Spatial changes in innovation processes - Analysing the Finnish innovation data

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Abstract

This paper examines the geographical evolution of the Finnish innovations and innovative firms. Our goals are to provide new information on (1) the geographical distribution of innovations and innovative firms over time and (2) changes in the innovation processes and characteristics of innovations during the period 1945-98. With the help of the existing databases on Finnish innovations commercialised during the period 1945-98, we are able to use qualitative data on innovations, cut down into the various categories related to innovations and their development processes.

Keywords: Innovative SMEs, spatial distribution, Finland

1. Introduction

In recent years there has been a growing interest in innovation, entrepreneurship and technological change, and their impact on regional and national economic development and welfare. It is generally accepted that innovation is a major, if not the most important, source of productivity growth and that R&D is also very important in this respect. In the new economic geography the spatial aspect of industrial locations and innovative behaviour has been taken into the agenda. A lot of research has been devoted to studying the agglomeration, urbanisation and localisation benefits for the countries and regions (Fujita et al 1999; Ottaviano & Puga, 1998; Krugman, 1991; Marshall, 1920). In another research tradition the concept of accessibility has been used in order to analyse the evolution of the regions (Hirschman, 1958; Myrdal, 1957). In some studies such abstract concepts as “production milieu” (Davelaar, 1991) and “innovative milieu” (Camagni, 1991) have been used to highlight the importance of agglomeration and local networks. However, when it comes to knowing in precise detail the interconnections between geography, innovation and evolution over time, we get less clear answers.

This paper examines the geographical evolution of the Finnish innovations and innovative firms. Our goals are to provide new information on (1) the geographical distribution of innovations and innovative firms over time and (2) changes in the innovation processes and characteristics of innovations during the period 1945-98. Considering the first objective, we analyse the distribution of innovations (divided into four areas of industry) by applying the central-periphery approach (Hoover, 1948[1]; Krugman, 1991a) to study the changes in innovative activity over time. Here we closely follow the conceptual setting, which has been developed by Davelaar (1991).

The point of departure in order to analyse changes in the innovation processes and characteristics of innovations, and their effects on economic development in general, is to start from the micro-level, from individual innovations and the firms responsible for developing and commercialising them. With the help of the existing databases on Finnish innovations commercialised during the period 1945-98, we are able to use qualitative data on innovations, cut down into the various categories related to innovations and their development processes. The biggest advantage of our innovation data is the possibility to study long-term changes in the relationships between various characteristics of innovations and the spatial changes in innovation processes in Finland.

The structure of this paper is as follows. This introductory section is followed by the theoretical section, 2, where the most relevant theories in innovation literature are discussed and a theoretical framework is developed. The main focus is directed at theories in which the spatial aspect of innovation activity and the evolution over time are taken into account. Section 3 presents the data used in this study. The main findings regarding the changes in the innovation processes and characteristics of innovations are presented in section 4,. The concluding section, 5, provides key insights from the study, as well as a recapitulation of the main findings.

2. Empirical and Theoretical Background

Various factors have affected the establishment of new firms over the years. Usually, new innovative firms have been established in locations in which the knowledge base and critical factors (see Arrow, 1962) for the survival of the firms' activities have existed. Before the developments in the public research infrastructure, the closeness to a large existing company from the same field of industry was seen as important. The availability of raw materials was also one of the

[1] Hoover used the concept ”decentralisation with maturity” (see Hoover, 1948, p. 174-176).

factors affecting the decision making by company managers. However, since the public research infrastructure has expanded in geographical terms, the newest technical and scientific information has also become easily available to new firms across the country.

In a regional context, R&D conducted in firms is not the only way of enhancing innovativeness. High innovativeness also requires a suitable environment and infrastructure, and co-operation within clusters of firms (Stern et. al. 2000; Porter & Stern, 1999). In this context, the presence of other sectors that support the innovativeness of one sector is important (Porter, 1998).

Urbanisation, agglomeration, localisation and other benefits accruing from external economies form one of the main channels that transform the regional balance within nations (Fujita et. al. 1999; Ottaviano & Puga, 1998; Krugman, 1991; Marshall, 1920). The term *agglomeration benefits* can be seen to comprise both urbanisation and localisation benefits. Urbanisation benefits accrue from the presence of several actors and sectors in the same geographical area. Localisation benefits refer to the utility of firms owing to the presence of other firms in the same industrial sector as well as benefits from physical proximity (see e.g. Boschma, 2005; Audretsh & Feldman, 1996).

There is a long tradition of viewing the accessibility of regions as a matter for economic development (Hirschman, 1958; Myrdal, 1957). Regions close to markets are better off than those located further away from the centres. Accessibility in terms of high-quality connections (infrastructure) to the centres alleviates the disadvantage of a peripheral location. Accessibility depends on the location of the geographical areas with regard to the markets and the state of the infrastructure. In other words, accessibility is a factor related to agglomeration, since large agglomerations tend to have high accessibility due to the size of their own markets (Huovari et. al. 2001).

Human capital is regarded as a crucial factor for economic growth in a modern knowledge-based society. In particular, human capital is at the heart of innovative behaviour, which is the source of technological progress. Groundbreaking innovations, in turn, usually take place at a higher intensity in large agglomerations than at the periphery (Kangasharju & Nijkamp, 2001; Freeman, 1990). Finally, agglomerations tend to have high accessibility due to the size of their own markets and high-quality connections to other agglomerations.

Firms' innovative efforts do not proceed in isolation but are supported by external sources of knowledge (Kline & Rosenberg, 1986; Dosi, 1988). Firms that are located close to these sources will enjoy relative advantages over more distant firms and consequently tend to have a higher innovative performance (Beaudry & Breschi, 2000). Significant sources of external knowledge are local universities and public research centres. By operating close to these sources of knowledge, inventors and firms in a specific industry have a greater likelihood of sharing the latest knowledge.

In the Scandinavian countries, the geographical perspectives of innovation activities have recently become popular. Jonsson *et al* (2000) studied the Swedish medicine-technology sector. They found that the innovative activity was highly concentrated, as some 80 per cent of the creation of new products and processes originated from the five metropolitan and urban areas (Stockholm, Gothenburg, Malmö, Uppsala & Halmstad). The manufacturing sector was found to be less concentrated than other industries within the sector. Similar central-periphery patterns are found for the manufacturing industry in Norway. For example, Wiig and Isaksen (1998) found a clear central-periphery pattern when measuring different Norwegian regions' share of firms with innovation costs and share of firms producing new or significantly altered products. The peripheral regions had a substantial lower share of both. Moreover, Asheim and Isaksen (1996) show that the costs associated with innovation of firms in the central areas are mainly made up by (or are related to) R&D, while the same costs for firms in the peripheral areas, on the other hand, mostly constitute trial production and production start-ups. This suggests that firms in the central areas are more concerned with radical innovations while firms in the peripheral regions are skewed towards incremental innovations and tend to "…import and alter innovations from outside" (Asheim & Isaksen, 1996, p. 23).

The complexity issue in the innovation literature has a relatively short history (see e.g. Kline, 1990; Miller et al. 1995). On the one hand, it is believed that complexity is an important characteristic of innovations that should be captured in successful innovation studies. This is due to the fact that complex products and systems play a vital part in the modern economy. On the other hand, it has been hypothesised that the complexity of an innovation is correlated with the innovation process - especially with the competence base of the innovation.

To date, there are no studies in which complexity of innovations is analysed in the geographical context. By this we mean that, to our knowledge, the relationship between the geographical location of the innovative firm and the level of complexity of the innovations has not been studied. In general, the term *complex* is used to reflect the number of customised components, the breadth of knowledge and skills required and the degree of new knowledge involved in production, as well as other critical product dimensions (Hobday et al. 2000; Wang & Tunzelmann 2000). In addition, the complexity issue has been related to the increasing systemic nature of innovations. This means that innovations nowadays consist of large numbers of different parts or technologies, which are successfully tied together. From the discussions presented above, it follows that in order to develop complex innovations firms must increasingly rely on external knowledge bases, and to develop close collaboration links with knowledge providers, such as research centres and universities. As these institutions are typically located in urban agglomerations and large cities, we assume that innovations originating from the central areas are more complex in their nature compared with innovations commercialised by firms located outside the centres.

On the basis of this discussion, we formulate some hypotheses to be tested with the help of the Finnish innovation data. The hypotheses are:

H1-a: During the early phase of industry, most of the innovations originate from the central areas (Davelaar, 1991).

H1-b: An industry produces more innovations in earlier phases of its life cycle (Kangasharju & Nijkamp, 2001).
H2-a: Radical innovations take place in the centres (Asheim & Isaksen, 1996).
H3-a: Young innovative firms are located in the centres.
H4-a: Firms located in the centres are developing more complex innovations.
H5-a: Development times of innovations are shorter in the centres (Lehner & Maier, 2001) (faster innovation rate).

3. The Data
3.1. The Finnish Innovation Database

The data we use in this study originates from the Finnish innovation data for the period 1945-98. The innovation data collection was based on the so-called literature-based innovation output (LBIO) method (Palmberg et.al. 1999; Pentikäinen et. al. 2002). An advantage of this method is that it can trace the exact location where the innovation was developed (Kleinknecht et al. 1993). According to previous results from this type of study, a remarkable regional concentration of new product announcements has been discovered when analysing LBIO data (Feldman, 1994; Brouwer et al. 1999), while a similar concentration was not visible in R&D data (Kleinknecht & Poot, 1992). Van der Pahne (2006) also notes the strength of LBIO for spatial innovation research.

The innovation data used covers some 3,100 innovations commercialised in Finland by Finnish companies (Saarinen, 2005). An innovation has been defined as "invention that has been commercialised on the market by a business firm or the equivalent" (see Oslo Manual, 1997). For each innovation, there is information on the commercialising firm. This information includes entry, exit, geographical location, turnover, number of employees, patents, and industrial classification (SIC) according to the main industrial sector of the firm. An innovative firm has been defined "as a firm, which has developed and commercialised a new product – an innovation".

3.2. Division of Regions

In this study we have divided Finland into three different classes, following the methodology used in the study by Kangasharju & Nijkamp (2001). The cities and municipalities have been subdivided into central, intermediate and peripheral [2] classes on the basis of the GDP of the area. We have not only focused on the size of the central city of the area; instead, we have considered the surrounding sub-region (NUTS 4) as one region, which benefits from the presence of one large city. This implies that we expect the spatial diffusion to emerge not only according to physical distance to central regions but rather according to their ability and willingness to adopt innovations (approximated here by size of a city).

In this study we have seven central areas and seven surrounding sub-regions. The central areas are Helsinki, Tampere, Turku, Oulu, Lahti, Jyväskylä and Kuopio. All of these cities are nowadays considered "growth centres", which means that they are growing more rapidly than the other areas in Finland and they attract people to move in from the peripheral areas. The cities and municipalities belonging to our seven sub-regions are based on the latest division of geographical areas in Finland. This division was made in 2001, and was taken into use immediately. The rest of the country outside the selected cities and sub-regions are here considered peripheries.

Altogether, if we calculate the number of inhabitants together, the central cities with surrounding sub-regions have 2.7 million people, which is more than half of the population of the whole of Finland.[3] When we count the inhabitants living in our seven central cities together, the number is 1.3 million. The future expectations for our selected areas are that the population will continuously concentrate during the coming decades. Worth noticing is that this growth is not caused by an increase in births; the largest part of this population comes from peripheries.

4. Results
4.1. Overview of the Finnish Innovation Data

In order to get some idea of the coverage of the innovation data, some basic results are presented. Among all the variables collected, the year of commercialisation is probably the best to start with because this information is available for almost all of the innovations. It also gives some indication of the long-term development of the innovative pattern in Finland, in rather general terms. The following Figure 1 shows the number of innovations according to the year of commercialisation. The first observation from the Figure is that the general trend in the number of innovations is increasing over time (Figure 1). The general pattern gives some clear indications of the increasing level of innovative activities of Finnish firms, but the trend also makes tentative sense since it is consistent with other indicators, such as R&D expenditures of GDP and domestic patent applications. Next we look at the geographical distribution of innovations. For that purpose, we have divided innovations into three different groups according to the location of the commercialising firm.

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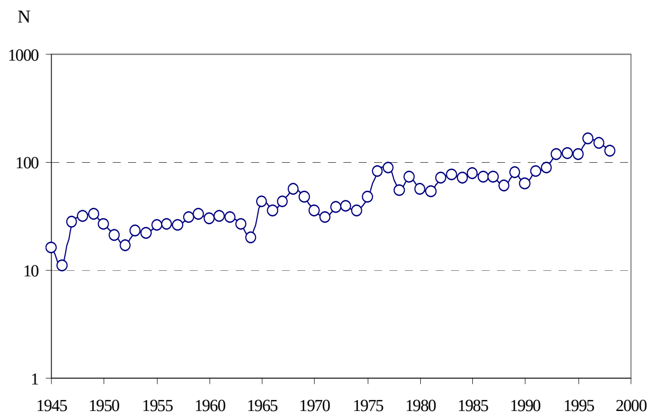
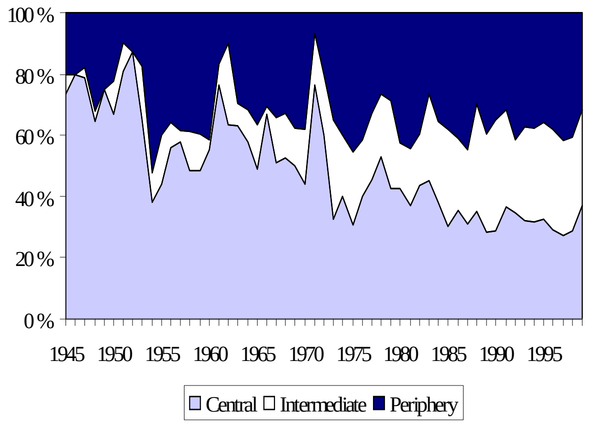
[2] The periphery classification includes also mid-size cities and towns (in Finnish terms, cities with 30,000 – 80,000 inhabitants).
[3] Total population in Finland is 5.2 million.

Figure 1 (on the left-hand side). Number of innovations according to the year of commercialisation
Figure 2 (on the right-hand side). Geographical distribution of all innovations





The main message in Figure 2 is that in central areas, i.e. in large cities, the share of innovations has decreased in 50 years from over 70 per cent to a level of 30 per cent. Considering the industrial structure in Finland, as well as the relocation of heavy machinery-based industries to the less populated areas, the detected pattern is in line with expectations. However, if the geographical development should follow the theory of new and maturing industries (Hoover, 1948), the emergence of the electronics industry in the late 1970s, followed by the ICT boom, both known as really innovative industries, should be noticed from the Figure. In order to get the pattern of new industries out of the Figure, the development of these particular sectors has to be studied.

Considering the intermediate areas, their share of all innovations began to increase in the early 1970s, continuing to take over shares during the next decades. Here, one major explanatory factor has been the development of the cities of Espoo and Vantaa.[4] In particular, Espoo's location close to Helsinki, as well as the moving of Helsinki Technical University from Helsinki to Espoo in the middle of the 20th century and the presence of Nokia's R&D departments (from the 1970s), have influenced the pattern in Figure 2.

In peripheral areas, the long-term (ten years) average has been a slight increase since the beginning of the period. In the early 1950s the share passed the 30 per cent level, and since then it has varied between 30 and 40 per cent. Worth noticing is that during the 1980s and 1990s the peripheral areas have been more innovative than the central and intermediate areas, as measured by the share of commercialised innovations.

In order to get some indication of the distribution across different industrial sectors, we divide the whole industry into four different categories. The first category is called traditional industries, which includes branches like wood and paper products, metal, textiles, foodstuffs, vehicle and chemical industries (ISIC 11-28). The machinery industry consists of manufacturing of machines and machinery (ISIC 29). The electronics and electrical industries include manufacture of electrical and optical equipment (ISIC 30-33). In the case of the software industry, telecommunication services (ISIC 64), and computer software and services (ISIC 72) form the base for this sector.

By having hypothesis *H1a* as guidance, the expected pattern should be that most of the innovations originate from the central areas during the early phase of the industry. We examine four groups of industries by taking account of the developments in both time and space. Table 1 shows the geographical distribution of innovations across various industries over time.

[4] Espoo and Vantaa are large Finnish cities and, together with Helsinki and some small municipalities, make up the Helsinki metropolitan area.

Table 1. Geographical distribution of innovations across various industries

	Traditional industries				Machinery industries		
	Central	Intermed.	Periphery		Central	Intermed.	Periphery
1945-54	63 %	5 %	32 %	1945-54	67 %	7 %	26 %
1955-64	45 %	15 %	40 %	1955-64	61 %	6 %	33 %
1965-74	50 %	13 %	37 %	1965-74	53 %	11 %	36 %
1975-84	40 %	20 %	40 %	1975-84	39 %	17 %	44 %
1985-94	31 %	23 %	46 %	1985-94	36 %	25 %	39 %
1995-	26 %	23 %	52 %	1995-	34 %	18 %	49 %

	Electronics & Electrical				ICT industries		
	Central	Intermed.	Periphery		Central	Intermed.	Periphery
1945-54	91 %	7 %	2 %	1945-54			
1955-64	78 %	10 %	12 %	1955-64			
1965-74	54 %	30 %	17 %	1965-74	33 %	67 %	0 %
1975-84	50 %	30 %	20 %	1975-84	41 %	35 %	24 %
1985-94	30 %	38 %	33 %	1985-94	30 %	42 %	27 %
1995-	27 %	49 %	24 %	1995-	37 %	38 %	24 %

The most interesting result from the Table is that the share of innovations in the central areas has reduced, irrespective of the sector concerned. This means that our hypothesis *H1a* is valid. In the traditional and machinery industries the change has been from the central areas direct to the peripheries, whereas in the electronics & electrical industries the intermediate areas have advanced greatly. Considering the software industry, the central and intermediate areas are competing for the top position.

Although our first hypothesis turned out to be correct, the second hypothesis, *H1b*, is a little bit trickier. According to *H1b*, an industry produces more innovations in the earlier phases of its life cycle. As has been seen in Figure 1, the number of innovations in our database is increasing continuously. This is also the case in our four industrial sectors. A general observation from Table 1 is that in the traditional, machinery and electrical & electronics industries the number of innovations originating from the central areas has more or less been at a constant level (with some minor variations) over the studied period. In the traditional and machinery industries the biggest increase in the number of innovations has been experienced by the peripheral areas, whereas in the electrical & electronics industry the intermediate areas have advanced the most. In the software sector the main drivers behind the increase in innovations have been the central and intermediate areas.

4.2. Characteristics of Innovations

In this section we are systematically going through the hypothesis related to the static state of innovations and innovation processes. Due to the limitations and incompleteness of the data, the results presented here are based on different numbers of innovations. For instance, considering Tables 3 and 5, the innovation data from the period 1985-98 is based on the survey results, not on the whole stock. Despite these difficulties with the data, the results presented here might give some new insights into the geographical characteristics of innovations and changes in innovation processes. We begin with radical innovations in the static state, and construct the following Table.

Table 2. Distribution of radical innovations according to geographical location (n=2317)

	Central	Intermediate	Periphery
Traditional industry	33,0 %	25,6 %	41,5 %
Machinery industry	41,8 %	17,6 %	40,6 %
Electrical & electronics	49,0 %	29,0 %	21,9 %
Software industry	43,1 %	33,8 %	23,1 %
Total average	*44,9 %*	*19,5 %*	*34,3 %*

Table 2 shows the distribution of radical innovations across the geographical location. In order to be radical, an innovation has to fill two requirements: first, it has to be totally new to the commercialising firm and, second, it has to be new to the world markets. This type of classification has also been implemented from the OECD's definition, in which the distinction was made between firm-only innovations and world-wide innovations. It is also compatible with the evolutionary theories, which stress the complex set of interactions between innovation and the dynamic competencies of the firm. Only radical innovations are included in the Table. In this section our aim is to study how well the hypothesis *H2a* fits with the Finnish innovation data. According to the hypothesis, radical innovations should take place in the centres. If we only look at the total average numbers, the hypothesis seems to be valid, as almost 45 per cent of all radical innovations are commercialised by firms located in central areas. Even at the sectoral level, the hypothesis works well, the traditional industry being the only exception.

Table 3. Distribution of young firms (0-9 years) according to their geographical location (n=3107)

	Central	**Intermediate**	**Periphery**
Traditional industry	32,8 %	19,1 %	48,1 %
Machinery industry	39,0 %	19,8 %	41,2 %
Electronics & electrical	41,1 %	31,0 %	27,9 %
Software industry	42,0 %	29,6 %	28,4 %
Total average	*37,4 %*	*23,2 %*	*39,4 %*

The distribution of young firms across the geographical areas is presented in Table 3. The hypothesis *H3a* was that young innovative firms are located in the centres. If we look at the average numbers for the whole of industry, the central areas are not achieving the highest shares. In fact, the largest share of young innovative firms is located in the peripheries. This is a quite interesting result in the sense that it is against the theories on agglomeration benefits, in which the local factors should encourage the innovativeness of the region and the easy entry of young innovative firms. In addition, the low share of young firms located at the intermediate areas is remarkable. In rapidly growing cities like Espoo and Vantaa (both located around Helsinki), as well as growing municipalities close to Turku, Tampere and Oulu, the continuous construction of science parks and business incubators should have some impact on Table 3. In relatively new industries, such as electrical & electronics and the software industry, the share of young innovative firms is higher than the traditional and machinery industries. However, they are alarmingly close to the shares of the peripheries.

When continuing at the industrial sector level, there are some sector-specific patterns to be noticed. In sectors where the evolution has jumped directly from the incubation to the stagnation phase, most of the young innovative firms are located in the peripheral areas. However, in the machinery industry the difference between the centre and the periphery is not so big. In this particular sector, 39 per cent of young firms are located in the central areas, compared with 41 per cent in the peripheries. In the traditional industries the distinction between central and peripheral areas is more notable. These results might indicate that as industry reaches the phase of stagnation, products become more specialised niche-type goods with high additional value, which have only a limited group of customers. The production facilities are relatively small and the amount of produced goods is modest.

In electronics & electrical, as well as in the software industry, the pattern is slightly different. The largest share of innovations originates from the young firms located in the central areas. In addition, the intermediate areas are also ahead of the peripheries. These results have some similarities with the patterns detected in Table 1. Industrial sectors in which innovations originating from the central and intermediate areas seem to behave differently to sectors in which the central and peripheral areas are the main sources of innovations. Table 4 is presented in order to see how the complexity of innovations varies between different geographical areas.

Table 4. Distribution of high-complexity innovations according to geographical location (n=3068)

	Central	**Intermediate**	**Periphery**
Traditional industry	43,5 %	26,9 %	29,0 %
Machinery industry	48,9 %	14,5 %	36,0 %
Electrical & electronics	48,0 %	20,0 %	18,7 %
Software industry	37,1 %	35,3 %	27,6 %
Others	16,7 %	50,0 %	16,7 %
Total average	*44,8 %*	*19,4 %*	*34,2 %*

In hypothesis *H4a*, which was developed in order to tackle the issue of complexity, we assumed that firms located in the centres are developing more complex innovations than firms located in the intermediates and peripheries. A look at the Figure supports our hypothesis. In total, 45 per cent of high-complexity innovations are commercialised by firms located in central areas. In the traditional, machinery and electrical & electronics industries the difference between central and other areas is quite significant. However, in the software sector the intermediate areas are following closely behind. This pattern in the software industry might be explained by the nature of the industry itself. The duties can be performed wherever the computers are available. Due to the rapid growth in mobile solutions, the geography is losing its importance in this particular industry. In addition, emergence of a new sector has provided an opportunity to broaden the industrial base in the region.[5]

[5] Municipalities also intentionally attract new sector firms through establishing technology parks, etc.

Table 5. Average development times of innovations in various industrial sectors across geographical location (n=913)

	Central	Intermediate	Periphery
Traditional industry	3,6	4,9	3,3
Machinery industry	3,1	4,1	3,2
Electrical & electronics	4,0	4,1	2,9
Software industry	2,7	3,8	2,9
Others	6,0	6,6	4,5
Total average	*3,5*	*4,4*	*3,2*

As can be seen in Table 5, there are some great variations in the development times of innovations across geographical location. Overall, the longest development times are experienced in the intermediate areas, where the average of all innovations is 4.4 years. This is almost one year more than in the centres and over a year longer than in the peripheries. Irrespective of the industrial sector, the longest development times take place in the intermediate areas. One explanation for this type of pattern might be that firms located in the intermediate areas do not have such a close collaboration with research centres and universities (see Davelaar, 1991) as companies located in the central areas. This means that in order to be at the leading edge in the competition, innovative firms have to devote more time and resources to their in-house R&D activities. This is a time-consuming manoeuvre with an uncertain outcome.

Next, we focus on the short development times. In terms of total average, the peripheries have the shortest development times. At the sectoral level, development times are shortest in the traditional and electrical & electronics industries. In addition, the development times are equal [6] across the different sectors. As our hypothesis *H5a* was that development times of innovations are shorter in the centres, where the renewal rate is fastest, the results we get from the Finnish innovation data do not completely support this hypothesis. Only in the machinery and software industries do the development times go slightly under the periphery numbers. To get some reasonable answers for these results, we take the time aspect into account and try to identify some space-time patterns of the innovative activity of Finnish firms.

5. Conclusions

As the results indicate, the period we have studied has witnessed some major changes. Considering the first goal of the study, the Finnish innovation data gives strong support to the central-periphery model. Innovations that are based on new and emerging technologies are commercialised by firms located at the core of the province. As time goes by, new innovative companies are established in the intermediate and peripheral parts of the sub-region. As a result, the number of commercialised innovations becomes more evenly distributed between the geographical areas. Later on, the peripheries take over the development and production of matured technologies and a wave of innovations based on new emerging technologies are commercialised by firms located at the core of the sub-region. In order to get a general picture of the changes in the innovation processes and characteristics of innovations in a space-time context, we have put our hypothesis together in Table 6.

Table 6. Concluding table

	Traditional industry	Machinery industry	Electrical & Electronics	Software industry	Industry total
H1-a: During the early phase of the industry, most of the innovations originate from central areas.	+	+	+	(-)	+
H1-b: An industry produces more innovations in earlier phases of its life cycle.	-	-	-	-	
H2-a: Radical innovations take place in centres.	-	+	+	+	+
H3-a: Young innovative firms are located in the centres.	-	-	+	+	?
H4-a: Firms located in centres are developing more complex innovations.	+	+	+	+	+
H5-a: Development times of innovations are shorter in centres.	-	+	-	+	-

As Table 6 shows, our findings with the Finnish innovation data do not completely support our hypothesis or the current findings in the literature. However, as the literature on innovation processes in a space-time context seems to be rather non-existent at the moment, we are not willing to make any precipitate conclusions based on our findings. Instead, what we can do is re-formulate our hypothesis, re-consider the accuracy of Davelaar's theoretical model with our data, and write the second version of this paper.

[6] if we do not take "Others" into account.

6. Literature

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