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Exit And Entry Over The Product Life Cycle: Evidence From The Swedish Manufacturing Industry

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Exit and Entry over the Product Life Cycle: Evidence from the Swedish Manufacturing Industry

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Abstract:

In this paper the process of exit and entry of plants in the Swedish manufacturing industry is investigated within the framework of the product life cycle. The product life cycle theory explain how the high degree of uncertainty, as regards product designs and production methods, is connected to the early stages of the product life cycle requires a high level of knowledge-intensity. As uncertainty decrease over time less knowledge is needed in young industries. This implies that knowledge-intensity differs for plants that exit and enter in different stages of the product life cycle. Five hypotheses regarding these relationships are stated and empirically tested in this paper, using data at the 5 digit SIC-level for the Swedish manufacturing industry during 1990-96. The empirical results show that firms exiting and entering in the early stages of the product life cycle are more knowledge intensive than plants who exit or enter in later stages. There are also some indications that entrants in early stages of the product life cycle should be more knowledge-intensive than incumbents.

Key words: Exit, entry, product life cycle, knowledge-intensity, manufacturing industry

1 Introduction

Exit and entry of firms are fundamental elements of the structural development of different industries. Innovations and technical change are very important for a firm's decision to exit or enter the market. The mechanism of innovation and technical change can be explained by three activities. A firm can introduce a new technology, imitate an existing technology or remove an obsolete technology. New technologies are often embodied in physical capital and hence the exit and entry of plants are fundamental aspects of industrial structural change. The establishment of new firms/plants may, for example, be the result of entrepreneurs commercialising their innovations, entrepreneurs imitating other entrepreneurs' innovations, or entrepreneurs discovering new opportunities, due to changes in demand and profit opportunities. These forces are also important for the exit decisions of firms. When the production technique and/or the product becomes obsolete, demand declines, profits decrease and eventually firms have to consider exiting the market.

The process of structural change can be investigated in connection with the framework of the product life cycle theory. Some early thoughts within the life cycle concept were introduced during the early years of the 20th century (e.g. Kuznets 1929, Schumpeter 1939), but the probably most important contributions were made during the 1960s by economists such as Vernon (1966) and Hirsch (1967). The product life cycle describes the development of a product from innovation and introduction to the death of the product. During the life of a product, demand for different types of inputs such as knowledge and labour skills changes (Vernon, 1966). Firms that recently introduced a new technology or product are for example expected to need more qualified personnel than firms producing standardised products. This implies that firms that enter and exit the market in different phases of the product life cycle reveal different characteristics concerning the knowledge-intensity and skills of their employees. The objective of this paper is to analyse the exit and entry of firms within a product life cycle theory framework with special reference to innovation and knowledge-intensity.

This paper is organised as follows: Section 2 presents the theoretical framework. In particular the dynamics of exit and entry are connected to theories of the product life cycle and the labour skill characteristics over the cycle. The theoretical discussion results in five hypotheses regarding the connection between exit, entry and knowledge-intensity of firms. Section 3 describes the method, data and the empirical analysis. Conclusions and suggestions for future research are finally presented in section 4.

2 The entry and exit of firms - a product life cycle framework

The purpose of this section is to analyse the theoretical aspects of entry and exit in relation to the product life cycle. Subsection 2.1 discusses the product life cycle from a knowledge-intensity perspective. This is followed by a description of the pattern of exit and entry over the product life cycle.

2.1 Knowledge-intensity over the product life cycle.

The introduction of a new product on the market can basically be made in two different ways. A product can be either totally new to the market or it can be the result of a major change in an existing product. Irrespectively of the causes of the product innovation, the act of innovation is connected with fundamental uncertainty about for example customers' reactions and input requirements. When an innovator or early imitator enter the market he does not know which product design that is going to be the dominant design. The uncertainty connected to various aspects of the production and sales of a new product influence the characteristics and optimal structure of a firm within an industry in the early stage of the product life cycle. Magee (1977) clearly describes different aspects, such as information creation, skill intensities, other characteristics of production, the nature of the market, and appropriability, over the life cycle. In the early stages competition is high and firms and plants are usually small. The capital intensity in production is low and a lot of resources are instead devoted to R&D, customer contact, marketing, design improvements and equipment design. The intensity of skilled labour is of great importance during this stage. We therefore expect the knowledge-intensity of innovating firms and early imitators to be high.

In the early stages of the product life cycle customers have few possible suppliers to choose between and the demand for the product is therefore high in relation to what can be supplied by the market. Demand tends also to be both price and income inelastic. This, in connection to the absence of substitutes and perhaps the presence of patents, implies that the firms entering early in the product life cycle can benefit from market power and monopoly profits. However, some of the firms entering during early stages of the product life cycle, may not succeed in producing the dominant design and therefore might have to exit already before the product mature. The major force of competition during this early stage of the product life cycle is product competition, i.e. competition base upon product characteristics. (Karlsson, 1988)

The presence of monopoly profits creates incentives for more firms to enter the market. When the product becomes more and more standardised, firms can no longer entirely compete with product characteristics. When the new product and its characteristics becomes known to customers, the market expand gradually. In this stage customers become more and more sensitive to price, and over time the price decreases. During this later stage of the product life cycle the major type of competition is price competition. (Karlsson 1988) In order to compete with price most of the innovations during the later stages have the character of process innovations. The presence of economies of scale tend to result in larger plants, higher capital intensity, and a more concentrated industry structure (Magee 1977). Initially the process innovation activities also require skilled labour but eventually the process technique also becomes standardised. Since process innovations often result in production techniques that can be operated by less skilled labour, we could expect knowledge-intensity also for this reason, to decrease over the product cycle. As the frequency of process innovations increases, earlier used production technologies become obsolete. For some of the more knowledge-intensive firms, variable cost of producing might be higher than price, and they have to consider the necessity of exit.

Figure 2-1 illustrates the process of the product life cycle in relation to the knowledge-intensity needed for production during different stages. To summarise the discussion above, this means that knowledge-intensity tend to be high in the early stage of the product life cycle, and that it decreases over time. (Johansson and Karlsson, 1987)

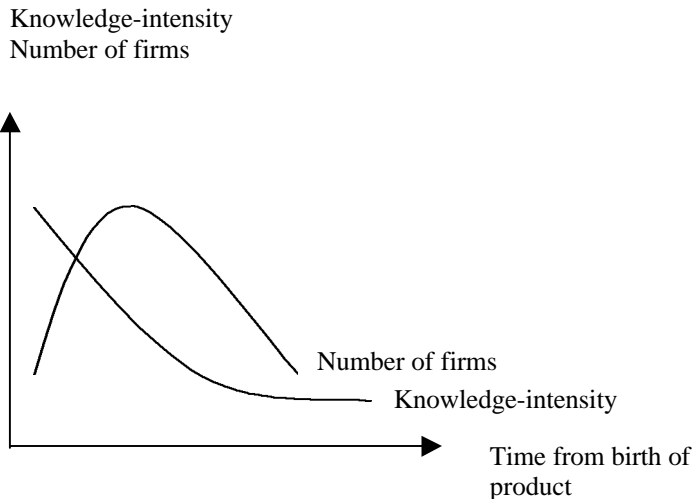


Figure 2-1: Knowledge and knowledge-intensity in a product life-cycle perspective

Source: Johansson and Karlsson 1987

The above description of the product life cycle concerned the characteristics of firms entering and exiting the market during different stages of the product life cycle. Another interesting feature to consider is the dynamics of innovation *within* incumbent firms during the development of different stages of the product life cycle. Consider a firm that has recently entered the market. As price competition increase over the product life cycle, each firm has to decide how to respond to these changes. There are basically three actions that can be taken, namely closing down, to invest in a new technology (process innovation), or to try to create a new product innovation. The decision to exit was briefly discussed above. Regarding the choice between process or product innovations, Klepper (1996) show in a theoretical model that producers, over time, increase their efforts concerning process innovation relative to product innovations. The model describes the incumbent's decision to remain in the industry and potential entrant's decision whether to enter or not. Each firm also has to decide how much process development and product R&D respectively to perform.. The emphasis on process development indicate, according to the discussion above, that one should expect the knowledge-intensity in entering firms to decrease over time.

2.2 Entry and exit of firms over the product life cycle

In this section we present a theoretical framework that makes it possible to identify the industries that are positioned in different stages of the product life cycle. A first step towards connecting the exit and entry of firms to the product life cycle perspective is to determine the patterns of entry and exit over the cycle. Figure 2-2 describes market development, exit and entry during the five phases that can be identified during the product life cycle (Gort and Klepper, 1982, Agarwal and Gort, 1996). In the first stage a new product is introduced and the number of producers is low. Net entry is positive and increasing. Eventually demand and supply increases rapidly, (stage 2) and the number of producers increases significantly. By the end of the period, exits increase due to stronger price competition. Stage 3 is characterised by a temporal equality of entrants and exits. In stage 4 exits exceed entry and this stage is known as the “shakeout period”. In stage 5 the market is considered as mature.

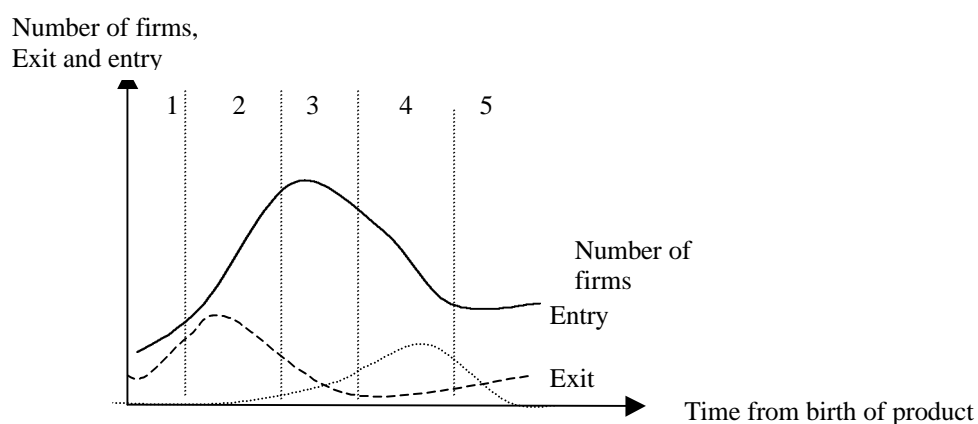


Figure 2-1: Entry, exit and number of firms over the product life cycle

Source: Agarwal and Gort, 1996

To summarise the above it seems as if net entry tends to be positive in early stages and negative in later stages of the product life cycle. This assumption makes it possible for us to identify the position of various industries in the different stages of the product life cycle.

2.3 Hypotheses

The description above can be concluded by stating some hypotheses about what to expect concerning the knowledge-intensity of firms during different stages of the product life cycle. We claimed that innovating firms need a high share of skilled labour to be able to handle the high degree of uncertainty connected to the early stages of the product life cycle. We also claimed that the major force of competition during early stages of the product cycle is product competition, and in order to outcompete existing firms by means of more advanced products, new firms must be more knowledge-intensive. We can therefore state the following hypotheses:

Hypothesis 1: Firms that enter the market during the early stages of the product life cycle are more knowledge-intensive than incumbents.

During later stages of the product life cycle firms mainly compete with the product price. In order to outcompete existing firms new firms must compete with lower costs and one way to accomplish that is to less qualified employees in the production. We therefore expect that:

Hypothesis 2: Firms that enter the market during later stages of the product life cycle are less knowledge-intensive than incumbents.

Due to the product competition, and the development of a dominant design, in early stages of the product life cycle we also expect that:

Hypothesis 3: Firms that exit in earlier stages of the product life cycle are more knowledge-intensive than firms that exit in later stages.

For the same reasons we predict that:

Hypothesis 4: Firms that enter in earlier stages of the product life cycle are more knowledge-intensive than firms that enter in later stages.

Since firms tend to put more effort into process innovation than to product innovation after they enter the market, we expect that:

Hypothesis 5: Knowledge-intensity in entering firms is decreasing over time.

At this stage it might be motivated to say a few words to clarify the differences and similarities between the five hypothesis. Hypotheses 1 and 2 *compare the group* of entrants with incumbent firms, while hypotheses 3 and 4 compare the knowledge intensity *within the group* of entering and exiting firms respectively. At last hypothesis 5 provide yet another perspective, since it refers to what happens *within the firm*.

3 Empirical analysis

3.1 *Method and data*

The data used in this paper is collected by Statistics Sweden and is covering the Swedish manufacturing industry. The data is collected for plants on a 5-digit SIC-code level. The fine industrial classification on 5-digit level corresponds to a great extent to what would be called a product and not a industry. Some examples might help us to understand how disaggregated the data is on the 5-digit level. Manufacture of cutlery and manufacture of pumps and compressors are examples of industries that are reported separately on the 5-digit SIC-level. The data material consists of about 280 different sectors and the total number of observations counts to about 8 000 plants each year. The data contains information about for example industry codes, sales value, wages and employment. The data covers the period 1990-96. Comparable data for the years before 1990 and after 1996 does not exist because of changes in industrial classification and data collection methods.

The value of salaries to white collar workers as a percentage of total labour costs is used as a measure for knowledge-intensity. The higher share of white-collar salaries of total labour costs, the higher the expected knowledge-intensity.

In order to identify the different stages of the product life cycle, all industries in the manufacturing sector were allocated to one of 6 groups. The characterisation was made according to the assumption stated earlier, that different stages of the product life cycle show different patterns of exit and entry. Early phases of the product life cycle show a positive net entry whereas entries are less than exits in the later stages of the product life cycle. Hence, it is possible to allocate industries into six different groups depending upon their different patterns of net entry. Group 1 had positive net entry all but one year during the studied period. Group 2 had positive net entries all but two years, and so on. Group 6 is corresponding to industries that had a negative net entry during the whole period. Group 1-3 is regarded as industries working in the earlier phases of the product

life cycle and group 4-6 are supposed to be declining industries. What kind of industries do we identify in the different stages of the product cycle? Among the industries that are working in the early stage we find for example sectors within the publishing, printing and reproduction of recorded media industry (SIC-code 22). Less successful are sectors for example in the manufacture of fabricated metal products and manufacture of machinery and equipment (SIC-code 28 and 29). Appendix 1 provides an overall description of the data material.

3.2 Empirical results

To test our hypotheses we use regression analysis. In this section the specification of the regressions and the results of the regressions testing the five hypotheses are presented.

Hypothesis 1: Firms that enter the market during the early stages of the product life cycle are more knowledge-intensive than incumbents

The tested regression relationship is formulated as follows:

$$KI_{Early} = \mathbf{a}_1 + \mathbf{b}_1 D + \mathbf{e} \quad \mathbf{e} \sim N(0, \mathbf{s}^2) \quad (1)$$

where KI_{Early} is the knowledge-intensity in plants working in early stages of the product life cycle and D is a Dummy variable taking the value 1 if entering plant, 0 otherwise. Since entrants are expected to be more knowledge-intensive, we expect a positive sign for \mathbf{b}_1 .

The empirical results are presented in table 1. The economic interpretation of the α_1 -coefficient is that the knowledge intensity in incumbent firms is generally a little bit more than 0,25, which means that 25% of the total salaries paid, are paid to white collar workers. The variable of our main interest, the \mathbf{b}_1 -estimate, have the expected positive sign during five of the six years, although only two years are significant at the 5%-level. We can therefore not totally reject the hypothesis about entrants in early stages of the product life cycle being more knowledge-intensive than incumbents.

Table 1. Regression results hypothesis 1

Year	Coefficients		Std. Error	t-value	p-value	R ² (adj.)	N
1991	α_1 -estimate	0,239	0,002	95,689	0,000	0,000	2984
	β_1 -estimate	-0,001	0,006	-0,185	0,853		
1992	α_1 -estimate	0,250	0,003	89,633	0,000	0,138	2845
	β_1 -estimate	0,186	0,009	21,323	0,000		
1993	α_1 -estimate	0,279	0,003	85,271	0,000	0,002	2729
	β_1 -estimate	0,027	0,010	2,709	0,007		
1994	α_1 -estimate	0,278	0,003	84,968	0,000	0,000	2826
	β_1 -estimate	0,013	0,010	1,278	0,201		
1995	α_1 -estimate	0,272	0,003	82,011	0,000	0,000	3025
	β_1 -estimate	0,011	0,010	1,183	0,237		
1996	α_1 -estimate	0,269	0,009	84,568	0,000	0,000	3201
	β_1 -estimate	0,005	0,009	0,599	0,550		

Hypothesis 2: Firms that enter the market during later stages of the product life cycle are less knowledge-intensive than incumbents.

The regression is specified as follows:

$$KI_{Later} = a_2 + b_2D + e \quad e \sim N(0, s^2) \quad (2)$$

were KI_{Later} is knowledge-intensity in plants working in later stages of the product life cycle and D is a dummy variable taking the value 1 if the plant is an entering plant, 0 otherwise. Since entrants are expected to be less knowledge-intensive in the later stages we predict a negative sign for b_2 .

The empirical analysis suggests that we should reject the hypothesis. The results presented in table 2, were no estimate of the b_2 -coefficient are significantly negative,

implies that there might not be any differences regarding the knowledge-intensity of entrants in different stages of the product life cycle. Perhaps entrants are more knowledge-intensive than incumbents irrespectively of what stage they are in the product cycle. The introduction of a product innovation might be the most important reason for a plant to enter the market.

Table 2. Regression results hypothesis 2.

Year	Coefficients		Std. Error	t-value	p-value	R ² (adj.)	N
1991	α_2 -estimate	0,234	0,002	140,749	0,000	0,000	6122
	β_2 -estimate	0,008	0,005	1,786	0,074		
1992	α_2 -estimate	0,245	0,002	141,200	0,000	0,001	5727
	β_2 -estimate	0,018	0,007	2,807	0,005		
1993	α_2 -estimate	0,259	0,002	129,356	0,000	0,012	5233
	β_2 -estimate	0,057	0,007	8,004	0,000		
1994	α_2 -estimate	0,260	0,002	127,360	0,000	0,000	5205
	β_2 -estimate	-0,001	0,007	-0,200	0,841		
1995	α_2 -estimate	0,250	0,002	122,455	0,000	0,000	5291
	β_2 -estimate	-0,002	0,007	-0,353	0,724		
1996	α_2 -estimate	0,248	0,002	122,983	0,000	0,000	5314
	β_2 -estimate	-0,007	0,007	-0,989	0,322		

Hypothesis 3: Firms that exit in earlier stages of the product life cycle are more knowledge-intensive than firms that exit in later stages.

The regression estimated is the following:

$$KI_{Exit} = a_3 + b_3 S + e \quad e \sim N(0, s^2) \quad (3)$$

were KI_{Exit} is knowledge-intensity in exiting plants and S is a stage variable ranging from 1 to 6, were 1 is the earliest stage in the product life cycle and 6 is the last stage.

The higher the stage the plant is in, the lower is knowledge-intensity. We therefore expect a negative sign for b_3 .

If we look at the estimations presented in table 3, the hypothesis about plants exiting earlier in the product life cycle being more knowledge intensive than plants exiting in later stages, can not be rejected. The predicted negative relationship exist during all years and are significant during the three last years.

Table 3. Regression results hypothesis 3

Year	Coefficients		Std. Error	t-value	p-value	R ² (adj.)	N
1991	α_3 -estimate	0,232	0,011	20,581	0,000	0,000	1408
	β_3 -estimate	-0,001	0,003	-0,695	0,487		
1992	α_3 -estimate	0,237	0,012	19,079	0,000	0,000	1212
	β_3 -estimate	-0,003	0,003	-1,070	0,285		
1993	α_3 -estimate	0,279	0,013	21,071	0,000	0,002	1294
	β_3 -estimate	-0,005	0,003	-1,849	0,065		
1994	α_3 -estimate	0,379	0,025	15,220	0,000	0,013	674
	β_3 -estimate	-0,018	0,006	-3,178	0,002		
1995	α_3 -estimate	0,331	0,025	13,443	0,000	0,010	503
	β_3 -estimate	-0,014	0,006	-2,426	0,016		
1996	α_3 -estimate	0,351	0,025	13,839	0,000	0,010	589
	β_3 -estimate	-0,016	0,006	-2,659	0,008		

Hypothesis 4: Firms that enter in earlier stages of the product life cycle are more knowledge-intensive than firms that enter in later stages.

The regression relationship is:

$$KI_{Entry} = \mathbf{a}_4 + \mathbf{b}_4 S + \mathbf{e} \quad \mathbf{e} \sim N(0, \mathbf{s}^2) \quad (4)$$

were KI_{Entry} is knowledge-intensity in entering plants and S is a stage variable ranging from 1 to 6, where 1 is the earliest stage in the product life cycle and 6 is the last stage. The higher the stage the plant is in, the lower is the expected knowledge-intensity. Hence we expect a negative sign for b_4 .

Also regarding this hypothesis we can not reject the hypothesis. Table 4 shows that five out of six years there is the expected and negative value of the β_4 -coefficient. The estimate is also significant at the 5% level four of these five years.

Table 4. Regression results hypothesis 4

Year	Coefficients		Std. Error	t-value	p-value	R ² (adj.)	N
1991	α_4 -estimate	0,246	0,011	22,263	0,000	-0,001	1182
	β_4 -estimate	-0,0012	0,003	-0,459	0,646		
1992	α_4 -estimate	0,589	0,031	18,940	0,000	0,093	676
	β_4 -estimate	-0,0649	0,008	-8,362	0,000		
1993	α_4 -estimate	0,240	0,023	10,588	0,000	0,015	688
	β_4 -estimate	0,0186	0,006	3,374	0,001		
1994	α_4 -estimate	0,316	0,022	14,571	0,000	0,005	743
	β_4 -estimate	-0,0118	0,005	-2,183	0,029		
1995	α_4 -estimate	0,305	0,020	15,312	0,000	0,005	788
	β_4 -estimate	-0,0111	0,005	-2,146	0,032		
1996	α_4 -estimate	0,297	0,019	15,496	0,000	0,005	791
	β_4 -estimate	-0,0109	0,005	-2,189	0,029		

Hypothesis 5: Knowledge-intensity in entering firms is decreasing over time.

The following regression is to be estimated:

$$KI_{Entry,t} = a_5 + b_5 D + e \quad e \sim N(0, \mathbf{s}^2) \quad (5)$$

were $KI_{Entry,t}$ is knowledge-intensity in entering plant at time t and t is time from entry where t=0 is time of entry the maximum value of t is 5. D is a dummy variable ranging from 1 to five capturing time from entry, were 5 is five years after entry. The longer time from entry the lower is knowledge-intensity, and hence we predict a negative sign for b_5 .

Regarding this hypothesis the empirical results presented in table 5 do not show any clear results. (Note here that any estimations for the year 1996 is not possible since no observations of knowledge-intensity are available for the year after.) The b_5 -coefficient show ambiguous signs and just two of the estimates are significant. We therefore reject the hypothesis about knowledge-intensity to decrease in entering firms.

Table 5: Regression results hypothesis 5

Year	Coefficients		Std. Error	t-value	p-value	R ² (adj.)	N
1991	α_5 -estimate	0,247	0,001	4,714	0,000	0,005	4281
	b_5 -estimate	0,005	0,001	4,714	0,000		
1992	α_5 -estimate	0,349	0,008	45,683	0,000	0,000	2255
	b_5 -estimate	0,002	0,004	0,555	0,579		
1993	α_5 -estimate	0,313	0,006	48,266	0,000	0,000	2223
	b_5 -estimate	-0,005	0,004	-1,321	0,187		
1994	α_5 -estimate	0,271	0,006	46,060	0,000	0,002	1863
	b_5 -estimate	-0,011	0,005	-2,318	0,021		
1995	α_5 -estimate	0,264	0,007	40,401	0,000	-0,001	1428
	b_5 -estimate	0,002	0,010	0,207	0,836		

The regression model specified to test hypothesis 5 basically tests if there are successive decreases in knowledge-intensity from the time of entry. During the data analysis, we got some indications regarding the process of knowledge-intensity. We observed that a decline in knowledge-intensity seems to occur the year after entry, and thereafter remain rather stable. This pattern would be interesting to study more thoroughly, both

empirically and from a theoretical perspective. Some more suggestions for future research and the conclusions of this paper are presented in the next chapter.

4 Conclusions and suggestions for future research

The comparisons between firms entering in different stages and incumbent firms (hypotheses 1 and 2) show a quite weak differences between knowledge-intensity in entering firms and incumbents. There are at least three possible explanations to this. The first interpretation of the weak results raise questions about the importance of process innovations. It might be the case that product innovations to some extent are of greater importance during the whole product life cycle, implying that process innovations are mainly made by incumbent firms. This is also indirectly what Klepper (1996) suggests, since he states that the most recent entrants account for a disproportional large share of the product innovations made. This relationship is also supported by empirical studies by, for example, Utterback and Abernathy (1975). Another explanation might be that costs and skill requirements during the start up period, are of such great importance that there is still indications of entrants being more knowledge-intensive in the later stages of the product life cycle. The presence of “learning by doing economies” would also give such results. The third explanation is connected to research made by for example Gibbons and Johnsson (1974). They state that it is common for entering firms to rely on external sources of knowledge, especially in the early stages of the development of a technology, something which our statistics is not able to capture.

The empirical results presented in this paper do not reject hypotheses 3 and 4, and hence firms that enter and exit in earlier stages of the product life cycle are more knowledge intensive than firms that enter or exit in later stages.

Regarding future research there are some methodological refinements that would be interesting and perhaps necessary to do. Of course it would be interesting study exits and entries over a longer time period. Another aspect of the method used is that it does not account for different length of the product life cycles. If some products go through the product life cycle in a very short time, this means that they might have gone through the cycle during the six years that are studied in this paper. The characterisation of different stages that is done here become then a bit misleading. A further development

of the empirical analysis would be to refine the characterisations of different stages using other criteria's for identifying different stages.

According to earlier research some technologies do not follow the pattern of the product life cycle, (e.g. Pavitt and Rothwell, 1976). Therefore it would be interesting, in the empirical analysis, to distinguish between industries that do follow the product life cycle, and industries that do not. In industries where economies of scale are not important one would expect that the process and product innovation pattern would work in a slightly different way.

5 References

Agarwal, R. and M. Gort, (1996), "The Evolution of Markets and Entry, Exit and Survival of Firms", *The Review of Economics and Statistics*, Vol. 78, 3:489-98.

Agarwal, R. (1997), "Survival of Firms over the Product Life Cycle", *Southern Economic Journal*, Vol. 63 3:571-84.

Gibbons, M and R. Johnston, 1974, "The Role of Science in Technological Innovation", *Research Policy*, 3:220-42.

Gort, M. and S. Klepper, (1982) "Time Paths in the Diffusion of Product Innovations", *Economic Journal*, Vol. 92 p 630-653.

Hirsch, S., (1967), *Location of Industry and International Competitiveness*, Oxford University Press, Oxford.

Johansson, B and C. Karlsson, (1987) "Processes of Industrial Change: Scale, Location and Type of Job" in M. Fischer and P. Nijkamp (eds.) *Regional Labour Market Analysis*, North Holland, Amsterdam, pp. 139-165.

Karlsson, C., (1988), *Innovation Adoption and the Product Life Cycle*, Umeå Economic Studies No. 185, Umeå University.

Klepper, S., (1996), "Entry, Exit, Growth, and Innovation over the Product Life Cycle", *American Economic Review*, Vol. 86, 3:562-84.

Kuznets, S., (1929), "Retardation in Economic Growth", *Journal of Economic and Business History*, 1:534-60.

Magee, S. P, (1977) "Multinational Corporations, the Industry Technology Cycle and Development", *Journal of World Trade Law*, 2:297-321.

Pavitt, K. and R. Rothwell, (1976), "A comment on 'A dynamic model of process and product innovation'", *Omega*, 4:375-77.

Schumpeter J A, (1939), *Business Cycles: A Theoretical Historical and Statistical Analysis of the Capitalist Process*, McGraw-Hill, New York.

Utterback J. M. and W. J. Abernathy (1975), "A Dynamic Model of Process and Product Innovation", Vol. 3; 6:639-56.

Vernon R. (1966), "International Investment and International Trade in the Product Cycle", *The Quarterly Journal of Economics*, Vol. 2, p.190-207.

Appendix 1: Number of observations incumbents, entries and exits 1991-1996

	Stage	1991	1992	1993	1994	1995	1996
Incumbents	1	54	63	56	83	87	103
Incumbents	2	445	447	429	443	476	554
Incumbents	3	2039	2015	1958	2022	2095	2163
Incumbents	4	2525	2537	2290	2212	2314	2367
Incumbents	5	1570	1559	1424	1406	1433	1428
Incumbents	6	1295	1246	1122	1126	1126	1114
Total incumbents		7928	7867	7279	7292	7531	7729
Entry	1	14	5	31	12	22	17
Entry	2	145	24	52	71	128	130
Entry	3	291	262	205	199	218	238
Entry	4	388	208	177	265	234	207
Entry	5	213	121	126	137	122	154
Entry	6	135	57	100	63	66	49
Total entry		1186	677	691	747	790	795
Exit	1	11	5	12	4	8	6
Exit	2	115	113	72	38	38	50
Exit	3	363	315	319	141	126	150
Exit	4	439	376	455	255	163	181
Exit	5	264	224	256	144	110	127
Exit	6	218	184	181	96	63	78
Total exit		1410	1217	1295	678	508	592