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AUTHOR'S NOTE

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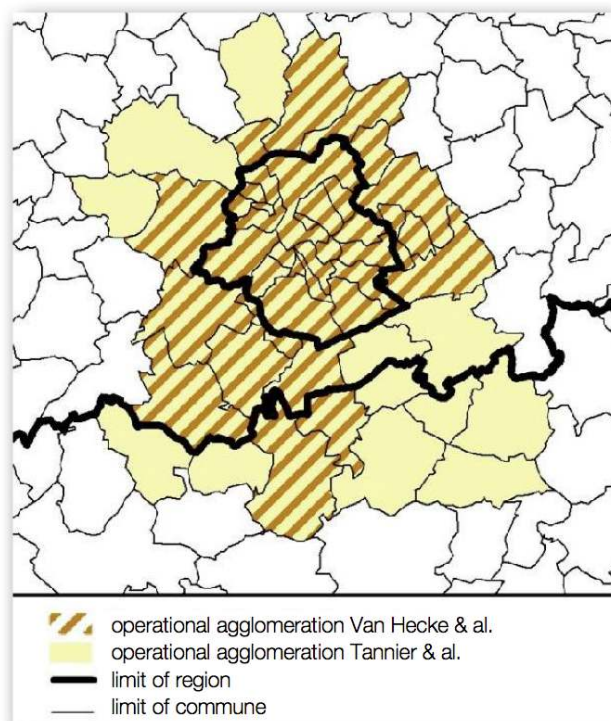
Introduction

- 1 The iterative process, high costs, risk, and complexity of innovation has driven scientific attention to interactions within and between firms or sectors, and shifted the interest towards the systems that host innovation activities [Lundvall, 1992]. Innovation is anchored in the regional industrial structure by knowledge flows that are exchanged locally or non-locally [Bathelt, Malmberg, and Maskell, 2004]. Therefore, the firm's approach towards knowledge exchange in innovation cannot be seen independently from the local environment.
- 2 The identification in the 1990s of the European paradox – high abundance of knowledge at universities and public research organisations (PROs) which is not fully translated into innovation in the business sector – and the increasing attention to small and medium-sized enterprises (SMEs) to explain growth differences between Europe and the United States, put innovation in SMEs and industry-science relations are high on the policy agenda. Moreover, over the past decade and enhanced by the ambition of the European Union to become a more knowledge-based economy, increasing attention is paid to services, and more particularly Knowledge intensive business services (KIBS). KIBS include services in computer and related activities, research and experimental development, and other business activities. KIBS are services and business operations heavily relying on professional knowledge. They are in particular concerned with providing knowledge-intensive support for the business processes of other organisations. Their employment structures are heavily weighted towards scientists, engineers, and other experts. KIBS are considered one of the main engines for future growth within the European Union, are important drivers for regional or local economic growth, and tend to be geographically clustered in large (capital) cities [European Commission, 2012]. Those cities increasingly are viewed as “local innovation systems” forming an ecosystem based on the interaction among differentiated types of actors co-located in the same area [Cantner and Graf, 2008] and enhancing creativity by connecting people to discuss, meet, confront ideas, and build assumptions [Cohendet *et al.*, 2010].
- 3 Knowledge spillovers are key for innovation, and knowledge diffusion in KIBS depends on locally available resources, and these resources differ between high-density urban agglomerations and other regions [Herstad and Ebersberger, 2015]. In large agglomerations the variety of knowledge exchange is broader and limits repetitive information, offering opportunities for more radical innovation [Fitjar and Rodriguez-Pose, 2011].
- 4 This article focuses on the particularities of knowledge exchange in innovation active SMEs in KIBS in Brussels. Particular interest is in industry-science relations since firms in KIBS aim at solving client problems and tend to rely on academic expertise combined with creativity and pragmatically justified rules of thumb. This expertise is often tacit and embodied in the minds of individual experts and provided to clients by means of direct interactions. Therefore, this form of knowledge-intensive service provision can be considered highly localised [Herstad and Ebersberger, 2015].

1. The Brussels urban agglomeration

- 5 Brussels is the capital city (region) of Europe and the abundant presence of European institutions is an incentive for many (multinational or internationally oriented) companies to be located in the city. It is an interesting example of a so called multi-cultural administrative and highly services oriented metropolis connected with a hinterland that is more manufacturing oriented [Tödting and Trippl, 2005]. R&D activities in the private sector are relatively low compared to the research at universities and public research centers [Corijn *et al.*, 2009], but specialisation in R&D in business services is high [Teirlinck and Spithoven, 2005]. Similar to some other capital cities in Europe (London, Zurich, Vienna, Stockholm, Paris) Brussels is largely endowed with KI (B)S [European Commission, 2012] and firms in KIBS are prominent actors in each of the key clusters defined in the Regional Innovation Plan for Brussels [Innoviris, 2016].
- 6 Since the administrative borders of the Brussels region ignore its morphological surrounding, we focus on the Brussels city agglomeration. In a Belgian context, a city agglomeration refers to an urban living core and comprises the core city and the city surrounding (*stadsrand*) which is immediately connected to the core city by means of housing, industrial and commercial buildings, public infrastructure in terms of building, roads, parks, sport facilities ... The “borders” of the city agglomeration consist of more rural areas, woods, waste land and dispersed habitation. The operationalised agglomeration is obtained by adapting the morphological agglomeration to the borders of the municipalities by including municipalities with over half of the inhabitants belonging to the living core [Luyten and Van Hecke, 2007].

Figure 1. The Brussels urban agglomeration



NOTE: WE CONSIDER THE HATCHED AREA

Source: Thomas *et al.* (2012, p.5).

2. Local innovation systems and knowledge spillovers

- 7 The central argument to study local innovation systems is that knowledge exchange and accumulation not only depend on knowledge and competencies of single actors but also needs to be seen as a collective progress [Lawson, 1999] depending on – the territorial specificities of – the system of relationships and learning processes the actors are embedded in. The central research theme in this paper is the identification of particularities in knowledge exchange for innovation between science and industry in Brussels. We study knowledge exchange in terms of knowledge sources used for innovation, collaboration in innovation and openness of the innovation strategy.
- 8 Novel ideas are at the origin of innovation. These ideas can come from within the organisation but are believed to be increasingly provided in interaction with external partners. Potential knowledge sources at the origin of innovation include the own organisation, supply chain partners, external private consultants or competitors, institutional sources (government and higher education) and temporary clusters [Maskell *et al.*, 2006].
- 9 Networking and knowledge exchange in innovation is not an objective in itself. It is intended to continuously fill the firm's innovation pipeline with ideas in order to remain competitive and to survive. The process of turning ideas into innovation can be exclusively internally organised (closed), or can be more open and rely on co-

development, adaption of externally developed knowledge or outsourcing [for services - Chesbrough 2011].

3. Industry-science knowledge spillovers in Brussels

- 10 Based on data from two waves of the Community Innovation Survey (stratified sampling – size, sector, region – for the periods 2008-2010 and 2010-2012), the official instrument to collect innovation data in Belgium, we obtained a representative sample of SMEs (defined as firms with 10 or more and less than 250 employees) engaged in product and/or process innovation in KIBS in Brussels. A product innovation is defined as the market introduction of a new or significantly improved good or service with respect to its capabilities, user friendliness, components or sub-systems. A process innovation refers to the implementation of a new or significantly improved production process, distribution method, or supporting activity.
- 11 We benchmark SMEs in KIBS in Brussels with their counterparts in the – combined – four large city agglomerations of Antwerp, Charleroi, Ghent and Liège. SMEs in KIBS can be profiled as highly active on international markets, and generating close to one seventh of their turnover from radically new innovations (Table 1). SMEs in Brussels are significantly larger, more active on the national market, have a higher share of turnover related to innovations that are new to the firm, and are more engaged in process innovation and less in combined product and process innovation.

Table 1. Innovative SMEs in KIBS in the Brussels agglomeration and in the large city agglomerations of Antwerp, Charleroi, Ghent and Liège, 2008-2012

	Brussels agglomeration (n = 196)	Large city agglomerations (n = 206)
Number of employees (n)	61,74 ***	45,03
Firm is active on the local market (% yes)	0,80 *	0,71
Firm is active on the national market (% yes)	0,90 ***	0,77
Firm is active on international (EU) market (% yes)	0,66	0,70
Firm is active on international (outside EU) market (% yes)	0,40	0,42
Product innovation (% yes)	0,36	0,32
Process innovation (% yes)	0,17 **	0,10
Product and process innovation (% yes)	0,45 **	0,56
Share (%) of radical (new to the market) turnover from innovation	0,14	0,16
Share (%) of new to the firm turnover from innovation	0,14 *	0,10

T-TEST ARE USED TO DETERMINE IF TWO SETS OF DATA ARE SIGNIFICANTLY DIFFERENT FROM EACH OTHER. T-TESTS ARE HERE USED TO IDENTIFY DIFFERENCES BETWEEN SMES IN THE BRUSSELS CITY AGGLOMERATION AND IN THE OTHER LARGE CITY AGGLOMERATIONS (*, **, *: 10 %, 5 %, 1 % SIGNIFICANCE LEVEL). NO RESPONSE BIAS IS IDENTIFIED IN TERMS OF THESE VARIABLES BETWEEN UNITS INVOLVED IN THE ANALYSIS AND THE ONES EXCLUDED (DUE TO ITEM NON-RESPONSE).**

SOURCE: COMMUNITY INNOVATION SURVEY (2008-2010 AND 2010-2012)

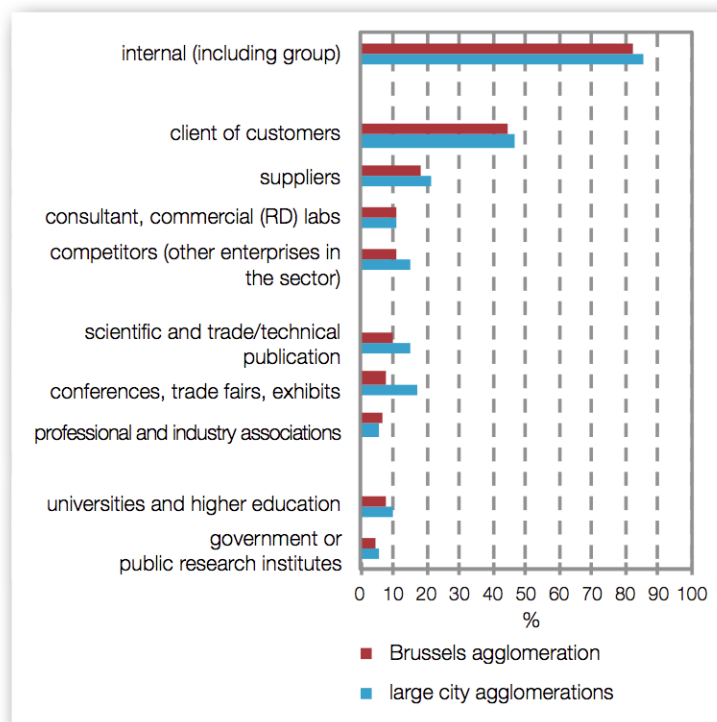
3.1. Sources of Innovation

- 12 Firms rely on different sources for their innovations. These sources can be classified as internal, market related, institutional and other (including temporary clusters) [Maskell *et al.*, 2006]. For SMEs in KIBS the ideas for innovation (Figure 2) mainly stem from within the enterprise (or enterprise group), indicating an internal capacity to generate novel ideas. Together with the high reliance on clients or customers this shows a clear market focus and highlights the importance of bringing proper ideas to market to remain competitive [Herstadt and Ebersberger, 2015]. Other sources are more modest, in line with what is expected in terms of offering novel solutions to clients in KIBS [Herstad and Ebersberger, 2015]. Temporary meeting places at conferences, professional and industry associations, and specialised publications are the third source of innovation. In contrast with the large endowment with knowledge at universities and PROs [Corijn *et al.*, 2009], a rather modest role (although not significantly lower than in the other large city agglomerations) of these public research actors can be noted as sources for innovation for SMEs in KIBS in Brussels. Also surprising is that in the conference city in Belgium par excellence, reliance on sources for creative ideas in temporary clusters in conferences, trade fairs, and exhibitions is significantly lower. However, the latter as such should not

be perceived a negative element since highly relying on knowledge provided in temporary clusters can be an indication of low source awareness [Maskell, 2014].

- 13 Inspired by the limitations of the Community Innovation Survey in terms of measurement of number of partners, Laursen and Salter [2004] use the term breadth to mean the number of different types of search channels a firm draws upon as an enabler for innovative performance. For Brussels this amounts to 2.02, which is significantly lower (5 percent significance level) than the breadth of sources of SMEs in KIBS located in the other large city agglomerations (2.33).

Figure 2. Sources of information for innovation (2008-2012), % of total innovative firms, Brussels agglomeration



Brussels agglomeration N=161; city agglomerations of Antwerp, Charleroi, Ghent, Liège: N=185. Significant differences between the Brussels agglomeration and large city agglomerations for conferences, trade fairs and exhibitions as a source of information for innovation (pr test, significant difference at 1 % level); for scientific journals and trade/technical publications and for competitors or other enterprises within the sector (10 % significance level).

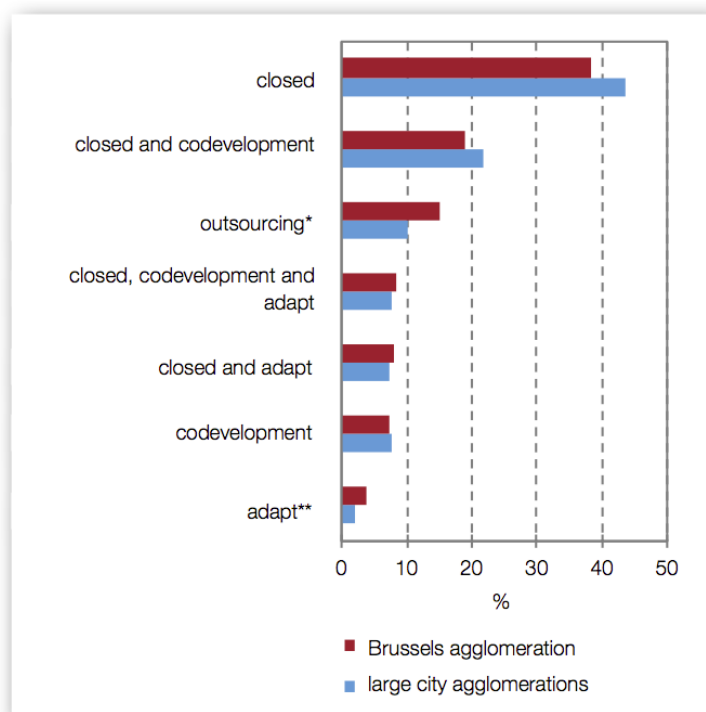
SOURCE: COMMUNITY INNOVATION SURVEY (2008-2010 AND 2010-2012)

3.2. Innovation Development Strategy

- 14 Closely connected to the ideas (and idea generating process) for innovation, the firm puts forward a strategy to turn creative ideas into innovation (process of bringing a novel idea to the market). A distinction can be made between a closed (internal), a codevelopment (together with external private/public organisation), an outsourcing (buy from external private/public organisation), and an adapt (from external private/public organisation) strategy [see e.g. Teirlinck and Spithoven, 2008]. A firm is usually involved in different innovation projects, each warranting a different strategy. Despite the huge attention to open innovation practices, two out of five SMEs entirely rely on internal development, or

in other words follow a closed innovation strategy (Figure 3). This percentage is somewhat lower in Brussels, and in line with the slightly lower reliance on internal sources (Figure 2). One out of five firms combines a closed with a codevelopment strategy. A closed strategy combined with adaptation of external ideas – whether or not including codevelopment – is followed by about one out of seven SMEs. Innovating by outsourcing existing external technology occurs less frequently in the sector. This is in line with the client and market driven focus of SMEs in KIBS. However, for Brussels, a strategy involving buying external knowledge for innovation development occurs more frequently and in close to five percent of the SMEs even is the sole strategy. This points in the direction of a sufficiently large internal (absorptive) capacity to absorb external ideas and to turn these into innovation [Cohen and Levinthal, 1990].

Figure 3. Innovation development strategy, % of total innovative firms 2008-2012, Brussels agglomeration



BRUSSELS Agglomeration N=190; City Agglomerations of Antwerp, Charleroi, Ghent, Liège: N=197. NO INFORMATION IS AVAILABLE ON THE OUTWARD TRANSFER OF TECHNOLOGY AND IDEAS (E.g. OPEN EXPLOITATION PROCESS WITH SELLING OF IDEAS THAT DO NOT FIT WITHIN THE FIRM'S CORE BUSINESS OR STRATEGY). *STRATEGY INCLUDING OUTSOURCING (WHETHER OR NOT COMBINED WITH A CLOSED, CODEVELOPMENT, ADAPT STRATEGY). **ADAPT STRATEGY AND ADAPT IN COMBINATION WITH CODEVELOPMENT STRATEGY.

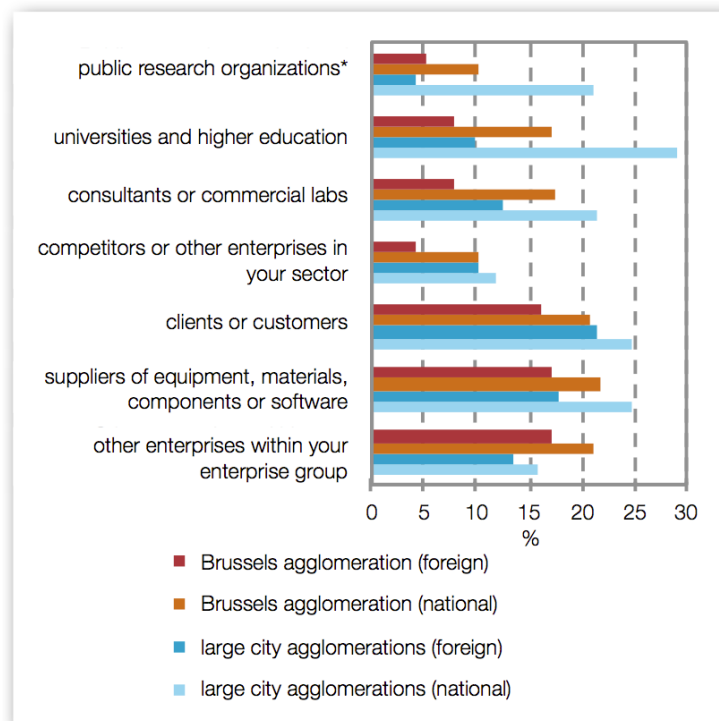
SOURCE: COMMUNITY INNOVATION SURVEY (2008-2010 AND 2010-2012)

3.3. Collaboration in Innovation

- 15 About half the firms rely on codevelopment for (some of) their innovations. This refers to more formal collaboration for transferring a creative idea into innovation (bringing to market) and includes both technical and market access support collaboration. The codevelopment approach reflects that knowledge creation, learning and innovation are

interactive processes, meaning that different actors possessing different types of knowledge exchange this information in order to solve technical, commercial, organisational or intellectual problems. During the period 2008-2012 universities and PROs, as well as clients and suppliers are the most solicited partners (Figure 4). The role of universities and PROs is far larger than the more limited role these actors occupy in terms of sources of information (ideas) for innovation (Figure 2). So it seems public research partners are more solicited for practical help to solve problems or in the innovation development process at large. Surprisingly, and highly significant, universities and PROs play a reduced role in this process in Brussels (compared to their counterparts in the four large city agglomerations). Also, reliance on other partners is somewhat lower (but not significantly) in Brussels, the exception being other enterprises within the proper group. The latter indicates an important cross border knowledge codevelopment in Brussels, in particular since the groups are found to be mainly international. This finding is in line with the significant higher reliance on an outsourcing strategy in Brussels (see before – Figure 3).

Figure 4. Collaboration in innovation development (2008-2012), % of total innovative firms, Brussels agglomeration



BRUSSELS Agglomeration N=188; City Agglomerations of Antwerp, Charleroi, Ghent, Liège: N=185. Significant differences between the Brussels and the large city agglomerations for collaboration with universities or other higher education institutes and with public research organisations (PR test, significant difference at 1% level). *including semi-public research organisations

SOURCE: COMMUNITY INNOVATION SURVEY (2008-2010 AND 2010-2012)

- 16 The breadth of collaboration in terms of number of different types of national partners amounts to 1.19 in Brussels, which is significantly (10 percent level) lower than the 1.49 in the large city agglomerations. For international partners it is 0.76 (versus 0.90).

Conclusion: Industry-science mismatch in Brussels?

- 17 The promotion of industry-science knowledge interactions is high on the science, technology and innovation (STI) policy agenda [OECD, 2016]. This is also particularly relevant at regional level since the presence of universities and PROs (the public knowledge infrastructure) has been identified as a main location and clustering factor for private R&D, also in the small open Belgian economy [Teirlinck and Spithoven, 2005].
- 18 The available evidence suggests an industry-science mismatch in Brussels; reflected in limited interactions between industry and science in terms of knowledge sourcing, and a particularly low engagement in industry-science collaboration. But is there really a mismatch? At least some critical reflections need to be made. First, an explanation for the limited industry-science interactions could reside in the differences between Brussels and other large city agglomerations with respect to SMEs in KIBS. The average firm in Brussels is larger, less involved in combined product-process innovation, and operates more on the national market. Second, firms make a trade-off between access to a wide range of knowledge and too many ideas to manage and implement [Hessels *et al.*, 2014]. This is particularly relevant in the case of university-industry networks because of rising coordination costs to align the agendas of university researchers and business. So, it might simply be that SMEs in KIBS in Brussels are better informed which sources to use and where to find them [Maskell, 2014]. The latter could be related to advantages of the high specialisation and concentration of KIBS in Brussels. The low reliance on sources in temporary clusters and the higher reliance on outsourcing in the innovation process support this view.
- 19 Whatever the reason or combined reasons is or are, this study highlights specificities for knowledge sourcing, strategies for developing ideas into innovation, and collaboration profiles between innovative SMEs in KIBS in Brussels compared to the other large city agglomerations in Belgium. These particularities should be taken into account in the Regional Innovation Plan for Brussels. Moreover, more attention needs to be paid to the morphological borders of the city, since the views presented at city agglomeration level shed a different light on the mismatch. Indeed, in a regional comparison, Brussels ranks high on the ratio public versus private R&D expenditures. However, at city agglomeration level, *i.e.* taking into account the morphological boundaries of the city agglomeration, the research strength of Brussels lies rather in the private sector. In order to better understand the topic, a more refined evidence base is necessary for policy making. We recommend to refine data collection in the Community Innovation Survey allowing to make a geographical link between private innovation actors in Brussels and collaboration or sources provided by public research actors within (local buzz) and beyond (knowledge pipelines) the borders of the region or city agglomeration. Also, attention should not only be paid to the existence of these knowledge interactions, but also to their relevance and content.

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ABSTRACTS

This study provides insights in knowledge spillovers in terms of the use of different sources of knowledge at the origin of innovation, collaboration in innovation, and the reliance on a closed or more open innovation strategy by firms in the Brussels agglomeration. The focus is on innovative small and medium-sized enterprises (SMEs) in knowledge intensive business services (KIBS) in Brussels. These firms are compared with their counterparts in the other large city agglomerations in Belgium.

Based on data from two waves of the Community Innovation Survey (2008-2010 and 2010-2012) it is revealed that universities and public research organisations (PROs) play a rather limited role as providers of ideas at the origin of innovation in these firms in Brussels, and are significantly less solicited for industry-science collaboration.

These findings contrast the more open innovation development strategy of SMEs in KIBS in the capital city agglomeration and the abundant presence of knowledge at universities and PROs, and hence raise the question of an industry-science mismatch.

Cet article fournit un aperçu de la diffusion des connaissances dans les entreprises de l'agglomération Bruxelles, à travers l'examen des différentes sources d'informations qu'elles utilisent à des fins d'innovation, des collaborations mises en place en la matière et du degré d'ouverture de leur stratégie d'innovation.

L'étude se concentre sur les PME innovantes actives dans le domaine des services aux entreprises intensifs en connaissance (SEIC) à Bruxelles, au regard de celles des autres grandes agglomérations de Belgique.

D'après les données issues de l'Enquête communautaire sur l'innovation (volets 2008-2010 et 2010-2012), il s'avère qu'à Bruxelles, les universités et organismes de recherche publics (ORP) jouent un rôle assez limité dans l'approvisionnement de ces entreprises en idées favorisant l'innovation, la sphère scientifique étant en outre significativement moins sollicitée à des fins de collaboration avec l'industrie.

Ces constatations, qui contrastent avec la stratégie plus ouverte de développement des innovations adoptée par les PME du secteur des SEIC entreprises de l'agglomération de Bruxelles ainsi qu'avec l'abondance de connaissances propres aux universités et ORP, amènent à s'interroger sur l'existence d'une inadéquation entre l'industrie et le milieu scientifique.

Dit onderzoek biedt inzicht in kennisoverdracht op het vlak van het gebruik van verschillende informatiebronnen voor innovatie, samenwerking op het vlak van innovatie en het volgen van een gesloten of meer open innovatiestrategie door ondernemingen in de Brusselse agglomeratie. De focus ligt op innovatieve kleine en middelgrote ondernemingen (KMO's) in kennisintensieve business services (KIBS) in Brussel. Deze ondernemingen worden vergeleken met hun tegenhangers in andere grote agglomeraties in België. Uit de gegevens van twee Europese-innovatie-enquêtes (2008-2010 en 2010-2012) blijkt dat universiteiten en publieke

onderzoeksinstituten een vrij beperkte rol spelen als leveranciers van ideeën die aan de oorsprong liggen van innovatie in dergelijke ondernemingen in Brussel, en aanzienlijk minder worden aangesproken voor industrieel-wetenschappelijke samenwerking.

Deze bevindingen steken af bij de meer open innovatiestrategie gevolgd door KMO's in KIBS in de Brusselse agglomeratie en de overvloedige aanwezigheid van kennis aan universiteiten en bij publieke onderzoeksinstituten. Dit roept de vraag op of er een *mismatch* bestaat tussen industrie en wetenschap.

INDEX

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Keywords: economic development, economy, innovation, research and development

Trefwoorden: economische ontwikkeling, economie, innovatie, onderzoek en ontwikkeling

Mots-clés: développement économique, économie, innovation, recherche et développement

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