

The spatial organisation of innovation: open innovation, external knowledge relations and urban structure

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**The spatial organisation of innovation:
open innovation, external knowledge relations and urban
structure**

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3 The spatial organisation of innovation: open innovation, external knowledge relations and
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5 urban structure
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22 Abstract
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27 The increased use of external knowledge relations, complementary to in-house R&D,
28
29 influences the way firms are organised to manage innovation. The ‘new’ imperative of open
30
31 innovation promotes the idea that firms organise innovation, to a greater extent, in interaction
32
33 with outside parties. This paper argues that both the organisation of innovation as well as the
34
35 use of external knowledge depends on the physical, socio-economic and cultural environment.
36
37 The outcome of the analysis supports the idea that (open) innovation is spatially organised.
38
39 Contrary to the expectations, innovative firms in less urbanised areas show a higher degree of
40
41 openness.
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48 JEL codes: L20, O18, O32, R12
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50 Key words: Open innovation, external knowledge relations, urban structure
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55 1. Introduction 56

57 Due to the increasing complexity of innovation, companies use external knowledge to
58
59 complement their in-house innovative activities. The well-known linear model of innovation
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3 was replaced by its successor, the non-linear feedback model (KLINE and ROSENBERG,
4
5 1986), incorporating the changed nature of technology and zooming in on the learning process
6
7 within, and between, firms and other organisations. However, as innovation networks grew
8
9 even more complex, the innovation strategies of firms changed accordingly. This
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11 development is captured by the 'new imperative' for creating and profiting from technology:
12
13 open innovation. In the 'open innovation model' firms adapt their business model in favour of
14
15 R&D activities and technical change that take place outside the firm. As such, innovation
16
17 becomes increasingly distributed amongst various partners (VON HIPPEL, 1988).
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22 Naturally, external knowledge is not to be found around every corner. It is crystallised
23
24 in space and not in some random manner. The rise of spatial organisation in the innovation
25
26 literature is being exemplified by many notions and concepts such as 'innovative
27
28 environments' (AYDALOT, 1985), 'clusters' (PORTER, 1990), 'innovative milieux'
29
30 (CAMAGNI, 1991), 'regional innovation systems' (COOKE, 1992), and 'learning regions'
31
32 (FLORIDA, 1995).
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36 The adoption by firms of the open innovation model has some potential implications
37
38 for the spatial organisation of innovation networks (COOKE, 2005). Interactions become the
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40 focus of research and these interactions imply an adapted spatial setting to facilitate the
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42 establishment of innovation networks and external knowledge relations. This paper aims at
43
44 the inclusion and empirical testing of the relation between (1) a physical, socio-economic and
45
46 cultural environment, (2) the openness of the firm, and (3) the external knowledge relations it
47
48 maintains. Therefore, the analytical difference between the internal open innovation business
49
50 model and the external knowledge relations of firms is important. The next section briefly
51
52 reviews the existing literature on this relation. The concepts and data are elaborated in section
53
54 3. Empirical testing for Belgium is dealt with in section 4. Tentative conclusions and
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56 guidelines for further research conclude the paper.
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2. Theoretical framework: knitting the strands together

The spatial organisation of innovation couples two strands of research. The first one acknowledges innovation as a main driver for local and regional economic growth, and places the innovation strategies of firms at the centre of the arguments. The second one aims at explaining how the spatial organisation works as a catalyst for innovation activities by firms. A closer look at these research themes brings out their points of intersection and the lines along which the analysis is conducted.

2.1. Open innovation and external knowledge relations

The notion of open innovation is the result of the increasing complexity of innovation and how innovation management should cope with this complexity. It reflects an ever changing research environment (CHESBROUGH, 2001): the increasing mobility of knowledge workers; the applicability of research results of universities to enterprises; more widely distributed knowledge; erosion of oligopoly market positions; more deregulation and an increase in venture capital. This resulted in an open stage gate process with the following features: (1) the centralised in-house R&D lab is no longer the main source of ideas or knowledge and is being complemented by other enterprises, new technology based start-ups, universities, and public research centres; (2) commercialisation also occurs outside the traditional markets of the enterprise through licensing, spin offs, and research joint ventures; (3) the role of the first mover advantage becomes more important than the development of a defensively orientated system of knowledge and technology protection. Chesbrough sees the well established 'closed' innovation model (Figure 1a) for managing industrial R&D eroding and gradually being replaced by an 'open' innovation model (Figure 1b) (CHESBROUGH, 2003: xxii and xxv).

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3 ** INSERT FIGURE 1a AND 1b ABOUT HERE **
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6 The most important implications of the open innovation model rest in the detection of
7 interesting technological trends and which knowledge and R&D is to be acquired through the
8 market. External knowledge relations are an indispensable element in the open innovation
9 business model and complement internal research (COHEN AND LEVINTHAL, 1990;
10 VEUGELERS, 1997; CHESBROUGH *et al.*, 2006). Many ideas Chesbrough formulated were
11 already around (COHEN and LEVINTHAL, 1990; ARORA and GAMBARDELLA, 1994;
12 HOWELLS, 1999; QUINN, 1999; CHIESA, 2001; VEUGELERS and CASSIMAN, 1999).
13
14 The particular focus in this paper on external knowledge relations in the ‘open innovation’
15 model is closely related to the concept of ‘distributed innovation’, i.e. means and measures
16 allowing companies to capture the distributed knowledge within a wide network of actors
17 (users, manufacturers, suppliers, research centres, and others) to solve a technical problem
18 (VON HIPPEL, 1988; COOMBS *et al.*, 2003; CHESBROUGH *et al.*, 2006).
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34 Although the open innovation model further emphasises the importance of the
35 ‘knowledge landscape’ for the organisation of internal R&D (CHESBROUGH, 2003: p.53),
36 none of the abovementioned authors felt the necessity to look into possible spatial impacts
37 these ideas brought in their wake. However, according to Cooke (2005), it is expected to find
38 spatial implications accompanying this change in business organisation. This paper deals with
39 this lacuna.
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51 2.2. Bringing in the spatial dimension of innovation

52 The spatial organisation of innovation has attracted the attention of many (FELDMAN, 1994;
53 BRESCHI, 1999). The concept is hardly new. It can be found in the works of Marshall
54 (‘industrial districts’) where the spatial specialisation of economic activities leads to
55 agglomeration economies. In terms of industrial policy, the cluster approach (PORTER, 1990)
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3 has occupied a prominent position since the nineties. The attraction of the cluster concept
4
5 remains very strong until today. Yet these 'clusters' mostly consist of several specialisations
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7 and are far less (if at all) rooted in space.
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11 However, the concentration of knowledge resources providing a critical mass for
12
13 innovation is mainly to be found in urban areas which give them a relative advantage over
14
15 more non-urban locations (FELDMAN, 1994). The transfer of knowledge is enhanced in
16
17 urban areas because of the concentration of innovative companies, universities and research
18
19 centres (MALECKI, 1979), and on account of the provision of pools of technical knowledge
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21 and specialisations having the capacity to develop new technologies assisted by similar
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23 concentrations of business services. The latter provide the marketing and commercial
24
25 knowledge required for the introduction of innovations on the market (FELDMAN, 1994).
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30 The tendency of enterprises to open up their innovation process through directing their
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32 business models so as to incorporate and manage the external knowledge relations could
33
34 transform the spatial organisation of innovation. It is hypothesised that open innovation
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36 entails an intensification of the external knowledge relations and thus depends to a greater
37
38 extent on available knowledge resources. These resources are assumed to be predominantly
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40 concentrated in urban areas due to the presence of universities, public research organisations,
41
42 etc. Moreover, localised interactions promoting technological innovation are thought to be a
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44 driving force behind the persistence of urbanisation and localisation because spatial proximity
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46 improves flows of information upon which innovators depend, creating technological
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48 'spillovers'. In this respect there is fragmentary but fairly convincing evidence that urban areas
49
50 are centres of innovation in the production of both ideas and knowledge, and in their
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52 commercialisation (FELDMAN and AUDRETSCH, 1999; JAFFE, TRAJTENBERG and
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54 HENDERSON, 1993).
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3 Possessing different specialisations, urban areas have a main advantage in offering
4 possibilities for 'picking and mixing' knowledge inputs as and when they are needed
5
6 (SIMMIE, 2003). Moreover, urban areas facilitate learning and are particularly attractive for
7
8 highly-talented young people who have large potential returns from learning. In addition,
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10 labour mobility among highly qualified professional and technical workers which contribute
11
12 to the sharing and diffusion of knowledge is more likely to occur within urban labour markets
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14 (FLORIDA, 1995). The absorption of knowledge from contact with more skilled individuals
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16 in their own industry and the number of probable contacts an individual makes it an
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18 increasing function of city size (GLAESER, 1999). The economic and social diversity jam-
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20 packed into a limited space facilitates haphazard, serendipitous contact among people
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22 (JACOBS, 1969), and face-to-face contact (STORPER and VENABLES, 2003) creates an
23
24 important advantage for urban areas.
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31 Based on these insights the basic hypothesis of this article is that innovative firms in urban
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33 areas have a business model that favours open innovation and relies increasingly on external
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35 knowledge relations since the firms operate in an environment inducing them to act
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37 accordingly.
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43 2.3. Additional factors: firm characteristics and the nature of innovation

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45 Space related differences in the business model of open innovation and the use of external
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47 knowledge must not lead to neglect various other features that can influence this relation. The
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49 literature points to firm size, sector of activity, novelty of innovation and type of innovation.
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53 Since Schumpeter firm size is coupled to innovative activities and enhances the ability
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55 to adapt to the environment, to create and to assimilate knowledge. It affects both knowledge
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57 and technology transfer because it involves identifying the appropriate sources, interacting
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59 with those sources, acquiring the knowledge and/or technology, and integrating them into
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3 existing organisational systems and procedures (ZMUD 1982). Large firms are thought to
4
5 embrace the model of open innovation to a greater degree than smaller ones. The latter
6
7 sometimes lack a critical mass of absorptive capacity and – especially in the case of
8
9 knowledge intensive firms – are less likely to be open to outside partners. These firms are
10
11 often based on the exploitation of a new idea and, given the danger they face from leakage of
12
13 their ideas, they limit the nature and scope of external interaction. They are also extremely
14
15 resource constrained and may therefore lack the time and attention necessary to capture
16
17 knowledge from external sources.
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21
22 The second firm characteristic is the sector of activity of the firm. Pavitt (1984)
23
24 established a taxonomy of four different sector types for manufacturing industry: science
25
26 based, scale intensive, resource intensive and specialised suppliers. Tidd *et al.* (1997) added a
27
28 fifth type (including services): the information intensive sector. From the perspective of
29
30 differences in knowledge exchange – according to the taxonomy – geographical location
31
32 matters because of differences in knowledge endowment opportunities. In this respect, it is
33
34 supposed that science-based, specialised suppliers and information intensive enterprises prefer
35
36 urban areas. On the other hand, scale intensive firms are assumed to locate outside urban areas
37
38 because of the availability of physical space. For resource intensive firms the situation is
39
40 ambiguous. On the one hand they seem to be less dependent on the urban environment and
41
42 locate wherever the (natural) resources are available. On the other hand, they are attracted by
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44 the diversity of activities in urban areas hinted at by Jacobs (1969), Feldman and Audretsch
45
46 (1999) and Simmie (2003).
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53 As for the nature of innovation, a distinction should be made between the type of
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55 innovation (product versus process innovation) and the degree of novelty (incremental versus
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57 breakthrough innovation). Innovative firms in urban areas are found to be more involved in
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59 product innovation, whereas non-urban areas tend to have a bias towards process innovation.
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3 Based on empirical evidence for Great Britain by Harris (1988), and by Kleinknecht and Poot
4
5 (1999) for the Netherlands, innovative firms in urban areas are found to be more involved in
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7 product innovation, whereas non-urban areas tend to have a bias towards process innovation.
8
9

10 Breakthrough product innovations are supposed to be associated with a high degree of
11
12 risk and uncertainty and, in the early stage of their life cycles, often undergo drastic changes
13
14 due to unforeseen technical problems, consumer reactions, and actions by competitors. Thus
15
16 firms are supposed to rely on specific 'new' insights that might be developed in collaboration
17
18 with key players (universities, suppliers, customers, etc). Consequently, agglomeration
19
20 advantages can be of considerable importance for the emergence of such innovations and for
21
22 the probability of their success or failure. As such, urban areas are a better breeding place for
23
24 this kind of innovation (KLEINKNECHT and POOT, 1992). In a later stage of a technology
25
26 life cycle, agglomeration advantages may lose importance and production may be transferred
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28 to locations in more non-urban areas where factor prices are lower (MARKUSEN, 1985).
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36 2.4. Research design

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38 The preceding paragraphs hand down three dimensions to study the innovation strategies of
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40 firms: (1) its location in the urban structure; (2) the degree of openness of the innovator; and
41
42 (3) its position vis-à-vis external knowledge relations. To understand the spatial organisation
43
44 of innovation the urban structure is central. Hence the search for associations between urban
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46 structure and degree of openness; between urban structure and external knowledge relations;
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48 as well as the interaction effect between all these variables. This is reflected in the upper part
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50 of Figure 2. The lower part lists the control variables.
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54 ** INSERT FIGURE 2 ABOUT HERE **
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3 All variables (printed in capitals) are categorical and have different levels. It is common to
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5 analyse these data through loglinear modelling. The number of enterprises is placed between
6
7 brackets. The model in Figure 2 guides the analysis in the empirical section 4.
8
9

10 11 12 13 3. Data description: Community Innovation Survey and urban structure

14 15 3.1. Open innovation and external knowledge relations

16
17 The paper draws on data for Belgium gathered as part of the Third European Community
18
19 Innovation Survey conducted in 2002 by the different member states of the European Union.
20
21 The survey was organised by postal mailing and stratified according to firm size (measured in
22
23 terms of employment), economic activity (following the International Standard for Industrial
24
25 Classification), and geographical location (following the NUTS-classification and stratified at
26
27 NUTS1 level). For the latter, the location of the economic activity rather than the location of
28
29 the headquarters is the main criterion. The target population includes private enterprises with
30
31 10 or more employees, active in a broad range of sectors.
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36 The survey provides information on the overall innovation activity by firms.
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38 Innovative firms have achieved at least one product and/or process innovation during the
39
40 period 1998-2000. A representative sample of 1,274 innovating firms was retained. Their
41
42 innovation activities include firm level data on the sources and acquisition of innovation, and
43
44 collaboration in the field of innovation. A wide pallet of partner types are included both for
45
46 collaboration and sources (including universities, public research organisations, competitors,
47
48 clients, suppliers, etc.), painting the innovation networks of companies. The survey gathered
49
50 information on the type (product and/or process) of innovations, and on the degree of novelty
51
52 of innovations. The sector of activity and firm size are also known.
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57 To capture 'open innovation' the respondents were divided into three types referring to
58
59 the 'degree of openness', using the mutually exclusive answer on the question 'who is *mainly*
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3 responsible for the product and/or process innovation developed within the firm?' The
4
5 possibilities are: mainly the enterprise (i.e. the 'closed' or 'in-house' innovator), the enterprise
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7 in collaboration with others (the 'co-developing' innovator), or mainly others (the
8
9 'outsourcing' innovator). A hierarchy in the degree of open innovation is imposed between
10
11 these types in the sense that co-developing innovators are considered to be more 'open' than
12
13 'outsourcing' innovators. The reason is that the co-developing innovator maintains a
14
15 deliberate two way interaction between the innovator and another party based on mutual trust
16
17 and knowledge sharing. An innovator mainly outsourcing its innovation is, in turn, more
18
19 'open' than the firm mainly making its innovations in-house because there is an undeniable
20
21 one way transfer of knowledge from outside the company. It is important to note that the
22
23 degree of openness is only defined in terms of the realisation of the innovation.
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30 In contrast with the division in terms of openness of innovation, the different forms of
31
32 external knowledge relations are not mutually exclusive: each innovator can be involved in
33
34 each of the three types of external knowledge relations. The sources of innovation are further
35
36 divided into market sources, public sources and other sources. When it comes to acquisition, a
37
38 distinction is made between buying external R&D, embodied technology, and intellectual
39
40 property rights. Collaboration is divided into collaboration with market partners, public
41
42 partners or partners operating in a technology market. Special attention is paid to these
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44 divisions further on. The mutual occurrence of these external knowledge relations implies that
45
46 the research design will be tested for each of these relations separately.
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53 3.2. Urban structure

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55 Empirical research on the location of innovation evolves around the key notion of
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57 agglomeration. Based on the work of Lösch (AYDALOT, 1985 and FELDMAN and
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59 AUDRETSCH, 1999), urbanisation economies represent advantages gained by all firms,
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3 regardless of sector, from being located together. The emphasis lies on the different assets of
4
5 place for innovative effects stemming from the internal operating of geographic areas
6
7 (FELDMAN and AUDRETSCH, 1999). Urbanisation economies can be regarded as a general
8
9 form of localisation economies, which refer to advantages that firms in a single industry, or in
10
11 a set of closely related industries, gain from being located in the same place. In the case of
12
13 urbanisation economies, all firms benefit from a pooled market for knowledge workers in
14
15 general, from more efficient suppliers to the industry in general, and from a more efficient
16
17 provision of general research infrastructure. Reference can also be made to certain
18
19 technological spillovers benefiting a whole range of sectors, as opposed to one particular
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21 sector.
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27 The concept of 'urban structure' can be made useful to detect features of urbanisation
28
29 economics. The hierarchical urban structure is the principal framework used to account for the
30
31 extension and evolution of urbanisation processes in Belgium (VAN DER HAEGEN *et al.*,
32
33 1996, LEEMANS *et al.*, 1990). The urban structure consists of a classification of spaces
34
35 defined by the combination of a variety of functional, morphological and dynamic criteria.
36
37 The degree of urbanisation, together with socio economic and socio cultural data, determines
38
39 a hierarchical pattern in the localisation of people within cities and villages. This hierarchical
40
41 structure includes four areas: urban, suburban, commuter, and other.
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46 The urban area is a morphological agglomeration defined by the continuity of
47
48 residential dwellings (the threshold is 250 metres) around a central city characterised by a
49
50 certain concentration of shops and services, a given density of population as well as the age
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52 and size of its dwellings. In the case of innovation, these surroundings provide a central
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54 feature of the knowledge base because most universities and public research infrastructure are
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56 located in this area.
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3 The term 'suburban area' is used to define 'an area around the urban area'. Its definition
4 is based on the population growth, the median income (relative to the district income), the
5 importance of residential migration from the agglomeration, the travel to work and school
6 flows, and finally the evolution of build-up surfaces. With regard to innovation, many of the
7 knowledge workers with higher incomes reside in suburban areas because of the perceived
8 higher quality of life (FLORIDA, 2002).
9

10
11 A 'commuter area' contains the municipalities where 15 % of the working population
12 resides and migrates from, on a daily basis, towards the urban area. While suburban areas
13 refer to the process of suburbanisation, the use of countryside areas refers to the residential
14 commuter area. Again, in the light of innovation activities, the commuter areas are endowed
15 with much more physical space to develop economic activities that require a large scale.
16
17

18 The final category consists of 'other' areas which are more or less of a rural nature. A
19 good example of these type of areas can be found in the Southern part of Belgium (the
20 Ardennes) which is far less populated and accessible due to the forests.
21
22

23 The urban structure capturing the overall attraction of municipalities in terms of a variety of
24 socio-economic and cultural variables can be described through the classification of the 589
25 municipalities in Belgium in 17 city regions. Each of these city regions includes urban,
26 suburban and commuter areas, and is to a high extent spatially independent from the other city
27 regions. Of the 589 municipalities 98 are classified as urban areas; 117 as suburban areas; 160
28 as commuter areas; and the rest (214) as other areas. These categories make up the urban
29 structure in Belgium as depicted in Figure 3. It shows that the urban structure classifies
30 geographical areas all over the Belgian territory in four distinct categories. This results in a
31 limited spatial dependency for the areas classified in the same category, and has important
32 implications for the empirical analysis (see further). The Figure also illustrates that, although
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3 distances are fairly small and there is an abundant supply of transport facilities, it is incorrect
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5
6 to refer to Belgium as a whole being an urban field.
7

8 ** INSERT FIGURE 3 ABOUT HERE **
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10 The innovation data provided by the Community Innovation Survey are linked to the urban
11
12 structure by means of the postal code available for each innovative enterprise. Careful
13
14 screening is done in order to take into account the location where the economic activity takes
15
16 place rather than the location of the headquarters.
17
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21 22 3.3. Control variables: firm characteristics and the nature of innovation 23

24 Control variables include, firm size, sector of activity, the degree of novelty of innovation and
25
26 the type of innovation. Firm size is measured by the number of employees. Only enterprises
27
28 of 10 or more employees are taken into account. Firms employing between 10 and 49
29
30 employees are classified as small. Large enterprises employ 50 or more employees.
31
32

33
34 The sector of activity is based on a conversion of the ISIC-classification used in the
35
36 innovation survey in the adapted Pavitt taxonomy (see Annex 1). It differentiates between
37
38 'science based', 'specialised suppliers', 'resource intensive', 'scale intensive', and 'information
39
40 intensive' firms.
41
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43 Concerning the innovation characteristics (degree of novelty and type of innovation),
44
45 the results of the Community Innovation Survey allowed a differentiation between enterprises
46
47 realising only product innovations, those only involved in process innovation, and those
48
49 specialised in both types of innovation. The degree of innovation (breakthrough versus
50
51 incremental) was proxied by the fact whether the innovation was new to the enterprise only
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53 (incremental) or totally new for the market (breakthrough).
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60 3.4. Data restrictions and robustness

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3 The use of data provided by the Community Innovation Survey has its limitations. First, the
4 survey captures an aggregate picture of firm innovation behaviour. Consequently, variations
5 in innovation behaviour at the project level may be obscured. Secondly, due to the response
6 burden it would generate, the analysis does not consider mutually exclusive activities for
7 external knowledge relations (sources of innovation, acquisition of innovation or
8 collaboration on innovation). The other variables considered (degree of openness of
9 innovation, urban structure, firm size, sector of activity, degree of novelty and type of
10 innovation) do not suffer from this problem. Furthermore, the interactions between the degree
11 of openness of innovation and external knowledge relations on the one hand, and the type and
12 degree of novelty of the innovation on the other hand can be troubled because of measuring
13 both aspects within the same (two-year) time-span.
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29 The analysis uses variables divided into discrete categories. It looks for possible
30 associations and effects of interaction between the different variables in a multidimensional
31 frequency table. The technique of loglinear modelling is well-suited for this and the number
32 of observations (see Figure 2) allows doing so. The use of urban structure limits the problem
33 of spatial dependency (in this case, the spatial reach of knowledge relations) and does not
34 imply spatial econometrics.
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46 4. Empirical analysis

47 4.1. Urban structure and open innovation

48 Table 1 links urban structure to degree of openness of innovation. There is a significant
49 difference between urban and suburban areas on the one hand and commuter and other areas
50 on the other. Innovators in the latter areas apparently are more open innovation minded. This
51 difference is reflected in a higher preference for innovations together with third parties (co-
52 developing) and, for 'other' areas, also in a higher propensity for relying on external parties
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3 (outsourcing) for the development of innovations. The statistical dependency reveals that the
4
5 degree of openness of innovation significantly differs for the four areas shaping the urban
6
7 structure.
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10 ** INSERT TABLE 1 ABOUT HERE **
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12 At a first glance, the results are not in line with those derived from the theoretical insights
13
14 presented in the introduction. Innovating firms active in a more urbanised environment would
15
16 be expected to have a business model for innovation that is more (and not less) open for
17
18 interaction with the environment. All this because of the larger opportunities for positive
19
20 spillovers from the presence of universities, public research centres, other enterprises, and
21
22 services firms enhanced by a relatively better developed research infrastructure and
23
24 knowledge networks. A closer look at the external knowledge relations (sources, acquisitions
25
26 and collaborations) by urban structure could help explaining this finding.
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34 4.2. Urban structure and external knowledge relations

35 4.2.1. *Urban structure and the sources of innovation*

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37 Table 2 presents the external technology sources of innovation. For 1,256 out of the 1,274
38
39 firms information on their sources of innovation is available. Respondents could give multiple
40
41 answers indicating more than one source. All taken together, no overall significant association
42
43 is found between the type of external technology source used and the urban structure of the
44
45 environment.
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50 ** INSERT TABLE 2 ABOUT HERE **
51

52 Market sources are very popular, except in the case of competitors. This might be caused by
53
54 the need to protect innovation in order to benefit from it. Public information sources, which
55
56 are mostly located in urban areas, are the least popular in all areas of the urban structure. The
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3 other sources of innovation have an outspoken general character and are also a very popular
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5 channel.
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10 4.2.2. *Urban structure and acquisition of innovation*

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12 The innovation survey gathered information on three types of external technology offered on
13 the market: external R&D, embodied technology and intellectual property rights. External
14 R&D refers to the creative work to enlarge the stock of knowledge in the company needed to
15 develop new products or processes. A company can also buy embodied technology offered on
16 the market. In this case, advanced equipment, computer hardware, and specialised machinery
17 is purchased in order to develop new products or processes. Finally, the firm can decide to
18 buy intellectual property rights (patents, licences, trademarks, etc.) for the use of its
19 innovation(s). These types are considered in Table 3.
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31 ** INSERT TABLE 3 ABOUT HERE **
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34 According to the test of association, there is a difference in the dispersion of acquisition
35 activities in relation to urban structure at a 10 % significance level. The acquisition of
36 embodied technology is a common activity in all areas of the urban structure but occurs
37 relatively less in the urban areas. Almost one third of all innovators have external R&D.
38 Again, this is to a lesser extent the case in the urban areas. The reason might be that the
39 knowledge base for enterprises in urban areas is larger than for enterprises operating in other
40 areas.
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53 4.2.3. *Urban structure and collaboration on innovation*

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55 A limited number of innovating firms are involved in collaboration in the field of innovation.
56 From the 1,274 firms in the sample, 380 collaborated on innovation. Firms restricting
57 collaboration to the enterprise group were excluded, for it can be argued that in a lot of cases
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2
3 this kind of collaboration is hardly external. Firms collaborating within the enterprise group in
4
5 addition to other types of partners remained in the sample.
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8 ** INSERT TABLE 4 ABOUT HERE **
9

10 From the results in Table 4, no clear dispersion is noted according to the test of association.
11
12 Overall, urban based universities are frequently solicited for collaboration (50.8% as
13 compared to 36.9% when universities are considered as a source of innovation, Table 2). The
14
15 opposite is the case for all market partners: suppliers, clients and competitors. This
16
17 phenomenon could be explained by the idea that collaboration with these partners might lead
18
19 to negative spillover effects and thus jeopardise profitability.
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24 In sum, based on Tables 2, 3 and 4, no clear association between urban structure and
25
26 the various external knowledge relations is found.
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31 4.3. Urban structure, open innovation and external knowledge relations 32

33 Combining the pieces of the open innovation business model and the reliance on external
34
35 knowledge relations in one model while bringing in the urban structure, allows looking for
36
37 associations between the three components of the basic model as presented in the research
38
39 design. Because external knowledge relations are not mutually exclusive each type of relation
40
41 is modelled separately. The screening of the best loglinear model is done using a simple
42
43 backward strategy. Starting from a saturated model where the frequency table is completely
44
45 replicated ($L^2=0$), the Brown's screening method based on Akaike's and/or Bayesian
46
47 information criterion (AIC and BIC) checks, in a hierarchical way, for non significant effects.
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51 This approach penalises for complexity and sample size and thus results in the most
52
53 parsimonious model (that with the lowest L^2). The p-value indicates how well the model fits
54
55 the data. A balance needs to be found between this goodness of fit (p-value) and the
56
57 simplicity (AIC and BIC based on the L^2 -statistic) of the model (HAGENAARS, J.A., 1990).
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3 For the sake of brevity, this paper only reports the best model in terms of AIC and BIC which
4
5 in all models did not contradict each other.
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10 4.3.1. External sources of innovation

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12 Figure 4 presents the three models depicting the relations between urban structure, degree of
13
14 openness of innovation, and external sources of innovation (market or public or other – see
15
16 section 4.2.1).
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19
20 ** INSERT FIGURE 4 ABOUT HERE **
21

22 The model including market sources shows a significant association between market sources
23
24 and degree of openness of innovation, and between openness of innovation and urban
25
26 structure. Apparently, firms mainly co-developing their innovations are significantly less
27
28 involved in market sources. The opposite is true for innovators mainly outsourcing to
29
30 complete their innovations.
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34 A similar model appears when concentrating on the public sources of innovation. The
35
36 association between degree of open innovation and public sources of innovation is also
37
38 significant. Firms outsourcing their innovation use significantly less public sources. The
39
40 opposite is true for firms co-developing their innovations and to a lesser extent (at 10%
41
42 significance level) also for in-house innovators. These results are in line with the findings in
43
44 Table 1.
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46

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48 Other sources, although often used as external technology source (Table 2), are not
49
50 related to urban structure, nor to the degree of open innovation. This is an indication that these
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52 sources are equally present in all areas and for all degrees of open innovation. This should not
53
54 come as a surprise since meetings and magazines and fairs and exhibitions are presumably the
55
56 easiest sources to access.
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4.3.2. Acquisition of innovation

Figure 5 presents the results of three separate loglinear models for each type of acquisition (external R&D, embodied technology, intellectual property rights), urban structure and the degree of openness of innovation.

**** INSERT FIGURE 5 ABOUT HERE ****

Firms mainly co-developing their innovation with third parties, rely significantly more on acquisition of external R&D and of intellectual property rights. In the case of external R&D, the opposite is true for ‘outsourcing’ innovators. In-house innovators, on the other hand, are significantly less involved in the acquisition of embodied technology. Furthermore, the latter form of acquisition occurs significantly less in urban areas. These differences offer a partial explanation for the rather odd finding in Table 1 i.e. innovators tend to have a more ‘closed’ innovation strategy in urban areas. A larger part of the innovating firms in other areas tend to rely on embodied technology which is rather easy commercialised, whereas firms in urban areas tend to be more oriented towards the acquisition of external R&D and intellectual property rights referring to innovation requiring more in-house absorptive capacity before it can be translated into potential commercial success. However, these results can not explain as to why there are more firms co-developing their innovations with third parties in the less urbanised areas.

4.3.3. Collaboration on innovation

Figure 6 presents the results of the loglinear models for collaboration (collaboration with market partners, public partners and partners active on the technology market), urban structure, and degree of open innovation.

**** INSERT FIGURE 6 ABOUT HERE ****

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2
3 Firms mainly co-developing their innovations tend to rely more on collaboration with market
4 partners in comparison to firms mainly outsourcing their innovations. The finding in Table 4
5
6 that collaboration with competitors (and more generally market partners) is more preferred in
7
8 urban areas in comparison to other areas, possibly refers to larger opportunities for economies
9
10 of agglomeration in urban areas than in non-urban areas. As such, it corroborates the ideas
11
12 mentioned in the theoretical framework.
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16
17 In the case of collaboration with public partners or with partners operating in the
18
19 technology market there is a significant association between urban structure and openness of
20
21 innovation. When it comes to the subset of collaborating firms – from the 1,274 innovative
22
23 firms, only 380 firms are involved in collaboration – this association seems to hold.
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25

26
27 The lack of differences in public and technology market collaboration for each area
28
29 could be an indication that in an economy with dense infrastructure and good
30
31 telecommunication networks, accessibility of this kind of knowledge is homogeneously
32
33 distributed.
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35
36 In sum, testing the association ‘urban structure – open innovation – external
37
38 knowledge relations’ reveals significant associations between the business model in terms of
39
40 openness to innovation and the use of external knowledge sources, and between openness of
41
42 innovation and urban structure. With the exception of the acquisition of embodied technology,
43
44 no links are found supporting a direct association between external knowledge relations and
45
46 urban structure (see Table 2, 3 and 4). Therefore, differences in the business model in terms
47
48 of open innovation are associated with differences in urban structure rather than with
49
50 differences in external knowledge relations (confirming the results obtained in section 4.1 and
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52 4.2).
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60 4.4. Taking into account firm characteristics and the nature of innovation

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3 In extension of the basic model, firm size, sector of activity, degree of novelty of innovation
4 and type of innovation are included to verify whether these characteristics change the
5 associations between urban structure (U) – openness of innovation (O) – and external
6 knowledge relations (E = I, A or C). Only changes in the associations as they appear in
7 section 4.3 are reported. The distinction between (the sublevels of the) sources, acquisition
8 and collaboration on innovation is maintained.
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20 *4.4.1. Sources of innovation*

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22 Section 4.3.1 revealed an association between urban structure and openness of innovation for
23 all types of innovation sources. For market and public sources, a significant association is
24 detected between open innovation and the innovation source itself (this is referred to as the
25 basic model in Table 5).
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31 ** INSERT TABLE 5 ABOUT HERE **
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34 The inclusion of size exerts no influence on the basic model for each of the three types of
35 sources. The same can be said for the breakdown between breakthrough and incremental
36 innovations (degree of novelty of innovation).
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41 The inclusion of the sector of activity through the enlarged Pavitt taxonomy confirms
42 the associations detected in the basic model between open innovation and innovation source
43 (OI). On the other hand, the association between urban structure and open innovation (UO)
44 seems to run indirectly via the sector of activity: open innovation is significantly associated
45 with the sector of activity which is in turn associated with urban structure. As it appears, it is
46 the transitivity of this association which results in the association between urban structure and
47 open innovation (UO) in the basic model. This transitivity phenomenon is also present in the
48 relation between urban structure and openness (OU) when adding the type of innovation (T).
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3 Regarding the latter, however, it should be noted that the direct relation between urban
4 structure and openness (UO) seems to hold in the case of market sources.
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10 *4.4.2. Acquisition of innovation*

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12 Looking at the acquisition of innovation, associations mainly exist between urban structure
13 and openness of innovation (see section 4.3.2.): the degree of openness differs according to
14 the urban structure the firms are located in (UO). Inclusion of firm (S and P) and innovation
15 characteristics (D and T) reveals that the association between urban structure and open
16 innovation (UO) is indirect and runs via the sector of activity and via the type of innovation.
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25 These results are summarised in Table 6.

26
27 ** INSERT TABLE 6 ABOUT HERE **
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29
30 The association between open innovation and type of acquisition holds for external R&D with
31 the inclusion of the additional characteristics. For IPR, however, the association (OA)
32 vanished by the introduction of firm size (with which it presented a significant association)
33 and degree of novelty of innovation, and became transitory for the type of innovation. In the
34 case of embodied technology, the inclusion of the degree of novelty of innovation and the
35 type of innovation rendered the models insignificant.
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45 *4.4.3. Collaboration on innovation*

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48 The basic model showed significant associations between urban structure and openness of
49 innovation (UO), and between openness of innovation and collaboration with market partners
50 (OC). The absence of association between urban structure and public collaboration also
51 deserves attention. Inclusion of firm and innovation characteristics has no significant impact
52 on the association between open innovation and collaboration (OC) in the case of
53 collaboration with market partners (Table 7). With the exception of the inclusion of the type
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3 of innovation, the same can be said for the association between urban structure and open
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5 innovation (UO).
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8 ** INSERT TABLE 7 ABOUT HERE **
9

10 For innovation partners operating in the technology market, the association between urban
11 structure and open innovation holds when including firm size, sector of activity and degree of
12 novelty of innovation. Only the type of innovation renders this association insignificant.
13
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16 Finally, for collaboration with public partners, the expected – albeit absent –
17 association in the basic model between urban structure and collaboration with public partners
18 did not appear when including the additional characteristics. The relation only indirectly pops
19 up when including the sector of activity and the type of innovation.
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22
23 The results presented in Tables 5 to 7 indicate that the associations between urban
24 structure and open innovation are indirectly related. They are both influenced by the sector of
25 activity and by the type of innovation. Regarding the former, these influences depend on the
26 type of external knowledge relation and lacked significance in case of collaboration.
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29 30 31 32 33 34 35 36 37 38 5. Conclusions and directions for future research

39
40 The aim of this paper was to establish differences between innovative firms (in terms of
41 external knowledge relations and in terms of the business model for open innovation) related
42 to urban structure.
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47 A significant association was found between the business model for open innovation
48 (differentiating between the ‘in-house’, ‘outsourcing’, and ‘co-developing’ innovator) and
49 urban structure. Contrary to the literature, it turned out that firms in less urbanised areas have
50 a more open business model for innovation which was reflected in a higher presence of both
51 outsourcing, and co-developing innovators.
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3 The association between urban structure and the use of external knowledge relations
4 (including sources, collaboration and acquisition) proved insignificant. External knowledge
5 relations, though, seemed to be highly associated with open innovation. In this respect, 'co-
6 developing' innovators rely significantly more on the acquisition of external R&D and
7 intellectual property rights. 'Outsourcing innovators' were found to be significantly more
8 oriented towards the acquisition of embodied technology and to rely less on external R&D to
9 perform their innovations. For 'in-house' innovators the opposite is true. Taking into account
10 that different forms of acquisition have different requirements in terms of absorptive capacity,
11 this indicates a different innovation strategy according to the business model for open
12 innovation.
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27 The addition of firm characteristics and a refinement of the nature of innovation
28 revealed that firm size and the degree of novelty of innovation (breakthrough versus
29 incremental innovation) did not significantly influence the association between the business
30 model for open innovation, external knowledge relations and urban structure. The type of
31 innovation (product versus process innovation) and the sector of activity (in terms of Pavitt
32 taxonomy) did have an impact on this relation but did not make the urban structure redundant.
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41 There are several limitations to this study which deserve attention in future research.
42 First, further work should appreciate the innovation project itself as a tendency exists towards
43 more openness in simple or discrete technologies that are relatively easy to master (NELSON
44 and WINTER, 1982). A project rather than a firm based approach (here proxied by means of
45 differentiation between incremental and breakthrough innovators) could clarify this.
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52 Secondly, extra attention should be paid to the relation between openness of
53 innovation and strategic efforts in order to capture the returns on innovation bearing in mind
54 the tensions between openness and appropriability of the results of the innovation.
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3 A third challenge is to include the dynamics over time in the networking behaviour of
4 innovative firms, as argued by Chesbrough. These dynamics are needed to search for causal
5 relations.
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10 Bearing in mind the limitations of the analysis and the suggestions for further research,
11 an important conclusion for policy makers that could be drawn from this paper is the
12 significant relation between urban structure and business attitude towards open innovation.
13 For (regional) policy makers, it is an indication that the facilitation of the – transitory –
14 process towards more open innovation minded business models depends, at least partly, on
15 the socio-economic and cultural environment as measured by the urban structure approach.
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Table 1. Relation between urban structure and the degree of openness of innovation – in column percentages

Degree of openness	Urban structure				All respondents
	Urban areas	Suburban areas	Commuter areas	Other areas	
In-house innovator	58.1	58.0	48.3	46.8	53.5
Outsourcing innovator	13.3	12.0	13.3	18.2	14.4
Co-developing innovator	28.6	30.0	38.4	35.0	32.1
Number of observations	573	150	211	340	1274

Note: Chi-square = 17.401 and p = 0.008

Source: Third Community Innovation Survey, Belgium, 2002. Own calculations.

Table 2. External technology sources by type of source of innovation and by urban structure – in %

External technology sources		Urban structure				National total
		Urban areas	Suburban areas	Commuter areas	Other areas	
Market	Suppliers	72.9	76.0	72.9	78.2	74.7
	Clients	68.8	67.8	66.2	68.4	68.2
	Competitors	55.3	53.4	51.2	51.9	53.5
Public	Universities	36.1	37.7	39.6	36.1	36.9
	Government	25.5	21.2	21.7	21.8	23.4
Other	Meetings and magazines	66.7	70.5	61.8	62.7	65.3
	Fairs and exhibitions	66.7	69.9	72.9	71.6	69.4
Number of observations		568	146	207	335	1256

Note: Chi-square = 6.875 and $p = 0.991$

Source: Third Community Innovation Survey, Belgium, 2002. Own calculations.

Table 3. Acquisition of innovation by type of activity in relation to the urban structure – in %

Type of acquisition	Urban structure				National total
	Urban areas	Suburban areas	Commuter areas	Other areas	
External R&D	29.2	32.4	33.6	37.7	32.6
Embodied technology	62.2	70.3	71.1	68.0	66.2
Intellectual property rights	26.6	20.3	24.6	21.1	24.0
Number of observations	561	148	211	337	1257

Note: Chi-square =10.960 and p=0.090

Source: Third Community Innovation Survey, Belgium, 2002. Own calculations.

Table 4. Type of partner in collaborating on innovation by urban structure – in %

Type of partner		Urban structure				National total
		Urban areas	Suburban areas	Commuter areas	Other areas	
Market	Suppliers	65.1	68.8	68.3	70.9	67.4
	Clients	54.3	58.3	46.7	50.0	52.6
	Competitors	34.9	20.8	28.3	24.4	29.7
Public	Universities	50.0	56.3	51.7	48.8	50.8
	Government	29.0	14.6	28.3	29.1	27.1
Technology market	Consultants	45.2	29.2	30.0	41.9	40.0
	R&D labs	25.8	20.8	35.0	34.9	28.7
Number of observations		186	48	60	86	380

Note: Chi-square =16.422 and p=0.563

Source: Third Community Innovation Survey, Belgium, 2002. Own calculations.

Table 5. Urban structure, degree of openness of innovation, external source (market - public - other) and firm characteristics and features relating to the nature of innovation – Loglinear models, results.

	Source of innovation (I) - N = 1,256		
	Market	Public	Other
Basic model*	UO, OI (L ² =14.61; p=0.10)	UO, OI (L ² =6.56; p=0.68)	UO, I (L ² =11.81; p=0.38)
Firm size (S)	UO, OI, OS (L ² =36.92; p=0.18)	UO, OI, IS (L ² =25.76; p=0.73)	UO, OS, IS (L ² =23.46; p=0.83)
Economic activity (P)	OI, OP, UP (L ² =95.12; p=0.26)	OI, OP, UP, IP (L ² = 85.68; p=0.40)	OP, UP, I (L ² =86.97; p=0.57)
Degree of novelty (D)	UO, OI, D (L ² =30.29; p=0.30)	UO, OI, OD, ID (L ² =21.22; p=0.85)	UO, OD, ID (L ² =20.57; p=0,92)
Type of innovation (T)	UO, OI, OT, IT, UT (L ² =56.87; p=0.08)	OI, OT, UT, IT (L ² = 49.18; p=0.47)	OT, UT, IT (L ² =66.58; p=0.07)

* Basic model = urban structure (U) – openness of innovation (O) – external knowledge relation (source, I), section 4.3.1

Table 6. Urban structure, degree of openness of innovation, acquisition (external R&D - embodied technology - IPR) and firm characteristics and features relating to the nature of innovation – Loglinear models, results.

	Acquisition of innovation (A) - N = 1,257		
	External R&D	Embodied technology	IPR
Basic model*	UO, OA (L ² =7.56; p=0.58)	UO, OA, UA (L ² =5.31; p=0.50)	UO, OA (L ² =11.69; p=0.23)
Firm size (S)	UO, OA, AS (L ² =28.92; p=0.57)	UO, OA, AS (L ² =36.98; p=0.21)	UO, AS (L ² =42.88; p=0.12)
Economic activity (P)	OAP, UP (L ² =74.07; p=0.51)	OA, OP, UP, AP (L ² =81.88; p=0.51)	OA, OP, UP, AP (L ² =91.79; p=0.24)
Degree of novelty (D)	UO, OA, OD, AD (L ² =21.74; p=0.83)	-	UO, OD, A (L ² =26.38; p=0.75)
Type of innovation (T)	OA, OT, UT, AT (L ² =48.72; p=0.48)	-	OT, UT, AT (L ² =55.72; p=0.30)

* Basic model = urban structure (U) – openness of innovation (O) – external knowledge relation (acquisition, A), section 4.3.2

Table 7. Urban structure, degree of openness of innovation, type of collaboration on innovation (market – public – technology market) and firm characteristics and features relating to the nature of innovation – Loglinear models, results.

	Collaboration on innovation (C) - N = 380		
	Market	Public	Technology market
Basic model*	UO, OC (L ² =5.87; p=0.75)	UO, C (L ² =3.78; p=0.97)	UO, C (L ² =8.90; p=0.63)
Firm size (S)	UO, OC, S (L ² =29.83; p=0.58)	UO, CS (L ² =38.28; p=0.24)	UO, C, S (L ² =30.33; p=0.65)
Economic activity (P)	UOP, OC (L ² =57.45; p=0.22)	UO, UP, CP (L ² =91.68; p=0.35)	UO, OP (L ² =109.64; p=0.10)
Degree of novelty (D)	UO, OC, OD (L ² =19.45; p=0.93)	OCD, U (L ² =42.42; p=0.13)	UO, OD, CD (L ² =34.33; p=0.31)
Type of innovation (T)	OC, UT, CT, OT (L ² =47.57; p=0.53)	CT, UT, OT (L ² =48.32; p=0.58)	UT, OT, CT (L ² =54.50; p=0.34)

* Basic model = urban structure (U) – openness of innovation (O) – external knowledge relation (collaboration, C), section 4.3.3

Annex 1. Classification of sector of activity: adapted Pavitt taxonomy

SCIENCE BASED	SPECIALISED SUPPLIERS	RESOURCE INTENSIVE
Aerospace	Non-electrical machinery	Food, beverages and tobacco
Primary sector (biotech)	Electronics-communications	Textile and clothing
Computers, office machinery	Electrical machinery	Wood and furniture
Scientific instruments	Financial intermediation	Petroleum refining
Pharmaceuticals	Postes	Non-ferrous metals
	Transport	Non-metallic mineral products
SCALE INTENSIVE	Business services	Fabricated metal products
Paper printing	Wholesale	Recycling
Rubber and plastic products	INFORMATION INTENSIVE	Construction
Chemicals	Computer and related activities	Gas, water, electricity
Motor vehicles	Telecommunications	Other manufacturing
Ferrous metals	Research and development	
Shipbuilding	Technical engineering	
Other transport equipment		

Sources: Pavitt, 1984; Tidd *et al.*, 1997; Kristensen, 1999.

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Figure 1a: The closed innovation model

Source: CHESBROUGH, 2003: xxii and xxv.

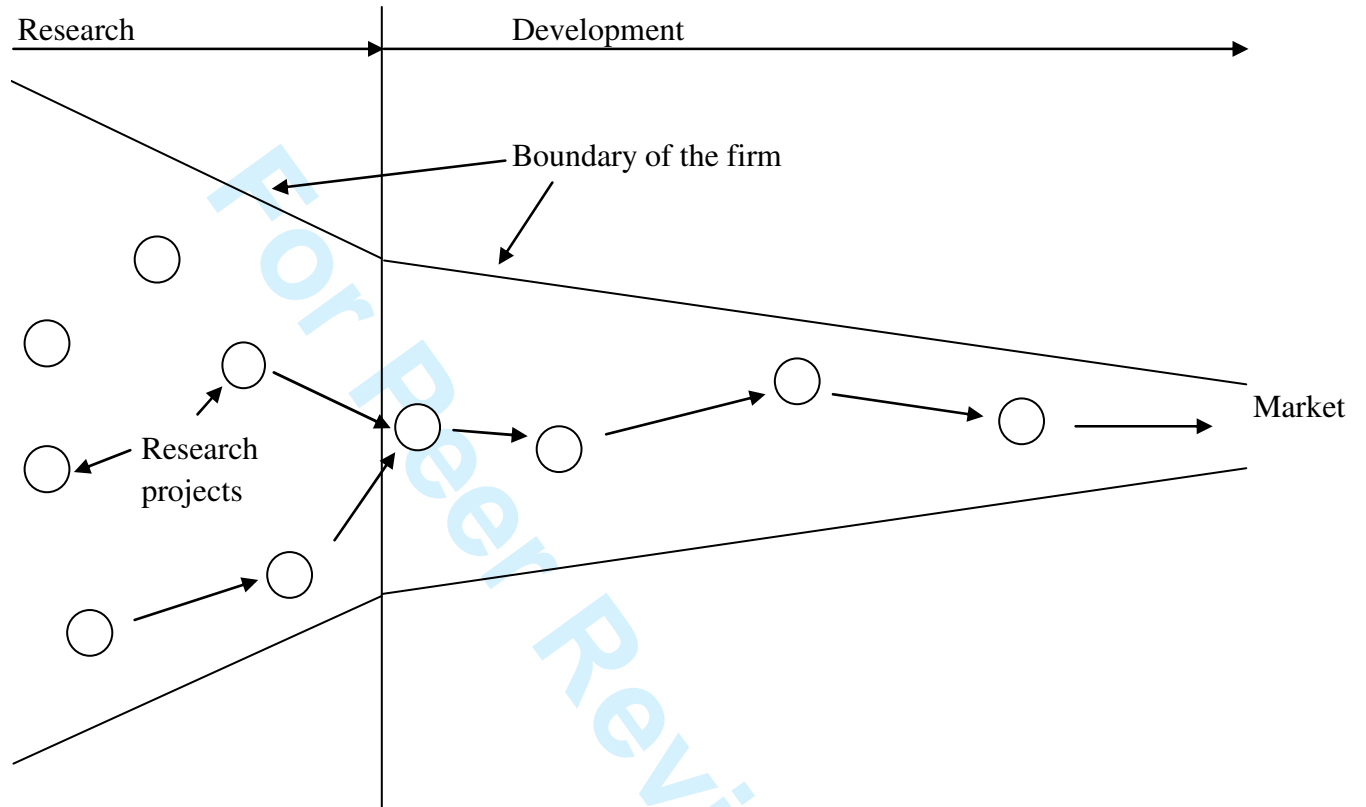


Figure 1b: The open innovation model

Source: CHESBROUGH, 2003: xxii and xxv.

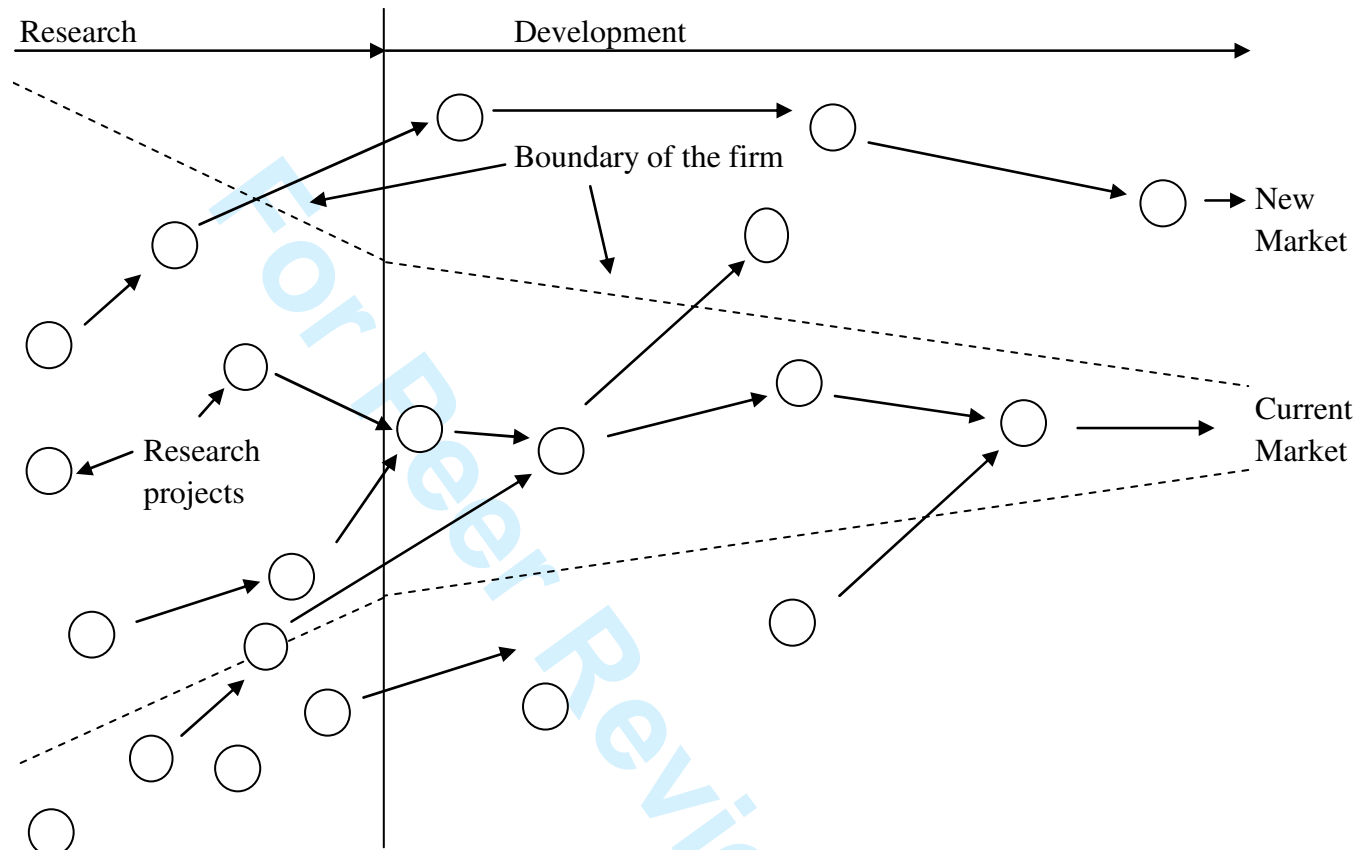
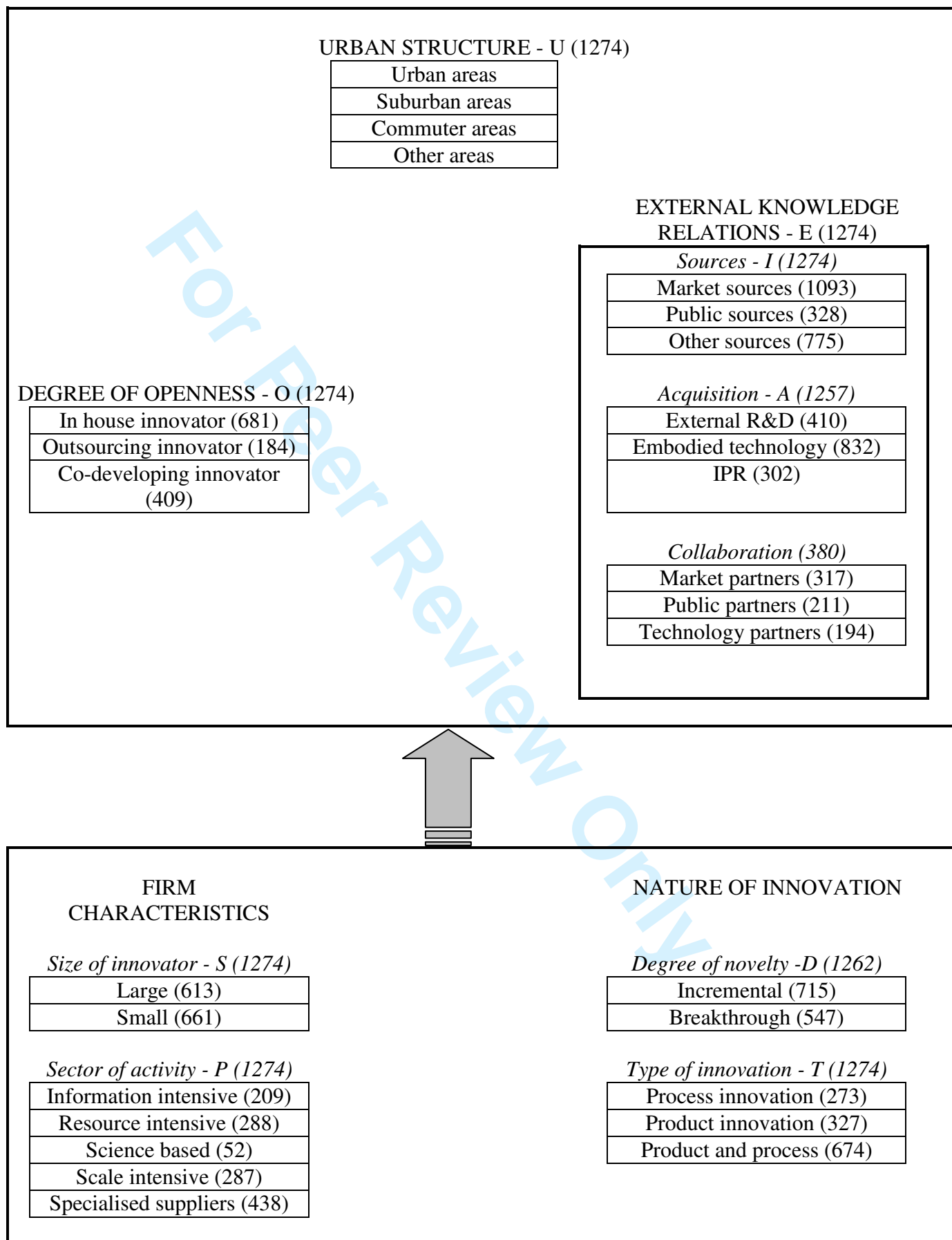


Figure 2: Conceptual framework of this study



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6 Figure 3: The urban structure of Belgium
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8 Source: Van der Haegen *et al.* (1996)
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Figure 4: Urban structure, degree of openness of innovation and external source (market - public - other) – Loglinear models, results.

Source: Third Community Innovation Survey, Belgium, 2002. Own calculations.

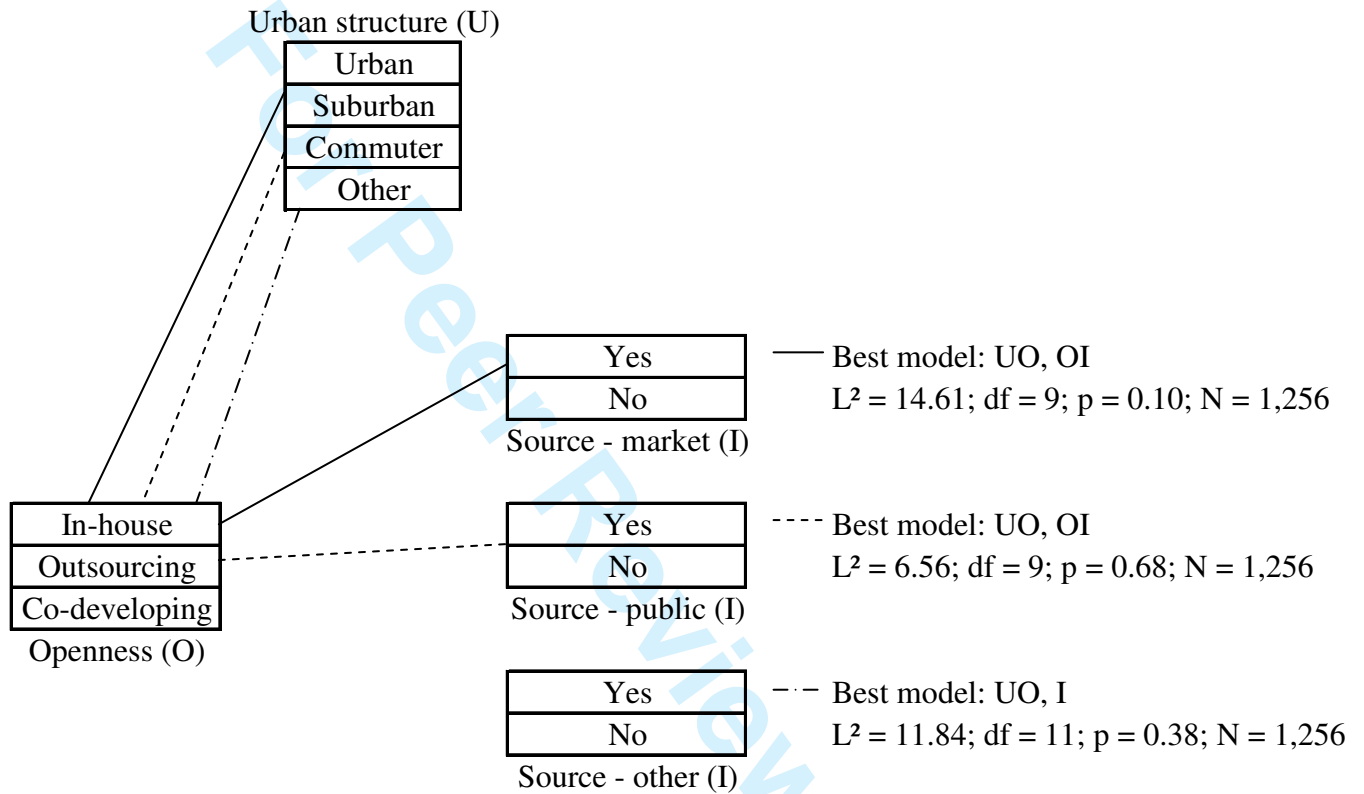
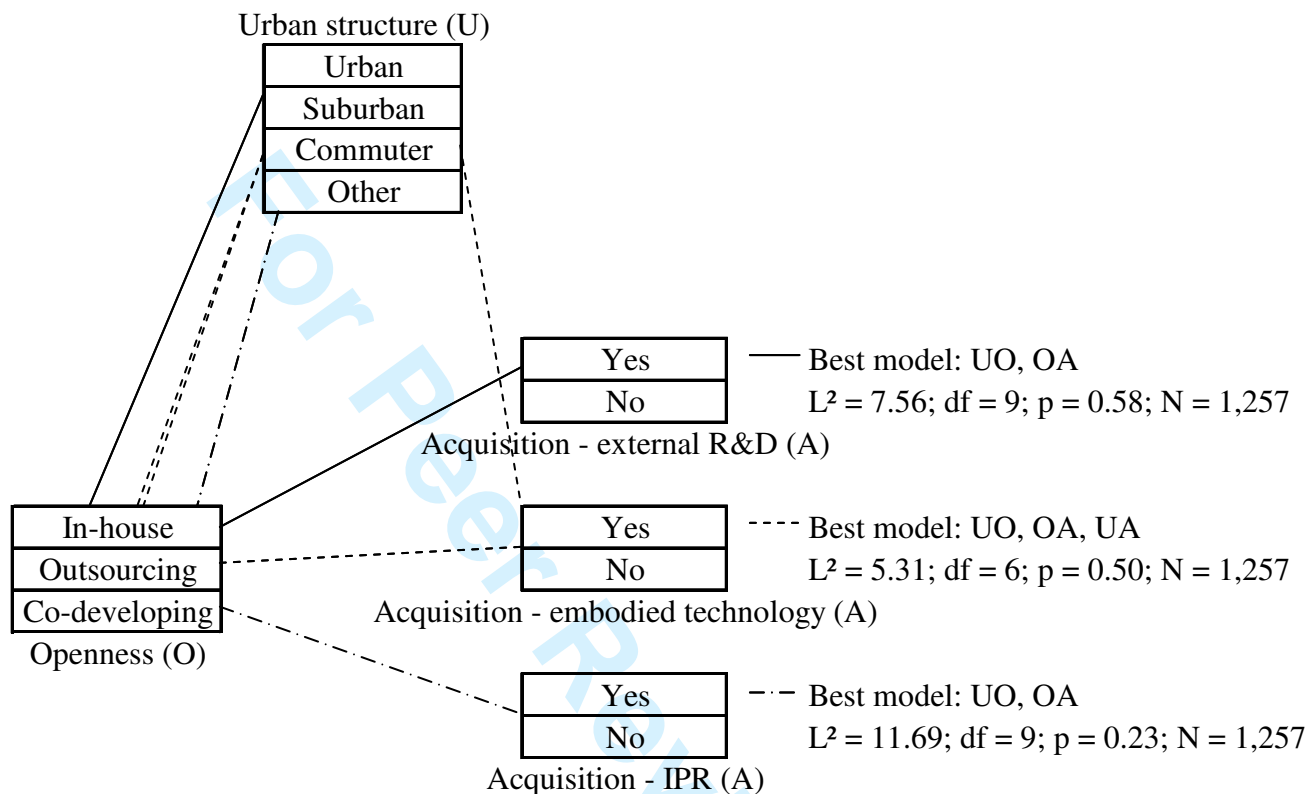


Figure 5: Urban structure, degree of openness of innovation and acquisition (external R&D - embodied technology - intellectual property rights) – Loglinear models, results.

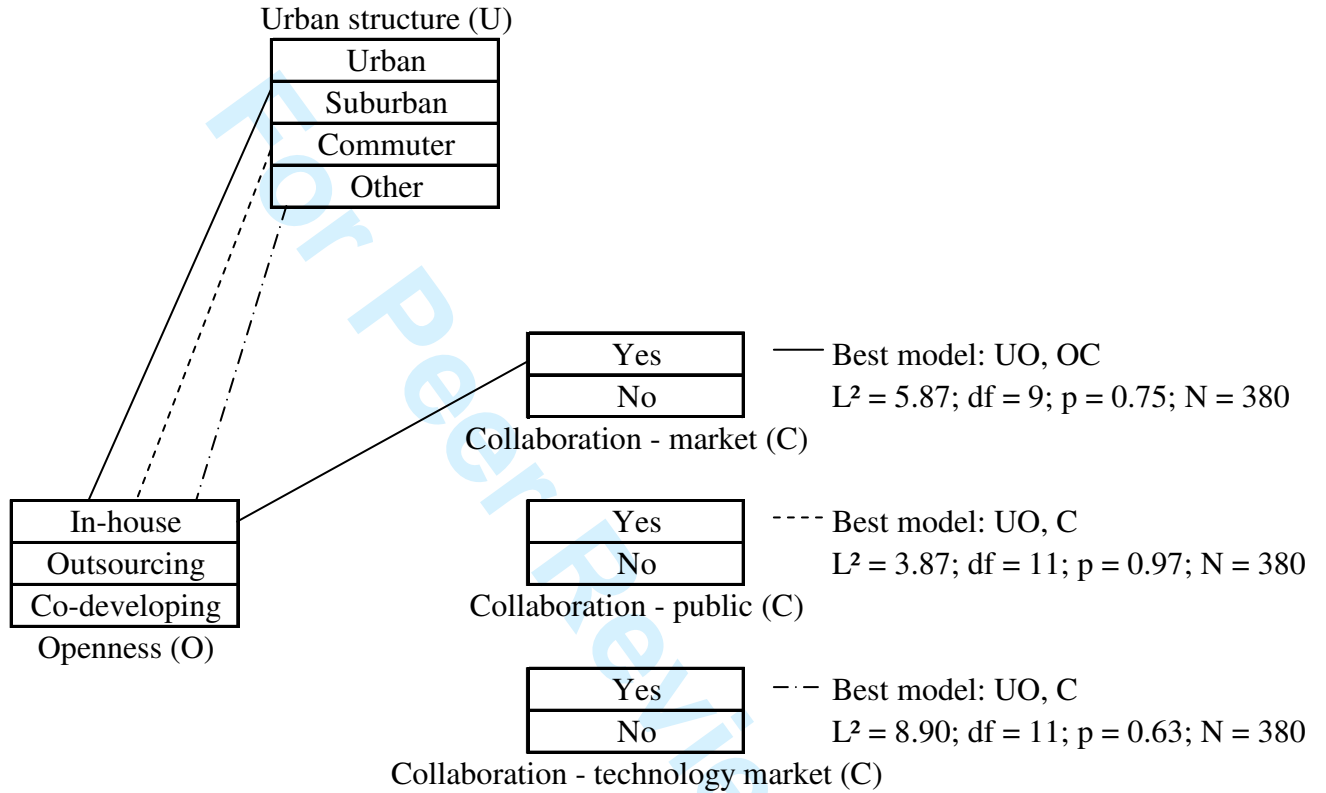
Source: Third Community Innovation Survey, Belgium, 2002. Own calculations.



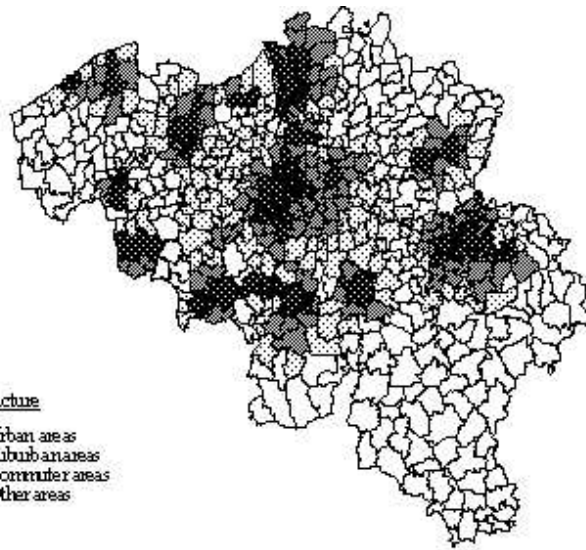
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Figure 6: Urban structure, degree of openness of innovation and collaboration (market - public - technology market) – Loglinear models, results.

Source: Third Community Innovation Survey, Belgium, 2002. Own calculations.



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