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Technovation xx (0000) xxx–xxx

technovation

www.elsevier.com/locate/technovation

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.

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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 ITC 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, 1999). 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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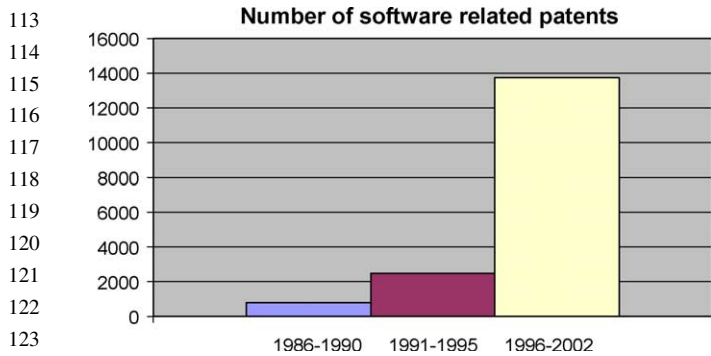


Fig. 1. Number of computer software related patents.

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 US\$40 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 (ITCs) 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,

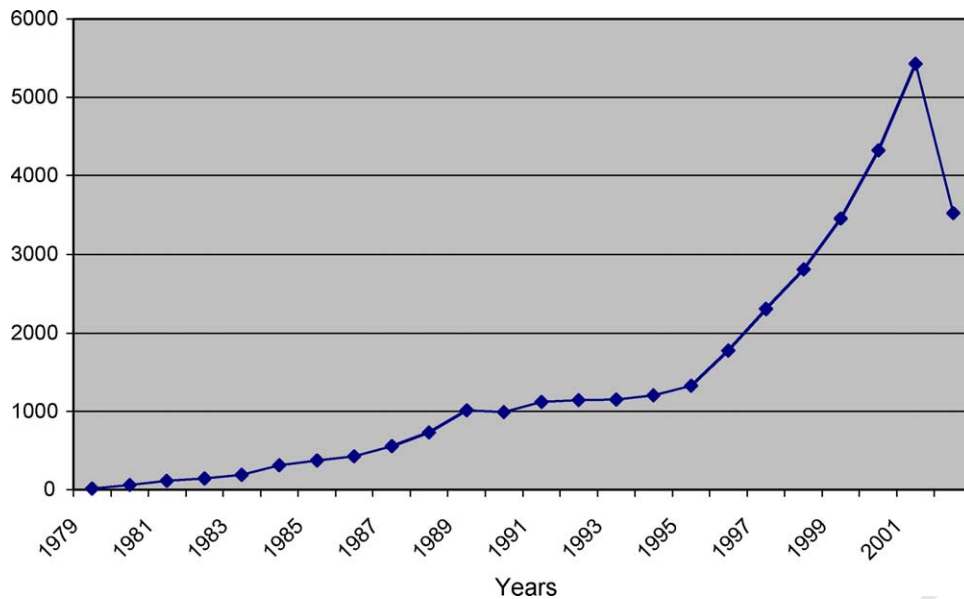


Fig. 2. European software patent applications, 1979–2002.

software should not be patented (Merges, 1996; Shulman, 2000; 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).

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

346 Also, software companies are classified with service
 347 industries, and product invention tends to be patented much
 348 more than process invention. Thus, intellectual property
 349 specialists have tended to concentrate on product patenting
 350 and to neglect the tens of thousands of software patents
 351 applied for¹.

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

368 Another factor that impacts the propensity to patent is the
 369 size of the firm. Many authors have shown that the
 370 propensity to patent increases with the size of the firm
 371 (Scherer, 1983; Mansfield, 1986; Arundel and Kabla, 1998;
 372 Brouwer and Kleinknecht, 1999). Larger firms have more
 373 resources than smaller ones, and substantial resources are
 374 needed to obtain patents and eventually defend them in case
 375 of litigation. This assertion must also be true in the software
 376 industry.

377 Innovation activities tend to be strongly concentrated in a
 378 few geographical regions in each developed country.
 379 Besides, firms operating in the same industry tend to cluster
 380 geographically, a tendency that Alfred Marshall had found
 381 in the early twentieth century and that many authors have
 382 confirmed and illustrated many times (Swann et al., 1998).
 383 Also, firms in clusters innovate more (Baptista and Swann,
 384 1998). Different explanations tried to account for the
 385 geographical agglomeration of innovating firms. Some
 386 authors insisted on the fact that knowledge externalities
 387 flow mostly at the regional level, as some of the key
 388 knowledge generated by the innovating firm is tacit and
 389

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

393 easily flows to neighbouring ones through person to person
 394 communication (Audretsch and Feldman, 1996). Other
 395 authors have argued that innovation in one firm forces the
 396 neighbours to innovate in order to survive the competitive
 397 threat posed by the initial innovator (Porter, 1990). We thus
 398 expect software firms to cluster and software innovators
 399 with patents to concentrate geographically. Finally, agglom-
 400 eration increases the likelihood that clustered firms will
 401 patent: it has been observed that knowledge flows from one
 402 company to another within a region via the mobility of
 403 scientists and engineers; patenting thus reduces the risk of
 404 losing key knowledge through the departure of research
 405 personnel to rival firms within the cluster (Almeida and
 406 Kogut, 1999).

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

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

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

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

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

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

443 Competition within clusters may be strong, and ideas
 444 also flow from one company to another, within a given
 445 geographical region, through the flow of people. Thus we
 446 expect a higher propensity to patent within a cluster than in
 447 more isolated firms.
 448

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 services². 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 their 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 inventions³.

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.

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

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

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

590 We grouped patents by region (defined as metropolitan
591 census areas plus its close proximity) and found that, not
592 surprisingly, Silicon Valley was the main cluster of software
593 invention, followed by Austin (Texas), Seattle (location of
594 the main Microsoft R&D laboratories), Saint-Paul (Minne-
595 sota) and New York (Table 3). Among the twenty-four
596 agglomerations with 100 software patents or more, twenty-
597 four were American and only one Canadian, in Toronto).
598 California was the most important state with three different
599 regional innovation systems (Silicon Valley, San Diego and
600 Los Angeles) Table 4.

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

607 We thus tested our hypotheses 2, 3 and 4. The three
608 hypotheses seem to be confirmed by our logistic regression
609 analysis. The three variables combined explain about three
610 quarters of the propensity to patent. Our model is robust and
611 shows that size of firms, clustering and the product/service
612 mix explain much of the tendency to patent. Large firms
613 patent more, companies with more products and companies
614 in clusters patent more than others. The cross tabulations
615 and correlation analysis both go in the same direction
616

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
Seattle	WA	USA	2151	9.6
Saint Paul	MN	USA	1351	6
New York	NY	USA	1053	4.7
Triangle	NC	USA	837	3.7
Research Park				
Miami	FL	USA	810	3.6
Denver	CO	USA	694	3.1
Poughkeepsie	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

(Tables 6 and 7). No co-linearity affects the validity of the logistic regression results.

651 Finally, we tested H5 with the same variables through a
652 linear regression. It appeared that only one variable
653 explained most of the variation in the dependent variable,
654 this time the number of patents, a metric one. The size of the
655 firm explains almost 80% of the number of patents. The
656 region and the product/service divide were unrelated to the
657 number of patents. We thus hypothesize that, within
658 innovating regions, companies tend to patent, especially if
659 they are more centred on products than on services, and that
660 in the decision to patent or not, company size is important
661 but less than the other two variables. Conversely, once a
662 company has decided to patent, the size of the firm is the
663 only major variable.
664
665
666

6. Conclusion

667 Our study extends and confirms other research results
668 conducted by others in different industries. We also find
669 support for three of our hypothesis: larger firms tend to
670 patent more often, as do firms with more products than
671
672

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

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

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