ETLA
ELINKEINOELÄMÄN TUTKIMUSLAITOS
THE RESEARCH INSTITUTE OF THE FINNISH ECONOMY
Lönnrotinkatu 4 B 00120 Helsinki Finland Tel. 358-9-609 900
Telefax 358-9-601 753 World Wide Web: http://www.etla.fi/

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Heli Koski* – Carolina Sierimo**

ENTRY AND EXIT IN THE ICT SECTOR

– NEW MARKETS,

NEW INDUSTRIAL DYNAMICS?

* *The Interdisciplinary Institute of Management, London School of Economics, Houghton Street, London WC2A 2AE, UK, and The Research Institute of the Finnish Economy, Lönnrotinkatu 4 B, 00120 Helsinki, Finland.*
E-mail: H.A.Koski@lse.ac.uk.

** *During this study the author was working at The Research Institute of the Finnish Economy, Lönnrotinkatu 4 B, 00120 Helsinki, Finland.*
Current E-mail: carolina_sierimo@hotmail.com.

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ABSTRACT: Network industries have special characteristics that may influence the nature and the order of magnitude of entry and exit barriers in these industries. Consequently, the entry and exit dynamics of network industries such as the information and communications (ICT) sector may differ from those of the traditional industrial sectors. We use data from the Finnish industrial sectors from 1995 to 2000 to empirically explore this question. Our data suggests that, indeed, factors determining the rates of entry and exit are different among ICT and non-ICT industries. The data support our hypothesis that the special characteristics of network industries intensify the role of market concentration and economies of scale as a barrier to entry and exit. This empirical finding emphasizes the importance of antitrust regulation and careful evaluation of potential anti-competitive consequences of mergers and acquisitions in network industries.

Key words: entry, exit, network industries, ICT

1 INTRODUCTION

A recent consolidation trend of firms in network industries[1] has emphasized the importance of the question of the abuse of market power vs. the advantages of economies of scale in network markets. Competition authorities have not only considered the antitrust risks of the mergers of large companies (e.g., AOL and Time Warner) but also potential needs to *demerge* some companies with substantial market power. Particularly the antitrust case *US vs. Microsoft* has involved a great number of lawyers, economists and policy makers, and motivated a more general discussion and also various academic studies concerning the antitrust issues in the network markets (see, e.g., Shapiro, 1999; Economides, 2001; Farrell and Katz, 2001).[2] The academic discussion has stressed the importance and potentially substantial competition policy implications of the special characteristics of network markets, particularly *network effects* and *switching costs* (see Farrell and Klemperer, forthcoming, for a comprehensive discussion of the topic).

Network effects mean that the market exhibit *economies of scale* on the *demand side* as consumer's value of a product increases with the number of consumers using a compatible or complementary product or service[3]. Consumer switching costs arise from the specificity of his investment[4] to a company, and they are directly related to the network effects as they accent the importance of compatibility between the current and previous purchases of a customer. Farrell and Klemperer (forthcoming) suggest that "*the most important effects of switching cost on competition overall may be effects on entry*". On the one hand, large incumbent companies may want to extract profits from their existing customer base and charge higher prices than the entrants - as long as they can keep a sufficiently profitable installed base of old customers - making a small scale market entry easy. On the other hand, economies of scale or network effects may make small scale market entry unprofitable and/or the incumbents may strategically prevent entry, for instance, by innovation strategies (e.g. investments in patent portfolios) or by increasing switching costs[5].

Entry barriers are often also exit barriers, and thus the special characteristics of network industries may influence not only entry but also exit in these industries. An interesting question arising from the theoretical argumentation of Farrell and Klemperer is whether the market entry and exit patterns of network industries differ from those of non-network industries. This question is the focus of our empirical study that uses data covering firm entry and exit patterns in Finland, a country that was one of the most ICT-

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1 According to CNN (http://money.cnn.com/news/deals/mergers/biggest.html), in 2002, half of the 20 biggest mergers of the year involved firms in network industries.

2 See also the web page of Nick Economides (http://www.stern.nyu.edu/networks/site.html) for a documentation and analysis of the Microsoft case.

3 The examples of compatible products involving network effects are, e.g., telephones and fax machines. The markets for hardware and software such as DVD-players and CDs and computer operating systems and software provide examples of network effects arising from complementarities.

4 Investment may be, for instance, a purchase of a certain product (e.g., a mobile phone that may further be incompatible with the other standard technologies on the market such as GSM in the US market offering also TDMA and CDMA), a contract (e.g., switching a telephone operator may not only involve transaction costs but consumer may also need to change a telephone number), and learning to use a certain technology (even compatible technologies such as different models of GSM phones function differently).

5 The mobile communications markets provide an example of such strategic behaviour. The implementation of mobile number portability in the industrialized countries has been slow due to, by and large, the opposition of incumbent telecommunications operators (Koski, 2002).

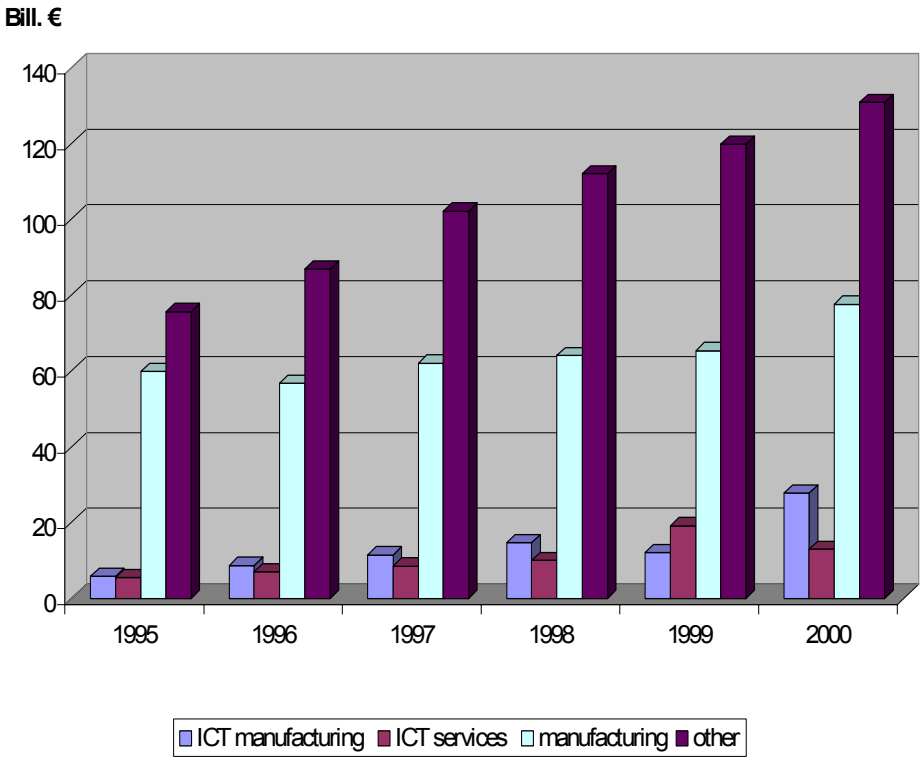
specialized industrialized country (in terms of ICT production and exports), during the second half of the 1990s (Koski et al, 2002). We are interested in the determinants of entry and exit in the ICT industries – particularly the impacts of market power and scale economies - and whether they differ from those in the traditional industries.

The rest of the paper is organized as follows. Section 2 sheds light on the industrial entry and exit patterns of the ICT and non-ICT industries in Finland during the years 1995-2000. Section 3 discusses the potential determinants of entry and exit based on the previous economic literature, and also how entry and exit in network industries may differ – due to the factors such as network effects and consumer switching costs that are specific to network industries – from those of non-network industries. Section 4 introduces the data and the econometric method. Section 5 reports the estimation results. Section 6 concludes with a summary and a brief discussion of the policy implications of our empirical findings.

2 INDUSTRIAL ENTRY AND EXIT PATTERNS: ICT VS. OTHER SECTORS

The importance of the ICT sector grew dramatically during the second half of the 1990s (see Figure 1)[6]. In 1995, the turnover of ICT manufacturing sector was about 4% of the total turnover of all Finnish sectors, whereas in 2000 the corresponding share had escalated to over 11%. The turnover share of ICT services witnessed a less drastic growth from 3.7% to 5.2% between 1995 and 2000.

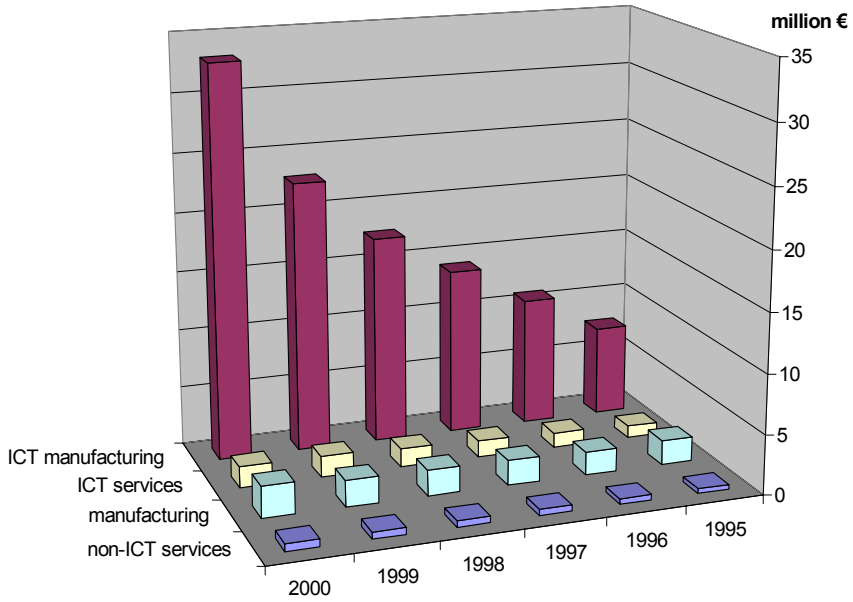
Figure 1. Turnover of ICT sector vs. other sectors, 1995 - 2000



Also, the average sales figures of firms suggest notable differences between ICT and other firms. In 2000, the average sales per ICT manufacturer exceeded 33 million euros being more than ten times greater than the average sales of firms - that was about 2.6 million euros - in non-ICT manufacturing sectors. Firms in the ICT services sector also had clearly higher turnovers, on average, than those in other service sectors. In 2000, the value of sales of an average ICT service firm was about 1.8 million euros, whereas the corresponding number for non-ICT service firms was about 0.6 million euros.

[6] Kangasharju's (2001) data from the information technology sector of Finland shows that in the period of 1993-1997, the employment growth of the information technology sector has been notably higher (about 52% growth) than the average growth rate of all Finnish firms (about 9% growth).

Figure 2. Total sales in relation to the number of firms in the ICT sector vs. other sectors, 1995 – 2000



From the point of view of the economic theory, it seems credible that higher (expected) profitability attracts a greater number of new entrants to an industry. During the second half of the 1990s, the ICT sector witnessed a period of remarkable growth accompanied with glorious expectations on the future revenue streams or profits of ICT companies. Therefore, on the one hand, it seems possible that this development - sometimes called 'ICT hype' - resulted in a notable increase in the entry of new firms to the ICT sector. On the other hand, the previous empirical studies do not support the existence of a strong relationship between the entry rates of firms and profitability of industries (Geroski, 1995).

Figure 3 suggests that, indeed, throughout the period of 1995-2000 the number of new firms in relation to all firms in the industry has been higher in the ICT sector than in the other industrial sectors as a whole. About 14,5% of the annual stock of the ICT firms have been new companies, on average, while the annual average entry rate of firms in other industries has been less than 11%. The average annual exit rates didn't differ notably: they were about 9% for both the ICT sector and other industries. The bankruptcy rates were substantially smaller than exit rates: only about 1% of ICT companies and 0.8% of non-ICT companies were about to exit market due to the insolvency or bankruptcy of a company (i.e. they either faced a bankruptcy judgment or their bankruptcy proceeding was dropped due to the firm's insolvency).[7] Our empirical exploration will shed light on the factors causing the observed inter-industry differences in the entry and exit rates.

[7] From now on, we will use the term 'bankruptcy' while discussing the data to refer to the firms that either faced a bankruptcy judgment or whose bankruptcy proceeding was dropped due to their insolvency.

Figure 3. Entry, exit and bankruptcies patterns: ICT vs. other industries

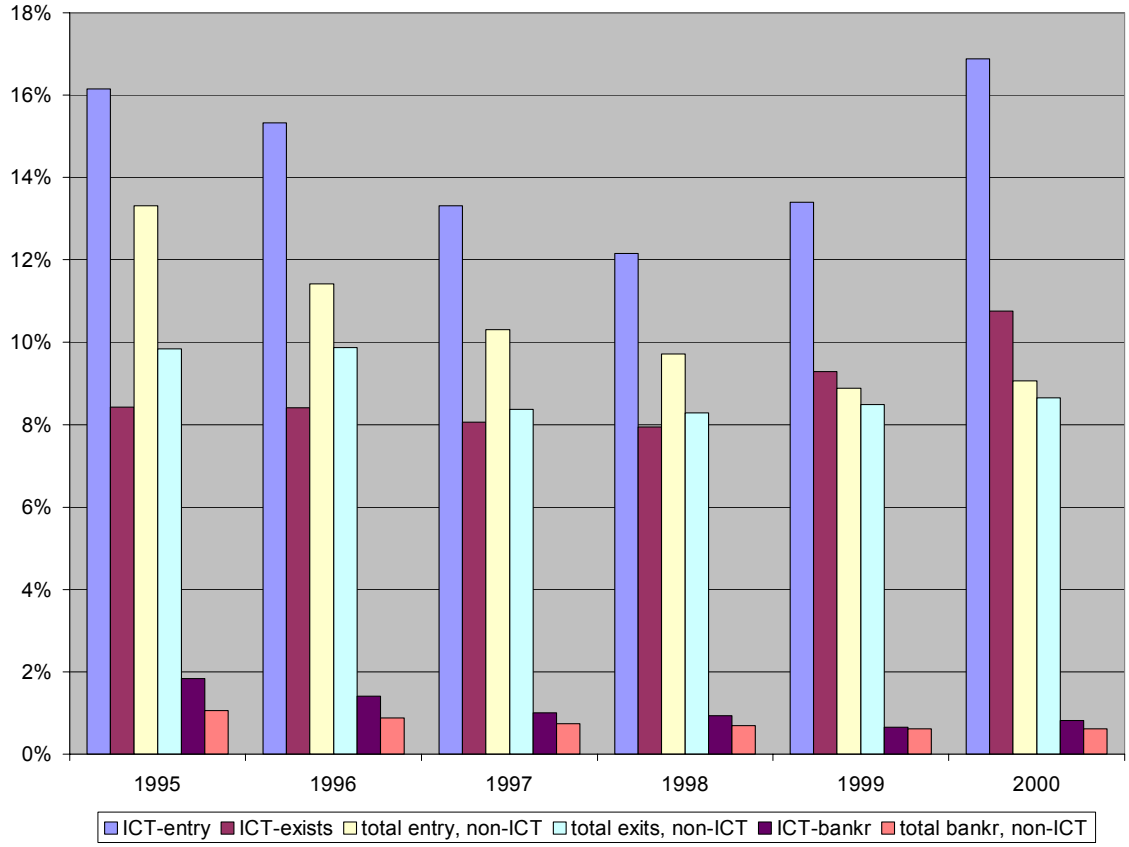


Figure 4 illustrates the share of new and exiting ICT firms and the bankruptcies of ICT firms of those of the total number of Finnish companies from 1995 to 2000. An increase in the share of new ICT firms of all new firms was pronounced. In 1995, new ICT firms represented slightly over 3% of the stock of the new firms in Finland, whereas in the year 2000 about 6% of the new firms were operating in the ICT sector. The ICT sector was flourishing, and the establishment of new firms did not result in a proportionally equal market exit. The number of exiting ICT firms in relation to the total number of firms exiting the market increased from about 2% to 4% from 1995 to 2000. The ICT bankruptcies formed, on average, about 4% of the total number of annual bankruptcies during the years 1995-2000.

Further investigation shows that an increase in the number of ICT firms has occurred largely due to an expansion in the ICT service sector. The number of ICT service firms increased about 35% (or 1892 new firms) from 1995 to 2000, whereas the corresponding increase in the ICT manufacturing was about 9% (or 71 new firms). In 2000, the number of firms providing ICT services was about 4.5% of service providers, whereas the share of ICT manufacturers was less than 3% of all manufacturing firms (see Figure 5).

Figure 4. Entry, exit and bankruptcies of ICT firms

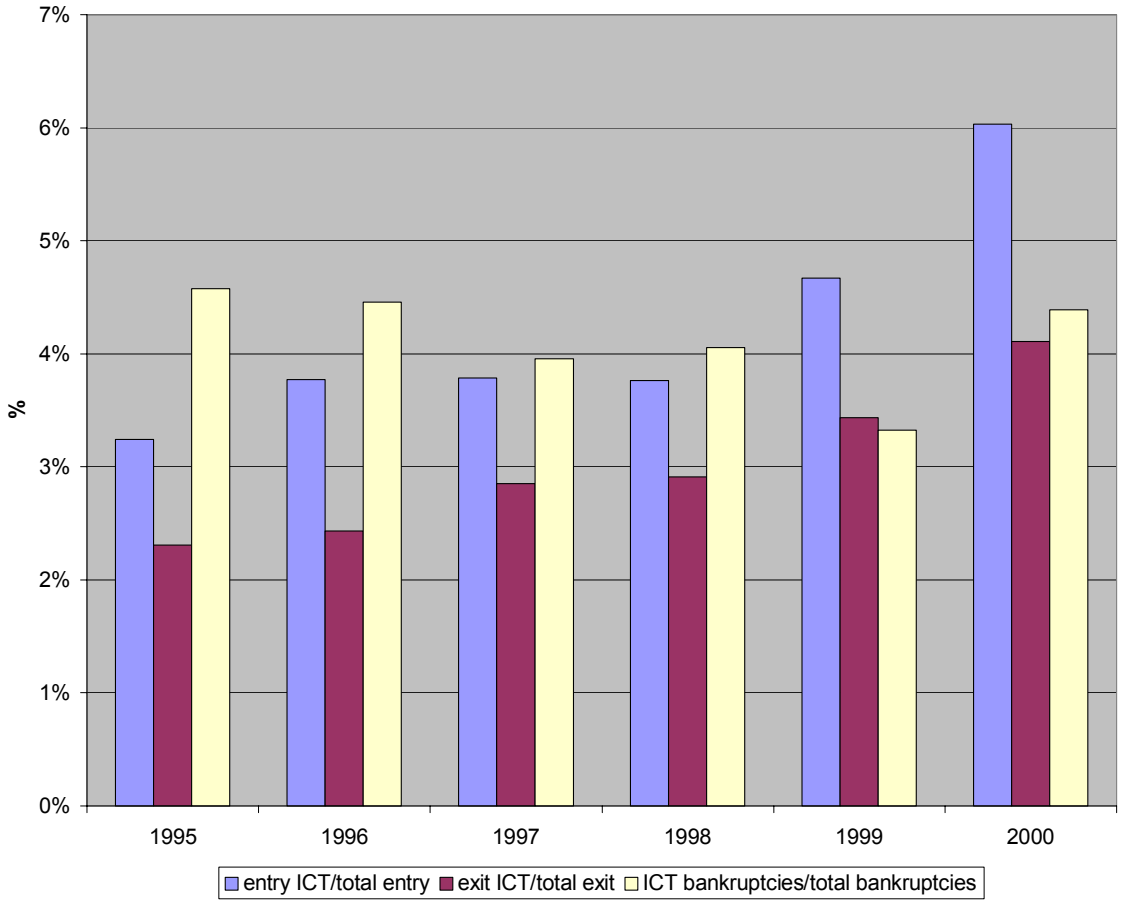
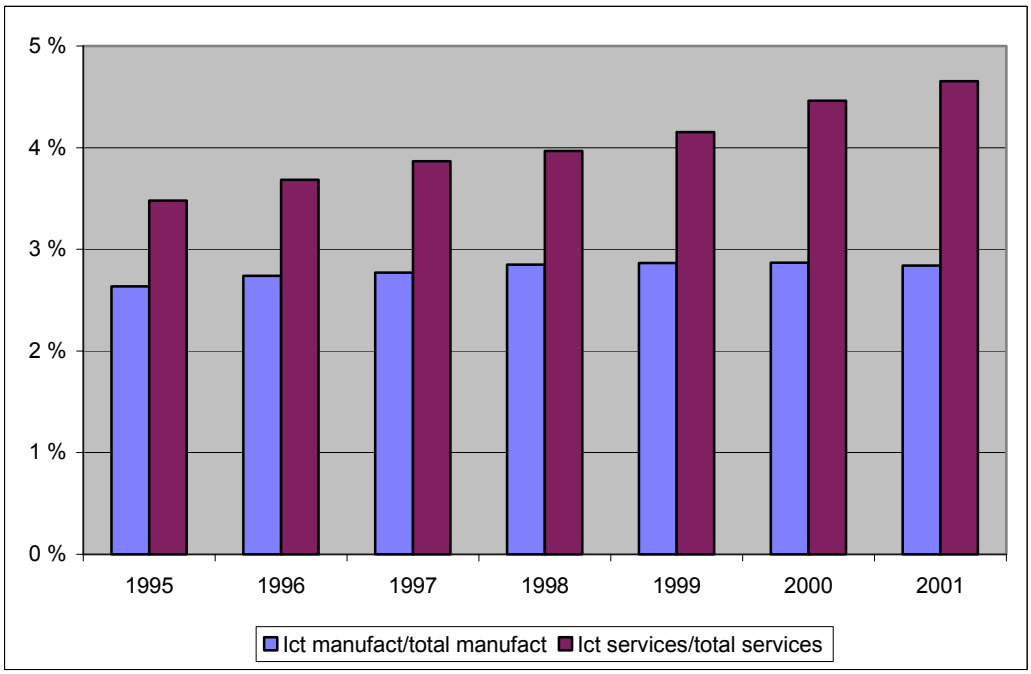


Figure 5. Share of ICT firms of all firms in Finland



Next section discusses more detailed the potential determinants of the entry and exit in the ICT sector and other sectors.

3 DETERMINANTS OF ENTRY AND EXIT

The ICT sector[8] is typically characterized by strong demand-side economies of scale or network effects. In other words, the value of goods and services is increasing in the number of their users (e.g., user value of the Internet). Also, switching costs are generally substantial in network markets[9]. Switching costs arise from the specificity of consumer's investment in a company and accent the importance of compatibility between the current and previous purchases (e.g., a consumer's purchase of a certain computer may influence his further investments in accessories such as a CD-writer). On the one hand, due to economies of scale or network effects, a small scale market entry may be unprofitable. Also, the incumbents may strategically prevent entry (e.g., by increasing switching costs to consumers). On the other hand, large incumbent firms may want to extract profits from their existing customer base and charge higher prices than the entrants - as long as they can keep sufficiently profitable installed base of old customers - making a small scale market entry in network markets easy (Farrell and Klemperer, forthcoming).

The previous empirical studies suggest that scale economies in production may form a significant entry barrier as they require new entrants to undertake substantial sunk investments, but the evidence on their role as an exit barrier is weaker (see Ilmakunnas and Topi, 1999)[10]. Economies of scale in production are also typical in the network industries and may similarly create entry/exit barriers. As the incumbents in the ICT sector benefit from both supply- and demand-side scale economies, the influence of economies of scale for entry and exit may be stronger in the ICT sector than it is in the other sectors. We approximate **economies of scale**[11] by two variables. First, we measure the *minimum efficient scale* (MES) by the median firm turnover in the industry divided by total turnover of the industry (variable *SCALE_REL*). This variable measures the *relative* MES in an industry. Second, the *absolute* MES is measured by the median firm turnover in the industry (variable *SCALE_ABS*).

The market power of incumbent companies, usually measured by the concentration of an industry, may also affect the order of magnitude of entry and exit barriers in the industry. It may be a particularly efficient entry barrier in the markets characterized by network effects. The presence of a few large firms generally implies large user networks and great benefits related to network effects. Lock-in to the use of a dominant technology (e.g. in the spreadsheet markets) is also more likely in the heavily concentrated markets. Consequently, higher industrial concentration may imply higher switching costs for consumers of changing from the incumbent firm to a new firm, and thus reduce the possibilities of new entrants to succeed. High industrial concentration may also allow and facilitate collusion of large firms that aim at creating entry barriers to new firms (see, e.g., Bunch and Smiley, 1992). Empirical evidence on the influence of market concentration for entry and exit is, however, inconclusive (Mata and Portugal,

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[8] We use the OECD definition of the ICT sector comprising ICT manufacturing and services (see Annex 1 for a detailed description).

[9] For instance, in the telecommunication markets customer loyalty is high and consumers rarely switch from one telecommunication network to another (see Koski, 2002).

[10] The study of Ilmakunnas and Topi (1999) investigates the role of scale economies – measured by median firm turnover in relation to total turnover of the industry - in the entry and exit patterns in the Finnish manufacturing industry during the years 1988 - 1993.

[11] Unfortunately, our data does not allow us to distinguish scale economies on the demand side from those on the supply side.

2001). **Market concentration** is approximated by the turnover of the five largest firms in the industry divided by total turnover of the industry (variable *CONCENTR*).

A notable feature of various ICT industries is that the production of knowledge intensive goods often requires less physical capital and manpower than the production of traditional goods. These industries may involve relatively low fixed costs of entry[12] and thus provide opportunities for small innovative entrants. Moreover, after the initial investments in the development of new products, production costs are typically low. Creating the first copy of a new working piece of software or the first design of a new semiconductor chip may be costly, but running off further copies costs virtually nothing. Furthermore, transportation costs do not matter as products (as well as their advertisement) can be transferred in a digital format over the communications network. Thus, entry to the global markets is cheaper than in the case of traditional products. Due to these economic features of the ICT industries producing services and goods primarily based on knowledge or intangible resources, we assume that entry has been particularly strong in these industrial sectors. The dummy variables for ICT sectors are used to detect differences between the entry and exit patterns in the ICT and other sectors. We also estimate the models separately using data from the ICT sector.

Growth in demand creates opportunities to new firms enter the market, and thus rapidly growing sectors are likely to attract more entrants than those witnessing lower growth. Furthermore, fast growing industries may provide new firms with higher chance to survive since incumbents are not likely to respond aggressively to entry when it does not decrease their market shares (see, e.g., Audretsch, 1995a). Consequently, we assume that the variable describing the growth of an industry – the relative change in total sales of the industry from previous year (variable SALES_*growth*) - is positively related to entry and negatively related to exit.[13]

The speed of **technological change** may also influence firm entry and exit. The incumbents of the industries characterised by the routinized technological regime benefit from their experience, and there are typically less start-ups than in the industries witnessing rapid technological changes (see, e.g., Winter, 1984). Innovative new entrants may have advantage over large incumbents when new knowledge is the key element in innovation production, whereas when innovations are, by and large, based on non-transferable experience, the incumbent firms tend to have innovative advantage over new firms (see, e.g., Williamson, 1975; Audretsch, 1995b). Another stream of literature suggests, instead, that in highly innovative sectors the incumbents may create barriers to entry by the strategic protection of intellectual property rights, e.g. by using patent portfolios (see, e.g., Hall and Ziedonis, 2001). Therefore, the relationship between entry and technological change is unambiguous.

Audretsch (1995b) finds that new entrants are less likely to survive in highly innovative industries. Rapid technological progress seems to create a barrier to survival for many new firms that consequently fail to adjust to the competitive environment and produce viable products. Thus, we expect that the relationship between the speed of technological change and exit is positive.

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[12] Nevertheless, the risk of producing an output that behaves like knowledge may be higher than in the routinized industry. Introduction of a new product or service typically requires substantial R&D costs accompanied with uncertain success of producing profitable innovation. In other words, entry to the ICT sector often involves substantial risk.

[13] The empirical findings of Ilmakunnas and Topi (1999) from the Finnish manufacturing industry during the years 1988-1993 support this view.

We measure the speed of technological change by the innovation intensity using data concerning industry-level R&D activities (variable *R&D*). Low innovation intensity is assumed to reflect slowdown in major innovations or signal that the industry is characterized by the routinized technological regime. Thus, we expect that the relative order of magnitude of R&D expenditures influence positively exit and unambiguously to entry.[14]

The size of an industry may also influence its entry and exit dynamics. A greater number of firms provides more potential for new firms to replace the old ones (Baldwin, 1995), and thus the relationship between the industry size (variable SIZE(t-1) and both entry and exit should be positive. More entry typically relates to the shorter lifetimes of firms due to displacement effects and increased competition. Furthermore, high entry barriers mean high sunk costs or irreversibility associated with investments, and therefore also higher barriers to exit. Therefore, variable ENTRY(t-1) capturing **the number of industry entrants** during the previous year of observations should be positively related to exit. It is also notable that, according to the various previous empirical studies, entry and exit rates are positively correlated (see, e.g., Dunne et al, 1988; Mata and Portugal, 1994).

Macroeconomic conditions are also likely to influence firm entry and exit. Recession increases the probability of exit, whereas entry is generally highest during a boom. The GDP growth signals a higher (expected) profitability of entrants, and may consequently increase the number of firm entering the market (Audretsch, 1995a; Caves, 1998). We control the influence of the business cycle by using the annual percentage change in GDP (variable *GDP_growth*). Macroeconomic policy means such as interest rates (variable *INTEREST*) may also affect directly investment and production: high interest rates tend to reduce investment and production and further increase business failures or firm exit.[15]

[14] We may note here that the related empirical result of Nurmi (2002) does not support the view that R&D intensity affects significantly the hazard rates of the manufacturing firms.

[15] The previous studies have found a positive relationship between the hazard rate of new establishments and unemployment rate and the real interest rate (Audretsch and Mahmood, 1995).

4 DATA AND ECONOMETRIC METHODS

4.1 Data

Table 1 presents the variables used in the empirical analysis and their descriptive statistics (mean and standard deviation) values.

Table 1. List and descriptive statistics of variables

VARIABLE	DESCRIPTION	SECTOR	MEAN (standard deviation)
ENTRY	Number of firms entering to an industry.	All Non-ICT ICT Manuf.	38,760 (104,629) 38,478 (104,057) 45,969 (118,704) 11,348 (22,616)
EXIT	Number of firms exiting from an industry.	All Non-ICT ICT Manuf.	34,008 (83,997) 34,178 (84,503) 29,656 (70,044) 10,791 (19,966)
BANCR	Number of bankruptcies in an industry (number of bankruptcy judgements and the bankruptcy proceedings that have been dropped due to the insolvency of a company).	All Non-ICT ICT Manuf.	22,128 (35,890) 22,732 (36,339) 6,609 (14,340) 4,928 (6,695)
CONCENT	(Log) turnover of 5 largest firms in an industry divided by total turnover of industry.	All Non-ICT ICT Manuf.	-0,310 (0,296) -0,315 (0,298) -0,168 (0,169) -0,152 (0,171)
SCALE_ABS	(Log) The median turnover of an industry (thousand €) divided by the CPI, CPI = consumer price index (1995=100).	All Non-ICT ICT Manuf.	0,167 (0,632) 0,168 (0,637) 0,126 (0,496) 0,338 (0,724)
SCALE_REL	(Log) The median turnover of an industry (thousand €) divided by total turnover of industry.	All Non-ICT ICT Manuf.	-2,755 (0,822) -2,735 (0,815) -3,265 (0,846) -2,604 (0,894)
SIZE(t-1)	(Log) number of firms in an industry at time t-1.	All Non-ICT ICT Manuf.	2,012 (0,751) 2,010 (0,758) 2,067 (0,536) 1,675 (0,696)
SALES_GROWTH	Growth in the total sales of an industry, (SALES(t)-SALES(t-1))/SALES(t)	All Non-ICT ICT Manuf.	0,028 (0,557) 0,027 (0,558) 0,060 (0,545) 0,007 (0,532)
R&D	(Log) research and development expenditures/ total turnover in an industry.	All Non-ICT ICT Manuf.	-3,447 (0,940) -3,443 (0,926) -2,026 (0,991) -3,427 (0,951)
ENTRY(t-1)	(Log) number of new firms in an industry at time t-1.		
INTEREST	(Log) three-month money market real interest rate (1995-1998 Helibor, since 1999 Euribor).		-1,471 (0,055)
GDP_GROWTH	(Log) Growth in gross domestic product (at 1995 prices), (GDP(t)-GDP(t-1))/GDP(t).		0,049 (0,008)
ICT_MANU_dmy	Dummy variable that gets value 1 if observation is from ICT manufacturing sector, 0 otherwise.		
ICT_SERVICE_dmy	Dummy variable that gets value 1 if observation is from ICT service sector, 0 otherwise.		

MANUF_dmy	Dummy variable that gets value 1 if observation is from manufacturing sector, 0 otherwise.		
DumSman	ICT_MANU_dmy*SCALE_ABS		
DumSser	ICT_SERVICE_dmy*SCALE_ABS		

The sector-level data on the total number of firms and the number of entering and exiting firms for the years 1995-2000 is compiled by the Register of Enterprises and Establishments of Statistics Finland.[16] The activities of the firms are reported using a 5-digit activity classification, TOL-95, that is an adjusted version of NACE Rev 1. (a 4-digit activity classification used by the European Union).[17] The data also comprises information regarding the concentration ratio and median and total turnover of the industries.

The number of exiting firms may give a biased picture of the industry dynamics as it also comprises firms that have exited the statistics for the reasons other than going out of business (e.g., firms exiting market due to a merger or acquisition). Therefore, we also use bankruptcy data to shed further light on the exit dynamics. Our bankruptcy variable comprises industry level data of the number of bankruptcy judgments and the bankruptcy proceedings that have been dropped due to the insolvency of a company. The data concerning bankruptcies are also obtained from Statistics Finland. Unfortunately, the bankruptcy statistics are not available at a 5-digit classification level from all industries, and we have thus replaced part of the 5-digit bankruptcy observations by 3-digit values. Similar problems arise in the case of R&D expenses that are extracted from the science and technology statistics of Statistics Finland.

The variables controlling for the macroeconomic business environment are obtained from the database of the Research Institute of the Finnish Economy. The growth of the gross domestic product at 1995 prices (variable GDP_GROWTH) and the three month Euribor interest rate (variable INTEREST) capture general macroeconomic conditions (business cycle) and macroeconomic or monetary policy, respectively, potentially influencing the industry dynamics. The macro variables are in real terms, i.e. they are deflated by the consumer price index.

4.2 Econometric methods

Our empirical exploration uses industry-level count data on the entry and exit patterns of firms in Finland to shed light on the underlying factors affecting industry dynamics and in particular, to detect differences between the ICT and non-ICT sectors. Our dependent variables take nonnegative integer values and therefore, the use of count data models seems appropriate. The Poisson model is a first natural candidate but our data do not seem to follow the shape of the Poisson distribution with its restrictive assumption of the mean and variance being equal. The data covering all industries are clearly overdispersed, i.e. the variance of the dependent variables exceed their mean values[18], that is

[16] The data comprises all Finnish firms and employers subject to VAT that have operated at least for six months during a year and employ at least half a person or have annual turnover exceeding a certain minimum (that was 8987 euros in 2001).

[17] Some bias in the number of entering and exiting firms may arise due to classification. For example, multi-product firms are classified to the industry where their main activity is, and a change of ownership or legal status (e.g. due to a merger/acquisition) is classified both as an exit and entry.

[18] The mean-variance ratios for the number of industry entries, exits and bankruptcies are 0.003, 0.005 and 0.017, respectively indicating substantially higher values for variances than means. The likelihood ratio test based on Poisson and negative binomial distributions clearly supports the presence of overdispersion.

supported by the statistical significance of the overdispersion variable (see results in Table 2-4). Similarly, we find that dependent count variables are over-dispersed among the samples of non-ICT and manufacturing industries. Consequently, in these cases, we estimate and report the results of the negative binomial model that allows the presence of overdispersion. The estimated overdispersion variables appear not to be statistically significant in the case of the ICT sample, and we therefore report the estimation results of the Poisson models for the entry, exit and bankruptcies in the sample comprising ICT industries.

As some explanatory variables of our primary interest (i.e. the dummy variables for the ICT sector) are time invariant, we estimate the random effects models for our three dependent variables.[19] In other words, we assume that the overdispersion parameter is randomly distributed accross industry groups. Tables 2-4 report the estimation results.

Table 2. The estimation results of the random effects models for entry (negative binomial model if not otherwise indicated)

	ALL	**ICT^P**	**MANUF**	**NON-ICT**
Constant	-2.193** -11.827	3.989** 2.876	-0.247 -0.472	-2.312** -12.203
ICT_manu_dmy	-0.254 -0.750		0,163 0.465	
ICT_service_dmy	0.297** 2.687			
SIZE (t-1)	1.735** 32.737	0.036 0.305	1.806** 14.922	1.776** 32.019
CONCENT	-0.279** -4.468	-2.007** -3.284	-0.379 -1.757	-0.244** -3.852
SCALE_REL	-0.163** -3.575	-0.801** -6.837	-0.061 -0.688	-0.144** -3.015
SCALE_ABS	-0.308** -7.855	-0.333 -0.825	-0.310** -5.197	-0.300** -7.548
SALES_GROWTH	0.002 0.081	-0.069 -1.298	-0.023 -0.402	-0.004 -0.164
INTEREST	-0.247** -2.749	2.508** 4.519	0.729* 2.281	-0.336** -3.505
GDP_GROWTH	3.914** 5.982	-20.050** -8.149	-2.811 -1.667	4.336** 6.814
R&D	0.071** 5.522	-0.319* -2.148	-0.109 -1.920	0.075** 5.881
∀	8.108** 12.364	0.570* 2.100	15.881** 5.703	8.353** 12.258
∃	8.704** 9.973		8.543** 5.156	8.538** 9.925
Log-likelihood	-7721.782	-343.634	-2290.492	-7380.205
# observations/ # industries.	2552/574	96/21	997/213	2456/553

Note: * denotes statistical significance at p=0.05, ** denotes statistical significance at p=0.01.
∀ refers to the industry specific effect, and ∃ is the negative binomial overdispersion parameter .
P = Superscript P means that the estimation results of the Poisson model are reported here.

[19] Time invariant variables are collinear with industry-specific intercepts, and therefore the fixed effects model does not suit to our purpose.

Table 3. The estimation results of the random effects models for exit (negative binomial model if not otherwise indicated)

	ALL	ICT^{P}	MANUF	NON-ICT
Constant	-0.119 -0.691	1.870 1.144	-0.032 -0.833	-0.113 -0.634
ICT_manu_dmy	-0.133 -0.646		0.076 0.516	
ICT_service_dmy	0.152 1.108			
SIZE (t-1)	1.985** 37.405	0.691** 4.992	1.947** 16.508	2.035** 35.919
CONCENT	0.015 0.266	-1.599** -2.610	-0.230 -1.012	0.053 0.941
SCALE_REL	-0.012 -0.351	-0.529** -5.178	0.001 0.15	0.008 0.206
SCALE_ABS	-0.245** -7.865	-0.023 -0.070	-0.235** -5.008	-0.252** -7.985
SALES_GROWTH			0.019 0.346	-0.022 -0.795
INTEREST	0.495** 6.116	1.830** 2.241	0.531* 2.497	0.447** 5.237
GDP_GROWTH	-3.728** -5.557	-16.315** -5.102	-4.850** -3.642	-3.489** -5.069
ENTRY(t-1)	0.250** 10.058	0.227 1.061	0.149** 4.915	0.240** 9.552
R&D	-0.015 -1.466	-0.201 -0.927	-0.145** -3.479	-0.012 -1.157
∀	38.777** 13.508	0.141** 2.455	286.044 1.593	40.390** 12.887
∃	12.920** 13.554		19.537** 5.514	12.084** 13.430
Log-likelihood	-6941.787	-290.283	-2074.252	-6645.315
# observations/ # industries.	2552/574	96/21	997/213	2456/553

Note: * denotes statistical significance at p=0.05, ** denotes statistical significance at p=0.01.
∀ refers to the industry specific effect, and ∃ is the negative binomial overdispersion parameter .
P = Superscript P means that the estimation results of the Poisson model are reported here.

Table 4. The estimation results of the random effects models for bankruptcies (negative binomial model if not otherwise indicated)

	ALL	ICT^{P}	MANUF	NON-ICT
Constant	0.928** 2.917	0.842 0.139	1.310 1.491	0.896** 2.785
ICT_manu_dmy	-2.224** -2.738		-0.375 -0.833	
ICT_service_dmy	-0.713* -2.152			
SIZE (t-1)	0.873** 10.556	1.380 0.941	0.511** 2.594	0.861** 10.305
CONCENT	-0.284** -3.019	-0.720 -0.256	-0.932* -2.255	-0.287** -3.048
SCALE_REL	0.264** 3.871	0.765 0.723	0.095 0.754	0.251** 3.629
SCALE_ABS	-0.177* -2.417	-0.581 -0.312	0.016 0.133	-0.173** -2.338
SALES_GROWTH	0.028 1.054	0.301 0.809	0.017 0.173	0.026 0.986
INTEREST	-1.098** -7.067	0.748 0.245	0.605 1.185	9.971** 10.612
GDP_GROWTH	9.794** 10.480	-5.473 -0.331	-2.190 -0.801	-1.125** -7.183
ENTRY(t-1)	0.019 1.038	0.524 1.023	0.051 1.432	0.017 0.937
R&D	0.132** 8.760	-0.526 -1.743	-0.633** 5.322	0.136** 8.907
∀	2.436** 8.369	1.594 1.358	3.723** 5.612	2.436** 8.147
∃	0.673** 15.256		1.060** 8.735	0.666 15.094
Log-likelihood	-7173.843	-175.157	-2100.887	-6993.893
# observations/ # industries.	2456/555	92/20	994/213	2364/535

Note: * denotes statistical significance at p=0.05, ** denotes statistical significance at p=0.01.
∀ refers to the industry specific effect, and ∃ is the negative binomial overdispersion parameter .
P = Superscript P means that the estimation results of the Poisson model are reported here.

5 EMPIRICAL RESULTS

We estimated separate equations for the whole sample or all industries, and the samples of ICT[20], non-ICT and manufacturing industries – columns ALL, ICT, non-ICT and MANUF, respectively, in tables 2-4 - to investigate differences in the determinants of entry and exit patterns between the industries. The estimation results of the negative binomial model are reported when the data support its use, i.e. when the overdispersion parameter, ∃, appears to be statistically significant, whereas the Poisson model is used in the estimations when overdispersion is not an apparent problem. Tables 2-4 present the estimation results for the models for entry, exit and bankruptcies, respectively.

Table 2 reports the results of the estimations regarding firm entry. The estimated coefficient of the dummy variable for ICT manufacturing industries (*ICT_manu_dmy*) is not statistically significant, but the dummy variable for ICT service industries (*ICT_serv_dmy*), instead, is positively and statistically significantly related to firm entry in the whole sample (see column ALL). This finding is consistent with our descriptive analysis of the data (see Section 3): during the second half of the 1990s, the ICT service sectors witnessed greater than an average industrial entry rates in Finland. It seems that various factors have lowered entry barriers in and facilitated entry to the ICT service industries: production of knowledge intensive goods, particularly digital versions that can be copied at almost zero cost, is typically less capital intensive than the production of traditional goods. Furthermore, the distribution and marketing of digital products may involve minor costs as they can be advertised and sold cheaply via the Internet.

The variables *ICT_manu_dmy* and *ICT_serv_dmy* are not statistically significant in the exit equation for all industries (see Table 3) – again consistent with our descriptive analysis. The negative sign and statistical significance of these variables in the estimated equation for the number of bankruptcies among all sample industries, instead, indicates that the ICT sector witnessed significantly less bankruptcies during the second half of the 1990s than the other industrial sectors. Low bankruptcy rates of ICT firms are probably related to the favourable financial conditions that high future profit expectations of ICT companies created for ICT start-ups during the sample time period. In fact, the estimated model for bankruptcies among ICT industries fails to explain inter-industry differences in the number of bankruptcies: none of the estimated coefficients of explanatory variables appears to be statistically significant.

Our estimation results suggest that, indeed, the role of market power and economies of scale as entry and exit barriers are different in the ICT sector than in other sectors. First, the measure of market power, variable CONCENT, is negatively and statistically significantly related to firm entry both among the sample of ICT and non-ICT industries. However, the estimated coefficient of variable CONCENT is clearly smaller (negative number) – suggesting stronger negative impact of industry concentration on entry - in the case of ICT industries than in the estimations regarding other industrial groups. The estimated coefficient of variable CONCENT appears not to be a statistically significant explanatory variable of entry among the sample of manufacturing industries.

Interestingly, variable CONCENT is also negatively and statistically significantly related to the ICT exit, whereas it is not a statistically significant explanatory variable of

[20] Unfortunately, the data (or insufficient number of observations in these industrial sub categories) did not allow us to estimate separately equations for ICT manufacturing and ICT service industries.

exit in the case of other industries. Our data thus suggests that, indeed, market power efficiently prevents entry to and also results in less exit from the network industries. Industry concentration seems to reduce the number of bankruptcies among non-network industries though the exit rates are not significantly affected by the concentration variable.

Economies of scale seems to form a notable entry and exit barrier among all of our sample industrial groups. However, we find, again, a notable difference between network and non-network industries. The estimated coefficient of the relative MES variable, SCALE_REL, is negative and statistically significant in the estimated entry equations for both ICT and non-ICT sectors (though not in the case of manufacturing industries). The absolute MES, SCALE_REL, is clearly negatively related to entry in all other estimated equations but not among the ICT industry sample. Similarly, our data suggests that the relative MES is clearly negatively related to exit among ICT industries, whereas the absolute MES fails to explain variation in ICT exit. Among the manufacturing and non-ICT sectors samples the absolute MES, instead, is negatively and statistically significantly related to market exit.

The data seem to suggest that among network industries large-scale firms as such do not form a notable entry/exit barrier unless the medium firm size in relation to the total industry output is large. In other words, it seems that large sunk investment costs matter as an entry barrier only if a typical incumbent ICT firm also captures a relatively large share of the industry turnover. Network effects and related consumer switching costs may explain this finding. Entry to network markets may become too risky or costly for a potential new firm if it not only involves substantial sunk investments in production but if success or survival in the markets also requires – due to economies of scale on the demand side - creation of a certain minimum market share or a customer base. In non-network industries, instead, only the absolute – not relative - minimum efficient size of the firms matters.

The R&D intensity variable does not explain statistically significantly variation in ICT exit but is negatively and statistically significantly related to ICT entry. Among manufacturing industries, the R&D intensity variable is negatively and statistically significantly related to entry, exit and bankruptcies – though the relation to entry is only weakly statistically significant - suggesting that R&D represents sunk costs forming both an entry and exit barrier. Among non-ICT sample, the R&D intensity variable is positively and statistically significantly related to entry giving some support to the view that there are more start-ups in the industrial environment with rapid technological change. Also, the estimation results regarding non-ICT industries suggest that there is a statistically significant relation between R&D and bankruptcies (though the R&D variable appears not to be able to explain variation in industry exit rates). This finding weakly supports Audretsch (1995b) who argues that rapid technological progress is a barrier to survival as it makes adjusting to the competitive environment more difficult. Overall, the estimation results regarding the R&D variable suggest that the relationship between the speed of technological change and firm entry and exit is highly industry-specific.

The industry size, variable *SIZE(t-1)*, is positively and statistically significantly related to entry, exit and bankruptcies (as expected) among all of our industry samples except the ICT sector. It seems that among network industries, the number of firms in the sector neither affects future entry nor bankruptcies though it is positively and statistically significantly related to the exit rates. Also, we find that the relationship between the or-

der of magnitude of previous year's market entry (variable ENTRY(t-1)) and exit is positive and statistically significant among all other samples but the ICT sample.[21] Among network industries more entrants did not mean notably more firms exiting the market during the years 1995-2000. Whether this phenomenon was typical only to the time period considered – the ICT boom of the late 1990s – cannot be evaluated until more data will become available. The variable ENTRY(t-1) was not able to explain statistically significantly variation in the number of bankruptcies among any of the sample industries.

Variation in the market or demand growth, variable SALES_GROWTH, was not able to explain differences in the entry, exit or bankruptcy rates among any of the sample industries.[22] Some previous empirical findings are consistent with this finding. For instance, the study of Audretsch and Acs (1994) suggests that the relationship between demand growth and entry is not statistically significant.

Macroeconomic variables, the GPD growth and interest rate, were used, respectively, to control for changes in the macroeconomic environment and macroeconomic policy. A higher GDP growth and lower interest rates were clearly related to less market exit among all industry samples, as expected. The estimations results of entry and bankruptcy equations were less consistent with our expectations. A higher GDP growth and lower interest rates were related to more entry among all industries and the sample of non-ICT industries. However, among ICT and manufacturing industries, the estimation resulted in opposite results: entry seemed to be positively related to interest rate and negatively related to the GDP growth. The macroeconomic variables failed to explain variation in the number of bankruptcies among ICT and manufacturing industries but the estimation results among the non-ICT industries were according to our expectations, i.e. the GDP growth negatively and interest rates negatively related to the number of bankruptcies.

Our empirical exploration has clearly shown that the factors affecting the entry to or exit from the industries vary substantially between non-network and network industries. In the next section, we will briefly summarize our major empirical findings and discuss their policy implications.

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[21] Ilmakunnas and Topi (1999) found a similar positive relationship using data from the Finnish manufacturing industries from 1998 to 1993.

[22] As the estimated exit models for the ICT and ALL samples did not converge when all explanatory variables were used, we removed a statistically non-significant SALES_GROWTH variable from the model to achieve convergence.

6 DISCUSSION AND POLICY IMPLICATIONS

Our empirical study suggests that the entry and exit dynamics of network industries clearly deviate from those of non-network industries. Our empirical findings strongly indicate that market concentration and economies of scale act as substantial entry and exit barriers among network industries. The data support our hypothesis that the special characteristics of network industries intensify the influence of market concentration and economies of scale for entry to and exit from the ICT sector. Due to network effects and consumer switching costs, a greater market power of incumbent firms is a greater barrier to entry and exit in network industries than it is in non-network industries. These empirical findings emphasize the importance of antitrust regulation and careful evaluation of potential anti-competitive consequences of mergers and acquisitions in network industries.

The role of innovation or R&D intensity in the industrial entry and exit patterns appears to be highly industry-specific. Among network industries, it seems that R&D expenditures form a notable sunk cost and that the incumbent ICT firms have substantial innovative advantage over potential new entrants efficiently inhibiting entry to highly innovative network industries. Among non-network industries, instead, R&D is positively related to market entry - suggesting that rapid technological change attracts more innovative start-ups - but also positively related to more bankruptcies indicating that a fast technological progress makes it harder to firms to survive and adjust to the competitive environment. Among manufacturing industries, the R&D expenditures seem to represent sunk costs preventing both entry and exit though its relationship to entry is only weakly statistically significant.

This empirical exploration is the first reported empirical study – according to the best knowledge of the authors – investigating differences in the determination of entry and exit between network and non-network industries. We used data from a small economy that was one of the most ICT-specialized industrialized country in terms of production and exports during the sample time period. Potential cross-country differences in the industrial dynamics – e.g., the determinants of entry and exit in network industries of less ICT-specialized and bigger countries than Finland - remain as an open question to be resolved by the further empirical studies. Also, our data covers the booming growth years of the ICT sector, 1995-2000, when various ICT industries were in their early stages of development. It would be interesting to see – when the data becomes available – whether and how the industrial dynamics changes when the ICT industries mature.

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Annex 1

Data classification by the OECD definition (ISIC rev. 3):

ICT manufacturing:

3000 Manufacture of office, accounting and computing machinery

3130 Manufacture of insulated wire and cable

3210 Manufacture of electronic valves and tubes and other electronic components

3220 Manufacture of television and radio transmitters and apparatus for line telephony and line telegraphy

3230 Manufacture of television and radio receivers, sound or video recording or reproducing apparatus, and associated goods

3312 Manufacture of instruments and appliances for measuring, checking, testing, navigating and other purposes, except industrial process control equipment

3313 Manufacture of industrial process control equipment

Services-goods related:

5150 Wholesale of machinery, equipment and supplies

7123 Renting of office machinery and equipment (including computers)

Services-intangible:

6420 Telecommunications

7200 Computer and related activities.

E L I N K E I N O E L Ä M Ä N T U T K I M U S L A I T O S (ETLA)
THE RESEARCH INSTITUTE OF THE FINNISH ECONOMY
LÖNNROTINKATU 4 B, FIN-00120 HELSINKI

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