R&D, Product Renewal and Clusters in Belgium

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Abstract[§]

Using the cluster definitions of the European Cluster Observatory, this paper investigates the link between cluster membership and firm-level product innovation; using data from the Community Innovation Survey for Belgium. Clustered firms account for 71 percent of total product renewal generated in 2004 and for 58 percent of all exports; compared to 29 and 42 percent for non-clustered firms, respectively. Using a logit and tobit model, cluster membership is shown to be conducive to firm-level product innovation and renewal once firm size, internationalization and research inputs are taken into account.

JEL classification: D21, F23, L20, L23, 031, O33
Keywords: Product innovation, Clusters, Community Innovation Survey

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[§] We are especially grateful to Manu Monard, Peter Teirlinck and the CFS/STAT Commission of the Belgian Science Policy for allowing access to the Community Innovation Survey data at the firm level for Belgium; for answering questions related to the data and for their hospitality. Any remaining errors are naturally our own.

1. Introduction

The liberalization of markets, more outward-looking development policies, and the attractiveness of regional economic integration initiatives have all helped to push out the territorial boundaries of firms. The ease with which firms can transfer tangible and especially intangible assets across borders is being constrained by the fact that the location of the creative activities and use of these assets is becoming increasingly influenced by the presence of immobile clusters of complementary value-added activities. Silicon Valley (Saxenian, 1990) and Hollywood (Christopherson and Storper, 1986) may be the world's best-known clusters, but examples abound in every international, national, regional, state and even metropolitan economy, especially in the more advanced nations (Porter, 1998), although some developing countries, such as several countries in South America and the Caribbean, China and India, have also taken this to heart (see for instance De Beule et al., 2005). Thus, while globalization suggests that the location and ownership of production is becoming geographically more dispersed, other economic forces are stimulating a more pronounced geographical concentration of economic activity both within particular regions and countries (Dunning, 1998).

While the observation that firms tend to cluster in particular regions is hardly novel, it has recently been taken up in explaining the stickiness of certain locations in an increasingly slippery world (Markusen, 1996). These theories suggest that firms may be drawn to the same locations because proximity generates positive externalities or agglomeration effects (Markusen, 1994). Economists have proposed agglomeration effects in the form of both static (pecuniary) and dynamic (technological) externalities to explain industry localization (Baptista, 1998). Increasingly, the analysis of geographically clustered firms has tended to shift towards the study of predominantly untraded exchanges of knowledge and ideas (Storper, 1995, Maskell, 2001). Firms secure competitive advantages through gaining rapid access to knowledge concerning the innovations, techniques and strategies of competitor firms (Henry and Pinch, 2006).

This paper will add to the latter research and analyze the innovation propensity of firms in Belgium. We will thereby make a specific distinction between clustered and non-clustered firms. We will use two measures of innovation, namely a binary variable whether firms have introduced product innovations or not, and the percentage of newly innovated products in turnover. The empirical analysis employs Belgian data of the European Community Innovation Survey (CIS), obtained from the Belgian Science Policy. Section 2 discusses the relevant literature and draws hypotheses. Section 3 deals with the data description and methodology, while section 4 discusses the results. Section 5 concludes.

2. Literature review and hypotheses

There is a long tradition in industrial location theory and regional economics, extending back to the nineteenth century, of theorizing about why new industries emerge in particular places and why, once these places have experienced take off, further expansion of the sector is likely to be constrained to the original or neighboring sites.

It was by observing industry localization that Marshall derived the concept of external economies. In Marshall's seminal analysis of industrial organization (1890), the three fundamental reasons for geographical concentration or spatial clustering of production were identified as

(1) the existence of a pooled market for workers with specialized skills:

> "A localized industry gains a great advantage from the fact that it offers a constant market for skill. Employers are apt to resort to any place where they are likely to find a good choice of workers with the special skill which they require; while men seeking employment naturally go to places where there are many employers who need such skill as theirs and where therefore it is likely to find a good market".;

(2) the provision of specialized inputs from suppliers and service providers:

> "Subsidiary trades grow up in the neighborhood, supplying it with implements and materials, organizing its traffic, and in many ways conducing to the economy of its material […]".; and

(3) the relatively rapid flow of business-related knowledge between firms, which result in what we would now call technological spillovers:

> "The mysteries of the trade become no mystery; but are as it were in the air. […] Good work is rightly appreciated; inventions and improvements in machinery, processes and the general organization of the business have their merits promptly discussed: if one man starts a new idea, it is taken up by others and combined with suggestions of their own; and thus it becomes the source of further new ideas".

In short, the external effects of agglomeration are various types of benefits and cost savings obtained outside the market that may lead to increased productivity of a firm. These effects may consist of the availability of skilled labor, the access to specialized suppliers of intermediary goods, but also localized knowledge spillovers. All of these factors are covered by the notion of agglomeration, which suggests that the stickiness of a place resides not in the individual firms or workers, but in the external economies available to each firm from its spatial conjunction with other firms and suppliers of services at a particular location. These economic benefits allow to increase the productivity of firms in a static perspective and to augment the capacity for innovation and sustained productivity growth in a more dynamic perspective.

Static agglomeration economies are said to occur when the unit costs of production of a business enterprise or establishment are lower in the context of relatively dense clusters of other firms or specialized resources, such as skilled labor or infrastructure, than would be the case if the typical business were located elsewhere. Krugman recapitulates earlier work in offering as sources of static agglomeration economies: a local concentration of customers (or downstream firms) sufficient to permit suppliers to achieve economies of

scale in production or distribution, great enough for local firms to amass sufficient demand to warrant the provision (usually by or via local governments) of specialized infrastructure, and large enough to attract a deep and diversified pool of workers sufficient to realize a more specialized local division of labor (Krugman, 1991).

Dynamic agglomeration economies, on the other hand, refer to the heightened prospect for technological learning to occur (not simply reductions in unit costs of production with a given technology) in relatively dense clusters compared with less dense locations. Studies on geographic location and economic performance have showed that economic and technological activities have a strong tendency to agglomerate at certain locations, giving rise to patterns of national and regional specialization; and, that the performance and the growth of firms depend to a large extent on the conditions of the environment in which they operate, and particularly on those in the immediate proximity (Malmberg, Sölvell and Zander, 1996). The common starting point is the assumption that firms rarely innovate in isolation and need a network of suppliers and users with complementary knowledge to innovate successfully. In this way the cluster concept provides another way of looking at the economy and innovation and offers an alternative to the traditional sectoral approach (OECD, 1999).

To the extent that differences in innovative behavior among firms are in part attributable to properties of the local economies of which they are a part, most contemporary urban economic and geographic theory treats such dynamic growth processes in terms of the local production and diffusion of information relevant to the firm's decision to adopt (take up) a technology, and of the organizational capacity of that firm to make use of such information.

Hypothesis 1a. *Firms in clusters will have a tendency to have higher product innovation, ceteris paribus, than firms in non-clustered sectors.*

Hypothesis 1b. *Firms in clusters will have more product renewal, ceteris paribus, than firms in non-clustered sectors.*

Agglomeration processes in innovative activities can be accelerated by the increasing role played by multinational corporations as creators of innovation across national boundaries, as well as by the recent trend for multinational corporations (MNCs) to establish internal and external networks for innovation (De Beule, et al., 2005). Internationally integrated networks within the firm may lead to an improvement of innovation capacity both of the MNC and of the host location. Inter-firm networks established between MNC subsidiaries and local firms may, in addition, amplify the advantages of geographical agglomeration in some particular lines of technological development, reinforcing the existing sectoral pattern of technological specialization of local systems (Cantwell and Iammarino, 1998). The economics of industrial and technological localization are therefore likely to be increasingly shaped by the interaction between multinational corporations and local clusters.

MNCs are also increasingly seeking complementary foreign assets and capabilities of a knowledge-facilitating kind wishing to add value to their core competitive advantages. This is particularly the case as their affiliates are becoming more firmly rooted in host economies. Examples of this approach are the view that foreign-owned subsidiaries typically tap into local industry in order to keep their parent company informed about leading-edge thinking (Porter, 1990; Bartlett and Ghoshal, 1994). Additionally, studies by Frost (1998) and Almeida and Kogut (1997) show how subsidiaries draw from local sources in their innovation processes.

MNCs have therefore increasingly invested in foreign clusters to augment their knowledge base through obtaining direct access to foreign pools of skilled human resources and knowledge (Dunning, 2000; Rugman and Verbeke, 2001). The positive impact of foreign industrial clusters on the asset creating nature and competitiveness of MNCs has become the focus of several studies (Birkinshaw and Hood, 1998; Birkinshaw, 2000; Birkinshaw and Hood, 2000; Enright, 2000; Peters and Hood, 2000), which provide a rich set of conceptual and practical insights into the contribution of foreign industrial clusters in general and foreign subsidiaries in particular to the competitive position of MNCs.

MNCs tend to perform R&D investments in foreign locations with strong technological capabilities, and this leads to a further strengthening of indigenous R&D activities. There is an increase of knowledge seeking FDI by MNCs, because the intra-firm specialization and the related local embeddedness of know-how make it difficult to achieve international innovation processes within the MNC without participating in foreign clusters.

Yet, being in a foreign cluster does not necessarily create positive effects on the innovation process of MNCs for the following reasons. Different sub units within the MNC may have a specialized knowledge base and a specific technological trajectory, which may be inconsistent with the knowledge absorbed in a foreign cluster. In addition, the MNC unit involved in the knowledge absorption process may be faced with difficult choices between maximizing convergence of its own operations with the other parts of the MNC-network, and maximizing convergence with the functioning of the localized knowledge cluster in which it is physically embedded (Cantwell and Santangelo, 1999).

In the case where foreign subsidiaries are set up as 'listening posts', they may be used to collect information and knowledge from the clusters and disseminate it to the parent companies and other subsidiaries. In an advanced stage, they can serve as a vehicle to transfer skills and capabilities from the cluster to the rest of the group. Dunning has used 'asset-augmenting investment' to describe the situation in which MNCs invest abroad to gain access to specific capabilities present in a foreign cluster in order to enhance the assets that the corporation already possesses (Dunning, 1998; Dunning, 2000; Cantwell and Glac, 2005).

In the case of stand-alone market-seeking investments, foreign subsidiaries often serve as the centre for a particular business segment of MNCs at a global or regional scale. MNCs may also benefit from advantages that a foreign cluster might have in developing and producing a particular product or service that can be transferred to the existing business units of the group through its subsidiaries in the cluster (Enright, 2000).

Despite this ambiguous relationship, foreign ownership is hypothesized to be positively associated with the generation of product innovations (Castellani and Zanfei, 2006).

Hypothesis 2a. *Multinational subsidiaries will have more product innovation, ceteris paribus, than domestic firms.*

Hypothesis 2b. *Multinational subsidiaries will have more product renewal, ceteris paribus, than domestic firms.*

3. Data and methodology

Data on clusters in Europe are available from the European Cluster Observatory[1]. The cluster concepts used are based on the original definitions developed at the Institute for Strategy and Competitiveness of the Harvard Business School. Identification of clusters is achieved by looking at the geographic distribution of employment in the United States (Porter, 2003). Based on employment concentration patters, three types of industries are identified: local industries, serving local markets and not exposed to direct competition across regions; traded industries (clusters) which are concentrated geographically and that choose where to locate; and natural resource-based industries, which are necessarily located close to their source. Traded or clustered industries account for about 32 percent of employment in the US (Porter, 2003), and about 37 percent of European employment (European Cluster Observatory).

Translation of the US cluster definitions is achieved in three steps. First, the Cluster Observatory translated the US SIC classification into the European Nace classification. Since there is no one-to-one correspondence between the two systems, some choices in translation had to be made, resulting in 38 clusters for Europe, or three less than the original 41 clusters defined for the US. Second, to identify clusters in Europe, regions

[1] www.clusterobservatory.eu .

were identified using the NUTS classification. For most countries, NUTS 2 regions were used (usually the provincial level). However, for a number of smaller countries, including Belgium, NUTS 1 regions were used in order to make the size of the regions comparable across Europe. Finally, the Cluster Observatory obtained employment data at the highest level of detail available (usually Nace four-digit level). Collection of these data was performed during the period December 2006 – June 2007. The data for Belgium pertain to the year 2004.

In addition to identification of clusters in Europe, which was achieved using employment concentration patterns, the Cluster Observatory classifies these clusters according to their strength, based on three criteria: size, specialization and focus. If a cluster is in the top ten percent of all clusters in Europe in terms of employment (*size*), it receives one star. If employment concentration in a particular region and industry is larger than overall employment concentration of that industry in Europe (*specialization*), it receives a second star. Finally, if the cluster is in the top ten percent of industries in the region in terms of employment, it receives a third star.

Translation of the clusters identified by the Cluster Observatory is not straightforward since complete concordance tables (giving detailed Nace codes corresponding to each of the clusters) are as of yet not available[2]. Hence, cluster definitions applied here and listed in Appendix A, are necessarily crude. As can be seen in Appendix A, whether a firm is part of a cluster depends on two criteria: (1) the industry the firm belongs to; (2) the region of activity for the firm. Industries are defined using the Nace[3] classification commonly used in European statistics. Regions are defined at the NUTS-1 level for Belgium, this implies that there are three regions: Brussels, the Flemish region and the Walloon region.

[2] According to the Cluster Observatory, complete concordance tables will be provided in the near future.

[3]The Nace classification can be downloaded from the Eurostat ramon server at http://ec.europa.eu/eurostat/ramon.

Flanders was quick to adopt the clustering concept back in the early 1990s, soon after the regionalization of the main economic decision making in Belgium. The idea caught on and a number of clusters or valleys were launched. But the difficulties in identification of promising technologies and the rather artificial localization of some proposed actors in geographically narrow valleys proved that a success model cannot be copied too mechanically. For instance, the Lernout and Hauspie Speech Products scandal and eventual bankruptcy meant the end of the Flanders Language Valley, and to some extent, the cluster policy.

Flanders has more recently renewed its interest in clusters, as the ministry has selected six technological clusters on which to focus its innovation policy. They are transport and logistical services, ICT and health services, food, new materials and nanotechnology, social economic innovation, and energy and the environment.

At the Walloon level, the burden of the heavy industry and the structure of the economic fabric have not promoted the natural appearance of networks of companies. As such, the Walloon government was rather late in adopting clustering, but has followed through. In 2000, the Walloon Government set ‘the support to the appearance of networks of companies’ among the priority measures of its Contract for the Future for the Walloon Region, proving its willingness to promote co-operation and partnerships between Walloon enterprises, both SMEs and large enterprises.

After an evaluation period of specific policies and clusters, the Walloon government has recently voted a decree project related to the support and the development of the networks of enterprises in clusters, which called for a specific support for national and international cooperation. Wallonia will thereby focus upon aeronautics, automotive, solid waste, eco-building, space, nutrition, clinical research, ICT, and transport and logistics.

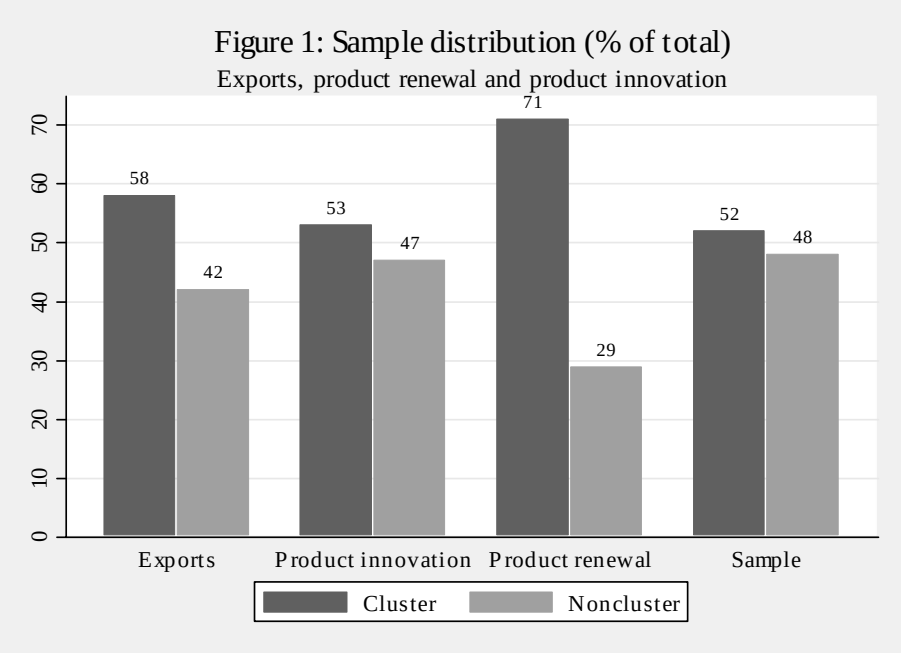
Firm-level data on innovation are taken from the Community Innovation Survey for Belgium (CIS4) and were obtained from the Belgian Science Policy[4]. The Community Innovation Survey (CIS4) collects information on innovations at the firm level for the period 2002 – 2004. Although the survey is organized by the EU, data are collected by national authorities. For Belgium the Belgian Science Policy is responsible for the data collection. Apart from innovation-related information, the survey also records detailed information on employment, turnover, ownership and exports of the firm. The CIS4-questionnaire pertains to the years 2002-2004, although some information is only available for 2004. The data are cross-sectional in nature.

The CIS data are available for 3,322 firms and are representative for the full population of Belgian firms employing at least 10 people[5]. Firms with missing identification number (1 firm) and firms with exports amounting to more than 100 percent of sales in 2004 (1 firm) are omitted. Hence, the final sample of firms consists of 3,320 firms. The questionnaire contains detailed information on firms' innovation activities. Apart from R&D expenditures, which are reported for 2004; the data set contains information on whether firms have introduced product and/or process innovations during 2002-2004 as well as on the share of turnover that is accounted for by the introduction of new products (either new to the market or new to the firm). Appendix B provides an overview of the specific questions asked to firms in the questionnaire concerning their innovation activities.

By combining the information on clusters in Belgium with the CIS-data, we can classify firms into two groups: (1) firms that are part of a cluster, i.e. are active in a sector that is part of a cluster and are active in the region in which this sector is identified as a cluster; (2) firms that are not part of a cluster. According to this definition; 1,607 firms in the sample are not part of a cluster, compared to 1,713 firms that are.

[4] We would like to thank Manu Monard, Peter Teirlinck and the CFS-STAT Commission of the Belgian Science Policy for granting access to the data at the offices of the Belgian Science Policy in Brussels.
[5] For a detailed overview of the CIS population selection process and the sampling issues involved, we refer to Teirlinck (2005).

To gain some preliminary insights into the performance of firms that are part of a cluster in Belgium, figure 1 shows the contribution of cluster and non-cluster firms to total exports, product innovation and product renewal in the sample. The figure also shows, for comparison purposes, the distribution of the number of firms in the sample.



As can be seen in figure 1; 52 percent of all firms are active in sectors and regions part of a cluster, compared to 48 percent in non-clustered industries. The number of firms that report to have introduced a product innovation during the years 2002-2004 shows an almost identical distribution: 53 percent of all firms that introduced a new product are active in clusters, compared to 47 percent for the firms not part of a cluster. For exports and product renewal (percentage of new products in turnover); the distribution is clearly in favor of firms part of a cluster. These firms account for 71 percent of total product renewal generated in 2004 and for 58 percent of all exports; compared to 29 and 42 percent for non-cluster firms respectively.

In order to obtain further insights into the importance of cluster membership for firm-level innovative behavior, we estimate the following empirical model:

$$Inn_i = \alpha_0 + \alpha_1 Cluster_i + \alpha_2 Exp_i + \alpha_3 \ln\left(Emp_i\right) + \alpha_4 RD_i + \alpha_5 Foreign_i + \sum_j \beta_j Region_i + \sum_k \beta_k Ind_i \quad (1)$$

where

Inn_i	Firm-level innovation measure, defined as product innovation (dummy), or the share of new products in turnover.
$Cluster_i$	Dummy, equal to one if the firm is part of a cluster.
Exp_i	Firm-level export intensity, defined as the share of exports in total turnover.
Emp_i	Employment of the firm, measured in full-time equivalents.
RD_i	R&D-intensity of the firm, measured as total internal R&D expenditures relative to firm turnover.
$Foreign_i$	Foreign ownership dummy, equal to one if the head office of the group is located outside of Belgium.
$Region_i$	Region dummy, defined using NUTS2-regions.
Ind_i	Industry dummies (two-digit Nace level).

Estimation of (1) is achieved using a different methodology depending on the innovation measure used. Product innovation is an indicator variable, hence a logit model is estimated. The share of new products in turnover is limited below by zero and above by one, hence we estimate a tobit model.

As was indicated in Hypothesis 1, membership of a cluster is expected to contribute positively to innovation. In addition to cluster membership, a number of control variables are included in (1) to control for other firm-level characteristics. Firms that are larger (in terms of employment) are expected to have more product innovation and renewal. Firms that have access to a larger network through their exporting activities are also expected to innovate more than their purely domestic counterparts. Moreover, as stated in hypothesis 2, foreign multinationals have a tendency to innovate more, hence we expect a positive

impact of multinational ownership on firm-level innovation. Finally, R&D-intensity of the firm is taken into account to control for the input side. Higher investment in R&D is expected to be positively related to the different measures of innovation.

4. Results

The results of estimating (1) for the full sample of firms are given in table 2, separately for two measures of innovative output: (1) product renewal or the share of new products in turnover of the firm during the period 2002-2004; (2) product innovation indicating whether or not the firm has introduced a product innovation during 2002-2004. Both regressions include region and two-digit industry dummies. Reported values are coefficients, z-values are reported between brackets.

From table 2, it is clear that cluster membership is conducive to product innovation. The cluster dummy has a positive and significant sign in both regressions. Cluster membership not only increases the likelihood of a product innovation, it also significantly increases the share of new products in sales.

As expected, employment and exports are both positively related to the innovation measures. This confirms our hypothesis that larger firms with exposure to global markets are more likely to introduce product innovations and renew their products..

Contrary to our expectations, however, foreign ownership does not contribute in any significant way to firm-level innovation. This insignificant effect is robust to the exclusion of exports from (1), so even if we do not control for exports at the firm level, foreign ownership does not contribute significantly to firm-level innovation.

Finally, investment in R&D is positively related to both innovation measures, although the impact is only significant for the binary variable product innovation. More R&D

clearly increases the odds of product innovation, but does not necessarily increase the likelihood of more new products.

Table 2: Product innovation and product renewal determinants

Dependent variable	*Product renewal*	*Product innovation*
Cluster	0.127***	0.465***
	[3.575]	[2.744]
ln(*Emp*)	0.052***	0.334***
	[6.664]	[8.750]
Export	0.002***	0.012***
	[7.771]	[8.513]
Foreign	-0.004	0.034
	[-0.166]	[0.326]
R&D-intensity	0.004	0.962**
	[0.840]	[2.461]
Number of observations	3,320	3,320
Psuedo R-square	0.19	0.18
chi2	655.02	740.00
Estimation methodology	tobit	logit

5. Discussion and recommendation

The current analysis has clearly shown that cluster membership can indeed be an important factor in the innovation process of firms. Firms in clusters enjoy a substantial and significant benefit from their presence. Controlling for research and development intensity, industries, export orientation, size, and regional differences; clusters are shown to be a serious catalyst in the renewal process of membership firms' product portfolio.

For firms in clusters, this means that their research and development is put to better use. The return on investment in innovation -that is expenditure on research and development- is more productive in clustered sectors. For policymakers, this means that clusters are an important aspect of the promotion of innovation.

With regard to the second hypothesis, however, contrary to expectations, it does not seem to make a difference in terms of the propensity and importance of new product developments. This might be explained by the various roles of multinational subsidiaries.

On the one hand, multinational subsidiaries sometimes serve as scanning units that tap selectively into sources of advantage in foreign national industrial clusters. From the MNC perspective, these subsidiaries in a foreign cluster may bring several benefits: the access to knowledge, which otherwise would have remained out of reach; the potential leveraging of this knowledge throughout the firm's internal network; the transfer of global best practices; the monitoring of rivals active in the foreign clusters, etc. On the other hand, multinational subsidiaries can also be market seeking units because the country or region represents an important and leading market for the multinational group's products.

Given this variety of roles, multinational subsidiaries do not merely serve their own purpose but that of the multinational group. As such, these subsidiaries' product portfolio and innovation is most likely determined or at least driven by home office assignment.

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Appendix A: Cluster definitions				
Cluster	*Nace*	*Description*	*Region*	*Stars*
Agricultural	1	Agriculture	Flemish region	*
Forest	2	Forestry	Flemish region	*
Food	15	Food and Beverages	Flemish region	**
Tobacco	16	Tobacco	Flemish region	**
Textiles	17	Textiles	Flemish region	*
Publishing	221	Publishing	Flemish region	*
Chemical	24	Chemicals	Flemish region	**
Biopharma	244	Pharmaceutical products	Flemish region Walloon region	* **
Plastics	252 2416	Plastic products Plastics in primary forms	Flemish region	*
Heavy machinery	29	Machinery and equipment	Flemish region Walloon region	* *
Lighting	315	Lighting equipment / electric lamps	Flemish region	*
Automotive	34	Motor vehicles	Flemish region	*
Furniture	361	Furniture	Flemish region	*
Construction	45	Construction	Flemish region Walloon region	** *
Building fixtures	4534	Building installation	Flemish region	*
Metal	27 28 29	Basic metals Fabricated metal products Machinery and equipment	Flemish region	*
Distribution	51 52	Wholesale trade Retail trade	Flemish region	*
Transportation	60 61 62 63	Land transport Water transport Air transport Ancilliary transport activities	Brussels Flemish region Walloon region	* ** *
Aerospace	623 353	Space transport Aircraft and spacecraft	Walloon region	*
Finance	65 66 67	Financial intermediation Insurance and pension funding Ancilliary financial activities	Brussels Flemish region Walloon region	*** * *
Business Services	74	Business activities	Brussels Flemish region Walloon region	** ** *
Education	80	Education	Brussels Flemish region	* *
Entertainment	92	Recreational, cultural, sporting act.	Flemish region	*
Source: European Cluster Observatory (www.clusterobservatory.eu)				