving the user experience

The importance of the user experience provided by the mobile banking service cannot be undermined. A good mobile banking user experience is simple, intuitive and contains relevant features for the customer.

User experience starts with making common transaction simple, like log in, balance enquiry, funds transfer etc. One of the banks in Singapore found their mobile adoption increased significantly when they allowed users to log in for enquires with 1FA rather than 2FA which is required for financial transactions. Another bank made it easier to do a funds transfer by allowing its mobile banking customers to simply send money to the recipient's mobile number.

User experienced can be enhanced with personalization – this can be bank-led or

user-led. As an example of bank-led personalization, Axis Bank in India launched its mobile banking apps with individual designs and services for its youth, mass and high net worth individual markets. The apps were extremely well received by their customers and have become a new benchmark for mobile banking in India.

Ultimately, it is about understanding the target audience for each service, and knowing what appeals to them. Where the service is targeted at high-end customers with interests in investment products, the application interface should differ from how it would be for young adults with different banking needs.

Other banks offer personalization features that put the user in control. Maybank Singapore allows customers to personalize their mobile banking app with their own pictures and frequently used services. Another local bank in Singapore allows users to customize their pre-login menu so that they can rapidly access their preferred services.

In conclusion, while technology offers a broad spectrum of possibilities for banking services - innovation with the customer in mind is imperative. Most consumers have become increasingly disengaged with their banks as they hardly visit a branch anymore, let alone know their banker. The mobile platform gives banks an opportunity to re-engage with their customers. A successful mobile strategy is one that ensures that the service fits and exceeds customer expectations.

Intellectual structure of the entrepreneurship field: a tale based on three core journals

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Abstract. Underlying the scientific structure of a field is the network of informal communication linkages established among the most influential scholars within the area. These groups of mutually interacting and prolific scientists who exchange knowledge through communication channels are named "invisible colleges". In this study, we perform a two-stage analysis to identify invisible colleges in the field of entrepreneurship using three core journals: Entrepreneurship Theory and Practice (ETP); Journal of Business Venturing (JBV), and Small Business Economics (SBE). Using bibliometrics, a in depth analysis was conducted on the most influential authors, their professional affiliation and educational training, in order to map the informal links between the most-cited authors. Based on over 90 thousand citations from these 3 journals two invisible colleges emerged: ETP and JBV have similar intellectual groundings, targeting especially corporate and entrepreneurship venturing, while SBE gives emphasis to more economics-oriented research, namely innovation, growth and policy, and industrial dynamics.

Keywords. Invisible College, Entrepreneurship, Bibliometrics.

1 Introduction

Academic research on entrepreneurship has increased over the last few decades, accompanying society's interest in the matter (Landström, 2005; Aldrich, 2012; Shane, 2012; Carlsson et al., 2013). In fact, entrepreneurship research and teaching has been one of the most prominent social sciences in recent years, with jobs with a focus on entrepreneurship and faculty expertise in entrepreneurship continuing to rise (Finkle, 2007; Venkataraman et al., 2012; Gartner, 2013).

The explosion of entrepreneurship scholarship led to the need to measure scientific production (namely through bibliometric and scientometric approaches) in entrepreneurship and to understand the scientific structure of the field, such that several studies have dedicated significant attention to the matter (Cornelius et al., 2006, Grégoire et al., 2006, Schildt et al., 2006; Teixeira, 2011; Landström et al., 2012). Underlying the scientific structure of a field is a network of informal communication linkages among the most influential scholars within that area. These groups of mutually interacting and prolific scientists, who exchange knowledge through communication channels, were named "invisible colleges" (Crane, 1972; McMillan, 2008; Vogel, 2012) and are the focus of our study. In spite of the academic interest in entrepreneurship, research on invisible colleges, per se, are still relatively unexplored (some of the few articles on the subject include Reader and Watkins

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(2006) and Teixeira (2011)).

According to Landström et al. (2012), despite some signs of differentiation, the field of entrepreneurship is increasingly formalized and anchored in a small set of intellectual bases. The signs of fragmentation and specialization, reflected in the emergency of a number of subject specialties, are demonstrated in Teixeira (2011), who following a formal selection procedure to delimit the 'relational environment' of the field of entrepreneurship, analyzes the existence and characterizes the (in)visible college(s) of this field.

The 'invisible colleges' facilitate a process of social diffusion that fuels the growth of scientific specialties (Carey, 2011). This diffusion of ideas operates both through linkages between researchers and published journal articles. The former channel is particularly emphasized in the study of Teixeira (2011). The present paper seeks to complement Teixeira's (2011) contribution by focusing the analysis on three core entrepreneurship journals and thus providing a more in depth, though with lesser scope, perspective of the (potential) invisible colleges in the field. Researchers have long noted the importance of 'invisible colleges' in transmitting knowledge within disciplines. Thus, an analysis of the three core entrepreneurship journals provides valuable insights on how knowledge flows and who are the knowledge gatekeepers in those journals, permitting to uncover potential signs of differentiation and specialization which are likely to be useful for both newcomer and established researchers aiming to publish in this challenging area.

Contrary to Teixeira (2011), who used a statistical delimitation procedure to identify the 7 journals that 'defined' the entrepreneurship field, in the present paper we opted for a more conventional selection procedure based on relevant literature which identifies Entrepreneurship Theory and Practice (ETP); Journal of Business Venturing (JBV) and Small Business Economics (SBE) as core entrepreneurship journals (Katz, and Boal, 2002; Ritzberger, 2008; Stewart and Cotton, 2013). For each journal we collected all the articles published from their inception until the end of 2008. The main unit of analysis for identifying invisible colleges is citations to these articles (Zuccala, 2006; Dos Santos et al., 2011). Given that recent articles (those published in the last 3 years) receive few citations and the citations structure of rather old articles is unlike to change significantly in a three year period (Vieira and Teixeira, 2010), the truncation date we established for gathering citations (February 2009) might be acceptable. However, it is important to remark that the citations structure of articles published in the neighborhood of the the truncation date are likely to be significantly influenced by such a truncation option.

Resorting to Zuccala's (2006) framework, we gathered evidence about the most-cited authors, studies (articles or books) and journals for each of the core journals, enabling us to characterize the intellectual groundings of entrepreneurship, comparing the results for each of the selected journals. We then confirmed the existence of linkages between the most influential (i.e., most-cited) authors, through a all-inclusive study of their affiliations, educational training and research areas. Examining the social ties (or links) that connect influential authors in the field of entrepreneurship is fundamental to understanding the multifaceted nature of invisible colleges, since these are based on the (formal and informal) exchange of scientific knowledge. The combination of evidence gave us empirical support to conclude that there are distinct invisible colleges within the field of entrepreneurship.

The paper is structured as follows. In Section 2 the concept of invisible college is defined and related literature reviewed, including a description of Zuccala's (2006) approach. Section 3 details the bibliometric and scientometric methods, illustrating their main applications in entrepreneurship and other scientific areas; additionally, it describes the data and methodology pursued. The following section analyzes the most-cited authors, studies and journals in each core journal, further performing a

comprehensive study of the linkages among the most-cited authors. Finally, we draw the main conclusions, pointing out the study's limitations and suggesting paths for future research.

2 Searching for Invisible Colleges in entrepreneurship scientific research: a literature review

Back in the 1970s, Price (1971) defined an 'invisible college' as a hierarchical and elitist group of scholars, supported by an expectable inequality and a high level of connection. Influenced by Price's work Crane (1972) advanced with a wide-ranging examination of the invisible college phenomenon and expanded the scope of the concept of informal communication, to include informal discussions, relationships between teachers and students during thesis preparation, and the influence of a scientist's work on another (Teixeira, 2011).

More recently, Zuccala (2006: 155) emphasized the need to understand the multifaceted nature of the invisible college, proposing the following definition:

> *An invisible college is a set of interacting scholars or scientists who share similar research interests concerning a subject specialty, who often produce publications relevant to this subject and who communicate both formally and informally with one another to work towards important goals in the subject, even though they may belong to geographically distant research affiliates*.

The novelty in the definition, as Zuccala (2006) pointed out, is its openness to the possibility of combining different types of analysis – bibliometric, sociometric and qualitative – in the study of invisible colleges, benefiting from their unique contributions.

The majority of the studies which aim to identify the invisible colleges of the respective journals (e.g., McMillan and Casey, 2007; Casey and McMillan, 2008) undertake co-citation analyses. Indeed, co-citation analyses have developed into the main bibliometric technique to explore the intellectual structure of scientific communication (Lievrouw, 1989; Bayer et al., 1990; Gmür, 2003). According to Bellardo (1980: 231), co-citation analysis is founded on the premise that "the greater the number of times that a pair of documents is cited together, the more likely it is that they are related in content". A co-citation occurs when two references or authors are mentioned in the same bibliography and serves as a measurement for the closeness of content (Small, 1973; Garfield et al., 1978; Gmür, 2003). Although there has been some criticism regarding the use of citation and co-citation analysis, as the use of citation links is considered an inadequate representation of communication among researchers (Lievrouw, 1989), their credibility as indicators of scientific communication was vouched for by authors such as Small (1978) and Garfield (1979), and they constitute the grounding for identifying invisible colleges (Gmür, 2003).

Studies in general, as mentioned earlier, define invisible colleges as social processes, based on informal links. However, empirically, 'operational' invisible colleges are treated as structures of scholarship, measured by formal elements such as published documents. Although co-citation analysis is based on formal links, the key issue here is that the invisible colleges measured as such, involve research networks of authors who refer to each other in their documents without being linked by 'formal' organizational ties. Applications of this process encompass distinct areas such as economics (McMillan and Casey, 2007; Casey and McMillan, 2008) and management (McMillan, 2008). Verspagen and Werker (2004) apply a slightly different

methodology by using a survey to map the intellectual relations between active contributors in the discipline and identified possible social networks, i.e., invisible colleges.

In the scientific area of entrepreneurship, Reader and Watkins (2006) explored the existence of invisible colleges by complementing a co-citation analysis of the field's scientific structure with a questionnaire survey. The authors employed a comprehensive database, created by the Southampton Business School, which includes full coverage of the major niche journals in entrepreneurship, conference proceedings and other major, but not so specific, journals such as those on the Social Sciences Citation Index. The key authors were identified through a process of cross-referencing that reduced a list of 4405 documents initially generated by a keyword search of the word "Entrepreneur$" within the database. Using author co-citation and factor analysis, the authors try to identify, respectively, groups of entrepreneurship scholars whose work falls into similar areas and the topics that characterize and define the field. The survey allowed them to explore the social and collaborative nature of entrepreneurship research among the leading co-cited authors, unveiled in the first stage of the work. Therefore, the subfields identified in the author co-citation analysis of informal communication links between closely related authors and then validated by the survey, represent the "invisible colleges" to Reader and Watkins (2006).

In spite of the high-quality research dedicated to assessing the intellectual structure of the field of entrepreneurship, namely the presence and nature of scholarly communities that comprise the field, literature specifically focused on the matter of invisible colleges is still rare. The multifaceted nature of this phenomenon, particularly the structure versus social process issue, requires, as Lievrouw (1989) recommended, distinct approaches to the subject in order to provide new insights. Thus, we aim to explore the existence of invisible colleges in the field of entrepreneurship, undertaking a citation analysis of the articles published in three core journals in the area – Entrepreneurship Theory and Practice; Journal Business Venturing and Small Business Economics. For this purpose, and similarly to Teixeira (2011), the methodology proposed by Zuccalla (2006) was used, in order to explore the (widely debatable) concept of 'invisible college'. We argue that although the theory underlying the concept is well developed and relatively consensual, the empirical application of such a concept lags far behind theoretical achievements. Moreover, in our view, there is a need for an objective framework structure which enables, in a more precise manner, the 'measurement' and 'assessment' of invisible colleges.

According to Zuccala's (2006) definition of Invisible Colleges, mentioned earlier, and the corresponding research framework, an invisible college is a consequence of an interrelationship (through formal and informal communication) between three key elements: subject specialty, the social actors and Information Use Environment. The first informs the invisible college of its disciplinary rules and research problems, the second refers to the scientific scholars who understand and agree to the rules and interact with one another to solve problems, and the third and last element, represents the scientific workspace, i.e., the "set of elements that affect the flow and use of information messages into, within, and out of any definable entity" (Taylor, 1986: 3). The social actors, i.e., the most influential authors, make use of the invisible college to support their search of information and sharing patterns (informal communication) and reinforce the invisible college through bibliometric artefacts (formal communication). Therefore, Zuccala (2006: 8) concludes that the invisible college is an organizational structure produced by "the space that intersects the Information Use Environment, the subject specialty and the social actors" (cf., Fig. 1).

Thus, similarly to previous studies (e.g., McMillan, 2008; Casey and McMillan, 2008;

McMillan and Casey, 2007; Teixeira, 2011; Landström et al., 2012), this work applies a bibliometric analysis in order to obtain empirical evidence from which the development of the field's intellectual bases can be assessed. However, unlike some of these studies which are constrained to a narrow definition of invisible colleges and provide few insights regarding scholars interrelatedness through informal channels, but in line with the approach followed by Teixeira (2011), we complement the study of the most-cited authors, articles/books and journals, with an analysis of the linkages between the most influential (i.e., most-cited) authors, based on their educational affiliation, professional affiliation and research area.

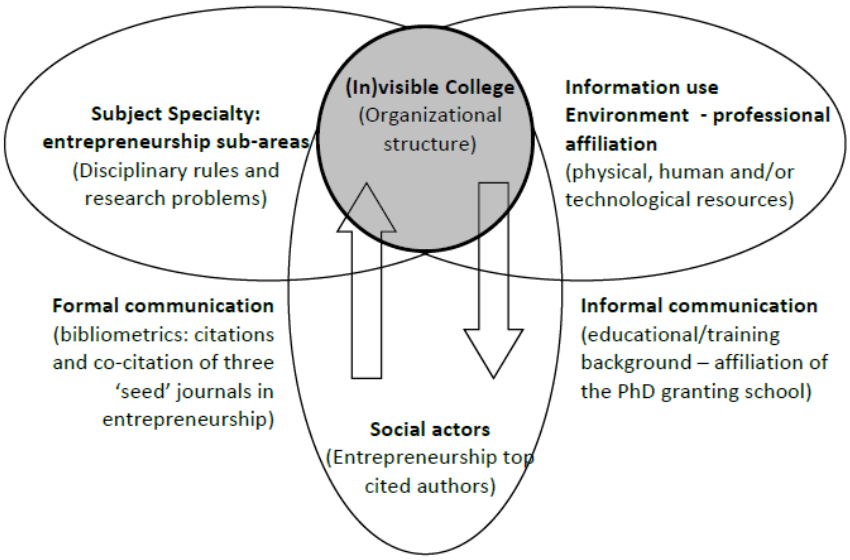


Fig. 1. Conceptual model to analyze the structure of an invisible college in entrepreneurship.
Source: In Teixeira (2011: 10), and adapted from Zuccala (2006: 156)

The use of three core journals, instead of only a single journal analysis (e.g., McMillan, 2008), permits determining whether there are distinct invisible colleges within the field of entrepreneurship according to the core journal considered. By circumscribing the study to three niche journals but including all articles available until February 2009, we ensure a wide-ranging analysis that preserves all relevant information. This is not the case of the studies which rely on a wider range of data sources, but confine their sample to a process based on the initial search of a specific keyword, within the chosen database – a limitation present in the studies mentioned previously (e.g., Cornelius et al., 2006; Schildt et al., 2006; Reader and Watkins, 2006). In fact, obtaining data through such a broad process does not ensure that the interacting authors share similar research areas, as proposed by Zuccala (2006), which constitutes a handicap in those studies. Additionally, and compared to Teixeira (2011), who uses more journals than us, her data is restricted to a shorter period of time (2005-2010).

3 Searching for the 'invisible colleges' in the Entrepreneurship literature: methodological underpinnings

3.1 Bibliometrics as a tool for identifying the intellectual structure of a field

Bibliometric methodology remains a fundamental tool to researchers by providing a concrete representation of the relationships among the products of science and enabling the mapping of documents generated by communication acts (Lievrouw, 1989). The term Bibliometrics gained notoriety with Pritchard, who suggested replacing the term "statistical bibliography" with the term "bibliometrics", describing it as the "the application of mathematical and statistical methods to books and other media of communication" (Pritchard, 1969: 349). Bibliometrics has been applied in monitoring the development of a specific scientific field, making use of journals and analyses of scientific areas (e.g., Ratnatunga and Romano, 1997; Phelan et al., 2002; Silva and Teixeira, 2008; Silva and Teixeira, 2009; Cruz and Teixeira, 2010) or individuals (e.g., Garfield, 1985); studying the intellectual development of a scientific field (e.g., Schildt et al., 2006; Cornelius et al., 2006; Culnan, 1987), and exploring the linkages between researchers (Reader and Watkins, 2006; McMillan and Casey, 2007). Beyond these applications, bibliometric methods are also crucial for research performance assessment (e.g., van Raan, 2003), serving as an instrument of science policy and research management (Glänzel, 2003), for decision-makers in government, management and institutional administration, such as universities (e.g., Garfield and Weeljams-Dorof, 1992; Moed, 2006), enabling them to evaluate research productivity for the purpose of resource allocation and promoting decisions (Laband and Piette, 1994).

Tables A1a-d (in Appendix) summarize and highlight several articles, according to their scientific area, and the main application areas of bibliometrics, namely: journal analysis (Table A1a), categorization of themes (Table A1b), intellectual structure (Table A1c) and invisible colleges (Table A1d). It is not meant to be a comprehensive list but rather a selection of the scientific areas based on its contiguity, in terms of knowledge, to our field of research – entrepreneurship – and on the similarity of employed methodology (as is the case of the scientific area of Industrial Relations & Labour).

In terms of the application of bibliometric analysis to the field of economics, Laband and Piette (1994) updated the work of Liebowitz and Palmer (1984) and uncovered possible transformations in the economics journal market, between 1970 and 1990. The authors justify that update with the usefulness of the Liebowitz-Palmer rankings to the evaluation of scholarly productivity by universities and colleges. To achieve their goal, Laband and Piette employed, among others tools that are detailed in Table A1a, a widely-used bibliometric indicator, citation analysis (Smith, 1981; Kostoff, 2002). Citation-based indicators are viewed as forms of measurement of the impact or international visibility of scientific research (Narin, 1976; Garfield, 1979), based on the assumption that bibliometric instruments accurately reflect scientific activity (Rinia et al., 1998). In the field of entrepreneurship, Gamboa and Brouthers (2008) conducted a review of the articles published by nine selected journals (from the areas of entrepreneurship, international business and management) over two five-year time frames, 1986-1990 and 2000-2004, in order to discover the role of international entrepreneurship research in major entrepreneurship, international business, and management journals. Complementarily, Romano and Ratnatunga (1996) developed a citation analysis to assess the impact of small enterprise journals and articles during the period 1986-1992, with the intention of providing an objective evaluation of scholarly research and the relative importance of publications.

Bibliometric analysis of topics and abstracts has recently been used in distinct research areas: structural change (Silva and Teixeira, 2008), evolutionary economics (Silva and Teixeira, 2009), regional studies (Cruz and Teixeira, 2010), and also entrepreneurship (Ratnatunga and Romano, 1997; Watkins and Reader, 2004; Van Praag and Versloot, 2008).

Ratnatunga and Romano (1997) provided a qualitative categorization of the topics, methodology and objectives of the most-cited articles, to identify the intellectual origins and directions of entrepreneurship research, whereas Watkins and Reader (2004) employed an original approach to identify current trends in the field of entrepreneurship. These authors used textual analysis and the ARPENT corpus as a data source, which allowed them to obtain a better understanding of the major topics in the literature. More recently, Van Praag and Versloot (2008) conducted a thoroughly research of title, abstract and full-text of 57 studies in order to discover if recent empirical evidence could corroborate the common notion that entrepreneurs are beneficial to the economy.

With regard to researching intellectual structures, authors in general employ co-citation analyses, exploring the relationships between the interdisciplinary specialties, namely management information systems (Culnan, 1987), innovation (Cottrill et al., 1989), and strategic management (Nerur et al., 2008). In entrepreneurship research, Cornelius et al. (2006) performed a bibliometric analysis of cited articles in three periods, 1986-1990, 1993-1997 and 2000-2004, in order to examine the intellectual structure of the field and assess its stage of maturation. The data is provide by the Social Sciences Citation Index, through a search of academic articles that include the word "entrep*" in the title, keywords, or abstract between 1986 and February 2005. The intention was to determine the field's research forefront, perceiving the most influential scholars and discovering the linkages among them and other authors. By evaluating the research output of key authors and the research topics over time, the authors found evidence to support the idea that entrepreneurship is evolving into a mature field. Similarly to the purpose of this latter work, Grégoire et al. (2006) studied the intellectual bases of entrepreneurship to understand the extent and nature of conceptual convergence in entrepreneurship research. In the study, they analyzed the co-citation networks provided by the articles published between 1981 and 2004 in the Frontiers of Entrepreneurship series and complemented it with an analysis by period (1981-1986, 1987-1992, 1993-1998 and 1999-2004). The emergence of consistent networks of co-citation provide evidence to support the argument that there has been convergence in entrepreneurship research over the last twenty-five years, although the overall levels of convergence observed were relatively low. In a complementary way, Schildt et al. (2006) conducted a bibliometric study and analyzed co-citations patterns of entrepreneurship-related articles, published during the period between 2000 and 2004, obtaining some evidence regarding the research directions of the subject, clarifying the state of entrepreneurship as a discipline and filling a gap in the literature. Twenty-five major research trends were identified; being present in the ten most-cited groups of study and subsequently explored their interrelatedness, through a co-citation network. The ten most-cited groups identified were: Entrepreneurial Networks and Resource Accumulation; Corporate Entrepreneurship and Venturing; Conceptualizations of Entrepreneurial Processes; Value Creation from Corporate Entrepreneurship; Alertness, Opportunity Creation, and Creative Destruction; Psychological Characteristics of Entrepreneurs, Qualitative Research Methods; Entrepreneurial Firm Survival and Growth; Societal Consequences of Entrepreneurship and Born-Global Firms (Schildt et al., 2006).

In the more restricted area of international entrepreneurship, Etemad and Lee (2003) studied the knowledge network of this sub-field from 1992 to 2000, through a

Boolean progression of keywords that focused on the Social Sciences Citation Index database. By using a bibliometric methodology, namely citation analysis, they found that scholars of international entrepreneurship depend highly on the disciplines of international business and entrepreneurship to support their scientific research.

3.2 Some descriptive information on the selected journals

Leading academic journals have played an increasingly important role in the dissemination of scientific results (Ratnatunga and Romano, 1997; Stewart and Cotton, 2013). In this study, based on the three top Level I journals in the John Carroll University Classification of entrepreneurship journals (see Table A2), the Entrepreneurship Theory and Practice (ETP), Journal of Business Venturing (JBV) and Small Business Economics (SBE) were selected as core journals. This choice is also supported by that fact that several studies (e.g., Fried, 2003; Ritzberger, 2008; Stewart and Cotton, 2013) suggest that these three journals stand as the most highly ranked in the field of entrepreneurship.

ETP began publication as the American Journal of Small Business from 1976 until 1988, year when the journal changed to its current title. ETP is a scholarly journal, published bi-monthly at Baylor University, and covering a broad range of topics, in compliance with its ultimate goal of contributing to the development of the field of entrepreneurship. JBV started its publication in 1985 and is established as a scholarly forum that provides innovative insights into the phenomenon of entrepreneurship, publishing presently 6 issues a year. SBE is the youngest of the three journals, having begun in 1989. With four issues per year, SBE focuses on entrepreneurship and small business research.

Since their first publication to the end of 2008, the three journals published a total of 2716 articles (see Fig. 2) - Obituaries, corrections and editorial comments were not included. ETP, being the eldest, is the most prolific journal, with a total of 1015 articles. SBE, although the youngest journal, follows ETP with 979 articles against the 722 articles published in JBV. Analyzing the period from 1989 to 2008 – common to the three journals – SBE is the most prolific journal, surpassing ETP and JBV in number of articles every year, with the exception of 1993, 2007 and 2008. JBV comes second, exceeding ETP, although ETP has been improving its publication numbers since 2005.

Table 1 provides a list of the 20 most prolific authors (i.e., with the highest number of published articles) for each journal until 2008, ordered by the total number of articles published in the three journals. The first three leading positions (black cells in Table 1) are different for each of the journals. James Chrisman (Mississippi State University, US) is the most prolific author on the list and is also ETP's most prolific author (although he occupies the 7th position in JBV and has not published any article in SBE). Ian MacMillan (University of Pennsylvania, US) and Roy Thurik (Erasmus University Rotterdam, NL) are, respectively, the leading contributors to JBV and SBE, although the first has not published any articles in ETP and SBE, and the second occupies a very low position in ETP and JBV.

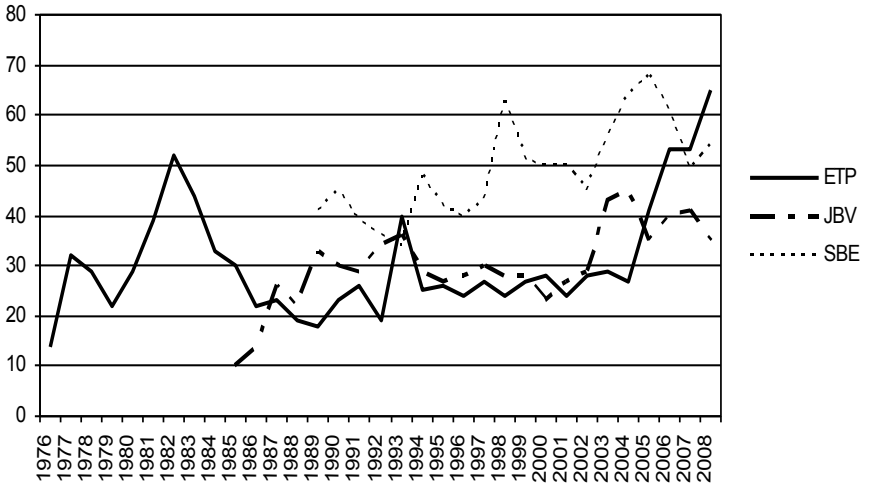


Fig. 2. Evolution of the number of articles per year published in ETP, JBV and SBE, 1976-2008
Source: Authors' computations based on our sample of articles collected manually for ETP and from Social Sciences Citation Index (SSCI) of the ISI Web of Science, for JBV and SBE, (n=2716). The number of articles included in the years 1985 and 1986 for JBV, and 1989, 1990 and 1991 for SBE were collected manually, since they were unavailable in the ISI database.

With regard to the total number of articles published, as mentioned above, James Chrisman (Mississippi State University, US) is the author with the highest number of published articles. He is followed by William Gartner (Clemson University, US), Michael Wright (University of Nottingham, UK) and Shaker Zahra (University of Minnesota, US). These three authors belong to a set of sixteen authors common to all three journals (grey cells in Table 1).

Table 1: List of the top 20 most prolific authors in ETP, JBV and SBE

		Rank			Number of Articles			
Author	**Affiliation**	ETP	JBV	SBE	ETP	JBV	SBE	**Total**
Chrisman, J.J.	Mississippi State University, US	1	7	-	31	10	0	41
Gartner, W.B.	Clemson University, US	4	3	40	15	16	3	34
Wright, M.	University of Nottingham, UK	3	9	7	16	9	9	34
Zahra, S.A.	University of Minnesota, US	2	5	177	17	13	1	31
Shepherd, D.A.	Indiana University, US	8	2	-	11	17	0	28
Macmillan, I.C.	University of Pennsylvania, US	-	1	-	0	25	0	25
Thurik, A.R.	Erasmus University Rotterdam, NL	128	92	1	2	2	20	24
Mcdougall, P.P.	Indiana University, US	9	10	69	11	9	2	22
Acs, Z.J.	George Mason University, US	-	-	2	0	0	19	19
Sapienza, H.J.	University of Minnesota, US	11	12	178	10	8	1	19
Westhead, P.	University of Durham, UK	33	17	19	6	7	6	19
Birley, S.	Bae Sistems (Retired), UK	26	6	-	7	11	0	18
Chua, J.H.	University of Calgary, CA	6	30	-	13	5	0	18
Audretsch, D.B.	Max Planck Institute of Economics, DE	78	61	4	3	3	11	17
Katz, J.A.	Saint Louis University, US	10	42	70	11	4	2	17
Brush, C.	Babson College, US	16	22	179	9	6	1	16
Kuratko, D.F.	Indiana University, US	5	203	-	15	1	0	16
Covin, J.G.	Indiana University, US	12	31	-	10	5	0	15
Reynolds, P.D.	George Mason University, US	299	32	8	1	5	9	15
Shane, S.	Case Western Reserve University, US	300	4	-	1	14	0	15
Busenitz, L.	University of Oklahoma, US	20	23	-	8	6	0	14
Hisrich, R.	Thunderbird School of Global Management, US	36	13	180	5	8	1	14
Hoy, F.	University of Texas at El Paso, US	13	43	-	10	4	0	14
Cooper, A.C.	Purdue University (Retired), US	79	8	-	3	10	0	13
Winn, J.	University of Denver, US	7	-	-	13	0	0	13
Honig-Haftel,	Wichita State University,	129	62	14	2	3	7	12

S.	US (Retired)							
Storey, D.J.	University of Warwick, UK	-	-	3	0	0	12	12
Wiklund, J.	Syracuse University, US	17	93	181	9	2	1	12
Bruton, G.	Texas Christian University, US	21	63	-	8	3	0	11
Cowling, M.	Institute for Employment Studies, UK	301	-	5	1	0	10	11
Deeds, D.	University of St. Thomas, US	80	14	-	3	8	0	11
Gatewood, E.J.	Wake Forest University, US	22	94	182	8	2	1	11
Reid, G.C.	University of St Andrews, UK	302	-	6	1	0	10	11
Sharma, P.	Family Firm Institute, Inc., US	18	95	-	9	2	0	11
Steier, L.	University of Alberta, CA	23	65	-	8	3	0	11
De Cenzo, D.A.	Coastal Carolina University, US	14	-	-	10	0	0	10
Franklin, C.M. †	University of Southern California, US	15	-	-	10	0	0	10
Oviatt, B.	University of New South Wales, AU	24	96	-	8	2	0	10
Phan, P.H.	Johns Hopkins University, US	-	11	183	0	9	1	10
van Stel, A.	EIM Business and Policy Research, NL	303	205	11	1	1	8	10
Baron, R.A.	Oklahoma State University, US	130	18	-	2	7	0	9
Bird, B.	American University, US	19	-	-	9	0	0	9
Carree, M.	Maastricht University, NL	-	206	12	0	1	8	9
Cressy, R.	University of Birmingham, UK	-	-	10	-	-	9	9
Kellermanns, F.W.	Mississippi State University, US	25	207	-	8	1	-	9
Wagner, J.	University of Lueneburg, DE	-	-	9	-	-	9	9
Abetti, P.A.	Rensselaer Polytechnic Institute, US	-	15	-	-	8	-	8
Autio, E.	Imperial College London, UK	-	208	15	-	1	7	8
Fitzroy, F.R.	University of St Andrews, UK	-	-	13	-	-	8	8
Kaufmann, P.J.	Boston University, US	305	19	-	1	7	-	8
Venkataraman, S.	University of Virginia, US	-	16	-	-	8	-	8
Dant, R.P.	University of Oklahoma, US	-	20	-	-	7	-	7

Henrekson, M.	Research Institute of Industrial Economics, SE	-	-	16	-	-	7	7
Johnson, P.	Durham University, UK	308	-	20	1	-	6	7
Karlsson, C.	Jönköping University, SE	-	-	17	-	-	7	7
Levesque, M.	University of Waterloo, CA	-	21	-	-	7	-	7
Watson, R.	University of Durham, UK	-	-	18	-	-	7	7

Source: Authors computations based on our sample of citations in ETP, JBV and SBE collected manually for ETP and from Social Sciences Citation Index (SSCI) of the ISI Web of Science, for JBV and SBE; the years 1985-1986 for JBV and 1989-1991 for SBE were not included, since they were not available on ISI database.
Note: Since the affiliation of the authors could be changed in the future, the validity of data concerning current affiliation is only guaranteed until August of 2009.

In spite of the existence of common authors in the three journals, SBE presents a very distinct ranking of entrepreneurship authors, with poor (or none) ranking positions for the majority of the authors listed in Table 1, with the exception of Michael Wright (University of Nottingham, UK). This results contrast with ETP and JBV, revealing clear signs of similarity: seven of the 20 most prolific authors in ETP and JBV are common to both journals and, at the same time, belong to the ten leading contributors to the total number of published articles. One could point out as a possible explanation for the differences found between ETP and JBV, on the one hand, and SBE, on the other, is the stricter scope (economics) of the latter.

With respect to the affiliation of the most prolific authors, Indiana University (US) provides the highest number of contributing researchers (five), followed by the University of Durham (UK) and the University of Minnesota (US), with four contributors each. The Mississippi State University (US) and the University of Nottingham (UK) are each affiliated with three authors. Exploring the affiliation according to the core journal, Indiana University (US) and the University of Minnesota (US) are the largest providers of prolific authors to ETP and JBV, whereas, to SBE, the most relevant institution is the University of Durham (UK).

Extending the analysis to the country where the institutions affiliated with the leading contributors are located, the United States of America clearly stands out as the major provider of the most prolific authors, with a total of thirty-four leading authors, followed by the United Kingdom with twelve contributors. This result, however, differs according to the core journal. While the United States is responsible for about 84% and 81% of the most prolific authors to ETP and JBV, respectively, its contribution to SBE is around 15%. In fact, the United Kingdom is the country that represents the largest proportion of prolific authors in SBE, a journal which receives contributions from a wider group of countries such as The Netherlands, Sweden and Germany.

We compiled and sorted the citations obtained from the source journals selected: ETP, JBV and SBE. JBV and SBE are indexed to the Social Sciences Citation Index (SSCI), managed by the Institute for Scientific Information (ISI)'s Web of Science Service, and export all the cited references included in SSCI of each of the articles published by JBV and SBE, from, respectively, 1987 and 1992 until February 2009. Cited references contained in articles from 1985 and 1986 for JBV and 1989, 1990 and 1991 for SBE were not included in the study due to their unavailability in ISI database. A different data gathering procedure was applied to the ETP journal, as SSCI did not provide any data prior to 2003. Thus, all the cited references of each article published between 1976 and February 2009 were collected manually and typed

in order to be processed. The citation database of each journal consisted of the relevant details of every cited reference: name of the author(s) of the cited reference, title of the cited reference, published source (i.e., title of the journal or book) and year of publication. Citations extracted from SSCI, however, only refer to the first author of the cited reference (authors who do not obtain first authorship are not represented), which bias the results and constitutes a database limitation for JBV and SBE. As mentioned previously, we did not consider as "articles" obituaries, corrections and editorial comments. Therefore, references/citations included in editorials, research notes, corrections, comments, replies and rejoinders were excluded. The data files of each journal were transferred to Microsoft Office Excel 2003 which enabled the harmonization and validation of the references/citations. Due to differences of format and text codification (for instance, in the names of the authors, titles of the cited paper, titles of journals or books and year of edition), between journals and within the journal itself, Excel functions were used to standardize the sample of citations.

A total of 2.598 articles were published in ETP (40%), JBV (27%) and SBE (33%), during the period considered (from 1976 (ETP), 1987 (JBV) and 1992 (SBE) to February 2009), which resulted in a total of 91.172 citations. Thus, the average number of citations provided per article was 35. Analyzing separately for each of the journals, JBV has the highest average of citations – 44 – followed by SBE with 34 and, finally, ETP with an average of 30 citations.

Table 2: Distribution of articles and citations per journals and year from 1992 to 2008

	Entrepreneurship Theory and Practice					Journal of Business Venturing					Small Business Economics				
	Number of Articles	%	Number of Citations	%	Average of citations per article	Number of Articles	%	Number of Citations	%	Average of citations per article	Number of Articles	%	Number of Citations	%	Average of citations per article
1992	18	4%	780	3%	43	34	6%	1001	4%	29	36	4%	816	3%	23
1993	25	5%	960	4%	38	36	6%	1276	5%	35	34	4%	779	3%	23
1994	27	6%	1154	4%	43	29	5%	1238	4%	43	48	6%	1201	4%	25
1995	15	3%	510	2%	34	27	5%	1118	4%	41	42	5%	1199	4%	29
1996	13	3%	558	2%	43	28	5%	1424	5%	51	40	5%	1106	4%	28
1997	14	3%	778	3%	56	30	5%	1381	5%	46	43	5%	1309	4%	30
1998	29	6%	1282	5%	44	28	5%	1286	5%	46	63	7%	2081	7%	33
1999	36	8%	1943	8%	54	28	5%	1276	5%	46	51	6%	1769	6%	35
2000	25	5%	1074	4%	43	23	4%	1208	4%	53	50	6%	1635	5%	33
2001	22	5%	1074	4%	49	27	5%	1611	6%	60	50	6%	1634	5%	33
2002	27	6%	1542	6%	57	29	5%	1659	6%	57	45	5%	1577	5%	35
2003	22	5%	1256	5%	57	43	8%	2071	7%	48	56	7%	2180	7%	39
2004	21	4%	1073	4%	51	45	8%	2339	8%	52	64	7%	2373	8%	37
2005	38	8%	2643	10%	70	35	6%	2150	8%	61	68	8%	2596	9%	38
2006	18	4%	1022	4%	57	40	7%	2365	8%	59	61	7%	2756	9%	45
2007	66	14%	4122	16%	62	41	7%	2205	8%	54	49	6%	2563	8%	52
2008	63	13%	3883	15%	62	35	6%	2248	8%	64	54	6%	2643	9%	49
Total	**479**	**100%**	**25654**	**100%**	**54**	**558**	**100%**	**27856**	**100%**	**50**	**854**	**100%**	**30217**	**100%**	**35**

Since the period considered differs according to the selected journal, Table 2 provides some insights regarding data distribution during the common period to all three journals: 1992 to 2008. ETP contributes with the lowest proportion of articles and citations, obtaining an average of 54 citations per article. Analyzing the evolution per year, ETP reveals an average increase since 2005. SBE, on the contrary, is the major publisher of articles that provided the largest proportion of citations, having the lowest average of citations per article.

After consolidating the citation databases, we were able to construct three distinct yet complementary rankings, for each of the core journals: the twenty most-cited (first in the case of SBE and JVB) authors; the ten most-cited studies and the twenty most-cited journals. The rankings allowed us to answer the first research question of the study, identifying the most-cited authors, studies (article or book), and journals, in each of the entrepreneurship journals selected. Once the key authors had been identified, we could then explore if there were similarities among the leading authors and answer the second research question, through an analysis that implied gathering personal data on the authors' educational background, research area and professional affiliation. The mapping of the intellectual groundings of the three core journals combined with the analysis of the relationships between the most-cited authors provided the fundamental tools to infer about the presence of invisible colleges in the scientific field of entrepreneurship, answering the last research question and achieving the main purpose of the study.

4 Empirical results

4.1 The most-cited authors, studies and journals submission

The most widely-cited author in ETP since its first publication to February 2009, is Michael Wright (University of Nottingham, UK). The author ranks 71st and 77th in JBV and SBE, respectively. The most cited first author in JBV, from 1987 to February 2009, is Arnold Cooper (Purdue University, US), who takes the 3rd and 37th positions in the ETP and SBE rankings, respectively. Zoltan Acs is the most-cited first author in SBE, during the period from 1992 to February 2009, raking 96th in ETP and 126th in SBE.

Table 3 presents the 20 most cited authors per journal, ordered by descending number of citations. The three rankings of the Top 20 most-cited authors only have one author in common: Howard Aldrich (University of North Carolina, US). Similarities regarding top cited authors are notoriously higher between ETP and JBV than with SBE. ETP and JBV have nine top cited authors common to them both, whereas JBV and SBE only share two authors, and ETP and SBE have no top author in common.

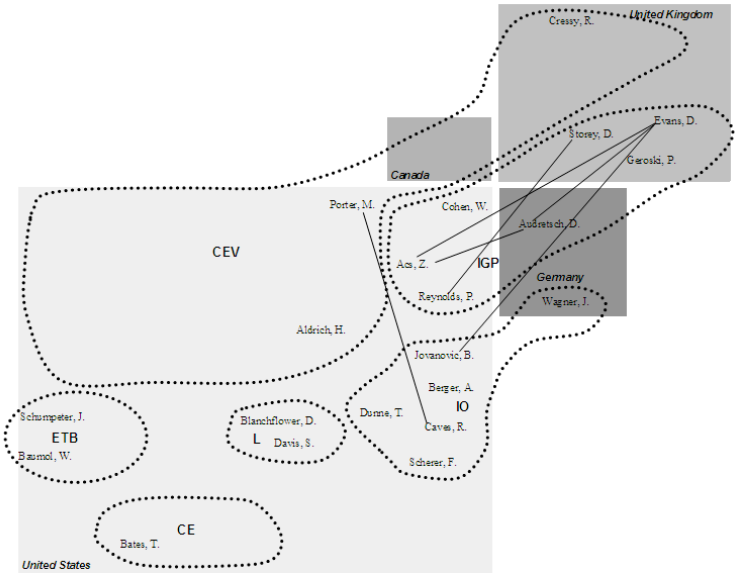
According to Zuccala (2006) (cf. Section 2), there are three main elements to take into consideration when defining an invisible college: influential scholars (i.e., most-cited authors); subject specialty (i.e., research areas) and information use environment (i.e., affiliation environment, such as institution and country). Following this framework, we assigned a main research area to each of the most-cited authors and analyzed, for each "core journal" and for all journals combined, the geographical distribution of the authors' current affiliation (Fig. 3).

Table 3: Ranking of the Top 20 most cited authors in ETP, JBV and SBE (name and number of citations)

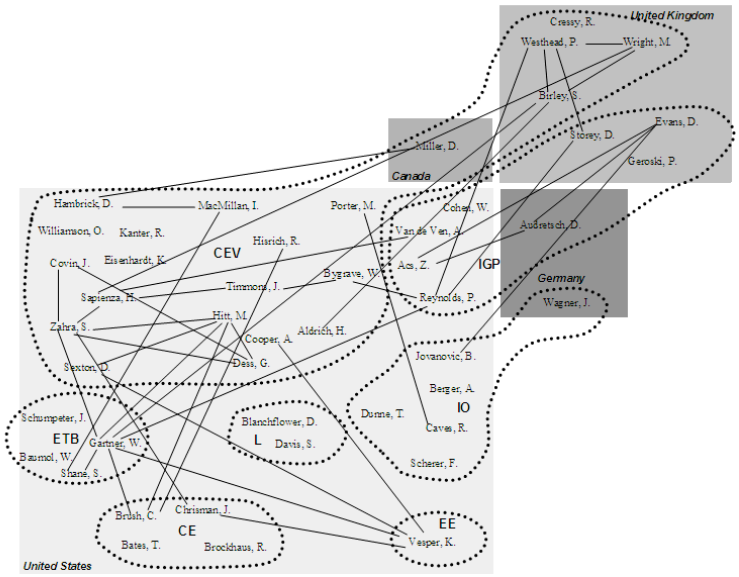
Entrepreneurship Theory and Practice (ETP)		Journal of Business Venturing (JBV)		Small Business Economics (SBE)	
Name	**#**	**Name**	**#**	**Name**	**#**
Wright, M.	178	Cooper, A.	307	Acs, Z.	509
Zahra, S.	168	Aldrich, H.	241	Audretsch, D.	508
Cooper, A.	144	MacMillan, I.	213	Storey, D.	276
MacMillan, I.	138	Gartner, W.	209	Reynolds, P.	258
Brush, C.	122	Miller, D.	183	Evans, D.	248
Bygrave, W.	121	Porter, M.	183	Schumpeter, J.	173
Chrisman, J.	118	Zahra, S.	182	Porter, M.	130
Covin, J.	118	Shane, S.	180	Blanchflower, D.	126
Aldrich, H.	117	Vesper, K.	143	Geroski, P.	123
Hitt, M.	115	Hambrick, D.	141	Dunne, T.	116
Miller, D.	113	Covin, J.	135	Jovanovic, B.	116
Gartner, W.	112	Bygrave, W.	130	Cressy, R.	112
Westhead, P.	111	Birley, S.	129	Bates, T.	107
Sexton, D.	107	Eisenhardt, K.	128	Wagner, J.	100
Reynolds, P.	103	Schumpeter, J.	124	Baumol, W.	99
Sapienza, H.	103	Van de Ven, A.	121	Aldrich, H.	98
Hisrich, R.	100	Williamson, O.	120	Berger, A.	97
Birley, S.	90	Brockhaus, R.	118	Caves, R.	96
Dess, G.	87	Kanter, R.	116	Cohen, W.	94
Hambrick, D.	86	Timmons, J.	115	Davis, S.	93
				Scherer, F.	93

Source: Own computations based on citations in ETP, JBV and SBE, collected manually for ETP and from Social Sciences Citation Index (SSCI) of the ISI Web of Science, for JBV and SBE. In the case of JBV and SBE citations refer only first authors.

Common to all three journals
Only common to ETP and JBV
Only common to JBV and SBE
Only common to ETP and SBE



SBE



ALL

Legend: **ETB** - Entrepreneurship Theory Building; **CE** – Characteristics of the Entrepreneur; **CEV** - Corporate and Entrepreneurship Venturing; **EE** - Entrepreneurship Education; **IGP** – Innovation, Growth and Policy; **L** – Labor; **IO** – Industrial Organization

Fig.1. Mapping the international scientific linkages of the most influential authors in entrepreneurship by 'core journal'

The designation of the core research areas is based on a comprehensive survey of the

research topics in entrepreneurship (in Santos and Teixeira, 2009), which allowed for the establishment of five distinct research areas within the field of entrepreneurship. Santos and Teixeira (2009) identified eleven major topics on entrepreneurship literature: Entrepreneurship theory building; Entrepreneurial psychological issues; Demographic traits; Entrepreneurial context; Corporate entrepreneurship; Venture capital; Entrepreneurship education; Policy; Innovation; Growth and Regional. Due to the wide scope of academic interests reflected in the influential authors' publications, we aggregated these topics into five, so that we could assign only one major research area to each of the authors, which enabled mapping the constructions in this study. Furthermore, the analysis of the academic publications and areas of interest of the most-cited authors of each journal revealed that it was necessary to include two additional research areas (Labour and Industrial Organization), economics-oriented, outside the entrepreneurship field (Table 4).

Table 4: Areas of scientific research associated with top cited authors

Research Areas	Abbreviaton
Entrepreneurship Theory Building	ETB
Characteristics of the Entrepreneur	CE
Corporate and Entrepreneurship Venturing	CEV
Entrepreneurship Education	EE
Innovation, Growth and Policy	IGP
Labor	L
Industrial Organization	IO

Legend: ETB - Entrepreneurship Theory Building; CE – Characteristics of the Entrepreneur; CEV - Corporate and Entrepreneurship Venturing; EE - Entrepreneurship Education; IGP – Innovation, Growth and Policy; L – Labour; IO – Industrial Organization.

Considering all the core journals, the United States is the most prominent country, covering around 79% of the most-cited authors. The United Kingdom comes in second, with 15%. Germany and Canada are less prominent, affiliating, respectively, two and one of the influential authors in entrepreneurship research. With regard to research areas, CEV has the highest proportion of most-cited authors (47%), followed by IGP (17%) and IO (13%). The other research areas have less influence. While this pattern is seen in the UK, in the US CEV remains the research area with the highest number of top cited scholars (46%), followed by IO (14%). IGP represents 11%, along with CE and ETP. Overall, the US is the only country with influential scholars in all seven research areas.

By examining the map comprising all the core journals (Fig. 4), we can see that the most cited authors in entrepreneurship-specific areas collaborate with key authors from other research areas, particularly CVE, where different authors relate to other scholars from five distinct areas. The economics-oriented areas are the exception to this scenario, containing highly-cited authors who are rather isolated from each other, with occasional or no collaboration ties.

Comparing the mapping for the most-cited authors for each of the selected journals, we found that both ETP and JBV present similar intellectual structures, with respect to the research areas, EE being the exception – there are no key authors in this area in ETP. For both journals, CVE is the subject specialty involving the highest number of

influential authors and the economics-oriented subject specialties of IO and L do not appeared in the set. The main difference between the two journals seems to lie on the areas of CE and EE.

CE appears to be a more influential research area in ETP in comparison to JBV, namely through contributions from Candida Brush and James Chrisman (5th and 7th in ETP's top 20 most-cited authors, respectively), boosting collaboration between researchers from distinct subject specialities. In JBV, this area has only one influential author – Robert Brockhaus – with no visible collaborations. The opposite situation occurs with EE: although excluded in the ETP mapping, it plays a significant role in JBV, due to the work of Karl Vesper (9th in JBV's top 20 most-cited authors). Nevertheless, influential authors such as Gartner, Zahra, Covin, Hambrick, MacMillan, Aldrich and Birley and their collaborations remain common to both journals. The geographical distribution of the top cited authors is also very similar: both journals have no influential authors located in Germany, maintaining the US, Canada and the UK (although the UK concentrates a higher number of key scholars in ETP when compared to JBV). The results obtained support the assessment of existing similarities in the intellectual structure and linkages among influential authors for ETP and JBV, which suggests that they could be part of the same invisible college.

SBE's mapping is substantially different from the other two core journals. The core area with the highest number of most-cited authors is Innovation, Growth and Policy, IGP (with seven authors), followed by Industrial Organization, IO (with six authors). CEV, previously the top research area for ETP and JBV, occupies here the third position, with only three key authors. SBE is the only journal to contemplate the economics-oriented areas of IO and L and, contrarily to ETP and JBV, collaborations between influential authors from distinct subject specialties are almost nonexistent. Instead, the mapping of SBE unveils a high concentration of collaborations between the most-cited authors within the main research area – IGP. Additionally, SBE's top five authors belong to this subject specialty. The geographic distribution of the most-cited authors also differs: American dominion is counterbalanced by the UK and Germany. The two European countries account for more than half of the total key authors' affiliations in the core area of IGP, and three of these key scholars are among the top five authors in SBE. Canada is absent in SBE. The findings seem to indicate that the core journal SBE represents a rather distinct invisible college within the field of entrepreneurship.

The differences found above would not have surfaced if this study had been based on a single data source, thus emphasizing the importance of using three core journals to determine the existence of invisible colleges. Table 5 presents, for each of the selected journals, the top 10 most-cited studies, ranking them by number of citations.

Table 5. Ranking of the Top 10 most-cited studies in ETP, JBV and SBE

	Author(s)	Date	Title	Source	Number citations
ETP	Schumpeter, J.	1934	The theory of economic development: An inquiry into profits, capital, credit, interest, and the business cycle	-	90
	Gartner, W.	1988	"Who is an entrepreneur?" is the wrong question	American Journal of Small Business	63
	Shane, S.; Venkataraman, S.	2000	The promise of entrepreneurship as a field of research	Academy of Management Review	59
	Barney, J.	1991	Firm resources and sustained competitive advantage	Journal of Management	57

	Gartner, W.	1985	A conceptual framework for describing the phenomenon of new venture creation	Academy of Management Review	57
	McClelland, D.	1961	The achieving society	-	55
	Porter, M.	1980	Competitive strategy: Techniques for analyzing industries and competitors	-	55
	Stinchcombe, A.	1965	Social structure and organizations	-	52
	Low, M.; MacMillan, I.	1988	Entrepreneurship: Past research and future challenges	Journal of Management	49
	Covin, J.; Slevin, D.	1991	A conceptual model of entrepreneurship as firm behavior	Entrepreneurship Theory and Practice	45
	Vesper, K.	1980	New venture strategies	-	45
JBV	Schumpeter, J.	1934	The theory of economic development: An inquiry into profits, capital, credit, interest, and the business cycle	-	80
	Porter, M.	1980	Competitive strategy: Techniques for analyzing industries and competitors	-	79
	Vesper, K.	1980	New venture strategies	-	66
	Stinchcombe, A.	1965	Social structure and organizations	-	61
	Low, M.; MacMillan, I.	1988	Entrepreneurship: Past research and future challenges	Journal of Management	59
	Gartner, W.	1985	A conceptual framework for describing the phenomenon of new venture creation	Academy of Management Review	56
	Jensen, M.; Meckling, W.	1976	Theory of the firm: Managerial behavior, agency costs and Ownership structure	Journal of Financial Economics	53
	McClelland, D.	1961	The achieving society	-	52
	MacMillan, I.; Siegel, R.; Subbanarasimha, P.	1985	Criteria used by venture capitalists to evaluate new venture proposals	Journal of Business Venturing	47
	Porter, M.	1985	Competitive advantage: Creating and sustaining superior performance	-	47
	Storey, D.	1994	Understanding the small business sector	-	92
	Jovanovic, B.	1982	Selection and the evolution of industry	Econometrica	91
	Schumpeter, J.	1934	The theory of economic development: An inquiry into profits, capital, credit, interest, and the business cycle	-	89
SBE	Audretsch, D.	1995	Innovation and Industry Evolution		85
	Acs, Z.; Audretsch, D.	1990	Innovation and small firms		77
	Evans, D.; Jovanovic, B.	1989	An estimated model of entrepreneurial choice under liquidity constraints	Journal of Political Economy	75
	Porter, M.	1985	Competitive advantage: Creating and sustaining superior performance	-	66

Schumpeter, J.	1942	Capitalism, socialism, and democracy	-	53
Stiglitz, J.; Weiss, A.	1981	Credit rationing in markets with imperfect information	American Economic Review	52
Acs, Z.; Audretsch, D.	1988	Innovation in large and small firms: An empirical analysis	American Economic Review	49
Dunne,T.; Roberts, M.; Samuelson, L.	1989	The growth and failure of U.S. manufacturing plants	Quarterly Journal of Economics	49

Source: Authors computations based on our sample of citations in ETP, JBV and SBE, collected manually for ETP and from Social Sciences Citation Index of the ISI Web of Science, for JBV and SBE.

Common to all three journals
Only common to ETP and JBV
Only common to JBV and SBE
Only common to ETP and SBE

The most-cited study in ETP (90 citations) and JBV (80 citations) is the book, The theory of economic development: An inquiry into profits, capital, credit, interest, and the business cycle, a seminal contribution by Joseph Schumpeter to the conceptualization of entrepreneurial processes (Schildt et al., 2006). Schumpeter's book is also the only cited study common to all three journals and ranks as the 3rd most-cited study in SBE. The most-cited study in SBE (cited 92 times) is David Storey's book, Understanding the small business sector, where the author summarizes research on small businesses and draws conclusions from a policy perspective (Landström, 2005).

Again, we can identify several similarities between ETP and JBV regarding top-cited studies. ETP and JBV's rankings have seven frequently-cited studies in common, contrasting emphatically with SBE's ranking, which, besides Schumpeter's book, only has Michael Porter's book, Competitive advantage: Creating and sustaining superior performance, in common with JBV. The differences between ETP, JBV and SBE extend to the main subjects of the most-cited studies. Whereas in ETP and JBV's studies prevail on topics related with corporate entrepreneurship and venture capital, SBE's topics revolve around innovation combined with industrial issues. The evidence gathered and illustrated in Table 5 further corroborates the distinct intellectual structure underlying ETP and JBV, on the one hand, and SBE, on the other.

The most-cited journals in ETP, JBV and SBE are identified and ranked in Table 6. The most-cited journal in ETP is ETP itself. The same occurs with JBV and SBE. The results are not surprising and they were to some extent expected, since it has been established by several authors that a journal will cite itself more often than other citing journals (Ratnatunga and Romano, 1997). Considering the total number of citations from the three journals, JBV is the most influential journal, receiving the highest number of citations (a total of 5468 citations). ETP ranks as the second most-cited journal with 3329 citations, followed by Strategic Management Journal (3206 citations). SBE appears in 6th place, being cited by the core journals 1841 times. The evidence obtained is in line with previous studies that highlighted ETP and JBV as the journals with the greatest impact on the field of entrepreneurship (e.g., Dean et al., 2007; Chandler and Lyon, 2001; Shane, 1997; Romano and Ratnatunga, 1996). The relatively low 'impact' of SBE may, at least in part, be explained by its youth as it was only first published in 1989, whereas ETP started in 1976 and JBV in 1985.

The three journals have eight cited journals in common but their distribution and citation pattern differs from ETP and JBV to SBE. Whereas in ETP and JBV, six of

the eight cited journals in common rank among the ten most-cited journals, SBE's top ten only includes three cited journals from the eight shared by all the core journals. The citation pattern also confirms the differences between SBE and the other two journals. In ETP and JBV, management-oriented journals dominate the top positions in the raking, whereas SBE gives preference to economics-oriented journals. The Academy of Management Review and the Journal of Finance are illustrative of the distinction between ETP/JBV and SBE. If the core journals' rankings were to only contemplate the ten most-cited studies, the gap between ETP/JBV and SBE would be even more visible: the selected journals would have only two of the most-cited journals in common, although ETP and JBV would still have nine journals in common. The similarities between ETP and JBV are notorious: from the twenty most-cited journals, sixteen are common to the two journals, and eight are exclusively common to the both.

The analysis of the most-cited authors, studies and journals attests to the multidisciplinary nature of research in entrepreneurship. The citations gathered arise from a wide range of disciplines across the social sciences, such as economics, management, marketing, finance, sociology and psychology.

Table 6. Ranking of the Top 20 most-cited journals in ETP, JBV and SBE

Entrepreneurship Theory and Practice		Journal of Business Venturing		Small Business Economics	
Cited Journal	**#**	**Cited Journal**	**#**	**Cited Journal**	**#**
Entrepreneurship Theory and Practice	2053	Journal of Business Venturing	2825	Small Business Economics	1662
Journal of Business Venturing	2047	Strategic Management Journal	1573	American Economic Review	762
Strategic Management Journal	1253	Entrepreneurship Theory and Practice	974	Journal of Business Venturing	596
Academy of Management Review	1134	Academy of Management Journal	933	Journal of Political Economy	564
Academy of Management Journal	971	Academy of Management Review	878	Journal of Finance	387
Administrative Science Quarterly	674	Administrative Science Quarterly	809	Strategic Management Journal	380
Journal of Small Business Management	660	Frontiers of Entrepreneurship Research	639	Review of Economics and Statistics	377
Family Business Review	516	Harvard Business Review	473	Quarterly Journal of Economics	361
Journal of Management	500	Management Science	428	Journal of Industrial Economics	331
Harvard Business Review	494	Journal of Small Business Management	418	Regional Studies	315
Management Science	300	Journal of Management	388	Entrepreneurship Theory and Practice	302
Organization Science	280	Organization Science	268	The Economic Journal	297
Journal of Financial Economics	235	Journal of Financial Economics	248	International Journal of Industrial Organization	292
Journal of Management Studies	231	Journal of Finance	246	Research Policy	278
Journal of Finance	230	American Economic Review	231	Econometrica	276
Journal of International Business Studies	222	Journal of International Business Studies	206	Journal of Small Business Management	237
Entrepreneurship & Regional Development	191	American Journal of Sociology	203	Journal of Financial Economics	234
American Journal of Sociology	189	Family Business Review	192	Administrative Science Quarterly	213
Small Business Economics	179	Journal of Marketing	191	Journal of Economic Literature	208
California Management Review	171	Research Policy	184	Academy of Management Review	205

Source: Authors computations based on our sample of citations in ETP, JBV and SBE, collected manually for ETP and from Social Sciences Citation Index (SSCI) of the ISI Web of Science, for JBV and SBE.

Common to all three journals
Only common to ETP and JBV
Only common to JBV and SBE
Only common to ETP and SBE

Several authors (e.g., Grégoire et al., 2006; Cornelius et al., 2006) report the diversity of entrepreneurship research, pointing out that this field attracts authors with different backgrounds and different methodological traditions. When comparing the most prolific authors with the most-cited authors, we observe that nineteen scholars fall into both categories, confirming that a highly productive author tends to stand as a highly influential author and, ultimately, vouches for the field's maturity. This conclusion is also congruent with Cornelius et al.'s (2006) results of an increasing internal orientation in entrepreneurship research. The fact that authors with research areas outside mainstream entrepreneurship research (such as IO and L) are among the most-cited authors appears to be a contradiction to the previous conclusion, since, as Cornelius et al. (2006) stress, entrepreneurship research has been increasingly self-reflective and the influence of outsiders (researchers who do not cite but are being cited by entrepreneurship researchers) has been decreasing over time. However, a closer look into the results reveals that the majority of outsiders comes from Small Business Economics, a more recent and economics-oriented journal than ETP and JBV, which underpins another finding of Cornelius et al. (2006): entrepreneurship scholars have increasingly specialized thematically, indicating that autonomous research groupings will develop.

The evidence obtained with regard to the most-cited authors, studies and journals, performed on the selected journals, characterizes the intellectual bases of the field of entrepreneurship and suggests that similarities between ETP and JBV could indicate the presence of an invisible college and, at the same, SBE's distinct intellectual structure may denote another invisible college.

4.2 Research areas and educational and professional affiliation of top cited authors

Through a (co)citation analysis, we identified 47 highly cited authors in the field of entrepreneurship. Co-citation techniques, although assessing the intellectual structure of a research field, do not capture all the insights related with the phenomenon of the invisible college (Zuccala, 2006). The issue here is, as Reader and Watkins (2006) put it, whether the most-cited authors are strictly part of a set of ideas constructed in the minds of the citers or there is an effective network of social interactions between the influential scholars. In order to more effectively answer this question, we complemented the (co)citation analysis, exploring the possible collaborations between highly cited authors, based on the analysis of their professional affiliation, educational background and main research area.

Table 7 presents personal data on the 47 most-cited authors (employer institution, research area and PhD granting school – the validity of authors' current professional affiliation is only guaranteed until August 2009; due to the absence of information, it was not possible to identify the granting school of one author and the graduation year of four authors), ranking them by the total number of citations obtained from the three selected journals. Among the top authors, David Audretsch is the scholar with the highest number of citations in all the core journals, although he is not part of ETP and JBV's top 20 rankings. With regard to the key authors' current affiliation – represented in the column "employer institution" – we found that a total of 40 institutions employ the 47 most-cited authors (three authors, Miller, Hambrick and Sexton, are affiliated with two institutions each). Harvard University (US) employs the highest number of most-cited authors (5), followed by Babson College (US) and University of Minnesota (US), with three authors each and George Mason University (US) and New York University (US), both with two. The remaining 32 institutions employ only one influential author each. With respect to the organizations' geographical distribution, the US hosts the highest number of institutions (29),

followed by the UK (7) and then, Germany and Canada, with two institutions each. By combining the number of citations presented in Table 7, with the corresponding research area, for each cited author, we confirm the previous results regarding research areas. CVE is the main research area for twenty-two influential authors, IGP involves eight scholars, followed by IO, with six scholars. CE, ETB, L and EE are less prominent areas of interest.

CVE is the most frequent research area associated with ETP and JBV, whereas in SBE, IGP dominates, as mentioned previously. Beyond that, we can also draw further evidence: IGP, although not the most frequent research area, is the main research area for the two most-cited authors – Audretsch and Acs – among the 47. Another point should be stressed: the bottom most-cited authors are exclusively associated with SBE (they are seldom cited by ETP and JBV) and eight of them are related with economics-oriented areas, whereas authors with research areas not related with entrepreneurship do not rank in ETP's and JBV's top 20. These findings support the previous evidence suggesting that the three entrepreneurship core journals embody two (in)visible colleges in the entrepreneurship field: one associated with ETP and JBV and the other with SBE.

Educational background is also explored here by gathering information concerning the institution granting the PhD degree and year of graduation. We identify 31 distinct universities granting a doctoral degree to 44 of the most-cited authors. Harvard University (US) granted 4 PhDs, followed by the Stanford University US), University of Michigan (US) and University of Washington (US), with 3 PhDs each. Pennsylvania State University (US), University of Chicago (US), University of Wisconsin (US) and University of London (UK) have two PhDs each among the most-cited authors. The remaining 23 universities granted a PhD to only one top cited author.

The geographical distribution of the cited authors' granting schools follows a similar pattern to that of their affiliation. The US concentrates a vast majority of the universities (33), followed by the UK (7). The only two differences are the inclusion of New Zealand and Austria, in the granting schools of the most-cited authors. In terms of graduation year, 44 of the most-cited authors took their PhDs a relatively long time ago (the most recent PhD degree was granted 17 years ago to Scott Shane).

Table 7: Information on the professional affiliation, educational background and research area of the 47 most cited authors

		Number of Citations							
	Author	ETP	JBV	SBE	Employer institution	Secondary unit	Research Area	Granting School (Ph.D.)	Year
1	Audretsch, D.	48	39	508	Max Planck Institute of Economics, DE	Entrepreneurship, Growth and Public Policy Group	IGP	University of Wisconsin-Madison, US	1980
2	Acs, Z.	32	37	509	George Mason University, US	School of Public Policy	IGP	Graduate Faculty, The New School, US	1980
3	Cooper, A.	144	307	73	Purdue University (Retired), US	Krannert School of Management (Retired)	CEV	Harvard University, US	1962
4	Aldrich, H.	117	241	98	University of North Carolina, US	Kenan-Flagler Business School	CEV	University of Michigan, US	1969
5	Reynolds, P.	103	94	258	George Mason University, US	School of Public Policy	IGP	Stanford University, US	1969
6	Gartner, W.	112	209	77	Clemson University, US	Arthur M. Spiro Institute for Entrepreneurial Leadership	ETB	University of Washington, US	1982
7	Zahra, S.	168	182	38	University of Minnesota, US	Carlson School of Management	CEV	University of Mississippi, US	1982
8	Porter, M.	55	183	130	Harvard University, US	Harvard Business School	CEV	Harvard University, US	1973
9	MacMillan, I.	138	213	14	University of Pennsylvania, US	Wharton School of Business	CEV	University of South Africa, ZA	1975
10	Storey, D.	49	36	276	University of Warwick, UK	Warwick Business School	IGP	Newcastle University, UK	1978
11	Schumpeter, J.†	49	124	173	Harvard University, US	-	EBT	University of Vienna, AT	1906
12	Miller, D.	113	183	42	University of Montréal and University of Alberta, CA	Ecole des Hautes Etudes Commerciales and Family Enterprise and Strategy	CEV	McGill University, CA	1976
13	Shane, S.	78	180	78	Case Western	Weatherhead	EBT	University of	1992

					Reserve University, US	School of Management		Pennsylvania, US	
14	Evans, D.	13	48	248	Law and Economics Consulting Group (LECG) Europe, UK	-	IGP	University of Chicago, US	1983
15	Bygrave, W.	121	130	33	Babson College, US	-	CEV	-	-
16	Birley, S.	90	129	54	Bae Sistems (Retired), UK	-	CEV	*N/a*	*N/a*
17	Covin, J.	118	135	17	Indiana University, US	Kelley School of Business	CEV	University of Pittsburgh, US	1985
18	Wright, M.	178	47	35	University of Nottingham, UK	Nottingham University Business School	CEV	University of Nottingham, UK	*N/a*
19	Brush, C.	122	86	36	Babson College, US	-	CE	-	-
20	Westhead, P.	111	47	85	University of Durham, UK	Durham Business School	CEV	University College of Wales, UK	1988
21	Hambrick, D.	86	141	12	Pennsylvania State University and Columbia University, US	Smeal College of Business and Graduate School of Business	CEV	Pennsylvania State University, US	1979
22	Williamson, O.	35	120	79	University of California, Berkeley, US	Walter A. Haas School of Business	CEV	Carnegie Mellon University, US	1963
23	Vesper, K.	64	143	15	University of Washington, US	University of Washington Business School	EE	Stanford University, US	1969
24	Eisenhardt, K.	63	128	26	Stanford University, US	Department of Industrial Engineering and Engineering Management	CEV	Stanford University, US	1982
25	Hisrich, R.	100	87	28	Thunderbird School of Global Management, US	Walker Center for Global Entrepreneurs hip	CEV	University of Cincinnati, US	1971
26	Sexton, D.	107	96	11	Ohio State University (Retired)/ Ewing Marion Kauffman Foundation, US	-	CEV	Ohio State University, US	1972

27	Van de Ven, A.	81	121	11	University of Minnesota, US	Carlson School of Management	IGP	University of Wisconsin, US	1972
28	Timmons, J. †	75	115	20	Babson College, US	-	CEV	Harvard University, US	1971
29	Sapienza, H.	103	80	27	University of Minnesota, US	Carlson School of Management	CEV	University of Maryland, US	1989
30	Bates, T.	25	76	107	Wayne State University, US	Department of Economics	CE	University of Wisconsin, US	1972
31	Brockhaus, R.	63	118	13	Saint Louis University, US	John Cook School of Business	CE	University of Washington , US	1976
32	Hitt, M.	115	59	9	Texas A&M University, US	Mays Business School	CEV	University of Colorado, US	1974
33	Chrisman, J.	118	47	15	Mississippi State University, US	College of Business and Industry	CE	University of Georgia, US	1986
34	Dess, G.	87	78	14	University of Texas at Dallas, US	School of Management	CEV	University of Washington, US	1980
35	Baumol, W.	20	48	99	New York University, US	Leonard N. Stern School of Business	ETB	University of London, UK	1949
36	Kanter, R.	47	116	3	Harvard University, US	Harvard Business School	CEV	University of Michigan, US	1967
37	Cohen, W.	11	53	94	Duke University, US	Fuqua School of Business	IGP	Yale University, US	1981
38	Blanchflower, D.	5	9	126	Dartmouth College, US	Department of Economics	L	University of London, UK	1985
39	Caves, R.	10	34	96	Harvard University, US	Department of Economics	IO	Harvard University, US	1958
40	Geroski, P. †	3	9	123	University of London, UK	London Business School	IGP	University of Warwick, UK	*N/a*
41	Jovanovic, B.	4	14	116	New York University, US	Department of Economics	IO	University of Chicago, US	1978
42	Cressy, R.	4	12	112	University of Birmingham, UK	Birmingham Business School	CEV	University of Edinburgh, UK	*N/a*
43	Scherer, F.	11	24	93	Harvard University, US	John F. Kennedy School of Government	IO	University of Michigan, US	1954
44	Dunne, T.	0	10	116	Federal Reserve Bank of Cleveland, US	Research Department	IO	Pennsylvania State University, US	1987
45	Berger, A.	9	11	97	University of South Carolina, US	Moore School of Business	IO	University of California, US	1983

46	Wagner, J.	12	4	100	University of Lueneburg, DE	Institute of Economics	IO	University of Hannover, DE	1984
47	Davis, S.	6	6	93	University of Chicago, US	Booth School of Business	L	Brown University, US	1986

Note: Authors are ordered by the total of citation in each journal. The grey cells indicate that the author is part of the Top 20 most cited authors in the designated journal.

Legend: **ETB** - Entrepreneurship Theory Building; **CE** – Characteristics of the Entrepreneur; **CEV** - Corporate and Entrepreneurship Venturing; **EE** - Entrepreneurship Education; **IGP** – Innovation, Growth and Policy; **L** – Labor; **IO** – Industrial Organization.

According to Zuccala (2006), the Information Use Environment is a key element to identify invisible colleges, representing a scientific workspace where information-related behaviours occur. Based on this concept, we included additional information regarding the academic experience of the most-cited authors, so that our analysis captures all the (invisible) links between the key scholars. Thus, to infer if there are social correlations between the most frequently cited authors, in addition to PhD university and current professional affiliation, data on other current affiliations was gathered, besides the main employer institution, and present visiting academic institutions along with data on previous affiliations (the past affiliations prior to the cited authors' doctoral degree were disregarded) and past visiting academic institutions (Table A3 provides the information collected in detail with respect to these two items).

Fig. 4 illustrates the links between the most highly cited authors, based on the academic institutions that received the authors over their professional career. We only considered institutions that had received or are currently employing more than two top cited authors, which gave us a total of 24 institutions. The map represents the links between a total of 44 authors, across 24 organizations. Each of the top cited authors is identified by their ranking as established in Table 7, as well as the colour of the respective research area. Each link is represented by straight lines and denotes that at least one top cited author worked in the two linked institutions. An overall analysis of the map tells us that all institutions have received at least one top cited author, which suggests a substantial degree of linkage among the most-cited authors in entrepreneurship research.

The connections between the institutions and number of influential authors associated with them are distinct, according to each institution. Harvard University (US) is the institution that gathers the highest number of top cited authors (9), followed by the University of Pennsylvania (US), with 7 key authors. A total of 12 institutions is linked to 3 top cited authors. The University of Pennsylvania (US) holds the highest number of links (11), which implies that top cited authors connect with others, through 11 distinct institutions. The University of London (UK) comes in second, with connections to 10 institutions. The least interactive institutions, among the top ones, are the University of Michigan (US) and the University of Washington (US), with 2 and 3 links, respectively.

It should be noted that the number of top cited authors associated with an institution is not, per se, an indication of the degree of connectivity between influential authors. For instance, the University of Washington (US) hosts 4 top cited authors but only links with 3 other institutions.

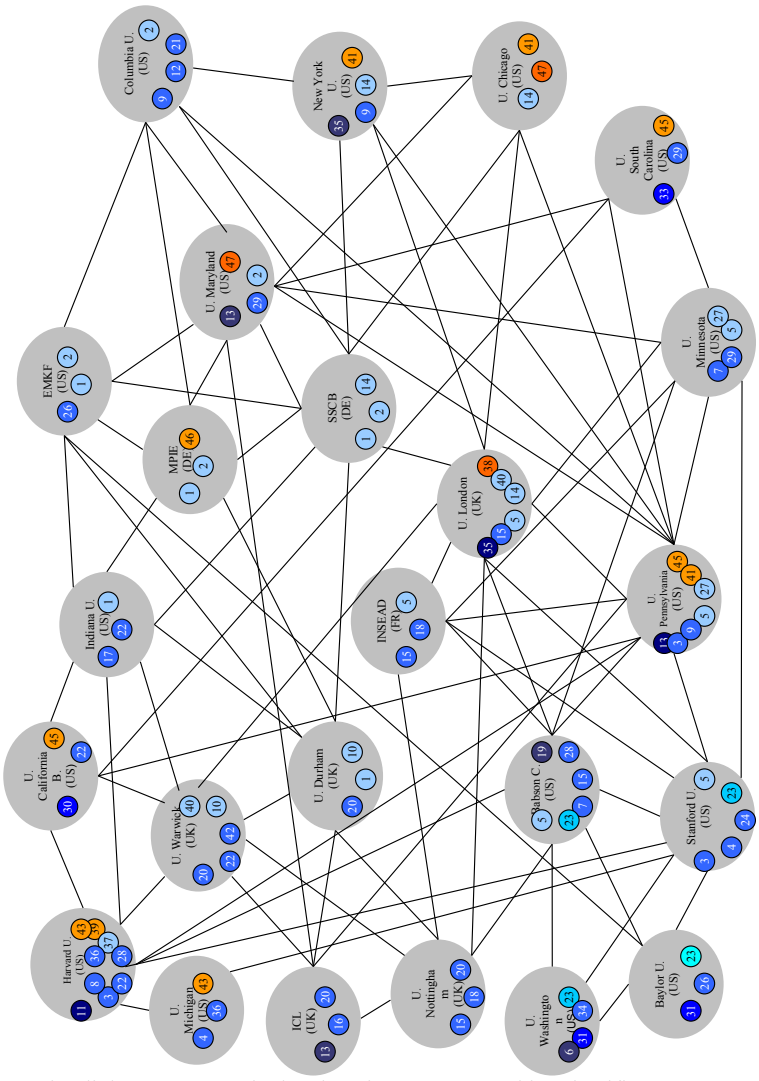


Fig. 2. Mapping links among top cited authors in entrepreneurship scientific area

Note: Each link means that at least one top cited author worked in the two linked organizations

ETB	Entrepreneurship Theory Building	CE	Characteristics of the Entrepreneur
EE	Entrepreneurship Education	IGP	Innovation, Growth and Policy
CEV	Corporate and Entrepreneurship Venturing		
IO	Industrial Organization	L	Labor

On the other hand, the Social Science Centre of Berlin (DE) receives only 3 top cited authors, but establishes connections with 9 distinct institutions, which attests to the top cited authors' professional mobility, confirmed when we identify two of the cited authors, Audretsch and Acs, the two most-cited authors in our study and renowned academics, with a vast and prolific career.

An analysis on the research area of the 44 most-cited authors indicates that the degree of collaboration, represented by the links between institutions, agrees with the initial distribution of authors by research areas, i.e., the majority of the links established belong to top cited authors, whose main research area is CVE, with IGP appearing in second, followed by IO. The exception to this pattern comes from the EE research area that, with only one top cited author, connects with 4 other institutions, surpassing the research area of Labour (L) with two influential authors but no established collaborations outside their current affiliation. The evidence obtained indicates that top cited authors are highly connected, which is particularly visible in the research areas of CVE and IGP.

5 Conclusions

The disciplinary rules and research problems of a scientific domain and their acknowledgment by scholars within that domain are rooted in the internal ties that link scientists with similar research interests in the form of what Crane (1972) calls "invisibles colleges". In this sense, Invisible Colleges are valuable instruments to identify processes of knowledge dissemination and monitor the dynamics of scientific developments (Reader and Watkins, 2006).

Identifying the most-cited authors, studies and journals for the three core journals selected allowed us to explore the intellectual structure of entrepreneurship research. Evidence supports the multidisciplinary nature of the field of entrepreneurship, since results show that highly influential authors in the field are working in several subject specialties, including research areas that are not so directly focused on entrepreneurship, such as economics.

These "non-entrepreneurship" researchers are highly related with the specific orientation of each of the core journals. The present study empirically corroborates the idea that ETP and JBV are the most influential journals in the field of entrepreneurship and SBE is more specialized and economics-oriented. In fact, the (co)citation analysis confirms several similarities between ETP and JBV regarding the most cited authors, studies and journals and main research area, as well as the distinct intellectual structure of SBE.

Additionally, by collecting personal data regarding the top cited authors' current and past professional affiliation, educational background and combining it with the research areas assigned, it was possible to infer about the social ties established among the most influential authors. The results reveal that 44 key authors are highly linked among themselves, through 24 different institutions where they developed or are currently developing their work.

The two-stage procedure enabled finding the key elements to assess the existence of invisible colleges: social actors (the most-cited authors); subject specialty (research areas) and information use environment (professional affiliation of the most-cited authors). Formal and informal communication is represented by, respectively, the most-cited studies/journals and professional affiliation linkages. Accordingly, we identified two invisible colleges: one associated with ETP and JBV and the other associated with SBE. The results obtained are summarized in Fig. 5. Social actors are represented by the top five most-cited authors of each core journal; the scientific

research area that attracts the highest number of most-cited authors is the "subject specialty", and the information use environment is defined by the professional affiliation where the most frequently cited authors currently work (until August 2009). Formal and informal communication is given, respectively, by the top five studies and journals for each of the three journals and the linkages extracted from information regarding top cited authors' current and past affiliations and PhD granting affiliation.

Based on an analysis on the core journals (ETP, JBV and SBE), we conclude that there are two invisible colleges in the field of entrepreneurship. The first invisible college is focused specifically on entrepreneurship research, the key orientation of ETP and JBV. The similarities between these two journals were a constant in all the stages of the study. The second invisible college is originated by the evolution of the entrepreneurship field into an increasingly specialized thematic discipline, developing autonomous research groupings, such as the one represented by SBE.

This study suffers from a series of limitations that must be highlighted. First, only one research area was imputed to each top cited author, which narrows down the academic scope of the researchers. The inclusion of more than one area of research would have been insightful to a better understanding of the social network formed by key scholars. Second, the analysis although involving a rather long time span is quite static; to compare the overall analysis with by-period analyses would provide insights regarding the evolution of the field which would enrich the research. Third, the subjective nature of the key element, "informal communication relations", underlying the concept of invisible colleges, raises some concern. We employed data regarding professional affiliations and educational background, but other methods, such as direct questionnaires, mailings, conference participation, could have been used.

Future research on the matter could combine bibliometric techniques with ethnographic methods of research so as to enhance our interpretation of the invisible college phenomenon. Nevertheless, we still believe that identifying and analyzing the two invisible colleges in entrepreneurship research provides a useful understanding of the scientific discipline, enlightening researchers, students and the public in general.

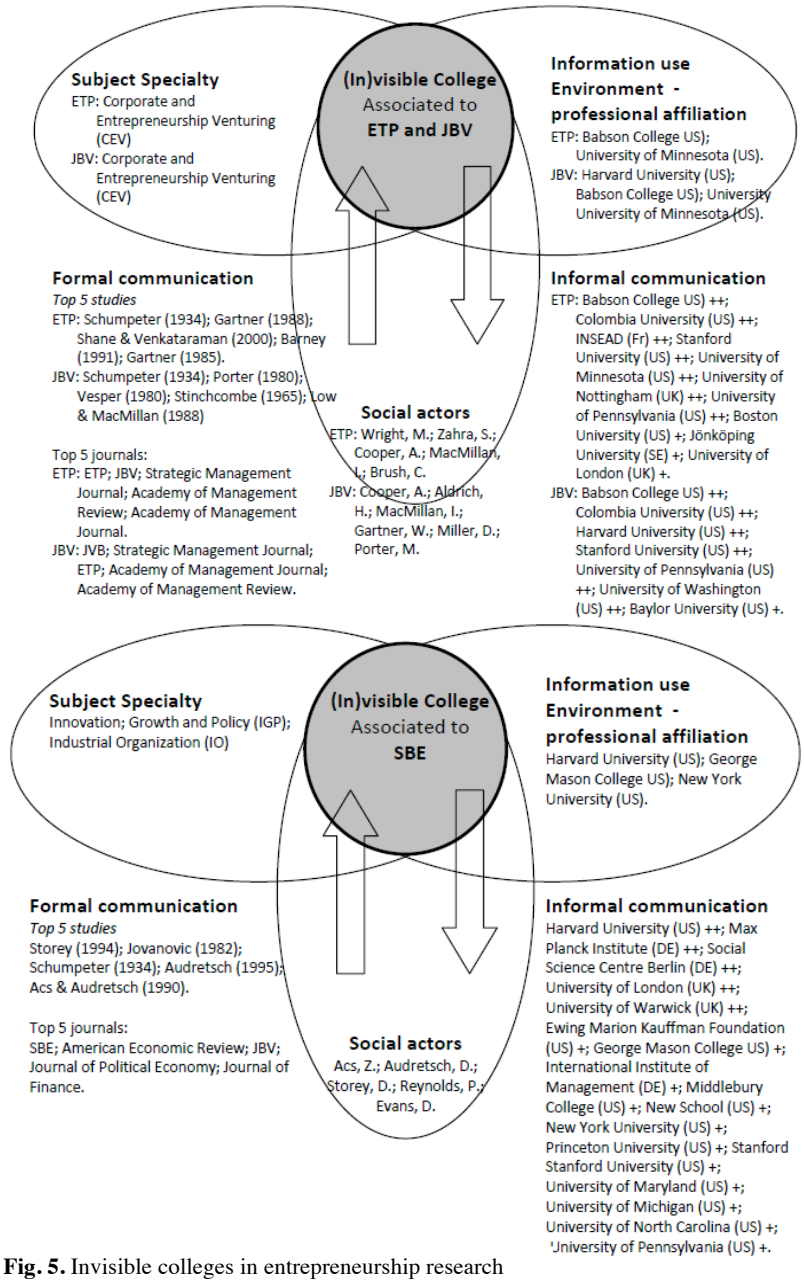


Fig. 5. Invisible colleges in entrepreneurship research

Notes: Universities listed in "Informal Communication" have affiliated at least 3 of the most-cited authors in the Journal (++) or have affiliated 2 of the most-cited authors in the Journal who have more than 3 links with universities that also affiliates most-cited authors in the Journal(+)

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Appendix

Table A1a: Bibliometric studies – Journal analysis

Application Areas - Journal Analysis			
Scientific Areas	**Authors (Date)**	**Main Research Items**	**Main Results**
Economics	Laband and Pieters (1994)	Objectives: - Update paper by Liebowitz and Palmer (1984 - Research possible changes in the economics journal market, during 1970-1990 Bibliometric Indicators : - Number of citations - Number of citations per article - Number of articles - Distribution of citations, via Lorenz-curve analysis	- Steady decrease in concentration of citations among the top economics journals between 1965-1990 - Market share has been taken by new entrants, but inequality in distribution of citations remained stable from 1970 to 1990 - Decline in the influence of "second-tier" general-interest journals in contrast with the increasing influence of specialized journals
Management	Phelan et al. (2002)	Objectives: - Examine internal changes in content of the *Strategic Management Journal*, over time Bibliometric Indicators: - Number of citations - Number of citations per article - Number of articles	- Increase in the length of articles, number of references per article and number of authors - Publication lag has increased - More intra-journal citations - Proportion of North American authors remains constant but there are signs of greater international collaboration - Increase in empirical papers
Marketing	Baumgartner and Pieters (2003)	Objectives: - Explore the overall and sub-area influence of marketing journals at three points in time: 1996-97, 1981-82 and 1966-67 Bibliometric Indicators: - Number of citations - Number of citations per article - Number of articles - Index of structural influence - Journal impact factor	- Influence share of general business and managerially oriented journals has declined in contrast with the increase in the influence of specialized marketing journals - Select set of journals concentrate influence in marketing and their position remained stable over the studied period - *Journal of Marketing* is considered the most influential marketing journal
Accounting	Van Campenhout et al. (2008)	Objectives: - Compare the overall and sub-area journal influence in accounting Bibliometric Indicators: - Number of citations - Number of articles - Index of structural influence	- Substantial differences exist between overall and sub-areas journal influences - For some sub-areas in accounting, specialized journals are not the ones with the highest influence
Entrepreneurship	Gamboa and Brouthers (2008)	Objectives: - Discover role of international entrepreneurship research in major entrepreneurship, international business and management journals - Assess possible differences in the type of international entrepreneurship articles published in the three type of	- Substantial increase in international entrepreneurship content in the top entrepreneurship journals by contrast to a much more modest increase in the top international business journals and management journals - Entrepreneurship journals tend to favour replication studies while

		journals Bibliometric Indicators: - Number of articles - Number and percentage of international studies	international business and management journals prefer nonreplications
	Romano and Ratnatunga (1996)	Objectives: - Assess the impact of small enterprise journals and articles during the 1986-1992 period Bibliometric Indicators: - Number of citations - Number of articles - Average number of citations per article - Average citation rate per published article - Self citedness; Uncitedness - Citation frequency - Journal impact factor	- Increasing level of impact in more recent years of the source journal articles as group on contemporary small enterprise research - Substantial number of articles were never cited - Self-citation problem was seen to be of limited impact - Entrepreneurship Theory and Practice and Journal of Business Venturing were the more influential journals during the studied period

Table A1b: Bibliometric studies – Themes categorizations

Application Areas - Journal Analysis

Scientific Areas	Authors (Date)	Main Research Items	Main Results
Structural Change	Silva and Teixeira (2008)	Objectives: - Provide a comprehensive survey of the economic literature on structural change Bibliometric Indicators: - Number of citations; Number of articles - Co-authoring; Abstracts analysis; Keyword analysis	- Technological issues increased there relevance during the studied period - Recent trends reflect a rising interest towards empirical work, despite the increased relevance of formal work in the nineties
Evolutionary Economics	Silva and Teixeira (2009)	Objectives: - Explore main research paths and contributions in the field of evolutionary economics Bibliometric Indicators: - Number of citations; Number of articles; Abstracts analysis; Keyword analysis	- Evolutionary contributions do not converge to an integrated approach - Appearance of two extreme strands: "History of Economic Thought and Methodology" and "Games" - Increase of formal approaches in contrast with the stagnation of empirical work
Regional studies	Cruz and Teixeira (Forthcoming)	Objectives: - Provide evidence that empirically complements the qualitative surveys of cluster-related literature Bibliometric Indicators: - Number of citations; Number of articles; Co-authoring - Abstracts analysis	- Share of "Appreciative+Empirical" and "Formal+Empirical" articles published in the top ranked cluster-related journals are above average - Evidence of positive correlation between the "quality" of the journals and formal-related research
Entrepreneurship	Van Praag and Versloot (2008)	Objectives: - Assess the contribution of entrepreneurs to the economy comparatively to non-entrepreneurs Bibliometric Indicators. - Keyword analysis - Title, abstract and full-text analysis	- Entrepreneurs have a higher, but more volatile, contribution to employment generation. They pay lower wages, but their employees appear to be more satisfied - Entrepreneurs contribute with equal importance to innovation but through different aspects - Entrepreneurs do not have higher

			productivity levels than their counterparts. They contribute more than their counterparts to growth of value added and productivity - Despite having lower and riskier incomes, entrepreneurs are more satisfied
	Watkins and Reader (2004)	Objectives: - Identify current trends in entrepreneurship research, in 2000 and 2001 Bibliometric Indicators: - Textual analysis (keyword and abstract analysis); Co-occurrence matrix	- Identification of twenty-two clusters - Incidence of work in areas very attended in the past or in vogue in the present, such as, respectively, Entrepreneurial Psychology and Social Entrepreneurs or Networking among Female Entrepreneurs was lower than expected
	Ratnatunga and Romano (1997)	Objectives: - Analyze, with a quantitative and qualitative approach, the articles in contemporary small enterprise research Bibliometric Indicators: - Number of citations; Number of articles - Articles full-text analysis	- Increase percentage of most-cited articles, published by the source journals - Substantial percentage of articles (more than 50%) are well-grounded in observational and contemplative theory - Diversity of topic areas, empirical support that there is no coherent structure for research in the field

Table A1c: Bibliometric studies – Research Intellectual Structures

Application Areas - Research Intellectual Structures

Scientific Areas	Authors (Date)	Main Research Items	Main Results
Innovation	Cottrill et al. (1989)	Objectives: - Explore the interrelationships between the specialties of the diffusion of innovations and technology transfer, in the 1966-1972 period Bibliometric Indicators: - Number of citations; Number of articles; Co-citation analysis; Cluster and factor analysis; Multidimensional scaling	- Clusters of authors obtained are similar to those identified in major reviews of innovation literature Little cross-referencing between the authors of diffusion of innovations and technology transfer Technology transfer research tradition is less integrated than the diffusion of innovations tradition
Strategic Management	Nerur et al. (2008)	Objectives: - Trace the evolution of the intellectual structure of the strategic management field during the period 1980–2000 Bibliometric Indicators: - Number of citations; Number of articles; Co-citation analysis; Multidimensional scaling; Factor analysis; Pathfinder analysis	- Multidisciplinary origins of strategy - Large number of significant inter-correlation between factors suggests that the field did not become fragmented - Theories of the firm have become central to strategy research, which suggests a greater theoretical orientation
Management Information Systems	Culnan (1987)	Objectives: - Document the intellectual structure of Management Information Systems, from 1980 to 1985 Bibliometric Indicators: - Number of citations; Number of articles; Co-citation analysis	- Identification of five clusters: foundations; psychological approaches to MIS design and use; MIS management; organizational approaches to MIS design and use; and curriculum

Entrepreneurship	Cornelius et al. (2006)	Objectives: - Analyze the development of entrepreneurship with respect to the research forefront and knowledge base, during the periods of 1986-1990, 1993-1997 and 2000-2004 Bibliometric Indicators: - Number of citations; Number of articles; Co-citation analysis; Cluster analysis	- Entrepreneurship research has been increasingly self-reflective - The number and influence of outsiders has decreased steadily over time while the reliance on insiders is greater - Theoretical issues are more pervasive - Research interests have evolved, despite their consistency - Researchers have increasingly specialized thematically
	Grégoire et al. (2006)	Objectives: - Assess conceptual convergence in the entrepreneurship field, through network co-citation analysis Bibliometric Indicators: - Number of citations; Number of articles; Co-citation analysis; Cluster analysis	- Evidence of convergence in entrepreneurship research over the last twenty-five years - Levels of convergence comparatively low - Entrepreneurship research based on the contributions of other disciplines, but evidence indicates that the field relies increasingly on its own literature
	Schildt et al. (2006)	Objectives: - Analyze co-citation patterns of entrepreneurship-related articles published, from 2000 to 2004 Bibliometric Indicators: - Number of citations; Number of articles; Co-citation analysis; Jaccard index; Cluster algorithm	- Evidence of fragmentation in entrepreneurship research - Research findings appear to be noncumulative - Research mostly centred on the United States, but other countries contribute significantly - Signs of isolation among entrepreneurship scholars
	Etemad and Lee (2003)	Objectives: - Define the knowledge network associated with the field of international entrepreneurship, during the period of 1992 to 2000 Bibliometric Indicators: - Number of citations; Number of publications; Bolean search progression of keywords; Co-authoring; Analysis of authors' affiliations	- Scholarly articles, followed by book reviews, dominate the document types - Upward movement over time in both the number of articles and their associated citations - Mild upward trend in both size of scholarly teams and theirs co-authorship, during the period of 1992-1998 - Authors affiliated with institutions located in the US dominate the distribution, but other country affiliations are also reported - Scholarly articles and books constitute the most important sources upon which research relays

Table A1d. Bibliometric studies – Research Invisible Colleges

Application Areas - Research Invisible Colleges			
Scientific Areas	**Authors (Date)**	**Main Research Items**	**Main Results**
Industrial Relations & Labor	Casey and McMillan (2008)	Objectives: - Compare Industrial & Labor Relations Review intellectual bases across three periods: 1974-1984, 1985-1995 and 1996-2006 Bibliometric Indicators:	- The most-cited journals were economic-oriented during the studied period Emergence of the field of human resources and management in recent years

		- Number of citations; Number of articles; Co-citation network analysis	
	McMillan and Casey (2007)	Objectives: - Uncover British Journal of Industrial Relations for two time periods, 1986-1995 and 1996-2005 Bibliometric Indicators: - Number of citations; Number of articles; Co-citation network analysis	- Evidence suggests that economics literature remains important, but sociological and management literature has dominated in recent years - Regarding authors, Millward's initial influence has been replaced by Kelly and Wood - Possible signs of internationalization
Management	McMillan (2008)	Objectives: - Examine R&D Management, in four time periods, 1986-1990, 1991-1995, 1996-2000 and 2001-2005 Bibliometric Indicators: - Number of citations; Number of articles; co-citation network analysis	- During the two first periods R&D Management focuses on more traditional technology and innovation management sources, contrasting with the last two periods, in which R&D Management was based on journals more detached from the traditional sources - Cohen and Levinthal's absorptive capacity model dominates the final two periods and possibly constitutes an emerging base
Economics of Technology and Innovation	Verspagen and Werker (2004)	Objectives: - Identify the role of "intellectual leaders" in connecting the research network - Study the structure of the field in terms of sub-communities Bibliometric Indicators: - Survey analysis	- The network of scholars in the field may be characterized as a scale-free network - The field does not seem to evolve in a mode of competition between paradigmatic approaches to the object of study
Entrepreneurship	Reader and Watkins (2006)	Objectives: - Identify groups of entrepreneurship authors whose work falls into similar areas and explore the themes that characterize entrepreneurship field - Investigate the social and collaborative structure of entrepreneurship research Bibliometric Indicators: - Number of citations; Number of articles; Co-citation analysis; Cluster analysis; Correlation matrix; Factor analysis; Questionnaire survey	- Findings reveal nine clusters of authors whose work falls into similar areas - Little evidence of international sharing of ideas - Strong evidence that closely related authors share both formal and informal communication links

Table A2. John Carroll University Classification of entrepreneurship journals

Level I
1. Journal of Business Venturing
2. Small Business Economics
3. Entrepreneurship: Theory & Practice
4. Journal of Small Business Management
Level II
1. Entrepreneurship, Innovation and Change
2. Family Business Review
3. International Journal of Entrepreneurship Development, Education and Training
4. International Journal of Entrepreneurship
5. International Journal of Technological Innovation and Entrepreneurship
6. Journal of Developmental Entrepreneurship
7. Journal of Enterprising Culture
8. Journal of Entrepreneurship Education
9. Journal of Private Enterprise
10. New England Journal of Entrepreneurship
11. Small Business and Enterprise Development
Level III
1. Economic Analysis: A Journal of Enterprise and Participation
2. Enterprise and Innovation Management Studies
3. Entrepreneurship Development Review
4. Journal of Entrepreneurship
5. Journal of International Business and Entrepreneurship
6. Journal of Technology Transfer
7. Small Enterprise Research: The Journal of SEAANZ
8. Studies in Cultures, Organizations and Societies

Source: Katz, J. and Boal, K. (2002), "Entrepreneurship Journal Rankings", in http://www.marketingtechie.com/articles/mtart20020307.pdf, accessed on July 2009.

Table A3: Information on current and previous professional affiliations/ visiting academic institutions of top authors

	Author	Affiliations/ Visiting Academic Institutions [a]	Previous Affiliations/ Visiting Academic Institutions [b]
1	Audretsch, D.	Indiana University, US	Georgia State University, US
		Ewing Marion Kauffman Foundation, US	Middlebury College, US
		Friedrich-Schiller-University Jena, DE	Social Science Centre Berlin, DE
		ZEW, Centre for Economic Research, DE	University of Durham, UK
		CEPR, Centre for Economic Policy Research, UK	Kiel Institute of World Economics, DE
		EIM Consulting for Small and Medium-Sized Business, NL	Tinbergen Institute, NL
2	Acs, Z.	Max Planck Institute of Economics, DE	University of Maryland, US
		University of Baltimore, US	Social Science Centre Berlin, DE
		Ewing Marion Kauffman Foundation, US	University of Illinois Springfield, US
		-	Manhattan College, US
		-	Columbia University, US
		-	Middlebury College, US
		-	Santa Anna School of Advanced International Studies, IT
		-	Université Aix-Marseille II, FR
		-	University of St Andrews, UK
3	Cooper, A.	Harvard University, US	Stanford University, US
		-	University of Pennsylvania, US
		-	University of Manchester, UK
		-	International Institute for Management Development, CH
4	Aldrich, H.	-	Cornell University, US
		-	Stanford University, US
		-	International Institute of Management, DE
		-	University of Oxford, UK
		-	Centre for Environmental Studies, UK
		-	Universita' Commerciale Luigi Bocconi, IT
		-	Wirtschaftsuniversität Wien, AT
		-	BI Norwegian School of Management, NO
		-	Universita' degli Studi di Trento, IT
		-	University of British Columbia, CA
		-	Keio University, JP
		-	Jönköping University, SE
		-	Universitat Autònoma de Barcelona, ES
5	Reynolds, P.	-	Florida International University, US
		-	University of London, UK
		-	Babson College, US
		-	Marquette University, US
		-	University of Minnesota, US
		-	University of Pennsylvania, US
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Innovation-related knowledge from customers for new financial services: A conceptual framework

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Abstract: Customers are reported to be providers of innovation-related knowledge for the development of new services. In order to benefit from this source of innovation-related knowledge, a company requires the organizational capability to identify and use it, denoted as its absorptive capacity. This research provides a conceptual framework for the co-creation of new financial services, which is driven by the underlying organizational learning mechanisms of a company's absorptive capacity. The context of financial services, which are characterized as being knowledge-intensive, should provide an interesting area of research for testing this conceptual framework.

Keywords: Absorptive capacity, co-creation, customer involvement, new financial service development.

1 Introduction

The objective of this paper is to develop a conceptual model for the co-creation of new service innovations within the financial sector. Involving customers in these companies' innovation process should allow accessing their innovation-related knowledge, which is vital for new service developments. This model can be used in subsequent research to propose testable constructs. To the best of our knowledge, this model is among the first to propose a knowledge view for the innovation process within financial services companies.

Solid empirical evidence on how new services are developed or how the characteristics of its development can predict the organization's innovation, are scarce (Stevens and Dimitriadis, 2004, Jaw et al., 2010). However a recent review found that research on new service development is gaining maturity (Papastathopoulou and Hultink, 2012). Relationships in general, customer-centricity in particular, are pivotal in explaining a possible co-creation of new services (Normann and Ramírez, 1993, Normann, 2001, Vargo and Lusch, 2004, Vargo et al., 2008). Customers can serve as a source of external knowledge (Greer and Lei, 2012) to leverage internal knowledge, accelerating the company's innovation process. The involvement of customers during the development (i.e. co-creation) of new financial services, known to be knowledge intensive (European Commission, 2012), will be the context of this research.

Various modes of customer involvement, ranging from the seminal contribution on lead users (von Hippel, 1986) to the consultation of expert users, have been studied and represent a major research stream within open innovation (Greer and Lei, 2012).

Open innovation is also a structural component of the current evolution towards a more knowledge-based economy (White et al., 2013).

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The company's absorptive capacity allows it to identify, internalize and exploit knowledge (Cohen and Levinthal, 1990, Zahra and George, 2002). This organizational capacibility can be the source of a competitive advantage (Liao et al., 2010), leading to innovative outputs (Tsai, 2001) and increased firm performance (Kostopoulos et al., 2011) while being essential for the innovativeness of new products and services (Melkas et al., 2010). Absorptive capacity is basically an internal feature because it's supported by organizational structures (Tu et al., 2006). It's the result of continuous learning through internal R&D (Cohen and Levinthal, 1990) or collaborations with customers (Dierickx and Cool, 1989). Companies should therefore be susceptible to innovation-related knowledge from their customers (Lane and Lubatkin, 1998, Zahra and George, 2002) and methods that help understand customer requirements during the innovation process (Hannola et al., 2013).

We will make three contributions to the literature on innovation management:

- Innovation for, and within, financial services generally requires more research attention (Mention and Torkkeli, 2012) and service innovations are understudied compared to research on product innovations (Ettlie and Rosenthal, 2011).
- The significance of customer involvement in new service development (de Brantani, 1993, de Brantani, 1995, Edvardsson et al., 2012) and the company's external knowledge exploration with customers (Grimpe and Sofka, 2009, Greer and Lei, 2012) has been emphasized before, yet the role of customers in the development of new financial services (Akamavi, 2005) and their co-creation (Oliveira and von Hippel, 2011, Martovoy and Dos Santos, 2012) is not extensively studied.
- Different sectors as organizational contexts for the innovation process and absorptive capacity needs more research (Flier et al., 2003, Jansen et al., 2005, Easterby-Smith et al., 2008, Fraga et al., 2008).

2 Literature Review

The following streams of literature will be considered in this section: the logic of value and value constellations (Normann and Ramírez, 1993, Michel et al., 2008b), the co-creation of new services with customers (Michel et al., 2008a, Edvardsson et al., 2011, Edvardsson et al., 2012, Ford et al., 2012, Perks et al., 2012) and the Service-Dominant (S-D) logic (Vargo and Lusch, 2004, Vargo and Lusch, 2006, Vargo and Lusch, 2008a, Vargo et al., 2008, Lusch et al., 2010).

2.1 The Strategic Interest of Involving Customers

Involving customers can result in innovations is reported in the literature on key users (von Hippel, 2005, Bogers et al., 2010), co-creation (Alam, 2002, Alam and Perry, 2002, Nambisan, 2002, Prahalad and Ramaswamy, 2004b, Bogers and West, 2012) and the external sources of innovation for companies (Hollenstein, 2003, West and Bogers, 2014). There is a wide variety of sectors in which customer involvement led to innovation, see for example Bogers et al. (2010). Recently an overview for the financial services sector was made available (Oliveira and von Hippel, 2011). The latter research found that important financial services innovations were first created and used by a type of customer which is actually able to self-service his needs. Hence customer involvement is important for new financial services innovations. Customer involvement in financial services is also reported to be understudied (Akamavi, 2005).

Multiple definitions for innovation are proposed in the literature, each emphasizing

the presence of something new (Garcia and Calantone, 2002), adding value for the customer (O'Sullivan and Dooley, 2009). Creating value is at the heart of a company's strategy and strategy links together the company's resources in order to achieve it. Knowledge and relationships are part of these essential resources and may alternatively be defined as the company's competencies and customers (Normann and Ramírez, 1993).

A company's competences refer to its accumulated knowledge over time, which is embodied in its business processes, techniques and technology used. Without these competences (i.e. knowledge), the company would not be able to dispose of its current service offer. Of course a company needs customers that actually want to this service offer, otherwise their competences (i.e. knowledge) would be futile. The company's customer base, which is a relationship with another entity, is hence essential for the going concern of the company. The customers are part of a value constellation with the company, and as such they are neither external nor internal, but rather both. The involvement of customers does not only bring (new) knowledge that shapes the company's (future) service offer, but also information (Lusch et al., 2007) and new relationships (Hunt and Derozier, 2004, Edvardsson et al., 2011).

There is an interactive loop between the company's knowledge (competences) and relationships (customers). New knowledge pushes companies forward into new business systems with new customers, who will in turn co-create new offerings that leverage the company's knowledge base, leading to the establishment of new relationships. The investments in the enlarged knowledge base (e.g. new technologies and expertise) must be recouped and this pushes companies to look for new customers, in order to dispose of a larger customer base to exploit their acquired knowledge. This restarts the loop, pushing the acquisition of new customers, stimulating the innovation process of the company.

A company's strategy aims at relentlessly increase the needed fit between its competencies (knowledge) and the value creating activities for its customers (relationships). It's about the perpetual design and redesign of the intertwined business systems (Normann and Ramírez, 1993). This requires a continuous dialogue between the company and the customers, because their role will be reconfigured during the process of value creation. This reconfiguration is a key task, changing the roles and relationships in the business system itself which can lead to strategic innovation, meaning significant customer value improvements, new business systems or the remodeling of the markets (Christensen et al., 2002). Because the environment is changing, adaptations to the strategy are required in order to survive, emphasizing the importance of reinventing value instead of limiting oneself to adding value (Normann and Ramírez, 1993).

The extent of customer involvement during the new financial service development initiative is reported to be different according to the type of financial service being co-created and the specific phase of this involvement in the development process. It is possible that more profitable, financial services can be created for one group of customers and that deeper relationships can be developed through other services, targeting different customers (Cheung and To, 2011). Despite this varying effectiveness of involving customers, doing so has a positive effect on the performance of the new financial service development process (Chien and Chen, 2010) and it is critical for its success (Carbonell et al., 2009). The benefit of involving customers, users or final beneficiaries in the development process of a new product or service has not been without critique. The co-creation is challenging because it requires the assimilation of knowledge and expectation management at the same time (Magnusson et al., 2003, Ford et al., 2012). There is also a risk that the involved customer shares (i.e. leaks) knowledge to competitors, leading to knowledge spill-overs that are contingent on future and existing customer involvement (Dyer and

Hatch, 2006). Research even found that customer involvement could be potentially harmful or of limited added value since innovative ideas do not always emerge from the customer himself and trying to satisfy the customer's wishes at all costs could lead to an impasse. This could be the case because customers' perception is limited to their actual situation yet formulating their needs can be limited to what is technically feasible for the company (Leonard and Rayport, 1997). This difficulty regarding customer needs is not new (Bonner, 2010). The requirements proposed by the customer to meet his need could also have changed by the time development is ready (Bennett and Cooper, 1981). Other critical views on customer involvement in innovation projects for financial services can be found in the literature, see for example (Avlonitis et al., 2001, Vermeulen, 2005). Retail segment customers were found to be more costly to get involved than corporate customers (Walter, 2009). Other factors that are essential for involving customers in new financial services innovation are local regulations and customer preferences (Grant and Venzin, 2009). This implies that customer needs' collection, and meeting those needs, can lead to a competitive advantage for national (retail) markets. Differentiation for the customers is of course driven by the various groups of customers. Retail banking offers a wide product range and multiple customer segments, therefore any internationalization involves making trade-offs between the different requirements of different business entities. The incentives of the involved customer must be known and the company should estimate its opportunity costs when engaging a specific group of customers. There can be agency costs resulting from the misaligned interests since customers want to acquire exactly what they need, whilst companies focus on as low as possible development costs and synergy effects by incorporating solution elements that they already possess (i.e. its current competences) (von Hippel, 2005).

Services and products shouldn't be regarded as two distinct elements that a company can offer (Normann, 2001, Vargo and Lusch, 2008b). They have a common element, namely the exchange of something during a process which is beneficial for the other entity and done with that entity. This means that the tangible elements in a service are an integral part of the service that is offered. If products are present in a service offer, then they are a construct of applied knowledge making it a support to the service provision itself (Vargo and Lusch, 2008b). This research positions itself in the stream which synthetizes product and service constituents during the exchange between entities. Knowledge is a central element, creating and facilitating this exchange, as part of the innovation process.

The characteristics of goods and services can be described by distinguishing between (Vargo and Lusch, 2004): *"…operant resources (those that act upon other resources), such as knowledge and … operand resources (those that an act or operation is performed on, such as goods)."* A further discussion regarding the assumptions, rationale and implications of this distinction, coupled with the evolution of an economy based on the exchange of goods towards one based on the exchange of services, can be found in the literature (Vargo and Lusch, 2004, Michel et al., 2008b, Vargo and Lusch, 2008b, Vargo and Lusch, 2008a, Edvardsson et al., 2012).

An overview of the main differences between goods and services can be found in Table 1.

Table 1: Goods versus services

	Goods	Services	Reference
The resources used	Primarily operand resources	Primarily operant resources, sometimes transferred by embedding them in operand resources-goods.	Vargo et al. (2008), p. 148
The role of customers	Receives a good. Marketing tries to categorize, promote and distribute to customers. The customer is an operand resource.	Co-producer of service. Marketing is a means to interact with the customers. The customer is mainly an operant resource, sporadically being involved as an operand resource.	Vargo and Lusch (2004), p. 7
The firm-customer interaction	The customer is acted upon to generate transactions with other resources.	The customer is actively involved in relational exchanges and co-production.	Vargo and Lusch (2004), p. 7
Creator of value	Firm, often with input from other firms in a supply chain.	Firm, network partners and customers.	Vargo et al. (2008), p. 148

Technology is omnipresent in the financial services sector due to its early adoption of it (Chiasson and Davidson, 2005) and because it is at the centre of structural change in this sector (Consoli, 2005). Furthermore financial services can be considered as a good example of a service industry because its core business is using its competences for processing information and dealing with intangible aspects (Baets, 1996, Avison et al., 2004), which implies the use of (mainly) operant resources. Therefore it is rightfully classified as a knowledge intensive sector (European Commission, 2012).

2.2 Co-creation with Customers

Customers can refer to users, lead users, intermediate users or the final beneficiaries of a service. These can provide crucial inputs for what they need and play an important role in new product and service development (von Hippel, 1986, Magnusson et al., 2003, Bogers et al., 2010, Edvardsson et al., 2011). The role of customers has also been changing due to a shift from a production economy to a service economy (Normann, 2001, Vargo and Lusch, 2008a), being a source of service innovations (Vargo and Lusch, 2004, Oliveira and von Hippel, 2011). A possible application to the financial services sector and a classification of types of customers through their involvement was researched (Pallister et al., 2007) whilst other classifications of customers, in non-financial services, are also available (Edvardsson et al., 2012). The customer can also develop new service ideas themselves and take the initiative to introduce it to an interested producer (von Hippel, 1978). This is also referred to as the democratization of innovation (von Hippel, 2005) because the user (i.e. customer) is put at the centre of interaction with

the company, the customer is actually the locus of search for innovation.

Co-creating new services represents an innovation activity where the interactions and relations between customer and company are central (Ramaswamy and Gouillart, 2010). The involvement of customers in the value co-creation should be done actively (Nuttavuthisit, 2010) since their relationship is believed to be a fruitful originating environment for innovations (Hult et al., 2007). The customer can always be a co-creator of value (Vargo and Lusch, 2006), emphasizing the intertwined business system where entities iteratively exchange (Vargo and Lusch, 2008a). This value is contextual and phenomenological determined by the beneficiary of the service (Vargo and Lusch, 2008a), implying that it has many possible manifestations.

The assessment of value is therefore done on the basis of the value in that specific context through co-creating it with the customer (Flint, 2006, Edvardsson et al., 2011). Co-creation is not the same as co-production because co-creation can lead to something which seemed valuable innovation during co-creation but which isn't after production because the customer can't or won't use it (Ford et al., 2012). Co-production is a phase of the service co-creation (Vargo and Lusch, 2008a), requiring entities in the business system to possess divergent knowledge to generate innovative combinations, making them a potential source of value co-creation. This co-creation is also embedded in a social context where the actors learn and adapt their roles. Communication is essential for this interaction, being paramount for the transfer of information between the customer and the company (Edvardsson et al., 2011) in the innovation process.

To conclude, this concept of co-creation refers to the part of a company's capability in developing and commercializing new services through knowledge-driven interactions with its customers. During these interactions, innovation-related knowledge can lead to a reconfiguration of existing competences in the company to provide the new service offer that delivers value to its customers. When the new service is commercialized, it will create relationships with new customers and reinforce those in the existing customer base. This growth of customer relationships will enhance new knowledge exchanges to keep delivering value for the enlarged customer base. The symbiosis between a company's competences (knowledge) and relationships (customers) restarts when the required value-in-use of the renewed service offer is co-created again. Therefore this reconfiguration of a company's competences does not only lead to service innovations, but also changes in its organizational structure and even its competitive landscape. For example new companies can be created that have a different strategy, one that does fit between the required competences (knowledge) and relationships (customers) to deliver value (Normann and Ramírez, 1993, Normann, 2001).

2.3 The Value Co-creating Process with Customers

Value co-creation is an iterative process (Prahalad and Ramaswamy, 2004a, Ramaswamy and Gouillart, 2010) of a knowledge-driven reconfiguration of the company's internal resources (Normann, 2001, Hunt and Derozier, 2004, Lusch et al., 2007, Edvardsson et al., 2011) This requires an organizational capability (i.e. absorptive capacity) to acquire new knowledge and reinvent value, through co-creation with customers. Knowledge is an essential element due to its in- and outflows between the involved actors (Bogers and West, 2012). Finally the probability of cooperation between innovation partners was also reported to be significantly influenced by their absorptive capacity (Guisado-Gonzalez et al., 2013).

Because of the presence of tangible elements (i.e. goods or operand resources) in any service offer, various definitions of "What is a service?" can exist (Spohrer and Maglio, 2008). An overview and its conceptualizations are available in the literature

and we follow the service and S-D logic's stream of research (Normann and Ramírez, 1993, Normann, 2001, Vargo and Lusch, 2006, Vargo and Lusch, 2008b, Vargo and Lusch, 2008a, Merz et al., 2009).

The difference between knowledge and information is that the latter refers to a (Lusch et al., 2007, p. 10): "… specialized operant resource which can be exchanged relatively independently of the operand resources – pure information". Knowledge is broader since it includes technologies, specialized expertise, business processes and techniques (Normann and Ramírez, 1993), making it less transferrable as a whole. This is also made apparent by the need to "liquefy" existing service offers, meaning unembedding operant resources (such as information or technology) from the operand resource in order to use it for reconfiguring it into a new service offer during co-creation with the customer (Normann, 2001). The company must therefore also be able to unlearn which can also be referred to as desorptive capacity (Lichtenthaler and Lichtenthaler, 2010).

The intangible nature of services requires a more extensive exchange of information with the customers during new financial service development (Vermeulen, 2004). Consecutive collaborative interactions with customers (Kristensen, 1992) during new service development are part of problem-solving exercises where recurrent meetings help build a shared understanding (Peters et al., 2010). The information needed is generally time-consuming to collect, transfer and use. This is costly and is also referred to as "sticky information" (von Hippel, 1994) or the "tacitness" of knowledge (Grant, 1996, Nielsen and Nielsen, 2009), reported to influence the locus of problem-solving during the innovation process (Simon, 1999). The type and amount of knowledge needed to innovate will contribute to the stickiness and innovation costs of information (von Hippel, 2005). This stickiness can be related to the characteristics of the specific information itself and the features of the involved actors (von Hippel, 1994). However the embeddedness of involved the actors can foster the development of new services by reducing this stickiness or tacitness (Granovetter, 1985, Uzzi, 1997, Uzzi and Lancaster, 2003, De Smet, 2012).

3 Learning Theory as a Theoretical Background

Organizational learning is all about achieving strategic renewal in the organization itself (Sambrook and Roberts, 2005). The co-creation with customers is part of this strategic renewal since the objective of strategy is to relentlessly increase the fit between the company's capabilities and the value creating activities for its customers. Organizational learning is an essential element of new service development (Stevens and Dimitriadis, 2004) whilst the organizational learning process can also be viewed as an innovation process (Simon, 1999). The mechanisms that connect the organizational learning (i.e. structural, cultural, psychological and policy) influence its absorptive capacity (Knoppen et al., 2011) and absorptive capacity drives innovation (Lichtenthaler, 2009). Learning theory is therefore inherently driving the concept of absorptive capacity (Easterby-Smith et al., 2008), being part of the innovation process. These mechanisms that connect the learning process in an organization, leading to new knowledge stocks, are contingent on the relational context (Lipshitz et al., 2002, Naot et al., 2004, Knoppen et al., 2011). This importance of relationships was emphasized before for the co-creation of new services, where the interactions between the customer and the company are central (Prahalad and Ramaswamy, 2004a, Ramaswamy and Gouillart, 2010).

The structural mechanisms refer to the established routines during exploration and the social integration mechanisms that foster it and a subsequent exploitation (Dyer and Singh, 1998). The financial services sector is generally characterized by a more

conservative environment (Vermeulen, 2004) with more rigid hierarchical lines of control (Johne, 1993) and more formal rules and procedures as micro-regulative forces (Vermeulen et al., 2007). This can lead us to believe that the structural mechanisms should be more developed, to facilitate institutional control. These could be beneficial for financial services companies since a centralization of the approach for innovation, offering more control, fosters organizational knowledge capitalization (Yeoh, 2009). On the other hand the organizational structures can have impeding effects on the innovation process (Vermeulen and Dankbaar, 2002) while the financial services is argued to be less innovative (Volberda et al., 2001, Vermeulen, 2005).

Policy mechanisms refer to decision making managers, how they want innovation initiatives to be handled and choices in directing the learning process, especially regarding the partner to learn with (Easterby-Smith et al., 2008), a customer for example. Insights into the specific policies (Lane et al., 2006) which focus on involving customers as a source of external knowledge, should be interesting. The influence of managers in steering the inter-organizational relationships for innovations (e.g. with a customer) was also found to be important (Easterby-Smith et al., 2008).

Cultural mechanisms of organizational learning refer to norms and values that encourage learning such as for example transparency, integrity and accountability (Knoppen et al., 2011). The psychological mechanisms refers to the psychological safety fostering risk taking in order to learn something new (i.e. deviating from routinization) and the commitment to share knowledge with others (Lipshitz et al., 2002). Within the financial service sector, micro institutional factors (regulative, normative and cultural/cognitive) were researched before, showing the presence of risk avoiding and various different meanings associated to knowledge exchanges during co-creation (Vermeulen et al., 2007). The social context around the customer and company during new service developments also need to be taken into account (Edvardsson et al., 2011) because otherwise knowledge exchanges will not be possible (Nicolajsen and Scupola, 2011). This is also related to the need for trust, another social characteristic, in the interactions between customers and the company (Roberts et al., 2005).

3.1 Absorptive Capacity and Innovation-related Knowledge

There have been many discussions regarding the conceptualization of absorptive capacity (Cohen and Levinthal, 1990, Lane et al., 2006, Easterby-Smith et al., 2008, Volberda et al., 2010) and this research will follow the description by Zahra and George (2002) because their internal process approach is aligned with the research need of this study. The process of absorptive capacity drives innovation but its internal composition is always debatable because its components are expected to be strongly interrelated (Knoppen et al., 2011). Absorptive capacity is composed of two elements: potential and realized absorptive capacity (Zahra and George, 2002). Potential absorptive capacity describes the company's organizational capabilities to acquire and assimilate external knowledge (Lane and Lubatkin, 1998). The acquisition capability describes the identification and acquisition of external knowledge that is critical for the company (Zahra and George, 2002). The assimilation capability refers to the routines in place to analyze, interpret and understand information obtained from an external source.

Absorptive capacity is a multifaceted concept with a broader empirical support (Lim, 2009, Murovec and Prodan, 2009, Flatten et al., 2011, Jiménez-Barrionuevo et al., 2011, Kostopoulos et al., 2011). It has moderating effects on the relationship between technological opportunity and innovative effort (Nieto and Quevedo, 2005). The industry was found to have a moderating effect on the knowledge acquisition and

innovation capability (Liao et al., 2010). The knowledge acquisition was also found to be able to increase the innovativeness of the involved company (Cepeda-Carrion et al., 2012). Absorptive capacity plays an important role in organizational learning and the reconfiguration of resources to better fit the company with its strategy and environment (Lewin and Volberda, 1999).

Within the context of knowledge intensive financial services, customers were reported to be important sources of innovations (de Jong and Vermeulen, 2003). Meeting latent customer needs (Avlonitis et al., 2001) requires tapping into their knowledge and initiate the process of absorptive capacity (Lane et al., 2006). The acquisition capability was found to have positive effects on absorptive capacity (Liao et al., 2010), confirming its theoretical relevance, therefore likely to facilitate the reconfiguration of the company's resources to address strategic opportunities identified with the customers. The path dependency between the phases of organizational learning (i.e. exploration, assimilation and exploitation) within the process of absorptive capacity should provide interesting venues of research (Lane et al., 2006).

3.2 Conceptual Model on Co-Creation with Customers

The literature review and learning theory lead to the development of the following conceptual model (Figure 1), which will be used to define the research propositions.

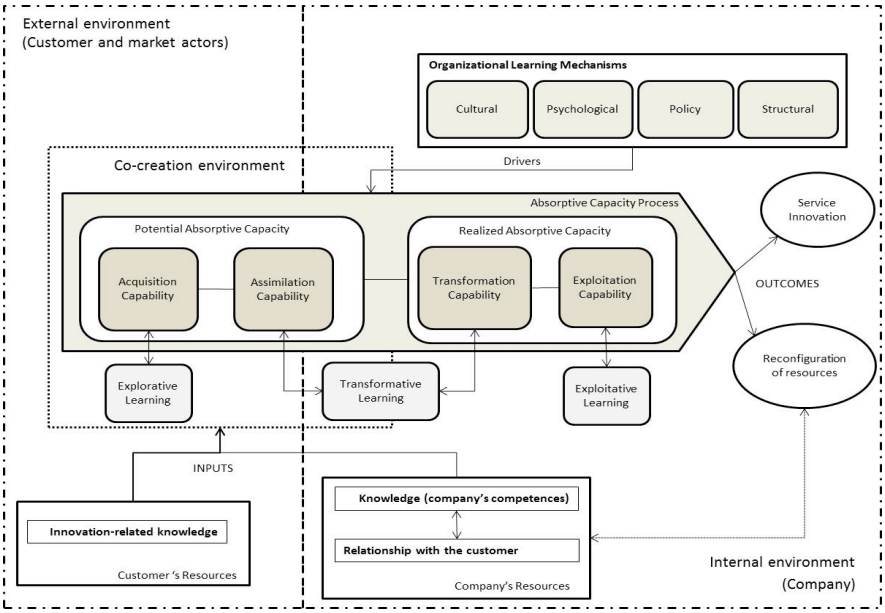

Figure 1: Conceptual Model

The customer is a source of critical knowledge (Greer and Lei, 2012), being the locus of search for the company's potential absorptive capacity. The current customer base will provide opportunities for knowledge exploration, requiring an acquisition capability within the company as part of its absorptive capacity (Zahra and George, 2002). The customer is a provider of innovation-related knowledge (Bogers et al., 2010) and the company's absorptive capacity helps to explore this knowledge, which can lead to creation of innovation after internalization and exploitation of this knowledge. Customer relationships can lead to new knowledge, initiating the value

co-creation process (because it's knowledge-driven), which is influenced by the organizational learning mechanisms affecting absorptive capacity.

The influence of co-creation initiatives within financial services companies on performance was found to be diverse, depending on its strategic type (Manion and Cherion, 2009). Favorable customer outcomes also require market orientation. However market and resource orientation are both needed for the company to achieve innovativeness (Paladino, 2007). Measures of co-creation require more research in general (Payne et al., 2008). However operational performance was found to be positively affected by leveraging customer knowledge (Yeung et al., 2008).

Co-creation through customer involvement is beneficial but much debate is ongoing regarding how this should be done as it also depends on the type of innovation being pursued (Gustafsson et al., 2012). It is also new within the financial services sector (Papastathopoulou and Hultink, 2012). Finally, the customer base of a company is often not considered as a resource for building capabilities during co-creation (Prahalad and Ramaswamy, 2004b, Zhang et al., 2011) and the decomposition of co-creation for service oriented companies has a capability has also been explored (Karpen et al., 2012).

4 Conclusions and Limitations

The extant body of literature on co-creation initiatives with customers for new service developments was reviewed. Specific attention was paid to the importance of customer resources (i.e. their innovation-related knowledge) and company resources (i.e. competences and customer relationships) as inputs for this format of new service developments in the financial services sector. A company's absorptive capacity will facilitate the exploration, transformation and exploitation of innovation-related knowledge. The organizational learning mechanisms within a company drive its absorptive capacity and the latter drives innovation in knowledge intensive sectors like financial services. This is synthetized in the conceptual model which has several implications for research and practice.

4.1 Academic implications

This conceptual model can be used to guide future research in co-creation initiatives within the financial service sector, by paying specific attention to the underlying organizational learning mechanisms.

A possible venue for new research would be the use of longitudinal case studies to get more detailed insights on how learning occurs, how financial services companies realize service innovations through their organizational learning mechanisms and hence develop and use their absorptive capacity. There are various theoretical frameworks that could be used for further empirically testing the proposed conceptual model. The use of social capital theory could provide interesting research propositions to explore the influence of reciprocity, trust and network ties on the organizational learning mechanisms. A single in-depth case study might also be used, where detailed insights are collected on a very specific financial service innovation. The level of innovativeness of the co-created services is another area to be explored, since good customer relationships might have negative effects on the innovativeness of the new service (Knudsen, 2007).

Future research could focus on the possible differences between first movers and first followers, regarding customer involvement for co-creating new financial services. The diffusion of financial service innovations is reported to be rapid amongst competitors since they can be copied quickly (Roberts and Amit, 2003), giving an

advantage to imitators (Molyneux and Shamroukh, 1999) and imitators' development costs can be halved compared to the first movers (Tufano, 1989).

4.2 Managerial implications

Innovation managers and executives of financial services companies can gain insights from this conceptual model. It emphasizes that the involvement of customers for their new services development requires an investment in elaborating a dedicated environment (Nonaka and Konno, 1998) to do so. They need to pay attention to the needed absorptive capacity and contextual organizational learning mechanisms that can help to improve this capacity for leveraging innovation-related knowledge from customers. In particular the policy and structural learning mechanisms can be stimulated to enhance the effectiveness of the co-creation initiatives with customers and even initiate the learning to co-create with hem. The cultural and psychological learning mechanisms are also something that addresses executive leadership by emphasizing the importance of innovation (e.g. values), devising a strategy for innovation and by fostering an environment where risks can be taken for learning from customers. Vision is needed (Nonaka and Takeuchi, 1995, von Krogh et al., 2000) to generate new knowledge within the company and stimulate its search, fostering the involvement of external actors (Giroux and Taylor, 2002) such as customers.

4.3 Policy implications

Policymakers could stimulate innovation networks and support transversal exchanges with new customers since these can stimulate a company's absorptive capacity. The costs of organizing a space for co-creation and learning can be high, costs that private actors do not always want to bear, creating a possible role for policy makers to facilitate networks. Following this, the challenge of knowledge appropriability regimes for financial services companies emerges (Bader, 2008). The public authorities could develop new laws or guidelines to facilitate productive cooperation as innovation has important economic spillovers (Leahy and Neary, 2007). Other policy measures could be oriented towards stimulating the formulation of a strategy for innovation and associated initiatives.

4.4 Limitations

The objective of this paper is the formulation of a conceptual model that can be used a s a basis for guiding empirical research. As such, the elaboration of targeted research hypotheses is excluded from this research. However various venues for future research have been formulated. Other industry or country characteristics could also be considered since these should influence service co-creation with customers due to its foundational differences (Fraga et al., 2008). The linking of the conceptual model with established service development models (Alam, 2002, Alam and Perry, 2002, Nambisan, 2002) is also left outside the scope and presents an additional future contribution to this research.

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Payment Habits as a Determinant of Retail Payment Innovations Diffusion: the Case of Poland

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Abstract. New and innovative methods for electronic funds transfer are emerging globally. These new payment tools include extensions of the established payment systems as well as new payment methods that are substantially different from traditional transactions. They have made the retail payments faster, cheaper, easier and more convenient for customers. Simultaneously, these payment innovations influence retail payment market around the world. During the last few decades it has changed remarkably and has become a very competitive one. Financial institutions are increasingly in competition with technology companies and other organizations to be the preferred providers of consumer payment services. There are huge differences between retail payment markets in developing countries and those in the mature markets. Payment habits are mostly influenced by local cultural drivers, so global trends are few and far between. Nevertheless, as consumer expectations and habits are becoming more homogenized and financial institutions start to be interested in new markets, the opportunities to learn from the experiences of other economies appear. The paper discusses theoretical and empirical foundation of retail payment innovations diffusion, presents the retail payment taxonomy and the results of a survey held in Poland in 2013. It is concluded that Polish experience can be assessed as a benchmark for searching determinants of retail payment markets development. However, copying success factors for sustainable market development is rather impossible with regard to payment culture, experiences and habits.

Keywords. retail payments, payment innovation, consumers' adoption, consumers' payment habits, innovations diffusion

1 Introduction

Despite the large number of papers focusing on innovations and the factors of their diffusion (Manning, 1995; Ram and Sheth, 1989; Sathye, 1999; Citrin et al., 2000; Kolodinsky et al., 2004; Juwaheer et al., 2012) there is still the lack of their taxonomy and categorization concerning retail payment market and innovative payment instruments. This paper fulfills that gap and contributes to the results of other research analyzing payments habits in Poland concerning traditional payment instruments.

The main research questions relate to:

- the categorization of retail payment innovations,
- the knowledge about innovative payment instruments/methods and their usage,
- the role of payments habits in the process of innovative payment

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instruments/methods adoption,

- barriers to- and drivers for payment innovations.

The paper was prepared combining descriptive theoretical and empirical methods. A two-step methodology was designed for the research. The first step involved an investigation of the current professional literature, including books and journals, reports, conference proceedings, dissertations and theses, social media and portals. This analysis was the foundation for preparing the questionnaire for the second step – an empirical survey which was conducted in the first half of 2013.

This field of research is especially important because payments have recently been experiencing the fastest pace of development since the introduction of electronic services. Technological advances have paved the migration from paper to electronic payments. In the European context, this development has been complemented by the establishment of the Single Euro Payments Area (SEPA), which aims at creating an integrated and harmonized pan-European payments market thereby fostering competition and driving innovation. The most spectacular innovations appearing on retail payment market, like mobile or online payments, are strictly connected with new market players such as Amazon, Google, PayPal and other online giants, telecom operators, merchants and service providers. However their popularization on the market needs users' acceptance. In two-sided markets, i.e. retail payment market, the major challenge lies in achieving a critical mass of two groups of end-users (consumers and merchants). Furthermore, these both sides of the market must adopt the innovation at the same time. It is easier to convince merchants e.g. by creating incentives to join the network or by cutting the cost of doing so. But consumers might not be interested in a new payments instrument if they are satisfied with the instrument and methods which have been used so far. It is very important and relevant to verify this assumption. We did it on the example of Poland, where consumers still prefer cash or traditional payment instruments such as credit transfer or debit cards.

This paper examines the fundamental relationship between consumers' habits and the diffusion of retail payments innovations. Using data from desk and field research the results confirm that payment habits are probably the most important drivers for the adoption of payment innovations. Consumer propensity to use innovative payment instruments/methods is considered as one of the barriers to - or the driver for - retail payment innovation diffusion. Among the other drivers are the following: dynamic technical development, rapid growth of electronic commerce and increasing customers' expectations concerning convenience and price.

2 Retail payment innovations diffusion and development

2.1 The innovations in retail payments

Payment services are one of the most important financial services for economy, companies and consumers. Their dynamic growth created the need of unifying their definition and the European countries' attitude to payment market. The Payment Service Directive (PSD) was the response to that need. According to the directive (Directive 2007/64/EC), a payment service is defined as any business activity which concerns: services enabling cash to be placed on a payment account as well as all the operations required for operating a payment account, services enabling cash withdrawals from a payment account and the operations required for operating a payment account, execution of payment transactions, including direct debits, payment transactions through a payment card or a similar device and credit transfers, including standing orders, execution of payment transactions where the funds are covered by a credit line for a payment service use. The definition of a payment service also

includes issuing and/or acquiring of payment instruments, money remittances and execution of payment transactions, where the consent of the payer to execute a payment transaction is given by means of any telecommunication, digital or IT device and the payment is made to a telecommunication and IT system or a network operator, acting only as an intermediary between the payment service user and the supplier of goods and services.

Payment services are realized by payment instruments. The payment instrument means any personalized device(s) and/or set of procedures agreed between the payment service user and the payment service provider and used by the payment service user in order to initiate a payment order. According to that definition, payment instruments are as follows: credit transfers, e-transfers, direct debits, debit cards, contactless cards, credit cards, cash payments, mobile and online payments.

Not all of them could be classified as innovations. Generally, innovation is defined as the implementation of new ideas, processes, products or services (Thompson, 1965) or anything perceived to be new by the people doing it (Rogers and Kim, 1985). More precisely, innovation could be defined as a process of implementing new products/services or adopting new ways of their usage (Janasz and Kozioł, 2007). So innovation is the first commercialization of the idea for a new product or process. Financial innovation (Frame and White, 2002) represents something new that reduces costs, risks or provides an improved product/service/instrument that better satisfies participants' demands. Taking that into account payments made by debit or credit cards, as well as cash payments, credit transfers and direct debits could not be considered as innovative ones.

Payment innovations, as other innovations, can be categorized in several ways. One of the most common and useful typologies defines four types of innovations that encompass a wide range of changes in firms' activities. It divides innovations into: product innovations, process innovations, organizational innovations and marketing innovations (Oslo Manual, 2005). Product and process innovations are the most common on a retail payment market. The first type of innovation should include contactless cards, mobile and online payments and the second ones are for instance improvements in payment initiation, processing or receipt of payment.

Considering the degree of novelty there are two kinds of innovations: incremental and radical (Schumpeter, 1942). Many authors suggest that differential incentives will lead incumbents (i.e. banks in the retail payments market) drive forward with incremental innovations, whereas entrepreneurial new entrants will pioneer radical innovations (Hill and Rothaermel, 2003; Furst and Nolle, 2004; Sullivan and Wang, 2007). The greater part of payment innovations is incremental and is related to the use and the founding of card payments. These innovations have focused on the way of payments and improvement of their safety. The radical innovation in this area are contactless cards, mobile and online payments. Table 1 presents the innovation range and usage possibility of selected payment instruments. Another factor that differs payment instruments, despite the range and usage possibility, is the ability to use them as a micropayment instrument. In the future cash domination in this area will be probably decreased by the electronic purse, contactless cards and mobile payments.

Table 1 Innovation range and usage possibility of selected payment instruments

Payment instruments	Usage possibility		Innovation range		
	Traditional point of sales	Internet	Not innovative	Innovative	
				Incremental	Radical
Cash	X	X	X		
e-transfer		X		X	
Direct debit		X	X		
Debit cards	X	X	X		
EMV debit cards	X	X		X	
Contactless cards	X			X	
Cheques	X		X		
Electronic purses	X				X
Mobile payments	X	X			X
On-line payments		X			X

Precise classification of all payment innovations is quite difficult because of their large variety and number. Two large surveys were conducted to identify retail payment innovations. 101 central banks took part in an audit of payment instruments and methods which was carried out by the World Bank in 2010 (Payment Systems Worldwide, 2010). The purpose was to collect information on innovative payment instruments and products such as electronic money, mobile and Internet payments as well as prepaid card services and process-related innovations. In order to capture all different types of innovations, for the purposes of the survey, innovative products were defined as products that are not based on cheques, traditional credit and debit cards or traditional direct credit and debit services. Therefore, prepaid cards, card-based e-money products and other types of e-money products including those developed around mobile phones and mobile technology, among others, were all intended to be captured under the previous definition. 173 innovations were identified as a result. Most of them were used in person-to-business (P2B) or person-to-person (P2P) payments. New payment instruments and methods are usually implemented by non-banks and they appear to have fairy well-developed pricing models. Their main disadvantages are: very limited interoperability, a lack of direct connection with the traditional interbank clearing and settlement infrastructure and relatively low safety level.

A similar payment innovation review was made by Committee on Payment and Settlement Systems (CPSS). In June 2010 a working group was set up to investigate developments in retail payments, focusing especially on innovations. (*Innovation in Retail Payments,* 2012*)*. According to their findings, generally there are two kinds of payment innovations: product innovations and process innovations. The first categorization is based on the user's point of view. From this point it, five product-related innovations should be identified: innovations in the use of card payments, online (Internet) payments, mobile payments, electronic bill presentment and payment (EBBP) and improvements in infrastructure and security (see table 2).

Process-oriented categorization focuses on the back office of the payment process and entails payments initiation, overall payment process (including clearing and settlement) and receipt of a payment.

It is worth emphasizing that this classification does not include contactless payments. Taking into account the device they should be classified as the first category of innovations (contactless cards) as well as the third category (mobile devices enabling contactless payments). In many studies on innovative retail payments they are classified as mobile payment (*White Paper Mobile Payment*, 2010) or treated as a specific payment category (*Advanced Payment Report*, 2011).

Table 2 The classification of retail payment product innovations

Innovation	Characteristics
Innovations in the use of card payment (about 25%)*	This product category relates to cards as access devices for payments. They refers to following access channels: - payments on the Internet – innovations in card-not-present transactions for online shopping (e.g. virtual card numbers), - payments at the POS, e.g. contactless card payments using NFC technology, devices connected to mobile equipment that allow payments to be accepted
Internet payments (about 20%)	This product group refers mainly to the access channel. In this case, payments are initiated by devices connected to the internet (e.g. desktop PCs, laptops, tablets and mobile phones) where payment instructions are transmitted and confirmed between consumers and merchants and their respective PSP's in the course of an online purchase of goods or services (e.g. related to an e-commerce transactions. There are three main group of innovations in this category: - on-line payments – a banking-based solutions that forward consumers from e-merchant's website to their online banking applications, - escrow services where a third party is interposed between the payer (buyer) and the payee (seller) in a e-commerce transaction and ensures the delivery versus payment of the foods or services - electronic money payment via the internet.
Mobile payments (about 25%)	In this category the mobile payments are not defined as a device but an access channel what means payments initiated and transmitted by access devices that are connected to the mobile communication network using voice technology, text messaging (via either SMS or USSD** technology) or NFC. Among these devices are mobile phones and tablet computers. Mobile payments include: - mobile payments using traditional bank account, - mobile payments using the mobile phone bill collection process; payers pat the invoiced mobile payment account as a part of their mobile phone bill; the payee receives the amount from the mobile phone operator, - mobile payments using prepaid accounts (sometimes called "mobile money").
Electronic bill presentment and payment (about 10%)	These category include following processes: - the payee initiates the payment using the electronically presented bill, - the payer initiates the payment using the electronically presented bill. Furthermore the payer can store the bill and the related payment documentation electronically.

Innovations connected with improvements in infrastructure and security (EBPP) (about 25%)	Improvements in this field aim at improving payment processing efficiency and/or improving security. The category includes: - cheque truncation or cheque imaging systems, - shortening the time for clearing and settlement, - providing payment services to the unbanked or underbanked, - security improvements.

* Approximate share in a number of all reported innovations
** USSD - Unstructured Supplementary Service Data is a Communications protocol used by Global System for Mobile (GSM) mobile phones operators.

As evident in literature and other surveys' findings regarding the analysis, the following payment instruments/methods were considered during the field research: debit transfer, e-transfer, direct debit, debit card without the possibility of making contactless payment, debit card with the possibility of making contactless payment, contactless card, contactless payment made by mobile phone, mobile payment and on-line payment.

2.2 Factors influencing diffusion and development of payment innovations

The retail payment market is an example of two-sided markets which involve two groups of agents (end-users) who interact via "platforms," where one group's benefit from joining a platform depends on the size of the other group that joins the platform (Rochet and Tirole 2003; Evans, 2003). There are markets with network externalities in which surplus is created - or destroyed in the case of negative externalities - when the groups interact (Katz and Shapiro, 1994; Farrell and Saloner, 1986; Liebowitz and Margolis, 2004; Armstrong, 2006). On the payment market it means that the more widely a payment instrument is accepted, the more benefits it brings to a consumer using it (demand side externality). From the acquirers' perspective network effects are just economies of scale which foster the industry's willingness for cooperation - supply side externality (Kemppainen, 2003; Farrel and Klemperer, 2007). As a result of two-sides markets' specific character, the crucial factors influencing the popularization of payment innovations are: consumers' ability to use them and sufficiently developed acceptors network.
Retail payment innovations development depends on exogenous and endogenous factors which could be both drivers or barriers (see figure 1).

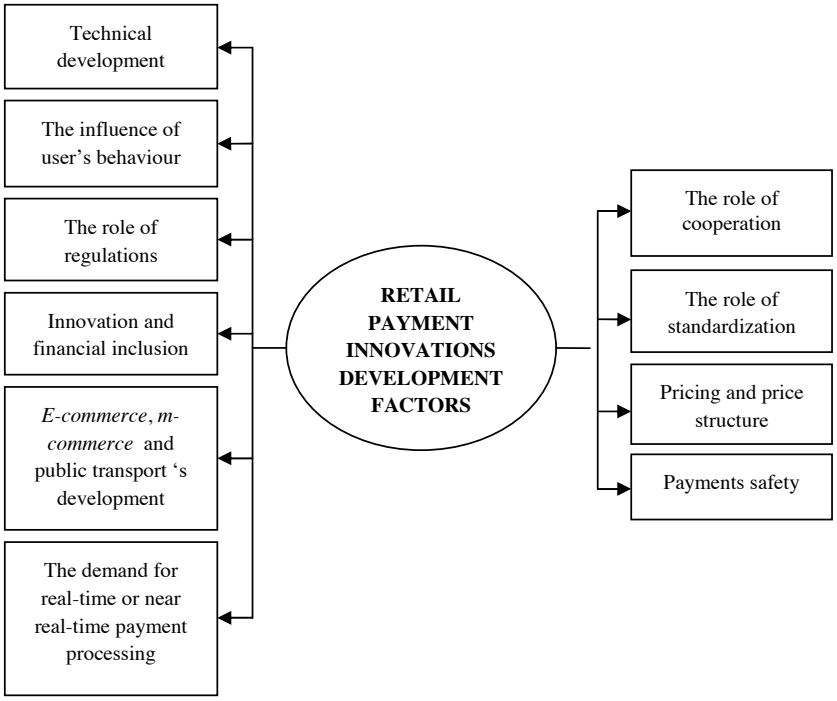


Fig. 1 The factors influencing retail payment innovations development (Harasim, 2013)

Exogenous factors relate to those that are determined outside the payments ecosystem, notably technical developments, user behaviour and regulations. On the other side, endogenous factors are determined inside the payments ecosystem, e.g. cooperation, standardisation, price structure and security (*Innovations*..., 2012). Technology is one of the fundamental catalysts for new and improved payment services and, consequently, the new business models that allow an innovation to be brought to the market. The rapid growth of e-commerce and online transactions together with higher penetration of mobile phones and smartphones will surely influence the retail payment markets in the nearest future. The second crucial, exogenous factor is user's behavior. It is probably the most important driver for innovations. Innovations in the area of retail payment are strongly driven by end users' need for payment instruments that are more secure, efficient and convenient. Merchants and consumers generally prefer to accept or choose payment instruments that deliver them more benefits, and they are unlikely to change such preferences in the absence of some significant expected advantages. The last exogenous retail payment innovations factor is regulation. Regulation may affect the potential demand for payment innovations or their expected production cost. It might be considered either as a driver for- or a barrier to innovation development. There are two prominent rationales for regulating the payment markets. The first is that regulators wish to ensure that the market is secure, since payment services need to be trustworthy in order to be accepted. The second is to increase market efficiency. Recently, there is a tendency to place a stronger emphasis on this second aspect of regulation. In Poland this has entailed improving competition by opening up the payment market to non-banks - in the European Union, according to the Payment Service Directive (2007/64/EC), a new type of non-bank institution, such as payment institutions and

electronic money institutions, can provide payment services. They are subject to less restrictive licences and need to meet lower regulatory burden than the institutions with full banking licence.

The endogenous retail payment innovations' factors are cooperation, standardisation, price structure and payment security.

The role of cooperation is crucial because of substantial fixed investments costs which are required for payment innovations, although there is no guarantee that the new product or process will attract sufficient demand. Cooperation could help to overcome this obstacle by helping reduce costs (e.g. through shared investment or economies of scale and scope) or by ensuring sufficient demand (e.g. by increasing the pool of potential customers or through integration of additional services). Moreover, innovation in retail payments often involves many participants. Thus, cooperative agreements may be the only way to make progress.

In the retail payments industry, where activity is based on networks of numerous players, standardisation plays a crucial role in developing the agreements needed for technically efficient communication. It is considered to be an essential driver to innovation, as it increases the business case by exploiting economies of scale and scope. Standardisation can be achieved by creating open or proprietary standards. Open standards are freely available and are developed and maintained via a collaborative and consensus-driven process. They facilitate interoperability and data exchange among different products or services and are intended for widespread adoption. In contrast, proprietary standards are privately owned and are generally not approved by an independent standardisation body. They are adopted by the industry typically because of the owner's market power. Standard-setting bodies can take a long time to establish a standard, and often develop standards on the heels of a leader that has successfully imposed a proprietary platform. Standardisation affects innovation in a number of ways (CPSS Innovations in retail payment, 2012):

- it facilitates the achievement of critical mass - in contrast, insufficient standardisation can lead to a proliferation of incompatible payment instruments or systems, each of them remains too small to grow into a widely used solution.
- it can create stable ground for new players to come into the market, allowing them to keep upfront investment low. In this way, standardisation encourages competition on the basis of common, rather than competing standards. By contrast, a lack of common standards could reinforce the dominance of an existing platform.
- a lack of common standards could impede innovation because of the uncertainty and risks attached to an early market entry or to the costs involved in overcoming the lack of standards. Moreover, the additional revenue gained by standardizing processes lets successful players funnel more resources into developing new products.
- players operating in many countries are likely to benefit from broader and more open standardisation.

Pricing strategy may play a role in the success of an innovation, since prices set by the payment services providers (PSPs) must be both competitive and raise sufficient revenue in order to support the business case. Therefore, prices may play a twofold role in innovation: if PSPs can set the right incentives, they are a driver for innovation. In the opposite case, however, prices can turn out to be a barrier. Difficulties in price-setting can arise from a number of factors affecting a PSP's choice of pricing strategies, including the cost structure and market power of the players involved, the type and magnitude of the eventual network effect, and the regulatory environment.

Insufficient security and safety, whether real or perceived, could erode public confidence in a new payment solution and hence its business case. Technical advances and faster processing generate new opportunities in retail payments, but they also increase the likelihood of security breaches. It is important for both PSPs and users to take responsibility for security. PSPs should, in their own interest, play a more proactive role in promoting a secure environment for the user, offering technical support, advising and providing assistance where security incidents occur. On the other hand, users are responsible for their own security and should have adequate skills to manage it. Raising public awareness is also important, as it could lead to the implementation of better safeguards and ultimately encourage the adoption of retail payment innovations.

Banks are aware of the payment innovations implementation's necessity. According to World Payment Report (2012) from the banks' perspective the main drivers are: customers' retention and acquisition, efficiency improvement, cost savings, creating new markets (new payment method/customer segment), meeting challenges from competitors and brand positioning. The report also pointed out some barriers. The most important of them are: an attitude to change (from traditional approaches), building business case and security concerns for a new technology (see figure 2 and 3).

Over the longer-term banks are expected to focus more on customer-driven innovation. For banks, the move toward disruptive innovation is necessarily gradual, given the constraints of their traditional businesses, so partnerships with non-banks might feature in their strategies going forward. In fact, banks and non-banks are already forming "co-opetition" payments innovation relationships—cooperating in some cases and competing in others. Banks need to innovate more around consumers' needs to drive loyalty and retention. Customers will continue to be the catalyst for innovation among both non-banks and banks. The customer imperative will reflect both increased urgency around existing needs and new demands. For example, among the existing customer needs that are becoming more pressing, such as real-time payments, easiness and predictability, invoicing and open account payments and e-payments.

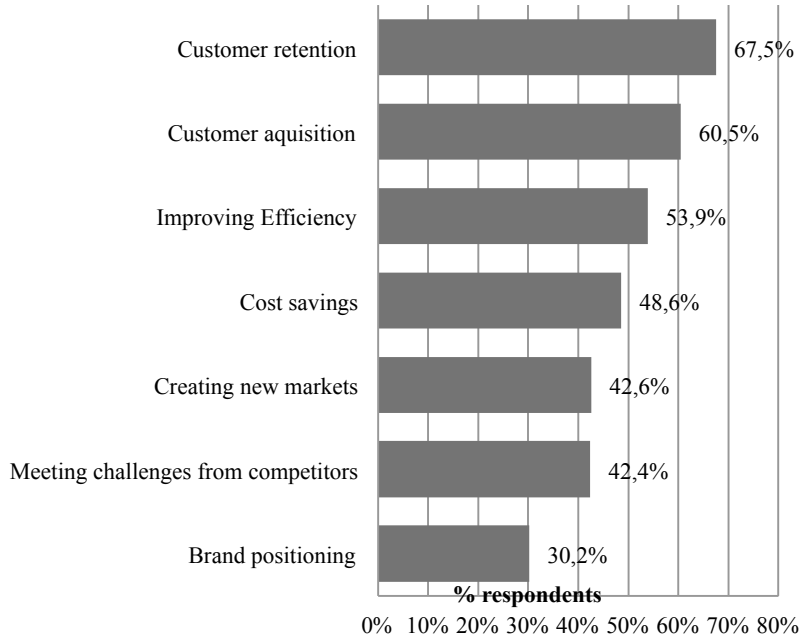


Fig. 2. Key retail payment innovations drivers (% of responders)

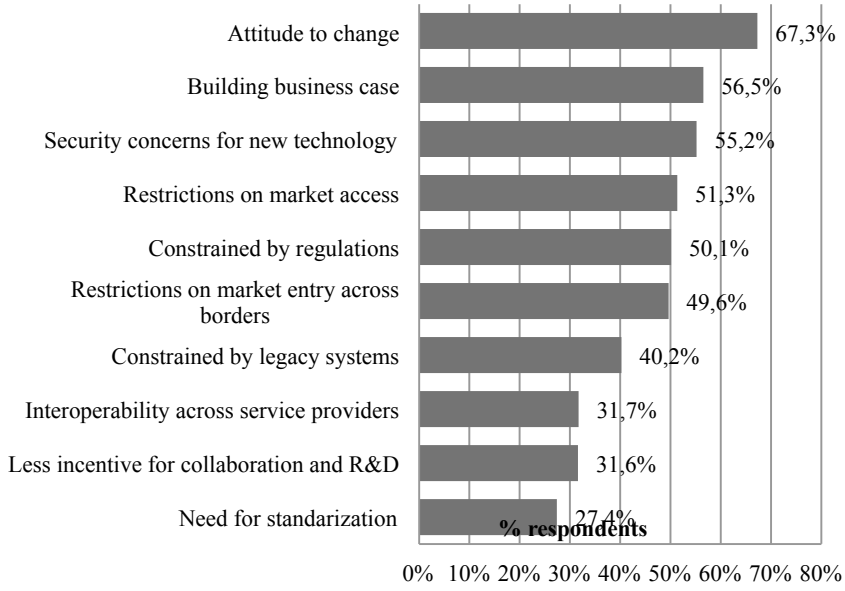


Fig. 3. Key retail payment innovations barriers (% of responders)

Among emerging customer needs (World Payment Report, 2012):

- more personalized services - PSPs once tended to favor 'one-size-fits-all' services, but homogenous offerings cannot cater adequately to the increasingly diverse needs of both corporate and retail customers, which are demanding customized services and products that fit their specific financial needs and schedules. Banks have an opportunity to analyze customer activities and payments patterns to deliver a more personalized customer relationship experience and proposition.
- corporate support for new payment instruments - since retail customers are gravitating toward payments via the Internet, smartphones, social media platforms, and virtual currencies, corporates (especially merchants) need to position themselves to accept a wide and diverse range of payment instruments.
- payments on mobile and social platforms - as the number of mobile and smartphone users rises rapidly, customers (mainly in the retail segment) are looking for payment options that use these technologies. Younger demographics expect in particular payment options to be integrated with social media to facilitate purchases of digital goods such as online games, applications, music and videos.
- payment options based on location and context - payment options based on location and customer context, such as the Starbucks POS m-payment option, are gaining traction and appeal. PayPal's open development platform also allows to develop customer-facing applications based on a customer's location/context.

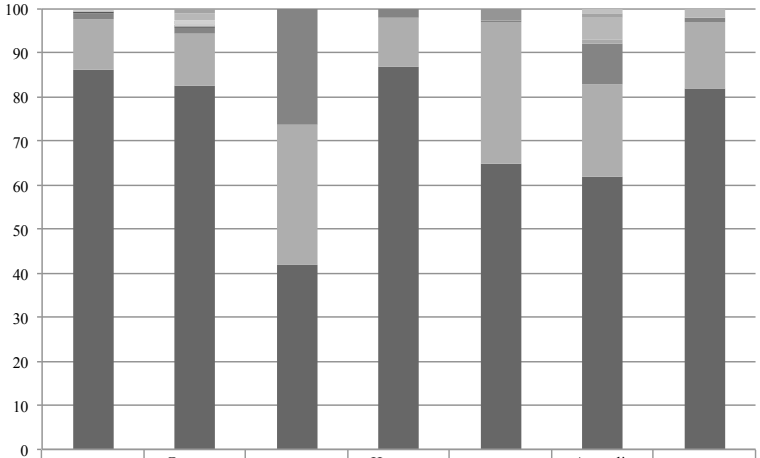
The key challenge for each bank is to assess its own customer key success factors (KSFs) and its own internal capability to innovate. By evaluating their readiness for innovation in this way, banks can take a customer-driven approach to prioritizing their innovation, taking into account their ability to execute successfully. This kind of approach will help clarify the business case, as customer needs will be driving the innovation strategy. That is the reason for focusing on this factor in the field research.

3 Research

Recently many modern, innovative payment methods have been implemented on the Polish retail payment market (e.g. Poland is one of the biggest market of contactless cards in the world). They have made the retail payments faster, cheaper, easier and more convenient for customers.

The existence of a wide range of payment instruments is essential to support customer needs in a market economy. A less than optimal use of payment instruments may ultimately have a negative impact on economic development and growth (Hasan et al., 2012). Moreover, the safe and efficient use of money as a medium of exchange in retail transactions is particularly important for the stability of the currency and a foundation of the trust people have in it.

Today Polish consumers can choice many modern and innovative payment methods which are fast, cheap and convenient. In spite of that, similarly to other countries, the use of traditional payment instruments, like credit transfers, direct debit, credit cards and debit cards, is still dominant on Polish retail payment market (see figure 4).



	Austria 2005r.	Germany 2008r.	Canada 2009r.	Hungary 2009r.	Holland 2010r.	Australia 2010r.	Poland 2012r.
cheques	0,2					1	
others		0,9				1	
direct transfers		1,8				5	2
direct debits		0,6					
internet payments		0,1				1	
e-money	0,2	0,5					
pre-paid cards		0,2			3		
loyalty cards	0,4	0,1					
credit cards	1,3	1,4	26,4	2	0,5	9	1
debit cards	11,5	11,9	31,9	11	32	21	15
cash	86,1	82,5	42	87	65	62	82

Fig. 4. Payment instruments structure in selected countries

But during the last decade, card payments in particular have led to a shift from cash to cashless payments (see figure 5). Ongoing innovations in retail payments have tended to a further reduction of the cash market share. However, as cash is used mainly for small-value transactions, especially in proximity and P2P payments, substantial substitutive effects can only be expected for the innovations that target these areas. According to 72% Polish customers, innovative payment methods are a competition for cash payments. Among them 42% stated that they are competitive for all kind of cash payments. For 30% of responders they are competitive only for micropayments. 19% of them declare that they are ready to start using innovative instruments against cash immediately, 34% - under some conditions (especially safety improvement) and 29% - in the nearest future. 22% of responders are not interested in using innovative payment methods definitely.

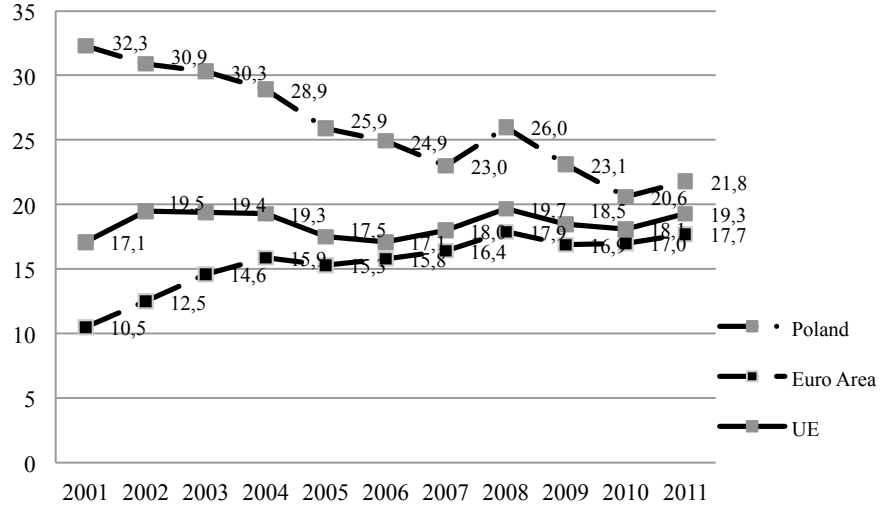


Fig. 5. Share of cash in money aggregate M1 in 2011 (*Porównanie*..., 2011)

About 75% of responders declare that they use traditional payment instrument and think that they are fast, easy, convenient and cheap what means that they in large extent meet Polish customers' expectations (see figure 6).

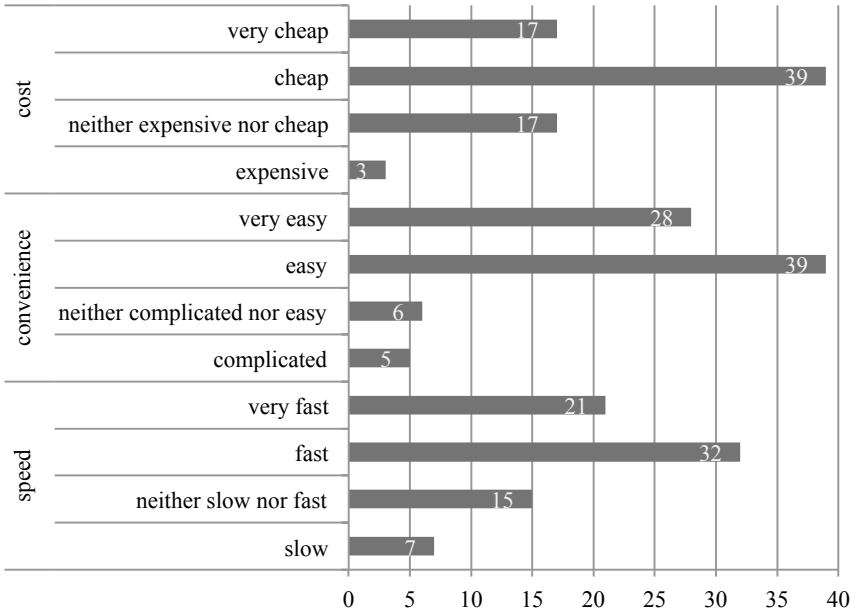


Fig. 6. Polish consumers' opinions on traditional payment instruments

One of the survey purposes was to establish the Polish consumers' knowledge level

concerning innovative payment methods. According to responders the most innovative ones are: contactless payments made by mobile phone, mobile payments, payments made via contactless cards, debit cards with the possibility of making contactless payment and online payments (see table 3).

Table 3 Innovative payment instruments in customers' opinion

Payment methods	% of responders
Debit transfer	6
e-transfer	24
Direct debit	4
Debit card without the possibility of making contactless payment	8
Debit card with the possibility of making contactless payment	37
Contactless card	42
Contactless payment made by mobile phone	66
Mobile payment	63
On-line payment	35

Generally, Polish consumers know innovative payment instruments but they do not use them. The most active group of responders are consumers in the age of 25-34. Contactless payments made by mobile phones or contactless cards are used by 7% of responders in the age of 25-34 and 2% in the age of 45-64. A similar situation concerns mobile payments which are used by 10% of responders under 25 years of age, 7% in the age of 25-34 and 2% in the age of 45-64. Debit cards with the possibility of making contactless payment and online payments are more popular (see table 4). Today the innovative payment instruments/methods such as e-transfers and contactless cards are usually used for micropayments.

Table 4 Knowledge on innovative payment instruments and their usage (% of responders)

Payment methods	Age											
	<24		25-34		35-44		45-54		55-64		>65	
	1	2	1	2	1	2	1	2	1	2	1	2
Debit transfer	60	25	33	59	42	55	45	52	58	37	51	31
e-transfer	40	48	21	78	36	58	37	58	42	40	35	14
Direct debit	57	23	45	45	58	33	50	45	53	30	59	20
Debit card without the possibility of making contactless payment	60	40	30	70	33	67	32	67	30	70	47	35
Debit card with the possibility of making contactless payment	63	35	29	68	48	45	52	43	58	26	33	16
Contactless card	78	0	68	19	79	6	67	8	65	2	33	2
Contactless payment made by mobile phone	68	0	78	7	76	0	75	2	53	2	27	0
Mobile payment	60	10	73	7	73	0	58	2	49	2	24	0
On-line payment	53	40	41	44	55	24	47	27	42	16	18	10

1 means "I know, but I do not use it", 2 means "I know and I use it"

Mobile and online payments have been implemented in Poland relatively late. Considering the Internet access and mobile phones market penetration (which are relatively high and grow fast) the potential for their development seems to be large.

Polish consumers have eagerly adopted mobile phones which serve them as communication devices, sources of entertainment, navigation tools and payment methods. As a result the payment demand is growing up systematically.

4 Conclusions

In the recent years the retail payment market has changed remarkably. A key feature of the retail payments landscape is the long-term shift away from paper to electronic means of payments (Furst and Nolle, 2004). The last decades have brought fast development of innovative payment instruments/methods such as contactless/NFC, online and mobile payments.

An increasing number and variety of payment innovations cause some difficulties in their classification. Generally they are divided into process-oriented and product-oriented innovations. They can also be classified as incremental and radical. Retail payment product innovations include five groups of innovations: innovations in the use of card payment, Internet payments, mobile payments, electronic bill presentment and payment and innovations connected with improvements in infrastructure and security. Process-oriented innovations are related to improvements in payment initiation, overall payment process (including clearing and settlement) and receipt of a payment. The majority of payment innovations are incremental and focus on the way of payment and payment safety improvement. Among the radical innovations are mobile and online payments. On the retail payment market they are introduced mainly by non-bank payment services providers, which are usually more flexible and better meet consumers needs and expectations than traditional PSPs - i.e. banks. Today it is especially difficult for banks to be competitive because they are usually large and mature. Furthermore non-bank payments and electronic money institutions are subject to less restrictive licenses and have to meet lower regulatory burden than an institution with full banking license.

There are many factors influencing retail payments innovations diffusion and development.

Key challenges relating to retail payments innovations diffusion result from a two-sided nature of retail payment market - especially from network externalities existing on their demand side. They are crucial for success or failure of a new payment instrument/method. The factors which could foster and/or impede the development of retail payment innovations can be divided into exogenous and endogenous. Exogenous factors include notably technical developments, user behaviour and regulations and endogenous e.g. cooperation, standardisation, price structure and security (*Innovations*..., 2012). As the fact-finding shows, innovations in the field of retail payments are strongly driven by existing payment habits and consumers need for payment instruments that are more secure, efficient and convenient. If consumers are satisfied with existing payment instruments, they do not look for new ones. Innovations emerging recently on the retail payment market could change the existing payment landscape.

Poland is among the countries experiencing fast development of payment innovations, but rather incremental, like contactless cards. In spite of this, the research findings show that Polish consumers still prefer traditional payment instruments like credit transfer, debit and credit cards or cash, which meet to a large extent their expectations in terms of speed, cost and convenience. According to the majority of responders, innovative payment methods are the most serious competition for cash payments. Over half of them declare to be ready to start using innovative instruments against cash immediately or under some conditions (especially safety improvement) in the nearest future. But we identified a significant gap between consumers' declarations

and practice with reference to innovative payment instruments/methods. Generally the results of research confirm that Polish consumers can identify innovative payment instruments and declare the willingness to use them but only very few of them actually do. Basing on the results of our research we can assume that innovative payment instruments/methods could not reduce significantly the cash usage in Poland in the nearest years.

Our study has focused on the adoption of retail payment from the consumer point of view. As the results of this research indicate, payment habits could be a significant barrier to payment innovations diffusion and development. They might be hard to overcome as they are the result of certain behaviors and attitudes rooted in people's daily experience. These habits run deep and they are sustained despite the costs associated with using cash. Customers are slow to change their payment habits and need several clear incentives in order to do so. On the other hand, consumer expectations and habits are becoming more homogenized. According to many customer survey findings, they will react to price differences.

It can be further implied that there is a need for banking institutions and policy makers to re-orient their existing market policy, in order to enhance and empower customers on the various benefits of retail payment instruments/methods. The following actions could be undertaken:

- promoting non-cash instruments/methods, especially Internet and mobile payments, and the benefits of using them as speed, low cost and convenience,
- developing safety of the innovative payment instruments usage,
- setting the common standards and regulations concerning modern, innovative payment instruments/methods in Poland and all over Europe

Customers education and the involvement in the development of payment services will also be critical to payment innovations adoption. The results also imply that before the launch of a new retail payment instrument/method, payment services providers should take into account not only the willingness of consumers to use them, but also the level of their satisfaction with the existing payment means.

5 Limitations of the research

The presented survey has analyzed the role of habits in the process of developing and adopting new retail payment methods and instruments on the Polish market. There are some limitations of the findings presented in this paper, notably due to the sample concentration on one country and taking into account only the customers' perspective. Further research could also take into account the perspective of banking executives, providers and business customers.

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R&D Cooperation with External Partners and Implementing Open Innovation

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Abstract. This paper addresses the role of R&D cooperation with external partners in companies implementing inbound and outbound open innovation. The results of the survey of 206 companies show that the cooperation with external partners is different in companies implementing inbound, outbound, and coupled open innovation compared to closed companies oriented towards internal R&D. Increased importance, success, and intensity of cooperation with external partners are observed for companies with internal R&D and inbound, outbound, and coupled open innovation compared to other firms. The more a company implements open innovation, the higher the intensity, importance, and success of cooperation with external partners are. The importance and success of cooperation with domestic partners is higher than for cooperation with foreign partners for all types of companies.

Keywords: R&D, open innovation, innovation strategy, cooperation, external partners, Russia.

1 Introduction

The role of cooperation in research and development (R&D) in the global and turbulent business environment cannot be underestimated. Companies build links and cooperate in R&D with their stakeholders, such as customers, suppliers, competitors, and public institutions (Enkel and Gassmann, 2008, Smirnova et al., 2009). Many studies show that external links and cooperation increase a company's innovation capability and have a positive effect on innovation output (Bayona et al., 2001; Kaufmann and Tödtling 2001; Klomp and van Leeuwen, 2001; Hagedoorn, 2002; Loof and Heshmati, 2002; Romijn and Albaladejo, 2002; Belderbos et al. 2004; Vivero, 2004; Veugelers and Cassiman, 2005; Lundvall et al., 2002). Better cooperation skills increase companies' innovativeness, and ability to utilize external knowledge, which results in better innovation performance (Cohen and Levinthal, 1990).

The role of the collaborative approach to innovation has significantly increased in the open innovation era (Enkel et al., 2010), resulting in the growing importance of innovation networks (Dittrich and Duysters, 2007; Chesbrough and Prencipe, 2008, Torkkeli et al., 2008). However, the open innovation framework still lacks empirical

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evidence of what the best way is to utilize this concept (Enkel et al, 2010) and how important cooperation with external partners is within this framework.

This paper addresses R&D cooperation within the open innovation framework. The authors apply the classification proposed by Gassman and Enkel (2004), to define three core processes within the open innovation framework: 1) the outside-in process (inbound open innovation) – searching for and incorporating the external knowledge of suppliers, customers, competitors, universities, and research organizations; 2) the inside–out process (outbound open innovation) – transferring the surplus ideas, technologies, and intellectual property to the market; 3) coupled open innovation – a combination of the outside-in and inside-out processes.

This paper studies the role of R&D cooperation with external stakeholders when implementing open innovation in practice. The focus is on the type, importance, and success of R&D cooperation. The main research question is *"Is there a difference in the external R&D cooperation in companies implementing and not implementing open innovation?"* and is followed by these sub-questions:

1. *How are the intensity and success of external R&D cooperation different for companies without open innovation and for companies implementing inbound, outbound, or coupled open innovation?*
2. *What is role of the different types of cooperating partners for inbound, outbound, and coupled open innovation?*
3. *Is there a difference in cooperation with various types of domestic and foreign partners?*

The authors suggest that the differences in companies' intensity and success of cooperation in R&D mainly come from the differences in the degree of innovation strategy openness (adopting none, inbound, outbound, or coupled open innovation) and the proximity of the partner (local or international).

The paper is structured as follows: part 1 introduces the research topic and sets the research questions. Part 2 reviews the literature on open innovation and R&D cooperation and formulates the hypotheses. Part 3 describes the research design, data collection process, and measurement. Part 4 presents key results of the study, part 5 discusses the results, and part 6 concludes.

2 Cooperation in R&D and Implementing Open Innovation

2.1 From a Traditional to an Open Approach to Innovation

Previously, companies had to control all stages of the innovation process themselves and thus most of the R&D was conducted internally (in-house R&D) (Wheelwright and Clark, 1992). Not only R&D, but new product development (NPD), technology innovations, and the commercialization of new products and technologies were conducted within the company. This approach is nowadays referred as the *traditional or closed approach* to innovations.

Since the beginning of the 1990s, the world economy has entered new era, when uncertainty and the globalization process have intensified, and market and

environmental turbulence have increased (Kotler and Caslione, 2009), thus companies have faced higher risks and have become more exposed to domestic and international competition. Due to the degree of turbulence, increased competition, and newly emerged technology opportunities, companies have intensified the use of knowledge, both internal and external (Cohen and Levinthal, 1990; Klevorick et al., 1995).

It has become obvious that the traditional approach to innovation and R&D does not fit this changed environment. Thus, companies have started a transition towards a new, more *open approach to innovations*.

When Chesbrough (2003) launched the term "open innovation", it was a very appropriate time to describe the latest transformation processes in the field of innovations. Nowadays, the open approach has become essential for many companies' innovation practices in terms of an organized search for new ideas (Laursen and Salter, 2006), achieving better use of their internal R&D, and more effective commercialization, combined with decreasing costs and reducing the time to the market (Christensen, 1997).

Chesbrough (2003) introduced several factors that influenced the beginning of the open innovation era: 1) access to the best available knowledge sources, improved both inside and outside the company because of the increase in the educated labor force available; 2) an increased number of possible sources of financing for R&D projects; 3) companies started to cooperate more, search for ideas and technology outside, and incorporate them into innovation policy.

As mentioned in the introduction, open innovation can be classifies into an outside-in process (inbound), an inside–out process (outbound), and coupled open innovation – a combination of the outside-in and inside-out processes (Gassman and Enkel, 2004). In their later work, Enkel and coauthors (2010) also raise a question of finding the optimal ratio between introducing open innovation practices and investing in traditional innovations (Enkel et al., 2010).

In this study, we analyze firms with a traditional approach to innovation, utilizing the assumptions of Cohen and Levinthal (1990), Wheelwright and Clark (1992), and Klevorick et al. (1995), and we group firms with an open approach to innovation following the Gassman and Enkel (2004) classification of the open innovation process.

2.2 R&D Cooperation and Internal R&D

There have been multiple studies on a collaborative approach to innovations (Freytag, 2002; Andrew et Al., 2006; Blomqvist and Levy, 2006, Miles et al., 2004; Johnsen and Ford, 2000; Ford and Johnsen, 2001, Hakansson and Eriksson, 1993). Collaborative innovations are an addition to companies' in-house R&D and outsourcing (Baglieri and Zamboni, 2005) and create additional value within the partner relationship (Walter et Al., 2001, Smith and Blanck, 2002).

The motives for R&D cooperation depend on the type of partner (Tether, 2002, Belderbos et al., 2004). Some firms cooperate in order to extend their internal R&D expertise (Cassiman and Veugelers, 2002), others because of a lack or not of sufficient internal R&D (Keupp and Gassmann, 2009).

Cooperation in R&D may occur on different levels: strategic (partner selection and management), executive (teams and processes), or infrastructural level (Deck and Strom, 2002).

Independent from the level of cooperation, firms need to develop specific organizational competencies and *cooperation capabilities* to develop and manage partnership (Dyer and Singh, 1998), and integrate skills and tacit knowledge with external partners. Companies with a greater cooperation capability can have access to a larger range of technologies and can better manage their R&D resources (Torkkeli et al., 2009).

The intensified cooperation in innovations in the last decades indicates the lack of companies' internal resources and capabilities to satisfy the need for innovations and R&D (Hagedoorn, 2002; De Propris, 2002). As we do not have enough theoretical and empirical evidence on R&D cooperation of companies without internal R&D expertise (a form of outsourcing), and rely on evidence of Baglieri and Zamboni (2005) and Cassiman and Veugelers (2002) mentioned earlier, we assume that companies with internal R&D will cooperate with external partners on R&D more intensively then companies without their own R&D. More than that, we expect to get empirical proof that companies with internal R&D value their partners more and that R&D cooperation for these firms is more successful than for firms without R&D. Thus, our first hypothesis can be formulated as follow:

> *Hypothesis 1: Companies with internal R&D expertise will cooperate with external partners on R&D more intensively and more successfully than companies without internal R&D. Moreover, the external cooperation will be more important for firms with internal R&D than for those without.*

2.3 R&D Cooperation with External Partners

Companies can cooperate on R&D with different partners: suppliers (Hakansson and Eriksson, 1993), competitors (Clark and Fujimoto, 1991), customers (von Hippel, 1988), and research organizations (Gemünden et al., 1996). It is believed that the key sources for cooperative innovations are often lead users, suppliers, or universities (von Hippel, 1988). Companies can also use various channels (suppliers, users, universities) when they search for innovation opportunities (Laursen and Salter, 2006).

The issue of partner selection has been addressed in previous studies, such as the framework for predicting the efficiency of R&D cooperation with different partners proposed by Miotti and Sachwald (2003); or the effect of technology level in partner selection found by Faria et al. (2010).

For cooperative companies, external partners can be classified as core and fringe (additional) (Hart and Sharma, 2004), vertically forward or vertically backward, and horizontal or diagonal (von der Heidt, 2008). The role of core and fringe partners will be quite different for cooperating companies (Hart and Sharma, 2004), obviously core partners will contribute more to R&D, and cooperation with them will be more successful. Following this logic, our second hypothesis is formulated:

Hypothesis 2: The range of core partners and intensity of cooperation will be different for companies with internal R&D only compared to companies with a more diversified innovation strategy such as open innovation.

Companies can cooperate on R&D domestically or with foreign partners. Some studies underline the difference in R&D cooperation with foreign partners (Faria and Schmidt, 2007), when the attitude to knowledge sharing is different in different organizational cultures (Boisot, 1986).

In the case of Russia, we found that companies cooperate more easily with domestic partners due to having the same culture and language (Podmetina et al., 2009, Smirnova et al., 2009). Based on our previous research findings, we set our third hypothesis as follow:

Hypothesis 3: Cooperation with external domestic partners will be more intensive, more successful, and more important for companies than cooperation with foreign partners

2.4 R&D Cooperation and Open Innovation

Companies started to cooperate more, search for ideas and technology outside, and incorporate them into innovation policy, which was one of the factors influencing the beginning of the open innovation era (Chesbrough, 2003).

Customer value increases when companies exploit new ideas and develop new products and technologies both themselves (internally) (Wheelwright and Clark, 1992) and in cooperation with partners (suppliers, clients, or competitors) (inter-firm). The cooperation gives an opportunity to access knowledge and technologies and thus increase the innovativeness of the company, and decrease costs and risks (Faria and Schmidt, 2007).

Thus, cooperation is positioned as the cornerstone of the open innovation concept (Chesbrough, 2006), which implies a high degree of cooperation with partners such as other companies in the industry, suppliers, and clients (Chesbrough, 2003). Both the number of cooperative partners and the quality of cooperation matter for the success of introducing the open innovation principles (Kock and Torkkeli, 2008).

Based on our previous studies (Podmetina et al., 2011, Smirnova et al., 2012), Russian companies with internal R&D and R&D cooperation seem to be more eager to expand their innovation strategy for inbound and outbound open innovation. The other results of our previous research (Podmetina et al., 2009, 2011, Smirnova et al., 2009, 2012) also indicated that the role of external partners for the firms following a cooperative R&D and NPD approach is greater – they depend more on "core" stakeholders. At the same time, for the firms basing innovations on their own internal R&D, external partners can still be of vital importance.

Based on the principles of open innovation and our previous research of Russian innovative companies, we formulate the set of hypotheses related to differences in R&D cooperation in companies implementing inbound, outbound, and coupled open innovation (Hypotheses 4, 5, and 6):

Hypothesis 4: Companies with inbound open innovation will cooperate with external partners on R&D more intensively and more successfully than companies with internal R&D. Moreover, the external cooperation will be more important for firms with inbound open innovation than for those without.

Hypothesis 5: Companies with outbound open innovation will cooperate with external partners on R&D more intensively and more successfully than companies with inbound open innovation and companies with internal R&D. Moreover, the external cooperation will be more important for firms with outbound open innovation than for those without.

Hypothesis 6: Companies with coupled open innovation will cooperate with external partners on R&D more intensively and more successfully than other companies. Moreover, the external cooperation will be more important for firms with coupled open innovation than for those without.

3 Research Design

3.1 Sampling Strategy and Data Collection Process

The study is based on a stratified sample of 206 companies, collected in the nine most innovative regions of Russia (Saint Petersburg (29.1%), Nizhny Novgorod (13.6%), Rostov-on Don (9.7%), Saratov (5.3%), Samara (11.2%), Perm (3.9%), Yekaterinburg (14.6%), Novosibirsk (3.4%), and Krasnoyarsk (5.8%)). Top Russian innovative regions were selected by analyzing the data provided by the Russian Statistical Committee using the methodology of the European Innovative Scoreboard (2006). The strata were formed first by selecting only manufacturing companies with an annual turnover of more than 1 000 000 rubles (about 25 000 euros), then by applying a quota by industry – the share of companies from each industry is equivalent to the shares of these industries in the Russian GDP. Based on this sampling strategy, 1000 companies were pre-selected in the SPARK Russian Business Database. The response rate was about 20%, which provided us with 206 valid filled questionnaires.

The data collection method was personal structured interviews, due to the specific aims and the scale of the study. Interviews lasted from 2 to 4 hours. In Saint Petersburg and its region, the authors conducted the interviews, but in more distant regions, interviewing was outsourced to a professional statistics organization. In these cases, the authors conducted the selective control of the interview process and validation of the paper versions of the questionnaires by comparing them with the electronic ones.

The respondents were directors at different levels, leaders of R&D or innovation departments, and sometimes, sales and marketing directors. Due to the complexity of the questionnaire, it was sometimes necessary to interview several decision-makers in

the company, in order to increase the quality and reliability of the data. The empirical study was conducted during November 2009 – February 2010.

3.2 Questionnaire and Operationalization of Variables

This survey was done for a large-scale international project studying innovations in Russia. The structured questionnaire used for this survey was based on the OECD recommendations for conducting innovation surveys (Oslo manual, 2007) and the Community Innovation Survey (CIS) questionnaire. The questionnaire consisted of more than 100 questions, covering major aspects of the company's R&D, innovations, strategy, finances, cooperation, competition, international business, and so on. The scale of the survey is large, and this paper presents only small part of the research results.

The type of the questions used in this study was mainly dichotomous or a Likert scale from 1 to 5. We use variables related to cooperation on R&D with external partners: intensity of involvement, importance of cooperation, and success of cooperation (scales adopted from CIS Questionnaire, 2008). Importance and success of cooperation were tested only by respondents' answers. Success of cooperation means if companies perceive more efficient or less efficient cooperation with a certain partner.

The open innovation variables for representation of descriptive statistics and mean differences across opened and closed firms was operationalized as a dichotomous question of whether a company implemented or not inbound, outbound, and coupled open innovation (classification of Gassman and Enkel, 2004). The operationalization of the variables, questions, and sources of the scales are presented in Table 1.

3.3 Methodology of the Analysis

This study is an exploratory one aimed at analyzing the difference in cooperation with different external partners between closed and open companies. The size of the sample (N=206) increased the exploratory nature of the study. Due to the exploratory nature of the study, we use descriptive statistics and means analysis (Anova, T-Test). The sigma value is used in defining the significant difference ($p<0.05$).

3.4 Description of the Companies in the Sample

The data sample represented the high and medium technology companies: electronics and optics equipment (11.2%), electronic equipment (7.3%), rubber and plastic industry (3.9%), machine building (13.6%), chemical industry (10.2%), aviation (3.9%), IT and telecommunications (10.2%), metallurgy (17.5%), and others (16 %).

The share of companies conducting internal R&D was high: 78.6%. 100% of IT companies had internal R&D, 93.3% of electrical machinery firms, 91.3% in the electrical and optic industry, 87.5% in the rubber and plastic industry, 86.1% in metallurgy, 75% in aviation and in machinery and equipment, and 72.7% in the oil refinery industry. 86.4% of firms in the sample are new private companies found since 1991. The Soviet Union was dissolved in 1991 and the governmental companies' privatization process started.

Table 1. Operationalization of variables

Variables	Question	Description and Measurement
Internal R&D	Is your company implementing internal R&D?	A dichotomous question was used to measure whether the company conducts internal R&D. The scale was adopted from a CIS questionnaire (2008).
Inbound open innovation (InOI)	Does your company acquire external technologies, innovations, intellectual property, or patents? - no, sometimes, often	Constructed dichotomous variable. Dichotomous answers: "No" - not acquiring external technologies, "Yes" - acquiring sometimes, and acquiring often. Scale developed and validated in our previous survey in 2006 (Podmetina et al., 2009).
Outbound open innovation (OutOI)	Does your company sell the surplus of internally produced technologies, innovations, intellectual property, or patents? - no, sometimes, often	Constructed dichotomous variable. Dichotomous answers: "No" - not acquiring external technologies, "Yes" - acquiring sometimes, and acquiring often. Scale developed and validated in our previous survey in 2006 (Podmetina et al., 2009).
Coupled open innovation (COI)	Companies who implement both inbound and outbound open innovation.	Constructed dichotomous variable. Dichotomous answers: "No" – not implementing inbound and outbound open innovation, "Yes" - implementing inbound and outbound open innovation.
Involvement of external partners in the R&D process. List of partners*:	What external partners are involved in R&D processes? Dichotomous question for each type of partner.	A dichotomous question was used t o find out whether external partners were involved in the R&D process. The scale was adopted from CIS Questionnaire (2008).
Importance of R&D cooperation with external partners List of partners as before	How important is their participation for the success of R&D and innovations? 1 – less important, 5 – more important	The importance of cooperation with the external partners was estimated using a 5-point Likert scale from not important to absolutely important. The scale was adopted from CIS Questionnaire (2008).
Success of R&D cooperation with external partners List of partners: as before	How efficient is their involvement? 1 – inefficient, 5 – very efficient	Success of cooperation with the external partners was estimated using a 5-point Likert scale from inefficient to very efficient. The scale was adopted from CIS Questionnaire (2008).

** Suppliers in Russia, Suppliers abroad, Clients in Russia, Clients abroad, R&D partners, Intermediaries in Russia, Intermediaries abroad, Stakeholders, Competitors in Russia, Competitors abroad, Consultants, External commercial R&D organizations, State R&D centers, Universities, Partners in JVs, Other partners not included in the list.*

Companies are considered new in Russia if they were established after 1991. 12.6% are privatized companies and 1% are state companies. The average age of companies in the sample is 27 years, while the year of foundation varies from 1720 till 2009.

The companies in the sample are rather large: 10.2% have more than 3000 employees, 13.2% have from 1000 to 3000, 21% have from 500 to 1000, 11.7% have from 100 to 500, and 27.3% have from 100 to 250 employees. The share of companies with fewer than 100 employees is only 16.7%.

Out of the 206 companies in the sample, 1.9% assessed their economic situation as "near bankruptcy", 10.7% as "bad", 53.4 % as "satisfactory", 28.6% as "good", and only 3.9 % as "excellent".

The R&D intensity (ratio of R&D expenditure to company sales) was between 1.5 and 3.0% for 38% of companies. This corresponds to an average level of R&D intensity for most of the high and medium tech industries in EU countries. The R&D intensity ratio was lower than 1.5% in 20.7% of the companies. A rate of 3% to 10% was registered in 24.5% of companies, and the remaining 13.6% of companies had an R&D intensity higher than 10%.

4 Key Findings

4.1 Involvement of External Partners in the R&D Process

Our respondents in Russia indicated that innovative firms quite intensively involve external partners (consumers, suppliers, intermediaries, research organizations, and others) into the R&D process (29% on average, Table 3). Companies cooperate more intensively with external partners in product and service modification, technology modification, and in mutual NPD and technology development, than in technology acquisition, and organizational and marketing innovations (Figure 1).

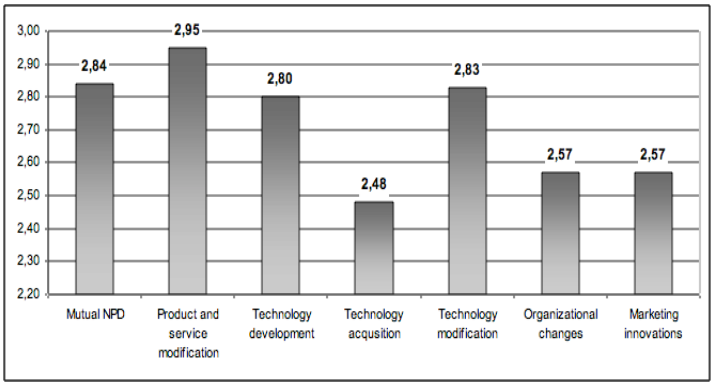

Fig. 1 Involvement of external partners in the R&D process (Likert scale 1 to 5)

Analysis of the involvement of external partners at the different stages of the R&D process (Figure 2) shows that companies cooperate more intensively with external partners in testing prototypes of the product or market testing, and launching the product, than in idea generation, product design, or the engineering stage.

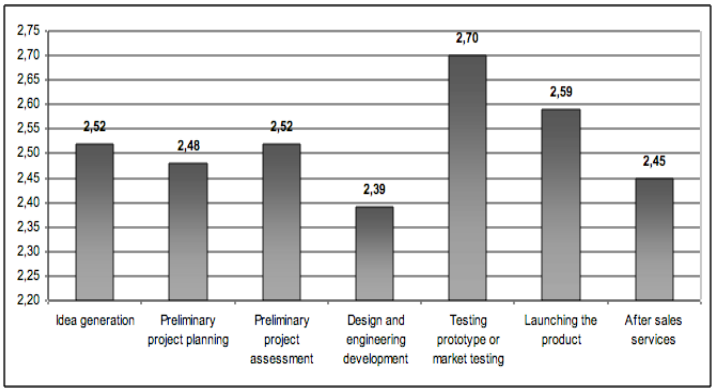

Fig. 2 Involvement of external partners in the different stages of the R&D process

The effect of cooperation can also be negative on the innovations of the companies in the sample. The role of external partners in the implementation of the innovation is shown in Figure 3, where the companies were asked to estimate the pressure from the different external partners on their innovations (Likert scale from 1 to 5).

The highest pressure that companies feel is from the Russian competitors and consumers, as well as from the state quality control and foreign competitors located in Russia. The pressure from the supplier's side (both local and foreign) is significantly lower.

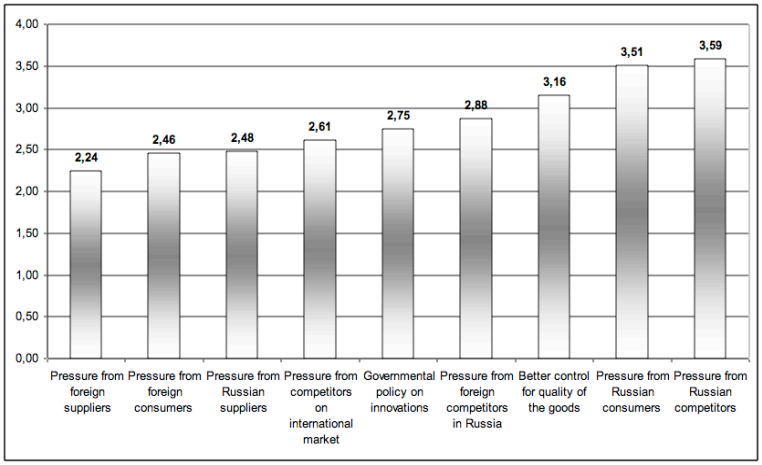

Fig.3 The influencing factors of innovations implementation

4.2 Open Innovation Framework of Russian Companies

In order to test the hypotheses, data were analyzed, separating and comparing the groups of companies as Gassman and Enkel (2004) suggested and testing the involvement of different external partners in the R&D process, the importance of their

cooperation, and the success of cooperation. In Table 2, the distribution of companies in these groups is presented.

Table 2. Open Innovation Framework for Russian Companies

Innovation Strategy	*N*	*Share, %*
	Internal R&D	
IntR&D*	162	78.6
No IntR&D	44	21.4
	Inbound Open Innovation	
InOI	64	31.1
No InOI	142	69.9
	Outbound Open Innovation	
OutOI	27	13.1
No OutOI	179	86.9
	Coupled Open Innovation	
COI and IntR&D	14	6.8
No COI	192	93.2

** Here and in the next tables: IntR&D – Internal R&D, InOI – Inbound open innovation, OutOI – Outbound open innovation, COI – Coupled open innovation*

The share of companies implementing internal R&D is high in the sample – 78.6% (Table 2). The share of companies that launched new or significantly modified products (services, concepts of products/services) was 89.3%.

The share is significantly higher than that found in other studies about NPD in Russia - 38.8% of companies with NPD (Dynkin and Ivanova, 1998) and 59% in the work of Kadochnikov (2004). 80.6% of companies in the sample implemented new or significantly improved technologies or production processes in the analyzed period. The products were developed mostly by the company itself (65.5%). 36.1% of companies developed new products (services) in cooperation with external partners.

31.1% of companies in the sample acquire external technology (inbound open innovation), and 13.1% of companies commercialize the surplus of their innovations to the market (outbound open innovation). A combination of the inbound and outbound open innovation (OI) was observed only in 6.8% of companies.

Companies implementing OI are medium to large size: more than 100 employees in 84.4% of companies with inbound OI, 92.3% of companies with outbound OI, and 94.1% of companies with coupled OI. Due to the fact that these companies are large and typical for Russian companies, and that large companies are older industrial giants, the average age of companies with inbound OI is 38 years, for outbound OI it is 34 years, and for coupled OI it is 39 years.

Companies implementing inbound OI are mostly operating in the electrical and optical, machinery and equipment, chemical, oil refinery and metallurgical industries. Companies with outbound OI are mostly in the metallurgical, machinery and equipment, aircraft, electrical and optical, and telecommunication industries. Firms with coupled OI operate in the metallurgical, telecommunication, machinery and equipment, and aircraft industries.

4.3 R&D Cooperation with External Partners

The analysis of the shares of companies involving external partners in cooperation among companies with internal R&D, and inbound, outbound, and coupled open innovation (Table 3) reveals a trend that companies implementing open innovation have, on average, a higher share of partners involved in the innovation activities.

Only 29% of companies with internal R&D cooperate with external partners in the R&D process, compared to inbound (36.2%), outbound (44%), and coupled (57.6%) open innovation. The intensity of cooperation with external partners increases for each type of partner for companies' open innovation.

Table 3. Intensity of involvement of external partners, %

Type of partner	Open Innovation Framework			
	IntR&D*	InOI*	OutOI*	COI*
Suppliers in Russia	**50.0**	**59.4**	**70.4**	**85.7**
Suppliers abroad	22.2	32.8	40.7	57.1
Clients in Russia	**55.6**	**45.3**	**59.3**	57.1
Clients abroad	23.5	28.1	33.3	42.9
R&D partners	**52.5**	**62.5**	**63.0**	**85.7**
Intermediaries in Russia	27.8	34.4	37.0	57.1
Intermediaries abroad	14.8	20.3	37.0	50.0
Stakeholders	24.7	34.4	44.4	50.0
Competitors in Russia	13.6	17.2	22.2	28.6
Competitors abroad	7.4	15.6	18.5	28.6
Consultants	**42.0**	**48.4**	**59.3**	**71.4**
External commercial R&D organizations	28.4	39.1	44.4	**64.3**
State R&D centers	**33.3**	**40.6**	**48.1**	**71.4**
Universities	28.4	32.8	37.0	42.9
Partners in JVs	27.8	**40.6**	44.4	**64.3**
Other partners	20.4	28.1	44.4	**64.3**
Mean	*29.5*	*36.2*	*44.0*	*57.6*

** Here and in the next tables: IntR&D – Internal R&D, InOI – Inbound open innovation, OutOI – Outbound open innovation, COI – Coupled open innovation*

4.4 External R&D Cooperation in Companies with Internal R&D

The analysis of the means of importance and success of cooperation with external partners shows higher numbers for companies with internal R&D compared to those who do not conduct R&D internally (Table 4).

The statement is valid for all types of external partners. However, a statistically significant difference is observed for the importance of cooperation with R&D partners, and for success of cooperation with domestic suppliers, clients, partners in joint ventures (JV), and R&D partners.

Hence, we can observe that the means of both importance and success of cooperation with domestic partners (suppliers, clients, intermediaries, and competitors) are higher than with foreign partners. It is valid both for companies with internal R&D and for those without.

Table 4. Cooperation with external partners for companies with internal R&D

Type of partner	%**	Importance of collaboration				Success of collaboration			
		Whole sample	IntR&D	No int R&D	T-test	Whole sample	IntR&D	No int R&D	T-test
		Mean	Mean	Mean	Sig	Mean	Mean	Mean	Sig
Suppliers in Russia	50.0	3.9	4.0	3.6	0.194	4.0	4.1	3.5	**0.049***
Suppliers abroad	22.2	3.8	3.9	3.0	0.078	3.8	3.9	3.4	0.356
Clients in Russia	55.6	4.2	4.3	3.8	0.054	4.1	4.2	3.6	**0.017***
Clients abroad	23.5	3.9	4.0	3.1	0.101	3.7	3.8	3.1	0.256
R&D partners	52.5	4.3	4.4	3.4	**0.000***	4.2	4.4	3.2	**0.000***
Intermediaries in Russia	27.8	4.0	3.9	4.1	0.676	3.7	3.7	3.8	0.776
Intermediaries abroad	14.8	3.7	3.8	3.1	0.233	3.4	3.5	3.1	0.576
Stakeholders	24.7	3.9	4.0	3.7	0.448	3.9	4.0	3.5	0.364
Competitors in Russia	13.6	3.6	3.5	3.7	0.683	3.3	3.3	3.4	0.747
Competitors abroad	7.4	3.2	3.2	3.2	0.975	2.8	2.8	3.0	0.820
Consultants	42.0	3.9	4.0	3.7	0.264	3.7	3.8	3.6	0.503
External commercial R&D organizations	28.4	3.9	4.0	3.7	0.507	3.8	3.9	3.3	0.141
State R&D centers	33.3	4.0	4.1	3.8	0.541	3.8	3.9	3.7	0.451
Universities	28.4	3.9	3.9	3.7	0.429	3.6	3.7	3.5	0.611
Partners in JVs	27.8	3.9	4.0	3.4	0.188	3.9	4.1	2.9	**0.007***
Other partners	20.4	3.8	3.8	3.2	0.244	3.8	3.9	3.2	0.277
Mean	*29.5*	*3.9*	*3.9*	*3.5*		*3.7*	*3.8*	*3.4*	

**Sig at p<0.05;*
*** % means the share of companies involving this type of partner among companies with internal R&D; IntR&D – results for companies with internal R&D; No Int R&D – results for companies without internal R&D; T-test - T-test for differences in means between firms with and without internal R&D.*

4.5 External R&D Cooperation in Companies with Inbound Open Innovation

The analysis of the means of importance and success of cooperation with external partners shows higher numbers for companies with inbound open innovation compared to those without (Table 5). The statement is valid for all types of external partners, except for clients in Russia, when importance is on the same level.

However, a statistically significant difference is observed for the importance of cooperation with consultants and external commercial R&D organizations, and for success of cooperation with external commercial R&D organizations and partners in joint ventures (JV).

Hence, we can observe that the means of both importance and success of cooperation with domestic partners (suppliers, clients, intermediaries and competitors) are higher than with foreign partners. It is valid both for companies with inbound OI and for those without.

4.6 External R&D Cooperation in Companies with Outbound Open Innovation

Next, we analyzed the means of importance and success of cooperation with external partners in companies with outbound open innovation compared to those without (Table 6). The results reveal no differences between the groups of firms in perceived importance and success of cooperation with external partners.

Table 5. Cooperation with external partners for companies with inbound open innovation

Type of partner	%**	Importance of collaboration				Success of collaboration			
		Whole sample	InOI	No InOI	T-test	Whole sample	InOI	No InOI	T-test
		Mean	Mean	Mean	Sig	Mean	Mean	Mean	Sig
Suppliers in Russia	59.4	3.9	4.2	3.7	0.058	4.0	4.2	3.9	0.236
Suppliers abroad	32.8	3.8	3.9	3.6	0.505	3.8	3.7	3.9	0.668
Clients in Russia	45.3	4.2	4.2	4.2	0.731	4.1	4.0	4.1	0.703
Clients abroad	28.1	3.9	4.0	3.8	0.648	3.7	3.5	3.9	0.321
R&D partners	62.5	4.3	4.5	4.1	0.072	4.2	4.4	4.1	0.132
Intermediaries in Russia	34.4	4.0	4.1	3.9	0.482	3.7	3.9	3.5	0.167
Intermediaries abroad	20.3	3.7	3.9	3.6	0.448	3.4	3.5	3.3	0.584
Stakeholders	34.4	3.9	4.3	3.6	0.071	3.9	4.3	3.5	0.073
Competitors in Russia	17.2	3.6	3.6	3.5	0.825	3.3	3.4	3.3	0.780
Competitors abroad	15.6	3.2	3.4	2.7	0.249	2.8	3.1	2.3	0.199
Consultants	48.4	3.9	4.2	3.8	**0.046**	3.7	4.0	3.6	0.145
External commercial R&D organizations	39.1	3.9	4.3	3.6	**0.036**	3.8	4.3	3.5	**0.011**
State R&D centers	40.6	4.0	4.2	3.9	0.376	3.8	4.1	3.7	0.219
Universities	32.8	3.9	4.0	3.8	0.411	3.6	3.9	3.5	0.258
Partners in JVs	40.6	3.9	4.1	3.7	0.168	3.9	4.3	3.4	**0.012**
Other partners	28.1	3.8	4.2	3.3	0.053	3.8	4.1	3.5	0.201
Mean	36.2	3.9	4.1	3.7		3.7	3.9	3.6	

**Sig at p<0.05; ** % means the share of companies involving this type of partner among companies with InOI; InOI – results for companies with InOI; No InOI– results for companies without InOI; T-test - T-test for differences in means between firms with and without InOI.*

Table 6. Cooperation with external partners for companies with outbound open innovation

Type of partner	%**	Importance of collaboration				Success of collaboration			
		Whole sample	OutOI	No OutOI	T-test	Whole sample	OutOI	No OutOI	T-test
		Mean	Mean	Mean	Sig	Mean	Mean	Mean	Sig
Suppliers in Russia	70.4	3.9	4.1	4.0	.480	4.0	4.0	4.0	.926
Suppliers abroad	40.7	3.8	3.7	3.8	.924	3.8	3.7	3.8	.664
Clients in Russia	59.3	4.2	4.4	4.2	.494	4.1	4.3	4.0	.378
Clients abroad	33.3	3.9	3.9	3.9	.947	3.7	3.7	3.7	.908
R&D partners	63.0	4.3	4.1	4.3	.412	4.2	3.9	4.2	.234
Intermediaries in Russia	37.0	4.0	3.9	3.9	.942	3.7	4.0	3.6	.313
Intermediaries abroad	37.0	3.7	3.8	3.7	.824	3.4	3.6	3.3	.564
Stakeholders	44.4	3.9	3.9	3.9	.838	3.9	3.8	3.9	.727
Competitors in Russia	22.2	3.6	3.4	3.6	.640	3.3	3.3	3.3	.845
Competitors abroad	18.5	3.2	3.2	3.2	.974	2.8	2.8	2.8	.966
Consultants	59.3	3.9	3.6	4.0	.107	3.7	3.6	3.8	.607
External commercial R&D organizations	44.4	3.9	4.0	3.9	.807	3.8	4.0	3.7	.590
State R&D centers	48.1	4.0	3.7	4.1	.263	3.8	3.6	3.9	.297
Universities	37.0	3.9	3.5	3.9	.251	3.6	3.7	3.6	.986
Partners in JVs	44.4	3.9	3.6	4.0	.217	3.9	3.8	3.9	.930
Other partners	44.4	3.8	3.6	3.8	.711	3.8	3.6	3.8	.615
Mean	*44.0*	*3.9*	*3.8*	*3.9*		*3.7*	*3.7*	*3.7*	

Sig at p<0.05; * % means the share of companies involving this type of partner among companies with OutOI; OutOI– results for companies with OutOI; No OutOI– results for companies without OutOI; T-test - T-test for differences in means between firms with and without OutOI

We can conclude that our Hypothesis 5 was not supported. The highest means, as expected, are obtained for cooperation with clients in Russia, but various forms of cooperation with R&D partners also have relatively high scores.

Hence, we can observe that the means of both importance and success of cooperation with domestic partners (suppliers, clients, intermediaries, and competitors) are higher than with foreign partners. It is valid both for companies with outbound OI and for those without. Then we can also mention the additional support for Hypothesis 3 on cooperation with domestic and foreign partners, in the case of companies with outbound OI.

4.7 External R&D Cooperation in Companies with Coupled Open Innovation

Finally, we analyze companies who implement the full scope of open innovation: inbound and outbound. The analysis of the means of importance and success of cooperation with external partners shows higher numbers for companies with coupled open innovation compared to those without (Table 7). For this overall assumption on the role of combining the elements of the open innovation strategy when shaping the company's cooperation with external stakeholders, no strong evidence was found to support it. In fact, the results confirm a statistically significant difference between firms with COI and without COI – in the case of cooperation with external commercial R&D organizations, the overall trend identifies higher scores both for importance and perceived success of cooperation by firms implementing COI.

Table 7. Cooperation with external partners for companies with coupled open innovation

Type of partner	%**	Importance of collaboration				Success of collaboration			
		Whole sample	COI	No COI	T-test	Whole sample	COI	No COI	T-test
		Mean	Mean	Mean	Sig	Mean	Mean	Mean	Sig
Suppliers in Russia	85.7	3.9	4.7	3.9	0.075	4.0	4.3	3.9	.285
Suppliers abroad	57.1	3.8	4.0	3.7	0.552	3.8	3.8	3.8	.846
Clients in Russia	57.1	4.2	4.6	4.2	0.301	4.1	4.4	4.0	.347
Clients abroad	42.9	3.9	4.3	3.8	0.421	3.7	3.7	3.7	.991
R&D partners	85.7	4.3	4.5	4.3	0.516	4.2	4.5	4.1	.300
Intermediaries in Russia	57.1	4.0	4.2	3.9	0.487	3.7	4.3	3.6	.083
Intermediaries abroad	50.0	3.7	4.2	3.6	0.221	3.4	4.0	3.2	.150
Stakeholders	50.0	3.9	4.4	3.8	0.308	3.9	4.7	3.8	.115
Competitors in Russia	28.6	3.6	3.5	3.6	0.862	3.3	3.3	3.3	.905
Competitors abroad	28.6	3.2	3.5	3.1	0.515	2.8	3.1	2.7	.542
Consultants	71.4	3.9	4.1	3.9	0.585	3.7	4.2	3.7	.192
External commercial R&D organizations	64.3	3.9	4.7	3.8	**0.033**	3.8	4.7	3.7	**.019**
State R&D centers	71.4	4.0	4.3	3.9	0.424	3.8	4.0	3.8	.758
Universities	42.9	3.9	4.3	3.8	0.331	3.6	4.4	3.6	.102
Partners in JVs	64.3	3.9	4.0	3.9	0.830	3.9	4.4	3.8	.137
Other partners	64.3	3.8	4.3	3.6	0.133	3.8	4.4	3.6	.222
Mean	*57.6*	*3.9*	*4.2*	*3.8*		*3.7*	*4.1*	*3.6*	

**Sig at p<0.05; ** % means the share of companies involving this type of partner among companies with COI; COI– results for companies with COI; No COI– results for companies without COI; T-test - T-test for differences in means between firms with and without COI*

5 Discussion of the Results

Russia has inherited some specific managerial practices from its Soviet past, which significantly influence companies' cooperative skills and cooperation strategy. Our research addresses the need of Russian firms to move from the orientation towards suppliers to orientation towards clients (Farley & Deshpande, 2005), and to build cooperative capabilities (Johanson, 2007). On the other hand, the developing Russian market provides us with an opportunity to research the emerging innovation strategies in Russian firms in general, and the emerging open innovation phenomena in particular. Russian firms might have specific drivers to firm's openness (Smirnova et al., 2011).

According to the applied open innovation framework (Gassman and Enkel, 2004), we found that 31.1% of companies in the sample acquire external technology (implement inbound open innovation), and 13.1% of companies commercialize the surplus of their innovations to the market (implement outbound open innovation). The combination of the inbound and outbound open innovation (OI) was observed in only 6.8% of companies. In our previous study (Podmetina, et al., 2013), we have already tackled the level of openness of the company both to sourcing and acquisition of external knowledge, and to R&D collaboration with external partners, as well as to internal knowledge exchange in the firm, and can conclude that sometimes the openness of the firm is not that obvious for companies themselves.

The limited number of companies with open innovation and specifically with outbound and coupled open innovation can be explained by the high traditionalism in management in Russia, less flexibility, the industrial composition of the sample, and institutional factors. To add to that fact, the open innovation concept is only starting to spread in Russia, with new workshops and training organized, international projects implemented, and journal articles published.

Our sample represents the innovative companies in Russia. The share of companies that launched new or significantly modified products (services, concepts of products/services) was 89.3%. The share is significantly higher than found in the other studies about NPD in Russia - 38.8% of companies with NPD (Dynkin and Ivanova, 1998) and 59% in the work of Kadochnikov (2004). Companies with internal R&D cooperate with external partners on R&D more intensively and more successfully than companies without internal R&D; and that external cooperation is more important for firms with internal R&D than for those without.

Thus, considering the limited statistical significance of the number of partners, we can conclude that our *Hypothesis 1* was partially supported. When building external relationships, Russian companies face obstacles such as instability of relationships in the market, low partner information availability, and high risk of opportunistic behavior (Salmi, 2004; Johanson, 2007).

The core R&D cooperation partners are almost the same for companies implementing open innovation and companies relying only on internal R&D: domestic suppliers and clients, R&D partners, consultants, and governmental R&D organizations. Thus, our *Hypothesis 2* got partial support: the range of core partners does not differ for companies with internal R&D and companies implementing open innovation, but the

intensity of cooperation with external partners is much higher for companies with open innovation.

The intensity of cooperation with external domestic partners (suppliers, clients, intermediaries, and competitors) is higher than with foreign partners for all types of companies, with the exception of equal intensity of cooperation with intermediaries in companies with outbound open innovation and cooperation with competitors in companies implementing coupled open innovation. Thus, *Hypothesis 3* was supported for most of the partners in most of the companies with open innovation and without.

We have also observed that the means of both importance and success of cooperation with domestic partners (suppliers, clients, intermediaries, and competitors) are higher than with foreign partners. This is valid for companies with internal R&D, inbound, outbound, and coupled OI, and without. Thus, we can also mention the additional support for Hypothesis 3 on cooperation with domestic and foreign partners in the case of companies with internal R&D, inbound, outbound, and coupled OI.

Companies with inbound OI cooperate with external partners on R&D more intensively and more successfully than companies without inbound OI; and external cooperation is more important for firms with inbound OI than for those without. Thus, considering the limited statistical significance of number of partners, we can conclude that our *Hypothesis 4* was partially supported. There are more cases of differences among groups of firms that could be identified at the level of $p < 0.1$.

Next, we analyzed the means of importance and success of cooperation with external partners in companies with outbound open innovation compared to those without. The results reveal no differences in perceived importance and success of cooperation with external partners between the groups of firms. We can conclude that our *Hypothesis 5* was not supported. The highest means, as expected, were obtained for cooperation with clients in Russia, but various forms of cooperation with R&D partners also have relatively higher scores.

Companies with coupled OI cooperate with external partners on R&D more intensively and more successfully than companies without coupled OI; and external cooperation is more important for firms with coupled OI than for those without. Thus, considering the limited statistical significance of number of partners, we can conclude that our *Hypothesis 6* was partially supported. There are more cases of differences among groups of firms that could be identified at the level of $p < 0.1$.

We can conclude that cooperation has an important role in Russian innovating companies and this role is defined by type of innovation (Smirnova, et al., 2009) and innovation strategy, which in our case is open innovation (Chesbrough, 2006). Our main assumption has been that following at least some of the open innovation strategy elements would have an impact on a company's R&D cooperation with external partners. Summing up the findings, we may conclude that all in all, the results show that firms with open innovation involve external partners more actively.

6 Conclusions

Companies from transitional economies, such as Russia, experience pressure from both global turbulence of the market and from the ongoing transformation process in

the market. Companies need more resources to compete with foreign rivals and need more knowledge to fill the innovation gap caused by the heritage of the centrally planned economy. Developing cooperation skills and increasing innovativeness provides an opportunity for companies to compete successfully on both domestic and international markets.

This study has shown that cooperation with external partners plays an important role when implementing open innovation in practice. The results of the study show that companies with more open innovation strategies tend to indicate higher importance and success of cooperation.

Open innovation theory puts cooperation in a milestone place in the process of implementing open innovation principles in practice. The logic behind this statement is defined by the nature of the externalization process –acting beyond a company's borders at all stages of the innovation process always involves a certain level of cooperation with external partners.

In addition, the effect of partner location was found during data analysis. Companies place more value on cooperation with domestic suppliers than with foreign suppliers. This is explained by the easier transfer of knowledge locally due to proximity, better communication, and cultural similarity.

The study has a number of limitations arising from the data collection in one country and the relatively small sample of companies, which enables us to generalize only for innovative companies in Russia. In addition, we excluded Moscow and the capital region from the data collection process, due to structural differences and the number of outlier indicators from Moscow, as created in our previous study.

The practical results of the study aim to equip managers with knowledge of the importance of analyzing stakeholders and cooperation partners in the process of implementing open innovation. For international society, it is beneficial to know more about the business practices of Russian companies, about which not much is known and which are actively entering international markets nowadays.

The future research in this field we see as deepening the analysis of causalities between the cooperation with different types of partners and success in implementing and benefiting from open innovation in terms of decreasing R&D costs and time-to-market for new products. The interesting aspect is the analysis of a portfolio of cooperation with external partners for companies with different types of open innovation strategies. In general, we see more theoretical and empirical papers on the benefits of open innovation, contributing to viewing open innovation as a theory, not just as a phenomenon.

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Technology Portfolio Dynamics

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Abstract. Innovations are significant source of competitive advantage for firms. They are also a major source of dynamics that forces firms to adapt their capabilities to sustain competitiveness. In this study we analyzed how firms manage their technological portfolio in mobile phone industry. Our first finding is that firms have focused differently their technology portfolios. Then we identified that most firms change their technology portfolio over time. And finally we conclude that firms in mobile phone industry have different levels of dynamics where some firms change their technology portfolio faster than others. This research identifies new challenges in dynamic capabilities research related to the appropriate level of dynamics in technology management. This information is crucial in practice in order to correctly manage the firm's dynamic processes.

Keywords. Technology portfolio, Technology strategy, Dynamic capability, Patent research, Mobile phone industry, Technology management.

1 Introduction

Technology and innovation management have become an integral part of modern businesses as innovations have a significant effect on firm's competitive performance. Despite long research tradition on this topic, many of the concepts in innovation management are still vague and discussion is mostly conceptual. The lack of practical approaches in literature is understandable as technology is inherently challenging to measure. From the management perspective the challenge is to be able to operationalize theories into practice, which usually requires clear measures and targets.

'Dynamic capability' is a central concept in innovation management (Teece et al., 1997). According to this theory, firms need to constantly adapt their capabilities to satisfy the current and also future demands set by their business environment. This theory builds on the ideas of Christensen (1997), who noted that even dominant dynasties could fail if they cannot adapt to the critical technological changes in their business environment. There are many big firms that have failed due to radical change in technology and their inability to correctly react to this change. One of the most recent examples of this is Kodak that failed to adapt to the era of digital photography and eventually filed for bankruptcy. Therefore, the ability to adapt to or even manage change is critical for the sustained competitive advantage of the firm.

In addition to being dynamic, a second implicit factor in firm's technology management is that it needs to adopt correct technologies. Technological development is, by default, very hard to predict. This has been evident e.g. in 'technology standard wars' where predicting the winning technology has proven to be hard. The challenge is materialized in cases where technologically superior products don't necessary become a dominant technology in the market (e.g. VHS vs. Betamax case (Cusumano et al,. 1992)). Therefore firms need to manage technologies in order to cope with the uncertainty related to innovations.

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A common way to manage this uncertainty is to have portfolios of different competing technologies. This enables the firm to have flexibility, as they are not tied to one specific technology. This diversifying can also extend to firms developing technologies outside their traditional domain. The firm's technology portfolio is accumulated over time, meaning that the structure of technology portfolio is based on firms past R&D activities. As technologies and their relative importance change over time it's safe to presume that technology portfolios change over time. A more challenging question is whether the emphasis on different technological classes changes also over time or do firms focus persistently on particular areas.

Despite central role of the dynamic capability theory, there are still relative few studies where the theory has been clearly operationalized (Easterby-Smith et al., 2009). The following challenge is that there are no existing best practices in theoretical discussion for measurement of firm's dynamics. Some conceptual discussion has focused on how different metrics behave, e.g. how does the 'evolutionary fitness' between business environment and capabilities affect the firm's competitiveness (e.g. Helfat et al, 2007; Easterby-Smith et al., 2009) but concrete measurements are missing. The dynamic capability literature does not offer any uniformly agreed measurement techniques.

In this study we provide an interesting way to operationalize this concept. We use patent information to measure firms' dynamics. A patent is an output proxy measure of the firm's R&D. As a measure it is not perfect, as all research projects don't lead to a patent. However, it offers a structured way to measure those technological steps that firms want to protect with legislative means. As such, patenting is likely to be common for those technologies that have significant competitive value. The value of a patent extends over time. Therefore, snapshot like analysis (e.g. per year) is not accurate, but patents need to be pooled together to form patent portfolios. In this study we then see the patent portfolio as an output proxy measurement of the firm's technology portfolio.

In this article, we focus on how firms manage their technology portfolios and how dynamic these technology portfolios really are. The research questions are as follows:

RQ1. Are technology portfolios between different companies in mobile phone manufacturer industry similar?

RQ2. Can firms be grouped based on technology portfolios?

RQ3. Do the firms change the structure of their technology portfolios over time?

RQ4. Do the firms change their technology portfolio structures differently?

The research is conducted in mobile phone industry by implementing a systematic review to each firm's patenting activity during the last 30 years. The phone industry was selected to include different types of companies ranging from phone vendors, operating system developers to technology licensors. In total the study included 13 companies. The selected firms were Alcatel (Alcatel-Lucent), Apple, Google, Ericsson (Sony-Ericsson), HTC, Huawei, LG, Microsoft, Motorola, Nokia, Research In Motion (RIM), Qualcomm, Samsung, ZTE. It is notable that some of these companies have been active in the mobile phone markets longer than others, so 30 years of data was not available for all companies.

The paper is structured so that in the first part we will develop the hypotheses for empirical research part. In third chapter we describe the research methodology and how the research data was developed. In fourth chapter we present the empirical results, which are discussed in chapter five and concluded in the final chapter.

2 Literature review

The RBV defines that all firms have a unique resource base (Barney, 1991; Peteraf, 1993). This uniqueness is built and maintained due to imperfect resource factor markets, which prevents acquirement of resources quickly from external sources (Barney, 1986). The functionality of resource factor market has since been more thoroughly analyzed in open innovation literature (Arora and Nandkumar, 2012). However, the original argument by Barney on resource factor market imperfections cannot be ignored.

The practical implication of imperfect resource factor markets is that it increases the importance of firm's internal innovation activities in building the firm's future resource base. Using the dichotomy of exploration-exploitation by March (1991), the need to accumulate new resources for the future stresses the importance of exploration activities.

The practical outcomes from explorative activities are the different types of new technologies, techniques, or processes that the firm can choose to try to utilize in the future. The common practice is to protect these entities by applying for a patent to claim the advancement. Therefore, patent information can be used as an output proxy of firm's research activities and patent information has been previously used to analyze firms' research activities (e.g. Arora and Nandkumar, 2012). The benefit of patent information is that it is naturally presented in a structured way due to patent regulation, which makes comparison between different firms over a long time period easier when compared to many other ways of measurement.

Therefore, the first hypothesis in our paper focuses on the patent portfolios of companies. If the firms truly have a unique resource base and they have to develop a significant portion of these resources by themselves due to imperfect resource factor markets, it should show in the patenting activities of the companies.

Hypothesis 1. Patent portfolios are different between the firms

The second hypothesis is tied to grouping of firms. The concept of strategic groups was introduced by Hunt (1970). The central argument of the concept is that there are companies in markets that are using similar strategies or business models to compete in the market place. These differences could be used to explain performance differences among firms within that compete in the same industry, but are part of different strategic group (ZuĬnfiiga-Vicente et al., 2004). Thus competition among these subgroups is different than competition in other areas of the market. The concept was further developed by Porter (1979) who identified that these groups actually formed different segments on the market. The strategic implication of this is that if these segments enabled the firm to profit from these markets they could also be protected against competitor entry allowing some degree of sustained competitive advantage within that market.

The aim of strategic grouping is to better understand the profitability differences between firms (Porter, 1979). Additional use scenario for the use of strategic group mapping has also been suggested to be ability to tracking and understanding industry dynamics (Harrigan, 1985). The empirical evidence has shown mixed results for the theory, which has been strongly linked to various different ways to operationalize the central concepts and methodological issues (McNamara et al, 2003). However, more recent studies (Ferguson et al., 2000; Nair and Kotha, 2001) have shown more consistent results. The theory has also been criticized from the fact that studies with a focus on the internal side of the companies, have shown that there are significant performance differences between firms within a single strategic group (e.g. Cool & Schendel, 1988). This line of reasoning led to much criticism against the founding economic theory behind strategic groups (Industrial Organization) and eventually to

the birth of the resource based view (RBV) (e.g. Barney, 1991).

Previous strategic group research has focused strongly on the market side of the firms' activities as research has been based on e.g. degree of vertical integration (Newman, 1978), investments to development (Porter, 1979), pricing policies (Budayan et al., 2009), type of clients (Budayan et al., 2009), financial performance measures (Short et al., 2007), and subjective rating of technical capability (Budayan et al., 2009). We approach this grouping from an internal perspective, as we measure firms' capabilities with higher detail by analysing a wide range of the firms' patents.

So the second hypothesis focuses on analysing the similarities among different firms by trying to group the different firms into strategic groups.

> Hypothesis 2. Firms form strategic groups based on technology portfolio analysis

Recent development steps in strategic management theory have led to development of the dynamic RBV theory (Dierickx and Cool, 1989; Helfat and Peteraf, 2003). The founding argument of this theory is that protecting the firm's unique resource base is not enough to sustain competitive advantage, but firms need to change their capabilities over time (Teece, 2007; Helfat et al., 2007). Likewise, economies of scale and scope or favorable market position (Porter, 1980; 1991) are not sufficient on the long run, where the capability to continuously innovate and renew the competitive foundations of the firm determine success (Teece, 2007). The central concepts behind this theoretical discussion have been the dynamic capabilities (Teece et al., 1997) and later the dynamic RBV (Helfat and Peteraf, 2003).

As defined above, the firm's internal research processes are crucial in defining the firm's (technological) capability base in the future. Continuing on this logic, if the firm wants to change its capability base, or in other words be dynamic, it needs these processes to adapt itself. Therefore, the second hypothesis focuses on the change of firm's patent portfolio over time.

> Hypothesis 3. The firm's patent portfolio emphasis changes over time

The final hypothesis focuses on the nature of change. Organizational adaptation presents managers with contradictory requirements of change and stability thus invoking the change-stability paradox (Klarner and Raisch, 2013). Fast-based change has been argued to be beneficial as it helps overcome organizational inertia by preventing the creation of organizational routines that reinforce current strategic direction (Amburgey and Miner, 1992), induce inertia (Hannan and Freeman, 1984) and give rise to competency traps (Levinthal and March, 1993). Due to these effects, maintaining excess stability in organizational change situations can be detrimental for long-term performance (Burgelman and Grove, 2007). Furthermore, fast-paced change can lead to establishing routines for change also called "metaroutines" (Adler et al., 1999) that lead to higher organizational flexibility and proficiency in managing organizational change and have been connected to higher performance, especially in highly dynamic environments (Brown and Eisenhardt, 1997).

However, excessively fast change can also prove detrimental to organizational performance. Periods of stability are required to allow for learning effects and establishing organizational routines that transform collective experience into performance (Levinthal and March, 1993; Eisenhardt and Martin, 2000). Moreover, fast-paced change may induce information overload for top management, where the capacity of the management to interpret new information on a level that enables making sound decisions is exceeded (Huber, 1991), thus leading to taking suboptimal decisions and formulating ineffective strategic responses (Eisenhardt, 1989). Moreover, attempting to increase the speed of organizational change will invoke time-compression diseconomies (Dierickx and Cool, 1989) leading to diminishing returns

on additional resources allocated to facilitating faster change. Recent research shows that while firms may enjoy short-term benefits by focusing on either change or stability, a balanced approach will yield superior long-term performance (Klarner and Raisch, 2013).

Scholars argue that some firms have better dynamic capabilities than other firms often due to routinizing change processes (Amburgey et al., 1993) and creating procedures for modifying or creating routines efficiently, through constant or continuous change (Brown and Eisenhardt, 1997). This would reflect that some firms are better at changing their capability base than others and that this difference in dynamic capability should be subject to time-compression diseconomies (Dierickx and Cool, 1989) and at least imperfectly (if at all) tradable, as "organizations learn to change only by changing" (Amburgey et al., 1993), thus potentially rendering it visible in the longitudinal data.

The final hypothesis focuses on this issue by assessing the amount of change in firm's patenting activity.

> *Hypothesis 4*. The pace and magnitude of change in the patent portfolio is different between firms

3 Methodology

3.1 Data development

The main data used for research is patent data. In this chapter we will describe how the data was gathered and cleared for research. The overall research process is described in the Figure 1. Table 1 describes how the number of patent data changed as the process progressed.

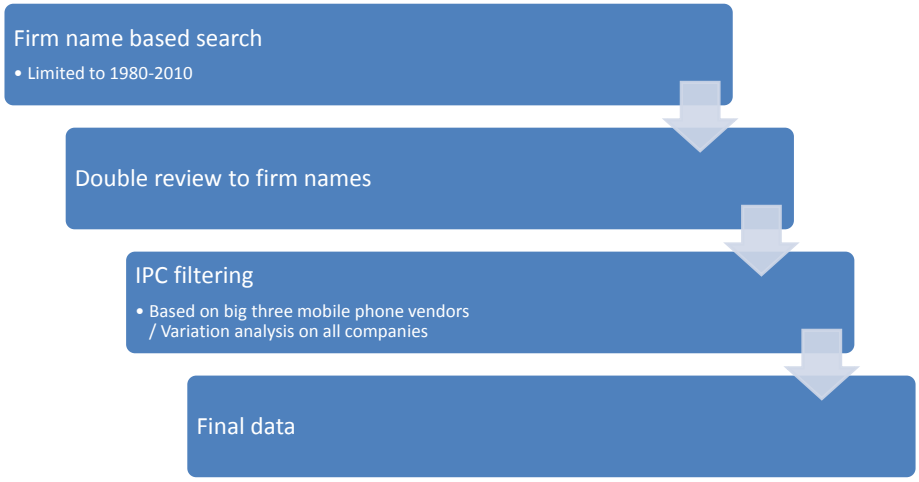

Fig. 1. Data development process

Table 1. Number of patents in different stages of research process.

STAGE	NUMBER OF PATENTS
Initial search result	1, 992, 783
Name filtering	1, 437, 608
IPC filtering	1, 299, 255

The first step in development was data extraction. The patent data was gathered from the PATSTAT database, which is maintained by the EPO (European Patent Office). The database was updated in 2012, which allows the use of reliable data until 2010. The two year delay in usability of the data is caused by the time it takes for a patent to be formally accepted by a patent office. Therefore the data was limited so that the newest patents included for the study where restricted to patents applied before 2011. The beginning time of analysis was restricted to year 1980 that precedes the launch of first commercial mobile phone (Motorola DynaTAC 8000x) by 3 years.

The patents' information was gathered by semantic searched based on the company name. Each company name was directly with wild card symbols both before and after the name. For companies which use both long and short version of their name both writing ways were used to gather data. The search words are presented in Appendix A.

The use of wildcards in semantic searches enables gathering of wide datasets but also inclusion of typos that exist in the dataset. It also creates challenges as many additional patents are included where the names of the company name letters are in same order. To counter this, to exclude extra patents from the dataset each company results were analyzed separately by two researchers. The independently made lists match rate was 98%. The 2% of names were decided based on discussion case by case by the two researchers.

The patents needed to be restricted also from another perspective. As the analysis period is long and many companies included to this study have not been active the years per firms was further restricted based on the amount of yearly patents applied. The limit was set to 50 patents where years with fewer patents were excluded from the analysis.

Another factor that has to be acknowledged is that most of the companies included to this study are conglomerate companies (e.g. Samsung and LG). Therefore, their patent portfolio is much wider and contains many unnecessary patents for making mobile phones. We filter the relevant patents by determining the core patenting classes from the patenting activity of three highly mobile phone manufacturing centric companies (namely Nokia, Ericsson, and Motorola). Each firm's top 30 most used IPC classes were combined as the filter list of central mobile phone patent classes. To avoid the potential time bias, we replicate this procedure twice based on time where first analysis includes years before 2000 and second analysis the data from last 10 years. This additional second round enables that more recent but from total time perspective smaller patent classes are included to study enabling more accurate analysis of recent dynamics. The final IPC class list included to the study is presented at Appendix B.

The final data is described in table 2. The final data describes the firm that is applying, the IPC classes the patent is applied in and finally the date when the patent is applied.

Table 2. Descriptive statistics from data

FIRM	TOTAL	AVERAGE / YEAR	MAX / YEAR
Alcatel-Lucent	141898	4434,31	16352
Apple	14007	437,72	1829
Google	4802	343,00	747
HTC	874	39,73	244
Huawei	61336	3228,21	12621
LG	240660	9626,40	30128
Microsoft	77043	2853,44	13633
Motorola	119614	3737,94	8116
Nokia	126354	3948,56	11275
Qualcomm	101221	3893,12	10073
RIM	27311	1517,28	4291
Samsung	487732	15241,63	54561
Sony-Ericsson	614768	19211,50	43157
ZTE	34703	2669,46	8826

3.2 Research methodology

The statistical testing is based on cross tabulation and Chi-Squared testing. The 23 patent classes included to this study set a challenge for mathematical analyses. The number of different classes was reduced by using clustering to narrow the amount down. We utilized hierarchical clustering with between-group linkage and squared Eucledian distance as the clustering method. We used the relative share of patents as the data for the analysis, e.g. how large share of all of the patents of a firm were from each patent class. Meaningful amount of clusters were between two and four and four clusters were chosen as the patent classes clustered meaningfully in these four. The distribution to different clusters can be found from Appendix C.

In addition some adjustment needed to be made for longitudinal analyses. To compensate for sometimes long lead times in patent development, 3 years rolling average is used for analysis. This enables also the simulation of portfolio perspective as longer projects are seldom managed over a course of one year.

4 Results

The first analysis is the cross tabulation of firms and clusters identified in the previous chapter. The cross tabulation of results are shown at appendix C. The Chi-Square tests results are clear as the 2-sided asymptotic significance is 0, thus showing a strong statistical support. One reason for strong statistical support is the extremely high sample size. Nevertheless, the data shows significant differences in patenting activities between the firms.

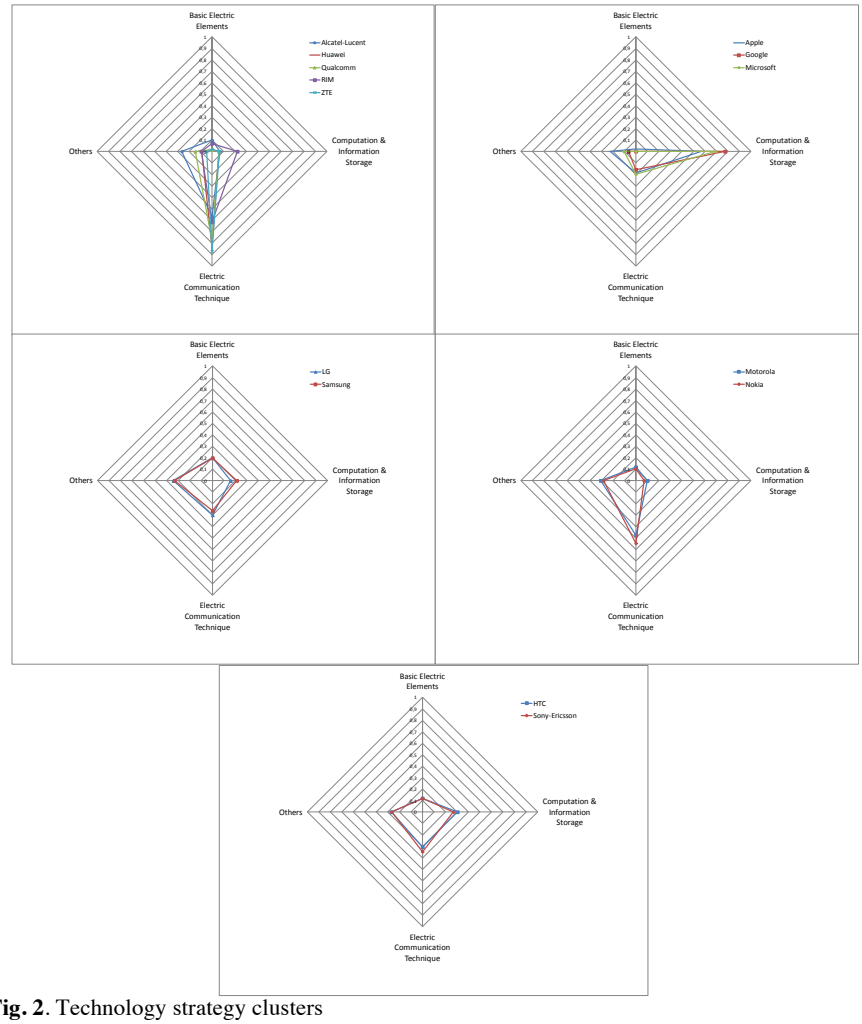

Fig. 2. Technology strategy clusters

Table 3. Technology strategy cluster descriptions

GROUP	COMPANIES	FOCUS
1	Alcatel-Lucent, Huawei, Qualcomm, RIM, ZTE	Strong focus on Electric communication techniques
2	Apple, Google, Microsoft	Computation & Information storage
3	LG, Samsung	Balanced technology portfolio
4	Motorola, Nokia	Electronic communication techniques emphasized, but also others
5	HTC, Sony-Ericsson	Relatively balanced, emphasis on electronic communication and computation & information storage

Figure 2 illustrates the relational weight of each identified patent class cluster. In total five different groups were identified within which the companies share a similar patenting activity. These groups are formed based on different kind of balances between different technology dimensions. It is notable that these measurements are all relative thus the absolute size differences among firms are not captured in these figures (Table 3).

The second part of tests was implemented by firm level cross tabulation between patent clusters and application year. The firm level analysis shows that all companies are changing their patent portfolio over time. Thus this supports the second hypothesis: firms change their patent portfolio structure over time. Figure 3 shows an example of how Nokia's emphasis to different patent cluster has changed over time. As expected the focus is strongly on electronic communication techniques, but it is notable that computation and information storage related patents have been rising steadily over the last 10 years. Also notable is the decline of other patents as Nokia turned from conglomerate to mobile phone manufacturer.

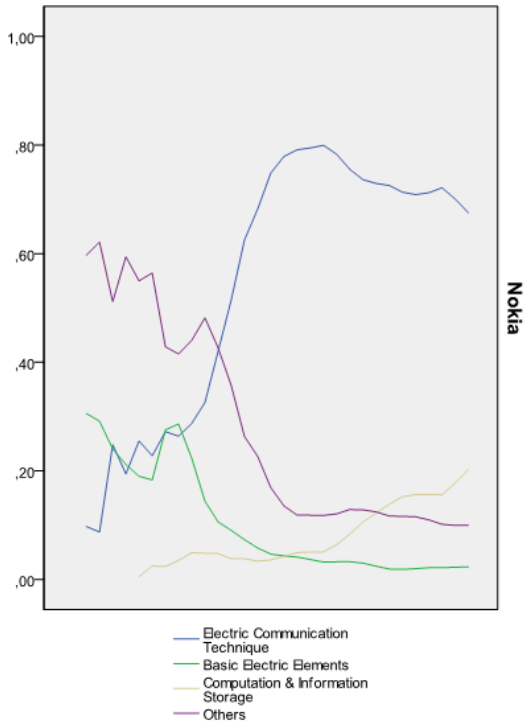

Fig. 3. Timeline of Nokia's patenting activity

The final research question was on the firm level differences in dynamics. The level of dynamics was measured by calculating for each firm the yearly relational change in each patent cluster. This crude measure gives the amount how much the company is changing its portfolio over time – higher number implies for larger change. The analysis shows that there are significant differences between firm averages over time. E.g. Nokia has much higher average change when compared to traditional phone vendors like Sony-Ericsson or Motorola.

Table 3. Dynamics of the companies

NAME	MIN	MAX	AVERAGE	YEARS
Alcatel-Lucent	0,7 %	21,9 %	5,9 %	30
Apple	1,4 %	21,6 %	7,6 %	27
Google	1,6 %	43,1 %	10,8 %	8
HTC	4,5 %	35,2 %	15,1 %	8
Huawei	1,0 %	11,6 %	5,3 %	12
LG	1,5 %	21,3 %	6,5 %	22
Microsoft	0,7 %	16,1 %	6,5 %	20
Motorola	1,8 %	13,0 %	5,6 %	30
Nokia	0,9 %	32,1 %	9,3 %	29
Qualcomm	1,8 %	16,8 %	5,5 %	22
RIM	0,9 %	56,4 %	12,1 %	14
Samsung	1,5 %	18,2 %	5,5 %	27
Sony-Ericsson	0,6 %	9,0 %	3,8 %	30
ZTE	0,7 %	4,3 %	2,1 %	9

5 Discussion

The support for hypothesis 1 is in line with the fundamental claim in RBV that firms have unique resources. Even when the number of different classes was diminished to just 4, the firms were found to be different over the whole inspection period. This finding can be expected as the study contained firms that are in different roles in the mobile phone industry. When the inspection is done only within each firm group that provide similar service to the market, the results show that firms don't have similar patent portfolios. This phenomenon occurs with the simplified patent data where only 23 patent classes were identified. As such, this finding strongly supports that even within a particular market segment firms don't have similar technology portfolios. Thus we find measured support for the basic principles behind RBV theory.

Further analysis of the firms' patent portfolios showed that the included firms could be divided to five different clusters based on overall patenting activity. These clusters suggest that there are certain technology strategies that a selected group of companies pursue. This finding supports hypothesis 2. Some of these groups were as expected based on market segmentation. For example, the software oriented firms (Group 2, Apple, Google, and Microsoft) had similar technological portfolios. An interesting finding is that despite similar backgrounds and technological portfolios only Apple has managed to successfully enter mobile phone markets with its own brand.

Another interesting finding in technology portfolio groups was that out of the dominant players the two most recent market leaders Nokia and Samsung did not

belong to same strategic group. Nokia was actually grouped with Motorola, which was the dominant firm in the market before Nokia and Sony-Ericsson, whereas Samsung was grouped with another upcoming Korean phone manufacturer LG. This finding suggests that some firms are competing in the same market with strongly differing technology strategies. The fact that the new market leader in mobile phones uses a significantly different technology portfolio than the previous leader suggests that there has been a significant shift in market needs during the time when market leadership shifted.

The third hypothesis analysed the dynamics in firms' capability accumulation. The results showed that firms change their patenting activities strongly, which is reflected in the statistical support for hypothesis 3. This finding has dual impact. First, it contradicts the original RBV theory that builds competitive advantage on protecting the firm's unique resources. Second, it supports the claim of the dynamic RBV discussion that firms need to constantly change their capabilities.

Although this evidence gives appealing support for dynamic RBV, the conclusion cannot be made so directly due to two distinctive reasons. First, the used data captures the dynamics only partly as exploitation of patents is not included. This means that based only on patent information it's impossible to analyse how companies actually decided to utilize their new technologies. As products ultimately define a firm's market performance they are critical in explaining the firm's performance on the market. Secondly, the data cannot be used to show undoubtedly strategic intent in the firm's action. As data shows that firms' patent portfolios are changing in a continuous way it suggests that this change is caused by a deliberate strategic decision to manipulate firm's technology portfolio. However, to ensure if this is caused by strategic decision the only way would be to analyse strategies either though yearly reports or interviews.

Hypothesis 4 could not be statistically tested, but the results from the descriptive analysis show that different firms have different levels of dynamics. The level of dynamics is not static but the speed of change for a firm varies over time. When looking from a longer perspective the averages show that some companies have constantly higher dynamics than others. Most of the biggest players in mobile phone industry have a moderate level of dynamics, putting them on the midrange of dynamics in our sample.

The firm's level of dynamics is also hard to describe. Our data shows that e.g. the firm's age in the market has low explanatory ability to the speed of change as e.g. HTC is one of the highest and ZTE is one of the lowest to change on average. From performance perspective the finding is also obscure. Firms like Sony-Ericsson and RIM, which have had severe performance problems, seem to have engaged in totally different level of dynamics. Sony-Ericsson had low level of dynamics versus RIM with one of the highest levels of dynamics. This finding cannot directly confirm, but it is in line with the argument by Klarner & Raisch (2013) that nor low or high dynamics is good for the firm but it's about balancing the dynamics and controlling the timing. Therefore, it can be argued that there are different levels of dynamics for firms but the important implication of these to firms' performance cannot be yet defined.

This research leaves us with interesting future research questions. In this paper we showed one way to operationalize a firm's technological dynamics. We also showed that with this measure firms can have different levels of dynamics. The question that follows is what is the appropriate level of dynamics for the firm? Is the correlation between dynamics and firm's performance linear or non-linear; is the correlation positive or negative? Also, to what degree this is a strategic decision? If firms want to change could they change faster than they actually do? These questions are still left open as in this paper we merely described the phenomenon. The managerial need for

guidelines for the management of dynamics is a serious issue and one that deserves further research.

Although the research was based on a large quantitative dataset, the analysis was done for a single industry. This effectively causes that the study is a case study that raises questions on generalizability of results. The observed phenomena of differences between firms' technology portfolios and technology portfolio dynamics were clear. During the analysis period, mobile phone industry has gone through several different technology cycles and a more fundamental shift from traditional phones to smart phones. From a technical perspective the firms have reacted to this same change in the business environment in different ways. This supports the claim that in our sample the firms have developed their capabilities differently. We argue that as the reaction from firms to external change is not standard, this phenomenon is likely to occur also in other industries. Still the only way to ensure generalizability is to replicate similar studies in other industries.

Generalizability of results leads to discussion on methodologies in dynamic capabilities research. As dynamic means change over time, longitudinal research approach is a necessity in empirical dynamic capability research. However, longitudinal research is challenging and many management studies have opted for a horizontal approach in sampling (Armstrong and Shimizu, 2007). This sets a clear challenge for future efforts to operationalize the dynamic capabilities concept. For generalizable results, research needs to adopt both longitudinal and horizontal dimensions in sampling. As such, the measurements need to be able to give relative measurements over time. In this study we used patents as proxies for measurement. They offer one way to measure dynamics, but cleansing, handling and analysing that quantity of data sets many practical challenges that need to be resolved.

6 Conclusions

In this paper we set out to analyze the dynamics of firm's technology portfolio. We make three conclusions and one proposal. First, we conclude that from the technological perspective firms seem to have unique technological backgrounds. This supports the RBV discussion that firms are unique capability combinations. Second, we found that firms can be clustered into different strategic groups. This adds to current knowledge that firms can be grouped also with internal measures as most previous studies have highlighted more the positioning of the firm in the end markets. Third, firms change their technology portfolios over time. The evidence clearly shows that firms change the structure of their technology portfolios. We cannot estimate to what extent this is a deliberate shift, but it does not change the fact that this change is happening. Finally, we propose that firms have different levels of abilities to change over time – or firms have different levels of dynamic capabilities. This however, remains only a proposition, as further research is needed to better understand this phenomenon and its determinants.

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Appendix

Appendix A. Search words for companies (is not case sensitive)

Mobile phone manufacturers	
Alcatel-Lucent	%Alcatel%, %Lucent%
Apple	%apple%
Ericsson (Sony-Ericsson)	%ericsson%, %sony%
HTC	%HTC%, %high tech computer%
Huawei	%Huawei%
LG	%LG%, %gold star%, %goldstar%, %dacom%, %serveone%
Motorola	%Motorola%
Nokia	%Nokia%
RIM	%Rim%, %Research in motion%
Samsung	%Samsung%
ZTE	%Zhongxing Telecommunication%, %Zte%

Support firms	
Google	%Google%
Microsoft	%Microsoft%
Qualcomm	%Qualcomm%

Effect of networks on product innovation: Empirical evidence from Indonesian SMEs

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Abstract. Innovative companies generally establish linkages with other actors and access external knowledge in order to benefit from the dynamic effects of interactive processes. Using data from 198 furniture and software firms in Indonesia, this study shows that the quality of interaction (i.e. multiplexity) as indicated by the depth of knowledge absorbed from various external parties and intensity of interaction (i.e., tie intensity) are better predictors of product innovation than the diversity of interaction.

Keywords. informal network, multiplexity, tie intensity, tie diversity, product innovation, Indonesia, developing country.

1 Introduction

In a globalized and knowledge-based economy, firms continuously need to increase efficiency and to innovate in order to improve their competitive advantage and to survive (cf. Veryzer, 1998). Accelerated product life cycles and increased product obsolescence in combination with rapid introduction of new and improved product versions increasingly call for fast responses. Technical lead times are often so long that there is a serious risk that a market may be lost before a proper response has been made. Innovation should therefore be performed as effective and efficient as possible (Postma et al., 2012). The knowledge-based theory argues that knowledge is the key resource in such a context.

In a world of increasing competition a firm cannot rely only on its own resources, capabilities and existing knowledge base, mainly consisting of the knowledge of its employees. These so-called internal factors include, for instance, a firm's inherited capacities, such as skills, routines, and the accumulated expertise and experience of its workforce (Webster, 2004; Waalkens, 2006), as well as the technological competences and appropriability conditions (see Vega-Jurado et al., 2008). Moreover, a firm might benefit from the knowledge of external actors (Inkpen and Crossan, 1995; Lane and Lubatkin, 1998; Larsson et al., 1998). Indeed, three streams of research can be distinguished here: the first stream focuses on the use of external sources for innovation; the second concentrates on internal capabilities and processes that determine firms' innovation activity (Colombo et al., 2011); and the third combines the two streams by considering both internal and external sources (Cassiman and Veugelers, 2006). This paper can be placed in the first stream of research. From the external point of view, innovative companies establish linkages with other actors access external knowledge and learn in order to benefit from the dynamic effects of interactive processes (Pfeffer and Salancik, 1978; Caloghirou et al., 2004; Waalkens et al., 2008). In other words a main issue here is the transfer of

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knowledge and the absorption of knowledge from interaction with dispersed external parties such as suppliers, competitors, buyers, online communities, and public knowledge institutions like universities (Meeus et al., 2001).

Interaction is triggered when a firm is in need of resources from the external environment in order to survive. The main reason for a firm to interact with other organizations is because it needs to access external sources to improve its capabilities and exploit opportunities (e.g. Chesbrough et al., 2006). Molina-Morales and Martinez-Fernandez (2010) argue that the use of externalities, such as public research can be used as inputs for an organization's innovation are not widespread and differ across sectors. They performed their research relating social capital to innovation in a specific industrial district research setting in Spain and established the relevance of social capital factors like social interactions for innovation. An understanding of the contribution of external networks to innovation is essential for the effective management and functioning of these networks. Morone and Taylor (2012) conceptualize the issue of knowledge integration which might affect a firm's innovation and suggest a research agenda on the subject of external knowledge integration and innovation. We concur with this and take up the challenge by exploring it and how external knowledge networks affect product innovation.

Building on this, our research is aimed at assessing the impact of social interaction in the form of an external network as represented by the social ties, between the owner-manager (hence OM) – which is in effect social capital as defined by Leenders and Gabbay (1999) – and a diverse set of network partners on a firm's performance in terms of product innovation. This study seeks to answer the following question: *do network characteristics (i.e., tie diversity, tie intensity, and multiplexity) contribute to product innovation?*

By using a survey held at 198 OMs of firms in the furniture and software sector in a certain region in Indonesia, we examine the effect of informal networks built upon interaction between the OM and their external parties. The furniture sector represents less-knowledge-intensive firms, while the software sector acts as exemplary for more-knowledge intensive firms (Alvesson, 2004).

In the next section, we discuss the relevant the concepts we use in this paper and derive the hypotheses to be tested. Section 3 discusses the methodology for this study. We present the results in Section 4. Section 5 concludes the paper.

2 Theoretical Framework

2.1 Innovation: stage, output, and level of newness

The business innovation literature offers various classifications of innovation (e.g. Avermaete et al., 2003; Johannessen et al., 2001; Schumpeter, 1934). Some authors (e.g. Avermaete et al., 2003 Porter, 1990; Veryzer, 1998) discuss innovation from the perspective of output (e.g. product, process, organizational), while others (e.g. Jansen et al., 2006; Veryzer, 1998) describe the concept in terms of the degree of change (i.e. radical new, really new and modified/incremental). Developing radical new products is fundamentally different from developing incremental new products. While both involve learning, this fundamental difference is reflected in two incompatible learning processes: exploration and exploitation (March, 1991). Following March (1991), exploration encloses processes such as search, variation, risk taking, experimentation, play, flexibility, discovery and innovation, whereas exploitation includes such things as refinement, choice, production, efficiency, selection, implementation and execution. Yet another perspective used in capturing the dynamic process of

innovation is that of the various stages of innovation.

As indicated, innovation can be the output of initiatives within a firm. Porter (1990) argues that a firm is a collection of activities that are performed to design, produce, market, deliver, and support its product. Innovation output can be distinguished into three types: product, process, and organizational innovation (Avermaete et al., 2003; Porter, 1990). Product innovation can be considered as any good or service that is perceived by an individual or a firm as new (Kotler, 1991). This means that it is possible that one person or organization may regard a product as an innovation while another party does not (Johannessen et al., 2001). For instance, new designs of chairs/tables or software may be perceived as a product innovation.

Furniture and software SMEs in Indonesia are usually "make-to-order" manufacturing firms, because of the nature of their products and their relationship with their buyers. This actually means that a firm is producing high variety products in relatively low volumes and products are manufactured to customer design and specification (Hendry, 1998). Furniture and software firms disclose more products-related innovation than process and organizational innovation (e.g. Van Geenhuizen et al., 2010). In Tanzania, Kristiansen et al., (2005) found dominance of product innovations over process and organizational innovation among small garment and furniture firms. Ebensberger and Herstad (2011) state that product innovations provide the better benchmark for investigating external learning interfaces. In the following we will discuss the effect of network on innovation.

2.2 Network: parties involved and characteristics

Essentially, a social interaction is any contact or relation that an actor or employee from one firm keeps with other actors or employees from other firms which can affect their access to and use of knowledge resources of the firm (Molina-Morales and Martinez-Fernandez, 2010:268). As indicated, in this paper, we take the perspective of the OM of a firm and his or her external network. A business network is a structure where in a business context a number of nodes is related to each other by specific threads, the threads can be considered the relationships between the network parties (such as producers, customers, service companies and suppliers of finance, knowledge and influence). This network is the result of complex social interactions between companies in relationships over time; each company is therefore embedded in a network of relationships (Ford et al., 2003).

Extant literature on firms' networks (e.g., Dyer and Singh, 1998; Dyer and Nobeoka, 2000; Levinson and Asahi, 1996) has widely discussed and accepted networks of firms as loci for innovation, knowledge creation and inter-organizational learning (Podolny and Page, 2000). A firms' innovation network consists of a collection of (often small) autonomous actors that pursue repeated and enduring reciprocal exchanges aimed at creating new or better products, services for final markets or creating new or improving production and/or administrative processes. According to Child et al. (2005) networks reduce uncertainty and provide flexibility capacity and speed, they also provide access to resources, information and skills not owned by the company itself. Aalbers et al. (2009) define informal communication networks as the contacts actors have with others within the organization that are not formally mandated, including friendships with co-workers, but also contacts unrelated to the day-to-day workflow, they resemble acquaintance networks (Morone and Taylor, 2012). Repeated, enduring and structured relationships are the main rationale behind the capability of networks to spread and diffuse knowledge among their members (Inkpen and Tsang, 2005), this means that the coming into existence of networks might be relevant. For a thorough discussion about network process research we refer to Hoang and Antonic (2003) and Slotte-Kock and Coviello (2009).

Parties involved. From the stakeholder perspective, the various parties involved in a (social) network are considered as those affecting or being affected by the actions of the business as a whole (Philips et al., 2003). The variety of parties which can be involved in interactive relations with a firm within a network can be relatively large: buyers, suppliers, competitors, government offices, industry associations, religious affiliations, universities, and consultants (e.g., Smeltzer et al., 1988; Fann and Smeltzer, 1989; Tidd and Trewhella, 1997). These parties are plausible sources of knowledge which we expect to enhance a firm's innovativeness. For Indonesia, Van Geenhuizen and Indarti (2005) found that the degree of interaction between SMEs and various external parties might not be sufficiently developed, while the possible advantages of these relations have to date not been properly explored. External interaction entails a broader access to relevant know-how, possibilities to perform benchmarking activities, as well as opening new markets.

Recent research shows (e.g., Von Hippel et al., 1999; Freel, 2000; Faems et al., 2005) that collaboration or interaction with *buyers* has a positive impact on product innovation performance. Likewise, many authors (e.g., Eisenhardt and Tabrizi, 1995; Nieto and Santamaria, 2007; Wilhelm and Kohlbacher, 2011) argue that interaction between a firm and its *suppliers* significantly stimulates the accumulation and sharing of knowledge, which can be used in the innovation of the firm's products.

Horizontal interaction or collaboration with *competitors* is positively related to a firm's innovativeness (Linn, 1994; Inkpen and Pien, 2006). Linn (1994) argues that cooperation with competitors enables firms to gain an insight into their technological know-how. *Consultants* also play crucial roles in the advancement of firms' innovation policies (Kelly, 1999; Tether and Tajar, 2008). *Government institutions* play an important role in the support and stimulation of firms' activities in the field of innovation by providing facilities, financial support and implementing supportive policies and a sound legal context (Hughes, 2001; Segelod and Jordan, 2002). *Industry associations* generally serve as a knowledge pool containing information on various domains, from knowledge about new technology to information regarding market opportunities (Hauschildt, 1992). Another aspect of the informal network in the Indonesian context, concerns *religious affiliations*, which may also form an important source of knowledge for product innovation. In this country, religious activities do not only take place in mosques and churches, but are also embedded in the societal context (e.g., Candland, 2000). *Research institutions/universities* are considered as scientific systems which function as sources of external knowledge for product innovation (Hauschildt, 1992). Tidd and Trewhella (1997) found that in the context of large firms, universities are the most important sources of external technology to produce product innovation.

Based on the previous discussion and by building on the value chain of Porter (1990) to unveil the various network parties for the Indonesian context, which are involved in innovation networks, we derive two categories of parties, namely individual and institutional parties. Individual parties include buyers, suppliers, competitors, and consultants, while institutional parties for instance consist of government institutions, industry associations, religious affiliations, and research institutions/universities (Van Geenhuizen and Indarti, 2008; Tidd and Trewhella, 1997). Fig. 1 shows the parties that are involved in the interactions between the focal firms and their network as a source of external knowledge for stimulating a firm's innovativeness.

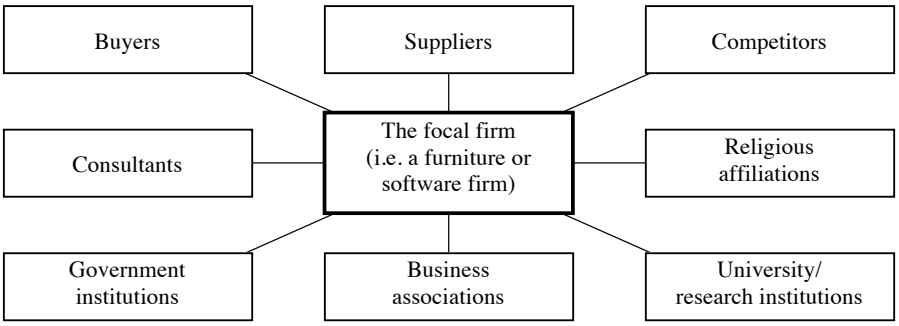

Fig. 1. Parties involved in a network.

This study addresses informal networks contributing to a firm's innovation in the context of Indonesian SMEs. Van Aken and Weggeman (2000) call a network an emergent network, when it is not created by deliberate actions, but emerges organically from frequent and satisfying business transactions between organizations and by personal interaction between organizational representatives. Dyer (1996) argues that spatial and cultural proximity plays an important role in the formation of an informal network. In a developing country like Indonesia where a collectivist culture (Hofstede, 1991) prevails, relationships with other parties usually come into existence in an informal way. An informal network develops through frequent interaction, which enables a firm to absorb relevant external knowledge, e.g. by using informal communication networks.

Based on our reading of the SME network literature, we found the following relevant network characteristics for our study, which are: (a) tie diversity (the number of different parties); (b) tie intensity (frequency of contacts); and (c) multiplexity (the number of knowledge domains).

Tie diversity. Previous studies (e.g. Becker and Dietz, 2004; Nieto and Santamaria, 2007) point out that interaction with diverse partners may provide various advantages. Diverse sources of knowledge allow the firm to create new combination of technologies and knowledge, which in turn it provides opportunities for the firm to select among various possible paths (Metcalfe, 1994). Partners may also contribute different resources and capabilities instrumental to improve the firm's innovation capabilities (Becker and Dietz, 2004).

Moreover, varied network partners, may attract more heterogeneous knowledge, experimentation, search, variation, and risk-taking, which contributes to explorative innovation (March, 1991; Nieto and Santamaria, 2007) and to sustain innovation (Laursen and Salter, 2006). More specifically, collaboration with varied partners improves the chance of achieving product innovation (Becker and Dietz, 2004; Nieto and Santamaria, 2007). Against this backdrop, therefore we propose

P1: The higher the tie diversity, the higher the innovation results will be.

Tie intensity. As indicated, repeated, enduring and structured relationships are the main rationale behind the capability of networks to spread and diffuse knowledge among their members (Inkpen and Tsang, 2005). Social interactions are reflected in the intensity in terms of number of times actors share time in any kind of event, so, more interactions between actors could mean more access to knowledge of others, possibly resulting in more sharing of this knowledge (see e.g. Molina-Morales and Martinez-Fernandez, 2010; Tsai and Ghoshal, 1998; Yue-Ming, 2005).

The firm's current innovation capability is determined by its history and experience

(Dosi, 1988), while the firm's current knowledge is dependent on its previous related knowledge (Cohen and Levinthal, 1990). When ties become more intense, the quality of the knowledge exchange is likely to increase, especially so-called strong ties (see Granovetter, 1973), allow for more knowledge exchange and more exploration (learning), and therefore we propose

P2: The more intense the ties, the higher the innovation results will be.

Multiplexity. Arguably, tie diversity and tie intensity do not suffice to capture the quality on interaction with diverse partners. Tie diversity indicates the number of partners in the network, while tie intensity denotes the frequency of interactions. To complement them, we introduce the notion of multiplexity to indicate the amount and the variety–i.e. the depth–of knowledge transferred during the interactions. Multiplex means that a single line or channel can carry various messages simultaneously; it refers to the complexity of the relationships, the variety of the exchanges embedded in the relationship or the number of diverse types of ties (see also, Tuli et al., 2010).

We argue that this issue concerns the number of various knowledge domains to which an interactive relationship refers ranging from design to production to markets. More multiplex relationships between firms in a network concern richer knowledge domains (Hoang and Antonic, 2003). Collaboration with different partners affects the amount and variety of knowledge to be shared which enhance the firm's innovation (Becker and Dietz, 2004).

We contend that the more diverse the knowledge that is exchanged in the relationships, the more probable will be that this knowledge positively affects a firm's innovation, thus we propose the following

P3: The higher the multiplexity, the higher the innovation results will be.

2.3 Control variables

Larger firms have higher financial capacity to fund innovation and may have access to a wider range of knowledge and other resources than small firms, allowing higher rates of innovation (Daghfous, 2004; Rogers, 2004). In their study of high-tech firms, Lee and Sung (2005) indicate that size as measured by the number of employees, is significantly related to R&D activities, which are often used as an indicator to measure a firm's innovation. Sørensen and Stuart (2000), who studied high-tech firms, state that a firm's age as measured by a firm's number of patents is positively correlated with innovation. Further, a study on innovation in Belgian small food firms by Avermaete et al. (2003) shows that older firms are more likely to introduce new products than younger ones. These findings support the claim that as a firm grows older, its organizational operations and competencies have gradually improved, which promotes a climate for innovation (Sørensen and Stuart, 2000).

Hence, we expect that a firm's size and age positively relate to product innovation; older and larger firms probably have more elaborate networks, which might positively affect the possibility to exchange knowledge and to innovate. Also, we expect that there might be sector-specific differences, because of the nature of the production processes and network relationships. In the more mature furniture sector we expect more established relationships between firms and external parties than in the generally younger software industry. Based on this, our conceptual model is presented in Fig. 2.

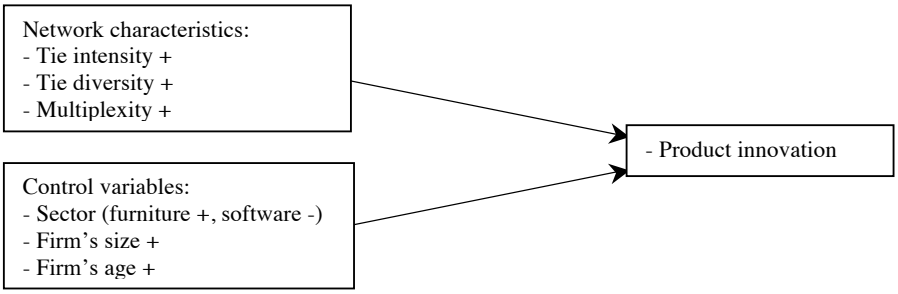

Fig. 2. Conceptual research model (including the propositions).

3 Methodology

3.1 Research instruments

This research is of a quantitative nature and data collection is performed by means of a questionnaire, which is held through a personal interview with owner-managers of small- and medium-sized firms in the software and the furniture sector in Indonesia.

The questionnaire consists of three parts. The first part consists of questions on demographical characteristics of the owners and the firms. The second part consists of items to measure product innovation. The last part consists of questions related to network characteristics including the frequency, mode of interactions and the content and nature of absorbed knowledge during the interactions.

3.2 Operationalization of the variables

Product innovation is measured by using six items and a 5-point Likert scale ranging from 1 (very seldom) to 5 (very often), which is adopted from Jansen et al. (2006). The items are: (1) our firm accepts demand which goes beyond existing products/services; (2) we frequently refine the provision or conditions of our current products/services; (3) we invent new products and services; (4) we regularly implement small adaptations to our current products/services; (5) we regularly improve our current products/services; (6) we commercialize products/services that are completely new to our unit (see Appendix).

Tie intensity indicates the intensity of interaction between the focal firm and the external parties. A firm that interacts more frequently with various external parties has stronger tie intensity. The respondents were asked to rate how often their firm interacts with each of the external parties (see Fig. 1), using a 6-point Likert scale (0=never; 5=very often). Tie diversity represents the number of various external parties involved in the interaction with the focal firm (see Fig. 2). A firm that has interaction with more various external parties has higher tie diversity. The respondents were asked to mention which external parties they interact with.

Multiplexity represents the depth of knowledge domains absorbed by the focal firms from various external parties (e.g. Simon 1976; Van der Spek and Spijkervet, 1997). The deeper and more various knowledge domains absorbed from the external partners, the higher the degree of multiplexity. The respondents were asked to indicate the specific knowledge content (for instance in terms of design/products,

process, and organizational) obtained from what external sources (see Figure 1) and also indicate the depth of the knowledge per domain using a Likert scale ranging from 1 (little) to 5 (very much). For example, a respondent may consider that knowledge on design/product were obtained from buyers was very much (score = 5) and that from government institutions was little (score = 1), while the knowledge on process scored differently. Arguably, innovation in one aspect (e.g., product innovation) may have affect or be affected by innovation on other aspects (e.g., process) (Avermaete et al., 2003). The higher the score, the deeper the knowledge obtained.

Subjective measurement is selected to address difficulties in the data collection process. Collecting objective data (such as number of patents and R&D expenses) among the Indonesian SMEs is impractical, mainly because most of them do not adopt modern management practice and have no proper documentation systems. In this study, we focus on informal networks that is neither well documented.

The *age of the firm* is measured by the number of years passed since a firm's establishment (Kimberly, 1976). The *size of the firm* is measured by the number of employees (Da Rocha et al., 1990; Flatten et al., 2011; Heunks, 1998). *Industry sector* is operationalized as a dummy variable (software firms = 1; furniture firms = 0).

3.3 Internal validity of the instrument

As discussed above, the questions of the research instrument were developed on the basis of various studies. After testing the questionnaire with some OM's in a real life situation, we slightly adapted the phrasing of some questions in the instrument in order to improve the understanding of the questions. In this study, we used Cronbach's alpha value to examine the internal consistency of the instrument. For all network and innovation variables the values of Cronbach's alpha were higher than 0.60 (see Table 1). Based on this, we conclude that the items to measure the tie-intensity, tie-diversity, multiplexity, and product innovation are acceptable, which means that they provide consistent results.

Table 1. Instrument reliability.

Variable	*Items*	*Alpha*
Multiplexity	24	0.91
Tie intensity	8	0.62
Product innovation	6	0.63

Notes: Reliability test is not relevant for the variables operationalized by only one item (i.e., tie diversity, firm's age, firm's size, and sector)

3.4 Data collection and analysis

This study concerns fieldwork in the furniture and software industry in four big cities in Indonesia. With respect to the furniture sector, the province of Yogyakarta, with its high density of furniture SMEs, was selected as our research site. A spatial analysis performed by Kuncoro (2000) indicates that Yogyakarta is one of the cities on the island of Java where relatively many SMEs are clustered. In addition, Yogyakarta is considered as one of the main visiting places for handicraft and furniture buyers in Indonesia (Raharjo, 2009).

The Indonesian software sector is still in its early years. The vast majority of SME software development firms in Indonesia are concentrated in large cities (Donny and Mudiardjo, 2006). In this study, we selected Bandung, Yogyakarta, Surabaya, and Malang, where many software firms are located, as the main research sites. These

four cities are known in Indonesia as main locations of institutions of higher education, such as universities, where the number of potential start-ups is relatively high (Rahardjo, 2002). The higher education institutions train thousands of software engineers every year.

The respondents are OMs of the firms. In the case of SMEs, the OMs are the main actors in charge of and responsible for the firms' growth and innovation, while practically all information goes to these people (c.f. Stanworth and Curran, 1976; Tidd et al., 2005). Therefore, information is obtained on the organization as a whole. To ensure that the respondents would match the objective of our study, we used a judgment sampling technique (Cooper and Schindler, 2008) and based on that established a number of criteria. Selected firms should be (1) furniture or software manufacturing firms which had existed for more than 2 years; and (2) firms which employed less than 100 people.

We have to add that many SMEs in Indonesia operate without a legal basis. According to data from The Indonesian Statistics Bureau (www.bps.go.id), this is typical for Indonesian SMEs which can be classified as home industries or family businesses. When selecting the firms in our sample we used the databases from the Business Directory of the Indonesian Department of Industry and Trade, the Indonesian Furniture Industry and Handicraft Association, the Association of Indonesian Software Developers, and the Internet (www.indonetwork.net). Since not all furniture and software firms are listed in the databases, we gathered additional information by following a 'snowballing' procedure: here, participating respondents suggest other relevant companies. Snowballing, which sometimes also referred to convenience sampling, is a common methodology used in the following cases: (1) when no comprehensive data are available (Cooper and Schindler, 2008); (2) when the participating respondents have access to extensive personal and informal networks; and (3) when a recommendation from a former respondent makes it easier to approach a potential new participant (Souitaris, 2001).

The data were collected in the period from October 2007 until March 2008 by means of personal face-to-face interviews with the firms' OMs, which took 45-60 minutes on average. All (100%) off the returned questionnaires were completed by the respondents and subsequently included in the data analysis.

Out of the 265 software firms we contacted, 132 (49.81%) were either closed down or less than two years in operation. The rest (133) was considered to be eligible for participating in the research. Of this group, 33 firms were not willing to participate in the research. So, 100 questionnaires were included, which accounted for a 75.2% response rate. As regards the furniture firms, out of 322 on the list, 168 were not eligible to participate as respondents because they had been operating for less than two years and were now engaged in the handicraft business. Of the rest of the firms (154), 100 were willing to partake in the study, resulting in a response rate of 64.9%. The total number of returned questionnaires was 200. No clear patterns were identified in the non-response. Mostly the non-responders were not willing to participate due to various reasons, such as a lack of time or other engagements at the time of the data collection. All in all, 198 sample firms were considered as suitable for analysis.

To deal with the possible violation of traditional statistical assumptions, we chose to use partial least square (PLS) to test the research model. PLS is soft modeling that combines a mathematically rigorous procedure that leads to efficient predictions, but it is well suited for research constrained by conditions of low information (small sample size), nascent or emerging theory and subjective observations of phenomena (Sosik et al., 2009).

4 Results

4.1 Demographics of the firms

As regards status, 96% of the firms are independent, most furniture (98.0%) and slightly less software (94.0%) companies in the sample are independent (see Table 2), which is a typical characteristic of small firms (Government of Indonesia, 2008).

In SME settings, particularly in developing countries such as Indonesia, the firm's owner is usually the initiator of new business ventures, which also applies to the owners of the firms we studied. They were the most important actors with respect to initiating new activities (80.8%). As regards the establishment of businesses, most (82.7%) furniture firms appear to have been initiated by their owners (see Table 2). In general, firms are located in an urban/town context, even 90.0 % of all software firms are located in such a context, but most of the furniture firms are located in suburban or village context, because they need a lot of space. A large proportion (79.0%) of the software firms is also initiated by the owner, followed by friends (35.0%). After their establishment, the firms' growth rate may vary. In general, we find that 66.3% of the firms in the two sectors started to expand within two years of their existence.

Table 2. Demographic aspects of firms.

Variable	*Furniture firms*		*Software firms*		*Both Sectors*	
	N	*%*	*N*	*%*	*N*	*%*
Status						
- Independent	96	98.0	94	94.0	190	96.0
- Subsidiary	2	2.0	6	6.0	8	4.0
Location						
- Urban/town	26	26.5	90	90.0	116	58.6
- Suburban	36	36.7	9	9.0	45	22.7
- Village	36	36.7	1	1.0	37	18.7
Firm's growth after its establishment						
- Within 2 years	61	62.2	70	70.0	131	66.3
- After 2 years	37	37.8	30	30.0	67	33.8
Initiator*						
- Your self (the owner)	81	82.7	79	79.0	161	80.8
- Parents	13	13.3	2	2.0	15	7.6
- Relatives	16	16.3	1	1.0	18	8.6
- Friends	5	5.1	35	35.0	40	20.2
Monthly revenue (IDR million)						
- < = 100 (EUR 7,702a)	85	86.8	89	89.0	174	87.9
- > 100	13	13.2	11	11.0	24	12.2

Note: *Multiple answers are allowed; awww.xe.com, accessed on 30 January 2010.

4.2 Correlation and regression analysis

Table 3 shows the result of the correlation analysis between the main variables in this study and some descriptive results. The size of the firm across the two sectors is about 15 employees, with a considerable standard deviation. The mean age of the firms in this data set is about nine years, also with a considerable standard deviation. Product

innovation is significantly and positively correlated with multiplexity and tie intensity, which is in line with our propositions; while it has negative significant correlation with tie diversity. The resulting variance inflation factors (VIF) for these variables are between 1.18 and 2.79, which are less than 10. According to general rules of thumb (e.g., Kutner et al., 2004), value above 10 alludes to a potentially severe problem of multicollinearity. Thus, we could conclude that there is no multicollinearity problem here.

Table 3. Correlation between variables and some descriptive results of the main variables.

Variable	*Mean*	*SD*	*Tie intensity*	*Tie diversity*	*Firm's size*	*Firm's age*	*Product innovation*	*VIF*
Multiplexity	1.48	0.48	0.56**	-0.56**	0.01	-0.09	0.23**	1.67
Tie intensity	1.49	0.71	1	-0.77**	0.22*	0.03	0.20**	2.67
Tie diversity	3.85	1.89		1	-0.28**	-0.07	-0.16*	2.79
Firm's size	14.71				1	0.13	0.13	1.18
Firm's age						1	-0.11	1.23

Notes: * p<0.05; ** p<0.01

We tested two models. The first model included only multiplexity, tie intensity, and tie diversity as the independent variables, while the second model brought in sector (as the control variable), firm's age, and firm's size (as the moderating variable). Results of the analysis of the first and the second models are depicted in Fig. 3 and Fig. 4 respectively.

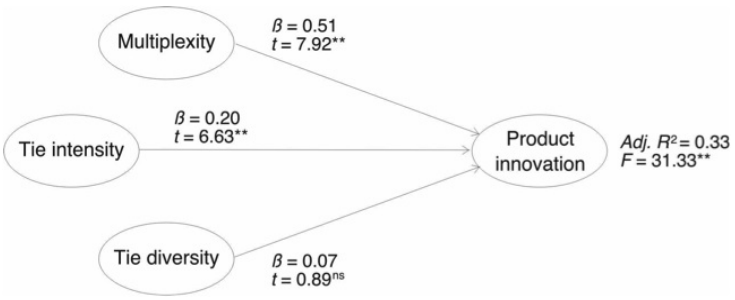

Fig. 3. Results of the analysis of the first model.

As can be seen in Fig. 3, we find that multiplexity and tie intensity significantly effect product innovation, while tie diversity does not. The two significant variables explain 33% of the total variance.

When the control variables are included in the analysis (see Fig. 4), the explanatory power of the model increases from 33% to 38%. Multiplexity and tie intensity are still significant predictors of product innovation, while tie diversity is not significant. We also find that firm's age has a negative significant impact on product innovation, while firm's has a positive impact. Note that, sector has no significant impact on product innovation.

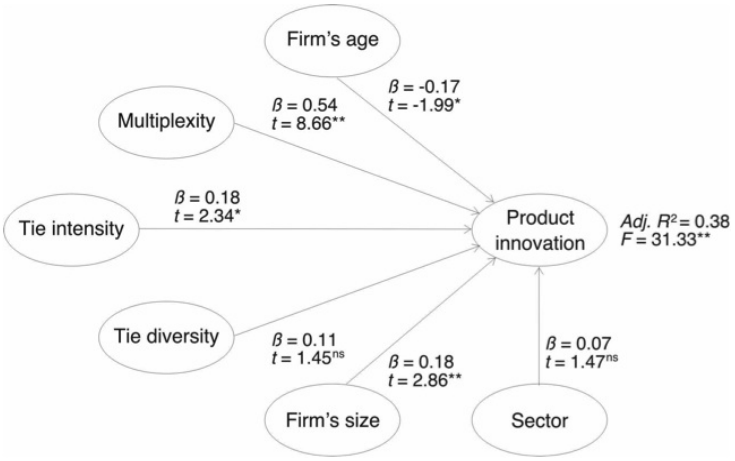

Fig. 4. Results of the analysis of the second model.

5 Discussion and Conclusion

In this paper, we have outlined the relevant network partners for Indonesian SME's in two sectors, i.e. the furniture and the software sector, in a central area of that country and discussed their possible contribution to product innovation.

Multiplexity and tie intensity are the variable of the set of network characteristics that has a significant impact on product innovation. This finding indicates that the depth of knowledge content absorbed from the external parties (i.e., multiplexity) and the intensity of interaction (i.e., tie intensity) are important for product innovation. This can be explained because through higher multiplexity and tie intensity, external economies of cognitive scope can be obtained (Nooteboom, 1999), which enhances a firms' innovation potential and is also in line with Waalkens (2006). Contrary to our expectations, the number of various external parties involved in the interaction (i.e. tie diversity) has no significant direct impact on product innovation. The findings indicate that the quality and intensity (sometimes referred to as strong ties) of interaction with certain external parties will be significantly more important than spreading energy to more various parties with less intensity of interaction. The varying degree of relevance of one external party to another (e.g., lead customers can be very important in order to detect certain trends, while input from other parties such as religious affiliations might be less relevant) may explain this finding.

The role of a firm's age and a firm's size as control variables are confirmed by the study but in different direction. The former affects product innovation a negative direction, while the latter does positively. These findings can be interpreted that the effect of the network variables on product innovation is stronger among the younger and the larger firms. The results also demonstrate that the industry sector has no effect on the relationship between tie intensity, tie diversity and multiplexity on product innovation.

A main contribution of this paper is that it provides the insight that in the context of an emerging economy, the quality of interaction as indicated by the depth of knowledge absorbed from various external parties (i.e., multiplexity) and the intensity

of interaction (i.e., tie intensity) is more important than the diversity of external parties (i.e., tie diversity) involved in the interaction in determining product innovation. As a consequence, in order to obtain a significant impact on product innovation, intensity of interaction should be set-up to get more knowledge on various domains.

Taken altogether, in this study, only P2 and P3 gain support, while P1 is not proven. Given, the correlation results, further research on the network variables is needed, maybe by finding another or a more comprehensive construct measuring the network effect; note that our research does not confirm the research by Molina-Morales and Martinez-Fernandez (2010). Age and size probably better can be treated as moderating variables (cf. Flatten et al., 2011). Also, the usual limitation of a cross section analysis applies here; probably a longer research time frame provides additional insights on the proposed relationships, especially when we consider absorptive capacity of a firm in the light of dynamic capabilities and strategic learning processes.

Another limitation of this study is the use of subjective measurement to operationalize the variables (i.e., tie intensity, multiplexity, and innovation), although this approach at the same time may be also considered as a strategy to cope with the uniqueness of the context. For the similar reason, we do not take the number of each type of partner into consideration when measuring tie diversity. Future studies may address these limitations both to validate the results and to provide better measurement strategies.

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Appendix

This appendix consists of items in the questionnaire used to operatonalize the variables.

Tie intensity

Based on your experience within the past two years, how do you rate the frequency of interactions between your firm and the following parties?

No.	*Party*	*Never*					*Often*
1	Buyers/customers	0	1	2	3	4	5
2	Suppliers	0	1	2	3	4	5
3	Consultants	0	1	2	3	4	5
4	Government offices	0	1	2	3	4	5
5	Competitors	0	1	2	3	4	5
6	Industry associations	0	1	2	3	4	5
7	Religious associations	0	1	2	3	4	5
8	Research institutions/universities	0	1	2	3	4	5

Tie diversity

The score for tie diversity is measured by summing the number of external parties from the above table with non-zero answers.

Multiplexity

Based on your experience within the past two years, please indicate what specific

knowledge content your firm gets from external parties. If an external party is not relevant, put a cross (x) in 0. Please indicate also the depth of knowledge on the domain (1=little, 5=very much).

		Knowledge domain/content		
No.	*Party*	*Product*	*Process*	*Organizational*
1	Buyers/customers	0 1 2 3 4 5	0 1 2 3 4 5	0 1 2 3 4 5
2	Suppliers	0 1 2 3 4 5	0 1 2 3 4 5	0 1 2 3 4 5
3	Competitors	0 1 2 3 4 5	0 1 2 3 4 5	0 1 2 3 4 5
4	Consultants	0 1 2 3 4 5	0 1 2 3 4 5	0 1 2 3 4 5
5	Government offices	0 1 2 3 4 5	0 1 2 3 4 5	0 1 2 3 4 5
6	Industry association	0 1 2 3 4 5	0 1 2 3 4 5	0 1 2 3 4 5
7	Religious affiliations	0 1 2 3 4 5	0 1 2 3 4 5	0 1 2 3 4 5
8	Research institution/ university	0 1 2 3 4 5	0 1 2 3 4 5	0 1 2 3 4 5

Product innovation

The following are several innovation activities that may be conducted in your firm within the past two years. Please rate each of innovation activities. Note: 1= seldom and 5= very often.

No	*Activity*	*Very seldom*				*Very often*
1	Our firm accepts demand that go beyond existing products and services	1	2	3	4	5
2	We frequently refine the provision of existing products and services	1	2	3	4	5
3	We invent new products and services	1	2	3	4	5
4	We regularly implement small adaptations to existing products and services	1	2	3	4	5
5	We regularly improve our current products/services	1	2	3	4	5
6	We commercialize products and services that are completely new to our unit	1	2	3	4	5