Appendix 1

JAPANESE AND SWEDISH CORPORATE PATENTING – A COMPARATIVE ANALYSIS

A1.1. Research questions for corporate "benchmarking"

As described in Chapter 1, the core empirical study for this book consisted of a number of sub-studies. One sub-study compared publicly available patent statistics for a number of large Japanese and Swedish corporations, some results of which will be presented below.

A broad picture of the patenting profiles of the largest Japanese and Swedish corporations is given here together with a comparison of the profiles for the important pairs of actual or potential Japanese and Swedish competitors. This comparison provides an illustration of a simple "benchmarking" with respect to patenting activities without going into a detailed comparative analysis of separate business areas in the large corporations studied. Several tables of data are provided simply for the interest of readers in the corporations studied. However, more extensive elaborations on patenting statistics for benchmarking and other information purposes are possible. At the same time a great deal of care must be exercised when drawing conclusions based on patenting statistics, as described in Chapter 9. Thus, fairly elaborate descriptions of the methodology used and the caveats involved are given here for instructive purposes. This hopefully serves as a starting point for further exercises in utilizing patenting statistics per se and especially in combination with other sorts of statistics. More specifically this section highlights the following questions:

a) What is the total level and trend of patenting over time in the largest technology-based Japanese and Swedish corporations?

b) What is the width of the corporate technology base (or the extent of technology diversification) as indicated by patenting activities?

If used for benchmarking Japanese and Swedish patenting, the findings of this appendix should be viewed in relation to the findings in the other sub-studies of the overall project described in Chapter 1.[1]

A1.2 Method

A1.21 Sample design

The large Japanese and Swedish corporations in the sample were selected according to the following criteria:[2]

1. The largest corporations with respect to R&D investments in 1990 in both countries should be included.

2. Together they should constitute a significant share of the total industrial R&D in the two countries.

3. The largest R&D spenders in each of the major industrial sectors should be included.

4. A number of actually or potentially competing Japanese and Swedish corporations should be ensured.

A "corporation" is identified as a non-majority-owned entity together with its majority-owned subsidiaries. The Japanese conglomerate structure (the "keiretsu") is not considered a corporation. Thus, e.g. NEC and Sumitomo Chemical, which both

[1] This section is based on the report from one sub-study (no.2a) out of eight in the project. See Deiaco (1993), Granstrand and Sigurdson (1992), Granstrand and Sigurdson (1993) and IVA (1993).

[2] There are many methodological hazards involved in comparing corporations from nations of widely varying size, see e.g. Scherer (1975).

belong to the Sumitomo keiretsu, are treated as separate corporations. The corporations have been viewed as they were consolidated at the end of 1990.[3]

Strictly speaking, "large corporation" in the sample refers to large corporations with large R&D budgets. However, corporations with large budgets usually have large sales, so most of the major industrial corporations by sales in the two countries are included in the sample.

Large corporations, although mostly multinational, usually have an undisputed nationality, and in a few cases they may have two. The only example of the latter in the sample is the Swedish-Swiss ABB, which, however, has been included in the Swedish sample.

A1.2.1 Patent data collection

The level of patenting is indicated by a simple count of the number of patents granted each year. The USPTO data is counted according to the year the patent was published in the USA, and by the European Patent Office (EPO) according to the year in which the priority year for a patent began in Europe.[4] The EPO grants what are called EPO patents, which give patent protection in a large number of European countries, including Sweden.

European patents are not the only possible means of obtaining patent protection in European countries. The propensity to use EPO varies among companies as well as over time. The other possibilities are to apply for national patents in various countries separately via an international application or to apply for a PCT patent. The latter

[3] Whether, when and how to consolidate companies in a study like this is a major problem, in fact. First, it is not clear, at least not without a sufficiently specific purpose, whether time serial data should refer to the company as it was consolidated at the year the data refer to (what from a methodological point of view we can call "floating consolidation") or a fixed year ("fixed consolidation") and, if the latter, which year. Second, it is not an easy task to find all subsidiaries which may have patenting activities in a large corporation. Third, the names under which the patents have been assigned to a company may vary, even in spelling. Fourth, reassignments of patents occur in the US patent statistics as acquisitions, mergers and divestments of companies occur but not without time lags and errors.

[4] The so-called priority year is the 12-month period beginning at the date the first patent application for a specific invention was filed (see Glossary).

gives patent protection through specially authorized national patent offices in those PCT-associated countries that the applicant chooses to designate. The possibilities may also be combined. Thus, it is difficult to get an overview of patent protection in Europe through simple patent counts. However, it appears from the survey study that companies increasingly use the EPO. This notwithstanding, time series data for EPO patents before the mid-1980s are suffering from a start-up bias, because the EPO started in 1978 creating a time lag between the patent application filing and registration date and the patent publishing and granting date, apart from other transient lapses.

The number of patent applications over time could have been used instead of the number of patents granted. However, some applications do not result in patents, and therefore, by looking at granted patents, poor applications are filtered out.[5] Additionally, application data for US patents are more difficult to collect.

The observation period from 1978-1991 was chosen, which provides useful US statistics. As mentioned European application data is not reliable before approximately 1985, since the EPO only started its work in 1978.[6]

The patenting systems and offices worldwide are supposed to use only one level of invention when assessing patentability. This level may vary among countries, however, although gradually, international harmonization is taking place. It may also vary over time. Ideally, one would have wanted a finer scale of inventiveness, or technical quality of a patent (as definitely distinct from the economic quality of a patent), for measuring purposes. Patents vary widely with regard to their technical qualities (as they certainly do in their economic qualities). A simple patent count does not reflect these variations. To some extent, so-called citation data, i.e. data on the number of times a certain patent has been cited in other patent applications, could be

[5] It is an interesting topic in itself to see why some patent applications do not result in patents granted and how the distribution of unfulfilled requirements vary over nations, sectors, companies, technologies and periods.

[6] The US statistics in this period are not fully reliable either, since there were fluctuations in the annual number of issued patents due to budget and workload constraints at the USPTO, see Griliches (1989, 1990).

used as a quality indicator. This was done at the industry level, as described in Chapter 5, but was not broken down to the company level.

A1.2.3 Indicator design

The limitations of patent statistics and the limitations of each single indicator based on such statistics should again be noted. Therefore several indicators are generally needed, even for the specific purpose of an analysis, in order to enable a sensitivity analysis.

The sheer volume of patenting by a company indicates its propensity to patent and its patent power. In order to measure the volume of patenting, one would ideally have wanted data on the portfolio of active patents or patents in force (that is, patents granted for which annual maintenance fees are paid by the patent holder in order to keep the patent in force) for each corporation over time. But such data are very costly to collect. Corporations vary considerably in their propensity and policies for maintaining patents over time in various countries. To some extent, long periods of observation of annually granted patents may give a clue to the rough size of the total volume of a corporation's patent portfolio.

Patents may be granted in various countries in which the applicant chooses to apply, based on the same invention. Thus, patent counts are not the same as invention counts. There are various ways to distil invention counts from patent counts but they have not been pursued here.

Several studies have shown the strong impact of technology diversification upon both corporate growth of sales and corporate growth of R&D.[7] Technology diversification is defined as the broadening of a corporation's technology base into new technologies, i.e. increasing its width. Both the width and the increase in the width have an impact on sales and R&D. To indicate the width of a corporation's technology base, several indicators have been calculated. Thus, for each Japanese and

[7] See e.g. Granstrand and Sjölander (1990) and Oskarsson (1993).

Swedish corporation respectively, and for US and EPO patents respectively, the following indicators have been calculated:

n_{kt} = the number of patents granted in year t in the USPTO and by the EPO respectively, with main classification in class k in the US patent classification system and in the IPC patent classification system as used by the EPO.[8] In contrast to the US classification system, the IPC system is hierarchical with, in falling order, levels for sections, subsections, classes, subclasses etc. Here n_{kt} is a count at IPC level three.

m_t = average number of patents granted per class in year t (classes with zero patents not excluded; inactive classes in the US system are excluded, that is, the number of classes in total that are actively used by USPTO among the available classes in the system appears in the denominator of m_t).

D_t = diversity (or diversification) index in year t for the corporate patent distribution over classes, which is = $1-H_t$ where

H_t = Herfindahl's concentration ratio = $\Sigma_k p^2_{kt}$
where p_{kt} is the share of a corporation's total number of patents in year t that fall in patent class k

N_t = number of patent classes containing one or more patents granted to the corporation in year t.

G_{st} = $(n._s/n._t -1)/(t-s)$, i.e. change in number of patents granted from year s to year t, divided by number of years lapsed, thus simply indicating average annual growth in patenting between year s and t ($n._s$ denotes $\Sigma_k n_{kt}$).

The index D_t indicates the width (breadth, diversity) of corporate patenting.[9] N_t also indicates the width of patenting but in a simpler and less robust way. However, N_t cannot be compared between the USA and Europe. The width of patenting in turn is an indicator of the width of the corporation's technology base or the technological diversity (or diversification) of a corporation. (Strictly speaking, technological

[8] Note that multiple classifications of a patent are common in both systems nowadays, but there is always a single main classification. Moreover, both systems allow for multiple claims in a single patent, thus allowing to some extent the applicant in principle to lump claims together into a single patent application. Before 1987, the Japanese patent system did allow only for single claims, which to some extent explains a larger number of Japanese patents in Japan. However, when Japanese companies patent in Europe and the USA, they may lump claims together in a single patent application, which they have often done, especially after 1987.

[9] Other diversity indicators like standard deviation and entropy were used originally but are not reported here.

diversification refers to the process of increasing technological diversity, i.e. increasing the width of a technology base rather than the width itself.) Finally, G_{st} is a simple growth indicator, subjected to yearly fluctuations, however.

A1.3 Data

The following Tables A1.2 – A1.5 give the corporate patent profiles in terms of number of published patents in Europe (represented by EPO patents) and the USA[10]. Indicators of level (or volume), width of the patent base and growth of patenting have been constructed as described in the preceding section.

A few observations may be made right away. First, there are large variations between companies. Patents show a skewed distribution among the corporations, especially for Sweden, with ABB as an outstanding patentor, even if only half of its patents are considered. The top patentors are in electronics, especially in Japan.

Second, the Japanese corporations appear to focus more on the USA than on Europe in terms of volume, width and growth of US and EPO patents granted. Swedish corporations have larger patent volume and width in the USA than in Europe, but more patent growth in Europe. It is notable that Swedish corporate patenting in the USA has declined during the 1980s and the growth in Europe is modest if ABB is excluded.

Third, the patenting volume and width of Japanese corporations are much larger in general than for Swedish corporations. The question is to what extent the corporations are comparable. This will be dealt with in the next section.

[10] The assistance of M.Sc. Peter de Bellmond at the Swedish Patent Office in collecting and checking the data is gratefully acknowledged.

Table A1.1 Patenting activities by Japanese corporations in Europe and the USA

Company	n[1)]	m[1)]	D[2)]	N[2)]	G[3)]
Europe[4)]					
Canon	141	1.195	0.852	17	7.40
Fujitsu	1468	12.441	0.819	42	-8.20
Hitachi	2265	19.195	0.933	75	20.80
Honda	240	2.034	0.836	22	9.40
Kirin Brewery	25	0.212	0.746	8	0.80
Kyocera	5	0.042	0.640	3	0.40
Matsushita	996	8.441	0.913	53	-3.00
Mitsubishi Heavy Ind.	1629	13.805	0.949	81	28.00
NEC	909	7.703	0.905	61	12.40
Nippon Denso	4	0.034	0.625	3	0.00
Nippon Seiko	5	0.042	0.560	3	0.00
Nippon Steel	222	1.881	0.873	27	3.20
Nissan	676	5.729	0.860	47	-11.40
OJI Paper	58	0.492	0.716	10	0.60
Sanyo	117	0.992	0.840	21	-1.00
Sharp	264	2.237	0.892	31	10.40
Shimizu	69	0.585	0.878	21	2.80
Sony	785	6.653	0.717	31	24.00
Takeda	323	2.737	0.573	15	1.00
Tokyo Electric Power	103	0.873	0.632	10	2.60
Toshiba	2096	17.763	0.877	62	6.20
Toyota	580	4.9153	0.838	38	20.4
USA[5)]					
Canon	7009	18.300	0.927	140	70.00
Fujitsu	2634	6.877	0.953	123	20.80
Hitachi	10505	27.428	0.982	241	60.30
Honda	2949	7.700	0.897	138	28.70
Kirin Brewery	70	0.183	0.939	30	1.20
Kyocera	135	0.352	0.952	48	1.20
Matsushita	4000	10.444	0.978	211	22.50
Mitsubishi Heavy Ind.	2	0.005	0.500	2	0.00
NEC	3286	8.580	0.964	114	37.10
Nippon Denso	18	0.047	0.877	13	0.20
Nippon Seiko	291	0.760	0.852	44	5.90
Nippon Steel	739	1.930	0.903	82	3.90
Nissan	3948	10.308	0.926	156	21.10
OJI Paper	53	0.138	0.840	16	0.50
Sanyo	944	2.4648	0.973	145	8.5
Sharp	2468	6.444	0.960	141	26.50
Shimizu	81	0.211	0.894	32	1.20
Sony	3003	7.841	0.900	123	7.50
Takeda	753	1.966	0.879	61	4.70
Tokyo Electric Power	322	0.841	0.899	52	3.30
Toshiba	8356	21.817	0.978	207	68.90
Toyota	3403	8.885	0.917	156	-4.00

Notes:

1) n and m are level indicators.

2) D and N are diversity indicators (indicating directly the width of corporate patenting and indirectly the width or diversity of the corporate technology base).

3) G is a growth indicator, equal to the annual average change in number of patents granted in 1980 and 1985 for Europe, and in 1980 and 1990 for the USA.

4) Granted EPO patents filed 1977-1989

5) Granted USPTO patents published 1979-1991

Table A1.2 Patenting activities by Swedish corporations in Europe and the USA

Company	n[1)]	m[1)]	D[2)]	N[2)]	G[3)]
Europe[4)]					
ABB	1014	8.593	0.900	60	8.20
AGA	14	0.119	0.857	9	0.60
Alfa-Laval	100	0.847	0.815	19	1.80
Astra	115	0.975	0.629	11	1.20
Atlas Copco	70	0.593	0.800	15	-1.40
Electrolux	180	1.525	0.895	35	2.80
Ericsson	177	1.500	0.810	23	1.80
Gambro	70	0.593	0.800	15	-1.40
Nobel	147	1.246	0.899	31	6.20
Procordia	79	0.669	0.774	7	2.60
SAAB	48	0.407	0.891	17	1.00
Sandvik	50	0.424	0.854	20	-0.60
SCA	7	0.059	0.612	4	0.40
Skanska	4	0.034	0.375	2	-0.60
SKF	150	1.271	0.522	17	1.40
SSAB	15	0.127	0.844	8	-0.20
STORA	2	0.017	0.500	2	0.20
Swedish Ordnance	30	0.254	0.609	5	1.20
Televerket (now Telia)	7	0.059	0.735	5	0.00
Tetra Pak	181	1.534	10.456	18	0.40
Vattenfall	0				
Volvo	74	0.627	0.847	18	1.00
USA[5)]					
ABB	2010	5.248	0.979	167	0.50
AGA	66	0.172	0.959	35	-0.70
Alfa-Laval	263	0.687	0.914	57	-0.80
Astra	191	0.499	0.813	35	0.00
Atlas Copco	173	0.452	0.917	46	-1.60
Electrolux	285	0.744	0.959	78	1.20
Ericsson	362	0.945	0.955	69	1.10
Gambro	96	0.251	0.835	25	-1.00
Nobel	770	2.010	0.959	104	-2.40
Procordia	155	0.405	0.898	31	0.20
SAAB	138	0.360	0.949	52	0.40
Sandvik	180	0.470	0.950	51	1.10
SCA	14	0.037	0.806	8	-0.40
Skanska	3	0.008	0.667	3	0.00
SKF	667	1.742	0.838	82	-1.00
SSAB	16	0.042	0.875	11	0.10
STORA	17	0.044	0.734	8	-0.10
Swedish Ordnance	21	0.055	0.834	11	0.10
Televerket (now Telia)	3	0.008	0.667	3	0.10
Tetra Pak	262	0.684	0.921	48	0.80
Vattenfall	0				
Volvo	234	0.611	0.948	58	-0.70

Notes:

1) n and m are level indicators.

2) D and N are diversity indicators (indicating directly the width of corporate patenting and indirectly the width or diversity of the corporate technology base).

3) G is a growth indicator, equal to the annual average change in number of patents granted in 1980 and 1985 for Europe, and in 1980 and 1990 for the USA.

4) Granted EPO patents filed 1977-1989

5) Granted patents published 1979-1991

A1.4 Comparative analysis

In this section, pairs of actually or potentially competing Japanese and Swedish corporations will be compared. The sole criterion for pairing the corporations is that they have at least one major product area in common, regardless of size of the corporations in terms of sales or R&D budgets. Since the corporations are already large by any standard, and mostly multinational, a common product area is the major factor determining the likelihood that they have met or will meet in the marketplace in Europe and/or the USA. Table A1.3 gives a comparison of the patent volume and patent width indicators for the pairs of competitors and Figure A1.1 gives some more detailed illustrations. It is immediately apparent that there is, with a few exceptions, a consistent pattern of larger absolute volume and width of Japanese corporate patenting activities in both Europe and the USA. However, apart from the general caveats and possible sources of statistical errors mentioned above, there are a number of additional considerations with regard to possible objections to this type of comparison.

When using EPO patents or European patenting statistics in general for comparing Japanese and Swedish companies, one should keep in mind that Sweden belongs to Europe while Japan does not. To the extent that a company's propensity to patent on its home market and its neighbouring markets might be expected to be higher than on other markets, European patenting statistics give a positive bias to Swedish companies compared to their Japanese counterparts, everything else being equal. From this point of view, US patenting statistics should give a more unbiased comparison between Japanese and Swedish companies. Moreover, the US patent statistics cover all patents in the USA with no specific transient effects as those arising from the start-up of EPO. Moreover, the various ways or routes to receive patents in Europe are not fully covered by EPO statistics. However, the general patterns found in EPO statistics are confirmed by the US statistics.

Table A1.3 Comparison of corporate patenting activities in Europe and the USA

Corporate pair[1)]	Sector	Sales Ratio	Patent volume ratio (n-ratio)		Patent width ratio (N-ratio)	
		(1991)	EP[2)]	US[3)]	EP[4)]	US[5)]
Hitachi/ABB	Electrical	5.5	2.2	5.2	1.3	1.4
Toshiba/ABB	Electrical	6.7	2.1	4.2	1.0	1.2
Takeda/Astra	Chemical	2.4	2.8	3.9	1.4	1.7
Sanyo/Electrolux	Mechanical	0.9	0.7	3.3	0.6	1.8
NEC/Ericsson	Electrical	3.7	5.1	9.0	2.6	1.6
Shimizu/Skanska	Construction	2.7	17.2	27.0	10.5	10.7
Nippon Steel/SSAB	Mechanical	11.8	14.8	46.2	3.4	7.5
Nissan/Volvo	Mechanical	3.4	9.1	16.6	2.6	2.6
Toyota/Volvo	Mechanical	4.5	7.8	14.3	2.1	2.6

Notes:

1) The corporations paired have at least one major product area in common.

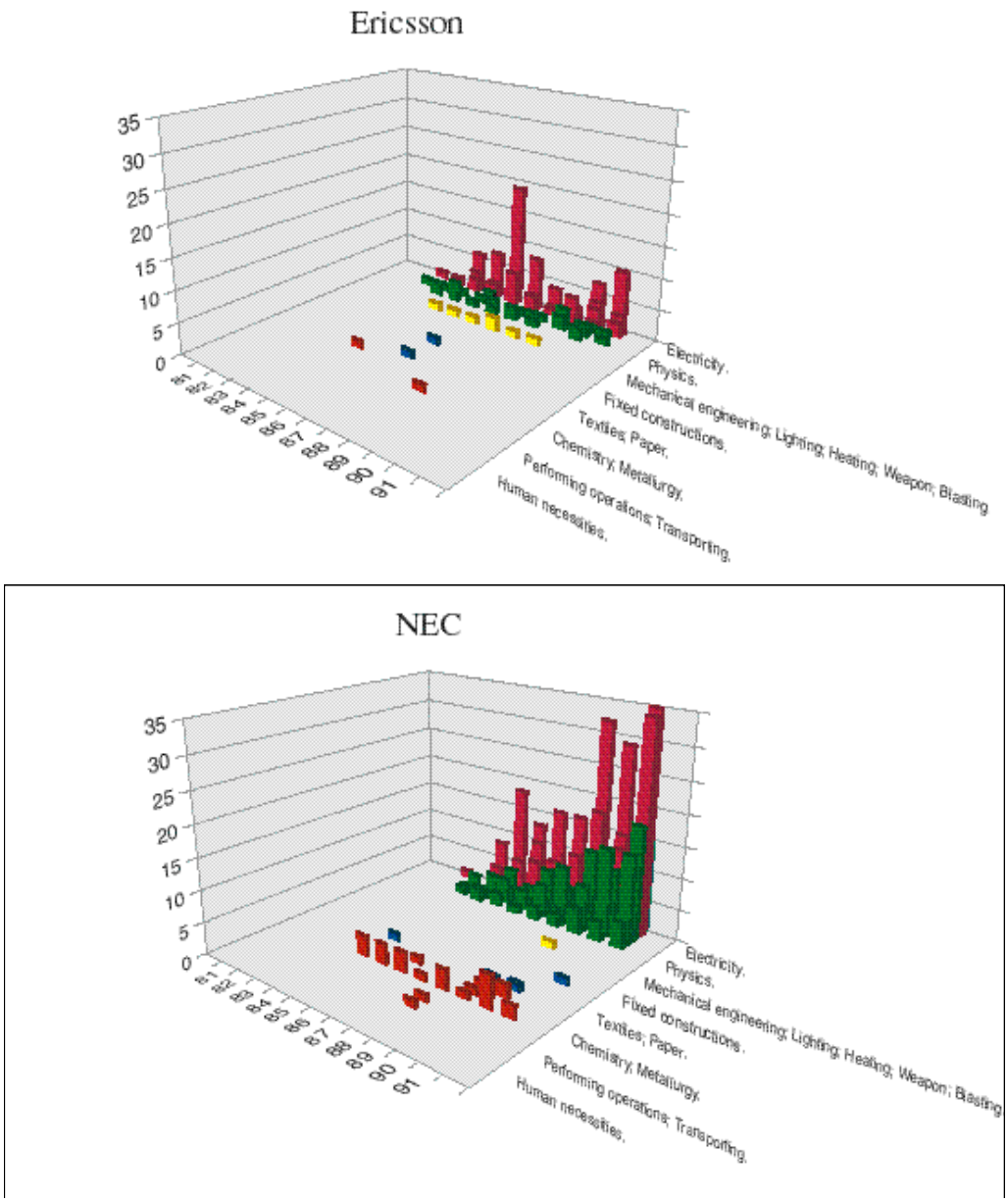
2) Ratio of number of EPO patents with priority 1977–1989 for the two corporations in the pair.

3) Ratio of number of US patents published 1979-1991.

4) Ratio of number of EPO patent classes with more than one patent with priority 1977–1989.

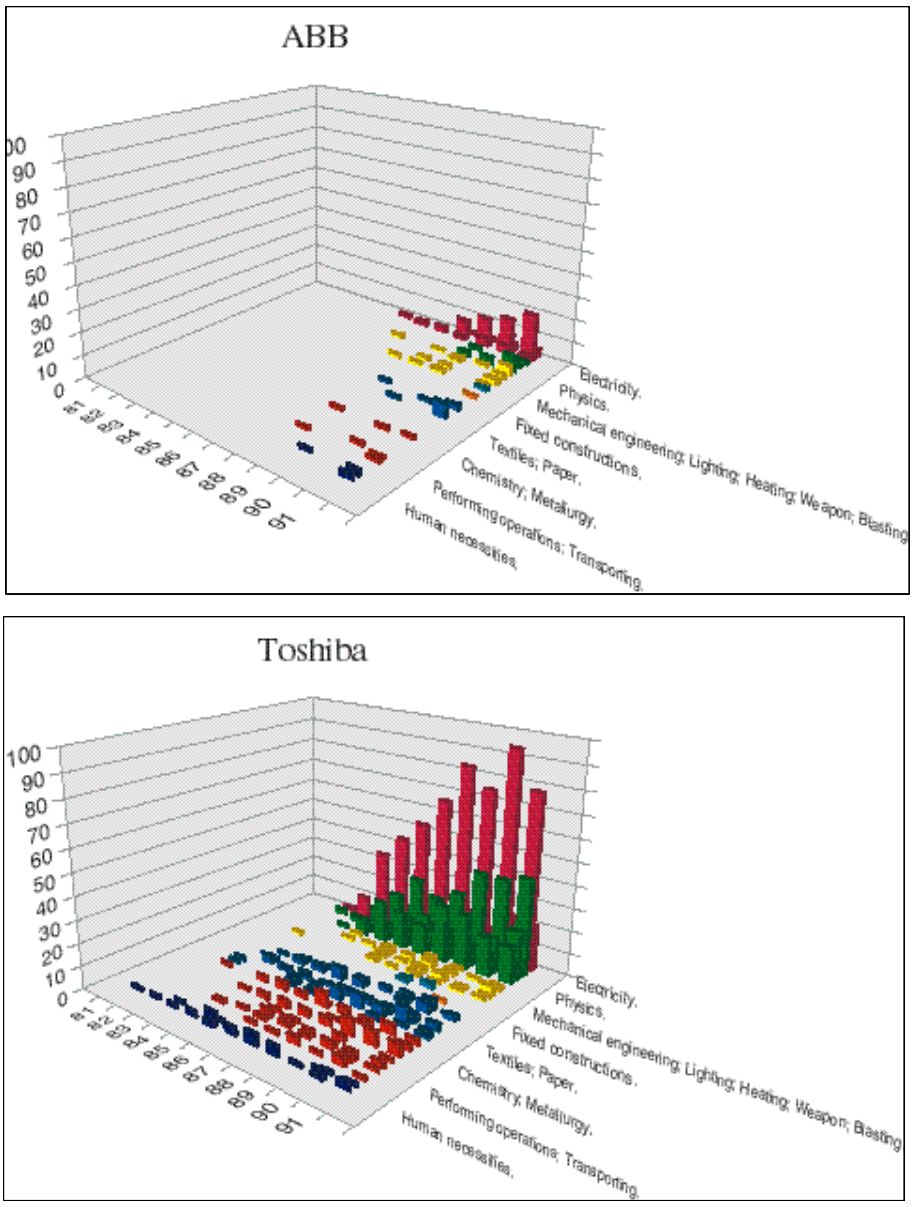
5) Ratio of number of US patent classes with more than one patent published 1979-1991.

Figure A1.1a The growth of patent portfolios (number of granted patents) in Swedish and Japanese companies (EPO), 1981-1991



Categories:	
A Human necessities	E Fixed constructions
B Performing operations; Transport	F Mechanical engineering; Lighting; Heating; Weaponry; Blasting
C Chemistry; Metallurgy	G Physics
D Textiles; Paper	H Electricity

Figure A1.1b The growth of patent portfolios (number of granted patents) in Swedish and Japanese companies (EPO), 1981-1991 (cont.)



Categories:

A Human necessities	E Fixed constructions
B Performing operations; Transport	F Mechanical engineering; Lighting; Heating; Weaponry; Blasting
C Chemistry; Metallurgy	G Physics
D Textiles; Paper	H Electricity

Secondly, a general caveat when comparing Japanese and Swedish patenting statistics concerns differences in the respective patent systems. As mentioned earlier, until 1987 the Japanese patent system did not allow more than a single claim in a patent application while the European, including the Swedish, patent system allowed multiple claims. In the latter system, companies have had the possibility to file a broad patent application with many claims while the corresponding application in the Japanese system would have to be split up in many applications, one for each claim. Despite the adoption of the multiple-claim system in Japanese patent law, it might be expected that it would take time until the companies adopt the new system in practice. Furthermore, nothing prevents companies from filing single-claim applications, either in Japan or in Europe although such a practice could jeopardize individual applications[11]. Companies could moreover lower their patent filing and maintenance cost through using multiple claims. This is what many Japanese companies often have done when patenting in Europe and the USA. Thus, the Japanese and Swedish companies can by and large as a first step be compared using this methodology regarding their number of patents in Europe and the USA and increasingly so after 1987. In addition, it must be kept in mind that only a minor share of the Japanese corporations' patents filed in Japan are used for applications in Europe and the USA, and this share is smaller than the corresponding share for the Swedish corporations.

Still, it may be objected that Japanese company patents in Europe have a more narrow scope on an average than Swedish company patents and, indeed, Western company patents as a whole. Interviews with Japanese and Swedish companies indicate that this has been and still is in fact the case, although the difference might decrease in the future. However, this matter pertains to the quality of patents, apart from the mere quantity. It is naturally desirable to take the quality into account as well by using some kind of weighting procedure in the quantitative analysis of patent statistics. To some extent this is possible through the use of the number of times a patent has been cited in other patent applications, as mentioned earlier. Another

[11] Earlier applications could be cited against later ones as prior art. Also the level of invention of individual claims could be insufficient.

possibility is to look at the age of cited patents in the patent applications, as done by Narin (1991) and others.

The breadth of the patenting activities is much higher for Japanese companies, in both Europe and the USA. This pattern is consistently indicated by the breadth indicators D and N (as well as by standard deviations and entropy measures, although not shown here). Thus, there is no need at this level of analysis to correlate the indicators internally and qualify the interpretations based on differences in indicator design.

Regarding the higher volumes of patents granted for Japanese corporations, these do not directly indicate a larger patent power, as would a larger portfolio of patents in force. As mentioned earlier, the comparisons are based only on data for granted patents, which do not give the size of the portfolio of active patents of the companies. Companies do differ in their propensity for keeping patents in force by paying maintenance fees. The vintage structure of patent portfolios differs over companies and industries. The table data here give only the inflow to the company patent portfolios over a period of time, which is actually shorter than the patent lifetime of 20 years. There is no indication that Swedish companies tend to keep their granted patents in force longer than Japanese companies on average[12]. Nor is there any indication whatsoever that Swedish companies in general had larger patent portfolios than their Japanese counterparts at the beginning of the period under observation, quite the contrary. If the patenting propensity of a company is persistently higher than for another company over a long period of time, its resulting patent portfolio will grow relatively larger if the companies keep their patents in force for similar times.

A natural objection is that the companies are not comparable since they might differ very much in terms of size of sales and/or size of R&D. Two points may be made to counter this objection. First, the Japanese and Swedish companies in the

[12] The survey data showed similar average length of time patents were kept in force, see Table 5.14, which shows that average number of years a patent is kept in force is 10.5 for the Japanese and 11.4 for the Swedish corporations. The vintage profiles (distributions of patent ages at expiration) differed, however.

sample are all large by any standard and the comparison of competitors do not differ by factors of 10 or more, regarding either sales or R&D (with some exception). Second, when comparing two companies operating in a similar product area, their size in various respects matters for their competitive strength. Thus, the size of their sales and R&D as well as the size of their patent portfolios should, in fact, be compared together with other indicators (regarding product quality etc.) when judging the competitive strength of the corporations (as they are consolidated, indicating the level at which they are internally coordinated). [13]

When the purpose of benchmarking a competitor is to judge the market power derived from patents (e.g. the probability of being able to block a competitor), a comparison of the patent portfolios is justified as one indicator. A common weakness of such comparisons, however, is that product areas and patent classes do not match very well. It is, moreover, difficult to sort out those patents, which relate to a specific product area.[14] Some comparisons at a finer level of detail in the patent classifications were made in the study, but did not reveal any major deviations from the general pattern above. It is seldom the case that one corporation in the pair has a strong patent profile in one patent area while the other has a strong patent profile in another patent area. Rather, the Japanese corporations commonly are strong in areas where their Swedish counterparts have most of their patents and are also strong in other patent areas. It could then be argued that patents in these other areas are less relevant in the comparison. For example, one could argue that many Japanese corporations are operating in electronics, thereby making them less comparable to Swedish mechanical engineering corporations. However, electronics is a technology of major relevance to competitiveness in the engineering industry in general, as has been described by

[13] Note that if there is a patent dispute, the relative sizes in some sense of the patent holders are legally irrelevant. Nevertheless, small companies usually attract more sympathy than large companies in a dispute.

[14] These difficulties are illustrated, e.g. in Scherer (1982). To make a general matching of patent classes to product areas is particularly difficult and will almost always involve sources of error, even at fine levels of classification. It is possible to relate specific patents to specific products, but this involves considerable work as a rule. Besides, a patent may relate to many products and a product may be based on many patents (products are multi-technology based and increasingly so, see Chapters 4 and 5). Thus, there is a many-to-many correspondence not only between patent classes and product classes but also between individual patents and products.

Kodama (1986). Of course, not all technologies have synergistic relations and to some extent the argument is valid. For example, when Nippon Steel entered biotechnology (as was somewhat voguish in the Japanese steel industry for a period in the 1980s), the competitive strength of Nippon Steel relative to the Swedish steel company SSAB in the steel industry did not actually increase.

In order to take this into account, one could adjust for the larger width of patenting in the Japanese corporations by simply comparing the n-ratios (patent volume ratios) and N-ratios (patent width ratios) in Table A1.3, which is a way of normalizing the data with respect to width of patenting. This kind of normalizing would disregard technological synergies and thus in fact favour the hypothesis that Swedish corporations have stronger profiles but concentrated in fewer areas. However, the n-ratio is generally significantly larger than the N-ratio, which does not support this hypothesis.

A1.5 Possible causes and effects of differences in patenting

Causes

What is behind the consistent differences in patent volume, width and growth between Japanese and Swedish corporations, as observed in the preceding sections? A full answer cannot be given here, but a few clues are offered. (A more comprehensive treatment is given in Chapter 5.) Some, though far from all, differences may be explained by the larger size of R&D budgets and IP departments and the wider range of product areas in the Japanese corporations. However, there are a multitude of factors behind the statistical differences that relate to historical differences in what can be called the patent cultures in Japan and Sweden, as described in Chapters 5 and 8. To repeat a bit here, Japan has consciously built up a patent culture, both at the national level and in industry, through the long process of catching up technologically with the West. In this process the Japanese had to learn several skills (e.g. how to avoid Western patents). At the same time, taking out patents in "holes" not covered by Western patents became prestigious for individuals, companies and the nation, and was a sign of gradually coming on par with the West. The fact that Japan is poor in

natural resources has turned her eyes, hopes and energies on developing intellectual resources and securing intellectual property rights, not least in the long-run preparation for securing foreign input and output markets. The pursuit of IPRs has traditionally not been particularly aggressive, however, especially not against the West, as this could have jeopardized the generally favourable conditions for transferring technology from the West to Japan, which prevailed for many decades after World War II (see Chapter 5).

Patents as legal instruments are designed to legally convey the right to exclude others. This makes them work like weapons in a legal war, which to some extent justifies the use of military analogies. When the US "Japan-bashing" sentiments grew during the 1980s, induced by Japan's increasing economic success on US markets, IPR issues came to the forefront in US national and corporate policy-making. At the same time, a new court for patent appeals in the USA was created in 1982, and IPRs were upgraded relative to anti-trust concerns (see Chapter 2). This resulted in a wave in the late 1980s of aggressive moves by US corporations and authorities in the IPR area against Japan and Asian NICs, e.g. claiming infringement penalties and increased royalties for US patents. Since, by design, there are few good alternatives to fighting patents with patents,[15] this resulted in a patent war with e.g. escalating patent applications. This "war" spread to Sweden but not to the same extent, and the Swedish corporations have often been slow to respond although, in all fairness, a number of Swedish corporations have in the 1990s reassessed their patent strategies and upgraded their patenting activities. The effects of the patent war should not be exaggerated, however. The most important explanation behind Japanese-Swedish patenting differences is still that the patent culture in large Swedish companies is weak compared with their Japanese counterparts for historical and managerial reasons. (See Chapter 8 for more details about patent culture.)

[15] Cf. the response strategies in case of patent blockage, described in Chapter 7. Several of these response strategies are in fact dependent upon bargaining power based on patents (patent power).