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Explaining the propensity to patent computer software

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Abstract

Several studies have explained the propensity to patent in industrial corporations. Larger companies are supposed to have a stronger tendency to protect their intellectual property through patents. Also, patents are related to industry, with chemicals and pharmaceuticals using them more frequently, and services industries less so. In the last 20 years, the rapidly growing software industry has greatly increased its tendency to patent. This study presents a statistical explanation of patenting in the US and Canadian (over 1700) publicly quoted computer software-producing companies, representing half of the world industry. We found that firm size, geographical clustering, and the mix of software products and services at firm level explain most of the propensity to patent.

Keywords: Computer software patent; Patent propensity; Software invention

1. Introduction

In the knowledge economy, information has become the most important resource allowing both firms and nations to grow. Information is the basis of competitive advantage at the micro and macro levels. For firms in the science-based industries, intellectual property is a key element of the assets of the firm. Thus, it is essential that the firm be able to master and protect this asset. Patents are considered one of the best economic instruments for inventors to keep control of their novelties and ensure a return on their investments in research and development (Mazzoleni and Nelson, 1998).

Software is ubiquitous in the knowledge economy and the software industry is one of the most important places where intellectual property is concentrated and wealth is created. The information and communication technology (ICT) industry accounts for over a third of the growth of the American economy between 1995 and 1999 (Cortright and Mayer, 2001). Within the ICT industry, the computer software segment has experienced exceptional development in the last ten years and is still growing, if at a less spectacular rhythm (McQueen, 2004).

The diffusion of the personal computer (PC) has contributed enormously to the development of the computer software industry (Mowery, 1996). PCs and software are now at the core of both services and manufacturing.

From the origins of the industry in the 1950s until now, computer software was mostly protected through copyright. In the 1980s, patents started being used to protect software along with copyrights. Since then, and for the last two decades, the growth of software patents in North America has been exponential. Thus the annual number of software patents passed from 200 in 1975 to over 7000 in 1995 and over 10000 in 2001 (Bessen and Maskin, 2002)(Fig. 1).

However, the rise of software patents has raised many concerns. Recently, Paul David expressed the apprehension that proprietary platforms may create barriers to the development of the industry (David, 2001). Similarly, the National Research Council of the United States (NRC, 2000) has expressed alarm about the new patenting trend. It suggested in particular that the United States Patent and Trademark Office (USPTO) might have insufficient skills to judge the novelty of software patents, and to evaluate prior art. Patents may also put an obstacle to the rapid development of the software industry, characterised by a life cycle of 18 months on average. The NRC study suggested that much research was necessary to evaluate the trends and outcomes of the patenting of software. This paper goes some way in this direction and tries to understand the determinants of patenting in the North American software industry.

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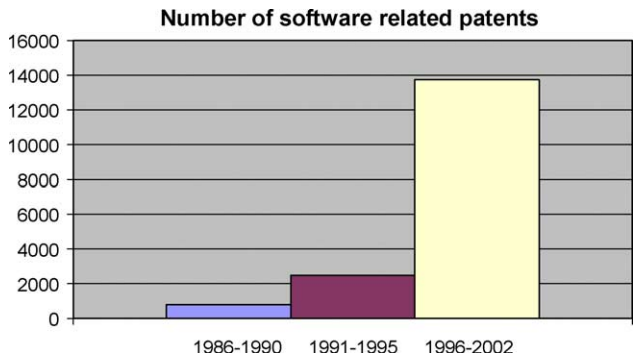

Fig. 1. Number of computer software related patents.

2. The computer software industry

The computer software industry is one of the major segments of the software industry. The latter includes several segments such as software for telecommunications, computers, robotics, numerically-controlled machines and game machines. In all these industries one finds companies providing three different types of products and services: hardware (i.e. computers, telecommunications equipment, NCMs), software and related services (i.e. systems integration, tailored product development, etc.).

Within the computer software segment, two major types of companies are to be found: computer hardware/software producers, such as IBM, Apple, Sun Microsystems and Compaq, and independent software producers such as Microsoft, Oracle, Computer Associates and, in Canada, Cognos and Corel.

The development of the computer software industry has passed through several phases (Hoch et al, 1999). The first one started in the 1950s with the rise of the independent professional software services firms, offering tailor-made programs to an elite market of government and industrial customers. By 1967, 2800 professional software service firms already existed in the United States. The second era was characterized by the development of software products, packaged software for institutional markets, launched in the mid 1960s. The third phase was that of customized enterprise solutions, started in 1969, with SAP of Germany being one of the first firms of this type. The development of the IBM PC in 1981 launched a fourth era, in which the PC packaged software market developed. The fifth software era started in 1994 with the Internet and Netscape browser. The present software industry has segments belonging to these different eras, but packaged software for the PC segment represents the major portion of the industry. Today many platforms compete, and both independent software firms (like Microsoft, Oracle and Computer Associates) and large computer manufacturing firms such as IBM (the world's largest producer of computer software), Hewlett Packard and Apple produce software for many different applications (Chandler, 2001). The world market for packaged software in 2002 has reached $ 200 billion US (against 77 billion in 1994). Also, in 1993 North American producers supplied over 75% of the world's packaged software, and it is estimated that they represented 50% in 2000. Similarly the US and Canada represented half of the global packaged software market.

Another indicator of the importance of the software industry is the total market capitalisation of the software editors. As of April 22, 2003, independent software companies were the seventh largest North American industrial group in terms of market cap, with US540 billion, far ahead of computer hardware (nineteenth with $250 billion US) and computer services (twenty-second, with $237 billion US). Also, Microsoft was the largest ICT company by market capitalisation, and IBM was second.

3. Why software patents?

A large number of companies operating in the Information and Communication Technology industries (ICTs) are now patenting software. One European source has analysed the European Patent Office Database and produced some statistics on European software patents (Fig. 2). They show that between 1976 and early 2003 there were 74517 software patent applications (including computer, telecommunications and other types of software patents) in the European Patent Office (EPO) and estimate that close to 80% (or 60,000) of these applications were accepted. Some 44% of the applications came from the United States, 29% from Japan, 22% from companies based in the European Union, and 2 from those based in Canada. The rest of the world represented 3% (Table 1).

We do not possess similar figures for USPTO software patents, but we found that publicly quoted North American computer software and hardware companies had obtained over 22200 software patents, a figure perfectly compatible with the EPO figures previously mentioned.

Why do ICT companies patent software? By publishing software, ICT companies release a product that is entirely made of information and can easily be copied. The traditional IP protection by copyright only protected the literal expression (lines of code) against piracy. Therefore, software companies looked for a stronger protection, that would also shield the idea (Band and Katoh, 1995). The search for patents started in the 1970s and intensified in the 1980s and 1990s, mostly in North America, while Western Europe and Japan were still reluctant to extend patent protection to software. Finally, both Western Europe and Japan started to participate in the race to protect software through patents. In the United States, the Supreme Court allowed a software patent in the Diamond vs. Diehr case (National Research Council, 1991) in 1973. Soon after, Canadian, European and Japanese software patents became common.

Two opposite points of view exist on the opportunity of patenting software. For some authors, mostly academics,

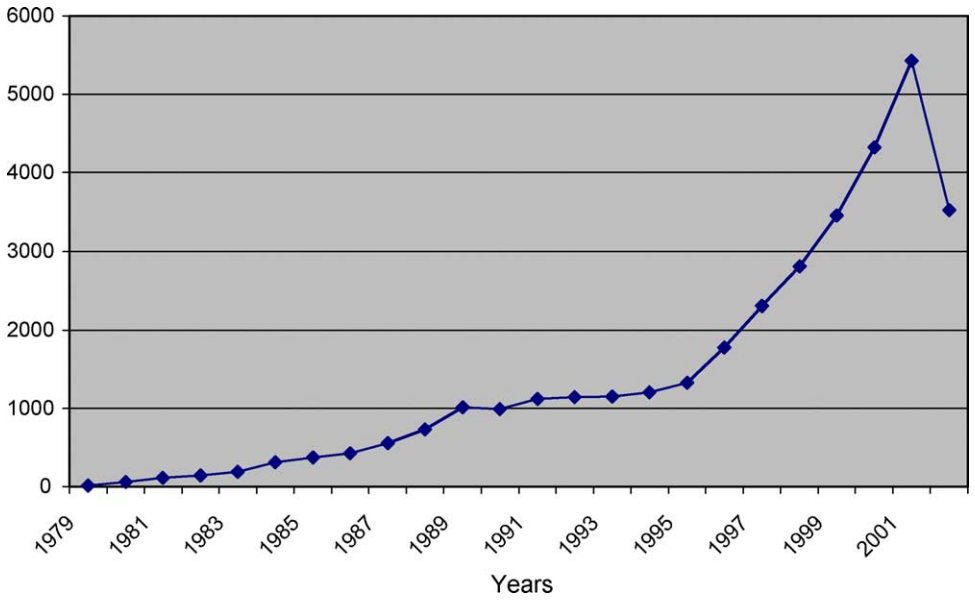

Fig. 2. European software patent applications, 1979–2002.

software should not be patented (Merges, 1996; David, 2001). First, patents may reduce the contestability of markets. The cumulative character of software is such that each advance builds on previous achievements. If future innovators must pay royalties to the previous ones, the chances that new firms will enter the industry will decline rapidly, thus leading to a monopolistic market. Second, patents on software risk to bring technological change to a halt in such a dynamic industry: the life cycle of software products is around 18 months, while patents are valid for twenty years. Finally, software is now used in all industries and is vital to their development. Software patents may endanger the viability of many different manufacturing and service industries by denying access to more efficient technologies based on ICTs. Finally, as NRC and others have demonstrated, the national patent offices may not be equipped to grant software patents. The ensuing surge in litigation may be socially and economically costly.

The arguments in favour of software patents are also strong. Large companies argue that the cost of developing and marketing software is escalating and is now in the dozens if not hundreds of millions of dollars for the PC software packaged market. Without patent protection these software investments would be prohibitive. Software piracy would be on the rise and affect the profitability of investments in new computer programs. The Business Software Alliance, an American association of software producers, calculates that four out of ten software programs are pirated worldwide. Also, in niche markets, smaller firms will not benefit from any license revenue if patents do not protect their investments from counterfeiters.

Whatever the theoretical and public policy discussion may be, it is certain that software patents are on the rise, in North America as well as in Europe. The issue we present in this paper will have increased relevance both economically and geographically as more countries accept to grant software patents and the number of patentees increases.

4. Why do firms patent? theories and hypotheses

Several studies have shown that the propensity to patent varies from one industry to another (Taylor and Silberston, 1973; Winter, 1989; Cohen et al., 1996; Arundel and Kabla, 1998). They all demonstrate that manufacturing industries show a much higher propensity to patent than the service sector. Also, within manufacturing industries, R&D intensity is related to patents, with science-based industries (pharmaceuticals, chemical and ITC industries) showing a much higher propensity to patent than medium and low technology industries such as transportation equipment, metal fabrication, pulp and paper, food or textiles. However rich, this literature has not examined the software industry propensity to patent. Reasons for this omission are many.

Table 1
European software patent applications by country/region of applicant, 1976–2003

Country	Software patents	
	N	%
USA	32873	44
Japan	21709	29
European union	16338	22
Canada	1219	2
Rest of world	2378	3
Total	74517	100

Source: Foundation for a Free information infrastructure, Munich, 2003 (On the basis of EPO figures).

First, there are tens of thousands of applicants and applications. The FFII European source cited above found over 38000 European patent applicants for some 75000 software patents. Second, there are no codes for software patents, and only keywords and company names can be used to distinguish software patents. But the vast majority of the independent software companies are privately owned, and it no easy task to find them and to understand their patenting strategies.

Also, software companies are classified with service industries, and product invention tends to be patented much more than process invention. Thus, intellectual property specialists have tended to concentrate on product patenting and to neglect the tens of thousands of software patents applied for [1].

Finally, software patents are close to process patents. Products circulate freely, so firms tend to protect as strongly as possibly the goods they produce. Conversely, process novelty can be kept secret by forbidding access to facilities to non-employees, and by signing confidentiality clauses with employees. In spite of the fact that software is related to processes, it consists in products that do circulate and can be copied, 'reverse engineered' and counterfeited. Thus, we would expect computer software firms with products (hardware manufacturers and software editors) to display a higher probability of patenting their inventions than service providers of custom-made software solutions. The latter do not circulate freely, and most often serve a single user. The probability of counterfeiting is thus lower for service providers; their propensity to patent is consequently lower.

Another factor that impacts the propensity to patent is the size of the firm. Many authors have shown that the propensity to patent increases with the size of the firm (Scherer, 1999; Mansfield, 1986; Arundel and Kabla, 1998; Brouwer and Kleinknecht, 1999). Larger firms have more resources than smaller ones, and substantial resources are needed to obtain patents and eventually defend them in case of litigation. This assertion must also be true in the software industry.

Innovation activities tend to be strongly concentrated in a few geographical regions in each developed country. Besides, firms operating in the same industry tend to cluster geographically, a tendency that Alfred Marshall had found in the early twentieth century and that many authors have confirmed and illustrated many times (Swann et al., 1998). Also, firms in clusters innovate more (Baptista and Swann, 1998). Different explanations tried to account for the geographical agglomeration of innovating firms. Some authors insisted on the fact that knowledge externalities flow mostly at the regional level, as some of the key knowledge generated by the innovating firm is tacit and easily flows to neighbouring ones through person to person communication (Audretsch and Feldman, 1996). Other authors have argued that innovation in one firm forces the neighbours to innovate in order to survive the competitive threat posed by the initial innovator (Porter, 1990). We thus expect software firms to cluster and software innovators with patents to concentrate geographically. Finally, agglomeration increases the likelihood that clustered firms will patent: it has been observed that knowledge flows from one company to another within a region via the mobility of scientists and engineers; patenting thus reduces the risk of losing key knowledge through the departure of research personnel to rival firms within the cluster (Almeida and Kogut, 1999).

The above theoretical discussion allows us to formulate the following hypotheses:

H1: the propensity to patent software is high, as software is basically a product than can easily be reverse engineered, copied and counterfeited. We thus expect a majority of computer software firms to request patent protection. As such, software programs should be close to chemical and pharmaceutical products, and their inventors should tend to patent them. Small and medium-sized software publishers should have a similar propensity to patent as small or meidum-sized biotechnology firms.

H2: The propensity to patent software increases with the size of the firm

Patenting is costly, and larger corporations should tend to patent much more often than smaller firms. Also, larger corporations conduct more R&D and have a more complex research strategy. This hypothesis partially opposes the previous one. Propensity to patent is defined as a dichotomy, the likelihood that a company does or does not patent software.

H3: The propensity to patent increases with the percentage of products (hardware and software) in the total revenues of the firm. Firms with high share of revenues in computer software services will generate fewer patents. Experience is part of the explanation for this hypothesis. Hardware computer companies have been patenting their novelties for over two decades. They are more acquainted with the patenting process. Thus, the higher the percentage of products (both hardware and software as opposed to services) in a computer software producing company the higher is the likelihood that the company patents its software.

H4: The propensity to patent is higher in firms localised in clusters. The percentage of patenting firms located in clusters is higher than the percentage of those located in regions with few software firms.

Competition within clusters may be strong, and ideas also flow from one company to another, within a given geographical region, through the flow of people. Thus we expect a higher propensity to patent within a cluster than in more isolated firms.

[1] Few analysts have studied software patents. D.H. McQueen and H. Olsson appear to be among the most active in the field (McQueen and Olsson, 2003; McQueen, 2004).

Table 2
Explaining the number of patents

Model	R	R Square	Adjusted R square	Std. error of the estimate		
1	0.914[a]	0.835	0.834	200.417		
		Unstandardized coefficients		Standardized coefficients		
		B	Std. error	Beta	t	Sig.
	(Constant) sales	− 28.093	9.726		− 2.888	0.004
		8.750E-05	0.000	0.914	46.719	0.000

Predictors, (Constant), Sales; Dependent variable, Total patents.

H5: The number of software patents increases with the size of the firm.

Among patenting firms, the larger the company, the more substantial are the resources that allow the company to patent. Thus, we expect computer software firms to behave similarly to firms operating in other areas, and we expect a strong correlation between size and the number of patents Table 2.

5. The study

Our study is supported by a database of 1700 software-producing firms located in the United States (some 1320) and Canada (some 380). The study covers all the publicly traded computer software firms and a few others for which we could find financial information. Some of the companies also produce hardware, but most of them are independent software producers.

We used different databases providing financial information (on sales, employees, assets, etc.), and we linked this information to the USPTO data on software patents. As there is no classification code (US or international) for software patents, and after consulting with the USPTO, we used a few keywords to identify software patents, such as 'business methods', 'computer methods', and 'software'. We identified companies with software patents for the period 1986–2002, and we combined this information with financial data for the 2000–2 period. We found 22254 computer software patents; we purposely excluded telecommunications equipment producers (such as Alcatel, Cisco, Ericsson, Lucent, Nokia, Nortel, Siemens or STET) each with thousands of software patents, as well as automotive corporations, numerically controlled machine producers, avionics producers and robotics manufacturers, to name a few industries in which software is produced in large numbers.

The first major finding was that only 220 publicly quoted North American enterprises had been granted computer software patents since 1986, and up to 2002. The propensity to patent for this group (13%) was fairly low when compared with other science-based industries. Software seems different from other SBIs, exhibiting a lower propensity to patent. This first result then tends to reject our first hypothesis. Software seems different from biotechnology in terms of its propensity to patent. In biotechnology, the R&D process leading to market products may extend over five to ten years, while for most software products, the R&D process is much shorter. Also, the life of a biotechnology product is much longer, while software products may become obsolete in a few years, thus making patent protection less indispensable.

Some 49% of our firms derive most of their revenues from products, and the other 51% mostly from services[2]. In addition, companies with a strong component of hardware products, as well as software edition, obtained most of the software patents. Table 3 gives the list of the main computer software patentees, the majority of whom are US corporations. Only one Canadian company has more than one hundred patents. IBM, a company most often identified with computer hardware, emerges as the largest owner of computer software patents, as well as Hewlett Packard and Sun Microsystems. Microsoft, the largest independent software producer takes second place.

In the late 1980s and early 1990s, many independent software companies originally opposed to patenting, such as Adobe, Novell and Oracle, changed there strategy concerning software patents. Microsoft, the first independent software producer to build a patent portfolio, requested its first software patent in the United States in April 1985, while IBM and other computer hardware manufacturing companies had already been granted hundreds of software patents. Threatened by larger competitors, and whatever their intellectual property strategy may have been in the 1980s, the then medium-sized independent software editors started requesting patents to protect their inventions[3].

[2] Software products are packaged solutions that meet generic computing requirements and include enterprise solutions (i.e. accounting or inventory control systems) software development tools, operating systems and utilities and personal computing tools. In the product companies we include also computer hardware manufacturing firms. Software services refer to software development and operation services provided to clients on a project basis, and include custom software development services and systems implementation and systems integration services.

[3] Thus in September 1990, Novell requested its first patent in the US. In November 1991, Oracle filed its first software patent application. Adobe and Silicon Graphics had made the same first request in September 1988.

Table 3
Main North American computer software patentees (1986–2002)

Company	Country of control	Activity	Software patents	
			n	%
IBM	USA	CH and S	10405	47
Microsoft	USA	ISP	2413	11
Hewlett-Packard	USA	CH and S	2300	10
Sun Microsystems	USA	CH and S	1023	5
Apple computer	USA	CH and S	616	3
Compaq computer	USA	CH and S	448	2
Unisys	USA	ISP	408	2
Oracle	USA	ISP	402	2
Imation	USA	ISP	283	1
Adaptec	USA	ISP	253	1
Silicon graphics,	USA	CH and S	230	1
Dell	USA	CH and S	223	1
Adobe systems	USA	ISP	215	1
EMC	USA	CH and S	201	1
Novell	USA	ISP	194	1
EDS	USA	ISP	176	1
Synopsys	USA	ISP	138	1
ATI Technologies	Canada	ISP	125	1
Sub-total			20053	90
All other companies			2201	10
Total			22254	100

CH and S, Computer hardware and Software producer; ISP, Independent software producer.

Table 4
Main North American concentration of software invention

Region	State/Province	Country	Total software patents	% of all software patents
Silicon Valley	CA	USA	4892	22
Austin	TX	USA	2363	10.6
Seatle	WA	USA	2151	9.6
Saint Paul	MN	USA	1351	6
New York	NY	USA	1053	4.7
Triangle Research Park	NC	USA	837	3.7
Miami	FL	USA	810	3.6
Denver	CO	USA	694	3.1
Pougheepsie	NY	USA	624	2.8
Boston	MA	USA	587	2.6
Syracuse	NY	USA	569	2.5
San Diego	CA	USA	315	1.4
Dallas	TX	USA	310	1.4
Portland	OR	USA	305	1.4
Washington	DC	USA	269	1.2
Boise	ID	USA	222	0.9
Houston	TX	USA	219	0.9
Tucson	AZ	USA	205	0.9
Provo	UT	USA	187	0.8
Toronto	ON	Canada	145	0.6
Los Angeles	CA	USA	137	0.6
Hartford	CT	USA	128	0.6
Chicago	IL	USA	127	0.6
Huntsville	AL	USA	123	0.5
Philadelphia	PA	USA	123	0.5
Eugene	OR	USA	110	0.5
Sub-total			18866	84.7
All other regions			3388	15.3
Total			22254	100

We grouped patents by region (defined as metropolitan census areas plus its close proximity) and found that, not surprisingly, Silicon Valley was the main cluster of software invention, followed by Austin (Texas), Seattle (location of the main Microsoft R&D laboratories), Saint-Paul (Minnesota) and New York. Among the twenty-four agglomerations with 100 software patents or more, twenty-four were American and only one Canadian, in Toronto). California was the most important state with three different regional innovation systems (Silicon Valley, San Diego and Los Angeles) (Table 4).

We then proceeded to examine the determinants of the propensity to patent. Our dependent variable was examined twice under two different models. In the first, we divided the dependent variable into a dichotomy and opposed the 220 firms with patents against a control random group of similar size. The results appear in Table 5.

We thus tested our hypotheses 2, 3 and 4. The three hypotheses seem to be confirmed by our logistic regression analysis. The three variables combined explain about three quarters of the propensity to patent. Our model is robust and shows that size of firms, clustering and the product/service mix explain much of the tendency to patent. Large firms patent more, companies with more products and companies in clusters patent more than others. The cross tabulations and correlation analysis both go in the same direction (Tables 6 and 7). No co-linearity affects the validity of the logistic regression results.

Finally, we tested H5 with the same variables through a linear regression. It appeared that only one variable explained most of the variation in the dependent variable, this time the number of patents, a metric one. The size of the firm explains almost 80% of the number of patents. The region and the product/service divide were unrelated to the number of patents. We thus hypothesize that, within innovating regions, companies tend to patent, especially if they are more centred on products than on services, and that in the decision to patent or not, company size is important but less than the other two variables. Conversely, once a company has decided to patent, the size of the firm is the only major variable.

6. Conclusion

Our study extends and confirms other research results conducted by others in different industries. We also find support for three of our hypothesis: larger firms tend to patent more often, as do firms with more products than

Table 5
Explaining the propensity to patent: A logistic regression Variables in the Equation

	B	S.E.	Wald	d.f.	Significance	Expected B
Activity concentration	0.943	0.211	20.009	1	0.000	2.567
Location	0.996	0.249	16.001	1	0.000	2.707
Sales	1.135	0.210	29.222	1	0.000	3.111
Constant	−4.837	0.655	54.559	1	0.000	0.008

Variable(s) entered on step 1: Activity concentration, Location, Sales

Omnibus tests of model co-efficients

	Chi-square	df	Significance
Step	74.768	3	0.000
Block	74.768	3	0.000
Model	74.768	3	0.000

Classification table

	Predicted patents N/Y		Percentage correct
	1	2	
Observed patents N/Y	1, 121	95	56.0
	2, 52	166	76.1
Overall			66.1

The cut value is ,500; Activity concentration (product or service), dichotomous; Location (in cluster or out of cluster), dichotomous; Sales of the firms, dichotomous.

services, and companies within innovative clusters tend to patent more often than those that are located in more remote regions. Also, once a company has decided to patent, the size of the firm determines the number of patents it requests.

Conversely, the propensity to patent (13% for publicly quoted companies) in the software industry is not particularly high when compared to other high-technology industries, such as the pharmaceutical, chemical or the ICT sector. However, we found that the number of companies patenting increases with time and it may happen that in a few years software firms will have a propensity to

Table 6
Cross Tabulations

Count		Patents N/Y		Total
Number of firms according to the Product/Service dichotomy and the presence or absence of patents				
		1	2	
Service	1	134	87	221
Product	2	82	133	215
Total		216	220	436
Firms in clusters and out of clusters, and the presence or absence of patents				
Out of cluster	1	75	35	110
In cluster	2	141	185	326
Total		216	220	436
Firms divided by sales and the presence or absence of patents				
Low sales	1	142	79	221
High sales	2	74	139	213
Total		216	218	434

Table 7
Correlations

		Patents N/Y	Cluster N/Y	Sales L/H	Service/ Product
Patents N/Y	Pearson Correlation	1			
	Sig. (2-tailed)				
	N	436			
Cluster N/Y	Pearson Correlation	0.217[a]	1		
	Sig. (2-tailed)	0.000			
	N	436	436		
Sales L/H	Pearson Correlation	0.295[a]	0.116[b]	1	
	Sig. (2-tailed)	0.000	0.015		
	N	434	434	434	
Service/ Product	Pearson Correlation	0.225[a]	0.003	0.097[b]	1
	Sig. (2-tailed)	0.000	0.957	0.044	
	N	436	436	434	436
		Total patents	Sales		
Total Patents	Pearson Correlation Sig. (2-tailed)	1			
	N	436			
Sales	Pearson Correlation	0.914[a]	1		
	Sig. (2-tailed)	0.000			
	N	434	444		

[a] Correlation is significant at the 0.01 level (2-tailed).
[b] Correlation is significant at the 0.05 level (2-tailed).

patent comparable to those operating in other high-technology industries.

In summary, most computer software patents are granted to large hardware and software companies. Very few small or medium-size enterprises, either independent software or computer hardware corporations, request and obtain patents. In fact, some 90% of North American software patents are held by a handful of firms. This finding has many implications, including implications for the debate about allowing the increase in the number of software patents. If these patents represent a major barrier to entry for thousands of small firms into the larger software products markets, then our paper provides some support for those (mainly academics) who have in the past expressed their opposition to this type of patent. However, a more detailed analysis of patenting trends by small firms may also bring some arguments for the opposite side: smaller firms can thrive into niches due to patent protection. These issues require a more detailed analysis of our database.

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