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ABSTRACT

Public choice theory provides a parsimonious explanation of changes in public policy, yet there is little systematic data available about the major beneficiaries of patent systems. This paper uses data from the US and Australia to identify those companies which own the largest number of patents from applications made between 1990 and 2001. In both countries the 100 companies owning the most patents own about one-third of all patents owned by organisations. Forty-six companies—many of them household names—are among both the top 100 US patenters and the top 100 Australian patenters. Forty-six companies are on both lists. Among the top 100 US patenters, 43 are US-based. In Australia only one of the top 100 patenters is an Australian company. Major patenters are selective in the technologies they patent in Australia—few semi-conductor companies take out Australian patents, while pharmaceuticals and chemicals have a larger share than in the USA.

Twelve of the 13 companies that played a major role in the development of the TRIPS agenda have been among the top 100 US patenters. However data on the top 10 US patenters from 1969 to 2006 show that since the mid 1980s—the very time when US patent policy was extending to achieve a global reach—overseas companies replaced US companies as the dominant US patenters.

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This paper has been accepted as a chapter in a forthcoming book. The full title and bibliographic entry for the book is *The Politics of Intellectual Property: Contestation over the Ownership, Use, and Control of Knowledge and Information*, edited by Sebastian Haunss and Kenneth C. Shadlen (Edward Elgar, 2009 forthcoming).

Who benefits?

An empirical analysis of Australian and US patent ownership

Introduction

The US patent system has been substantially strengthened since the early 1980s, and this stronger patent regime has spread to other countries both through borrowings in case law, and through trade diplomacy. This strengthening has occurred despite growing empirical evidence that, outside of pharmaceuticals and fine chemicals, patents are entirely unnecessary to obtain a good return on investments in research and development.[1] It has also occurred despite the general trend towards de-regulation (Landes and Posner 2004).

The longer duration of patents, and the requirement that they be granted for many subject matters previously excluded, has spread worldwide due to pressure by the US government. This US policy is attributable to the influence of a small number of corporate players. The story about the role of a handful of major companies in the inclusion of regulatory patent laws into "free trade" negotiations is well-told elsewhere (Drahos 1995; Ryan 1998; Drahos 2002; Sell 2003). Public choice theory, particularly rent-seeking and regulatory capture, provides a parsimonious explanation of these changes in patent policy.[2] A small number of entities benefit considerably from strong patent laws, and a large dispersed group pays lower, and largely hidden, costs. The focus of this paper is on identifying the small number of major beneficiaries.

It is not widely known that patent policy is based on the needs and interests of a very narrow segment of the community, though this has been documented for a considerable period of time (Edwards 1949). National Innovation Surveys confirm that only a minority of innovating firms use the patent system.[3] Patent renewal data show that only a tiny proportion of patents generate substantial private returns. The large and growing patent system thus benefits only a very small proportion of innovators. Those corporate interests which benefit substantially have been successful in hiding their direct material interests behind a wide range of claims and propaganda about the alleged general benefits of patent systems. These unsubstantiated claims include that inventions will not occur without legislated patent monopolies, that the major beneficiaries of patent systems are small businesses and individual inventors, and that imitation involves theft.

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[1] Full documentation of this point – that there is no general failure in the market for innovation – would take a book in itself. The interested reader could consult Mazzoleni and Nelson 1998; Scherer 2006 for brief summaries of the empirical evidence, or Boldrin and Levine 2008 for an exposition of the role of competition in driving innovation.

[2] While some changes are due to judicial decisions – such as the extension of patent coverage to life forms and software – legislators could have over-ridden these judicial changes in policy, were it not for the regulatory capture of patent offices and very effective lobbying of democratically elected representatives by the beneficiaries of a broader and stronger patent system.

[3] For example only 17 percent of innovating European firms use the patent system (Eurostat 2004), and only 4.4 percent of innovating Australian firms hold any patents (Australian Bureau of Statistics 2005).

These allegations run counter to the few available facts about patent systems. There is broad empirical evidence that, except for a narrow range of industries where technology is highly codified,[4] most industrial innovation would occur absent patents.[5] Imitation is the foundation of learning and involves considerable time and investment (Mansfield et al. 1981; Cohen and Levinthal 1989; Mandeville 1996). Imitation – and the improvement which so often accompanies it – is a cornerstone of competitive markets.

The patent system is an excellent example of public choice theory – a small number of parties benefit significantly from the intervention, but costs are widely dispersed across the community. The beneficiaries thus have a strong incentive to lobby for the continuation and strengthening of the system.[6] The motivation for Bessen and Meurer's book on patent failure was that 'patent policy has long been the domain of those entrenched interests who have the most to gain from patents' (Bessen and Meurer 2008: 257).

This paper addresses a very specific question – who are the companies most likely to be beneficiaries of the patent system? Identifying these key actors is a critical first step in assessing their impact and evaluating any possibilities for creating more balance in policy consideration. Of course, another major beneficiary group is Patent Attorneys, and they too play a major role in the formulation of patent policy. Investigating the role of Patent Attorneys lies well beyond the scope of this short paper. Here it is simply noted that the ratio of intellectual property lawyers to $US billions spent on research and development (R&D) has increased from under 45 in 1970 to about 75 in the late 1990s (Barton 2000).

The total cost to the community of this government-backed monopoly system may well exceed the benefits to the few. However, most losers individually face low and hidden costs, so there is no incentive for them to mount countervailing pressure on politicians.[7] A close parallel is tariff policy. However it is relatively easy to estimate the community cost of high tariff protection, and public interest groups have been successful in many countries in negotiating reduced tariff barriers.[8] It is harder conceptually to measure the costs of patent intervention, and fewer data are available on which to base any such estimates.

In addition to this direct lobbying effect, there is substantial evidence of regulatory capture of patent offices – they have been "captured" by the industry they are designed to regulate.

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4 That is, substantially reduced to written form.

5 This large empirical literature is summarised in Moir (forthcoming). The evidence was originally developed in the USA, but has been replicated in a number of European studies. Major references are Taylor and Silberston 1973; Mansfield et al. 1981; Mansfield 1986; Levin et al. 1987; Cohen et al. 2000. Beyond these specific studies, data from National Innovation Surveys confirm that patents are generally reported by business to be the *least* effective means of ensuring a return to innovation (see e.g. Eurostat 2004; Australian Bureau of Statistics 2005).

6 Shadlen demonstrates how this asymmetry in interests influence intellectual policy outcomes in three Latin American countries (Shadlen 2008); Oh and Gay provide data on the very large sums that pharmaceutical companies spend lobbying (Oh and Gay 2008: 7).

7 Who might, from some frames of reference, be expected to protect the public interest without the need for any such lobbying.

8 That the cost to a community of protecting a given sized industry is far lower when funded by direct subsidy than by tariff barriers is part of any first-year undergraduate economics course. In Australia the Tariff Board, later replaced by the Industry Commission and then the Productivity Commission, published a number of studies on individual industries, documenting the difference in these costs. This factual work was important in generating sufficient political support to dismantle high tariff barriers, often on a unilateral basis.

This capture appears to have happened at the very time patent offices have become responsible for advising executive government on patent policy. This likelihood was noted in a paper presented to the 1984 Australian review of the patent system (Beggs 1981). More recently Thambisetty has pointed to the isolation and self-reinforcing culture of patent office decisions (Thambisetty 2008), and Drahos has shown how the influence of one patent office can flow through to other countries (Drahos 2007). Where patent offices also operate as an important layer of the legal appeal system, as with the European Patent Office (EPO), such regulatory capture explains decisions that seem otherwise inexplicable.[9]

Ideally this paper would focus on identifying both the winners and the losers of patent systems. However the extreme dearth of useful patent data makes it impossible to estimate the losers in any systematic way. Boldrin and Levine (2008) document a number of major cases where patents were used to prevent or delay the development of new technologies, and to extract significant monopoly rents. The earliest documented case is James Watt's steam engine; more recent examples include airplane manufacture in the USA, radio development in Europe, and electricity.[10] These examples are well known. Their cost to the community can be considerable. Less frequently noted is the fact that the patent holder in these cases was often not the most significant inventor, and in some cases contributed only marginal modifications (Boldrin and Levine 2008).

The literature on the costs of patent systems is very small (Cole 2001). Bessen and Meurer recently suggested that a major unrecognised cost of patent systems is that of establishing clear boundaries to granted monopolies. This cost has become so high that it is not rational to even attempt to determine where the boundaries are. So the likelihood of inadvertent infringement has soared, and the risk of litigation increased. They estimate that, excluding pharmaceutical firms, the private cost of the patent system now exceeds the private benefit for publicly listed US firms (Bessen and Meurer 2008).

Beyond reporting on these studies it is simply not possible to assess the cost of patent systems with currently available data. The principal input necessary for such estimates would be the proportion of patents used. No such data are available.[11] Losers, of course, are not limited to users of the patent system. Any innovating firm, whether or not it uses the patent system, can potentially lose because of the patent system. These losses take several

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[9] The story of the EPO Technical Boards of Appeal lies well beyond the scope of this paper. Bakels and Hugenholtz (2002) find no rational basis for their decisions in regard to software, but if the decisions are seen from a regulatory capture perspective, the outcomes become more comprehensible. Palombi provides another insight into EPO "appeal" decisions in relation to what constitutes an invention (Palombi 2004).

[10] The Seldon car patent, which surfaced in 1903, could have had a similar impact on the US car industry, given its very broad scope (an engine on a chassis with four wheels). Henry Ford chose to contest the infringement suit, and won after an eight-year legal battle (http://en.wikipedia.org/wiki/George_B._Selden accessed 29 July 2008). Not all companies choose to defend such suits. The benefits of invalidating a patent are shared among many firms, so there is a system bias towards "invalid" patents going unchallenged. There is the added feature of considerable legal uncertainty. In the famous US *Kodak v Polaroid case*, Kodak had spent considerable resources making sure that it did not contravene the Polaroid patents (Bessen and Meurer 2008: 50-51). The court did not agree that it had achieved this outcome. Kodak ended up paying US$925 million in damages, and exiting the instant camera business which had involved $200 million in sunk costs and employed 800 full-time and 3,700 part-time staff (Jaffe and Lerner 2004: 113-114).

[11] Collection of such data was recommended in Australia by IPAC (1984), who suggested that firms be required to report data on patent use at the time of renewal. This recommendation was never implemented.

forms: firms may incur higher costs in "inventing around" a patent; or they may be sued by patent holders whose technology is allegedly infringed. In addition consumers can lose through the reduced output and higher prices consequent on the use of monopoly power.[12]

This paper is thus only able to address the other side of the balance – who benefits. Even here data deficiencies severely limit the form in which this question can be asked and answered. Nonetheless some partial answers are possible. The focus is on putting names to the major users of the patent system, and numbers to the degree to which a large proportion of the benefits of any patent system accrues to a very small number of companies.

This sounds a simple exercise. It has not been done before because of the significant challenges in finding patent data in a form that supports policy analysis. While most patent offices produce searchable on-line data systems, these are designed to meet the needs of patenters and patent attorneys, not policy analysts. There are only limited capacities to search these databases for analytically relevant data. Construction of the datasets used in this paper, and their limitations are discussed in the Appendix.

The next section briefly discusses the empirical studies on patent renewal data, which demonstrate the extremely skewed distribution of private returns to patenting. These studies demonstrate that only a small minority of patented inventions generate the bulk of the private returns. While these studies show the extremely skewed distribution, they do not identify who owns the most valuable patents.

Attention is then turned to patenting activity in the USA and Australia. Despite their radically different economic situations, there are several similarities in patterns of patent usage. This provides useful background to the discussion of major users of the patent system. The focus here is on the 100 companies who own a very large share of patents in each country. The paper concludes with some thoughts on directions for future research.

What do we know about patent winners?

Given the very specific topic investigated here – winners from the patent system – the most relevant literature is that on the private value of patents. There is a small but substantial empirical literature on this topic. The two main approaches are the analysis of patent renewal data, and estimates of the contribution of patents to stock market valuations.[13]

Most of the renewals analysis is based on European data as the US patent system does not require payment of annual renewal fees. These studies systematically show that the distribution of patent values is extremely skewed, with low average returns and a very small percentage of patents holding most of the private value from the patent system.

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[12] Some argue that most patents involve no monopoly power (e.g. Gans et al. 2004), but the corollary of this argument is that patents are entirely ineffective. This seems unlikely, given the volume of patenting.

[13] There is also at least one survey-based study (Gambardella et al. 2008). This approach is strongly criticised by Bessen and Meurer (2008) as providing inflated estimates, and failing to separate the value of the underlying invention from the value of the patent. Given the strong evidence that most inventions would occur absent patents, separating the value of the invention from the value of any associated patent is critical.

Pakes estimates average gross private returns to French and UK patents as $6000 to $7000.[14] Germany has a very much lower grant rate (less than half the proportion granted in France and the UK), so German patents are likely to be considerably more inventive. This is reflected in the higher estimated average value of $16 200. Only 1 percent of patents had values over $65 000 in France or the UK or over $118 000 in Germany. Overall half the total private value lay with 5 to 10 percent of the granted patents (Pakes 1986: 777-8). Schankerman and Pakes (1986) find that about half of granted patents were renewed to year 10, and about half were not.[15] They suggest that patents with low private value expire quickly, and those renewed to the end of the patent term – about 10 percent – have greatest value. Drawing on this work, Griliches (1990) suggests "that though the aggregate value of patent rights is quite large, it is only on the order of 10 to 15 percent of the total national expenditures on R&D" (Griliches 1990: 1682).

In an interesting study of 222 patents selected as being of most value,[16] Harhoff and colleagues find that fully 76 percent of the total gross private value of this set of valuable patents rests in just 19 (Harhoff et al. 1998). If these results are generalisable this means that the bulk of the value that lies with the top 10 percent of patents actually lies with the top 10 percent of that – that is with just 1 percent of patents.

These empirical studies demonstrate that a very small proportion of patents contribute most of the private value. The long tail of granted patents is extremely skewed – even among the most valuable patents, a small proportion dominate. The patent system has been likened to a lottery, and it seems that, like a lottery, most participants get a very low return on their investment. Perhaps traditional economic analysis, focussed as it is on decisions at the margin, is not the appropriate basis for analysing such a winner-takes-all market.[17]

It must be emphasised that these estimates are not of the total value of the invention, rather they attempt to estimate the additional value contributed by holding a patent. Indeed Pakes and colleagues conclude that 'patent protection per se is not the chief means by which firms appropriate the returns from their R&D investments' (Pakes et al. 1989: 362). The other strand in research on the private value of patents, also attempts to measure the value of patents, abstracting from the value of the underlying inventions. This approach uses multivariate statistical techniques to determine the impact of patent holdings on a company's stock market value. Using Australian data Griffiths and Webster find the value of patents has been falling over the period 1989 to 2002, but are able only to speculate on possible reasons for this (2004). Greenhalgh and Rogers (2004) find a positive value for European patent applications, but not for UK patent applications.[18] Bessen calculates the private value of patents for publicly listed US companies, to generate upper-bound

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[14] These figures are in 1980 US dollars, using official exchange rates for conversion (Pakes 1986: 768).

[15] In one of the few US renewal studies Thomas, using data on applications from the early 1980s, found that 40 percent had a life of eight years or less, and a further 20 percent had a life of 12 years. Just under 40 percent were renewed for the then full term of 17 years (Thomas 1999).

[16] As patents were sought and granted in both the US and in Germany, and renewal fees were paid to keep the German patents in force for their full life.

[17] This theme lies well beyond the boundaries of this paper. For an interesting discussion of winner-take-all markets see Frank and Cook 1995.

[18] Except for two sectors (science-based and production-intensive, scale) where firms with more than a threshold market share receive a positive return to UK patent applications.

estimates and confirm the reliability of valuations derived from renewal data. He estimates that a very high proportion of the global gross value of patents—over 80 percent—is owned by chemical and pharmaceutical companies, with a large share of this being owned by 'two dozen or so large pharmaceutical companies' (Bessen 2006: 19).[19]

Overall, these studies provide a weight of evidence that the gross private return to the average patenter is low. They also show that for a very small minority of patents, private values can be extremely high. None of these studies goes on to identify or analyse the firms owning the high value patents.

An overview of patenting in the USA and Australia

Attention in this section focuses on a different aspect of patent distribution – ownership. The discussion is limited to the USA and Australia, and the similarities and contrasts between these countries are useful in highlighting several aspects of patent ownership. The two economies are quite different in size: the Australian economy is only 6 percent the size of the US economy.[20] Because of this larger market, the US has a much deeper industrial structure, especially in manufacturing. This is despite the recent shifts in production to lower cost overseas countries. On the other hand, both countries have high levels of education and urbanisation, and strong traditions of innovation.

By the end of 2007 7,313,828 US patents had been issued and 4,222,954 of these (58 percent) had been issued in the period from 1963.[21] That is, over half of the patents ever granted in the USA have been granted within the last 50 years. This astonishing number of 'inventions' is likely to raise queries, in the minds of most readers, about just how inventive an invention has to be to be patented.[22]

Over the 38 year period 1964 to 2001, the volume of US patent grants increased by 483 percent. The increase was substantially greater for grants to foreigners (by a factor of more than three) than to domestic inventors. So the foreign share of granted patents increased from a low of around 20 percent in the early 1960s to reach close to 50 percent by the end of the period (see Table 1). The proportion foreign-owned has been quite stable since the mid 1980s.

Foreign ownership of US patents is highly concentrated. Only a small number of countries account for the bulk of foreign-held US patents (Figure 1). Until 1972, Germany accounted for most overseas-held US patents. In 1973 Japanese inventors became the most prolific

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[19] The special position with regard to pharmaceutical industries and the patent system has been well-documented. The higher degree of technological codification, the clearer patent boundaries, and the very high cost of Phase III clinical trials combine to suggest that if the patent system operates with a positive net welfare effect for *any* segment of the economy, it is for the pharmaceutical industry.

[20] GDP (expenditure approach, in constant US$s using constant purchasing power parities) data show estimated 2006 GDP as US$11,265,200 million in the USA and US$638,227 million in Australia. (http://stats.oecd.org/wbos/Index.aspx?datasetcode=SNA_TABLE1 accessed 25 August 2008).

[21] Throughout this paper references to US patents are references to utility patents (patents of invention) only (see Appendix).

[22] There is a voluminous literature on the quantum of inventiveness required for patent patentability. See, for example, Lunney 2001; Bagley 2001; Lunney 2004; Jaffe and Lerner 2004; and Lemley et al. 2005-06.

Table 1 US patent grants by residence of first-named inventor

	US granted patents				Share of foreign patents		
Year filed	**U.S. residents**	**Overseas residents**	**All grants**	**Foreign share**	**Japan**	**Germany, UK, France, Canada**	**Other countries**
1963	195314	47864	243178	20%	7%	65%	27%
1964-68	201315	68611	269926	25%	13%	60%	26%
1969-73	223215	104833	328048	32%	22%	53%	25%
1974-78	206329	123444	329773	37%	27%	48%	25%
1979-83	185914	136844	322758	42%	37%	43%	21%
1984-88	202492	182835	385327	47%	43%	38%	19%
1989-93	275860	232132	507992	46%	48%	32%	20%
1994-98	410474	338491	748965	45%	46%	29%	25%
1999-2003	439148	408686	847834	48%	43%	28%	30%
1964-2001:							
Total granted	**1995022**	**1450039**	**3445061**	42%	40%	37%	24%
Difference*	**71116**	**84559**	**155675**				
% change	**291%**	**1084%**	**483%**				

Source: http://www.uspto.gov/web/offices/ac/ido/oeip/taf/h_at.htm, Part A2 (accessed 4 March 2008)
Notes: * Difference in number of grants in 1964 compared to 2001
Data are by year of filing. Data for 1963 probably include applications filed in earlier years. Long pendency rates in processing applications mean that data for 2004-2006 are substantially incomplete. The notes in the source suggest a degree of incompleteness as far back as 2000, hence overall data are calculated only until 2001.

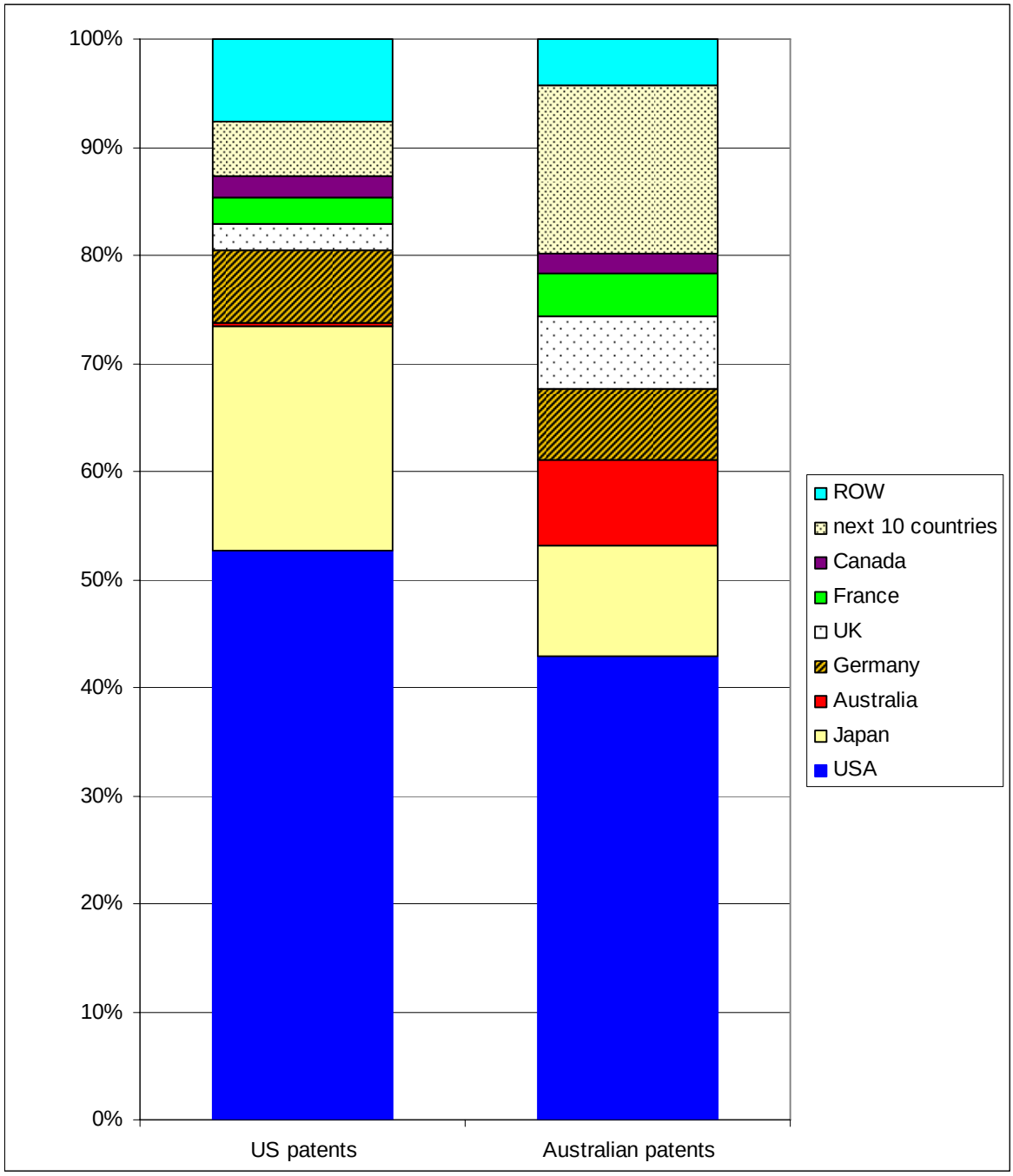
foreign patenters in the US. Germany, France the UK and Canada each hold small but respectable shares of US patents.[23] Overall, 73 percent of US patents held by foreigners are held by inventors in five countries, with a further ten countries holding another 10 percent. Despite being included in this list, Australia (and Israel, Belgium and Austria) each account for less 0.6 percent of US patents. So many countries that rank quite highly in ownership have in fact only a tiny share of the market. This is one sense in which patent ownership is highly concentrated. On a volume basis the bulk of potential "winners" are companies resident in the US, Japan, Germany, the UK, France and Canada.[24]

Most patents are owned by companies. Of US grants in the period 1964 to 2003, 82 percent are held by companies, less than 2 percent by governments, and 17 percent by individuals. The share of individuals is steadily declining – from well over 20 percent in the 1960s to around 12 percent in the 2000s. This is largely offset by an increase in corporate patent ownership – from 74 percent in the 1960s to 88 percent in the 2000s.

[23] There is then a drop from 4 percent for Canada to 2.5 percent for Taiwan.

[24] One might therefore anticipate that these five countries would have a positive technology balance of payments. But data for 1990 show that the ratio of technology receipts to technology payments was less than one (i.e. in deficit) in Japan (0.91), Germany (0.83), the UK (0.96), France (0.76) and Canada (0.93). The ratio was strongly positive in the USA (5.26) and was also positive for Sweden (5.47) and Denmark (1.14) (Gruen et al. 1996: 9).

Figure 1 Residence of inventor/owner of patents granted from applications in period 1990 to 2001: USA and Australia



Source: US data calculated from http://www.uspto.gov/web/offices/ac/ido/oeip/taf/us_stat.htm (accessed 4 March 2008) Australian data calculated from data provided by IPAustralia.

Notes: Total patents granted from 1990-2001 applications as at end 2007 were 1,811,967 for the USA and 161, 404 for Australia. The "next 10 countries" for US patents are Taiwan, Korea, Italy, Switzerland, Sweden, the Netherlands, Israel, Finland, Belgium and Austria. The "next 10 countries" for Australian patents are Switzerland, Sweden, Netherlands, Finland, Israel, Denmark, Korea, New Zealand, Italy, and Belgium. ROW stands for "rest of the world", i.e. all other countries.

So the US patent scene is one where the volume of patenting has "exploded", particularly since the mid 1980s.[25] Patent ownership is dominated by companies, but foreign companies, particularly from Japan, now have a very large share of US patents.

Although the Australian market is substantially smaller than that of the USA, there are some surprising parallels in the patenting experience of the two countries. But first, the differences. The overall volume of patenting is much less – 161,404 patents were granted from applications between 1990 and 2001, only 9 percent of the 1,811,967 equivalent US grants. This is unsurprising given that Australia's GDP is only 6 percent of that of the USA. The proportion of patents owned by foreigners is much higher in Australia than in the USA – it has long been the case that ownership of patents in small countries is dominated by foreigners (Bates 2003; Lamberton and Mandeville 1980; Penrose 1951).[26] Overall 92 percent of Australian patents are owned by foreigners compared to 47 percent in the USA.

But the share of patents granted to organisations is similar: 92 percent in Australia compared to 88 percent in the USA. In both countries the largest single patent owner group is US-based inventors: from 1990 to 2001 applications their share of patents was 53 percent in the USA and 43 percent in Australia. While US based inventors hold the largest share of US patents, Australian applicants rank only third in Australian patent ownership. With a mere 8 percent of patents, Australia is a long way behind the US, with its 43 percent share.

The degree of concentration in foreign patent ownership is similar to that in the USA—applicants from the top five countries own 76 percent of Australian patents held by overseas residents. As in the USA, applicants from a small number of countries hold almost all Australian patents. The USA dominates, then Japan, Germany, the UK and France (Figure 1). The next 10 countries hold a greater share of Australian patents than US patents, while the "rest of the world" holds a slightly larger share in the USA than in Australia.

Corporate patenting in the USA and Australia

The patent renewal literature showed that a tiny percentage of patents hold most of the private value. The above discussion shows that the large majority of patents are owned by companies, and that residents of only a few countries own the bulk of granted patents in both the USA and Australia. The other major patent offices (Europe and Japan) do not seem to allow ready access to comparable data. However the WIPO site provides an annual summary of Patent Cooperation Treaty (PCT) statistics, and their latest report indicates that

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[25] Studies on the massive growth in US patent applications focus on recent decades and so unambiguously attribute the explosion in US patent applications to the increase in patenting for US origin patents (Kortum and Lerner 1999; Hall 2005). This contrasts with the longer term data presented in this paper which suggest that the fastest growth rates have been in grants to foreign applicants. The share of foreign patents has been relatively stable since the mid 1980s.

[26] Bates cites 2003 WIPO data for selected countries, showing that the percentage of grants to residents (by grant year) is 12.4 in the UK, 15.1 in Sweden, 22.4 in Israel, 40.6 in Germany and 89.2 in Japan. While WIPO provides an interesting series on applications by country of grant and residence of owner/inventor (from 1883 to 2006), there are some difficulties with these data (http://www.wipo.int/ipstats/en/statistics/patents/index.html, accessed 15 March 2008). For example, they give the resident share of applications in Australia in 2006 as 30 percent. IPAustralia data indicate that the relevant figure is 11 percent (calculated from http://www.ipaustralia.gov.au/pdfs/statistics, Table P30(Feb08), accessed 15 March 2008).

the four top global patenting countries are Japan, the USA, Germany and Korea, sharing 73 percent of PCT grants in 2006 (WIPO 2008: 22).

Newspaper and magazine articles on specific frequent patenters – for example IBM – suggest that a few companies may dominate patent ownership. But there has been little recent academic interest in the concentration of patent ownership. The sole article locatedon this topic was published in 1970, and has never been cited.[27] Based on US data for three time periods (1921-38, 1939-55 and 1946-62) little increase was found in the concentration for the top four, eight and 20 companies. But there was a marked increase in concentration for the top 40 companies between 1938 and 1955 (Watson and Holman 1970: 115). They report the proportion of patents (by grant year) held by the top 100 companies rose from 35 percent in 1921-38 to 43 percent in 1939-55 to 46 percent in 1946-62.[28]

US patent data on organisations which have been granted 1,000 or more patents are available from 1969 to 2006.[29] These data show such organisations hold a stable but gradually increasing share of patents (35 percent in 1970, 40 percent in 2001). Very few of these large patenters are non-profit organisations: of the 340 organisations listed, eight were government agencies and 11 were non-profit research institutions.[30] Most of the patents held by these frequent patenters are held by the top 100 companies, whose share increased gradually from 27 to 33 percent. It was the growth in the share of the top 100 patent owners which drove the increase in share held by frequent patenters. Overall this frequent patenter group owns 45 percent of US patents granted to organisations, or 38 percent of all patent grants (Table 2).[31]

The concentration of patent ownership in Australia is surprisingly similar. The 100 companies holding most patents have 34 percent of all patents granted to organisations in this 12 year period.[32] The Australian data allow some insight into the wider distribution of

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[27] Based on information from the ISI Web of Knowledge as at 13 March 2008. The authors noted that prior to their article there had been considerable interest in industrial concentration, but that the ownership of patents had been a neglected topic of study.

[28] The dataset was patents held by all domestic corporations with 200 or more patents at the start of each period. The data are by year of grant of patent. Data on all patents granted were from a variety of sources.

[29] These data have one major disadvantage in identifying frequent patenters. If a company chooses to patent through a number of subsidiaries, it may not appear on the list even though it own more than 1000 patents. There are not, however, any alternative readily useable public sources of data on patent ownership. This, and other technical aspects of this dataset, are discussed in the Appendix.

[30] The 321 corporates were reduced to 300 after amalgamating companies that were more than 50 percent owned by another in the list. For example Genentech is 56 percent owned by Hoffman la Roche, so is included in the Hoffman La Roche entry; Telefonaktiebolget LM Ericsson and Ericsson Inc are combined.

[31] Because the US entry qualification to this table is holding 1000+ patents over the full 1969 to 2006 period, some of these 300 companies actually held very few patents from applications in the 1990 to 2001 period. For example the sole Australian company, Silverbrook Research Pty. Ltd. has only 471 patents for the shorter period compared to 1299 for 1969-2006. Silverbrook's first US patent grant was filed in 1998. In contrast RCA, once a top 10 US patenter, has been broken up and received no patents during the 1990 to 2001 period. The data are least reliable for the full set of 300 companies. For higher-ranking sets, such as the top 100 or even the top 200, the listing is likely to be more reliable (subject of course to the caveats discussed in the Appendix).

[32] The base is actually patents where there is only a single corporate owner. There are 5,040 patents in the 1990-2001 period that are owned by two or more companies. These data are excluded from both numerator and denominator in this analysis. See the Appendix for a fuller discussion.

Table 2 Corporately owned Australian and US patents, 1990-2001

		AU	AU	US	US
	# entities	**# patents**	**% of corporate**	**# patents**	**% of corporate**
Top 10 corporate patenters	10	13425	10%	163343	11%
Top 50 corporate patenters	50	35685	26%	407248	28%
Top 100 corporate patenters	100	47024	34%	513228	35%
Top 200 corporate patenters	200	58373	43%	619371	42%
Top 300 corporate patenters	300	61772	45%	656974	45%
Corporates with 19+ patents	908	85157	64%		
Corporate grants (single ownership)		136544	100%		
Total corporate/organisational grants		141584		1468408	100%
Total patents granted		161404		1713605	
Corporate share of grants		87.7%		84.3%	

Source: US data are calculated from http://www.uspto.gov/web/offices/ac/ido/ oeip/taf/h_at.htm, Part B (accessed 6 March 2008); grants to individuals are from Part A2 of the same table. Australian data are calculated from data supplied by IPAustralia and relate to grants by end 2007 from applications in the period 1990 to 2001.

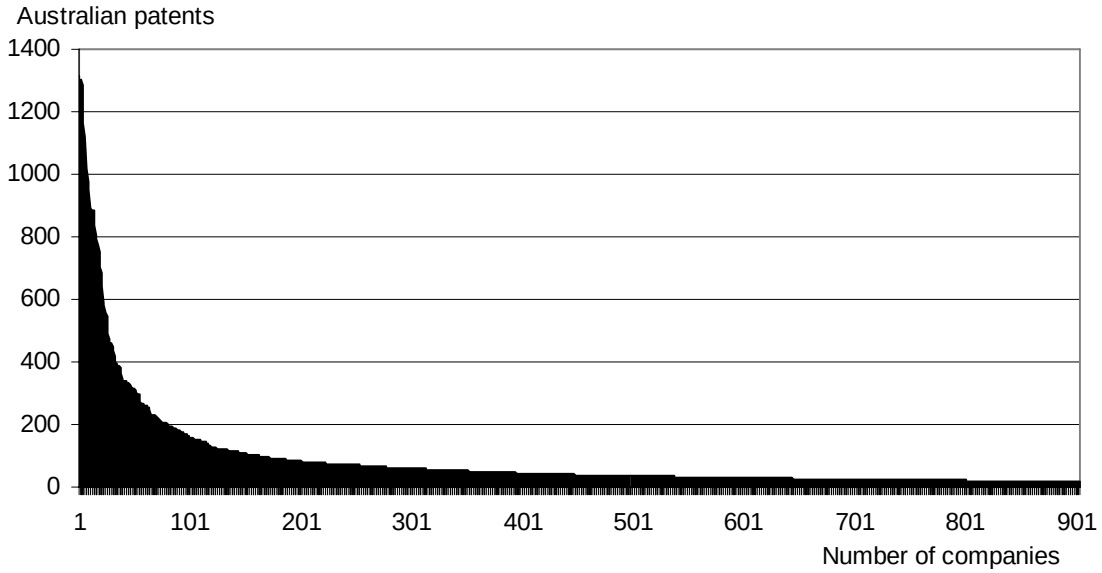
Notes: The data for Australia exclude patents where two or more companies share ownership. US patent count data are for patents granted by end 2006 from applications in the period 1990-2001 by organisations owning 1,000+ US patents. US data on the number of organisations are for the period 1969-2006.

corporate patents. Summary data are provided in Table 2, but the visual representation of the very skewed distribution of patent ownership (Figure 2) tells the story more strongly. This graphic excludes the three companies with most patents, because extending the scale to include them made the long tail harder to see. The tail also extends only to the 908 companies with 19 or more patents. If the unknown number of companies with fewer patents were included the skewness would increase considerably.[33]

It is hard to relate this distribution of Australian patent ownership to the universe of innovating Australian companies because 92 percent of Australian patents are foreign-owned. Among the top 100 Australian patenters there is only one Australian-based company. Data from the National Innovation Survey found 35 percent of Australian-based firms to be innovators (Australian Bureau of Statistics 2005). Among these innovating firms only 4.4 percent held patents.

[33] Figure 2 excludes 51,387 corporately owned patents at the right hand end of the scale. Assuming a (rather high) average of ten patents per company, this would mean over 5000 extra companies beyond the 905 shown in Figure 2.

Figure 2 Ownership distribution of Australian patents, 1990-2001



Notes: Excludes three companies with most patents (Ericsson 1858; Hoechst (Sanofi-Aventis) 1818 and Procter & Gamble 1526). Also excludes all companies with less than 19 patents granted in the period.

A major difference between the two countries is in the representation of domestic companies among major users of the patent system. In the USA, 43 of the top 100 patenters are US-based. In Australia, only one of the top 100 patenters is Australian-based.[34] Thus in Australia, in respect of this very large share of granted patents, almost all benefits flow overseas: royalty payments and knowledge spillovers. These are funded by Australian consumers through higher prices paid for products with monopoly powers.

The top 100 patenting companies

The list of companies with the most patents exhibits both stability and change over time. Seventeen companies that were in the top 100 patenters in the USA in the 1970 to 2001 period were no longer in that list in the period 1990 to 2001 (see Appendix, Tables A3 and A4). More US-based companies left the list than joined it: thirteen compared to seven. Three of the new entrants are semiconductor companies, seven operate in the IT/electronics industries, and two in telecommunications. Only two were chemical companies. This contrasts with the departing companies, where eight of the 17 were in the chemical industries, broadly defined.

Over 80 percent of the companies in the top 100 list held this leading position in both periods, and the majority of these (66) are US or Japanese. They are a diversified group in terms of industries, though chemicals, pharmaceuticals, electrics/electronics and computers/software dominate.

[34] The assignment of country of origin to companies in the top patenters list is based on the location of company headquarters, not the address given by the first inventor or applicant in the patent application.

Because the Australian data available are only for the recent (1990-2001) period, the focus in the remainder of this discussion is on this more recent period.

While there are 43 US companies among recent US top patenters,[35] there are 41 East Asian companies, dominated by Japan, with 35 companies. Nortel Networks is Canada-based, and the other 15 are European, mainly German, French or Swiss. Indeed the US has more companies among top Australian patenters (47) than at home. There are 38 European companies among top patenters in Australia, dominated by companies from Germany, Switzerland and the UK. Only 12 Japanese companies are found among Australia's top 100 patenters, despite Japan ranking second in the overall share of Australian patents.

In terms of the broad industry/technology sectors, among top US patenters electronics and information technology are the largest (Table 3). When semiconductors and telecoms are added to these two sectors, the share of patents rises to 19 percent.[36] This contrasts with Australia where less than 7 percent of top patenters' patents are in this broad sector. Another contrast is chemicals (broadly defined) and pharmaceuticals which take much the largest share in Australia, with 20 percent of all patents owned by the top 100 patenters. In the US this share is only 4 percent.

Table 3 Distribution of top US and Australian patenters by industry sector

	Top 100 US patenters, 1990-2001				Top 100 Australian patenters, 1990-2001			
Broadly defined industry sector	**Number of companies**	**Number of patents**	**share of corporate grants**	**share of total grants**	**Number of companies**	**Number of patents**	**share of corporate grants**	**share of total grants**
Electronics	16	99,375	6.8%	5.8%	7	2,096	1.5%	1.3%
IT	11	97,308	6.6%	5.7%	2	1,561	1.1%	1.0%
Instruments	11	68,072	4.6%	4.0%	10	3,135	2.3%	1.9%
Diversified	9	63,577	4.3%	3.7%	8	3,398	2.5%	2.1%
Semiconductors	12	45,552	3.1%	2.7%	0	0	0.0%	0.0%
Heavy machinery	14	42,135	2.9%	2.5%	9	1,869	1.4%	1.2%
Telecoms	6	36,954	2.5%	2.2%	7	5,378	3.9%	3.3%
Other chemicals	12	36,077	2.5%	2.1%	29	15,527	11.4%	9.6%
Pharmaceuticals	7	18,124	1.2%	1.1%	19	11,039	8.1%	6.8%
Miscellaneous	2	4,107	0.3%	0.2%	9	2,872	2.1%	1.8%
Top 100	100		34.8%	29.8%	100			
Total corporate grants		1,468,408				136,544		
Total grants		1,713,605				161,404		

If the lists of the top 100 companies owning patents in the USA and Australia are combined, a total of 154 companies are identified. Of these, 46 are among the top 100 patenters in both countries. All these companies are based in the US, Japan, Korea or

[35] If Alcatel and Lucent had not merged this would have been 44 as Lucent ranked among the top 100 US patenters in its own right. But the new merged company is based in France, so no longer shows up as a US company.

[36] Or to 21 percent if autos are added. Autos have been classified here to heavy industry, but a large share of innovation in the automobile industry is electronic.

Europe. Nearly half (18) are chemical (including oil but not oil services) or pharmaceutical companies, and a further 16 operate in the information technology/electronics/telecoms sectors. Many of these companies are household names (Table 4). This group of 46 companies owns 60 percent of the Australian patents owned by the top 100 Australian patenters, and 51 percent of patents held by the top 100 US patenters. A further perspective is that these 46 companies between them own 18 percent of all Australian patents and 16 percent of all US patents (from applications in the years 1990-2001).

These companies are clearly quite selective in what they patent in Australia compared to the USA. But where a company patents in both countries, the number of patents taken out in Australia is usually much less. Within the chemical and pharmaceutical industries the ratio various from 69 percent (Hoechst)[37] to 14 percent (Sumitomo Chemicals) around an average of 28 percent. On average the number of Australian patents acquired is less than 6 percent of those acquired in the US in electronics, information technology and telecoms. However the two mobile telecoms companies in the list (Ericsson and Nokia) both acquire about a third as many patents in Australia as in the US. Another company that has a high Australian patenting ratio is Kimberley-Clark (37 percent). Possible explanations are that only genuinely significant inventions are patented on a global basis, or that where Australia lacks industrial depth it is seen as unnecessary to take out patents.

There are 56 companies in the top Australian patenters list which are not among the top 100 US patenters (though 36 are found among the 300 companies in the US frequent patenters table). Details are shown in the Appendix in Table A5. Similarly there are 56 companies in the top 100 US patenters list which are not among the top 100 Australian patenters. Only nine of these are among the top 300 Australian patenters, though another 16 have at least 19 Australian patents (that is, are among Australia's top 900 patenters). Details are shown in the Appendix in Table A6.

There are quite distinct patterns in the industries/technologies represented in these two lists. Where a particular industry is totally absent in Australia—such as semiconductors—top US patenters simply do not patent at all in Australia. Only two of the twelve semi-conductor companies patent in Australia, and both operate across a wider range of technologies (Sanyo Electric and Texas Instruments). In contrast the companies which are among the top 100 patenters in Australia but not in the USA are dominated by chemical and pharmaceutical companies.

There are also quite distinct differences between these two lists in where the companies are headquartered. Among the 56 top US patenters, 30 are based in Japan, Korea or Taiwan, and 22 in the US or Canada. Only two are based in Europe. In contrast among these Australian top patenters, 23 are based in Europe and 27 in Japan.

As noted earlier there is only one Australian company among the top 100 Australian patenters. *Silverbrook Research* operates in the high-speed printing business, and its technology involves a high-speed printer, a scanning device, coded forms and invisible ink

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[37] This high percentage may be due to undercounting of Hoechst patents in the USPTO major patenters table. That table shows a 45 percent undercount for Hoechst for the 1969 to 2006 period compared to a basic USPTO search for the Hoechst constituent companies. If the 1990-2001 data are inflated by 45 percent then the ratio of Australian to US patents falls to 48 percent, which is still well above the sector average.

Table 4 Companies both in top 100 US and top 100 Australian patenters

Company name	HQ	US rank	AU rank	main field of activity	# AU grants from filings in:			# US grants from filings in:		
Chemical, pharmaceutical and related					**1990-1995**	**1996-2001**	**1990-2001**	**1990-1995**	**1996-2001**	**1990-2001**
Sanofi / Aventis [Hoechst]	FR	55	2	pharma	1,058	760	1,818	2,144	490	2,634
Procter & Gamble	US	32	3	mixed chemical	665	861	1,526	1,705	3,268	4,973
Exxon-Mobil	US	41	7	chemical / oil	553	608	1,161	2,863	1,019	3,882
Du Pont	US	26	11	chemicals / plastic, rubber	520	458	978	3,170	2,832	6,002
Bayer AG	DE	36	12	pharma	341	608	949	2,396	2,207	4,603
Merck Sharp & Dohme (MSD)	US	76	13	pharma	332	559	891	1,051	1,081	2,132
BASF AG	DE	28	14	chemicals / synthetics	395	495	890	2,585	3,288	5,873
Pfizer	US	57	16	pharma	382	501	883	1,117	1,391	2,508
Shell Oil Company	NL/UK	75	17	chemical / oil	424	412	836	1,274	859	2,133
Dow Chemicals	US	66	19	mixed chemical	509	287	796	1,596	764	2,360
Novartis AG	CH	71	21	pharma	475	276	751	2,178	70	2,248
Hoffmann La Roche	CH	85	23	mixed chemical	260	427	687	972	894	1,866
Wyeth	US	70	28	pharma	305	242	547	1,660	622	2,282
Eli Lilly	US	93	32	mixed chemical	241	218	459	930	782	1,712
Abbott Laboratories	US	92	35	pharma	194	222	416	936	781	1,717
L'Oreal	FR	77	46	cosmetics	110	224	334	651	1,478	2,129
Corning Incorporated	US	98	52	glass, ceramics, fibre optics	139	175	314	566	1,067	1,633
Sumitomo Chemicals	JP	84	58	chemicals	133	135	268	909	973	1,882
Sector sub-total					7,036	7,468	14,504	28,703	23,866	52,569
% of top 100 Australian or top 100 US companies' patents					**14.6%**	**15.5%**	**30.1%**	**5.2%**	**4.4%**	**9.6%**

Table 4 Companies in top 100 US and top 100 Australian patenters (continued)

Company name	HQ	US rank	AU rank	main field of activity	# AU grants from filings in:			# US grants from filings in:		
Electronics, computing, telecommunications and related					**1990-1995**	**1996-2001**	**1990-2001**	**1990-1995**	**1996-2001**	**1990-2001**
Ericsson	SE	30	1	telecoms	475	1,383	1,858	767	4,879	5,646
NEC	JP	3	5	IT	586	719	1,305	5,319	11,463	16,782
Alcatel-Lucent	FR (US)	17	8	telecoms	668	454	1,122	1,380	8,036	9,416
Nokia	FI	60	18	telecoms	315	494	809	265	2,199	2,464
Sony	JP	5	25	electronics / IT	276	312	588	4,530	9,636	14,166
Motorola	US	10	29	telecoms	308	182	490	5,887	6,069	11,956
Samsung Electronics	KR	11	30	diversified	31	439	470	2,590	9,249	11,839
Panasonic	JP	4	45	electrics, semiconductors	114	221	335	5,105	9,701	14,806
Sumitomo Electric	JP	69	47	electronics	193	138	331	1,339	965	2,304
AT&T	US	34	57	telecoms	231	42	273	2,891	1,871	4,762
Mitsubishi Denki	JP	8	61	electronics	131	131	262	6,055	7,058	13,113
Fujitsu Limited	JP	9	64	computers	179	77	256	4,516	8,174	12,690
General Electric	US	12	67	diversified	127	105	232	5,333	6,259	11,592
Philips Electronics	NL	15	70	electronics, lighting	130	100	230	3,505	6,418	9,923
Hitachi	JP	6	93	diversified	76	105	181	5,984	8,051	14,035
LG Electronics	KR	68	94	electronics, healthcare	19	160	179	168	2,142	2,310
Sector sub-total					**3,859**	**5,062**	**8,921**	**55,634**	**102,170**	**157,804**
% of top 100 Australian or top 100 US companies' patents					**8.0%**	**10.5%**	**18.5%**	**10.2%**	**18.7%**	**28.8%**

Table 4 Companies in top 100 US and top 100 Australian patenters (continued)

Company name	HQ	US rank	AU rank	main field of activity	# AU grants from filings in:			# US grants from filings in:		
Instruments; light machinery					**1990-1995**	**1996-2001**	**1990-2001**	**1990-1995**	**1996-2001**	**1990-2001**
Canon.	JP	2	10	cameras, copiers, printers	330	686	1,016	9,101	11,774	20,875
Medtronic	US	81	81	medical devices	126	78	204	530	1,402	1,932
Eastman Kodak	US	13	84	photographic & optical	125	69	194	5,200	5,725	10,925
Sector sub-total					**581**	**833**	**1,414**	**14,831**	**18,901**	**33,732**
% of top 100 Australian or top 100 US companies' patents					**1.2%**	**1.7%**	**2.9%**	**2.7%**	**3.5%**	**6.3%**
Diversified, and engineering										
3M	US	24	6	mixed	673	613	1,286	3,196	3,304	6,500
Siemens	DE	22	33	diversified	168	283	451	2,630	5,016	7,646
Robert Bosch	DE	29	56	automotive products, appliances	70	225	295	1,944	3,802	5,746
Eaton	US	79	62	diversified (components)	151	109	260	938	1,049	1,987
Honeywell	US	27	87	diversified (defence/aerospace)	64	126	190	2,918	2,983	5,901
Caterpillar	US	59	89	heavy equipment	80	106	186	856	1,615	2,471
Hughes Aircraft	US	83	96	defence/aerospace	161	17	178	1,834	51	1,885
Sector sub-total					**1367**	**1479**	**2,846**	**14,316**	**17,820**	**32,136**
% of top 100 Australian or top 100 US companies' patents					**2.8%**	**3.1%**	**5.9%**	**2.6%**	**3.3%**	**5.9%**
Other										
Kimberly-Clark	US	65	15	paper	331	553	884	650	1,714	2,364
Halliburton	US	90	85	oil services	83	110	193	698	1,045	1,743
Sector sub-total					**414**	**663**	**1,077**	**1,348**	**2,759**	**4,107**
% of top 100 Australian or top 100 US companies' patents					**0.9%**	**1.4%**	**2.2%**	**0.2%**	**0.5%**	**0.8%**
Total number of patents in group of 46					**13,257**	**15,505**	**28,762**	**114,832**	**165,516**	**280,348**
Total number of patents held by top 100 companies in Australia or the USA					**21,100**	**25,775**	**46,875**	**188,916**	**324,312**	**513,228**
Share of group of 46 in top 100 Australian or top 100 US patenting companies					**28%**	**32%**	**60%**	**21%**	**30%**	**51%**

Note: Country codes are shown at the end of the Appendix.

(Moir forthcoming: Appendix 6). This is an industry rife with patent thickets. Silverbrook's website notes with pride the number of patents it is acquiring. Many are clearly designed to hide the underlying technology, with titles such as "network refrigerator and printer" (a combined fridge and printer), "method for searching information using coded data" (a rather cumbersome web searching method) and "method and system for route planning" (prints a map with coded data, then a scanner and computer are needed to determine the route).

A very large proportion of patents granted in both countries are acquired by a very small number of companies. Ownership of such large numbers of patents does not guarantee that any of these patents fall in the very small set of high-value patents. But it does suggest that *their owners see an important value in patenting*. The chemical industries, as noted above, involve highly codified technologies and have always been seen as particularly suited to the patent intervention, given the high costs of Phase III trials. The electronics and semiconductor industries are well-known for requiring large volumes of patents which are cross-traded to acquire access to the patented technology owned by other parties.

But the interesting question from a political economy perspective is what role these major patenters play in the development of patent policy.

Thirteen US companies played a major role in the development of the TRIPS agenda (Drahos 2002: 118). Two of these companies—Rockwell International and FMC—were among the top 100 US patenters in the period 1970-2001,[38] and ten were major patenters in the 1990-2001 period.[39] Four of these latter ten are among the 46 companies which patent heavily in both the USA and Australia: Merck Sharp & Dohme, Pfizer, Du Pont and General Electric. Another three—IBM, Hewlett-Packard and General Motors—are among the top 100 patenters in the USA, and are frequent patenters in Australia, but not among the top 100. The final three—Bristol-Myers Squibb, Monsanto and Johnson & Johnson—are among the top 100 patenters in Australia, but not among the top US 100.

It is noticeable that seven of these 12 companies are from the pharmaceutical/chemicals sector, where knowledge is more highly codified. Two other companies are from the information technology sector, one of which, IBM, is very well known for its enormous patent portfolio. As at the end of December 2006 it had been granted 49,171 US patents. During the period from 1969 to 2001 IBM has been consistently among the ten most prolific patenters in the USA. General Electric is the next most prolific US patenter, having been among the top ten US patenters for 26 of these 33 years. It ranked top from 1969 until 1985 (Table 5). The marginally shifting pattern among the top ten US patenters illustrates a number of points. Despite a number of new entrants to this exclusive group, there are only 33 companies that have *ever* been in the top ten group in this 33-year period, and six of

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[38] Since 1979 Rockwell International began to spin-off its various business segments, and finally separated into Rockwell Collins and Rockwell Automation in 2001 http://en.wikipedia.org/wiki/Rockwell_International and http://en.wikipedia.org/wiki/Rockwell_Automation, accessed 25 August 2008). FMC ranked 91st among US patenters in the period 1970 to 2001, but was only 182nd in the 1990 to 2001 period.

[39] The thirteenth company closely involved in TRIPS was Warner Communications. During the lead-up to the TRIPS negotiations Warner Communications is likely to have had a greater interest in copyright than patents. In the early 1980s, when the Uruguay round of negotiations commenced, software was generally seen as unpatentable. Indeed copyright protection for software was written into the TRIPS Agreement (Article 10).

these have only been in the group for three years or less. So, in general, 25 companies dominate US patenting. But the most striking thing about the top ten patenters is the shift to a predominance by Japanese and Korean companies.

The story of the US-Japan patent wars has been told elsewhere (Warshofsky 1994). Another story that has been told elsewhere is the rising concern in the USA during the 1970s and 1980s about declining productivity (Scherer 2006). It was against this background that the argument to extend the reach of US patent legislation, initially through Special 301, and subsequently through the GATT framework, gained ground. It is therefore particularly ironic, that as US patent laws have broadened their reach, in response to US corporate lobbying, the major companies now taking advantage of these government-backed monopolies in the USA are foreign companies.

In 1969 the top ten patenters in the USA were all US companies. This number gradually dropped during the 1970s falling to three out of ten in the late 1980s. By 1995, the year TRIPS became mandatory as a qualification for membership of the WTO, only two out of the top ten US patenters were US companies. These outcomes would not actually have been known until the early 2000s, because of long processing delays. There has been some recovery since then, with Hewlett-Packard, Intel and Micron Technologies entering, but foreign companies still dominate the top ten US patenter ranks. There appears to be very little comment about this in the various debates about the US patent system.

Next steps: priorities for further research

In each of Australia and the USA a mere 100 companies own over a third of patents granted to organisations. This distribution has a very long tail, with very many companies owning just a few patents. Data from national innovation surveys show that the proportion of firms holding any patents is a tiny fraction of innovating firms. Frequent patenters may not receive the greatest gross private value from their patents, because of the very skewed distribution of patent values. But it is likely they receive substantial value from their patents or patent volumes would be lower. Their very high patent volumes increase costs for other innovators. Bessen and Meurer (2008) have pointed out how the costs of establishing the boundaries of patented technology increase with the volume of patents.

Despite the lack of empirical evidence that patents are needed to induce innovation, there is strong political support for stronger and broader patents. The most parsimonious explanation of this conundrum is the rent-seeking activities of a small number of major beneficiaries. Quite recently this aspect of patent policy has been noted (Landes and Posner 2004; Scherer 2006; Bessen and Meurer 2008). Because data on frequent patenters are not readily available, the specific companies concerned are rarely named. The exception is a small number of studies investigating the new subject matter area of business methods (Lerner 2002; Hall 2003; Wagner 2008).[40]

[40] Each of these studies finds quite concentrated patent ownership. For US business method patents granted to 2000, Hall found that 36 percent were held by just 44 companies. Lerner found that 25 percent of US finance patents were held by 19 companies. Wagner found that over 40 percent of business method applications at the EPO (where patents had already been granted in the USA) were held by just 14 firms.

Table 5 Top ten patenters in USA: 1969 to 2001

1969	1970	1971	1972	1973
GEC	GEC	GEC	GEC	GEC
Honeywell	Honeywell	Honeywell	Honeywell	Westinghouse
AT&T	AT&T	AT&T	General Motors	Honeywell
Dow Chemical	General Motors #	General Motors	IBM	Dow Chemical
IBM	Dow Chemical	Dow Chemical	Dow Chemical	General Motors
Du Pont	IBM	Westinghouse	AT&T	Du Pont
Westinghouse	Westinghouse	IBM	Westinghouse	IBM
Wyeth	Eastman Kodak	Du Pont	Du Pont	**Novartis**
Eastman Kodak	Du Pont	Eastman Kodak	**Novartis**	**Xerox #**
ConocoPhillips	**Novartis** #	**Novartis**	Eastman Kodak	**Siemens #**
US: 10	US: 9	US: 9	US: 9	US: 7

1974	1975	1976	1977	1978
GEC	GEC	GEC	GEC	GEC
Honeywell	Honeywell	Honeywell	Honeywell	Honeywell
Westinghouse	**Novartis**	Dow Chemical	Dow Chemical	Dow Chemical
Dow Chemical	IBM	Westinghouse	Wyeth	Exxon-Mobil
Xerox	Westinghouse	IBM	IBM	**Novartis**
Bayer #	**Philips**	**Novartis**	RCA	**Hitachi**
Novartis	**Xerox**	**Hitachi #**	Exxon-Mobil#	Westinghouse
Siemens	**Bayer**	AT&T	**Bayer**	**Bayer**
Philips #	Dow Chemical	RCA #	Westinghouse	AT&T
AT&T	Wyeth	**Bayer**	**Siemens**	IBM
US: 5	US: 6	US: 7	US: 8	US: 7

1979	1980	1981	1982	1983
GEC	GEC	GEC	GEC	GEC
IBM	Honeywell	IBM	**Hitachi**	**Toshiba**
Honeywell	**Hitachi**	Honeywell	**Toshiba**	**Hitachi**
Hitachi	IBM	**Hitachi**	Exxon-Mobil	IBM
RCA	Dow Chemical	RCA	Honeywell	Exxon-Mobil
Bayer	RCA	AT&T	IBM	Dow Chemical
Siemens	**Philips**	Exxon-Mobil	AT&T	Honeywell
AT&T	Exxon-Mobil	Dow Chemical	Dow Chemical	AT&T
Dow Chemical	AT&T	**Toshiba #**	**Philips**	**Philips**
Exxon-Mobil	**Siemens**	**Siemens**	**Canon #**	RCA
US: 7	US: 7	US: 7	US: 6	US: 7

1984	1985	1986	1987	1988
GEC	**Hitachi**	**Hitachi**	**Hitachi**	**Hitachi**
Hitachi	GEC	**Canon**	**Toshiba**	**Toshiba**
Toshiba	Dow Chemical	**Toshiba**	**Fuji Photo**	**Mitsubishi Denki**
Exxon-Mobil	**Toshiba**	GEC	**Canon**	**Canon**
Canon	**Canon**	**Philips**	GEC	**Fuji Photo**
Dow Chemical	**Philips**	Dow Chemical	**Philips**	GEC
Honeywell	**Fuji Photo**	**Fuji Photo**	**Mitsubishi Denki#**	**Philips**
Philips	Exxon-Mobil	IBM	IBM	Eastman Kodak
IBM	IBM	**Siemens**	**Siemens**	IBM
Fuji Photo #	Honeywell	**Mitsubishi**	Exxon-Mobil	Honeywell
US: 5	US: 5	US: 3	US: 3	US: 4

Table 5 Top ten patenters in USA: 1969 to 2001 (continued)

1989	1990	1991	1992	1993
Hitachi	**Toshiba**	IBM	IBM	**Canon**
Toshiba	**Hitachi**	**Toshiba**	**Canon**	IBM
Canon	**Canon**	**Canon**	Eastman Kodak	Motorola
Mitsubishi Denki	**Mitsubishi Denki**	**Mitsubishi Denki**	**Mitsubishi Denki**	**Mitsubishi Denki**
Eastman Kodak	Eastman Kodak	**Hitachi**	GEC	**Hitachi**
GEC	GEC	Eastman Kodak	**Toshiba**	**Panasonic**
Philips	IBM	GEC	**Hitachi**	**Toshiba**
Fuji Photo	Motorola #	**Panasonic #**	**NEC #**	GEC
IBM	**Fuji Photo**	Motorola	Motorola	Eastman Kodak
Du Pont	Du Pont	**Fuji Photo**	**Panasonic**	**NEC**
US: 4	US: 5	US: 4	US: 4	US: 4

1994	1995	1996	1997	1998
Canon	IBM	IBM	IBM	IBM
IBM	**Canon**	**Canon**	**Canon**	**NEC**
NEC	Motorola	**NEC**	**NEC**	Lucent*
Motorola	**NEC**	**Samsung#**	**Sony**	**Samsung**
Toshiba	**Fujitsu**	**Sony**	**Samsung**	**Canon**
Fujitsu #	**Sony**	Motorola	**Fujitsu**	**Sony**
Hitachi	**Hitachi**	**Fujitsu**	Motorola	Micron
Mitsubishi Denki	**Mitsubishi Denki**	**Toshiba**	Lucent* #	**Fujitsu**
Panasonic	**Toshiba**	Eastman Kodak	**Panasonic**	**Panasonic**
Sony #	**Panasonic**	**Panasonic**	**Toshiba**	**Toshiba**
US: 2	US: 2	US: 3	US: 3	US: 3

1999	2000	2001
IBM	IBM	IBM
NEC	**Panasonic**	Hewlett-Packard
Canon	Micron Technology	**Panasonic**
Lucent*	**NEC**	**Hitachi**
Sony	**Canon**	**Canon**
Panasonic	**Hitachi**	Micron Technology
Micron Technology#	Hewlett-Packard#	**Philips**
Samsung	Intel	Intel
Intel #	**Sony**	**Sony**
Hitachi	GEC	**Samsung**
US: 4	US: 5	US: 4

Notes: Companies shown in bold are headquartered outside the USA.

first entry into top 10 in period 1971-2001

- Lucent is now merged with Alcatel, but achieved top 10 entry on its own account so is counted here as a US company

Organisations representing large global companies have suggested it is inappropriate for non-profit non-government organisations to participate in global policy negotiations. However it has been the practice for some decades for profit-making non-government organisations (companies) to have an inside seat at the negotiating table. This has particularly been the case in negotiations on "intellectual property" policy. Indeed, the agenda to include intellectual property in trade negotiations was driven by the interests of a small number of very large companies (Drahos 2002; Sell 2003).

Given this, it seems at first sight surprising that there is so little analysis of the very skewed ownership of patents. It is also surprising that the patent case is not frequently used as an example in case studies of rent-seeking and regulatory capture. There are some real research opportunities here. A major reason for the dearth of empirical studies is, however, the difficulty in obtaining data that can be analysed from this perspective. Where such data are obtained they require long and tedious cleaning before they can be used.

The data presented here are a small first step in addressing this gap. The source data for the US is not the preferred source, but is the sole reasonably available public source. Both data series used here also suffer from gaps in identifying wholly or majority owned subsidiaries. Nor has it been possible to extend the analysis to Europe and Japan. Given the global reach of the patent system, a global analysis would be appropriate. Another interesting area for research would be how the ownership structure and distribution has changed for those countries forced to radically change their patent legislation or introduce patent systems as part of their WTO membership.

Bessen and Meurer point to the continued use of anecdote and rhetoric in patent policy discussions (Bessen and Meurer 2008: 3). There is some evidence that the lack of more systematic data is due to intervention by interested parties. In relation to the extension of patents to software and business methods, Kahin notes that a White House Office of Science and Technology Policy study into the quality of such patents was suspended due to the intervention of an (unnamed) large global company (Kahin 2003). He also notes the role of the patent bar in overturning a proposed US General Accounting Office study of business method patents.[41] Bessen and Meurer comment that the Federal Trade Commission (US FTC 2003) recommendation which was most prominently rejected by the Intellectual Property Owners Association was Recommendation 10 'expand consideration of economic learning and competition policy concerns in patent law decisionmaking' (Bessen and Meurer, 2008: 293-4). Calls for a European Patent Observatory have received no response (Bakels and Hugenholtz 2002).

The data placed on the table here will hopefully encourage innovation and competition policy makers to ask more demanding questions in regard to the impact of the patent system, and to insist on evidence-based answers to these questions.

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[41] This proposed study was in the penultimate Senate draft of the American Inventors Protection Act of 1999 (Kahin, 2003).

Appendix Data on patent ownership

This appendix looks briefly at two important economic considerations in analysing patent data: application versus grant data and grant data by grant year or application year. It also provides information on the data sources used in this paper and draws attention to some of their quirks and limitations.

Application or grant data?

From an economic perspective patent grants are of substantially more interest than patent applications. The main economic impact of an as-yet-ungranted application is to add to the cost of patent search.[42] But if an application is never granted it cannot deliver benefits nor interfere with subsequent innovation. This important economic distinction becomes less critical in practice where patent grant rates are very high. In the USA it has been suggested that some 95 percent of applications are granted (Quillen Jr. and Webster 2001). Grant rates were 93 percent in France, 83 percent in the UK and 35 percent in Germany for the period 1950 to 1979 (Schankerman and Pakes 1986: Table 1). For Australia grant rates in the years 1995 to 1998 varied from 88 to 94 percent (Table A2).

Despite the very high proportions of applications granted in some countries, some applications do not proceed to grant, often because they are withdrawn by the applicant.[43]

Grants by application year or grant year?

Much analysis of patent data is based on patent applications, largely because such data are far more readily available than data on patent grants. While aggregate grant data by grant year are often available, grant year data are subject to substantial impact by changing resourcing in patent offices (Griliches 1990: 1690-1693). Where grant rates are very high, application data are probably more reliable than grant year data. Withdrawn applications are likely to be relatively marginal in terms of their economic impact, and this error is probably less than the errors introduced by changing patent examination resources.[44]

This paper uses only data on granted patents. These data are presented by year of application, as it is then that the underlying business decision is made. As a consequence the data are not very recent – it can take as much as seven years for the bulk of a filing cohort to progress through a patent office.

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[42] In theory, businesses monitor patent applications to make sure they do not trespass on competitors' territory. In practice, most businesses do not do this, partly because of the distraction from their business, and partly because the cost is too high (see Bessen and Meurer 2008: 55). In some countries, e.g. the USA, infringement damages rules create an incentive not to know.

[43] Little seems to be written on the topic of applications which do not proceed to grant. For business method patents in Australia, withdrawal rates were in the range 33 to 43 percent (1998 to 2000), even after non-entry PCT cases were excluded from the applications data (Moir forthcoming: Table 4.1).

[44] Though where the subject of interest is ownership, there is a large unknown in terms of differential success rates for firms patenting frequently compared to infrequent patenters. Where a frequent patenter is developing a thicket, there may be a greater probability of allowing some patents to lapse in the face of examiner opposition.

A general caveat

A general caveat about the data used in this paper is that no account is taken of non-renewal. Whether patents are differentially renewed by frequent or less frequent patenters is certainly an issue of interest, but lies well beyond the scope of this study. Specific caveats about the US and Australia sources are discussed below.

US data

The US data used in this paper are from the USPTO (United States Patent and Trademark Office) web site. All grants data are grants by application (filing) year and are from the historical statistics on "utility" patents,[45] specifically the table "Historic Data, All Technologies (Utility Patents) Report".[46] Applications data (used in Figure 1) are from the **"**U.S. Patent Statistics Report" at the same site.[47]

Part A2 of this table shows the number of patents granted since 1963, distributed by the date of grant and the date of the patent application. It provides data by origin, using the residence of the first-named inventor to determine origin. It also separates data by broad categories of ownership, e.g., corporate-owned, government-owned, or individual-owned. These Part A2 data are used for Table 1, and for all data on total grants or grants to individuals. The data in this table refer to grants made between 1 January 1963 and 31 December 2006.

One unexplained aspect of the Part A2 tables is that the number of grants shown for filing year 1963 (243,178) is substantially greater than the number of grants shown for each of the following years (32,206; 54,917; 59,716; 60,077; 63,010). As the data are grants by file year, this suggests that the 1963 data may contain data from earlier file years.[48] For this reason data from the initial year are avoided in comparing changes over time.

Given the basis for determining origin, it is also important to be wary of drawing fine distinctions. Firstly, the classification is based on data at the time of the patent grant. Secondly, residence of first-named inventor could be different from residence of the owner. This is likely to introduce a small degree of error into the data. However, there is no evidence that inventor residence is substantially different from ownership residence. There will be differences at the margin, but in terms of providing an overall picture, the data should be reasonably reliable.

Part B of this set of tables provides data on the national and international corporations, government agencies and other organisations that have received 1,000 or more patents since 1969. Data are provided annually from 1969 to 2006, both by year of grant and by year of application. Again, however the data for the first year give rise to some concerns. In

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[45] The US categorises a number of legislative monopolies as "patents". Those called "utility patents" are for inventions, and are comparable with patents granted in other countries. All US data in this paper are for utility patents only.

[46] http://www.uspto.gov/web/offices/ac/ido/oeip/ taf/h_at.htm (accessed 4 March 2008).

[47] The best entry point for this series of tables is is http://www.uspto.gov/web/offices/ac/ido/oeip/taf/tafp.html, then choose "Patent Statistics Reports Available For Viewing". If that does not work search the USPTO site for "Calendar Year Patent Statistics".

[48] I have attempted to obtain the USPTO's views on this, but they have deleted my emails without reading them.

terms of the data by year of grant, the data for 1969 are sufficiently similar to data for subsequent years for them to appear robust. However this is not the case for the grant data by year of application, the data used in this paper.

Part B grant by year of application data for 1969 are systematically substantially greater than data for subsequent years by a factor of about four. As was the case with Part A2 data for 1963, this suggests that the 1969 data include grants from earlier file years. This could arise if the database is initially set up by year of grant. The earliest year will therefore include grants to patents filed over the previous six or seven years. If data for these earlier application years are not eliminated the data for the first year shown (either 1963 or 1969) will be inaccurate.

Another problem with these data on grants by application year is that recent years are likely to be substantially incomplete. The USPTO warns:

> "Since the average time period between filing for a patent and the issuing of the patent (i.e., the patent's "pendency") is now about 24 months [sic] (for utility patents), the patent grant data, as distributed by year of application, are incomplete for the most recent years that are displayed in the report. This is because a significant number of those applications which ultimately will become patents were still pending …"
>
> (http://www.uspto.gov/web/offices/ac/ido/oeip/taf/h_at.htm)

The note goes on to give figures for the completeness of data for cohorts of patent applications: 94% complete for 2000 applications, 86% complete for 2001 applications, 76% complete for 2002 applications, 54% complete for 2003 applications, and 27% complete for 2004 applications. Clearly data from 2003 and later application cohorts could be quite unrepresentative of the final complete cohort. In this paper an arbitrary decision has been made to include data up to and including 2001 in time trend estimates, despite the fact that the last two years of this period are 14% and 6% incomplete.

A final practical difficulty with these data is that the Part B data are for organisations, and no entry is provided for the total of all granted patents. Clearly data for individuals would not be included with organisations, but adding data for individuals from Part A2 to data for organisations from Part B does not give the totals for all granted patents shown in Part A2. The data are identical for the four years 2002-2006, and are reasonably close for individual years from 1970 to 2006 (the error ranging from -18 to 166). But for the year 1969, the difference is 131,733 (twice the reported number of grants (65,891) for that application year. Again this suggests that the start year contains data from applications filed over a number of years, not just in 1969. It also clearly suggests that it would be more accurate to base data for, and analyses of, the top patenting organisations on the period from 1970.

But the major disadvantage of this data source is that if a company patents through subsidiaries, and none of these individually own 1000+ patents, the company is not included in the table. Several large chemical, pharmaceutical and related companies are

identified as major patenters in Australia but do not show up in the top US patenters list.[49] Where companies are included their total patent count may be underestimated if major patenting subsidiaries do not reach the 1000 threshold.[50]

Australian data

The Australian data used in this paper refer only to standard patents.[51] IPAustralia provided excel spreadsheets for all granted standard patents filed from 1990 onwards, and granted by the end of December 2007.

A number of fields were included: application number, PCT number, year filed, year entered national phase, year granted, application status, death date, year of death, revoked date, patent life (years), invention title, IPC class (to sub-group level), owner name, type of owner (organisation / individual) and country name. Because of missing country codes, fields for address were added. The data were provided in separate annual files, based on the date of entry to national phase. For PCT (Patent Cooperation Treaty) applications this means that some data were provided in respect of patents filed before 1990.[52]

Initial inspection of the data showed that there were a number of duplicate entries. For the national phase entry years to 2001 these occurred wherever there were multiple owners of the patent, and duplicates ran consistently at 7 percent for each year. From 2002 duplicates occurred not just for multiple owners, but also for multiple IPC classifications.[53] The proportion of duplicate entries increased to 24 percent in 2002 and was over 40 percent for 2003 and 2004. The first step in preparing the data was thus to retain the data on multiple owners, while removing duplicate entries.

Pendency times

Once duplicate entries were removed, the data were set up by year of filing. Because of the way patent administration currently operates, several years can elapse between filing and

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[49] For example, Unilever is not in the list, but a name search identified 1156 patents granted to Unilever companies for applications from 1969 to 2006. Rhodia is not listed under any name, but a search for Rhone and Poulenc identified 3185 patents granted during the period.

[50] For example, Johnson & Johnson is among the top ten Australian patenters but only 249th in the USA, where it is listed as its subsidiary Ethicon, with a patent total of 1194 for the 1969 to 2006 period. A search for patents granted to any Johnson & Johnson company identified a total of 3954 patents for the whole period, increasing the US rank to 81st.

[51] Australia has a two-tier patent system. Standard patents are comparable to patents issued in most WTO member countries. They have a 20-year term, and require that the grant be for an invention which is novel, inventive and has utility in a field of economic activity. Australia also issues innovation patents, which have a shorter term, and a reduced inventiveness test. They can be granted without examination, but cannot be used to prevent others' activity until they have been examined.

[52] The Patent Cooperation Treaty (PCT) process allows an applicant to reserve the option of filing the same application in a range of countries, using the priority date of the first filing. Following filing in a single country, the applicant has up to 12 months to decide to file the application through the PCT route. The applicant then has a further 16 months to obtain an International Search Report (ISR). 'National phase' entry can occur up to 30 months after first filing, depending on circumstances. See http://www.wipo.int/pct/en/seminar/basic_1/timeline.pdf for a useful diagrammatic illustration of these timelines (last accessed 14 August 2007). There are no real limits on how long an application can stay in the system, as examiner and applicant exchange views about the merit of the 'invention', though renewal fees will be payable.

[53] The IPC (International Patent Classification) is used by examiners to search for similar "inventions". Patents can be classified to many different sub-groups.

grant.[54] This is in marked contrast to earlier periods, where patents had to be examined within a fixed time period (see Second Reading Speech, 22 May 1952, Senate Hansard: 687). From 1990 to 1997 patent cohorts were largely completed within a period of four years from year of filing. However it is evident from the data in Tables A1 and A2 that the time taken to examine a cohort of patents has increased substantially.

The pace at which a patent application proceeds through the system is largely driven by three factors: the wishes of the applicant, the volume of examination resources and the extent of any problems raised by the examiner. At each stage in the process the applicant has a period of time in which to respond, or request movement to the next stage. Some applicants want speedy processing, ask for expedited examination, and reply quickly to examiner's reports. Other applicants want the grant of the patent to be delayed, and take the longest possible time to respond to Patent Office timelines, such as direction to request an examination, or adverse examiner's reports. Indeed applicants often miss deadlines, and request extensions (after the fact), which are usually granted. The more marginal an "invention" the more likely an examiner is to raise objections. If the applicant's response to the initial objections is limited, the examiner may maintain her/his objections, and a further round of correspondence can occur. Since the introduction of the *Patents Act 1952* there has been no limit to the time an application can remain in examination, except for the 20-year limit from date of filing.

There are thus likely to be differences between patents which have moved quickly through the system, those that take an average time, and those that take a very long time. In analysing any set of patents it is therefore preferable to deal with completed filing cohorts, to avoid the unknown biases resulting from these factors. Due to the extended time now necessary for completion of a filing cohort, this means that patent grant data are not at all timely.

Table A1 shows the progress of filing cohorts through the Australian Patent Office. Row totals show the number of patents granted from filings in a particular year. Patents filed in 1997 were processed very speedily. But since 1998 the proportion of grants issued within two years of filing has dropped dramatically, offset by a big increase in the proportion of patents issuing five years after filing. For the 2001 cohort there is evidence of an increased proportion of grants not issuing until six years after filing. It now appears to take six to seven years for a cohort of patent applications to move substantially through the Australian patent administration system. The data are presented in Table A2 in terms of the proportion of grants made in a particular year after filing, and this table shows clearly the reduced percentage processed within two years, and the increased percentage taking six years or more to process.

Grant rates

Table A2 also shows, in the penultimate column, the proportion of applications granted a patent by the end of 2007. As data on applications are not readily available for earlier years,

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[54] One patent granted in Australia in 2007 was filed in 1992 – a pendency period of 15 years! At the time application 199225503 (“Gaseous ultrasound contrast media and method for selecting gases for use as ultrasound contrast media”) was filed by GE Healthcare AS, the maximum patent duration was 16 years. This was, of course later extended to 20 years to comply with the TRIPS Treaty.

these data are presented only for the period from 1995. Processing appears to be complete for the application years 1995 to 1998, and the data show that very high percentages of applications are granted patents: between 88 and 94 percent. As some patent applications are allowed to lapse by their owners, these data suggest that the Australian Patent Office is rarely successful in opposing grant of a patent, once an application is filed. It could almost be suggested that the very act of filing a patent application is sufficient to achieve grant of a patent, despite the theoretical patentability criteria that need to be met.

Ownership information

The ownership details in the dataset required considerable cleaning. Because of the focus on corporate ownership, the first step was to separate out individual owners (7.9 percent) and governments or non-profit research owners (4.4 percent). All patents owned exclusively by one or more individuals or only by governments or non-profit research owners are excluded from the analysis in this paper. The remaining 141,584 patents include at least one corporate owner and might also include individual owners and non-profit organisations (including government agencies).

Where multiple ownership involves a company and individuals,[55] a company and a non-profit organisation, or two branches of the same company, the patent is retained in the dataset. Patents owned by multiple companies (and any other entities) are not included in this analysis (this involves 5,214 patents or 3.7 percent of corporate grants in 1990-2001). The final dataset of 136,399 corporately owned patents included in this analysis thus covers 84.5 percent of granted patents, 91.8 percent of patents granted to organisations, or 96.3 percent of patents with at least one corporate owner.

Period covered

As discussed above, patent application cohorts for recent years are substantially incomplete as most patent systems allow a very long period for processing. In order to avoid the biases of including incomplete years, the data used in this paper were restricted to the application cohorts from 1990 to 2001. The analysis in this paper is based on this 12-year period.

The initial intent was to include in the analysis a review of changes in frequent patenting during the period, so the data were split into two sets: the period 1990-1995 and the period 1996-2001. Within each of these 6-year periods companies were sorted by name, then grouped into counts for the same company. This proved to be an extremely tedious and time-consuming business. This was due to the impact of both small typographical differences in how a name was entered, and to the fact that larger corporations often trade under many names, and register patents in business names which are hard to track down.

The first set of challenges involved the typographical differences in how names were entered. Small differences in how an owner's name is entered mean that entries for the same owner can be separated by entries for other owners. Thus spaces and punctuation, as well as abbreviations become meaningful, and increase the time needed to group together patents owned by a single entity. In addition, especially for overseas companies, where the data entry staff are clearly not familiar with the language, companies can be entered with the

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[55] Little is known about such patents, but possibilities include that the individuals work in the company or have agreed a joint approach to developing the patented “invention”.

word "company" first, rather than the company name. Thus AG, Aktiebolag, Aktiengesellschaft, AS, Aktiengesellschaft, Gmbh, Kabushiki Kaisha, KK, Oy, Société Anonyme all featured as initial words in a company name. In addition some companies were occasionally entered with the word "the" as in "The Gillette company". Companies with initials as part of the company name were a particular problem as spaces and punctuation changed the order of listing, and differently entered names had to be re-sorted and grouped together. Where patents were taken out in by different branches of the same company, for example, 'Aventis CropScience GmbH' and 'Aventis Cropscience S.A.', these entries can be separated by entries for other companies, and have to be re-sorted.

Beyond these straightforward cleaning exercises was the challenge of companies taking out patents in a range of company names, even though the ownership was common. Substantial effort has been put into tracking down common ownership for the more frequent patenters, especially those that are among the top 100 US patenters as well as among the top 100 Australian patenters. However a more complete exercise would require access to business name registers, which lie in the private domain and are not cheap to access.

Because of the initial intent to compare the volume of patenting of frequent patentees between the two six-year time periods, frequent patenters were initially defined on the purely arbitrary basis of those with 10 or more patents in any one 6-year period. On the basis of this decision-rule, 1,344 frequent patenters were identified. However the list excludes companies with less than ten patents in either six-year period. Thus companies with nine patents in each period could be excluded, yet such companies would have more patents than some identified in the listing. The decision-rule means that the clear cut-off in the identification of frequent patenters occurs at 19 patents in the twelve-year period—most such companies have been identified.[56] There are 908 of them.

[56] Of course, to the extent that variations in company names have not yet been picked up, there may be more frequent patenters than are identified here.

Table A1 Granted Australian patents by file and grant years: 1990 - 2007

File year	Grant year																
	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	total
1990*	3688	5638	2173	292	29	7	12	2	4	3	0	1	1	1			12,166
1991	366	3708	4903	1843	350	33	12	17	3	1	2	1	0	1			11,242
1992	1	440	3494	4306	2111	459	75	11	4	4	1	0	1	1	0	1	10,909
1993		6	464	2547	4138	2661	969	54	13	6	3	1	1	2	0	1	10,866
1994			8	339	1868	4455	4132	661	39	12	9	6	3	1	1	1	11,535
1995				7	215	1227	6321	3846	693	40	21	8	3	7	2	1	12,391
1996					1	325	2252	6256	4320	828	58	20	7	7	1	1	14,076
1997						7	599	1652	6496	5192	1116	91	20	15	6	4	15,198
1998							48	614	1372	6002	6280	1874	167	19	11	10	16,397
1999								24	505	1183	4878	6564	2868	345	38	16	16,421
2000									16	400	1019	3304	6351	3756	847	125	15,818
2001										8	285	873	2334	4333	4242	2309	14,384
2002											8	239	743	1552	2332	3882	8,756
2003												18	214	672	1166	1882	3,952
2004													17	220	562	1141	1,940
2005														38	188	539	765
2006															12	196	208
2007																15	15
Total	4055	9792	11042	9334	8712	9174	14420	13137	13465	13679	13680	13000	12730	10970	9408	10124	177,039

Source: Data on standard patent grants from filings in 1990 and subsequent years, provided by IPAustralia.

Note: As these are file year data, total grants by grant year (column totals) are incomplete for years up to around 1994 / 1995. Total granted from filings in years 1990-2001 is 161,403.

* Four patents from the 1990 cohort were granted in 1990, and 311 in 1991. Two patents from the 1991 cohort were granted in 1991. These data are not shown because of space restrictions.

Table A2 Proportion of Australian patents granted by years from filing

File year	Proportion of patents granted in:								Percent granted to date	Number granted from cohort
	Year of filing	Year after filing	Years after filing							
			2	3	4	5	6	7		
1990	0%	3%	30%	46%	18%	2%				12,166
1991	0%	3%	33%	44%	16%	3%				11,242
1992	0%	4%	32%	39%	19%	4%	1%			10,909
1993	0%	4%	23%	38%	24%	9%				10,866
1994	0%	3%	16%	39%	36%	6%				11,535
1995	0%	2%	10%	51%	31%	6%			**88%**	12,391
1996	0%	2%	16%	44%	31%	6%			**94%**	14,076
1997	4%	11%	43%	34%	7%	1%			**89%**	15,198
1998	0%	4%	8%	37%	38%	11%	1%		**91%**	16,397
1999	0%	3%	7%	30%	40%	17%	2%		**83%**	16,421
2000	0%	3%	6%	21%	40%	24%	5%	1%	**72%**	15,818
2001	0%	2%	6%	16%	30%	29%	16%		**63%**	14,384
2002	0%	3%	8%	18%	27%	44%			**39%**	8,756
2003	0%	5%	17%	30%	48%				**18%**	3,952
2004	1%	11%	29%	59%					**8%**	1,940
2005	5%	25%	70%						**3%**	765
2006	6%	94%							**1%**	208
2007	100 %									15

Note: These calculations are based on calendar years not elapsed years. That is among patents filed in 1997 and granted, 43% were granted in 1999.

Application data was to calculate grant rates are from Table P30(Feb08) available at http://www.ipaustralia.gov.au/about/statistics.shtml (accessed 29 July 2008).

It is evident from the column on the percent of filings (applications) granted that the cohorts for the last six years (2002 on) are substantially incomplete, and that many additional patents may yet be granted from patents filed in the years 1999, 2000 and 2001.

Table A3: Top 100 US corporate patentees: 1969 to 2006

		HQ	AU rank	# patents 1969 to 1984	# patents 1985 to 2006	# patents 1969 to 2006
1	IBM	US	107	9,794	39,377	49,152
2	GENERAL ELECTRIC	US	68	15,480	17,768	33,248
3	CANON	JP	10	3,738	28,659	32,397
4	HITACHI	JP	93	6,933	22,441	29,374
5	TOSHIBA	JP	663	4,412	21,406	25,818
6	PANASONIC #	JP	46	3,689	21,004	24,693
7	PHILIPS #	NL	71	7,494	14,838	22,332
8	NEC	JP	5	1,961	19,682	21,643
9	HONEYWELL #	US	44	11,507	9,882	21,389
10	EASTMAN KODAK	US	85	5,907	15,139	21,046
11	SONY	JP	25	2,536	17,974	20,510
12	MITSUBISHI DENKI	JP	62	2,021	18,185	20,206
13	SIEMENS	DE	33	6,838	11,800	18,638
14	MOTOROLA	US	29	3,581	14,992	18,573
15	FUJITSU	JP	65	1,415	16,402	17,817
16	DU PONT #	US	11	7,826	9,274	17,100
17	SAMSUNG ELECTRONICS	KR	30	2	16,819	16,821
18	FUJI PHOTO FILM	JP	788	3,510	13,190	16,700
19	HEWLETT-PACKARD #	US	345	1,022	15,616	16,638
20	AT&T	US	58	9,721	6,875	16,597
21	XEROX	JP	*	5,343	10,327	15,670
22	DOW CHEMICAL #	US	19	10,136	5,011	15,147
23	EXXON-MOBIL #	US	7	7,999	6,412	14,411
24	TEXAS INSTRUMENTS	US	836	3,350	11,039	14,389
25	BAYER	DE	12	6,877	7,377	14,254
26	MICRON TECHNOLOGY	US	--	1	13,953	13,954
27	GENERAL MOTORS	US	210	6,963	6,866	13,829
28	INTEL	US	600	190	12,527	12,717
29	3M #	US	6	3,386	9,110	12,496
30	BASF #	DE	14	3,865	8,466	12,332
31	ROBERT BOSCH	DE	57	3,422	8,759	12,181
32	WESTINGHOUSE ELECTRIC	US	304	8,438	3,537	11,975
33	NOVARTIS #	CH	21	7,273	4,192	11,465
34	ALCATEL-LUCENT	FR	8	0	10,352	10,352
35	KONICA-MINOLTA	JP	--	2,158	8,084	10,242
36	WYETH #	US	28	6,946	3,292	10,238
37	HONDA MOTOR	JP	191	1,457	8,664	10,121
38	SHARP	JP	299	1,023	8,767	9,790
39	CONOCOPHILLIPS #	US	72	6,863	2,542	9,405
40	RICOH	JP	--	1,808	7,158	8,968

Table A3: Top 100 US corporate patentees: grants by filing year (contd)

		HQ	AU rank	# patents 1969 to 1984	# patents 1985 to 2006	# patents 1969 to 2006
41	FORD MOTOR #	US	597	2,768	6,167	8,935
42	ADVANCED MICRO DEVICES	US	--	138	8,576	8,714
43	PROCTER & GAMBLE #	US	3	2,263	6,400	8,663
44	NISSAN MOTOR	JP	--	3,276	4,802	8,078
45	HOECHST (Sanofi Aventis)	FR	2	4,003	3,952	7,955
46	RCA (defunct)	US	*	7,218	670	7,888
47	TOYOTA JIDOSHA	JP	175	2,492	5,194	7,686
48	DENSO	JP	815	1,139	6,493	7,632
49	SHELL OIL	NL/UK	17	3,477	3,648	7,125
50	SEIKO EPSON	JP	800	33	7,074	7,107
51	UNISYS	US	--	5,022	1,978	7,000
52	ERICSSON #	SE	1	468	6,068	6,536
53	CATERPILLAR	US	89	3,183	3,121	6,304
54	PFIZER #	US	16	2,263	4,000	6,263
55	UNITED TECHNOLOGIES	US	225	3,138	2,872	6,010
56	MICROSOFT	US	*	-	5,658	5,658
57	OLYMPUS OPTICAL	JP	--	1,731	3,923	5,654
58	MONSANTO	US	64	4,273	1,349	5,622
59	SUN MICROSYSTEMS	US	186	4	5,616	5,620
60	BOEING	US	--	1,652	3,885	5,539
61	NIKON	JP	--	924	4,490	5,414
62	MERCK SHARP & DOHME	US	13	2,787	4,331	7,118
63	ICI	UK	80	3,530	1,802	5,332
64	DAIMLER #	DE	422	1,480	3,674	5,154
65	HUGHES AIRCRAFT	US	96	2,106	3,046	5,152
66	HOFFMANN-LA ROCHE INC. #	CH	23	2,476	2,619	5,095
67	HALLIBURTON #	US	86	2,013	2,989	5,002
68	ROCKWELL INTERNATIONAL	US	496	3,313	1,525	4,838
69	AGFA #	BE	--	2,517	2,181	4,698
70	SANYO ELECTRIC	JP	251	368	4,307	4,675
71	EATON	US	63	1,632	2,959	4,591
72	SUMITOMO CHEMICAL	JP	59	1,724	2,796	4,520
73	BRISTOL-MYERS SQUIBB #	US	24	2,098	2,406	4,504
74	TEXACO	US	244	3,110	1,309	4,419
75	YAMAHA #	JP	--	329	3,816	4,145
76	CORNING	US	53	1,719	2,345	4,064
77	THOMSON #	FR	277	1,707	2,355	4,062
78	TRW	US	481	1,830	2,197	4,027
79	MURATA MANUFACTURING	JP	--	228	3,793	4,021
80	GOODYEAR TIRE & RUBBER	US	75	1,899	2,049	3,948

Table A3: Top 100 US corporate patentees: grants by filing year (contd)

		HQ	AU rank	# patents 1969 to 1984	# patents 1985 to 2006	# patents 1969 to 2006
81	TAIWAN SEMICONDUCTOR	TW	--	-	3,937	3,937
82	ELI LILLY	US	32	1,671	2,184	3,855
83	SUMITOMO ELECTRIC	JP	48	546	3,302	3,848
84	APPLIED MATERIALS	US	--	23	3,823	3,846
85	PPG	US	81	2,711	1,115	3,826
86	INFINEON TECHNOLOGIES	DE	--	-	3,813	3,813
87	KIMBERLY-CLARK #	US	15	620	3,190	3,810
88	AMP (Tyco)	US	260	2,130	1,535	3,665
89	OKI ELECTRIC	JP	--	207	3,362	3,569
90	FMC	US	115	2,376	1,186	3,562
91	YAZAKI	JP	414	27	3,534	3,561
92	NATIONAL SEMICONDUCTOR	US	--	443	3,102	3,545
93	GTE PRODUCTS	?US?	--	2,546	976	3,522
94	HYUNDAI ELECTRONICS #	KR	--	-	3,517	3,517
95	BROTHER KOGYO	JP	--	180	3,335	3,515
96	GLAXOSMITHKLINE #	UK	22	1,661	1,848	3,509
97	LSI LOGIC	US	--	3	3,474	3,477
98	FUJI XEROX	JP	*	391	3,065	3,456
99	LG ELECTRONICS	KR	94	-	3,431	3,431
100	L'OREAL	FR	47	703	2,714	3,417
	Total			**299,087**	**711,220**	**1,010,307**
	Percent of patents to organisations			**31%**	**33%**	**33%**
	Percent of total patents granted			**29%**	**28%**	**28%**

Source: USPTO website (http://www.uspto.gov/web/offices/ac/ido/oeip/taf/h_at.htm#PartB, accessed 6 March 2008). Part B.

Notes: Australian rank data refer to the period 1990-2001.

Subsidiaries have been aggregated.

* In Australian list of frequent patenters, but <20 patents over 12 year period 1990-2001.

-- Not in list of Australian frequent patenters.

Table A4: Companies entering and leaving US top 100 patentees list

Company name	HQ	US rank	AU rank	main field of activity	Grants from filings in 1990-2001	
Companies in top 100 in 1969-2006, but not in 1990-2001 (leavers)					**US**	**AU**
Westinghouse Electric	US	32	304	electrics/diversified	1,453	60
Conoco-Phillips	US	39	72	oil	1,535	228
RCA (defunct)	US	46	*	electronics	0	15
Unisys	US	51	--	IT (mainframes)	1,365	--
Monsanto	US	58	64	chemicals	887	260
ICI	UK	63	80	chemicals	985	207
Rockwell International	US	68	496	auto/diversified	893	37
Bristol-Myers Squibb	US	73	24	pharmaceuticals	1,488	642
Texaco	US	74	244	oil	724	73
Thomson	FR	77	277	defence	1,559	66
Goodyear	US	80	75	tires and rubber	1,315	219
PPG	US	85	81	glass/paint	548	205
Infineon Technologies	DE	86	--	semiconductors	1,551	--
AMP (Tyco)	US	88	260	electronics	549	69
FMC	US	90	115	chemicals	810	146
GTE Products	?US?	93	--	telecommunications?	283	--
GlaxoSmithKline	UK	96	22	pharmaceuticals	1,436	702
Companies in top 100 in 1990-2001, but not in 1969-2006 (entrants)						
Abbott Laboratories	US	92	35	pharma	1,717	416
Nokia	FI	60	18	telecoms	2,464	809
Medtronic	US	81	81	medical devices	1,932	204
Shin-Etsu Chemical	JP	97	874	(semiconductor) chemicals	1632	20
Seagate Technology	US	62	---	IT (storage)	2453	--
United Microelectronics	TW	63	---	semiconductors	2434	--
Cisco Technology	US	79	---	IT (networking)	1942	--
Semiconductor Energy Lab	JP	83	---	semiconductors	1928	--
Compaq	US	86	780	IT (PCs)	1849	22
Delphi Technologies	US	88	850	electronics (mobile)	1769	20
Pioneer (Electronic)	JP	94	---	electronics	1670	--
Alps Electric	JP	98	---	electronics	1628	--
Hon Hai Precision	TW	99	---	IT; electronics	1613	--
Tokyo Electron	JP	100	---	semiconductors	1608	--
Nortel Networks	CA	53	228	telecoms	2710	75
Asashi Kasei	JP	67	---	diversified	2351	--
Whitaker	US	93	770	aerospace; networking	1694	23

Table A5 Top 100 Australian patenters, not in top 100 US

Company name	HQ	AU rank	US rank	main field of activity	Grants from filings in 1990-2001	
Chemical, pharmaceutical and related					**AU**	**US**
Johnson & Johnson	US	4	184	mixed, chemicals	1314	805
Unilever	NL/UK	9	--	mixed chemicals	1019	--
AstraZeneca	SE/UK	20	--	pharma	777	--
GlaxoSmithKline	US	22	111	pharma	702	1436
Bristol-Myers Squibb	US	24	109	pharma	642	1488
Nestle	CH	26	173	foodstuffs	579	845
Rhodia [Rhone-Poulenc]	FR	27	--	chemicals/vetinary	556	--
Schering		31	129	pharma	462	1230
Pharmacia & Upjohn	US	36	278	pharma	402	164
Ciba Specialty Chemicals	CH	38	156	chemicals	390	937
Linde	DE	39	--	industrial gases	388	--
Colgate Palmolive	US	40	159	personal care	380	925
Rohm & Haas	US	41	138	chemicals	362	1116
Syngenta	CH	43	--	pharma	342	--
Boehringer	DE	48	246	pharma	330	455
Henkel	DE	53	152	personal care / cleaning	309	976
Akzo	NL	54	170	chemicals / specialty (paints)	302	884
Servier	FR	55	--	pharma	298	--
Monsanto	US	63	169	chemicals / agricultural	260	887
Merck (DE)	DE	65	154	pharma	255	951
Lubrizol	US	69	249	specialty chemicals	230	437
ConocoPhillips	US	71	106	oil	228	1535
Novo Nordisk	DK	78	153	pharma	208	960
ICI	UK	79	151	chemicals	207	985
PPG Industries	US	80	228	glass	205	548
Dow Corning	US	83	136	specialty chemicals	194	1171
Covidien [Tyco health]	BM/ US	88	161	pharma; medical devices	188	924
Owens Corning	US	91	285	fibreglass	186	46
Allergan	US	95	--	pharma	178	--
S.C. Johnson & Son	US	100	--	cleaning products	169	--
Sector sub-total					12062	19705
% of AU or US top 100 patents					**25.7%**	**3.9%**
Electronics, computing, telecommunications and related						
Qualcomm	US	34	112	telecoms	434	1407
British Telecom…s	UK	37	188	telecoms	392	782
Daikin Industries	JP	98	208	electronics	171	675
Sector sub-total					**997**	**2864**
% of AU or US top 100 patents					**2.1%**	**0.6%**

Table A5 Top 100 Australian patenters, not in top 100 US (continued)

Company name	HQ	AU rank	US rank	main field of activity	Grants from filings in 1990-2001	
Instruments, light machinery					**AU**	**US**
Baxter	US	42	162	medical instruments	343	919
Becton Dickinson	US	51	135	medical devices	316	1179
Amgen	US	60	--	orthopaedics	264	--
Silverbrook Research	AU	76	242	printers	211	471
Smith & Nephew	UK	77	--	medical devices	209	--
Alcon	CH	82	--	ophthalmology	200	--
Moore North America	US	97	--	printing	178	--
Sector sub-total					**1721**	**2569**
% of AU or US top 100 patents					**3.7%**	**0.5%**
Diversified, and heavy engineering						
Illinois Tool Works	US	49	119	diversified (fasteners)	328	1337
Mitsubishi Heavy Industries	JP	68	125	heavy machinery	231	1277
Deere & Company	US	73	142	heavy equipment	222	1082
Westinghouse Air Brake	US	75	--	brakes	213	--
Raytheon	US	86	118	defence/aerospace	191	1343
Outokumpu	FI	92	--	stainless steel	183	--
ABB AB	CH	99	292	power; automation	170	294
Sector sub-total					**1538**	**5333**
% of AU or US top 100 patents					**3.3%**	**1.0%**
Miscellaneous						
Uni-Charm	JP	44	--	hygiene	337	--
Tetra Laval.	CH	50	--	packaging	318	--
Baker Hughes	US	59	126	oil services	265	1275
Schlumberger	US	66	130	oil services	247	1209
Sealed Air	US	72	--	packaging	223	--
Goodyear Tire & Rubber	US	74	123	tires and rubber	219	1315
DSM IP Assets	NL	90	--	life and materials sciences	186	--
Sector sub-total					**1795**	**3799**
% of AU or US top 100 patents					**3.8%**	**0.7%**

Source: Calculated from all standard patents granted by end 2007 from applications filed in the years 1990 to 2001. See Appendix Table 2 for source for US data.

Notes: Wholly owned and majority owned (over 50 percent) subsidiaries are combined.

Table A6 Top 100 US patenters, not in top 100 Australian

Company name	HQ	AU rank	US rank	main field of activity	Grants from filings in 1990-2001	
Chemical, pharmaceutical and related					**US**	**AU**
Shin-Etsu Chemical	JP	874	97	chemicals (for semiconductors)	1632	20
Sector sub-total					**1632**	**20**
% of AU or US top 100 patents					**0.3%**	0.0%
Electronics, computing, telecommunications and related						
IBM	US	107	1	IT	31182	154
Toshiba	JP	663	7	electronics	13738	27
Hewlett-Packard	US	345	14	IT	10866	52
Micron Technology	US	---	16	semiconductors	9608	--
Intel	US	600	18	IT (software)	9152	30
Texas Instruments	US	836	21	semiconductors, electronics	7824	21
Advanced Micro Devices	US	---	23	semiconductors	6808	--
Sharp	JP	299	25	electronics	6098	61
Ricoh	JP	---	35	electronics, imaging	4653	--
Seiko Epson	JP	800	37	electronics	4459	22
Sun Microsystems	US	186	38	IT (diversified)	4432	89
Microsoft	US	896	40	IT (software)	4347	19
Hyundai Electronics	KR	---	45	electronics	3428	--
Applied Materials	US	---	48	semiconductors	2946	--
Sanyo Electric	JP	251	49	semiconductors, batteries, phones	2894	72
Yamaha	JP	---	50	electronics, musical instruments	2816	--
Murata Manufacturing	JP	---	51	electronic components	2784	--
LSI Logic	US	---	55	semiconductors	2642	--
Taiwan Semiconductor	TW	---	59	semiconductors	2500	--
Seagate Technology	US	---	62	IT (storage)	2453	--
United Microelectronics	TW	---	63	semiconductors	2434	--
National Semiconductor	US	---	73	semiconductors	2206	--
Oki Electric	JP	---	74	semiconductors	2154	--
Cisco Technology	US	---	79	IT (networking)	1942	--
Semiconductor Energy Lab	JP	---	83	semiconductors	1928	--
Compaq	US	780	86	IT (PCs)	1849	22
Delphi Technologies	US	850	88	electronics (mobile)	1769	20
Pioneer (Electronic)	JP	---	94	electronics	1670	--
Alps Electric	JP	---	98	electronics	1628	--

Table A6 Top 100 US patenters, not in top 100 Australian (continued)

Company name	HQ	AU rank	US rank	main field of activity	Grants from filings in 1990-	
Electronics, computing, telecommunications and related (continued)					**US**	**AU**
Hon Hai Precision	TW	---	99	IT; electronics	1613	--
Tokyo Electron	JP	---	100	semiconductors	1608	--
Nortel Networks	CA	228	53	telecoms	2710	75
Sector sub-total					**159141**	**664**
% of AU or US top 100 patents					**31.1%**	1.4%
Instruments; light machinery						
Xerox	JP	1149	19	copiers; printers	8031	14
Fuji Photo Film	JP	788	20	photographic equipment	7865	22
Konica-Minolta	JP	---	31	cameras, copiers, printers	5496	--
Nikon	JP	---	44	(optics) precision instruments	3732	--
Olympus Optical	JP	---	47	(optics) precision instruments	2948	--
Fuji Xerox	JP	1021	64	copiers; printers	2378	16
Brother Kogyo	JP	---	72	printers; machinery	2246	--
AGFA	BE	---	95	optics/imaging	1644	--
Sector sub-total					**34340**	**52**
% of AU or US top 100 patents					**6.7%**	0.1 %
Diversified, and heavy engineering						
Honda Giken	JP	191	33	autos, diversified	4900	85
Ford Motor	US	597	39	autos	4421	30
General Motors	US	210	43	autos, financial services	3792	80
Toyota Jidosha	JP	175	46	autos	3138	94
Yazaki	JP	414	52	auto equipment	2774	44
DaimlerChrysler	DE	422	54	autos	2692	42
Nissan Motor	JP	---	57	autos	2556	--
Denso	JP	815	41	auto components	4022	61
Asashi Kasei	JP	---	67	diversified	2351	--
TRW	US	481	85	defence/diversified	1863	38
Boeing	US	---	87	defence/aerospace	1838	--
United Technologies	US	225	90	diversified	1726	76
Whitaker	US	770	93	aerospace; data networking	1694	23
Sector sub-total					**37767**	**573**
% of AU or US top 100 patents					**7.4%**	1.2 %

Source: Calculated from the USPTO table "Historic Data, All Technologies (Utility Patents) Report", Part B (http://www.uspto.gov/web/offices/ac/ido/oeip/ taf/h_at.htm, accessed 4 March 2008). See Appendix Table 1 for source for Australian data.

Notes: Wholly owned and majority owned (over 50 percent) subsidiaries are combined.

Acronyms and Country Codes

EPO	European Patent Office
GATT	General Agreement of Tariffs and Trade (first signed 1947)
GDP	Gross Domestic Product
IPAustralia	Intellectual Property Australia (includes the Australian Patent, Designs and Trade Marks Offices)
IPC	International Patent Classification
ISR	International Search Report (part of PCT processes)
PCT	Patent Cooperation Treaty
R&D	research and development
Special 301	1988 amendment to US International Trade Act (which requires imposition of US trade sanctions in respect of "unfair" overseas intellectual property laws)
TRIPS	"Trade-Related" Intellectual Property Treaty
USPTO	United States Patent and Trade Mark Office
WIPO	World Intellectual Property Organisation
WTO	World Trade Organisation (replaced GATT Secretariat in 1995)

Country codes

Patent systems use a set of two-letter codes to identify nations. Those used in this paper are:

Code	**Country**	**Code**	**Country**	**Code**	**Country**
AU	Australia	DK	Denmark	NL	Netherlands
BE	Belgium	FI	Finland	SE	Sweden
BM	Bermuda	FR	France	TW	Taiwan
CH	Switzerland	JP	Japan	UK	United Kingdom*
DE	Germany	KR	Korea	US	USA

* Within the global patent system the code GB is used for the United Kingdom, but their patent system also covers Northern Ireland, so here the technically correct identifier UK is preferred.

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