Paper no. 2007/08

Regional innovation measured by patent data – does quality matter?

Olof Ejermo (olof.ejermo@circle.lu.se)
CIRCLE, Lund University

Centre for Innovation, Research and Competence in the Learning Economy (CIRCLE)
Lund University
P.O. Box 117, Sölvegatan 16, S-221 00 Lund, SWEDEN
http://www.circle.lu.se/publications
ISSN 1654-3149

WP 2007/08

Regional innovation measured by patent data – does quality matter?

Ejermo, Olof

Abstract

Patent data play an important role as indicators of inventive and innovative activity across regions. This paper examines if the geographical distribution changes and in what direction if patent data are quality-adjusted. A quality index is constructed by means of factor analysis on the indicators forward citations and backward citations, family size and opposition incidence. Patent data over Swedish regions 1982-1999 are used to examine the distribution. The paper examines how the distribution has changed over time in the aggregate and on a technology-by-technology basis. When accounting for quality, patents become much more geographically concentrated than raw patents granted. Moreover, both concentrations have increased over time. Of the quality indicators, backward citations and family size seem to contribute most to concentration.

Keywords: RRegions, patents, patent quality, Sweden.

Regional innovation measured by patent data – does quality matter?

Olof Ejermo

CIRCLE

Lund University

P.O. Box 117

SE-221 00 Lund

Sweden

olof.ejermo@circle.lu.se

Abstract

Patent data play an important role as indicators of inventive and innovative activity across regions. This paper examines if the geographical distribution changes and in what direction if patent data are quality-adjusted. A quality index is constructed by means of factor analysis on the indicators forward citations and backward citations, family size and opposition incidence. Patent data over Swedish regions 1982-1999 are used to examine the distribution. The paper examines how the distribution has changed over time in the aggregate and on a technology-by-technology basis. When accounting for quality, patents become much more geographically concentrated than raw patents granted. Moreover, both concentrations have increased over time. Of the quality indicators, backward citations and family size seem to contribute most to concentration.

1 Introduction

Measurement of innovation is intrinsically difficult since innovation takes so many different paths. Although innovation may theoretically be taxonomized into categories such as product and process innovation, radical innovation, invention-innovation-diffusion, these are quite difficult to pin down to measurement to be used ubiquitously. The choices are even more restrained if we demand a high geographical precision on an innovation indicator. Patent data alleviate some of these problems. They are frequently invoked as inventive and innovative indicators for the reason that they can often be spatially positioned by means of publicly available address records of inventors and applicants, often companies. Patent requirements are also slowly changing and therefore reasonably comparable across time. They can also be divided by technology. For this reason, patent data are the preferred indicator for most contributions examining economy-wide geographical distributions of inventive/innovative activity. Patent documents also contain citations which have two major uses for innovation studies. First, since they show traces of knowledge antecedents, they may be used to study how localized knowledge flows ('knowledge spillovers') are. In other words, the question is whether citations are confined to the region of invention or does knowledge 'leak out' across many regions or even internationally (Jaffe et al., 1993) ? The second use concerns quality. Trajtenberg (1990) used the number of citations to patents as a rough indicator of value of patents related to computed tomography. He found that citation-weighing patents produced a correlation with estimated social value, a correlation that was not present when mere patent counts were used. Since then, a number of contributions have examined whether quality-adjustments can be done in additional ways, and the extent to which this helps to reflect the value of patents.

This paper draws on recent development in measurement of patent quality by using several indicators of quality embedded in patent documents. The paper makes two contributions. First, it applies quality-adjustment to the regional case of Sweden. Second, it makes an effort to examine whether the use of quality-adjusted patents changes the geographical distribution as compared to granted patent data.

The paper tests the following hypotheses:

Hypothesis 0 (H_0): Quality-adjusted patents are *equally* or *less* geographically concentrated than non-adjusted patents.

Hypothesis 1 (H_1): Quality-adjusted patents are *more* geographically concentrated than non-adjusted patents.

The remainder of the paper is organized as follows. Section 2 discusses the options available for examining innovation in terms of limitations and advantages of different data. The regional level is emphasized here. Two major applications of patent data for regional analysis work as illustrations of its use. Section 3 describes the patent data and quality indicators used to test the hypotheses in this paper. Considerations such as time trends in data and technological specificities are discussed. It is argued that these should be addressed in order to successfully test the stated hypotheses. Section 4 presents a factor analysis which is undertaken in order to construct quality-adjusted patents. This section presents concentration measures of patent counts and quality-adjusted patent counts. The hypothesis is tested for both pooled data and patents investigated technology by technology. Section 5 discusses the findings of the paper and gives suggestions for future research.

2 Measurement of regional innovativeness

2.1 Innovation indicators

The measurement of innovation is not uncontroversial. Most researchers agree that a complex thing such as innovation is difficult to capture by a single measure. Different indicators have their advantages depending on research setting. Kleinknecht (2002) and Smith (2005) discuss many aspects of innovation indicators on which this discussion is partially based. The emphasis here is on geographical aspects of innovation. The most common innovation indicators include research and development, patents, and two categories labelled by Smith (2005) as the object approach and the subject approach, respectively.

R&D data are available for decades back in time. Thus, they can be used to form consistent time series. “Research and experimental development (R&D) comprise creative work undertaken on a systematic basis in order to increase the stock of knowledge, including knowledge of man, culture and society, and the use of this stock of knowledge to devise new applications.” (OECD, 2002). Small lines of businesses though, more rarely undertake such activities as systematically as large ones do. Therefore, their innovative efforts are likely to be underestimated by R&D data. There are also biases depending on the sector in which a firm is active. For instance, in one sector firms may undertake relatively more marketing efforts in order to open up new markets, which will not fall under the heading of R&D. Service businesses also innovate differently and less ‘formally’ which may produce biases. R&D data are also often difficult to pinpoint to a geographical location due to what is labelled the Singapore effect, in which R&D is recorded at headquarters which may be outside the region or country where it is actually undertaken.

Belonging to the object approach are innovation counts where we find expert appraisals compiled by SPRU for the UK for the period 1945-1983 reported on in Pavitt et al. (1987), important innovations as assessed by the US Small Business Administration (SBA) (see e.g. Feldman and Audretsch, 1999), which is based on trade journals. Related are also literature based innovation indicators that have been collected for the Netherlands (Kleinknecht et al., 1993, Kleinknecht et al., 2002), for Italy (Santarelli and Piergiovanni, 1996) and recently for Finland (Saarinen, 2005). The problem with these indicators is that they often lack geographical scope. The SBA data from 1982 are an exception which provide information on innovation categories on the level of Metropolitan Statistical Areas.

Innovation surveys such as the Yale survey (Levin et al., 1987) have given more detailed information on the sources of knowledge and appropriation methods for innovation. The European Community Innovation Surveys in addition report on innovation expenditures and sales of imitative vs. innovative products on the firm level. These are not available on very fine geographical levels though since their availability on the finest level is on the EU NUTS2-level. CIS surveys, belonging to Smith’s (2005) subject approach, also have fairly low response rates of 40-50 %.

Patents are legal means for monopolizing a technology for a potential 20 years. In return for this monopoly, society demands that "patented technology must be disclosed so that rivals and courts know what is protected. Disclosure also ensures that the knowledge enters the public domain when the patent expires." (Scotchmer, 2004, p. 82).

Economists have considered patent data useful, since "…a simple patent count could be regarded as a more refined input measure (vis-à-vis R&D) in the sense that it incorporate part of the differences in effort and nets out the influence of luck in the first round of the innovative process." (Trajtenberg, 1990, p. 184). Patents are good at indicating geographical location compared with other indicators. The full addresses of inventors are available from European Patent Office data.[1] Data on patents and associated information are also highly available through computerized online records. Data on time are available to the level of individual dates. Very fine technology-levels can be discerned and described. Patents have well-known problems though as innovation indicators. The propensity to patent varies by sector (Scherer, 1983, Breschi et al., 2000) and its effectiveness varies as an appropriation mechanism (Levin et al., 1987). For companies active in industries where an appropriation mechanism such as secrecy is important, patenting plays a subordinate role due to its disclosure function.

Also, despite being costly to apply for, most of them are of little economic value. This is because a patent is often taken out for other reasons than economic ones as for instance patents are often used to block competition (Griliches, 1990). There may be alternative ways to reach a technological solution for a company and all efforts in between may become patented. As a kind of reaction to the negative conclusions for patents listed, there have been made attempts to gauge the quality of patents.

---

[1] In US patent trademark office data only the name and city are provided (see e.g. Trajtenberg et al, 2006).

2.2 ‘Quality-adjusted’ patents

A set of ‘quality-adjusters’ are beginning to form accepted ways of making patent data more representative of innovation. The invention represented by the patent does not automatically transform into innovations or growth. It is well known (cf. Griliches, 1984, Griliches, 1990, Silverberg and Verspagen, 2004) that the value of granted patents is skewed, so that only a limited number create large economic value, while the majority practically does not contribute to any value creation whatsoever. Later studies have shown that patent citations and other related measures contribute to the clarification of the value of individual patent applications. The functional and legal meaning of a patent citation (“prior art”) is that it delimits the technological scope of the new patent. The citation of earlier patents thus communicates that the patent does not embody the technological content of the cited patent. A patent citation *made* by a patent is often referred to as a backward citation. A citation which is made *to* the patent in question is referred to as a forward citation. Studies have used forward citations to ‘weigh’ the importance of patents, the main idea being that more valuable patent are more widely cited (Trajtenberg, 1990). This information can be complemented by other adjusters such as whether the patent has been renewed, degree of generality, originality and ‘radicalness’. A common indicator of patent quality is family size. Family size shows the number of patents protecting the same invention in different countries. More countries should reflect the commercial potential of the patent. For data from the European Patent Office (EPO) opposition can be used, which shows whether the granted patent was opposed in court. The rationale is that opposition signals that the patent is competitive and therefore other firms find opposing it worthwhile. The number of claims i.e. novelties of a patent, have also been used as a quality indicator. These measures have been validated by *indirect* studies relating the measures to productivity, expert appraisal of innovations, and stock market value of companies with patents in their portfolio (Lerner, 1994, Harhoff et al., 1999, Jaffe and Trajtenberg, 2002, Harhoff et al., 2003, Lanjouw and Schankerman, 2004, Hall et al., 2005, Hall and Trajtenberg, 2005, Dahlin and Behrens, 2005). *Direct* studies include Gambardella et al. (2005) who sent questionnaires to inventors and managers asking about the values of individual patents which provided direct validation for the above listed quality-adjustments. Another technique which is also direct since it makes use of the actual behaviour of the patentee, is based on renewal data. A patent can be granted for a potential 20 years, but needs to be renewed on a yearly basis, with progressively higher renewal fees. The renewal behaviour of patent holders can be observed and has been validated as an indicator for patent value in a number of studies (Pakes and Schankerman, 1984, Pakes, 1986, Schankerman and Pakes, 1986, Pakes and Simpson, 1989, Maurseth, 2005, Deng, 2007). A consensus conclusion from these studies is that quality indicators confirm that value distribution is highly skewed with a median value far below the mean.

2.3 Patents in regional analysis

This section reports on a few applications of patent data for regional analysis. At first, we may not that there has been plenty of work mapping national and European patenting. One should here note the efforts to map patenting to European regions, which has been used for cluster analyses (Moreno et al., 2005, Moreno et al., 2006) and analyses of networks (Frenken et al., 2007).

2.3.1 Spillover analyses

Geroski (1995, p. 76) starts his illuminating discussion on spillovers with the words: "Knowledge is probably the classic example of a public good." It has non-rival properties in the sense that it may be used by others without becoming less important. It is also non-exclusive so that the use of one actor does not prevent the use of another. Since public goods are enjoyed by many, knowledge production is associated with spillovers. Research about spillovers has been of great interest to economists, since clues about their existence may be informative about policy recommendations to stimulate knowledge production. Despite the claim of being public, knowledge also has properties which make it possible to appropriate. For instance, Arora et al. (2001) and Jones (2002) note that if knowledge must be embodied physically for it to be useful (e.g. software in computers) a market for it may develop more easily. Nevertheless has it been observed that innovation and efforts to achieve innovation tend to be more geographically clustered than population and production (cf. Ellison and Glaeser, 1997). Agglomeration economics in various forms are usually claimed to have high explanatory power behind these results (Ejermo, 2005). Explanations encompass localization economies, a concept which rests on industry specialization. These comprise cumulative learning effects; the presence of specialized suppliers, and economies of scale and scope, all of which lead to lower costs for firms in the same industry locating in vicinity of each other (Marshall, 1920, Arrow, 1962, Romer, 1986). On the other hand, urbanization economies stress the importance of diverse sets of suppliers. The variety of the set of goods and skills available in large urbanized areas make firms more innovative (Ohlin, 1933, Hoover, 1937, Jacobs, 1969).

For the purpose of examining whether innovation has spatially bounded effects, a stream of literature examines a) if the productivity effects of regional inventive/innovative activity are confined within the region and b) whether spillovers themselves from innovative activity are spatially bounded. The first type of studies rests on the so-called 'knowledge production function', a neoclassically inspired function which models output, either of production or 'knowledge' measured typically by patents. Among the variables that are used to explain this output we typically find R&D in various kinds. A common setup is to examine the effects of public vs. private R&D. Larger parameters are then attributed to larger spillovers. This literature tends to find that spillovers are localized for other innovation indicators than patents (e.g. Acs et al., 1992, Acs et al., 1994, Audretsch and Feldman, 1996a, Audretsch and Feldman, 1996b), as well as those using patent data (e.g. Jaffe, 1989, Paci and Usai, 1999).[2] A problem with this type of literature is, as noted by Breschi and Lissoni (2001a,b) in its interpretations. Findings can generally be explained by other agglomeration forces than 'knowledge spillovers', through e.g. labor mobility. Instead, a more direct way of testing for spillovers are those studies of type b) above which use patent citations to proxy for knowledge flows (Jaffe et al., 1993, Maurseth and Verspagen, 2002, Fischer and Varga, 2003). These studies show that citations between two patents tend to be more frequent when the two are closely located geographically, seemingly validating the spillover hypothesis.[3]

---

[2] Acs et al. (2002) have found that different innovation indicators are highly correlated for U.S. Metropolitan Statistical Areas (MSAs).

[3] The methodology used by Jaffe et al. (1993) has been debated by Thompson and Fox-Kean (2005) and Henderson et al. (2005).

2.3.2 Social networks

Yet, later studies reveal that these citations may partially be dependent on the individual social networks of inventors rather than genuinely reflecting knowledge spillovers (Breschi and Lissoni, 2003, Singh, 2005, Thompson and Fox-Kean, 2005). For small regions and certain technologies, the presence or non-presence of highly productive individuals have an impact on the innovative productiveness of regions.

Several studies emphasize the need for going to the individual level to examine inventive productivity, since creative output is unevenly distributed among individuals. For example do Zucker et al. (1998a) find that ‘star scientists’ in biotech, highly productive individuals affiliated with universities that are also linked to companies, give a boost to productivity and employment that cannot be attributed to non-stars. This literature also tells us that individuals shape patterns of citations and networks in semiconductors and biotech (Zucker et al., 1998b, Almeida and Kogut, 1999). Another impetus in this direction has recently come from Trajtenberg et al. (2006) who have organized the entire NBER data file on US patents by identifying individuals.

3 Data on patents for Swedish regions

3.1 Methodological considerations

The material presented in this section are EPO patent data allocated to Swedish regions and builds on previous work by Ejermo (2004). The present version which is part of CIDER[4] has undergone further development. In the latest version, two versions of postal

---

[4] CIDER stands for CIRCLE Innovation Databases for Economic Research.

registers, from 1993 and 2004 respectively, have been used to map inventors' addresses to 72 regions and recent changes in municipal structures have been taken into account.

In order to test the two hypotheses presented in the introduction we should note two characteristics of patent data. First, there are sectoral and technological specificities of innovation data in particular and patenting in particular. This is for instance shown in Breschi et al. (2000) who examine sectoral patterns of innovation based on the so-called Schumpeterian hypothesis. According to this perspective, firms may belong primarily to Mark I or Mark II patterns. Mark I industries are characterized by 'creative destruction', ease of entry, low appropriability and low cumulativeness (implying low path dependence). Mark II industries on the other hand are characterized by 'creative accumulation', a stable core of firms which are the main innovators, high appropriability and high cumulativeness. Their study confirms the fruitfulness of such a separation and they use patent data to show this. Similarly, quality-characteristics such as citations are for example much more frequent among patents in some technologies than in others (cf. Caballero and Jaffe, 1993). In other words, there are good reasons to conduct a technology-by-technology analysis on the scope of innovation distribution. An alternative would be to do this by sector. Although this data is available due extensive work documented and used in Ejermo and Kander (2007), it was considered that dividing patents by regions, technologies and sectors for a small country would be to strain the data too much. I considered that the technology division would be more exact and therefore used this instead of a sectoral one.

A second point concerns time trends. The data may show time trends in patenting and associated quality indicators which may not reflect actual changes in innovativeness or quality. For instance, the recent "explosion" in US patenting (Hall, 2005) has been concentrated in electronics, scientific instruments and related industries. Patents became more often upheld in litigation processes, with large penalties for infringers, so that patenting became more profitable. Patents were increasingly used for cross-licensing and trading/negotiation with other firms in complex products, and for securing finance for startups (Cohen et al., 2000).

In addition, it may also be of interest to try and get an overall picture of the distribution by doing the analysis on pooled data. Finally, since we deal with different quality indicators, we need a way to incorporate them into one measure. The literature has dealt with this by using factor analysis and we follow suit here. This method has the advantage that it extracts the variation that is common for different indicators into one or more components.

3.2 Data description

The definition of a Swedish patent used here starts from the argument that the creative act should be at focus, i.e. the patent is Swedish if inventors' addresses are and not necessarily the applicant(s). Hence, a patent is considered (partially) Swedish if at least one person with a Swedish address was registered as the patent's inventor. For this purpose fractional counting was used. For example for a patent with three inventors whereof two have Swedish addresses, 1/3 of the patent was allocated to each of the Swedish residential regions. Patent applications and opposition data come from the EPO bulletin. Information about whether patents were granted and citations are from OECD

(2005)[5] and family size data were provided by Grid Thoma (Hall et al., 2007) from PATSTAT data. The citations data used are not only from other EPO patents, but also from patents granted via the internationally harmonized PCT-process. The reason is that citations increasingly take this route instead of showing up from EPO-citations. PCT-citation praxis follows the same principles as EPO. Moreover, if for example a patent equivalent[6] is taken out under the US patent and trademark office and it receives citations from other EPO-patents or PCT-patents, these are also included. For the present paper, only granted patents were selected when calculating quality-weighed counts. For reasons of bias and truncation, the subset of Swedish EPO patents applied for in 1982-1999 is used for analysis. Although EPO started to grant patents in 1978, data show a sharp increase in the first few years. Only from 1982 onwards does the trend become more stable. The trends in applied and granted patents are shown in Figure 1. The year of application is consistently used, also for the granted patents. The figure shows a substantial increase in applications through 2001 but the number of grants started to fall after 1997, and the number of applications seems to have fallen in 2002. The development seem to follow the notion of 'patent explosion' (Hall, 2005). After 1999, many applied patents have not yet been registered in the databases and due to lengthy application procedures there are even lesser numbers granted.

< FIGURE 1 ABOUT HERE >

Five indicators based on patents are used for Swedish regions: number of grants: *GRANTS*, number of forward, or received, citations to patents: *FCIT3*, backward, or

---

[5] The version we use was distributed in late 2006.

[6] A patent equivalent is the same patent granted at a different patent bureau.

made, citations from patents: *BCIT*, family size: *FAMSIZE* and opposition: *OPPOSITION*. *FCIT3* are forward citations to patents within three years from the publication date. This is done to mitigate truncation problems since later patents have not yet had time to accumulate all their citations. The rationale for the use of these indicators is that patents that receive forward citations have been useful for the development of latter patents. Backward citations show the extent of use of earlier patents. On the other hand, many backward citations is also indicative of an invention more derivative in nature. A higher value for *FAMSIZE* shows that the applicant finds it worth the filing costs of extending the patent to additional countries and is thus suggestive of value. Opposition indicates that one or more agents find it worthwhile to undergo costly judicial processes in order to invalidate the patent. Figure 2-4 show the development over time of the quality indicators expressed as averages over the number of granted patents. *BCIT* per granted patent falls over almost the entire period. On the other hand, does *FCIT3* per patent rise slowly until 1998 followed by a sharp drop from 1999. *OPPOSITION* per patent has an erratic pattern falling slowly over time. *FAMSIZE* per patent rises, except for a sharp drop in the beginning of the period, which could possibly be attributed to start-up of the EPO. Although *FAMSIZE* is not confined to EPO countries, an influential factor could still be that the number of EPO-members increased from 9 in 1978 to 20 in 2000 and 31 in 2005. This means that the attractiveness of filing patents at the EPO has increased over time, since the increased number of members should yield some increasing returns to patent. A possibility is that while a patent with more designated states is probably more valuable, average quality may have been deteriorating since patenting costs relative to market size should have been lowered. Moreover, the number of citations to an older patent should increase because there are simply more countries gaining membership to the system. Since we cannot be certain that a time trend in the indicators are indicative of actual quality changes, comparisons over time should initially detrend these indicators before doing factor analysis of quality.

< FIGURE 2 ABOUT HERE >

< FIGURE 3 ABOUT HERE >

< FIGURE 4 ABOUT HERE >

3.3 Regional innovation and factor analysis

The regional distribution of patenting is highly skewed as shown by Figure 5. Over the period 1982-1999 Stockholm had an average of 262 granted patents per year, while Gothenburg and Malmö had an approximately equal average of around 110 patents each.

< FIGURE 5 ABOUT HERE >

Similar to Lanjouw and Schankerman (2004), Gambardella et al. (2005), Mariani and Romanelli (2006), 2006) and Hall et al. (2007) I create a variable which summarizes our indicators of patent quality using factor analysis. Factor analysis starts by obtaining communalities of different indicators, i.e. variance that is common to all of them. This means that the factors that summarizes them needs to be related to all of the indicators. This method led Lanjouw and Schankerman (2004, p. 448) to conclude that the factor was a measure of quality since it would be difficult to describe it otherwise. As a preliminary step, to remove time trends our indicators *FCIT, BCIT, FAMSIZE* and *OPPOSITION* are regressed on yearly time dummies:

(1) $$y_{ki} = \sum_t \beta_t D_{ti} + u_{ki},$$

where *i* refers to the *i*th observation, y_{ki} is the *k*th indicator in logs and D_{ti} are dummy variables for each year *t*.[7] Table 1 shows the correlation matrix of the residuals obtained from the quality indicators pooling all patent data.

<TABLE 1 ABOUT HERE>

The residuals of the four indicators, u_{ki}, are then used to form a component according to:

(2) $$u_{ki} = \lambda_k q_i + \varepsilon_{ki},$$

where q_i is the component normalized to have unit mean and zero variance, λ_k are loading factors. The covariance matrix of the residuals u_k is written:

(3) $$\Lambda = E[yy'] = \lambda\lambda' + \Phi$$

The matrix Φ represents the covariance between the ε terms. It is assumed diagonal. The common component is estimated by iterated principal-factoring which involves estimating the parameters λ_k and σ_k^2 that makes the theoretical covariance matrix as closely as possible resemble the observed correlation structure. The commonly used criteria in factor analysis is to retain those factors whose eigenvalues exceed one. For all factor analyses this criterion implied that one factor was chosen.

The quality component is given by:

(4) $$E[\mathbf{q} \mid \mathbf{y}] = \boldsymbol{\lambda}' \boldsymbol{\Lambda}^{-1} \boldsymbol{\lambda}$$

Since we have logged our indicators, the antilogs of the above calculated values were used to form our quality indices.

---

[7] We have zero values among our indicators and therefore used the transformation $y_{ki} = (1 + \log Y_{ki})$ for the *k*th indicator.

Next, on the pooled data in order to gauge the concentration of quality, simple linear regressions of each logged and detrended quality indicator *k* and the quality indicator *q in logs* on number of granted patents in logs on each region was run:

$$y_{ki} = \alpha_0 + \alpha_1 GRANTS \tag{5}$$

The interpretation of the estimated α_1 coefficients is that they represent elasticities. They show the percentage increase in the indicator of a percentage increase of the number of grants. If these estimated elasticities are larger than one, the interpretation is that the indicator is more concentrated than the number of patents granted. In addition, data suggest that non-linearity may be a more appropriate way to characterize the relationship between indicators and the number of grants. Therefore the regression:

$$y_{ki} = \beta_0 + \beta_1 GRANTS + \beta_2 GRANTS^2 \tag{6}$$

which includes the squared number of patents granted was also run for each indicator *k* and quality. The results are given in Table 2. This table also shows the results of the test:

$$H_0\text{: } \alpha_1 = 1 \qquad \text{against} \qquad H_1\text{: } \alpha_1 > 1$$

All quality indicators and the quality component are positively dependent on the patents granted in a region. The null hypothesis of the elasticity being equal to one versus the alternative of being larger than one is rejected in favour of the latter for *BCIT*, *FAMSIZE* and most importantly the quality component *q*. When examining non-linear effects, the squared variable is positive and significant for *FCIT3* and *OPPOSITION*, but negative and significant for *BCIT* and *FAMSIZE*. It is insignificant for the quality component. In fact, R^2 is extremely high (≥ 0.95) in all but one regressions (*OPPOSITION*, $R^2 = 0.77$) and particularly so for the quality component (almost 1.00). The squared number of patents does not add much to explaining the quality component. In sum, while all indicators are dependent on the number of granted patents, the quality component has an almost perfect relationship with the number of granted patents. The elasticity is statistically significant and larger than one, which shows that the concentration is larger than for just granted patents.

A summary measure of concentration can be calculated by the Hirschmann-Herfindahl index for each year *t*:

$$HHI_t = \sum_i s_{it}^2, \qquad (7)$$

where s_{it}^2 is the squared share of the indicator in region *i* for period *t*. Higher values for the index imply a larger concentration. This index is shown in Figure 6 for *GRANTS* and for the quality component *Q*.[8] The result here also shows that the quality component is much more concentrated than the number of grants. In addition, both for *GRANTS* and *Q* the concentration seems to increase over time.

< FIGURE 6 ABOUT HERE >

Finally, similar factor analyses on concentration was conducted over 30 technologies in which the patent data were divided, based on the technology division in (Hinze et al., 1997).[9] The technologies are listed in Table 2. The results are not qualitatively different and therefore not presented to conserve space. The quality component is always much more concentrated than for granted patents for the different technologies. The HHI-

---

[8] The antilog of the detrended values for grants and for quality is used since otherwise negative values would be summed.

[9] This division was also used for regional and technological applications in Ejermo (2004).

indices also reveal that most technologies have increasingly concentrated geographically over time.

4 Discussion

The paper examines the geographical distribution of patenting with and without quality-adjustment. While patenting is generally skewed towards larger regions to begin with, quality-adjustment makes this distribution even more skewed. Of the indicators of quality, backward citations and family size seem particularly prone to contribute to this concentration. Moreover, concentration seems to have increased over time. Similar results are reached by doing the analysis technology-by-technology.

Of the two hypotheses stated in the beginning, the answer delivered in this paper is that Hypothesis 1 (H_1) is more realistic: Quality-adjusted patents are *more* geographically concentrated than non-adjusted patents. This means that if we believe that quality-adjusted patents are more representative of innovation than non-adjusted ones, not taking this into account has implications for the empirical study of the geography of innovation. The discussion of empirical results using patent data for studies of the geography of innovation has highlighted two streams of literature. One dwells upon the effects of local R&D upon innovation. If patent data is used as a proxy for innovation, such examinations may be seriously flawed since coefficients may be biased. In addition, studies which aim at tracking knowledge flows through patent citations should take into account that some of these knowledge flows are to patents with little innovative value and weigh the results by their importance by means of a quality component or otherwise. Finally, studies which examine the mobility of inventors through patents, should consider how the quality of patents should weigh overall mobility. That is, also here may studies want to attribute more valuable patents higher weights.

A natural step in future research is therefore to employ this type of quality-adjusted data on the geography level to reexamine some of these issues.

References

ACS, Z., ANSELIN, L. & VARGA, A. (2002) Patents and Innovation Counts as Measures of Regional Production of New Knowledge. *Research Policy,* 31**,** 1069-1085.

ACS, Z., AUDRETSCH, D. & FELDMAN, M. (1992) Real Effects of Academic Research: Comment. *American Economic Review,* 82**,** 363-367.

ACS, Z., AUDRETSCH, D. & FELDMAN, M. (1994) R&D Spillovers and Recipient Firm Size. *The Review of Economics and Statistics,* 76**,** 336-340.

ALMEIDA, P. & KOGUT, B. (1999) Localization of Knowledge and the Mobility of Engineers in Regional Networks. *Management Science,* 45**,** 905-917.

ARORA, A., FOSFURI, A. & GAMBARDELLA, A. (2001) *Markets for Technology - The Economics of Innovation and Corporate Strategy,* Cambridge, Mass., MIT Press.

ARROW, K. J. (1962) The Economic Implications of Learning by Doing. *Review of Economic Studies,* 29**,** 155-173.

AUDRETSCH, D. B. & FELDMAN, M. P. (1996a) Innovative Clusters and the Industry Life Cycle. *Review of Industrial Organization,* 11**,** 253-273.

AUDRETSCH, D. B. & FELDMAN, M. P. (1996b) R&D Spillovers and the Geography of Innovation and Production. *American Economic Review,* 86**,** 630-640.

BRESCHI, S. & LISSONI, F. (2001a) Knowledge Spillovers and Local Innovation Systems: A Critical Survey. *Industrial and Corporate Change,* 10**,** 975-1005.

BRESCHI, S. & LISSONI, F. (2001b) Localized Knowledge Spillovers vs. Innovative Milieux - Knowledge Tacitness Reconsidered. *Papers in Regional Science,* 80**,** 255-273.

BRESCHI, S. & LISSONI, F. (2003) *Mobility and Social Networks: Localised Knowledge Spillovers Revisited*, CESPRI, Bocconi university: Milan.

BRESCHI, S., MALERBA, F. & ORSENIGO, L. (2000) Technological Regimes and Schumpeterian Patterns of Innovation. *The Economic Journal,* 110**,** 388-410.

CABALLERO, R. & JAFFE, A. (1993) Standing on the Shoulders of Giants: An Empirical Assessment of Knowledge Spillovers and Creative Destruction in a Model of Economic Growth. IN BLANCHARD, O. & FISCHER, S. (Eds.) *NBER Macroeconomics Annual.* Cambridge, Mass., MIT Press.

COHEN, W. M., NELSON, R. R. & WALSH, J. (2000) Protecting their intellectual assets: appropriability conditions and why U.S. manufacturing firms patent (or not). *working paper.* NBER.

DAHLIN, K. B. & BEHRENS, D. M. (2005) When is an invention really radical? *Research Policy,* 34**,** 717.

DENG, Y. (2007) Private value of European patents. *European Economic Review,* 51**,** 1785-1785.

EJERMO, O. (2004) Perspectives on Regional and Industrial Dynamics of Innovation. *Department of Economics.* Jönköping, Jönköping International Business School.

EJERMO, O. (2005) Technological Diversity and Jacobs' Externality Hypothesis Revisited. *Growth and Change,* 36**,** 167-195.

EJERMO, O. & KANDER, A. (2007) Swedish business research productivity – improvements against international trends. *Electronic Working Paper Series.* Lund, CIRCLE.

ELLISON, G. & GLAESER, E. L. (1997) Geographic Concentration in U.S. Manufacturing Industries: A Dartboard Approach. *Journal of Political Economy,* 10**,** 889-927.

FELDMAN, M. P. & AUDRETSCH, D. B. (1999) Innovation in Cities: Science-Based Diversity, Specialization and Localized Competition. *European Economic Review,* 43**,** 409-429.

FISCHER, M. & VARGA, A. (2003) Spatial Knowledge Spillovers and University Research: Evidence from Austria. *Annals of Regional Science,* 37**,** 303-322.

FRENKEN, K., HOEKMAN, J. & VAN OORT, F. (2007) *Towards a European Research Area,* Rotterdam, Nai Uitgevers & Ruimtelijk Planbureau.

GAMBARDELLA, A., HARHOFF, D. & VERSPAGEN, B. (2005) The Value of Patents. *NBER Workshop on the Economics of Intellectual Property.* Cambridge, MA.

GEROSKI, P. A. (1995) Do Spillovers Undermine the Incentive to Innovate? IN DOWRICK, S. (Ed.) *Economic Approaches to Innovation.* Edward Elgar: Aldershot.

GRILICHES, Z. (Ed.) (1984) *R&D, Patents, and Productivity*, Chicago: University of Chicago Press.

GRILICHES, Z. (1990) Patent Statistics as Economic Indicators: A Survey. *Journal of Economic Literature,* 28**,** 1661-1707.

HALL, B., THOMA, G. & TORRISI, S. (2007) The Market Value of Patents and R&D: Evidence from European Firms. *NBER working papers.* Cambridge, Ma, NBER.

HALL, B. H. (2005) Exploring the Patent Explosion. *Journal of Technology Transfer,* 30**,** 35-48.

HALL, B. H., JAFFE, A. & TRAJTENBERG, M. (2005) Market Value and Patent Citations. *The Rand Journal of Economics,* 36**,** 16-38.

HALL, B. H. & TRAJTENBERG, M. (2005) Uncovering general purpose technologies with patent data. IN ANTONELLI, C., FORAY, D., HALL, B. H. & STEINMULLER, W. E. (Eds.) *New Frontiers in the Economics of Innovation and New Technology - Essays in Honour of Paul David.* Cheltenham, UK, Edward Elgar.

HARHOFF, D., NARIN, F. & SCHERER, F. M. (1999) Citation frequency and the value of patented inventions. *Review of Economics & Statistics,* 81**,** 511.

HARHOFF, D., SCHERER, F. M. & VOPEL, K. (2003) Citations, family size, opposition and the value of patent rights. *Research Policy,* 32**,** 1343.

HENDERSON, R., JAFFE, A. & TRAJTENBERG, M. (2005) Patent citations and the geography of knowledge spillovers: A reassessment: Comment. *American Economic Review,* 95**,** 461-464.

HINZE, S., REISS, T. & SCHMOCH, U. (1997) Statistical Analysis on the Distance Between Fields of Technology. Fraunhofer-Institute Systems and Innovation Research (ISI): Karlsruhe.

HOOVER, E. M. (1937) *Location Theory and the Shoe and Leather Industries*, Harvard University Press: Cambridge MA.

JACOBS, J. (1969) *The Economy of Cities*, Vintage: New York.

JAFFE, A. (1989) Real Effects of Academic Research. *American Economic Review,* 79**,** 957-970.

JAFFE, A. & TRAJTENBERG, M. (2002) *Patents, citations and innovations: a window on the knowledge economy* Cambridge, MA, MIT Press

JAFFE, A. B., TRAJTENBERG, M. & HENDERSON, R. (1993) Geographic Localization of Knowledge Spillovers as Evidenced by Patent Citations. *Quarterly Journal of Economics,* 108**,** 577-598.

JONES, C. I. (2002) *Introduction to Economic Growth,* New York, W.W. Norton.

KLEINKNECHT, A., MONTFORT, K. V. & BROUWER, E. (2002) The Non-Trivial Choice Between Innovation Indicators. *Economics of Innovation and New Technology,* 11**,** 109-121.

KLEINKNECHT, A., REIJNEN, J. O. N. & SMITS, W. (1993) Collecting Literature-based Innovation Output Indicators: The Experience in the Netherlands. IN

KLEINKNECHT, A. & BAIN, D. (Eds.) *New Concepts in Innovation Output Measurement.* New York: St. Martin's Press.

LANJOUW, J., O. & SCHANKERMAN, M. (2004) Patent Quality and Research Productivity: Measuring Innovation with Multiple Indicators. *Economic Journal,* 114**,** 441.

LERNER, J. (1994) The importance of patent scope: An empirical analysis. *The Rand Journal of Economics,* 25**,** 319.

LEVIN, R. C., KLEVORICK, A. K., NELSON, R. R. & WINTER, S. G. (1987) Appropriating the Returns from Industrial Research and Development. *Brookings Papers on Economic Activity,* 1987**,** 783-820.

MARIANI, M. & ROMANELLI, M. (2006) "Stacking" or "Picking" Patents? The Inventors' Choice Between Quantity and Quality. *LEM Papers Series.* Laboratory of Economics and Management (LEM), Sant'Anna School of Advanced Studies, Pisa, Italy.

MARSHALL, A. (1920) *Principles of Economics*, Macmillan: London.

MAURSETH, P. B. (2005) Lovely but dangerous: The impact of patent citations on patent renewal. *Economics of Innovation and New Technology,* 14**,** 351-374.

MAURSETH, P. B. & VERSPAGEN, B. (2002) Knowledge Spillovers in Europe. A Patent Citation Analysis. *Scandinavian Journal of Economics,* 104**,** 531-545.

MORENO, R., PACI, R. & USAI, S. (2005) Geographical and sectoral clusters of innovation in Europe. *The Annals of Regional Science,* 39**,** 715-739.

MORENO, R., PACI, R. & USAI, S. (2006) Innovation Clusters in the European Regions. *European Planning Studies,* 14**,** 1235-1235.

OECD (2002) *Frascati manual,* Paris, OECD.

OECD (2005) Analysing European and international patent citations: A set of EPO patent database building blocks. *STI Working paper.* Paris: OECD.

OHLIN, B. (1933) *Interregional and International Trade*, Harvard University Press: Cambridge, MA.

PACI, R. & USAI, S. (1999) Externalities, Knowledge Spillovers and the Spatial Distribution of Innovation. *GeoJournal,* 49**,** 381-390.

PAKES, A. (1986) Patents as Options: Some Estimates of the Value of Holding European Patent Stocks. *Econometrica: Journal of the Econometric Society,* 54**,** 755.

PAKES, A. & SCHANKERMAN, M. (1984) The Rate of Obsolescence of Patents, Research Gestation Lags and the Private Return to Research Resources. IN GRILICHES, Z. (Ed.) *R&D, Patents and Productivity.* Chicago, IL, NBER, University of Chicago Press.

PAKES, A. & SIMPSON, M. (1989) Patent Renewal Data. *Brookings Papers on Economic Activity (Microeconomics)***,** 331-410.

PAVITT, K., ROBSON, M. & TOWNSEND, J. (1987) The Size Distribution of Innovating Firms in the UK - 1945-1983. *Journal of Industrial Economics,* 35**,** 297-316.

ROMER, P. M. (1986) Increasing Returns and Long-Run Growth. *Journal of Political Economy,* 94**,** 1002-1037.

SAARINEN, J. (2005) Innovation and Industrial Performance in Finland 1945-1998. *Economic History.* Lund, Lund University.

SANTARELLI, E. & PIERGIOVANNI, R. (1996) Analyzing literature-based innovation output indicators: The Italian experience. *Research Policy,* 25**,** 689-711.

SCHANKERMAN, M. & PAKES, A. (1986) Estimates of the Value of Patent Rights in European Countries During the Post-1950 Period. *The Economic Journal,* 96**,** 1052.

SCHERER, F. M. (1983) The Propensity to Patent. *International Journal of Industrial Organization,* 1**,** 107-128.

SCOTCHMER, S. (2004) *Innovation and Incentives,* Cambridge Ma, MIT Press.

SILVERBERG, G. & VERSPAGEN, B. (2004) The size distribution of innovations revisited: an application of extreme value statistics to citation and value measures of patent significance. *Working Paper.* Eindhoven, ECIS

SINGH, J. (2005) Collaborative Networks as Determinants of Knowledge Diffusion Patterns. *Management Science,* 51**,** 756-770.

SMITH, K. (2005) Measuring innovation. IN FAGERBERG, J., MOWERY, D. C. & NELSON, R. R. (Eds.) *The Oxford Handbook of Innovation.* New York, Oxford University Press.

THOMPSON, P. & FOX-KEAN, M. (2005) Patent Citations and the Geography of Knowledge Spillovers: A Reassessment. *The American Economic Review,* 95**,** 450-460.

TRAJTENBERG, M. (1990) A Penny for Your Quotes: Patent Citations and the Value of Innovations. *The Rand Journal of Economics,* 21**,** 172.

TRAJTENBERG, M., SHIFF, G. & MELAMED, R. (2006) The "Names Game": Harnessing Inventors' Patent Data for Economic Research. *NBER Working Paper 12479.* National Bureau of Economic Research, Inc.

ZUCKER, L. G., DARBY, M. R. & ARMSTRONG, J. (1998a) Geographically Localized Knowledge: Spillovers or Markets? *Economic Inquiry,* XXXVI**,** 65-86.

ZUCKER, L. G., DARBY, M. R. & BREWER, M. B. (1998b) Intellectual Human Capital and the Birth of U.S. Biotechnology Enterprises. *American Economic Review,* 88**,** 290-306.

Tables

Table 1. Correlation matrix of detrended residuals of log of patent grants and quality indicators.

	GRANTS	*FCIT3*	*BCIT*	*FAMSIZE*	*OPPOSITION*
GRANTS	1				
FCIT3	0.9117	1			
BCIT	0.9760	0.8537	1		
FAMSIZE	0.9595	0.8323	0.9814	1	
OPPOSITION	0.7795	0.8078	0.6983	0.6662	1

Table 2. Regression results of quality indicators and quality index on number of granted patents and granted patents squared.

	1	2	3	4	5	6	7	8	9	10
Dependent variable	*FCIT3*		*BCIT*		*FAMSIZE*		*OPPOSITION*		*q*	
GRANTS	0.85	0.69	1.36	1.56	1.62	1.95	0.37	0.19	1.77	1.79
	(34.97)***	(33.12)***	(51.52)***	(109.92)***	(37.12)***	(74.08)***	(15.13)***	(14.11)***	(142.17)***	(102.84)***
GRANTS^2		0.21		-0.27		-0.44		0.25		-0.02
		(10.86)***		(20.17)***		(17.65)***		(20.45)***		(1.33)
Constant	0.00	-0.06	-0.00	0.07	-0.00	0.12	0.00	-0.07	0.00	0.01
	(0.00)	(6.14)***	(0.00)	(11.40)***	(0.00)	(9.97)***	(0.00)	(11.55)***	(0.00)	(0.75)
	-6.35		13.66		14.27		25.39		62.04	
t-test GRANTS > 1	(0.99)		(0.00)***		(0.00)***		(0.99)		(0.00)***	
Obs.	72	72	72	72	72	72	72	72	72	72
R^2	0.95	0.98	0.97	1.00	0.95	0.99	0.77	0.97	1.00	1.00

Absolute value of t statistics in parentheses. The line t-test tests whether the elasticity with respect to *GRANTS* is larger than 1.

* significant at 10%; ** significant at 5%; *** significant at 1%

Table 3. Technologies 1-30 based on Hinze et al. (1997).

No.	Name	No.	Name
1	Electrical engineering	16	Chemical engineering
2	Audio-visual technology	17	Surface technology, coating
3	Telecommunications	18	Materials processing, textiles, paper
4	Information technology	19	Thermal processes and apparatus
5	Semiconductors	20	Environmental technology
6	Optics	21	Machine tools
7	Analysis, measurement, control technology	22	Engines, pumps, turbines
8	Medical technology	23	Mechanical Elements
9	Organic fine chemistry	24	Handling, printing
10	Macromolecular chemistry, polymers	25	Agricultural and food processing, machinery and apparatus
11	Pharmaceuticals, cosmetics	26	Transport
12	Biotechnology	27	Nuclear engineering
13	Materials, metallurgy	28	Space technology weapons
14	Agriculture, food chemistry	29	Consumer goods and equipment
15	Chemical and petrol industry, basic materials chemistry	30	Civil engineering, building, mining

Figures

Figure 1. Swedish patent applications and grants to the EPO 1978-2005.

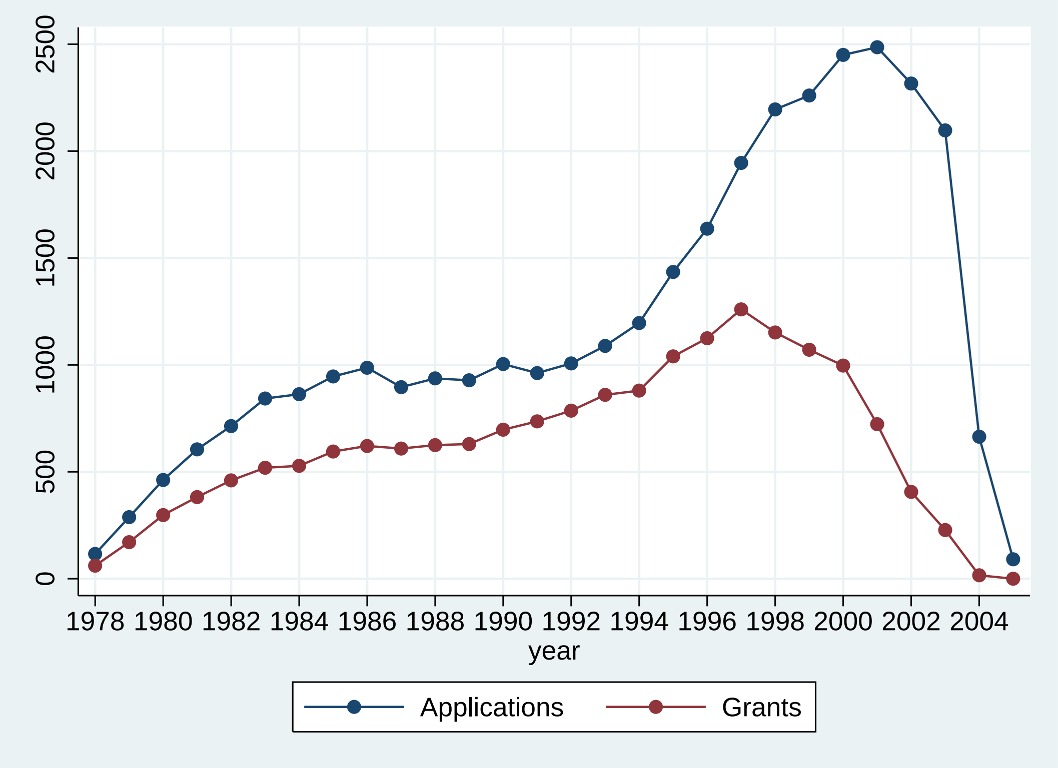


Figure 2. Forward and backward citations per granted patent.

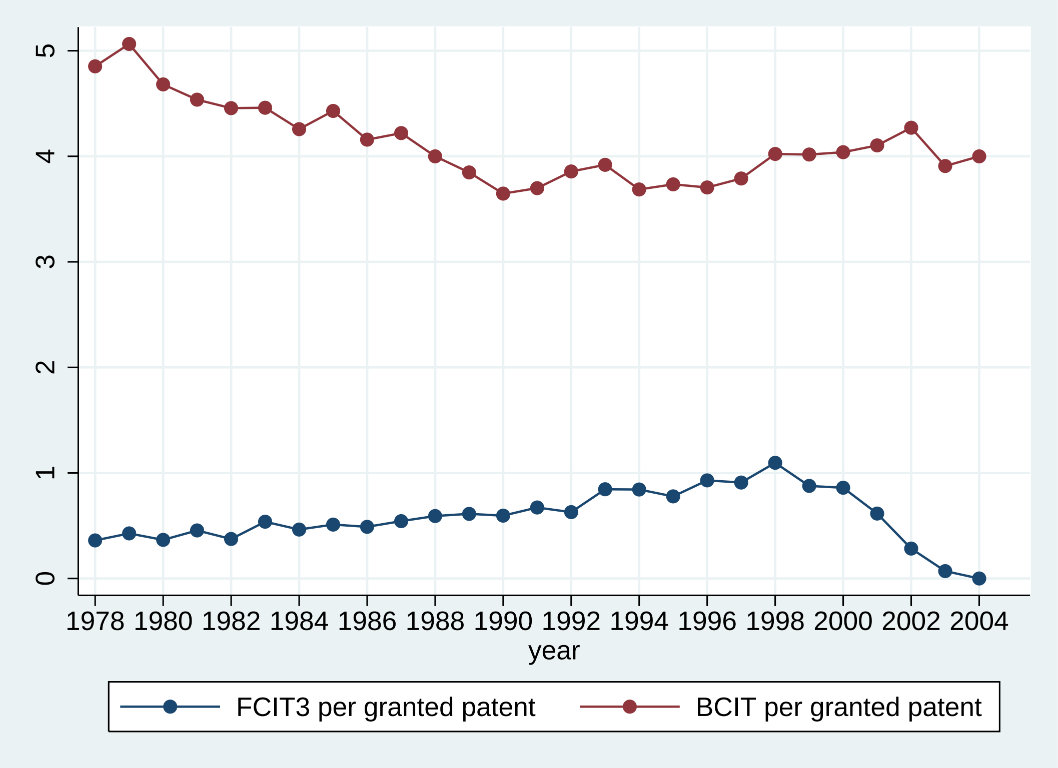


Figure 3. Average opposition incidence for granted patents.

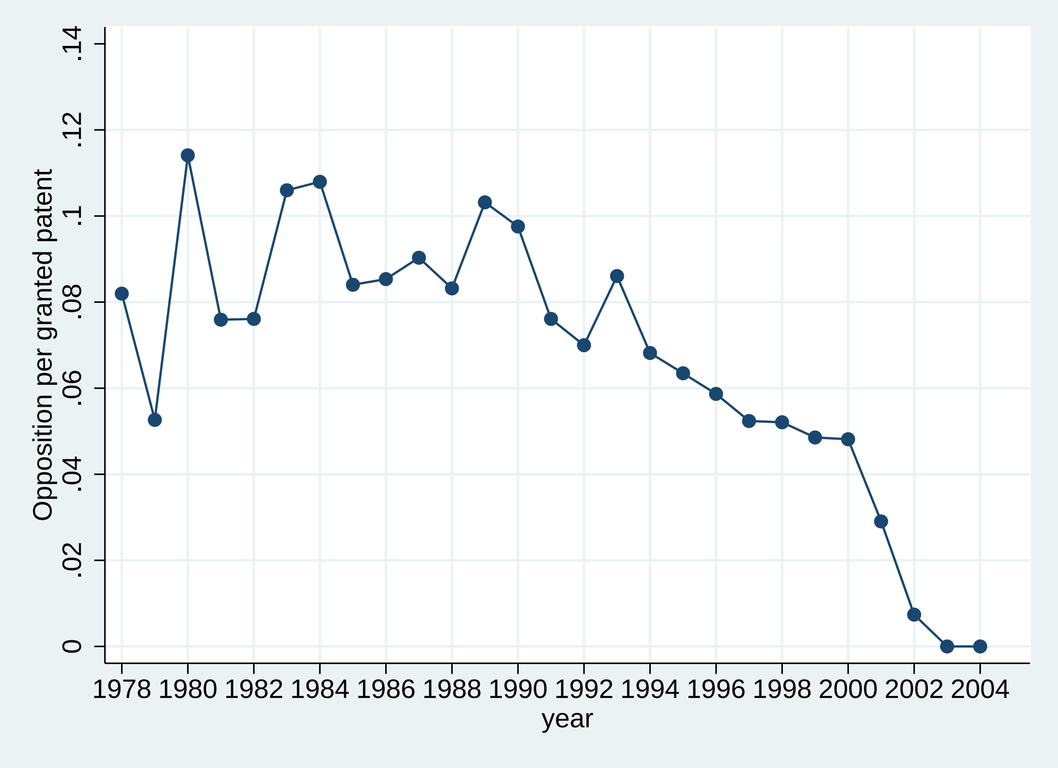


Figure 4. Family size per granted patent.

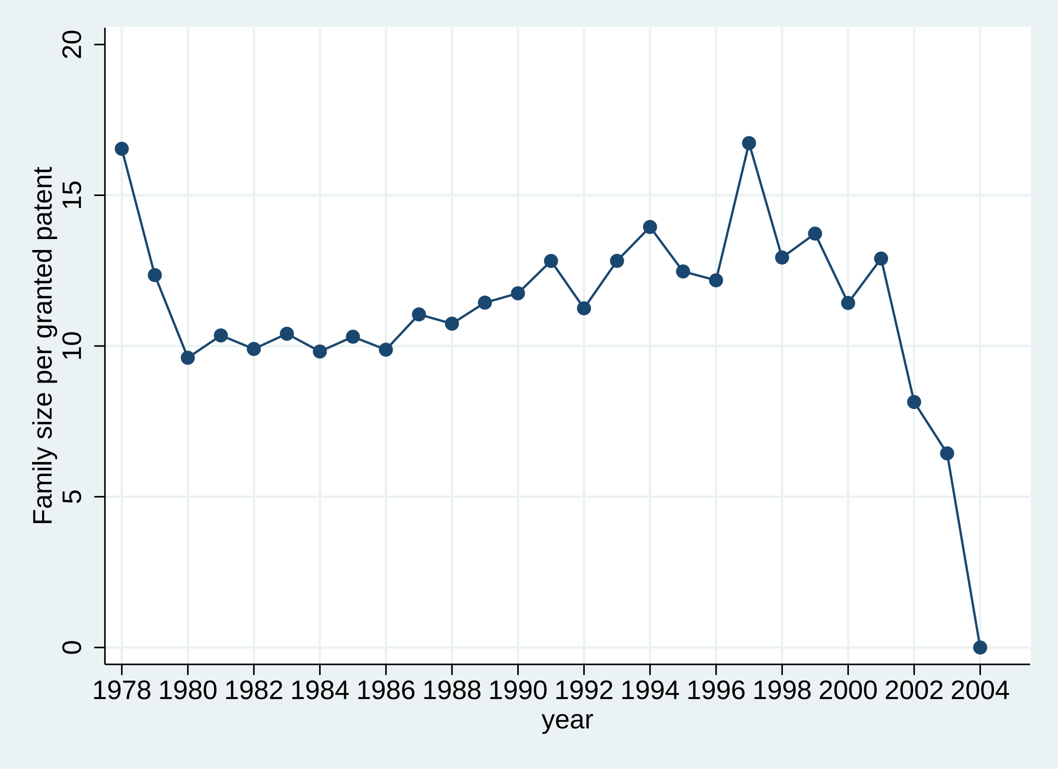


Figure 5. Average number of granted patents 1982-1999.

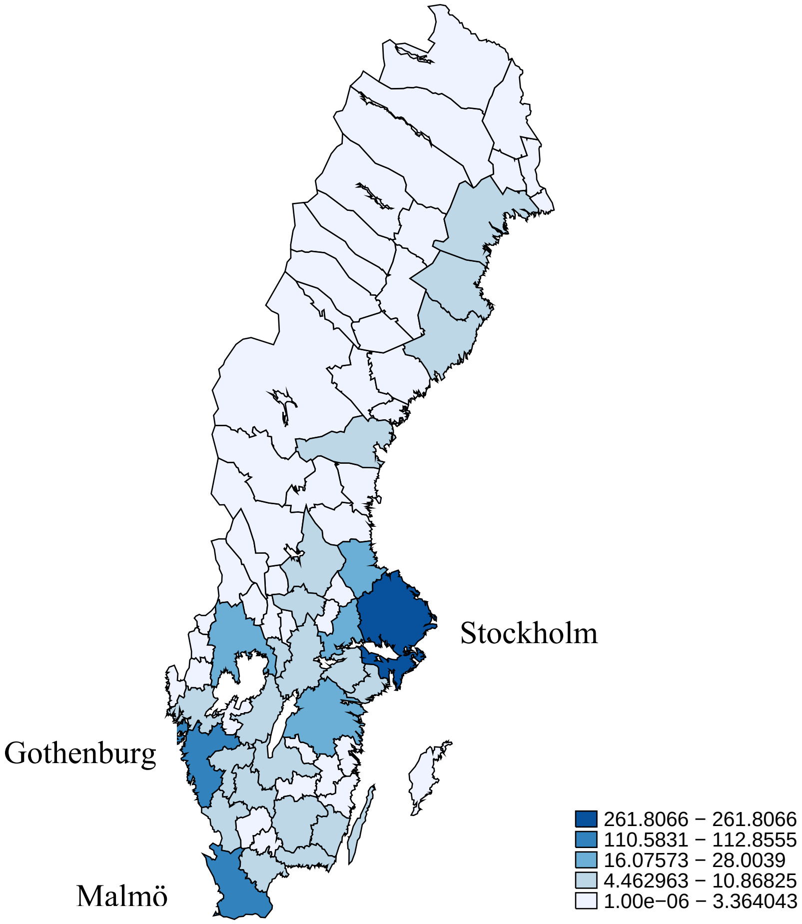
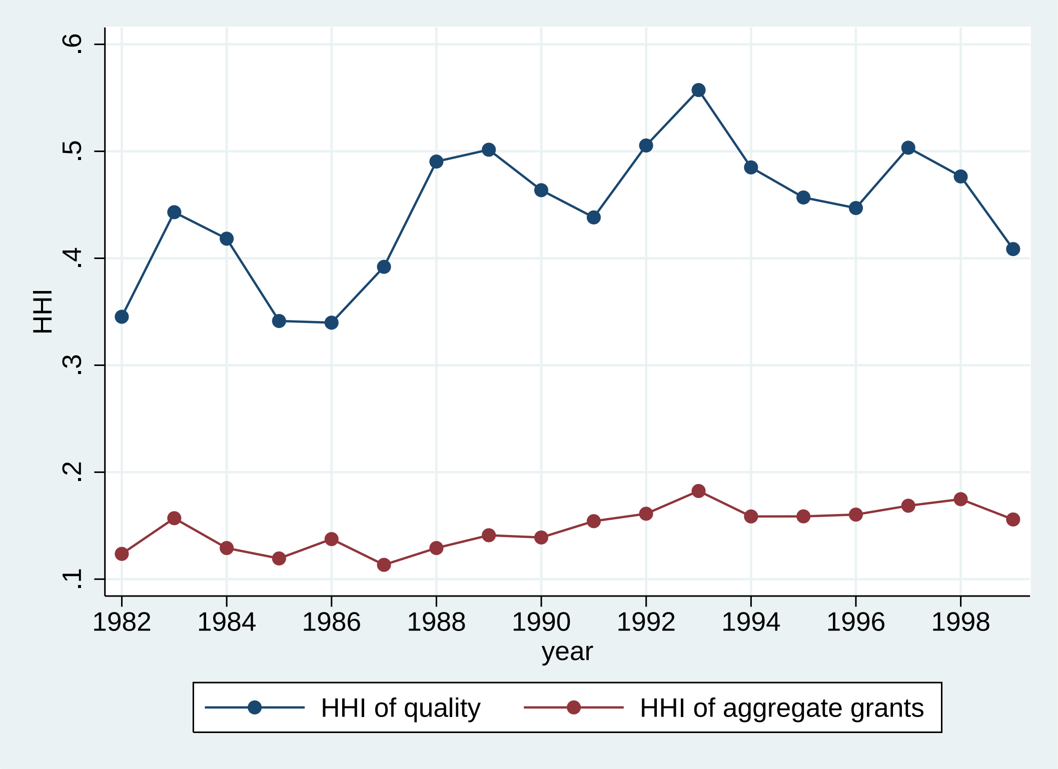


Figure 6. Hirschmann-Herfindahl indices of quality-adjusted grants and patent grants 1982-1999.



CIRCLE ELECTRONIC WORKING PAPERS SERIES (EWP)

CIRCLE (Centre for Innovation, Research and Competence in the Learning Economy) is a multidisciplinary research centre set off by several faculties at Lund University and Blekinge Institute of Technology. CIRCLE has a mandate to conduct multidisciplinary research and education on the following issues: Long-term perspectives on innovation, structural change and economic growth, Entrepreneurship and venture capital formation with a special focus on new ventures, The dynamics of R&D systems and technological systems, including their impact on entrepreneurship and growth, Regional innovation systems in different national and international contexts, International comparative analyses of national innovation systems and Policy design based on policy learning,

The CIRCLE Electronic Working Paper Series are intended to be an instrument for early dissemination of the research undertaken by CIRCLE researchers, associates and visiting scholars and stimulate discussion and critical comment.

The working papers present research results that in whole or in part are suitable for submission to a refereed journal or to the editor of a book or have already been submitted and/or accepted for publication.

CIRCLE EWPs are available on-line at: http://www.circle.lu.se/publications

Available papers:

2007

WP 2007/01
Path-following or Leapfrogging in Catching-up: the Case of Chinese Telecommunication Equipment Industry
Liu, Xielin

WP 2007/02
The effects of institutional change on innovation and productivity growth in the Swedish pharmaceutical industry
Malmberg, Claes

WP 2007/03
Global-local linkages, Spillovers and Cultural Clusters: Theoretical and Empirical insights from an exploratory study of Toronto's Film Cluster
Vang, Jan; Chaminade, Cristina

WP 2007/04
Learning from the Bangalore Experience: The Role of Universities in an Emerging Regional Innovation System
Vang, Jan; Chaminade, Cristina.; Coenen, Lars.

WP 2007/05
Industrial dynamics and innovative pressure on energy
-Sweden with European and Global outlooks
Schön, Lennart; Kander, Astrid.

WP 2007/06
In defence of electricity as a general purpose technology

Kander, Astrid; Enflo, Kerstin; Schön, Lennart

WP 2007/07
Swedish business research productivity – improvements against international trends
Ejermo, Olof; Kander, Astrid

WP 2007/08
Regional innovation measured by patent data – does quality matter?
Ejermo, Olof

2006

WP 2006/01
The Swedish Paradox
Ejermo, Olof; Kander, Astrid

WP 2006/02
Building RIS in Developing Countries: Policy Lessons from Bangalore, India
Vang, Jan; Chaminade, Cristina

WP 2006/03
Innovation Policy for Asian SMEs: Exploring cluster differences
Chaminade, Cristina; Vang, Jan.

WP 2006/04
Rationales for public intervention from a system of innovation approach: the case of VINNOVA.
Chaminade, Cristina; Edquist, Charles

WP 2006/05
Technology and Trade: an analysis of technology specialization and export flows
Andersson, Martin; Ejermo, Olof

WP 2006/06
A Knowledge-based Categorization of Research-based Spin-off Creation
Gabrielsson, Jonas; Landström, Hans; Brunsnes, E. Thomas

WP2006/07
Board control and corporate innovation: an empirical study of small technology-based firms
Gabrielsson, Jonas; Politis, Diamanto

WP2006/08
On and Off the Beaten Path:
Transferring Knowledge through Formal and Informal Networks
Rick Aalbers; Otto Koppius; Wilfred Dolfsma

WP2006/09
Trends in R&D, innovation and productivity in Sweden 1985-2002
Ejermo, Olof; Kander, Astrid

WP2006/10

Development Blocks and the Second Industrial Revolution, Sweden 1900-1974
Enflo, Kerstin; Kander, Astrid; Schön, Lennart

WP 2006/11
The uneven and selective nature of cluster knowledge networks: evidence from the wine industry
Giuliani, Elisa

WP 2006/12
Informal investors and value added: The contribution of investors' experientially acquired resources in the entrepreneurial process
Politis, Diamanto; Gabrielsson, Jonas

WP 2006/13
Informal investors and value added: What do we know and where do we go?
Politis, Diamanto; Gabrielsson, Jonas

WP 2006/14
Inventive and innovative activity over time and geographical space: the case of Sweden
Ejermo, Olof

2005

WP 2005/1
Constructing Regional Advantage at the Northern Edge
Coenen, Lars; Asheim, Bjørn

WP 2005/02
From Theory to Practice: The Use of the Systems of Innovation Approach for Innovation Policy
Chaminade, Cristina; Edquist, Charles

WP 2005/03
The Role of Regional Innovation Systems in a Globalising Economy: Comparing Knowledge Bases and Institutional Frameworks in Nordic Clusters
Asheim, Bjørn; Coenen, Lars

WP 2005/04
How does Accessibility to Knowledge Sources Affect the Innovativeness of Corporations? Evidence from Sweden
Andersson, Martin; Ejermo, Olof

WP 2005/05
Contextualizing Regional Innovation Systems in a Globalizing Learning Economy: On Knowledge Bases and Institutional Frameworks
Asheim, Bjørn; Coenen, Lars

WP 2005/06
Innovation Policies for Asian SMEs: An Innovation Systems Perspective
Chaminade, Cristina; Vang, Jan

WP 2005/07
Re-norming the Science-Society Relation

Jacob, Merle

WP 2005/08
Corporate innovation and competitive environment
Huse, Morten; Neubaum, Donald O.; Gabrielsson, Jonas

WP 2005/09
Knowledge and accountability: Outside directors' contribution in the corporate value chain
Huse, Morten, Gabrielsson, Jonas; Minichilli, Alessandro

WP 2005/10
Rethinking the Spatial Organization of Creative Industries
Vang, Jan

WP 2005/11
Interregional Inventor Networks as Studied by Patent Co-inventorships
Ejermo, Olof; Karlsson, Charlie

WP 2005/12
Knowledge Bases and Spatial Patterns of Collaboration: Comparing the Pharma and Agro-Food Bioregions Scania and Saskatoon
Coenen, Lars; Moodysson, Jerker; Ryan, Camille; Asheim, Bjørn; Phillips, Peter

WP 2005/13
Regional Innovation System Policy: a Knowledge-based Approach
Asheim, Bjørn; Coenen, Lars; Moodysson, Jerker; Vang, Jan

WP 2005/14
Face-to-Face, Buzz and Knowledge Bases: Socio-spatial implications for learning and innovation policy
Asheim, Bjørn; Coenen, Lars, Vang, Jan

WP 2005/15
The Creative Class and Regional Growth: Towards a Knowledge Based Approach
Kalsø Hansen, Høgni; Vang, Jan; Bjørn T. Asheim

WP 2005/16
Emergence and Growth of Mjärdevi Science Park in Linköping, Sweden
Hommen, Leif; Doloreux, David; Larsson, Emma

WP 2005/17
Trademark Statistics as Innovation Indicators? – A Micro Study
Malmberg, Claes