Employment Generation Potential of New, Technology-Based Firms During a Recessionary Period: The Case of Finland

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ABSTRACT. This article analyzes the employment generation potential of new, technology-based firms during a recessionary period. The empirical data is from Finland, a country that was hit particularly hard by the economic recession between years 1990 and 1993. In spite of the recession, the number of NTBFs (new, technology-based firms) rose by 17% from 1986 to 1993. In traditional manufacturing industry branches, the overall employment fell by as much as 33% during the same period. Alternative hypotheses to explain the increase in the importance of NTBFs are presented and discussed in the light of research findings. Both flexible specialization and recession-push hypotheses receive support in the empirical data.

1. Introduction

New, technology-based firms (NTBFs) provide an attractive focus for industrial and technology policy. This is because of two main reasons. First, NTBFs are perceived to contribute to economic growth and to social well-being in many ways. Second, it is generally considered possible to actively catalyze the formation of NTBFs through hands-on policy measures (European Commission, 1995; European Commission, 1993; Clinton and Gore, 1993).

The empirical analysis of this paper will enable us to see how NTBFs fare during periods of economic downturn. In the early 1990's, Finland experienced the deepest peacetime economic recession experienced by any modern industrialized country since World War II. From year 1990 to year 1992, the GNP of Finland fell by nearly 20%. In GNP terms, this fall is more drastic than the one experienced in the U.S.A. during the Great Depression of the 1930's. Furthermore, Finland, as a leading country in terms of the diffusion of information and communication technologies (Kleinwort-Benson report, 1996; Network Wizards, 1996), provides an interesting example of how the developments towards the Information Society might be reflected in the population of NTBFs.

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2. Economic contributions of NTBFS

A number of explanations have been proposed for the rapid increase in the number and economic importance that has been observed among NTBFs since the 1960's. Different theory frameworks tend to emphasize slightly different aspects, and thus to give slightly differing pictures of their economic contributions. These frameworks can be classified, for example, as follows[1]

1. Schumpetarian explanation: New, technology-based firms as agents of creative destruction
2. Flexible specialization explanation: New, technology-based firms as resource-dependent flexible specializers
3. Innovation system explanation: New, technology-based firms as innovation assets, or as outcomes of the process of vertical disintegration of R&D
4. Industrial organization explanation: New, technology-based firms as an indication of the changing balance between internal and external co-ordination costs

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The Schumpetarian explanations for the NTBF phenomenon can be traced back to his early Mark I model of innovation (Schumpeter, 1934) and the contribution of the neo-Schumpetarian economists (Freeman and Perez, 1988; Freeman, 1982). In this explanation, the primary role of NTBFs takes the form of introduction of new innovations into the realm of economic life, and that of the creation of new industries and new economic wealth through this process. The Schumpeterian explanation predicts particularly intensive emergence rates ("swarming" (Freeman, 1982)) for new, technology-based firms during the early stages of a new technoeconomic paradigm whereas at the consolidation stage, the advantages of specialization become more important than the economies of specialization (Freeman and Perez, 1988).[2]

The flexible specialization (or post-Fordism) explanation, the innovation system explanation and the industrial organization explanation contend that the co-operation between firms is in the increase due to the emergence of new communication and information technologies. This development should alter the balance between economies of scale and scope in a way that opens new niches for small and medium sized firms to exploit. The flexible specialization explanation attaches the NTBF to a manufacturing network (Piore and Sabel, 1984; Rothwell, 1983, 1989; Storper and Walker, 1989; Saxenian, 1991; Storper and Harrison, 1991; Turok, 1993), whereas the innovation system explanation views the NTBFs a result of the process of vertical disintegration of R&D, in which corporations increasingly outsource non-core R&D activities (Kline and Rosenberg, 1986; Autio, 1995) The flexible specialization and innovation system explanations also emphasize the importance of regional agglomeration benefits for NTBFs, for the natural reason that geographical proximity is important when accessing external resources (Garnsey et al., 1994; Donckels and Segers, 1990; North and Smallbone, 1995). The industrial organization explanation is close to the flexible specialization option, but explains the same phenomenon essentially from the perspective of costs related to the control of economic activities. Brynjolfsson (1994) Brynjolfsson et al. (1993) and Suarez-Villa (1994), for example, find evidence suggesting that information and communication technologies are altering the balance of internal and external coordination costs, in such a way that the attractiveness of the outsourcing option increases.

Despite the narrow scope of available data, the above discussion gives some pointers for empirical analysis. Except for the Schumpetarian explanation, all of the above explanations imply an increased degree of networking among NTBFs. Because the activities of the specialized NTBFs are based upon flexible specialization and the innovative combination of internal and external resources (Autio, 1996), the pursuit of profitability replaces the pursuit of market dominance as the overriding concern of the NTBF. In other words, if we are able to observe rapid growth in the number of NTBFs, and a rapid increase in their size, then the Schumpetarian explanation is supported. If, however, no rapid growth is observed and the division of labor between specialized technology suppliers and the system integrator is real, then the networking explanations can be considered supported.

A good way to assess the networking explanations is by checking the value added generated by firms in different size classes. If the relationship between value added and annual sales is high, then the value creation in the firm is 'pure'. If, on the other hand, the ratio between value added and annual sales is low, then the firm outsources a considerable portion of its output. Unfortunately, sufficiently detailed data on the value added generated by firms in different size classes is not available in Finalnd, largely because of confidentiality reasons. In our analysis, we are forced to use the value of annual sales per employee as a (admittedly crude) proxy.[3] If large systems integrator firms are using specialized NTBFs as technology suppliers, then the value of sales per employee should be higher for the systems integrator combining several inputs from external and internal sources and integrating them into a systemic product.

With a special note on the economic impact of NTBFs during a recessionary period, Jones-Evans and Westhead propose two further explanations, or hypotheses, to explain the increase in the number of NTBFs (Jones-Evans and Westhead, 1995). These they label as recession-push and redundancy-push hypotheses.[4] The key idea behind the first hypothesis is that during reces-

sionary periods, people might be pushed to start their own firms, due to shortage of jobs in existing firms. Consequently, if we are able to observe a rapid increase in the formation of new firms and only a moderate decrease in the employment offered by large firms, then the recession-push hypothesis might be considered supported. The key ideas behind the second hypothesis is that during recessionary periods, established firms might be inclined to 'stick to the knitting', that is, cut off non-core businesses by encouraging management buy-outs and assisted spin-outs. If this hypothesis is valid for Finland, we should then be able to see an increase in the number of small firms, combined with a drastic drop in the employment offered by established firms.

3. Review of empirical data

3.1. *Compilation of empirical data*

The empirical data analyzed in the present study was extracted from the databases of Statistics Finland. The high technology sectors were defined using an application of the NACE industry classification.[5] The database used in the present study focuses on two points of time only, on years 1986 and 1993.[6] The year 1986 was the year when the bubble economy phenomenon was reaching its peak in Finland, while the year 1993 was one of the most depressing years of the economic recession. In order to get an understanding of the performance of the new, technology-based firms during an economic recession, the high technology sectors are compared against all industrial manufacturing and industrial services sectors.[7] In the following analysis, this comparison group is referred to as 'low technology sectors' or simply as 'others'. Note that the comparison group does not include non-industrial sectors, such as agriculture, commerce, and, for example, personal services.

3.2. *Number of firms in 1986 and 1993*

The high technology sectors in Finland experienced a rapid growth during the years 1986–1993. During this period, the number of firms in these sectors increased by 42%, while the number of all industrial firms experienced a decline of 9%. These changes indicate a sharp increase in the relative importance of high technology sectors during the economic recession. If one takes the total stock of firms in manufacturing industries, their number remained stable. However, the share of NTBFs of all firms operating in industry sectors has grown from 19% in 1986 to 27% in 1993.

The table shows that, in particular, the number of technology-based micro firms has increased substantially. A micro firm is a firm that employs less than 10 employees. In spite of the severe economic recession of the early 1990s, the number of technology-based micro firms increased by 55%. In low-tech sectors, the number of micro firms fell by 9%. On the other hand, the number of large companies employing more than 1,000

TABLE I
The number of firms in high tech and in low tech sectors in 1986 and 1993

Size class	High-tech sectors		Change	Low-tech sectors		Change
	1986	1993		1986	1993	
0–4 employees	2,434	3,968	63%	11,144	10,487	–6%
5–9 employees	678	853	26%	1,555	1,626	5%
10–19 employees	415	365	–12%	1,449	1,035	–29%
20–49 employees	230	196	–15%	1,225	905	–26%
50–99 employees	70	89	27%	413	343	–17%
100–199 employees	39	45	15%	257	245	–5%
200–499 employees	28	36	29%	152	86	–43%
500–999 employees	12	6	–50%	41	54	32%
1000– employees	7	11	57%	56	43	–23%
Totals	3,913	5,569	42%	16,292	14,824	–9%

persons also went up from 7 to 11, incidentally representing almost exactly the same percentage increase, 57%. It is probable that the rapid growth in the smallest size classes is at least partly due to the rapid relative growth in the largest size class. This is to be expected, if the networking explanations for the NTBF phenomenon are to be believed.[8]

The relative growth rate of the number of medium-sized technology-based firms turned out to be more modest in nature. The number of firms employing from 10 to 50 employees has actually dropped during the period from year 1986 to year 1993. Our guess is that this drop, in addition to the recession, is also due to the acquisition of firms in this size class in particular. In an earlier study, we found that the fraction of independent firms in high technology sectors starts to drop sharply after the firm passes the size barrier of 10 employees. This drop is probably partly due to the fact that growth eats capital, partly due to the fact that small firms often have difficulties in accessing distribution channels. The relative shares of independent and non-independent firms in Finnish high technology manufacturing sectors are shown in Figure 1 (Laamanen and Autio, 1996).

The rapid increase in the number of very small firms (from 0 to 4 employees) seems to support the recession-push hypothesis, as put forward by Jones-Evans and Westhead. This conclusion is supported by the fact that the unemployment rate of university engineers increased from 1% in 1990 to 7% in 1993 while the unemployment rate for engineers with Bachelor's degree was close to 20% at the end of this time period (Autio and Aalto, 1996). It is probable that also the 'redundancy-push' hypothesis, as proposed by Jones-Evans and Westhead, has played a role in the rapid increase of small firms in high technology sectors. This conclusion is supported by an analysis of the development of the number of employees in different size classes of firms.

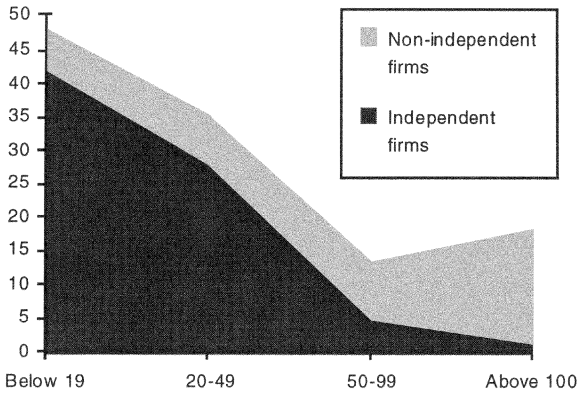

Figure 1. Medium-sized firms in high technology manufacturing sectors in Finland in 1994, classified according to the number of employees. Note that the figure indicates the absolute numbers in the sample, not the relative numbers.

Tables II and III show how the number of firms has changed in different industry sectors from year 1986 to year 1993. The highest growth occurred in high technology services. The three highest growth sectors in terms of the number of firms were computer programming services (+702 firms), construction technical services (+409 firms), and machine and process technical services (+386 firms). In all these sectors, the highest growth took place in the smallest size classes, in firms with less than 20 employees, see Table II. The hardest hit sectors were the technical planning and consulting services (–110 firms), electronic household appliances (–83 firms), and in computer services (–28 firms).

Of the hardware sectors, the highest growth was recorded in instruments and fine-mechanical apparatus (+160 firms) and in electronic and communications equipment (+61 firms). In these sectors, too, the growth can be largely attributed to small firms, the number of which increased by 148 firms and 49 firms, respectively. These two sectors, as well as the computer programming sector, testify the rapid increase in the telecommunications cluster in Finland, with the Nokia Corporation pulling small firms to growth.

Large firms with more than 1,000 employees have particularly increased their number in data processing machinery and office equipment, instruments and fine-mechanical apparatus, and in program transmission sectors. The impressive relative growth rates in program transmission services (+1,000%), in other data transmission services (+400%), in rubber (+200%), and in other data processing services (+200%) reflect the emergence and consolidation of new high technology sectors in Finland. Note that the large relative increases are due to the relatively small absolute number of firms in these sectors.

TABLE II
Number of firms in high technology sectors 1986–1993, firms with 19 employees or less

Industry sector (TOL 88 classification)	1986 firms with 0–19 employees	1993 firms with 0–19 employees	Absolute change	Relative change
1830 Resins and plastics	5	13	8	160%
1840 Rubber	1	1	0	0%
1870 Pharmaceutical products	4	8	4	100%
2610 Data processing machinery and office equipment	26	28	2	8%
2620 Electronic and communications equipment	173	222	49	28%
2630 Electronic household appliances	232	154	–78	–34%
2640 Instruments and fine-mechanical apparatus	464	612	148	32%
5810 Telephone operator services	12	18	6	50%
5820 Other data transmission	3	14	11	367%
5830 Program transmission	1	10	9	900%
7210 Computer services	121	97	–24	–20%
7220 Computer programming services	413	1,099	686	166%
7230 Data bank services	18	19	1	6%
7290 Other data processing services	26	109	83	319%
7120 Construction technical services	1,367	1,817	450	33%
7130 Machine and process technical services	248	619	371	150%
7190 Other technical planning and consulting services	377	275	–102	–27%
86 Research and development	36	61	25	69%

TABLE III
Total number of firms in high technology sectors, all size classes

Industry sector (TOL 88 classification)	1986 all size classes	1993 all size classes	Absolute change	Relative change
1830 Resins and plastics	9	20	11	122%
1840 Rubber	1	3	2	200%
1870 Pharmaceutical products	14	17	3	21%
2610 Data processing machinery and office equipment	34	36	2	6%
2620 Electronic and communications equipment	204	265	61	30%
2630 Electronic household appliances	249	166	–83	–33%
2640 Instruments and fine-mechanical apparatus	493	653	160	32%
5810 Telephone operator services	55	56	1	2%
5820 Other data transmission	3	15	12	400%
5830 Program transmission	1	11	10	1,000%
7210 Computer services	153	125	–28	–18%
7220 Computer programming services	456	1,158	702	154%
7230 Data bank services	19	23	4	21%
7290 Other data processing services	38	114	76	200%
7120 Construction technical services	1,460	1,869	409	28%
7130 Machine and process technical services	280	666	386	138%
7190 Other technical planning and consulting services	403	293	–110	–27%
86 Research and development	40	67	27	68%

3.3. *Employment generation in 1986 and 1993*

Despite the severe recession, the number of people employed by NTBFs actually increased by 17% from 1986 to 1993. This positive development is in sharp contrast with the development in the 'low' technology sectors. The severity of the recession is illustrated by the fact that the employment erosion in the 'low' technology industrial sectors was as high as 33%. Put together, these figures mean that the total employment in all industrial sectors in Finland fell by 26% from year 1986 to

1993. The progress of high technology sectors thus was not sufficient to compensate for the job erosion in low technology sectors. During the recession, the share of people employed in high technology sectors increased from 13% to 17% of the total workforce in all industrial sectors in Finland. The development of the number of employees in high technology and in low technology sectors is illustrated in Table IV.

The increase in employment was particularly steep among technology-based micro firms employing less than 10 employees. The overall employment generated by technology-based micro firms increased by 38% during the years 1986–1993, and they accounted for 33% of the workforce employed by all industrial micro firms by the end of the year 1993. Also the large technology-based firms have managed to increase their number of employees by 45% while the overall employment generated by large companies in low-tech sectors was more than decimated, the decrease being as drastic as 55%.

The flexible specialization explanations for the NTBF phenomenon seem to receive support from the last column in Table IV. The last column in Table IV shows the gross sales generated per employee in different size classes in high technology sectors. The table indicates that the amount of sales per employee generated in the largest size class (+1,000 employees) is more than four times higher than that of the other size classes. This drastic difference gives reason to suspect that an important fraction of the value added generated in the smaller size classes is actually transferred as inputs into the complex product systems maintained by a few large systems integrator firms, such as the Nokia Corporation. If one takes a look at the more successful SMEs in the OTC list of the Helsinki Stock Exchange, one will be surprised by the large number of SMEs that actually act as subcontractors to Nokia Corporation.

In the light of findings presented in Table IV, the most important potential of the NTBF sector seems to be in employment generation. Table IV shows that high technology firms, that employ less than 500 employees, employed 70% of the overall workforce in these sectors, while generating only 25.7% of the total annual sales. The 7 firms in the largest size class, while representing only 0.2% of the total number of firms and employing 34.6% of the overall workforce, generated 71.4% of the overall sales in these sectors.

The sector specific changes in the number of employees are presented in Tables V and VI. In Table V, the sector-specific employment changes are presented for firms with less than 20 employees. In Table VI, the sector-specific employment changes are presented for firms of all size classes.

The sectors recording the largest absolute increases in employment were the electronic and communications equipment (+3,960 employees), computer programming services (+3,875 employees), and instrument and fine-mechanical apparatus sectors (+3,462 employees), see Table VI. The most substantial losses are recorded by

TABLE IV
The number of employees in high tech and in low tech sectors in 1986 and 1993

Size class	High-tech sectors		Change	Low-tech sectors		Change	Sales per employee kFIM 1993, NTBFs
	1986	1993		1986	1993		
0–4 employees	4,104	6,153	50%	14,129	13,152	–7%	330
5–9 employees	4,342	5,532	27%	10,333	10,806	5%	417
10–19 employees	5,377	4,834	–10%	19,880	14,292	–28%	409
20–49 employees	6,832	5,755	–16%	37,456	27,276	–27%	530
50–99 employees	4,865	6,215	28%	27,901	23,905	–14%	668
100–199 employees	5,411	6,337	17%	36,114	39,383	9%	655
200–499 employees	8,464	11,353	34%	46,298	30,916	–33%	534
500–999 employees	7,961	4,150	–48%	29,172	38,111	31%	660
1000– employees	18,311	26,588	45%	222,333	99,925	–55%	2,481
Totals	65,667	76,917	17%	443,616	297,766	–33%	1,202

TABLE V
Employment in high technology sectors 1986–1993, firms with 19 employees or less

Industry sector (TOL 88 classification)	1986 firms with 0–19 employees	1993 firms with 0–19 employees	Absolute change	Relative change
1830 Resins and plastics	54	83	29	54%
1840 Rubber	4	5	1	25%
1870 Pharmaceutical products	9	41	32	356%
2610 Data processing machinery and office equipment	132	152	20	15%
2620 Electronic and communications equipment	489	907	418	85%
2630 Electronic household appliances	693	461	–232	–33%
2640 Instruments and fine-mechanical apparatus	1,343	1,632	289	22%
5810 Telephone operator services	145	147	2	1%
5820 Other data transmission	7	54	47	671%
5830 Program transmission	1	51	50	5,000%
7210 Computer services	523	334	–189	–36%
7220 Computer programming services	1,510	3,513	2,003	133%
7230 Data bank services	69	57	–12	–17%
7290 Other data processing services	124	230	106	85%
7120 Construction technical services	6,359	5,876	–483	–8%
7130 Machine and process technical services	973	1,877	904	93%
7190 Other technical planning and consulting services	1,318	816	–502	–38%
86 Research and development	73	246	173	237%

TABLE VI
Total employment in high technology sectors 1986–1993, all size classes

Industry sector (TOL 88 classification)	1986 all size classes	1993 all size classes	Absolute change	Relative change
1830 Resins and plastics	6,053	6,724	671	11%
1840 Rubber	4	87	83	2,075%
1870 Pharmaceutical products	6,280	5,849	–431	–7%
2610 Data processing machinery and office equipment	1,270	3,235	1,965	155%
2620 Electronic and communications equipment	8,884	12,844	3,960	45%
2630 Electronic household appliances	2,625	1,394	–1,231	–47%
2640 Instruments and fine-mechanical apparatus	4,094	7,556	3,462	85%
5810 Telephone operator services	8,288	8,314	26	0%
5820 Other data transmission	7	80	73	1,043%
5830 Program transmission	1	79	78	7,800%
7210 Computer services	4,408	4,369	–39	–1%
7220 Computer programming services	3,637	7,512	3,875	107%
7230 Data bank services	114	234	120	105%
7290 Other data processing services	1,037	1,512	475	46%
7120 Construction technical services	11,579	8,397	–3,182	–27%
7130 Machine and process technical services	4,310	5,566	1,256	29%
7190 Other technical planning and consulting services	2,780	2,229	–551	–20%
86 Research and development	241	839	598	248%

construction technical services (–3,182 employees), electronic household appliances (–1,231 employees), and other technical planning and consulting services (–551 employees).

The most rapid growth among the small firms employing less than 20 employees has occurred in service firms. The most rapidly growing sectors for small technology-based firms were computer programming services (+2,003 employees) and machine and process technical services (+904 employees). Importantly, in these service sectors the small firms account for the majority of new

employment creation. This is understandable, since the entry to these sectors does not require large financial resources. It is likely that economies of scope play a role in this phenomenon, in addition to the probably important influence of the recession-push mechanism.

In hardware, the employment growth in small firms in high technology hardware sectors is closely linked to the employment growth in large firms in the same sectors. In hardware, the most rapid employment growth occurred in firms producing electronic and communications equipment (+418 employees) and in instruments and fine-mechanical apparatus (+289 employees), see Table V. Large firms with more than 1,000 employees have increased their employment contribution most notably in data processing machinery and office equipment (+2,471 employees), electronic and communications equipment (+2,470 employees), and in instruments and fine-mechanical apparatus (+1,436 employees) sectors. In here, it is probable that large systems integrator firms, such as Nokia Corporation, ABB Industry (Finland) Oy, and ICL Data (Finland) Oy, generate pull forces that catalyze the emergence of small firms in the same sectors.

In the light of our theoretical explanations, a good example of a typical flexible specialization sector is offered by computer programming services (NACE 7220), where 50% of the experienced employment growth can be attributed to the increase in the number of small firms (from 413 to 1,099). Yet, during the same period, the average number of employees in the size class of less than 20 employees fell from 3,7 employees per firm to 3,2 employees per firm. In addition, a particularly good example of a 'redundancy-push' sector is offered by construction technical services (NACE 7120). In this sector, the overall employment fell from 11,579 employees to 8,397 employees, while the number of firms with 20 employees or less increased from 1,357 to 1,817. Yet, even in the size class of 20 employees or less, the overall employment fell from 6,359 to 5,876.

In order to check whether the relative importance of different size categories of firms had changed, the cumulative employment distributions were calculated for different size categories for years 1986 and 1993. The cumulative employment distributions are shown in Figure 2.

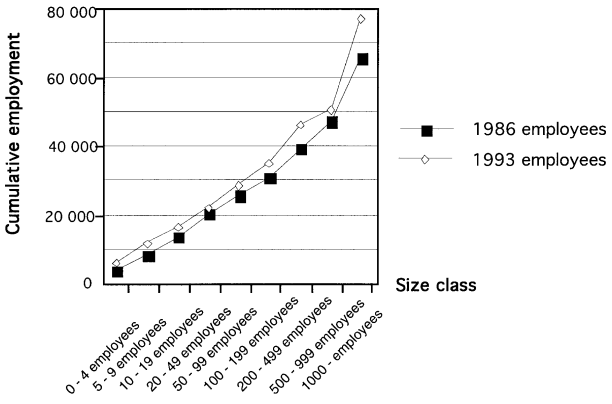

Figure 2. Cumulative employment distributions of firms in different size classes in 1986 and 1993.

There does not seem to have occurred any major changes in the shape of cumulative employment distributions during the period from 1986 to 1993. The shapes of the curves are quite similar, except perhaps for the size class of 500–999 employees. In this size class, it appears that firms have moved both to the left (to the smaller size class) and to the right (to the larger size class) during the recession. The available data does not allow us to determine, whether firms in this size class might have been acquired by larger firms.

4. Conclusions and discussion

The present study highlights the increasing importance of NTBFs in the Finnish economy. During the economic recession of the early 1990s, NTBFs have managed to increase their numbers faster than firms in low-tech industry sectors. The impressive increase in the number of firms as well as in employment and sales generation is largely due to the increase in the number of micro firms as well as in that of large firms. Furthermore, the most remarkable growth has occurred in electronics and telecommunications equipment as well as in information services sectors. Interestingly enough, this could support the hypothesis of NTBFs as increasingly important economic agents in the Information Society.

The research results show that sales per employee generated in the largest size classes is substantially higher than in other size classes. Even though the proxy used, sales per employee is a crude one, we are tempted to interpret this as

a reflection of the networking tendency among the Finnish NTBFs. Even though our data does not allow us to check the fraction of sales generated by NTBFs that is provided as inputs into complex product systems maintained by large systems integrator firms, the finding by Olofsson and Wahlbin gives reason to suspect that this fraction is not negligible. Studying university spin-off firms in Sweden, Olofsson and Wahlbin found that university spin-off firms provide a substantial part of all research and development subcontracting that was outsourced by established Swedish firms from Swedish industries and branch organizations (Olofsson and Wahlbin, 1993). Looking at the phenomenon from the other side of the window, Patel and Pavitt (1994) present evidence that the competence portfolios of systems integrator firms are rapidly developing to allow for the creation and maintenance of technologically dispersed networks of external technology suppliers.

The present study thus seems to provide an example of the complex product systems and networking tendency of the organizations operating within the same industry cluster. In Finland, the expansion of few large system integrator firms within the telecommunications cluster, most importantly that of Nokia Corporation, has catalyzed growth in related and supplying industries such as companies providing specialized outputs, machinery and associated services. Supporting this conclusion, the research conducted by Paija and Ylä-Anttila (1995), clearly suggests that the electronics component sector, information services and the plastics industry owe at least a part of their success to the booming telecommunications service sector.

In addition to the networking explanation, our analysis provides tentative support for the recession push and redundancy push hypothesis proposed by Jones-Evans and Westhead (1995). Firstly, the high unemployment rate of engineers has encouraged the formation of new technology based companies. Secondly, the recessionary period of the early 90's seems to have forced some firms to major restructuring programs, thus leading to the establishment of smaller autonomous firms. In particular, the construction technical services industry depicts strong signs of the economic recession being responsible for the growth in the number of firms in the smallest size classes.

The findings of this study can be used to illustrate some of the theoretical approaches presented earlier in this paper, even though our data is admittedly quite narrow in scope. The strength of using national statistics data is that an overlook at the phenomenon at the national level can be created. The weakness of national statistics data is that the depth of analysis is by necessity a narrow one. The analysis of the present study could be broadened in a number of ways. In order to develop a more thorough understanding on the interaction between the firm and its operating environment, future studies should focus more explicitly on the allocation of technological competencies in innovation networks. Firstly, the input-ouput linkages between industry sectors could be analyzed to detect possible clustering effects between industry sectors. Secondly, the present study has not used any efficiency indicators. Such indicators could include, for example, indicators of the R&D and innovation efficiency of firms in different size classes. Thirdly, in sectors where the flexible specialization trends are particularly strong, studies on lock-in effects and power effects of subcontracting could shed more light as to the possible growth constraints imposed upon locked-in NTBFs.

Acknowledgement

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Notes

[1] The categorization is illustrative only and s by no means exhaustive. It presents alternative, partially overlapping perspectives to the NTBF phenomenon. It serves to illustrate the impacts that the NTBFs inflict on industrial and economic structures. For instance, some sociological aspects, such as population ecology perspective are omitted in this study.

[2] Later Schumpeter rather reversed his thinking, contending that upon the invention of industrial R&D laboratories, the influence of economies of scale had become so important that large firms were destined to dominate the process of industrial innovation.

[3] We agree with one of the external referees that using sales per employee as a proxy can lead to misleading conclusions, as this measure could as well reflect, for example, a high market power, or simply high economies of scale. We urge

the reader to keep these cautionary remarks in mind when reading the data.

[4] Naturally, during recession, a natural reason for making employees redundant is the lack of demand. In our data, we cannot really distinguish between the effect of falling demand and redundancy push. We thank one of the two anonymous referees for pointing this out.

[5] The NACE industry classification is adopted from Butchard (1987) and used in several other studies (Keeble and Walker, 1994; Garnsey et al., 1994). The NACE classification has only been used in Finland since 1994. Prior to that year, a Finnish TOL 1988 classification was used instead. A conversion table between the TOL 88 and the NACE classification can be requested from the authors.

[6] Naturally, it would be preferably to have more years included in the analysis. At present, our data does not really allow us to track changes in the population during the business cycle. We thank one of the anonymous referees for pointing this out.

[7] In the following analysis, a NTBF is defined as a small and or medium sized firm operating in high technology industrial sectors, as defined by Butchard. A small and or medium sized firm is defined as a firm that has less than 200 employees.

[8] As is typical for this kind of analysis, we have no way of checking to what degree this finding is due to firms switching from one size class to another, and to what degree this finding is due to the establishment of new firms. Furthermore, we cannot really distinguish whether the growth in small firm employment is due to the emergence of new firms or reorientation of activities in the existing firms. We only have two images of the population at two separate points of time which is characteristic for the comparative statistics methodology traditionally used in job creation studies. For a detailed analysis of static and dynamic methodologies, see Kirchhoff and Greene (1995) and Robson (1996). For those interested, Statistics Finland has initiated a project that aims at monitoring the evolution of individual firms over time. The initial findings of this analysis are to be reported in Fall 1997.

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