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# THE DETERMINANTS OF AGGREGATE PRODUCTIVITY*

## The evolution of micro-structures and productivity within plants in Finnish manufacturing from 1975 to 1994

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**ABSTRACT:** This empirical study investigates the importance of the micro-structural changes and within-plant productivity growth for the aggregate productivity growth in Finnish manufacturing in the period from 1975 to 1994. The aggregate labour productivity growth is decomposed into the entry-exit effect, the share effect, the cross term and within-plant effect. The entry-exit effect is decomposed further into four components. The results demonstrate that the importance of micro-structural changes has increased since the mid 80's. The productivity growth at the plant level, on the other hand, seems have followed a log-linear trend rather closely up to 1994.

The growth of total factor productivity is also decomposed into the micro-structural effects and within-plant effect. The micro-structural factors of total factor productivity consist of the share effect and entry-exit effect, which in turn is divided into two parts: the entry effect and the exit effect. The results are very much in line with the ones obtained from the analysis of the components of the labour productivity. The importance of the micro-structural changes for aggregate productivity growth gained some strength since the first half of the 1980's. The total factor productivity development at the plant level had negative tendency in the period from 1987 to 1991, but the growth was exceptionally rapid in the period from 1991 to 1994. The long-term trend of the plant level growth was exceeded fairly clearly by 1994.

The changes in the micro-structural factors play an essential role in the evolution of the manufacturing sector. The factors that prevent reallocation of the resources, obstruct at one and the same time the development of the performance and the competitiveness especially in the long and medium term.

**KEY WORDS:** Productivity, Finnish manufacturing, micro-structures, plant dynamics

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**TIIVISTELMÄ:** Tässä empiirisessä tutkimuksessa selvitetään mikro rakenteiden ja toimipaikkakohtaisen tuottavuuskasvun merkitystä aggregaattitason tuottavuuskasvulle Suomen tehdasteollisuudessa vuosina 1975-1994. Aggregaattitason työn tuottavuuskasvu on dekomponoitu neljään osaan, jotka ovat sisääntulo-ulosmeno (aloittaneet-lopettaneet toimipaikat) vaikutus, osuustekijä, ristitermi ja toimipaikkavaikutus. Sisääntulo-ulosmeno -tekijä on jaettu edelleen neljään komponenttiin. Tulokset osoittavat, että rakenteellisten tekijöiden merkitys on voimistunut 1980-luvun puolestavälistä lähtien. Sen sijaan toimipaikkatason tuottavuuskasvu näyttää seuranneen melko tarkasti logaritmista lineaarista trendiä aina vuoteen 1994 saakka.

Myös kokonaistuottavuuden kasvu on jaettu mikro-rakennetekijöihin ja toimipaikkavaikutukseen. Kokonaistuottavuuden mikro-rakennetekijät koostuvat osuustekijästä sekä sisääntulo-ulosmeno vaikutuksesta, joka puolestaan on jaettu kahteen komponenttiin: sisääntulo-vaikutukseen ja ulosmeno-vaikutukseen. Tulokset ovat hyvin samansuuntaiset kuin tarkasteltaessa työn tuottavuuden komponentteja. Mikrorakenteiden merkitys aggregaattikasvulle voimistui 1980-luvun alkupuolelta alkaen. Toimipaikkatason kokonaistuottavuudella oli laskeva suunta vuosina 1987-1991, mutta kasvu oli poikkeuksellisen nopeata vuosina 1991-1994. Toimipaikkatason tuottavuuskehityksen pitkän aikavälin trendi oli ylitetty selvähkösti vuoteen 1994 menessä.

Mikrorakenteiden muutokset ovat olennainen osa teollisuuden kehitystä. Tekijät, jotka estävät tuotannontekijöiden uudelleen kohdentumista heikentävät samalla teollisuuden suorituskyvyn ja kilpailukyvyn kehitystä erityisesti pitkällä ja keskipitkällä aikavälillä.

**ASIASANAT:** Tuottavuus, tehdasteollisuus, mikrorakenteet, toimipaikkadynamiikka

YHTEENVETO - Finnish summary

Tutkimuksessa selvitetään mikrorakenteiden muutosten sekä toimipaikkatason tuottavuuskasvun vaikutusta aggregaattitason tuottavuuskehitykseen Suomen tehdasteollisuudessa vuosina 1975-1994. Perinteisesti tuottavuuden kehitystä on tarkasteltu aggregaattitason tuottavuusmuutosten perusteella. Kun käytettävissä on tuotantoyksikkötason aineistoa, perinteisesti mitattava tuottavuuden muutos voidaan jakaa useisiin komponentteihin. Tässä tutkimuksessa käytetään hyväksi Tilastokeskuksen toimipaikkakohtaista teollisuustilastoaineistoa.

Tässä tutkimuksessa työn tuottavuuden (kiinteähintainen arvonlisäys/tehdyt työtunnit) muutos on jaettu sisääntulo-ulosmeno -vaikutukseen, osuusvaikutukseen, ristitermiin ja toimipaikkavaikutukseen. Sisääntulo-ulosmeno -vaikutus on jaettu edelleen neljään tekijään. Sisääntulo-ulosmeno -tekijän suuruus on riippuvainen siitä, mikä on poistuvien toimipaikkojen suhteellinen tuottavuustaso ja niiden panososuus sekä siitä, mikä on uusien toimipaikkojen suhteellinen työn tuottavuus ja niiden työpanososuus. Osuustekijä on positiivinen silloin, kun tuottavuudeltaan keskimääräistä paremmat toimipaikat kasvattavat panososuuttaan. Ristitermi on toimipaikkojen osuusmuutosten ja tuottavuuden muutosten yhdistelmä. Se on negatiivinen silloin, kun tuottavuuden kasvu on nopeinta panososuuttaan pienentävissä toimipaikoissa. Toimipaikkavaikutus kuvaa toimipaikkatason tuottavuuden kasvua. Siihen vaikuttaa keskeisesti tuotantoyksiköissä tapahtuva teknologinen kehitys, mistä syystä sitä on kutsuttu myös teknologia-komponentiksi.

Myös kokonaistuottavuuden muutokset voidaan dekomponoida. Tässä tutkimuksessa kokonaistuottavuuden muutos on jaettu sisääntulo-ulosmeno -vaikutukseen, osuustekijään sekä toimipaikkavaikutukseen. Koska kokonaistuottavuuden mitta ottaa huomioon työpanoksen lisäksi myös pääomapanoksen käytön, toimipaikkatason kokonaistuottavuusmuutokset kuvaavat vielä paremmin teknologista kehitystä kuin toimipaikkatason työn tuottavuus ja varsinkin aggregaattitason työn tuottavuus.

Työn tuottavuuden komponentteja koskevat tulokset osoittavat, että mikro rakenteiden tai ns. kilpailullisten tekijöiden merkitys on voimistunut 1980-luvun puolivälistä alkaen. Osuustekijän vaikutus oli noin yksi prosenttiyksikkö vuodessa 1980-luvun alkupuoliskolla, mutta yli kaksi prosenttiyksikköä 1990-luvulla. Sisääntulo-ulosmeno -vaikutus oli merkityksetön vuoteen 1985 saakka, jolloin sen merkitys nousi ja on ollut keskimäärin noin yhden prosenttiyksikön suuruinen sen jälkeen. Ristitermi on ollut keskimäärin noin 1,5 prosenttiyksikköä negatiivinen tarkasteluajanjaksolla. Kaikki mikrorakennetekijät yhdessä ovat nostaneet kokonaisaineistoilla mitatua työn tuottavuutta 1-2 prosenttiyksikköä vuotta kohti 1980-luvun lopulta lähtien, joten perinteinen työn tuottavuuden mitta kuvaa huonosti toimipaikkatason työn tuottavuuskasvua.

Työn tuottavuuden kasvun eri tekijöitä on tarkasteltu myös toimialoittain. Tulokset osoittavat, että rakennetekijät ovat olleet erityisen merkittäviä TeVaNaKe-alalla sekä sähköteknisten tuotteiden valmistuksessa. Ensimmäinen näistä on ollut voimakkaasti supistuva ala — eräänlainen auringonlaskun ala — ja jälkimmäinen nopeasti kasvava, auringonnousun ala.

Kokonaistuottavuuden dekomponoinneista saadut tulokset ovat pääpiirteittäin samansuuntaiset kuin edellä. Sisääntulo-ulosmeno -vaikutus oli mitätön 1980-luvun puoliväliin saakka, mutta on ollut sen jälkeen keskimäärin vajaa yhden prosenttiyksikön vuodessa. Osuustekijä puolestaan alkoi voimistua 1980-luvun alkupuoliskolla ja on ollut 1990-luvulla noin 1,5 - 2 prosenttiyksikköä vuodessa. Toimipaikkavaikutus seurasi verraten tarkasti log-lineaarista trendiä 1970-luvun puolesta välistä 1980-luvun loppupuolelle. Toimipaikkatason kokonaistuottavuuden kehityksellä oli laskeva suunta vuosina 1987-1991. Sensijaan vuosina 1991-1994 tuottavuuden kasvu oli poikkeuksellisen nopeata ja vuonna 1994 toimipaikkapohjainen tuottavuussarja oli selvästi pitkän aikavälin trendin yläpuolella.

Poikkeuksellisen nopea kokonaistuottavuuden kasvu toimipaikkatasolla vuosina 1991-1994 heijastanee mm. parantunutta käyttöastetta, mutta mahdollisesti myös teknisen kehityksen kiihtymistä tai teknisten tuotantomahdollisuuksien tehostunutta käyttöä. On myös mahdollista, että toimipaikkojen kokonaistuottavuus on parantunut normaalia nopeammin niiden sisällä tapahtuneiden rakennemuutosten vuoksi. Tuotantoyksiköt ovat ulkoistaneet palveluja, jolloin korkea tuottavuus jäljellejäävissä tehtävissä korostuu. Ammattitaidoltaan korkeatasoisten työntekijöiden suhteellinen osuus on saattanut kasvaa olennaisesti, kun tuotantoyksiköt ovat karsineet työvoimaansa, eli toimipaikkojen työpanoksen laadun parantuminen on voinut kiihtyä eräänlaisten mikro-mikro-rakenteellisten muutosten vuoksi. Nämä kysymykset vaativat tarkempaa tutkimista jatkossa.

Tarkasteltaessa tuottavuuden kehitystä on hyödyllistä erottaa toisistaan lyhyt ja vähän pitempi aikaväli. Osa panososuuksien ja tuottavuuden muutoksista toimipaikkatasolla on väliaikaista tai johtuu mittausvirheistä. Tästä syystä lyhyen aikavälin komponentit saattavat yliarvioida tai aliarvioida kyseisen tekijän merkitystä pitkällä aikavälillä. Tämän vuoksi dekomponointeja on tehty myös käyttämällä 5 tai 10 vuoden periodeja. Hyvin lyhyellä aikavälillä uusilla toimipaikoilla ei ole juurikaan myönteistä vaikutusta aggregaattitason tuottavuuteen. Monet uudet toimipaikat pystyvät kuitenkin parantamaan tuottavuuden tasoaan sekä kasvattamaan työpanososuuttaan vanhoja toimipaikkojen nopeammin, joten uusien toimipaikkojen myönteinen vaikutus tulee näkyviin vasta ajan kuluessa. Sisääntulo-ulosmeno - vaikutus kokonaisuudessaan näyttää 10-vuotisperioideilla suuremmalta kuin mitä voitaisiin vuosimuutoksista päätellä. Esimerkiksi ajanjaksolla 1985-1994, tämä tekijä kontribuoi noin 17 prosenttiyksikköä aggregaattitason työn tuottavuutta. Vuosimuutosten perusteella vaikutus on 11 prosenttiyksikköä. Sen sijaan lyhyen aikavälin osuustekijä näyttää yliarvioivan jonkin verran sen pitkän aikavälin kasvuvaikutusta. Osuustekijällä on ollut kuitenkin noin 10 prosenttiyksikön vaikutus työn tuottavuuteen ajanjaksolla 1985-1994. Samansuuntaisia, mutta pienempiä eroja lyhyen ja pitkän aikavälin tarkastelussa havaitaan myös kokonaistuottavuuden tekijöitä tutkittaessa.

Tämä, kuten eräät muualla tehdyt toimipaikkatasoiset tuottavuustarkastelut osoittavat, että rakenteelliset muutokset mikrotasolla ovat yksi olennainen osa kasvutapahtumaa, joten kehitystä ei pystytä kuvaamaan tarkasti ns. edustavan yrityksen mallilla. Rakenteellisten tekijöiden voi odottaa korostuvan erityisesti silloin, kun toimintaympäristö muuttuu nopeasti ja merkittävästi. Tällaisessa tilanteessa sektorin menestyksen kannalta on hyvin tärkeätä, että tuotannontekijät kohdentuvat tehokkaasti uusiksi kokoonpanoiksi sektorin parhaimpiin tuotantoyksiköihin. Juuri tällaisissa oloissa on syytä huolehtia siitä, että eri instituutiot ja politiikkatoimenpiteet eivät hidasta liiaksi mikrorakenteiden sopeutumista.

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# 1 Introduction

A representative firm (or plant) model misses the huge heterogeneity of units that may occur even within a very specifically defined class of units. Both the level and the growth rate of productivity differ between plants. Another elementary feature in the evolution of a sector is the continuing turnover process at the micro-level; low productivity units lose their market shares or disappear and new plants emerge. This paper demonstrates how the micro-structural changes among heterogeneous plants may contribute to the aggregate productivity growth. This issue has received increasing attention in recent years as comprehensive longitudinal databases on plants and firms have become available to researchers in many countries (see for example Jensen et al., 1997; Baldwin, 1995; Baily et al., 1996).

Especially since the late 80's, Finnish manufacturing has experienced turbulent phases, accompanied by considerable changes in competitiveness and future prospects, considerable downsizing of the labour force, etc. The sudden and big changes in economic environment have put the performance level and flexibility of the businesses and plants to the test with varying consequences. A large number of plants were closed down and the hours worked fell by more than 20 per cent in Finnish manufacturing in the period from 1990 to 1994. Some plants were able to increase their relative shares and some plants managed to improve their performance so that they survived.

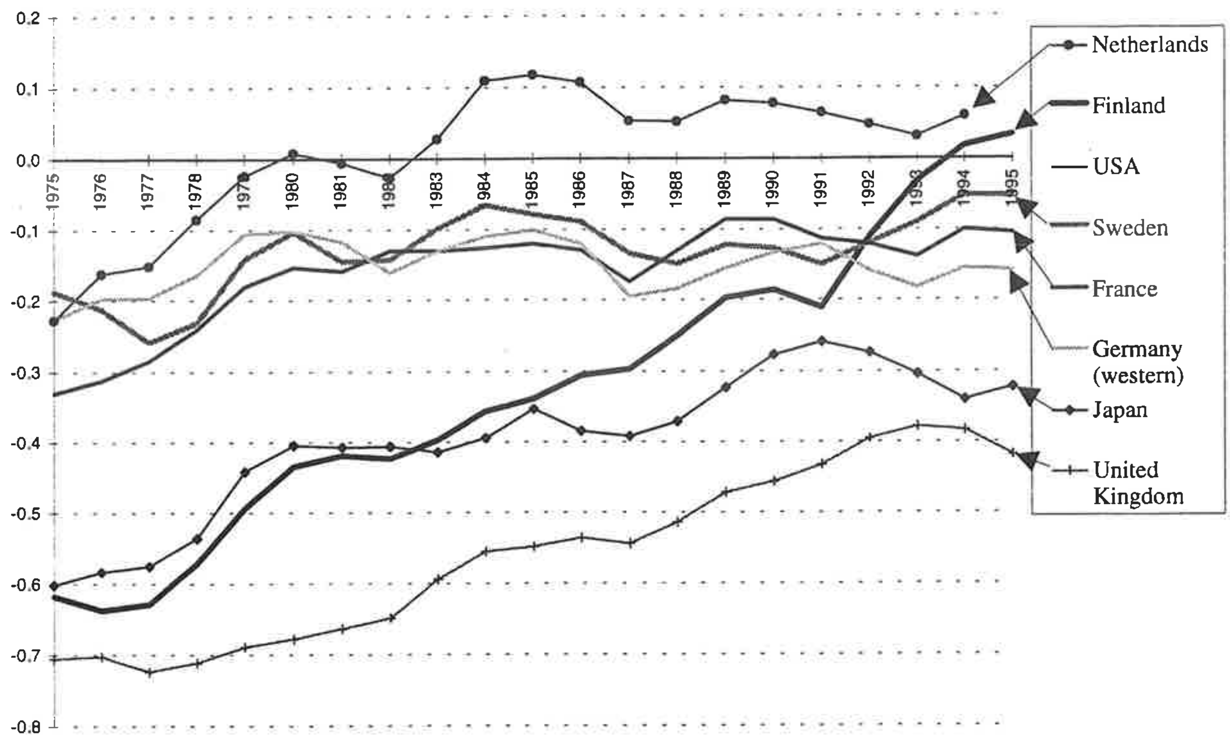
The focus of this paper is on micro-structural factors, i.e. what kind of role the different kind of factors have played in different time periods and different industries since the mid 70's. The plant-specific factors explaining differences in productivity levels and growth rates as well as the changes of market shares are beyond the scope of this paper. However such plant-specific factors as the spillover from the other plants in the same firm or in the same geographical location, skill level of labour force, managerial ability, production systems, export orientation, geographical location, etc. are of a great interest when outlining a broader picture on the evolution of manufacturing sector. The next natural step is to extend the analysis that direction (see Maliranta, 1997).

## 1.1 Some Findings from Studies on Comparative Productivity Levels by Sector

One of the major reasons for carrying out this study is illustrated in graph 1.1, which seems to indicate a notable catch-up process in Finnish manufacturing especially in the early 90's. While the improvement of the labour productivity level (real value added per labour hour) in relation to the United States stagnated in the leading European countries in the early 80's, the speed of the catch up in Finland remained quite steady at least until quite recently.[1]

[1] These results are based on the studies on comparative productivity levels by sector using the methods developed in the International Comparison of Output and Productivity (ICOP) project at Groningen University. The so-called industry-of-origin approach is followed in these studies, where value added by manufacturing industry is converted into a common currency on the basis of average unit value ratios for product samples. Each country's census of production and industrial survey was used as the basic data source for the measurement of labour input, value added in own currency and conversion factors required in the measurement of real relative labour productivity (see van Ark 1993).

**Graph 1.1. Real value added / hour, in log-differences, USA = 0, 1975-1995**




Source: Updated results from Maliranta (1996) that are based on the following studies: the level comparisons (with United States) of the Netherlands, France, Western Germany, Japan and United Kingdom obtained in ICOP project (see van Ark 1993), the level comparisons of Finland and Sweden in Maliranta (1996). In addition, the series of labour productivity growth rates in the countries in question for extrapolations are obtained from Bureau of Labor Statistics in the United States, Finnish national accounts and van Ark (1993).

The findings from the international comparisons of manufacturing labour productivity are of a great interest in many respects. The manufacturing sector still accounts for a significant share of the total employment and output in developed countries and therefore its labour productivity is associated with the prosperity of the nation, which is commonly measured by the GNP per capita ratio. A practical advantage of focusing on the manufacturing sector in the international comparisons lies in the fact that in most of the other sectors data problems are even more serious than in the manufacturing sector.

In addition to the result exhibited by the graph 1.1, several other findings about Finnish manufacturing sector were made in the international comparison of productivity with aggregate data sets.

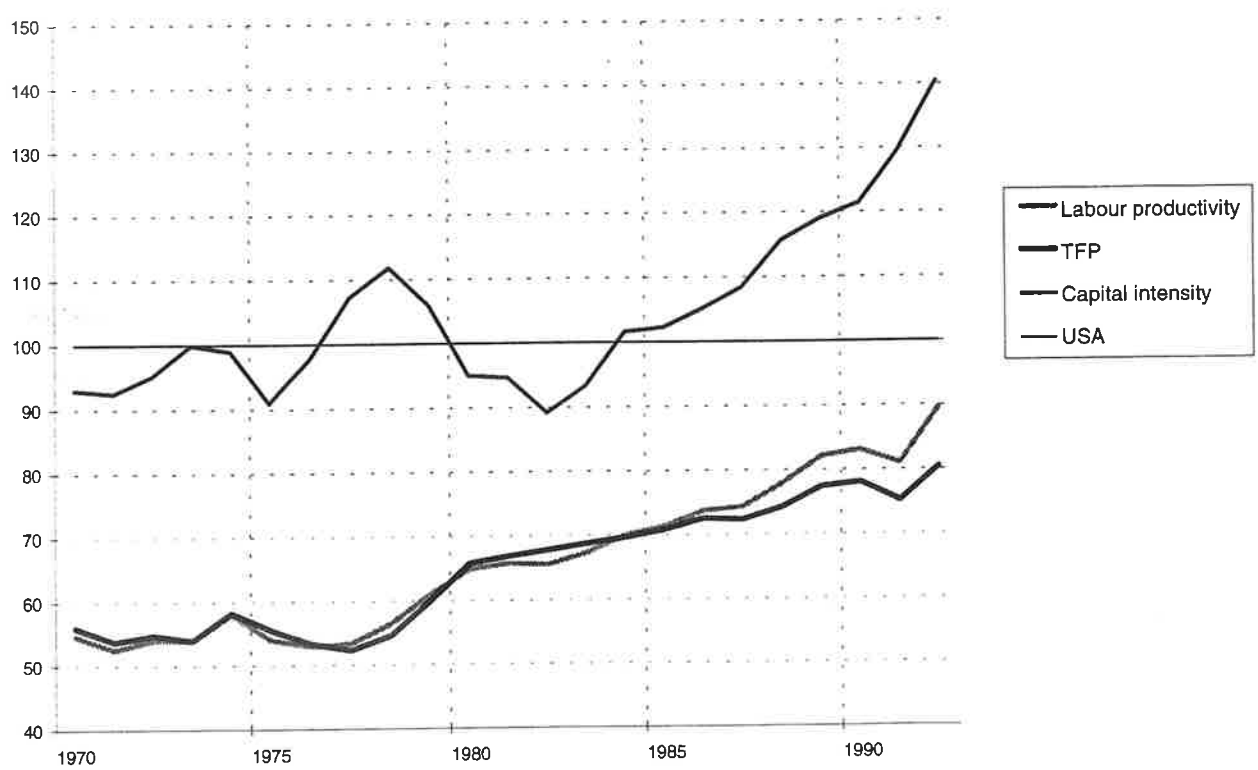
### 1. Catching up

There have been some dissimilarities in the catch up process among major branches of the manufacturing sector. During the last three decades the improvement of the relative labour productivity has been strongest in the basic metal industry and paper industry. In the food manufacturing, on the other hand, the catch up process did not attain into full speed until in the mid 80's in spite of the fact that starting level was quite low (see Maliranta, 1996).

## 2. Total factor productivity

The labour productivity measure may be inadequate as capital input is ignored. As there may be substantial differences in the capital intensity (capital input per labour input) levels as well as growth rates among countries, the labour productivity measure may lead to some delusive interpretations concerning for example the efficiency of the use of the resources or technological level and its development. Graph 1.2 shows the development of relative total factor productivity (TFP) in manufacturing, which is a weighted average of relative capital productivity and labour productivity. In addition, the relative labour productivity and relative capital intensity are presented in the same graph.[2] As graph 1.2 points out, the TFP measure gives a somewhat more modest picture of the Finnish relative performance level and the speed of the catch up process than the labour productivity measure since the mid 80's.

**Graph 1.2. Relative TFP, labour productivity and capital intensity, 1970-1992**




Source: Partly unreported results from (Maliranta, 1996).

## 3. Industry-mix effect on manufacturing productivity

According to graph 1.2, capital intensity was bigger in Finnish manufacturing than in the United States. This may be an indication that the labour input is substituted more intensively in Finland than in the United States so that more capital intensive production processes are chosen in Finland. This difference may be a result of different factor prices, for example. It is possible, how-

[2] Here capital input in both countries has been measured from investment series by using similar service life assumptions (17 years for machinery and equipment and 45 years for buildings and construction ). For scrapping it is assumed that the assets were retired uniformly between 20 per cent below and 20 per cent above the average service life. This method is used in several studies applying the ICOP-approach (see van Ark 1993, 393-394).

ever, that at a narrowly defined industry level the capital intensity levels are similar in both countries as the so-called factor price equalisation theorem predicts. But at the more aggregate level capital intensity levels may differ among countries because of the differences in the industry structure. This indicates that labour productivity comparisons should be done at a quite detailed industry level at least when the aim is to assess efficiency differences among countries at a given point of time (see Dollar — Wolff, 1993).

Labour productivity level in the manufacturing sector in one country may be relatively high because employment in that country is concentrated more strongly in those industries where capital intensity and absolute levels of labour productivity are high. For more detailed analysis of productivity differences between Finland and the United States, the manufacturing sector was divided into about forty subindustries. In 1987 the labour productivity in Finnish manufacturing was 74.3 per cent of the that of United States but when the compositional difference was adjusted the estimate fell to 69.6 per cent. In other words, the structure of the Finnish manufacturing was slightly favourable for labour productivity compared to the United States and so the labour productivity difference between Finland and the United States was typically bigger at the subindustry level than at the total manufacturing sector level.

## 4. Relative levels of Finnish labour productivity among manufacturing industries

There were substantial differences in relative labour productivity levels (in relation to the United States) among Finnish manufacturing industries (see table 1.1). The relative labour productivity levels were high in the paper industry and basic metal industry, which both happen to be rather capitalintensive industries. The relative position in Finnish manufacturing was worse in the food industry, beverage industry and tobacco industry. The relative position of a Finnish manufacturing industry seemed to be positively associated with its export share (export per production) so that comparative advantage in labour productivity appeared to lay in those industries that were the most open to the global competition.

**Table 1.1. Relative levels of labour productivity in 1987, USA=100**

| | Finland/USA Real Census Value Added/Person | Real Census Valued Added/Hour Worked | Sweden/USA Real Census Value Added/Person | Real Census Valued Added/Hour Worked |
|---|---|---|---|---|
| Food Products | 37.1 | 40.6 | 48.3 | 62.2 |
| Beverages | 51.2 | 55.4 | 50.6 | 58.9 |
| Tobacco Products | 60.5 | 67.0 | 80.3 | 92.8 |
| Textiles | 50.3 | 63.4 | 64.0 | 96.7 |
| Wearing Apparel | 60.7 | 67.1 | 54.3 | 71.7 |
| Footwear and Leather Products | 63.1 | 71.1 | 71.2 | 96.6 |
| Wood Products and Furniture | 66.0 | 76.7 | 70.2 | 88.3 |
| Pulp, Paper and Printing | 94.5 | 106.1 | 101.2 | 123.7 |
| Pulp and Paper | 101.9 | 110.9 | 94.3 | 114.1 |
| Printing and Publishing | 74.5 | 86.4 | 95.9 | 118.1 |
| Chemicals | 50.9 | 58.7 | 55.2 | 71.1 |
| Petroleum Refining | 98.3 | 106.7 | 155.7 | 150.7 |
| Rubber and Plastic Products | 61.0 | 72.0 | 81.2 | 111.6 |
| Stone, Clay and Glass Products | 61.8 | 71.7 | 74.3 | 98.2 |
| Basic Metals and Metal Products | 81.0 | 92.0 | 74.9 | 96.3 |
| Machinery and Transport Equipment | 67.9 | 75.5 | 59.3 | 73.8 |
| Electric Engineering | 59.3 | 64.1 | 60.3 | 76.9 |
| Other Manufacturing | 55.5 | 61.6 | 56.2 | 85.2 |
| **TOTAL MANUFACTURING** | **65.9** | **74.3** | **68.4** | **87.4** |

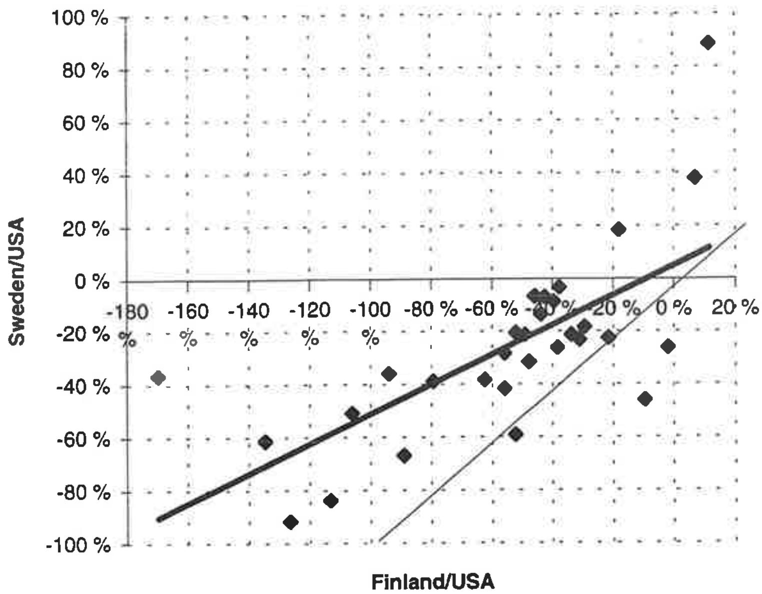
Source (Maliranta, 1996): More detailed description of the methodology is provided in van Ark (1993) and Maliranta (1996)

## 5. Similarities between Swedish and Finnish manufacturing in 1987

Also comparisons between Sweden and the United States were made in Maliranta (1996). The results of this comparison bore a great deal of similarities with the results obtained from the Finland-USA comparison. For the purpose of measuring relative productivity levels for Finland and Sweden, the price levels of each industry were measured for both countries. In both cases it appeared that relative price levels varied substantially among industries and subindustries. The industry structure of relative price levels turned out to be very much similar in Finland and Sweden. In other words, those (sub)industries in the Finnish manufacturing sector in which the prices were highest in relation to the United States were the ones in which the relative price levels were highest in Sweden, too, and vice versa. The similarity of the price structure among industries between Finland and Sweden might be expected and thus this observation gives some support to the approach applied in the price measurement.

Similar kinds of results that were obtained in the comparison of the price level structures between Finland and Sweden was obtained with relative labour productivity comparisons (see graph 1.3 and table 1.1). The Finnish and Swedish manufacturing shared same relatively strong and relatively weak (sub)industries. To sum up: whatever the factors affecting Finnish relative labour productivity are, a part of them is not solely associated with the Finnish specific factors (or measurement errors).

**Graph 1.3. Labour productivity differences among subindustries, in Sweden/USA and in Finland/USA comparison, 1987, log differences, USA=0**



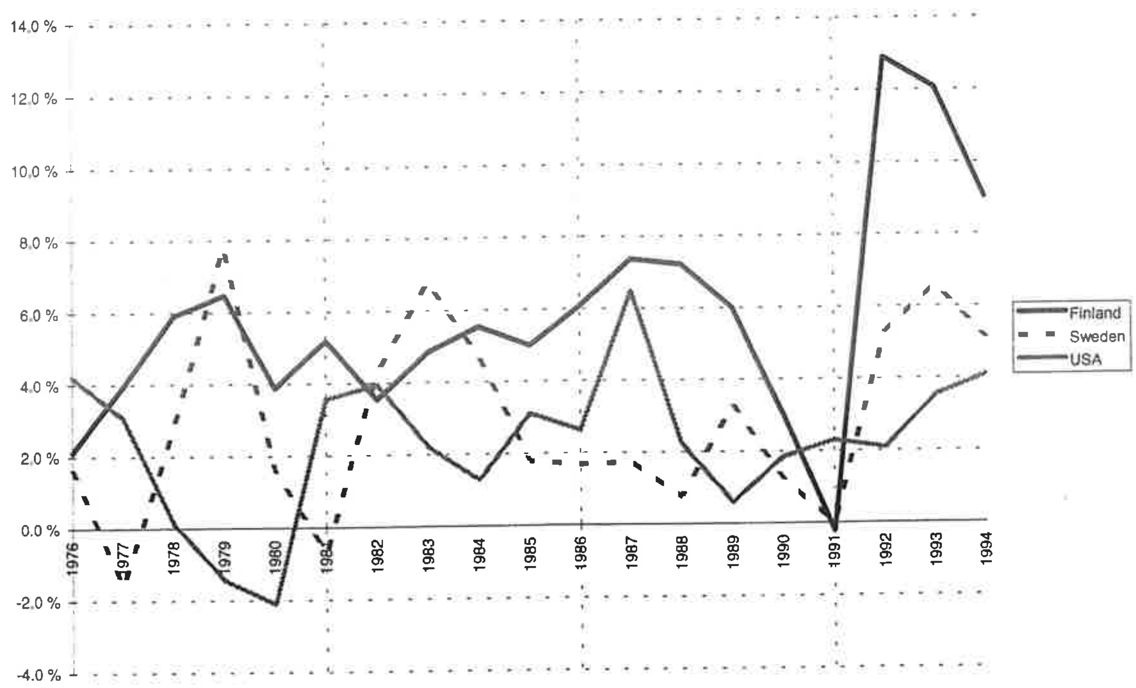

Source: Maliranta (1996).

## 1.2 Productivity evolution at plant level and at aggregate level

At the aggregate level a fairly large gap in labour productivity levels between Finland and the United States remained unexplained when the such factors as capital intensity, industry structure or plant size was studied. In addition, it seems that education level in Finnish manufacturing is relatively high. In spite of the steady catch up process in Finnish manufacturing during recent decades there seems to be still a considerable gap in total factor productivity levels between Finland and the United States. On the other hand, the labour productivity growth in Finnish manufacturing has been exceptionally fast, due to which Finnish manufacturing has climbed to the international top group in labour productivity level. As the graph 1.4 indicates, the labour productivity growth has been exceptionally fast in Finnish manufacturing in the early 90's unlike in the United States (or in the other important developed countries).[3]

[3] The series shown in graph 1.4 are subject to errors of many kinds, but this issue is ignored in this context. When the relative prices change, fixed-weight indexes may contain the so-called substitution bias resulting from the fact that consumers and investors tend to buy more of those goods and services that have became relatively cheaper. What is crucial for the international comparisons is that the magnitude of the bias may differ between countries depending on the characteristics of the economy or what kind of methods is applied in the construction of the volume series (see Dean et al., 1996). Furthermore, some bias may occur, for instance, because of the difficulties in adjusting quality improvements in the products. In different countries different kinds of methodologies are used for measuring computer prices, for instance, which may create inconsistencies in international comparisons of productivity (see Wyckoff, 1995 and Triplett, 1996). However, the central assertion that labour productivity growth in manufacturing has accelerated in Finland more than in most developed countries is maintained in all likelihood.

**Graph 1.4. Annual labour productivity growth in manufacturing, 1976-1994**




Source: The Bureau of Labor Statistics (for the United States and Sweden) and Finnish national accounts.

When interpreting results stated above, it should be kept in mind that they are based on the aggregate economic variables. Usually our ultimate concern is in the activities at the business unit level: how the various kinds of changes in the economic environment or the changes in the incentive schemes affect the decisions made at the plants or in the firms. The traditional approach to the empirical studies, based on the aggregate variables, is justifiable as far as the so-called 'representative firm' model is a good approximation to the reality. The bulk of empirical evidence on firm behaviour and performance around the world demonstrates huge heterogeneity in the distribution of decision making units along a wide variety of dimensions (see Jensen-McGuckin, 1997).

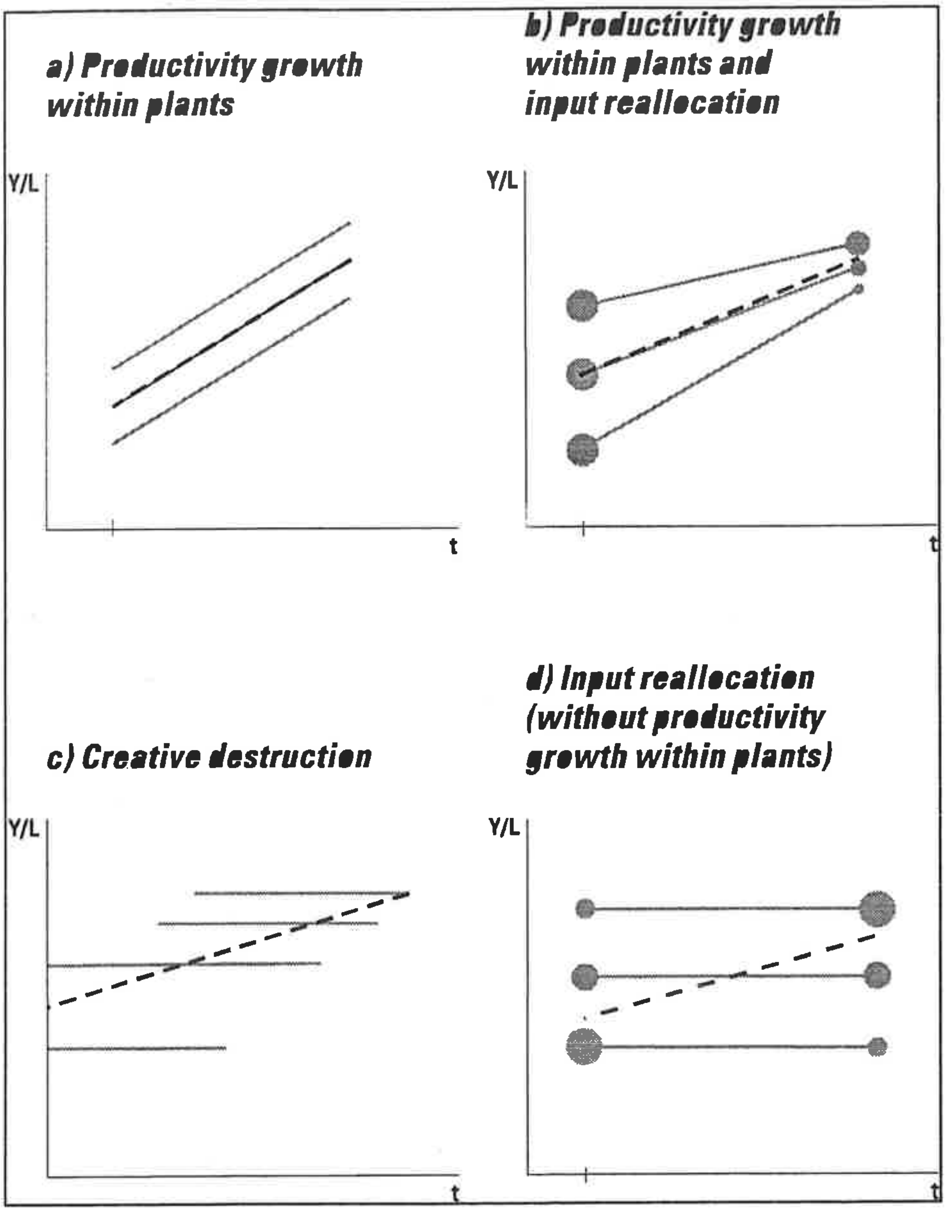
One of the main purposes of this paper is to study the factors of aggregate productivity in Finnish manufacturing in order to gain more detailed comprehension about exceptionally rapid catch up process since the late 80's until recently. Different sorts of micro-level determinants of aggregate labour productivity growth are illustrated in graph 1.5 and later the importance of these factors is studied with Finnish industrial production statistics.

Diagram (a) presents a situation where productivity growth within plants (solid lines) coincides with aggregate productivity growth (broken line) and in this case the 'representative plant' model is suitable for the analysis of the growth.

In diagram (b) there is heterogeneity among plants on both levels and in the growth rates of productivity. The spot indicates the magnitude of the labour input. The diagram illustrates that the swifter the downsizing of the labour input is, the faster the productivity growth. Because the determinant of aggregate growth presented in (b) is a combination of the changing labour input shares and the different growth rates among plants, this effect is henceforth called the cross effect, as described by Baily et al. (1996).

In diagrams (c) and (d) there is no labour productivity growth within plants even though aggregate data shows positive growth. In case (c) the aggregate growth is arising from the entry-exit process which can be described as 'creative destruction' according to Schumpeter (1939). In case (d) the entry-exit process is not occurring but the average growth is brought forth as the relative shares of labour input are increasing in the plants that have above average productivity level.

**Graph 1.5. Plant-level heterogeneity and aggregate development in productivity**




In all cases presented above, variation in labour productivity levels was allowed. Conceptually the factors affecting productivity levels can be divided into two parts. Technology available to the unit in question determines the level of potential output in a given amount input. Therefore part of the productivity differences may be 'natural' in a sense that production possibilities or production frontiers may differ between units because they are operating in different industries, using different technology or having different capital to labour input ratios to mention a few examples. In practice, a production frontier has to be estimated on the basis of available data and observable factors. Typically such observable plant-specific factors, which are extensively studied in the literature, are industry, size, location, ownership, for example. Ideally such factors as the quality aspect of technology, labour input or organisation should be accounted for in the determination of the unit-specific production frontiers but, unfortunately, those factors have almost without exception fallen into the category of the unobservable or the idiosyncratic factors. We are aiming to capture this sort of factors more explicitly in the future.

Specially in the empirical research, an increasing emphasis has put on the inefficiency, which has appeared to be substantial factor affecting productivity level. In other words, the level of output would be considerably higher if all plants were utilising fully their production possibilities. The definition of the production frontier, which has to be estimated for efficiency measurement, is rather clear: it is the maximum output technically possible for a specified amount of inputs. Strictly speaking, it is very difficult to determine what is possible for each unit.

The inefficiencies having some normative interpetation are traditionally assumed away in microeconomics. Profit maximisation implies that all resources are fully exploited. In a competitive environment inefficient units will not survive. In the light of empirical research since Leibenstein (1966) this approach seems to be, however, too restrictive when studying the determinants of economic development or competitiveness. Empirical research has shown that there may exist huge permanent differences in productivity levels even among otherwise similar business units. Case studies have shown that often profitability and productivity level can be improved markedly quite easily.

## 1.3 Data

The Finnish industrial statistics for the period from 1975 to 1994 is used in this study. The data set covers, in principally, all Finnish manufacturing plants having at least 5 persons. A researcher who is trying to become acquainted with this kind of data set may become troubled when realising the considerable amount of extreme outliers. It is certainly the case that for some reason or other some plants send poor quality data. For example, for multi-unit firms it may be difficult to divide costs between plants appropriately. In the following analysis we try to lean on the highly uncensored data sets. We are aware of the fact that a few extreme observation may have a significant effect even at the aggregate manufacturing level not to mention at a more disaggregated level.

In this study, however, our interest is mainly on the tendencies of the growth process at the total manufacturing level and in the some important industries and, as it will became apparent, although there is substantial short-term variation in many series, data problems do not prevent us from capturing some obvious changes in the aggregate productivity process since the mid 70's. Some deletion criteria, however, have to be applied. We are concentrating on the plants that are having industrial activities; thus for the analysis we exclude headquarters and auxiliary units. In addition, we exclude the plants having negative value added or less than 5 persons. For example, if a plant exhibits negative value added or its total employment drops below 5 person in some year, it is interpreted as a closed down plant.

For the subsequent analysis the total manufacturing is divided into 15 industries, which are shown in table 1.2. This classification corresponds approximately the one used in the Finnish national accounts nowadays. For brevity we call it NA classification from now on. Nominal value added and machinery and equipment (including transport equipment) investments of a plant is converted into 1990 prices by using implicit price indexes of a corresponding industry defined by NA classification. For the period from 1975 to 1984 also fire insurance values for different types of capital are available. Same deflators as for investments are applied, too.

**Table 1.2. Classification of plants into 15 industry groups (NA classification, see text)**

| Industry index, ISIC | Industry group |
|---|---|
| 310 | Manufacture of food, beverages and tobacco |
| 320 | Textile, wearing apparel and leather industries |
| 330 | Manufacture of wood and wood and cork products |
| 341 | Manufacture of paper, and paper products |
| 342 | Printing, publishing and allied industries |
| 351/2 | Manufacture of industrial chemicals (351) and other chemical products (352) |
| 353/4 | Petroleum refineries (353) and miscellaneous products of petroleum and coal (354) |
| 355/6 | Manufacture of rubber products (355) and plastic products n.e.c. (356) |
| 360 | Manufacture of non-metallic mineral products, except products in (35B) |
| 370 | Basic metal industries |
| 381 | Manufacture of fabricated metal products, except machinery and equipment |
| 382 | Manufacture of machinery except electrical |
| 383 | Manufacture of electrical machinery, apparatus, appliances and supplies (383) and instruments (385) |
| 384 | Manufacture of transport equipment |
| 390 | Others |

There are alternative output measures for plants. Because the so-called double counting is not a problem at the plant level, gross product could be used as an output measure. The problem is, however, that this output measure is heavily dependent on the intermediate input. The advantage of the value added measure is that it avoids double counting at the aggregate level. Because one of our interests is on the link between micro and macro level explanations of productivity growth, value added is a natural choice as an output measure of a plant.[4]

Although this study makes use of the implicit price indices from the national accounts and although the industrial statistics is the basic data source used in the national accounts, aggregate productivity results do not coincide precisely to the ones received from the national accounts. Contrary to the national accounts, some of the manufacturing labour input and output is excluded here as mentioned above. Secondly, the census value added measure may overestimate the growth of total value added in the manufacturing to some extent as manufacturing plants has outsourced non-industrial services during the time span.

# 2 Partial productivity measures

The so-called partial productivity measures are useful for many purposes because the data requirements are not very severe and these measures are quite easily calculated. Labour and capital input are the two central factors of production by which the plants create value added. Next we are trying to analyse and characterise the growth process by means of decomposing the labour productivity and capital productivity growth. The main interest here is how important a role the structural or competitive factors (i.e. entry, exit and changing shares) have played and, on the other hand, what kind of tendencies can be seen in the technology component, when it is evaluated on the basis of partial productivity growth within plants.

[4] In this study we employ the so-called census value added concept, which ignores non-industrial services. The advantage of this concept over the so-called total value added concept used in the national accounts is that the latter is more robust over the time span in the Finnish industrial production census. Census value added type measure is also applied in the international comparisons presented in graph 1.1.

## 2.1 Components of aggregate labour productivity growth

The aim is to evaluate the importance of the factors described in graph 1.5 in the Finnish manufacturing sector. The factors under investigation are:

1. Entry and exit (entry-exit effect)

2. Growth effect arising from the re-allocation of labour input shares among continuing plants that are having different productivity levels (share effect)

3. Heterogeneity in labour productivity growth rates and re-allocation of labour input shares among continuing plants (cross effect)

4. Labour productivity growth of the plants (within-plants effect).

### 2.1.1 Entry and exit

In order to measure the growth effect originating from the renewal of plant stock, the productivity growth is measured with two data sets. One consists of plants existing both at the beginning and at the end of the defined period (two years or more) and another set includes all plants in each year. Here the effect of the entry-exit is defined as a difference of the labour productivity growth rate measure obtained from these two data sets.

One of our ultimate issues of interest is how the relative importance of different factors changes in different periods and under different business conditions. In order to evaluate the tendencies and the regularities in the process during the time span, we are interested in year-to-year changes. Although the productivity measure usually indicates noticeable short-term variation in growth rates because of the inaccuracy or the changes in business conditions, we should, however make a long-term view on the productivity as emphasised by Baumol et al. (1989). For this reason it is of great use to extend the period to five or ten years, for example.

The measurement of the entry-exit effect (ENTEX) in the period from the year $t$-$s$ ($s \geq 1$) to the year $t$ can be measured as follows

(2.1) $$ENTEX \equiv \frac{LP_t^A}{LP_{t-s}^A} - \frac{LP_t^S}{LP_{t-s}^S},$$

where LP is labour productivity (real value added per hour worked), $A$ refers to the data set containing all the plants in the year in question, $S$ refers to the data set comprising the plants existing both in $t$-$s$ and in $t$ (the survivors).

The effect of entry-exit consists of four components:

1. The relative productivity level of the plants exiting next period

2. The relative labour input (hours) share of the plants exiting next period

3. The relative productivity level of the entering plants

4. The relative labour input share of the entering plants.

The effect of these factors can be presented and measured in the following way. Let us turn to the log-differences. We redefine the entry-exit effect by using log-differences (*entex*)[5]

(2.2) $$entex = \log\left(\frac{LP_t^A}{LP_{t-s}^A}\right) - \log\left(\frac{LP_t^S}{LP_{t-s}^S}\right)$$

$$= \underset{(I)}{\log\left(\frac{LP_{t-s}^S}{LP_{t-s}^A}\right)} + \underset{(II)}{\log\left(\frac{LP_t^A}{LP_t^S}\right)},$$

where the log refers to natural logarithm.

The term *(I)* — exit-effect — can be developed further by realising that

(2.3) $$LP_{t-s}^A = \left(1-w^D\right)\cdot LP_{t-s}^S + w^D \cdot LP_{t-s}^D,$$

where $w^D = \frac{L_{t-s}^D}{L_{t-s}^A}$, $0 \le w^D \le 1$.

*L* indicates the amount of labour input and *D* refers to the data set containing only those plants not existing in the year *t*. By inserting (3) into the term *(I)* we obtain

(2.4) $$\log\left(\frac{LP_{t-s}^S}{LP_{t-s}^A}\right) = -\log\left(1 - w^D\left(1 - \frac{LP_{t-s}^D}{LP_{t-s}^S}\right)\right).$$

Normally the labour productivity level is low among the plants disappearing in the near future, thus usually $\frac{LP^D}{LP^S} < 1$.

Under these circumstances, the lower $LP^D$ or the higher $w^D$, the greater is the positive effect of exit for aggregate labour productivity growth.

In a similar way we can render the term *(II)* in (2.2) — entry-effect — into the following formula:

(2.5) $$\log\left(\frac{LP_t^A}{LP_t^S}\right) = \log\left(1 - w^E\left(1 - \frac{LP_t^E}{LP_t^S}\right)\right),$$

where $w^E = \frac{L_t^E}{L_t^A}$ $(0 \le w^E \le 1)$ is the labour input share of the plants that exist in *t* but not in *t-s* and *E* refers to the data set containing only those plants (the entering ones).

[5] In small changes, log-differences approximate ordinary percentage differences quite closely.

Usually $\frac{LP^D_{t-s}}{LP^S_{t-s}} < \frac{LP^E_t}{LP^S_t} < 1$ at least with small values of $s$ and thus the term (2.5) is generally negative, because then the term inside the outer brackets on the right side of equation (2.5) is less than one. In addition, as $w^E < w^D$ in Finnish manufacturing since the mid 80's then the sum of the terms *(I)* and *(II)* was positive in that period.

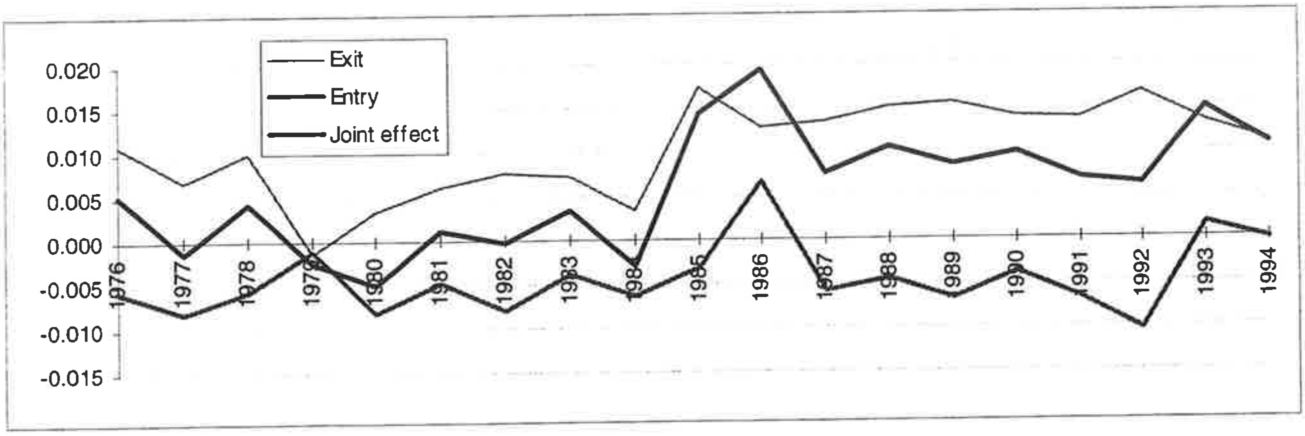
The effect of entry-exit component to the annual changes (s=1) of the aggregate growth is shown in the graph 2.1 (in log terms), graph 2.8 and in the table in the appendix. Until the year 1984 the entry-exit effect had played an insignificant role, but the importance of this effect rose to a bigger magnitude in 1985 and has been crucial ever since.

Graph 2.1 also illustrates the elements of the entry-exit effect in Finnish manufacturing. Taken as a whole, the entry effect has been quite stable and slightly negative in the short term, excluding a few exceptions. The short-term exit effect, in turn, has been positive and in addition quite noteworthy and stable since the mid 80's.

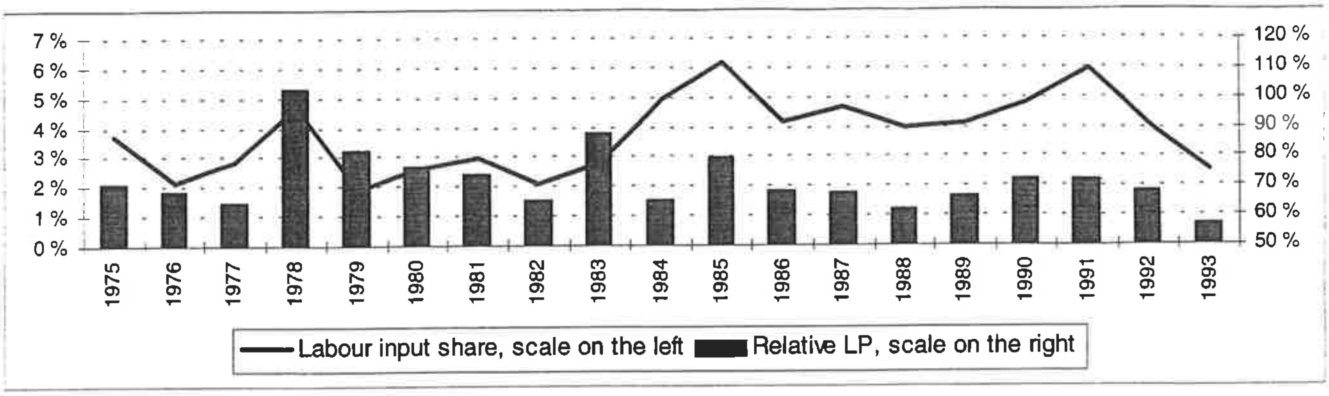
Graph 2.2 reveals that the labour input share of the plants to disappear the next year increased in the mid 80's and has been at a higher level since then. Furthermore, there seems to be a slight downward tendency in the relative labour productivity levels among disappearing plants since the early 80's. In other words, the disappearing plants had a bigger share of labour input (an increase in $w^D$ in equation (2.4)) and were weaker since the late 80's than earlier (an increase in $\left(1 - LP^D_{t-s}/LP^S_{t-s}\right)$ in the equation (2.4)).

The relative labour productivity level of the newly entered plants has fluctuated considerably in the course of time, but on the average, the relative level of labour productivity — likewise the relative labour input share — was higher during the period from 1985 to 1994 than during the first half of the 80's (see graph 2.3).

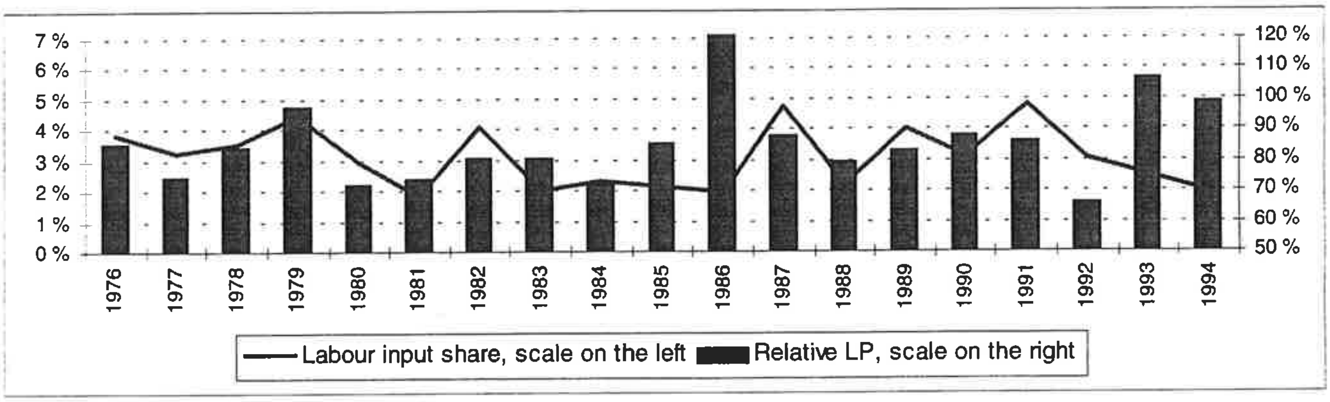
**Graph 2.1. Decomposition of the entry-exit effect on the aggregate labour productivity growth in Finnish manufacturing, log changes**



**Graph 2.2. Components of exit effect, relative share in the previous year**




**Graph 2.3. Components of entry effect**




N.B.: The relative level of labour productivity among newly entered plants in 1986 was 135 %. See also graph 2.5.

In previous graphs 2.1 to 2.3 annual changes were studied. Graph 2.4 indicates that the plants show clearly below average labour productivity three and two years before disappearance. In addition, the relative labour productivity level seems to decrease as 'doomsday' gets closer.[6] As graph 2.4 shows, the relative labour productivity level was rather high in the preceding three years among the plants that disappeared in 1992 or 1993. On the other hand, in 1994 mainly those plants which had been quite weak in terms of relative labour productivity in the near past were the ones to disappear. This could be expected as the economic situation normalised by 1994. In this respect the year 1994 resembles 1989, when the previous boom in the Finnish economy occurred.

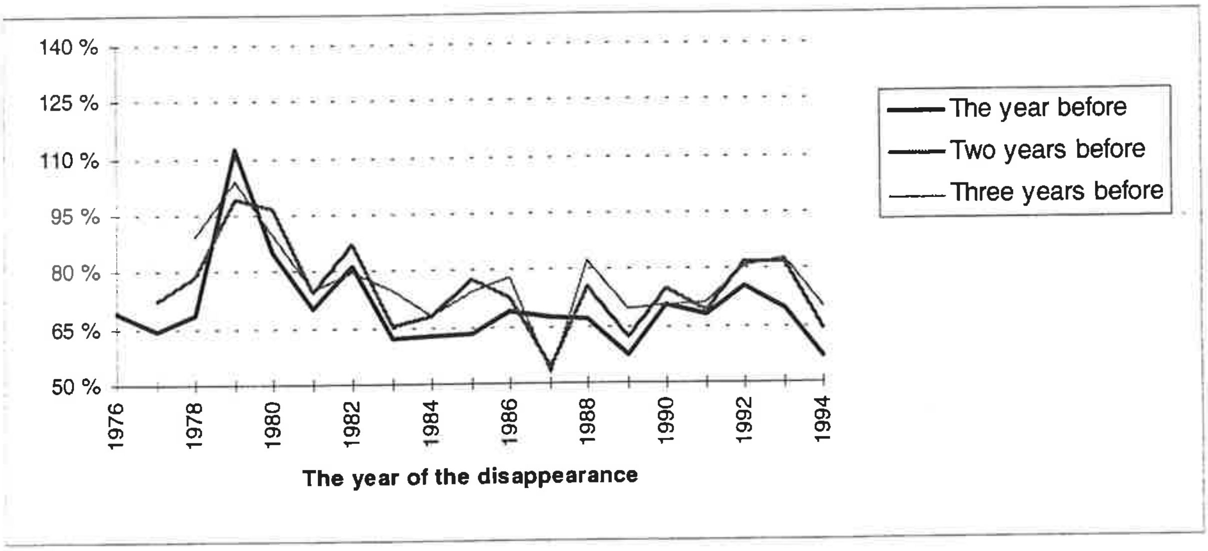
Although the relative labour productivity level of the one-year-old plants was, on average, lower during the period from 1975 to 1984 than since the mid 80's, graph 2.5 suggests that the relative level improved more rapidly in the subsequent years in the first half of the period under study.

This is the place to note some defects in our data set. As can be seen in graph 2.2, a considerable amount of plants disappeared in 1979. A recession in that year provides a partial explanation for this. Two things, however, lead to some doubts. Firstly, in 1978 the relative labour productivity level was exceptionally high among the ones to disappear in 1979. Secondly, there was a vast amount of entries in 1979 (see graph 2.3).

[6] The relative levels in graph 2.4 and 2.5 do not always coincide with the results shown in graph 2.2 and 2.3. Firstly, the reference levels are defined differently (see text). Secondly, entry and birth do not necessarily mean the same thing. Here the birth is defined as the first appearance during the period from 1975 to 1994. Sometimes a plant disappears and makes a new entry later.

A closer look at the data reveals that the plant code changed for a large number of plants in 1979. It was possible to match the older and proper code for 660 plants with the help of the enterprise code, address and some other variables.[7] It appears, however, that not all miscodings could be corrected. On the other hand, the plants that disappeared covered about 4 % of total labour hours, which is about 2 percentage points above the normal level of those times. Thus this kind of defect may have some effect on an annual change but is of a little importance in the long-term considerations. Other defects that may explain year-to-year variation in aggregate labour productivity components at least partly cannot also be ruled out[8]. One should, however, pay attention mainly to the tendencies and long-term effects when interpreting the results.

**Graph 2.4. Labour productivity level of the plants having zero, one or two years left relative to the plants having at least three years left**




Note: The productivity level of the disappearing plants is compared with the plants in operation at least three more years — except for 1992 and 1993 the disappearing plants are compared with those in operation in 1994.

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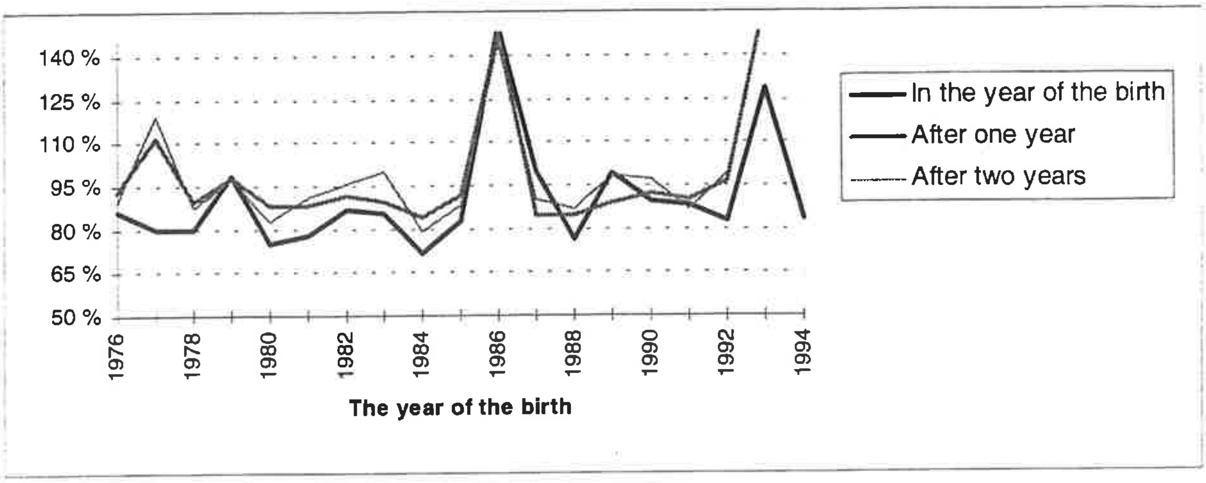
[7]Some breaks offs could also be recognised and corrected between 1975 and 1976 (some 400 cases) and between 1979 and 1980 (about 50 cases). The whole period was checked but no flaws could be detected in the plant codes.

[8]At varying intervals the Finnish industrial production census is supplemented by plants found in other registers. This happened, for example, in 1991. This explains why there was a big increase in the number of plants in spite of the severe economic slump at the time. There was also an increase in the labour input share of the plants that appeared in that year (see graph 2.3).

**Graph 2.5. Labour productivity level of the plants being in operation one year, two years and three years relative to the plants in operation more than three years**

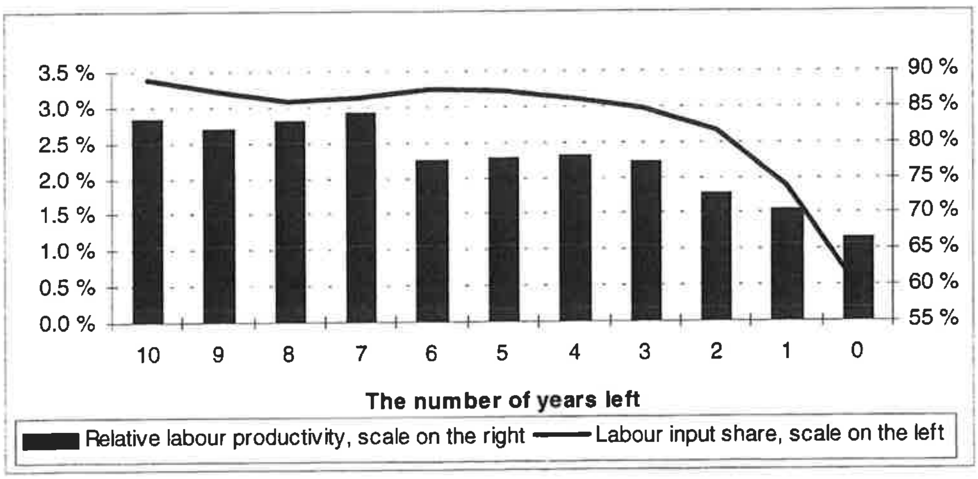



Note: The productivity level of the newly born plants is compared with the plants in operation already three years earlier except for plants that were born in 1976 or 1977, where the comparison is made with the plants that existed already in 1975.

In fact the process of exit begins many years before the final disappearance. In order to take a longer view of the process, the average relative labour productivity levels — measured now with nominal value added — is calculated for the plants having ten years, nine years etc. left — averaged over the period from 1982 to 1993. Graph 2.6 shows that the relative labour productivity level was a little more than 80 per cent of the average level of labour productivity as early as a decade before the death. The decrease of the relative labour productivity level accelerates a few years before the death and just before the death the labour productivity has been two thirds of the average level. The decrease of the labour input share among the plants to disappear begins about four years and is especially fast in the last two years before the death.

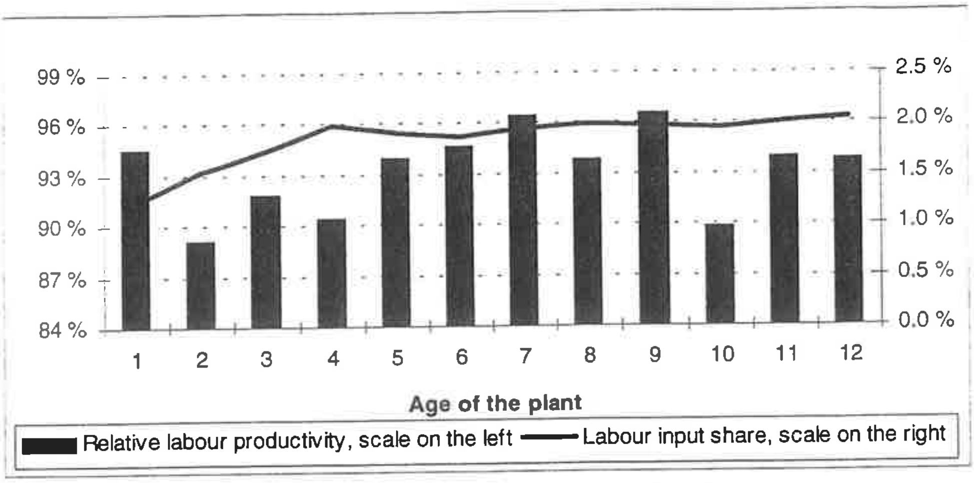
A similar kind of investigation is performed for the purpose of looking at the entry process. Graph 2.7 illustrates how the relative labour productivity level is rather low in the first few years but the level is clearly improved in about seven years. It is pointed out for example by Baldwin (1995) and Klette et al. (1996) that the probability of the disappearance is quite high in the newly born plants. But as the graph 2.7 indicates the growth of those plants that manage to survive outweighs the loss caused by the disappearing ones so that labour input share increases especially in the first few years.

**Graph 2.6. Decaying process of the plants, averaged over the period from 1982 to 1993**




N.B. Labour productivity is measured here by nominal value added per hour

**Graph 2.7. Evolution of the new plants, averaged over the period from 1982 to 1994**




N.B. Labour productivity is measured here by nominal value added per hour

### 2.1.2 Components of aggregate labour productivity growth among stayers

Thus far we have studied how the aggregate labour productivity is affected by the fact that the plant stock is renewed through the disappearance and the appearance of plants. Next we will look at the dynamics among staying plants. Henceforth we make use of a decomposition method applied by Baily et al. (1996) for a full panel of US manufacturing plants from 1972 through 1988. Unlike Baily et al., we are not making use of one full panel of the plants over a long period, but at the first stage several full panels are constructed, each consisting of the plants in two successive years.

The three components of annual labour productivity change are the 'within-plant' effect, a labour input share component and a cross term. The components of the labour productivity change from year *t-s* to year *t* can be calculated by following formula:

$$(2.6) \qquad \frac{\Delta LP_t}{LP_{t-s}} = \frac{\sum_i \phi_{t-s,i} \Delta LP_{t,i}}{LP_{t-s}} + \frac{\sum_i \Delta\phi_{t,i} LP_{t-s,i}}{LP_{t-s}} + \frac{\sum_i \Delta\phi_{t,i} \Delta LP_{t,i}}{LP_{t-s}},$$

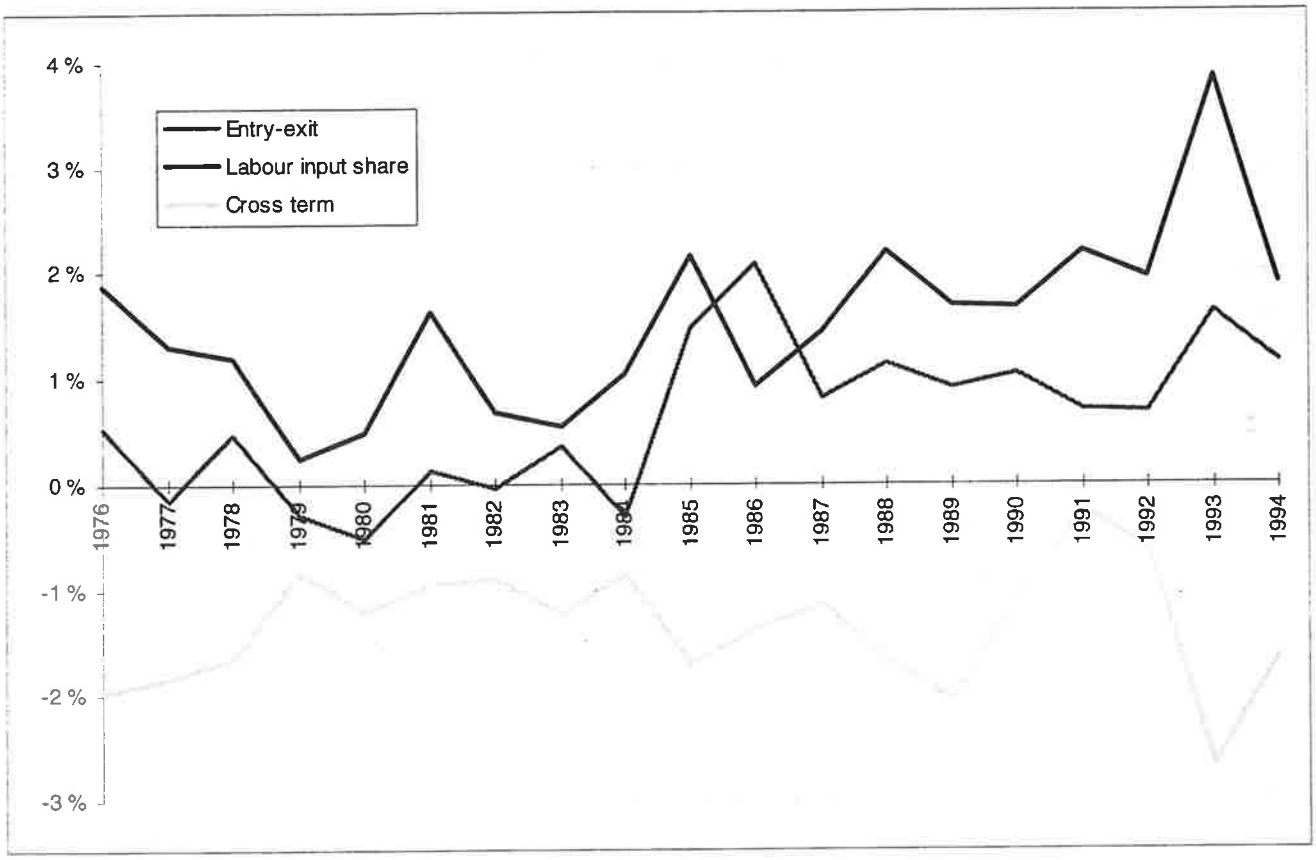
where *LP* is real value added per hour, $\phi_i$ is the labour input share of plant *i*.

The results of this decomposition with s=1 are shown in graph 2.8 and in the table in the appendix. The effect of the labour input share shows a clear upward trend and this effect contributed from 2 to 4 percentage points to the annual aggregate productivity growth in the 90's. The entry-exit effect (ENTEX) varied to some extent hand in hand with the labour input share effect, which could be expected as these processes are related to each other. The cross term, on the other hand, seems to be some kind of mirror image to the entry-exit effect.

The period from 1992 to 1993 deserves some further attention. A recovery from the economic slump was already emerging in Finnish manufacturing at the time. As can be seen in graph 2.2, the exit effect still existed but it is interesting that while some new high productivity plants emerged in 1993 they accounted for a relatively small share of the labour hours (graph 2.3). The graph 2.5 seems to suggest that those plants were even stronger in 1994. On the other hand, as the labour input share of those plants was relatively small, the possibility that a random effect or some kind of measurement error plays some role should not be ruled out.

However, the labour input share component in the graph 2.8 seems to confirm that something real and exceptional happened between 1992 and 1993. The graph 2.8 suggests that there was also an outstanding re-allocation of labour input shares among stayers. Firstly, the plants with an above average labour productivity level had increased their labour input share to a greater extent than before. Secondly, the cross-term was significantly negative, indicating that the plants with an above average growth rate accounted for a declining share of labour input. These results seem to suggest that in the period from 1992 to 1993 the gainers were those plants which had managed to reach high labour productivity performance earlier as well as those low productivity plants which were able to adjust their labour input[9]. These results bear a resemblance to what happened in the US manufacturing sector in 1981, but these results are economically even more significant than in the United States (see Baily et al. 1996, page 7).

**Graph 2.8. Effect of entry-exit, labour input share and cross term for the annual aggregate labour productivity growth rate**




The process of the decline or the increase of a plant's share is not typically a smooth one. There is a lot of short-term variation in the input shares and a substantial share of annual increase or decline of a plant's employment share is reversed in the subsequent years (see Baldwin, 1995). This may be caused by the fact that economic fluctuations are not necessarily synchronous among plants or that there may be temporary measurement errors in labour input figures. These features may have an essential effect on the components of aggregate growth in the short term periods as will be seen.

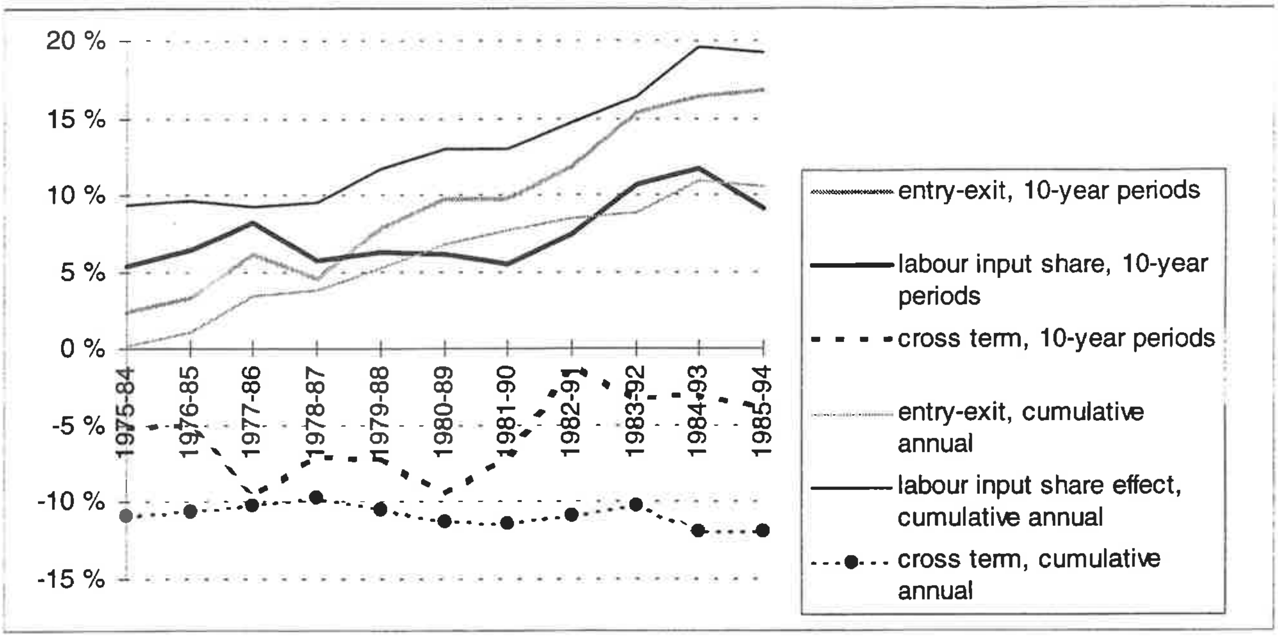
[9] When interpreting a particular year-to-year change as in this case one should bear in mind that problems with data may bias the results. We could not locate any such data problems that could give rise to the results reported above, unlike in the case of the year 1979 or 1991 (see footnote 8), where some explanations for the surprising results could be traced.

Let us consider a case where a plant's labour input figure is too small in a certain year because of a measurement error and therefore the labour productivity level of the plant is overestimated. Next year the labour input is measured correctly and thus the change of the labour input share for the plant in question is overestimated — this plant contributes positively the share effect in our calculations. The plant's productivity growth, in turn, is underestimated — together with overestimated share growth — tending to make the cross term negative. Thus, the obvious negative correlation between share component and the cross term may be explained by the fact that the short-term variation in labour input measure plays an important role in the annual changes of the components under study.

As we are interested in the long-term implications of structural factors we have examined changes in the longer periods, too. Also the problems described above are moderated by lengthening the period of the measurement. For graph 2.9 the structural factors are calculated in two different ways. The components of aggregate labour productivity growth are calculated for 10-year periods (s=9). These results are exhibited in graph 2.9 by thick black, grey and broken line. The main results remain unaltered: both the entry-exit effect and share effect are positive and their contribution has increased during the time span. On the other hand, the relative significance of these components is reversed when turning from annual changes to the longer periods. In the period from 1985 to 1994 the entry-exit effect has contributed some 17 percentage points and the share effect less than 10 percentage points.

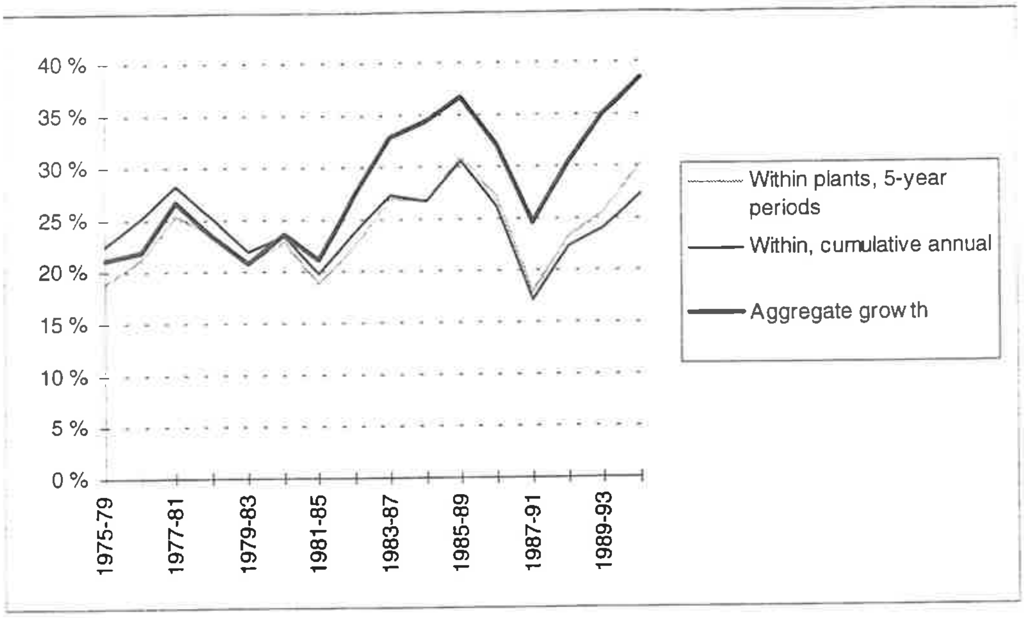
As graphs 2.2, 2.3, 2.6 and 2.7 points out in the short term entry and exit is quite insignificant in terms of labour input share but, on the other hand, over a longer period the effects are cumulated and eventually they play an essential role in the evolution of the manufacturing sector. For the purpose of comparison we have calculated cumulative effects of annual components (shown in graph 2.8) over the 10-year periods and the results are indicated by thin black, grey and broken line. As might be expected, the cumulative impact of the share effect is clearly bigger than the that which is calculated directly for 10-year periods. The difference is about 10 percentage points in the period from 1985 to 1994 and less in the earlier 10-year periods. The cumulated entry-exit effect, in turn, seems to underrate a longer term effect of the renewal of the plant stock. Also the results concerning the cross term are in line with our expectations: the cross term is negative and the short-term component overrates the importance over a longer period.

**Graph 2.9. Structural factors in 10-year periods**




To conclude the analysis of the factors of aggregate labour productivity growth, graph 2.10 points out that the aggregate level measure poorly describes the plant level development or technological change, for example. Although aggregate level series suggests that the labour productivity growth has accelerated during the course of time — leading to some speculation on the nature of technological change among other things —graph 2.10 denotes that the explanation for the acceleration lies rather in the structural factors. Another reason why the aggregate labour productivity indicator is a deficient measure of technological change is that it ignores an important factor of production, namely the capital input, which is taken into account later.

Graph 2.10. Aggregate labour productivity growth and within-plant effect




## 2.2 Decomposition of the labour productivity growth by industries

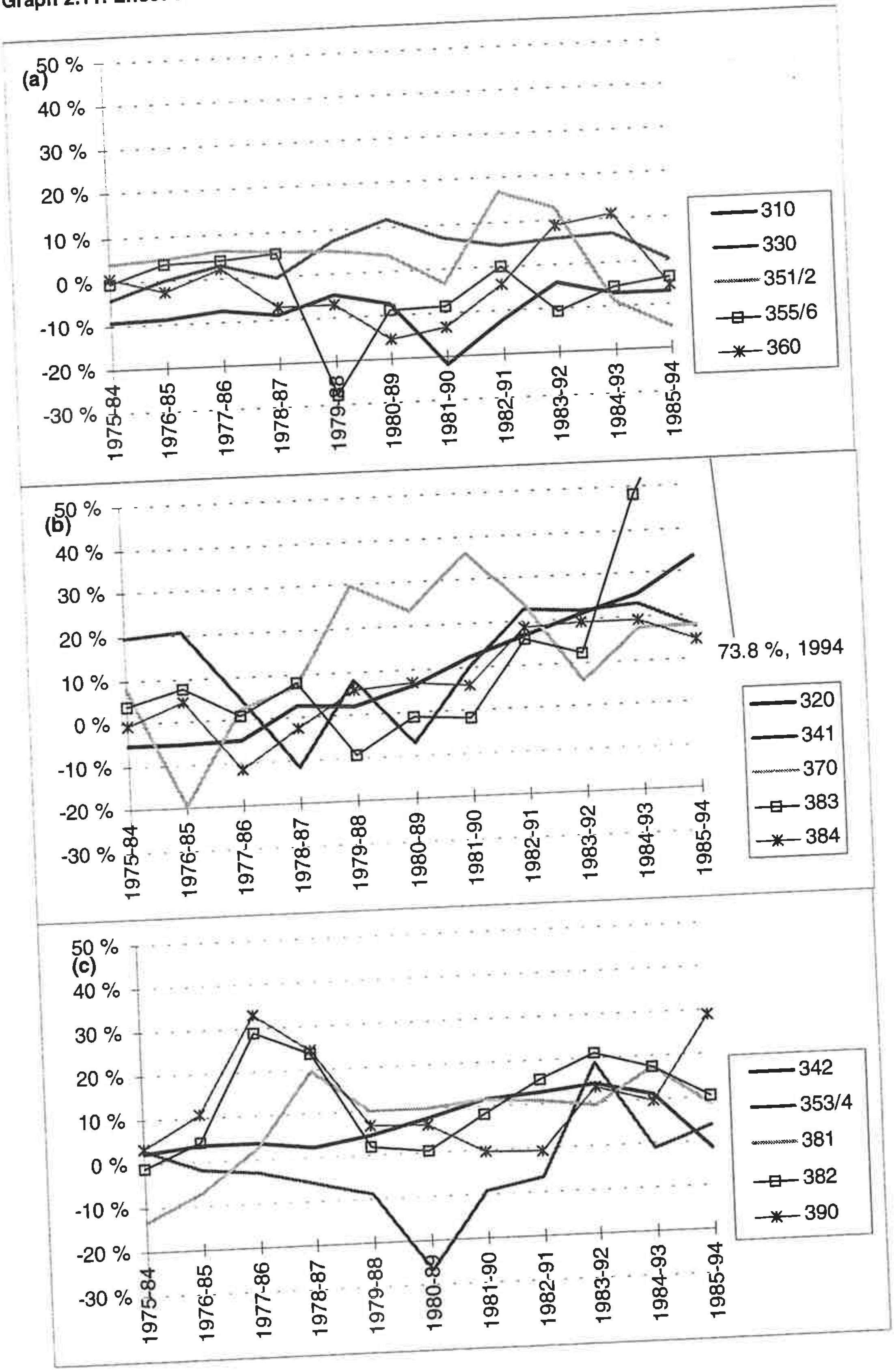
Above it was studied how the different kinds of plant level occurrences have affected the aggregate growth at the total manufacturing level. The extent of entry and exit and the growth rate, as well as many other characteristics of the plants vary between industries and thus the plant level dynamics is also associated with the changes in the industry structures. In the following three graphs the importance of micro-structural or competitive factors to the aggregate growth in the long term (s=9) is studied by industries.

In graph 2.11 (a) those industries are presented in which the difference of the aggregate growth and plant level growth is relatively small. This group included such industries as the manufacture of food, beverages and tobacco, which produces products mainly for domestic consumers, and the industry (ISIC 360), which produces among other things supplies for the domestic building industry.

The industries from the other extreme is shown in graph 2.11 (b). The most striking case is the industry ISIC 383, which contains the manufacture of communication equipment and apparatus — a very rapidly growing and very important industry for Finnish manufacturing. The significance of structural factors has also grown a lot in the textile, wearing apparel and leather industries (ISIC 320) — the industry which has experienced the swiftest downsizing since the late 80's. In other words, the competitive factors have been the most noticeable in the most typical sunrise and sunset industries in the Finnish manufacturing in the period from 1985 to 1994. The all competitive components (entry-exit, labour input share and the cross term) by industries are shown in the appendix. In the ISIC 383, all structural factors had positive effect, which is quite exceptional. In the textile industry in turn, entry-exit effect has dominated.

At the aggregate level comparisons (see table 1.1) between Finland and the United States it appeared that the performance level was relatively good in Finnish paper industry (ISIC 341) and basic metal industry (ISIC 370) in 1987 and, furthermore, the improvement of the performance level seems to have been also considerable in these industries. In both of these industries the plant level dynamics has also played a crucial role. The relative labour productivity was lowest in the food and beverage industry, where, as we saw in graph 2.11 (a), the competitive factors have had a more negative than positive effect.

**Graph 2.11. Effect of structural factors on aggregate labour productivity growth in industries**



## 2.3 Capital input and capital productivity

Along with labour input, capital input is another important factor of production. Although there are many sorts of problems in the measurement of capital input especially at the micro-level, it should be taken into account for its great importance to plant's potential output and labour productivity. On the basis of the findings reported by Jensen and McGuckin (1997) it seems quite possible that capital-labour ratios may differ between plants even within a quite narrowly defined industry and for that reason considerable effort has been put on the accurate measurement of plant-level capital input.

We use several capital input measures for the purpose of being able to assess the robustness of our results. Machinery and equipment stock (machinery stock henceforth for brevity) is measured in two ways. Fire insurance value of machinery stock is available over the period from 1975 to 1984. These values are converted into 1990 prices by implicit industry specific (NA classification) machinery and equipment investment deflators obtained from the national accounts. For the purpose of obtaining suitable capital input measures for the whole period from 1975 to 1994 the machinery stock is calculated from real investments (deflated by same deflators as fire insurance values) series by using the so-called perpetual-inventory method (PIM), which uses the following relation:

(2.7) $K(t+1)= (1-\delta)*K(t)+I(t+1),$

where $K(t)$ is the net stock of physical capital at time $t$, $I(t+1)$ is the flow of investments during period $t+1$, and $\delta$ is a constant depreciation rate. To apply this method we have to have an estimate of the depreciation rate and the initial stock $K(0)$. Usually the depreciation rate of machinery and equipment is assumed to be 12-15 % (see Morrison, 1993). In this study we use the value of 15 %.

The initial machinery stock of a plant is determined here as an industry specific (NA classification) proportion of fire insurance value of its machinery stock. The industry specific proportion is estimated in the following manner. We wish that our measure of the net capital stock is constructed in a way that is as consistent as possible with fire insurance value measure as far as the growth of capital input at the aggregate industry level is concerned during the period from 1975 to 1984. We picked out those plant's having positive fire insurance value of machinery stock in every year in the period from 1975 to 1984.[10] To derive a net capital stock measure by means of PIM we took the sum of investments in these plants. The initial stock of aggregate net capital (in 1975) is a proportion of aggregate gross capital (fire insurance value). For each industry the initial stock $K(0)$ in 1975 is defined by

(2.8) $K(0)=X*$*fire insurance value of machinery stock in 1975.*

The proportion $X$ is determined in the following way:

*minimise standard deviation [log(NC in 1975/GC in 1975), log(NC in 1976/GC in 1976), ... , log(NC in 1984/GC in 1984)],*

where $NC$ is net capital stock calculated by the formula (2.7) (and using 15 % as a depreciation rate) and $GC$ is the gross capital stock measured by fire insurance value. In the period from 1975 to 1984 the first value of net capital measure of a plant $i$ in the industry $j$ is $K_{i,j}(0)=X_j*GC_i$. The subsequent values of net capital series for the plant $i$ are calculated by the formula

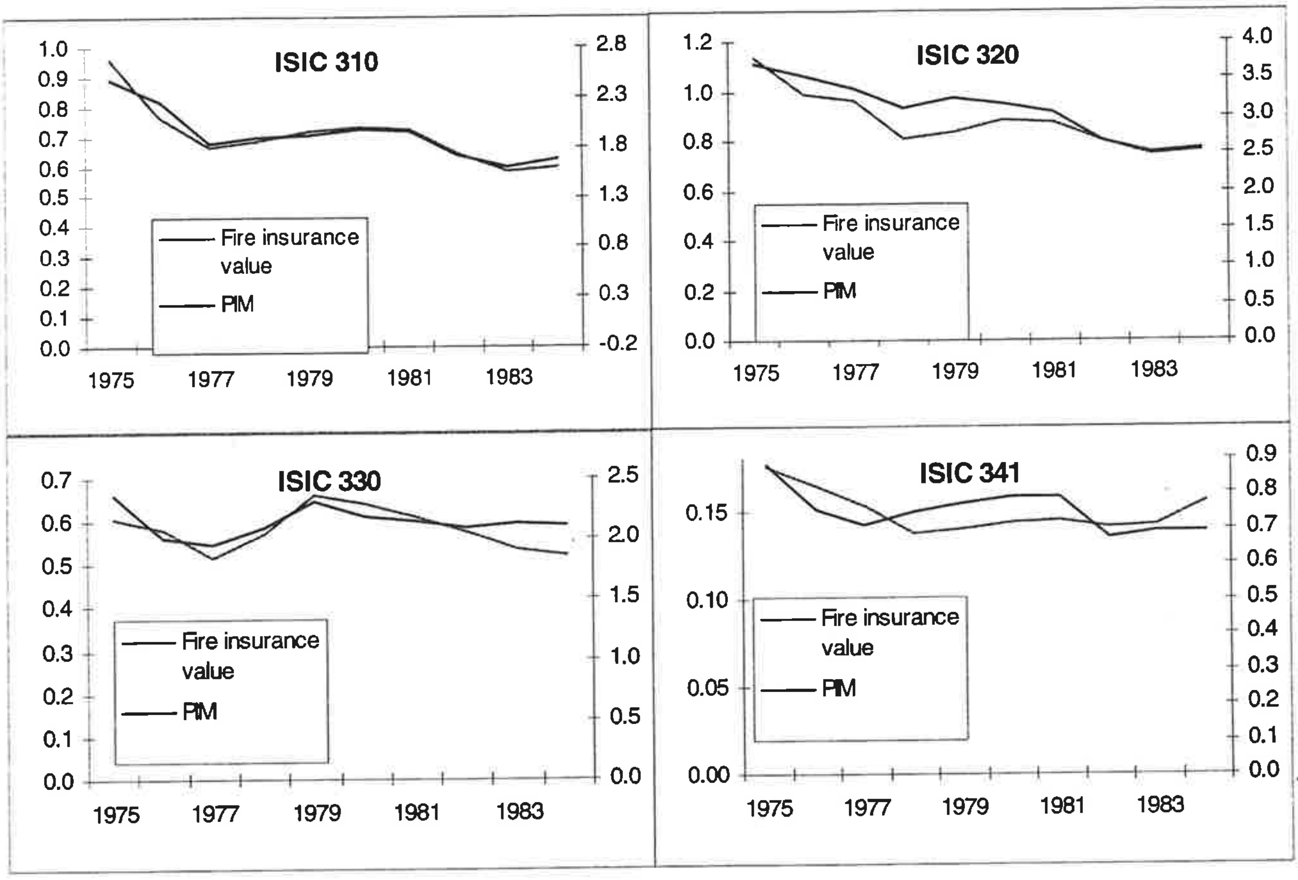
[10] In other words we construct a full panel of plants having a positive estimate of a machinery stock.

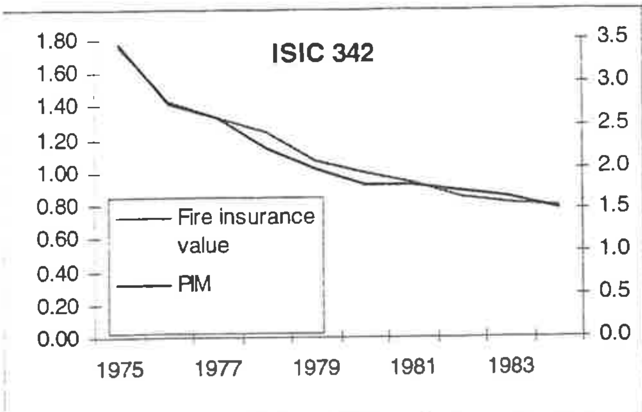
(2.9) $$K_i(t+1)= (1-0.15)*K_i(t)+I_i(t+1).$$

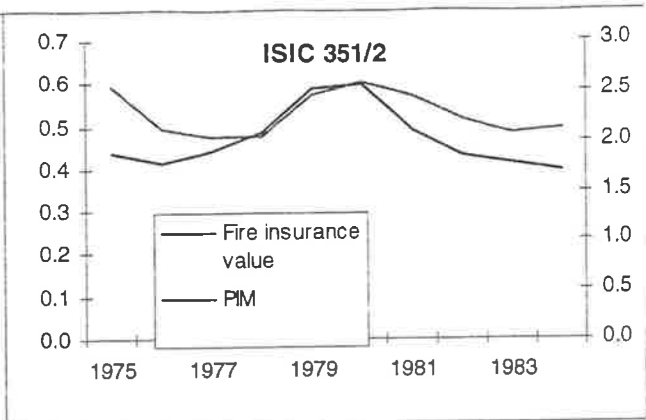
In other words it is presumed that the net capital stock to gross capital stock ratio at aggregate industry level is as stable as possible with the given depreciation rate. This proportion was rather low among the plants in the basic metals (18.5 %) and high among the plants operating in printing and publishing (51.0 %). As the net capital measure is constructed in this way, the capital productivity indicator measured by using the PIM estimate should give a similar kind of result as when the capital input is measured by fire insurance value. The graph 2.12 shows that this indeed is the case for most industries, which gives some support to our method of constructing net capital measure for the plants.

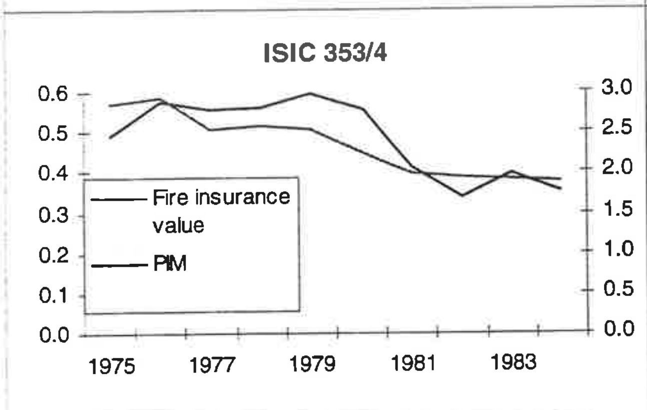
The results show that in some industries the development of capital productivity from 1975 to 1984 was quite poor. Capital productivity improved significantly in the basic metal industry (ISIC 370) and was rather constant in the forest industries (ISIC 330 and ISIC 341).

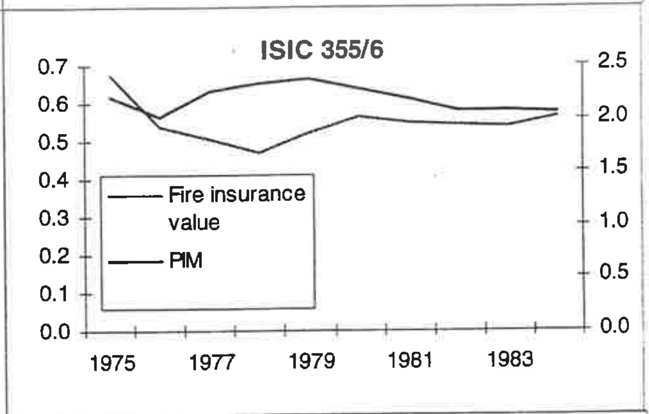
**Graph 2.12. Aggregate capital productivity (measured with machinery stock) among stayers by industries from 1975 to 1984, measured with PIM (scale on the right) and with fire insurance value (scale on the left)**




ISIC 342
1.80
1.60
1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.00
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
1975
1977
1979
1981
1983
Fire insurance value
PIM


ISIC 351/2
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
3.0
2.5
2.0
1.5
1.0
0.5
0.0
1975
1977
1979
1981
1983
Fire insurance value
PIM


ISIC 353/4
0.6
0.5
0.4
0.3
0.2
0.1
0.0
3.0
2.5
2.0
1.5
1.0
0.5
0.0
1975
1977
1979
1981
1983
Fire insurance value
PIM


ISIC 355/6
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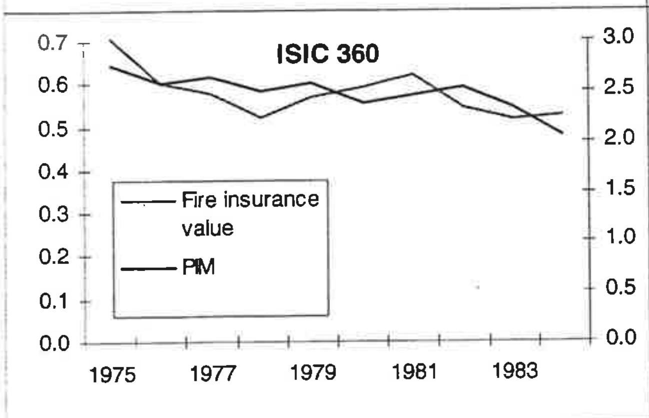
0.6
0.5
0.4
0.3
0.2
0.1
0.0
2.5
2.0
1.5
1.0
0.5
0.0
1975
1977
1979
1981
1983
Fire insurance value
PIM


ISIC 360
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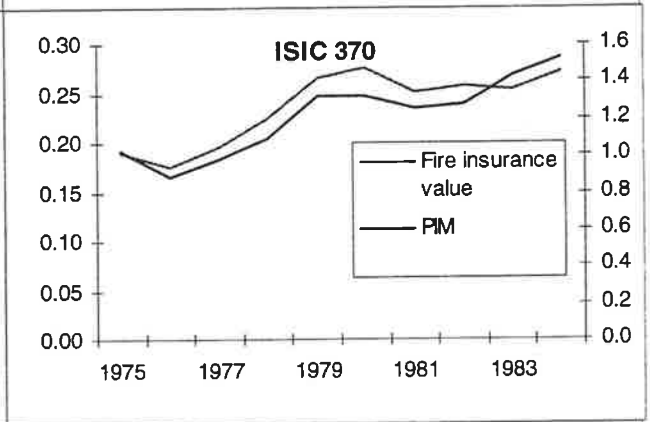
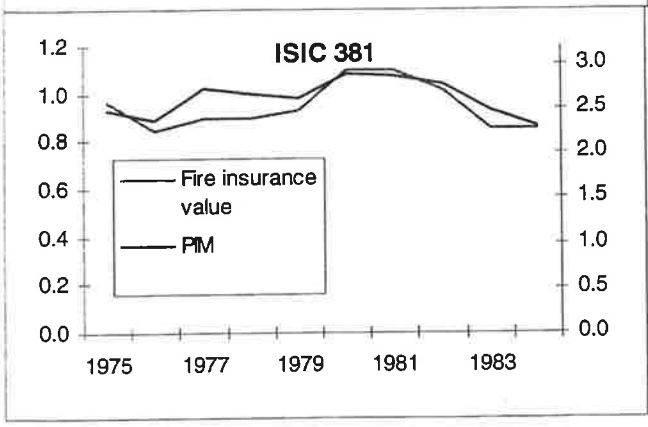
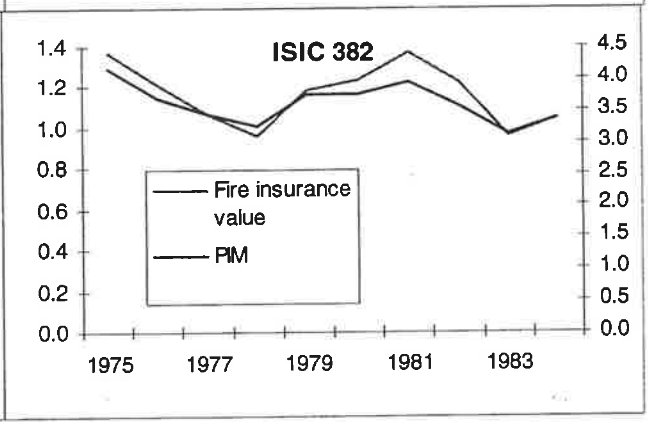
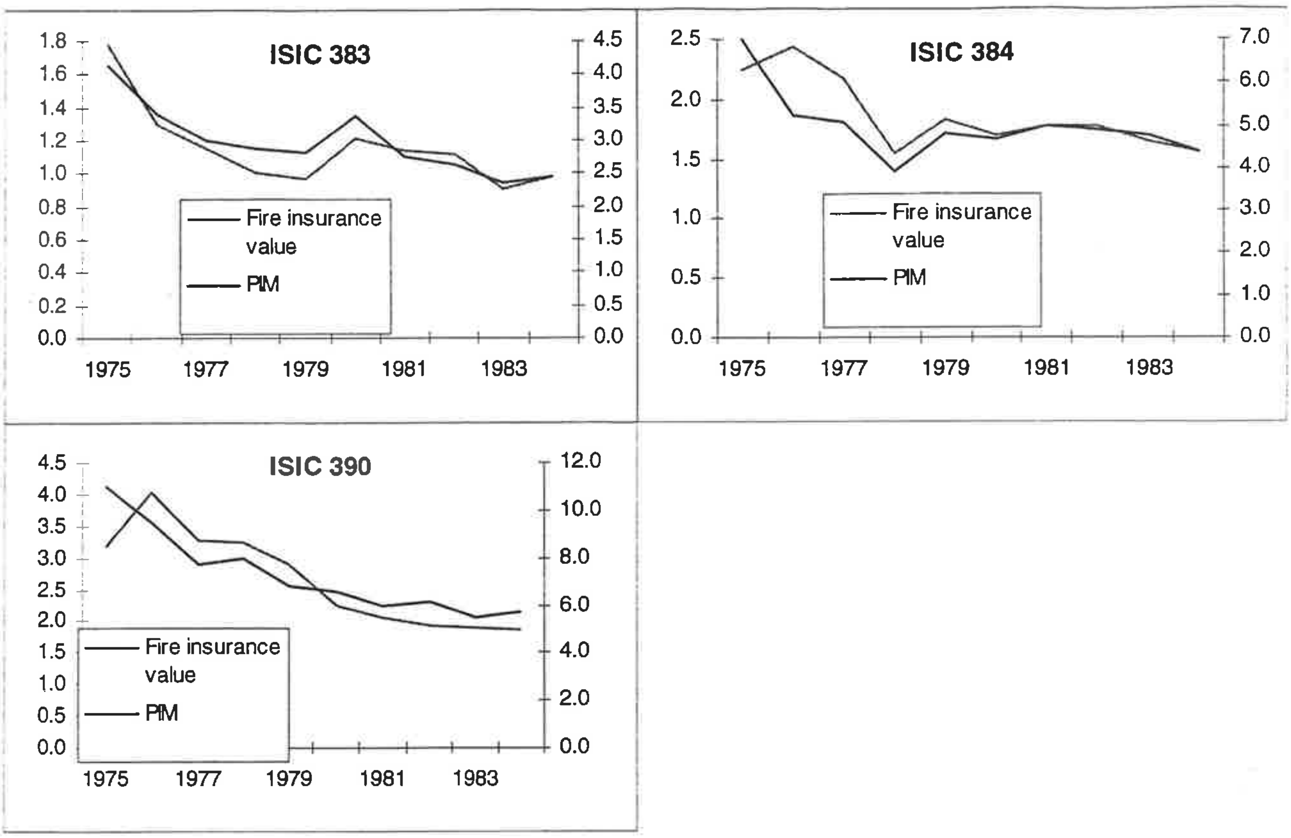
0.6
0.5
0.4
0.3
0.2
0.1
0.0
3.0
2.5
2.0
1.5
1.0
0.5
0.0
1975
1977
1979
1981
1983
Fire insurance value
PIM


ISIC 370
0.30
0.25
0.20
0.15
0.10
0.05
0.00
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
1975
1977
1979
1981
1983
Fire insurance value
PIM


ISIC 381
1.2
1.0
0.8
0.6
0.4
0.2
0.0
3.0
2.5
2.0
1.5
1.0
0.5
0.0
1975
1977
1979
1981
1983
Fire insurance value
PIM


ISIC 382
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
1975
1977
1979
1981
1983
Fire insurance value
PIM

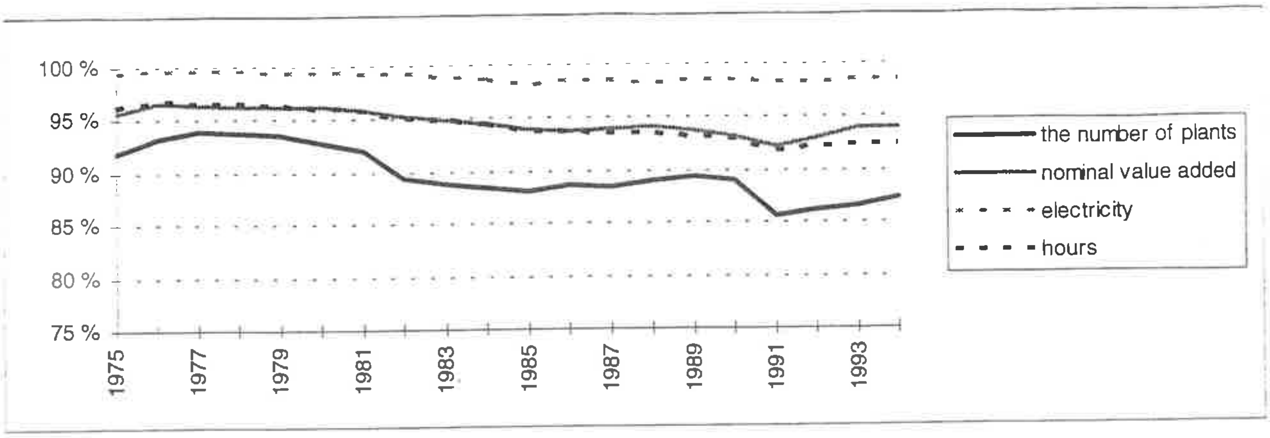



N.B. Capital productivity is measured by real value added per fire insurance value of machinery stock in fixed prices (scale on the left) and real value added per PIM estimate of machinery stock (scale on the right). Here capital productivity is measured among those plants that existed (had positive values of variables that was needed in the calculations) all the time from 1975 to 1984.

We were able to construct a machinery stock measure for a set of plants that covered 87 per cent of total number of plants, 92 per cent of hours worked, 94 per cent of value added and 98 per cent of electricity consumed in the total manufacturing in 1994 (see graph 2.13). In other words, the subset of plants that have a machinery stock estimate is comprehensive but not quite representative. These plants are larger and — judged by the consumption of electricity — their capital productivity is lower than on average.

Also the building and construction stock is estimated by PIM in a similar kind of manner as for the machinery stock (the depreciation rate for buildings and construction was assumed to be 7 %). The subset of plants that have both the machinery and building stock estimate is clearly smaller than the one consisting of the plants having an appropriate estimate of machinery stock. This subset covers 55 per cent of the total number of the plants, 75 per cent of hours worked, 80 per cent of value added and 94 per cent of electricity consumed in manufacturing in 1994.

**Graph 2.13 Shares of the plants having PIM estimate of machinery capital stock**

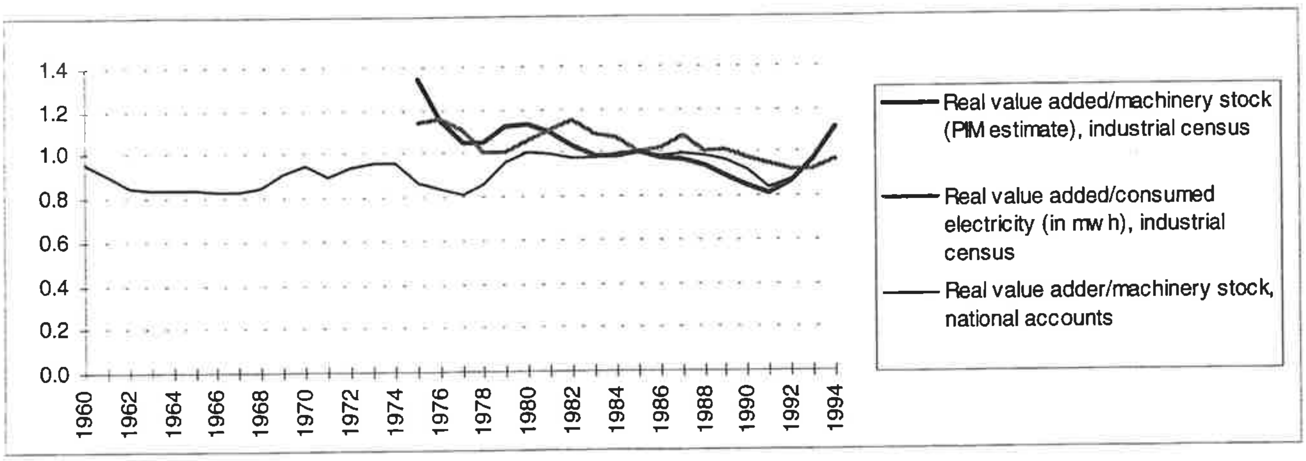



Another way to check the quality of our plant level capital input measures is to compare the aggregate capital productivity series calculated from our sample to the ones obtained from the Finnish national accounts. The capital productivity series calculated from the plant level information are indicated by thick black line (capital input is measured by PIM estimate of machinery stock) and a grey line (capital input is proxied by the consumption of electricity) in graph 2.14.

The real value added per machinery stock ratio calculated from the national accounts is indicated by thin line in graph 2.14. As can be seen in graph 2.14, in the latter part of the 70's the national account series differ markedly from the ones derived from our sample of manufacturing plants, but since the early 80's our estimate of plant's machinery stock seems to be in the line with the national accounts series. This is the case despite the fact that the machinery stock is measured here quite differently than in the national accounts. Therefore is seems that at least since the early 80's our data set is suitable for a more detailed analysis of the factors behind the aggregate behaviour of capital productivity and total factor productivity — the latter is a combination of labour and capital productivity.

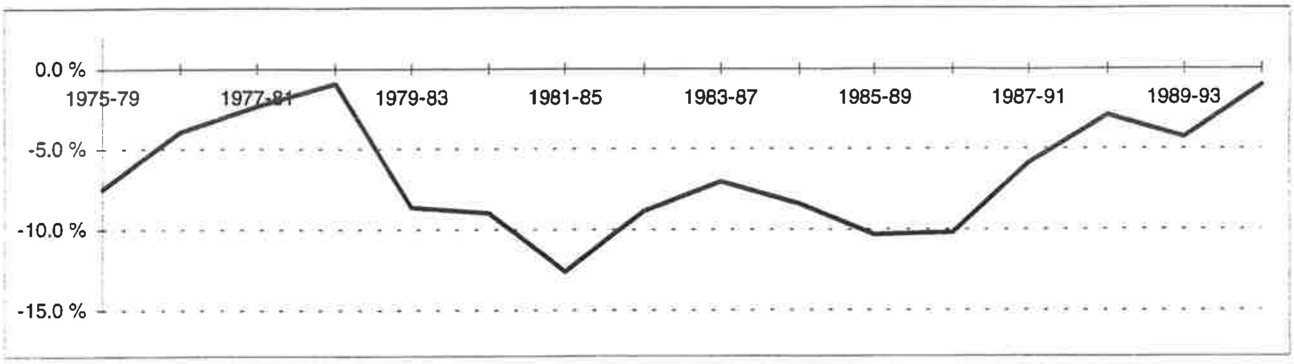
The capital productivity series where the capital input is measured by the consumed electricity reveals some problems involved in the capital stock measure when there is considerable fluctuation in business conditions as it has been the case in Finland since early 90's.

**Graph 2.14. Capital productivity in Finnish manufacturing**




A similar decomposition as that for labour productivity is performed for capital productivity. The contribution of structural factors for aggregate capital productivity in 5-year periods is shown in graph 2.15. On the contrary to the labour productivity, the aggregate capital productivity growth seems to underrate the plant level capital productivity growth but, on the other hand, the gap has been vanishing at least since the early 80's. Although graph 2.14 suggests that the capital productivity weakened in the 80's, the plant level capital productivity does not show any clear trend in that period.

**Graph 2.15. Effect of structural factors (=the difference of aggregate and within growth) upon capital productivity growth measured by real value added per machinery stock (PIM)**




# 3 Decomposition of total factor productivity

Next we investigate the effect of micro-structural factors on the total factor productivity (TFP for now on) growth by using an approach which bears much resemblance with the methods applied above. TFP is defined as a ratio of output to a combination of two input types — labour and capital. Formally TFP at the moment $t$ is defined as follows:

(3.1) $$TFP_t = \frac{Y_t}{L_t^{\alpha} K_t^{\beta}},$$

where $Y$, $L$ and $K$ refers to real value added, labour input, and capital input respectively, and $\alpha$ and $\beta$ are the factor elasticities. The industry (NA classification) and period specific elasticity is estimated here by income shares obtained from the national accounts. The share of labour is the ratio of nominal labour compensation to nominal value added. We assume constant returns to scale, so that the capital share is one minus the labour share.[11]

The TFP changes are calculated separately for each industry. The entry-exit effect in an industry is, again, defined as follows:

(3.2) $$Entry-exit\ effect \equiv \frac{TFP_t^A}{TFP_{t-s}^A} - \frac{TFP_t^S}{TFP_{t-s}^S},$$

where $A$ refers to the total set of plants in a given point of time and $S$ refers to the plants which exist in year $t$ and year $t$-$s$ in the industry in question. The labour input share $\alpha$ is measured by an arithmetic average:

[11] Implicitly we are assuming competitive product and factor markets. The assumption of constant returns to scale has received support from (Baily et al., 1992), where the TFP of the plants in the US manufacturing is studied (see also Baily et al., 1990).

(3.3) $$\alpha = \frac{(\alpha_t + \alpha_{t-s})}{2}$$

TFP among stayers, in turn, can be decomposed by using a similar kind of method as Bernard and Jones (1996) when they decomposed aggregate convergence among OECD countries into industry productivity gains and changing sectoral shares.

Aggregate TFP (here at the industry level) can be written as a weighted sum of plants' TFP, where the weights are the ratios of an index of inputs in the plant to an aggregate index of inputs:[12]

(3.4) $$TFP = \sum_i \frac{Y_i}{L_i^{\alpha} K_i^{1-\alpha}} \cdot \left(\frac{L_i}{L}\right)^{\alpha} \left(\frac{K_i}{K}\right)^{1-\alpha} = \sum_i TFP_i \cdot w_i \ .$$

The change of the aggregate TFP level between time points t-s and t can be calculated as

(3.5)

$$TFP_t^S - TFP_{t-s}^S = \Sigma\left(TFP_{i,t} - TFP_{i,t-s}\right) \cdot \left(\frac{w_{i,t} + w_{i,t-s}}{2}\right) + \Sigma_i \left(w_{i,t} - w_{i,t-s}\right) \cdot \left(\frac{TFP_{i,t} + TFP_{i,t-s}}{2}\right).$$

By dividing both sides by $TFP_{t-s}^S$ we get the formula where the percentage change of aggregate TFP level among stayers is divided into two components — the within effect and share effect:

(3.6) $$\frac{TFP_t^S - TFP_{t-s}^S}{TFP_{t-s}^S} = \sum \left(\frac{TFP_{i,t} - TFP_{i,t-s}}{TFP_{i,t-s}}\right) \cdot \left(\frac{TFP_{i,t-s}}{TFP_{t-s}^S}\right)\left(\frac{w_{i,t} + w_{i,t-s}}{2}\right)$$

$$+ \sum_i \left(w_{i,t} - w_{i,t-s}\right) \cdot \left(\frac{(TFP_{i,t} + TFP_{i,t-s})/2}{TFP_{t-s}^S}\right)$$

where the former term on the right is the within effect and the latter is the share effect. The components of aggregate TFP growth for each 15 NA industries during the period from 1975 to 1994 is calculated by using the formulas above. Calculations are carried through by using short intervals (s=1) and longer intervals (s=4). To give a broader view on the determinants of growth at the total manufacturing level, we report the weighted averages calculated in a similar manner as Baily et al. (1992). Each industry is weighted by its share of nominal value added, averaged over the beginning and the ending years of the period.[13]

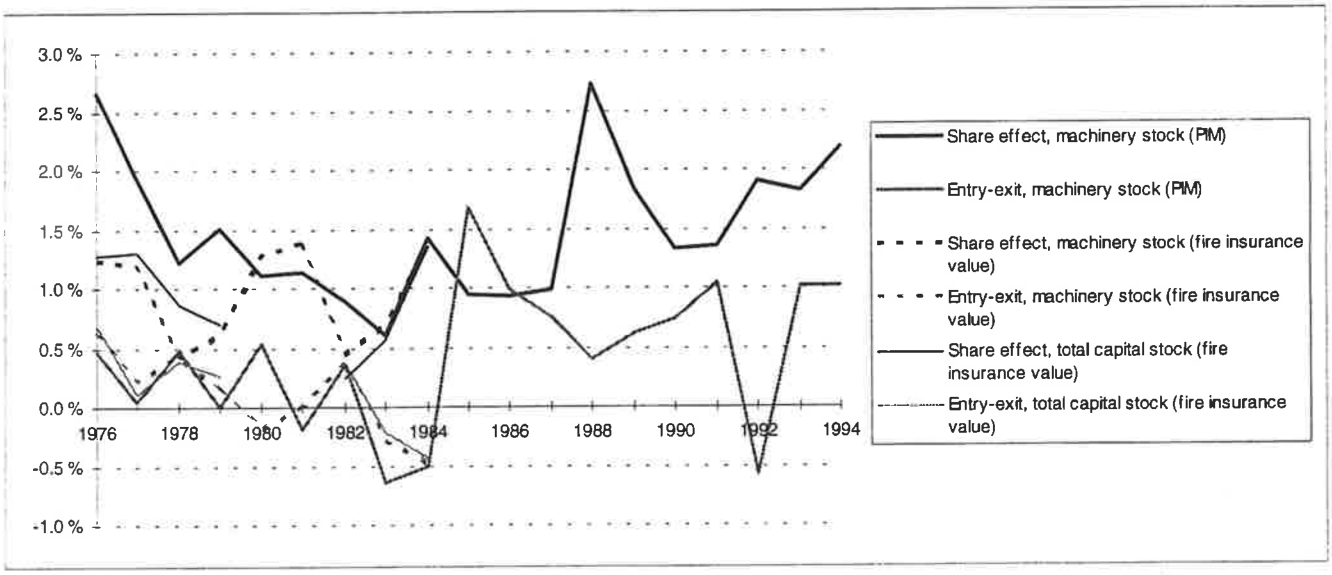
The graph 3.1 gives clear evidence that both the share effect and the entry-exit effect have had a positive and — since the first part of the 80's — increasing effect on the aggregate annual change of

[12] Baily et al. (1992, 191) weighted plant's TFP by nominal output share. This method was carried out here, too, but the results are not reported. This approach gave very low or negative within effects. The problem may be that output share may be especially volatile (here the output is measured by value added whereas Baily et al used gross output shares which may be more robust to the temporal changes). For measurement errors or for some other reasons the output level of a certain plant may temporarily high in the period *t-s*. The TFP growth in this plant may be low from the time *t-s* to *t* as the output level returns to its path. But the plant's excessively low growth has excessively big weight in the measurement, creating a downward bias to the within effect.

[13] Baily et al. (1992) used gross output shares.

TFP. In other words, the results are in keeping with the ones obtained with the labour productivity measure. Possibly partly due to the deficiencies inherent to the PIM estimates at the beginning of the series, the relative importance of structural factors in the mid 70's remains to some extent unclear. When capital input is measured by using the PIM estimate of machinery and equipment stock, the share effect seems quite significant in the mid 70's. To check the results, the TFP indicator for the period from 1975 to 1984 is calculated by using alternative capital input measures. When the capital input is measured by the fire insurance value of machinery and equipment stock, the share effect seems clearly more moderate than with the PIM estimate in the first few years of the period under study. On the other hand, the gap between the two measures has vanished by the beginning of the 80's. The same observation applies to the usage of fire insurance value of total capital stock.[14] We are inclined to conclude that the share effect was rather stable up to the beginning of the 80's and had an upward tendency since then.

**Graph 3.1. Effect of structural factors on annual TFP growth in manufacturing**




Like with the labour productivity, the entry-exit effect on the total factor productivity can be divided into the entry and exit effect. The entry-exit effect measured by log-changes (*entex*) can be decomposed in the following manner:

$$entex = \underset{(I)}{\log\left(\frac{TFP^S_{t-s}}{TFP^A_{t-s}}\right)} + \underset{(II)}{\log\left(\frac{TFP^A_t}{TFP^S_t}\right)}, \tag{3.7}$$

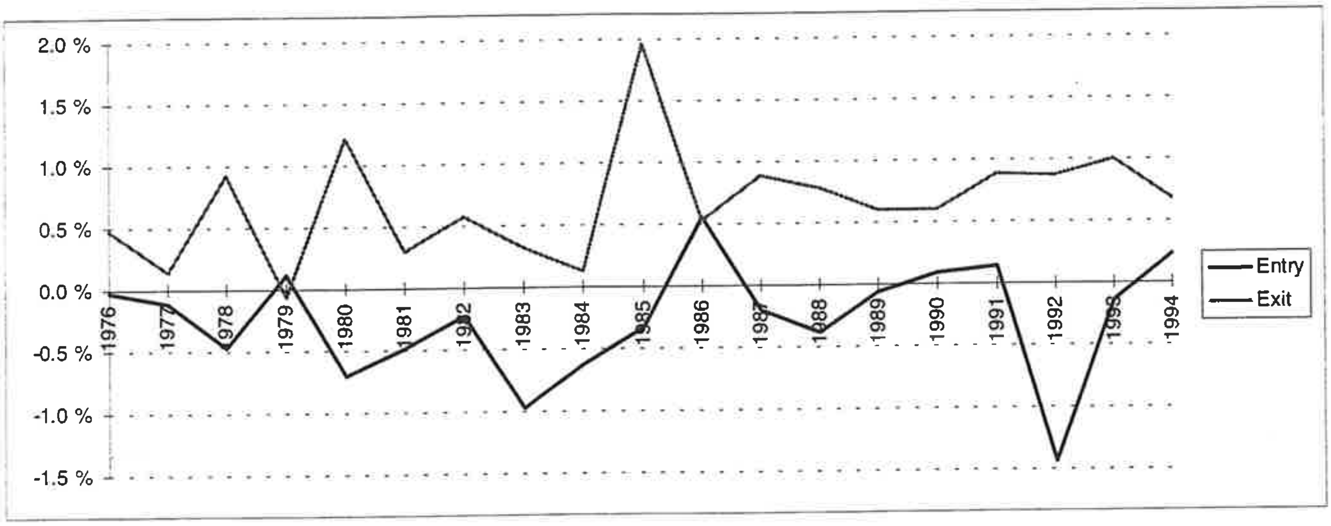
where TFP is aggregate total factor productivity, $S$ refers the data set consisting of the plants that exist both in $t$-$s$ and $t$ and $A$ refers to the data set covering all the plants in the year in question. The first term *(I)* on the right side is the exit effect and the latter term *(II)* is the entry effect. If TFP in the year $t$ is higher in the set $A$ (which includes both stayers and the plants that entered after $t$-$s$) than in the data set $S$ (which includes merely the stayers) the entry effect is positive. If, in turn, TFP

[14] Fire insurance values of the total capital stock are deflated by industry-specific (NA industries) implicit price indices that are derived from the total investment series obtained from the national accounts. Fire insurance values for total capital stock are lacking in 1980 and therefore the components during the period from 1979 to 1980 and from 1980 to 1981 cannot be calculated with the total capital stock measure.

is higher in the year *t-s* among stayers than in the data set *A* (which includes also the ones to exit before the year t), exit effect is positive.

The components of entry-exit effect at the aggregate manufacturing level are shown in graph 3.2. There seems to be a slight positive tendency in both components since the early 80s'. Some abnormal observations are also conspicuous in the graph. The exit effect contributed about 2 percentage points in 1985. The increase in this term occurred in many industries (especially in ISIC 341, 342, 382, 390), which is an indication that the finding is not a mere reflection of some peculiarities in our data set. Another observation out of the ordinary comes from the year 1992, where the entry effect has a strongly negative value. This was the case especially in the following NA industries: ISIC 370, 351/2, 341.

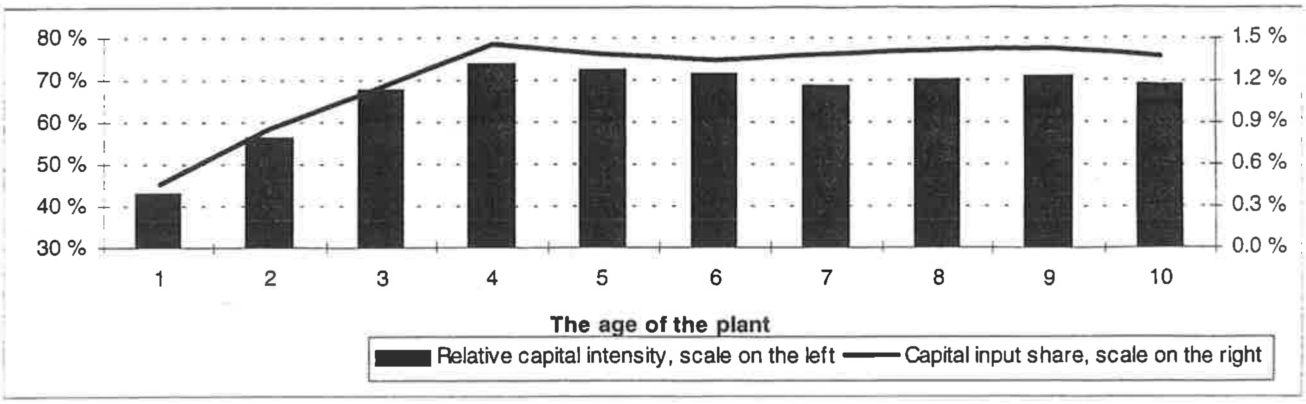
**Graph 3.2. Component of entry-exit effect, log-changes**




We have studied how the capital intensity and capital input share evolve in the plants in the first decade after appearance. Graph 3.3 demonstrates that the relative capital intensity as well as capital input share increases substantially in the first few years. Graph 3.3 suggests it takes a very long time to create a high capital intensity level.

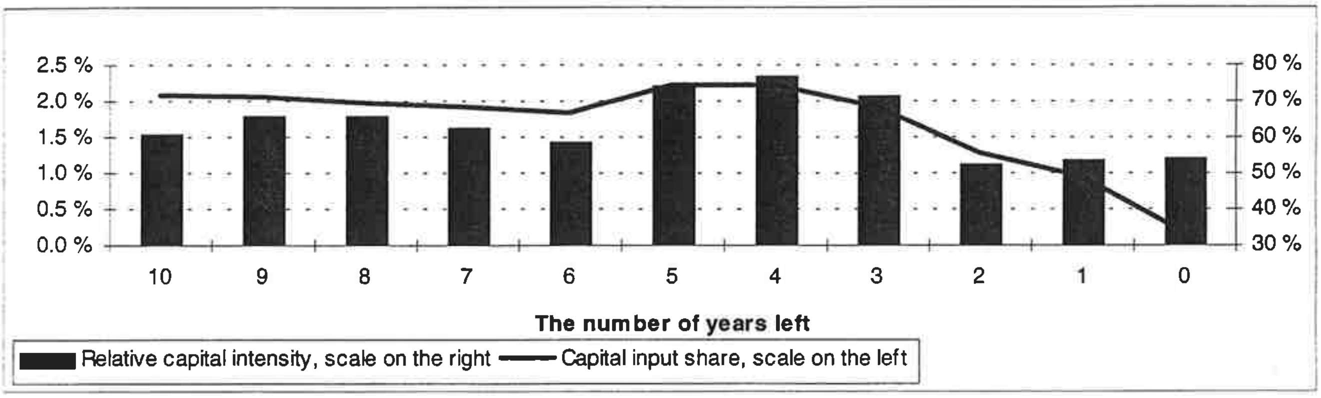
The graph 3.4 shows that the relative capital intensity is fairly low as early as a decade before the disappearance. The graph demonstrates also the finding made with labour input (see graph 2.6) that the decaying process accelerates a few years before the death. The downsizing of the machinery stock seems to be even more rapid than labour input in the last few years, which can be inferred from the finding that the relative capital intensity decreases before the disappearance.

**Graph 3.3. Increase of relative capital intensity among new plants, averaged over the period from 1982 to 1994**




N.B. Capital input is measured by machinery and equipment stock.

**Graph 3.4. Deterioration of the plants before disappearance, averaged over the period from 1982 to 1993**



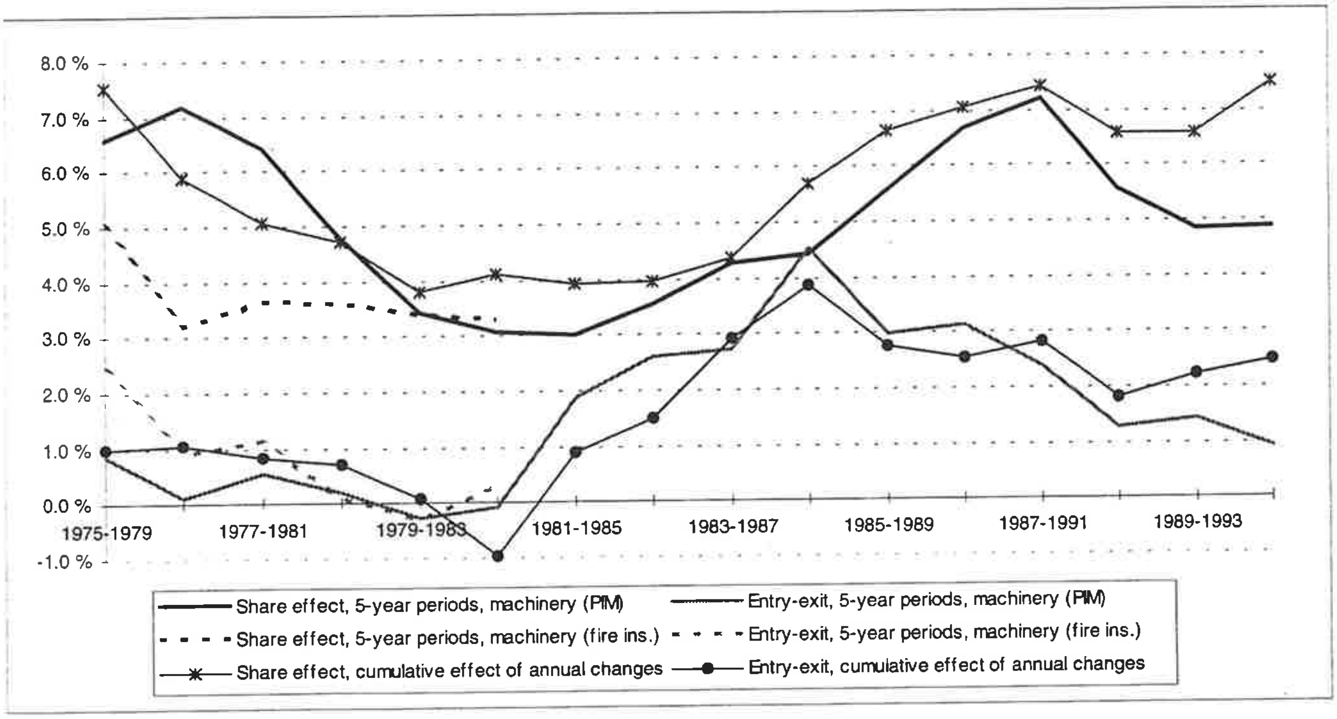

One should, however, be cautious when interpreting the results concerning the role of capital input in the entry-exit process. The measurement of capital potential or effective capital usage is particularly inaccurate for the plants taking the first or last steps in its lifespan. There are various reasons why it may take some time before the purchase of new capital is reflected in the output. The efficiency of capital input usage may improve due to learning, for example (see Doms, 1992). On the other hand, the capital stock may be underutilised among the downsizing plants.

The extension of the measurement period from two years to five years provides a complementary analysis of the factors behind the aggregate growth process. As could be expected on the basis of our findings with the labour productivity measure, the annual share component tends to overrate the longer term effect on aggregate TFP, as a part of short-term changes is reversed in the subsequent years. Graph 3.5 shows that the cumulative effects of annual changes are rather consistent with the results obtained using directly five year periods (s=4), except in the early 90's, where the gap between the two methods widens, especially in the case of the share effect but also in the case of the entry-exit effect.

When using 5-year periods there is still a clear upward tendency in the share effect since the early 80's but the development is broken at the end of the 80's. In the period from 1990 to 1994 the share effect contributed aggregate TFP growth by about 5 percentage points whereas this component was in its peak in the period from 1987 to 1991 — being more than 7 percentage points in five years. Generally the share effect was high in those 5-year periods that covered the year 1988. As can be seen in graph 3.1 the annual share effect was exceptionally high in 1988. A more detailed analysis revealed that this was the case in many industries, especially in the basic metal industry and in the chemical industry but even without these industries the share effect in the period from 1987 to 1988 was more than 2 percentage points.

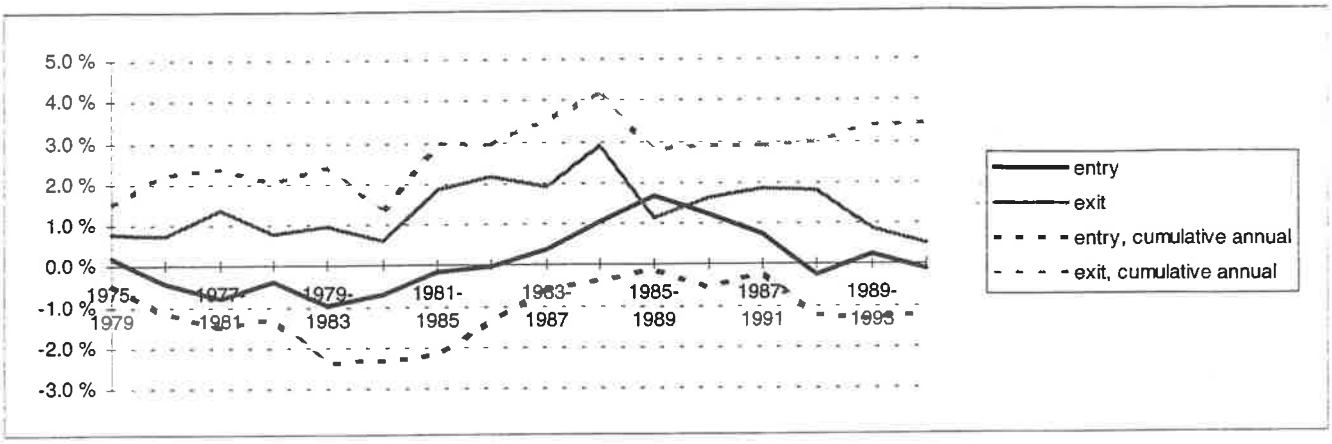
Quite interestingly, the annual share effects suggest that the flow of the resources to the plants having an above average total factor productivity level has stayed about as substantial in the first half of the 90's as in the late 80's. In other words, although there is still a significant relationship between the TFP level and the change of resource usage share in the next year, it seems that a smaller proportion of short-term variation was permanent in the 90's than in the 80's. The two methods used in studying the longer term effects of the entry-exit provide quite similar results except for the past few 5-year periods, where also annual components seem to overrate the long-term consequences.

**Graph 3.5. Effect of the structural factors on TFP growth in 5-year periods**



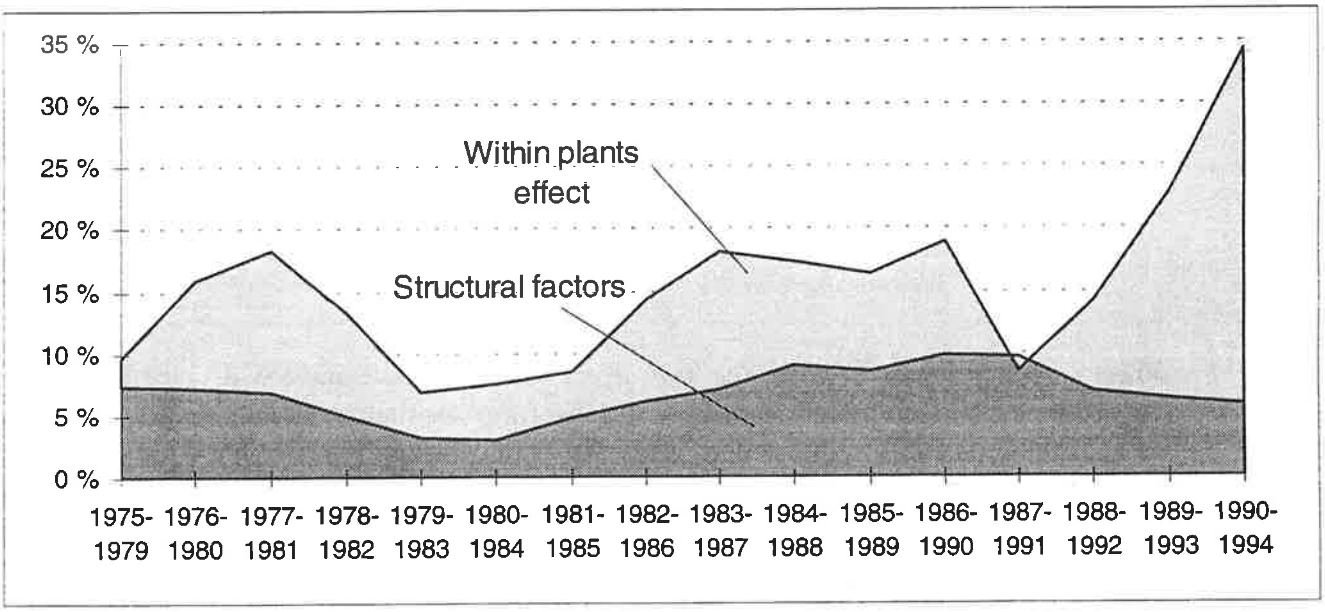

When studying 5-year periods, the exit effect seems to have increased since the early 80's and reached its peak in the period from 1984 to 1988 (grey continuous line in the graph 3.6). Since then the contribution of this term has decreased. The path of the entry effect has a very similar pattern to that of the exit effect (black continuous line in the graph). The results obtained with 5-year periods are compared with the results obtained by adding up annual changes represented in graph 3.2. Although the difference between the results obtained with different methods was not generally very big with the entry-exit effect, this is clearly the case for the entry and exit component studied separately. The annual entry effect fails to capture the positive longer term effect of the new production units. An obvious explanation for this is that the relative TFP level of new plants increases over time. The annual exit effect, in turn, seems to overrate the exit effect in the longer term. The relative productivity level some years before the exit is not as poor as immediately before the exit as we saw in the analysis of labour productivity (see graph 2.6).

**Graph 3.6. Components of entry-exit effect in 5-year periods, log-changes**



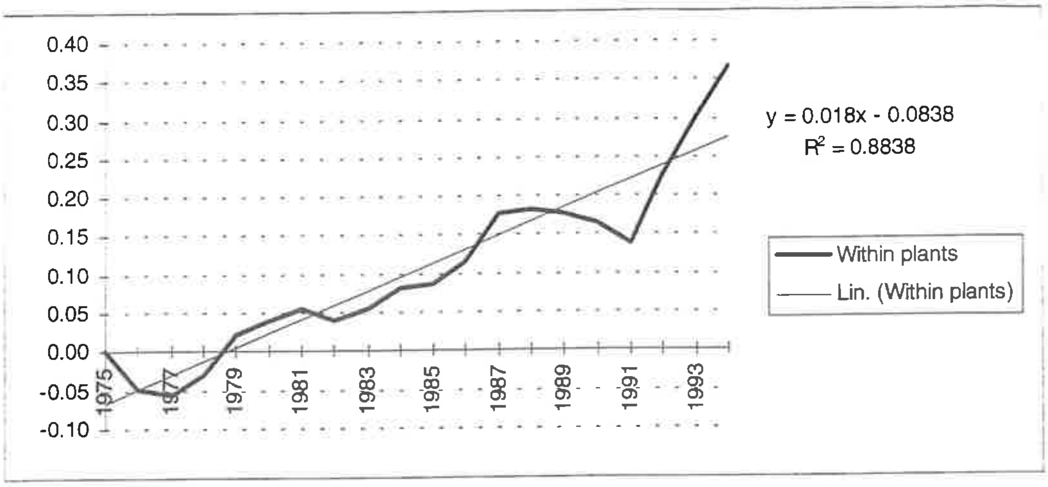

Graph 3.7 points out two findings: there is a positive tendency in the aggregate TFP growth rate since the early 80's and structural factors account for a substantial share of the growth in the five-year periods: typically 40-50 per cent of the aggregate growth. The cyclical factors play an important role in the within effect: as a result of the low utilisation rates in the plants in 1991, the growth of TFP was negative in the period from 1987 to 1991 but was outstandingly positive in the period from 1990 to 1994. The development of structural factors exhibits a much smoother path. The results obtained here demonstrate that micro-structural factors may be important for aggregate TFP both in upward periods (like in 1986-90) and in downward periods (like 1987-91).

**Graph 3.7. Components of aggregate TFP growth, 5-year periods**




Total factor productivity growth within plants describes the technological development that takes place at production units. Graph 3.8 suggest that plant-level technological development has followed a log-linear trend rather closely up to the latter part of the 80's. Plant-level total factor productivity growth was remarkably poor in the period from 1987 to 1991. Thanks to exceptionally rapid growth in the early 90's, the total factor productivity series is well above the long-term trend in 1994.

Graph 3.8. Total factor productivity growth within plants, log differences, 1975=0




# 4 Conclusions and discussion

The micro-structural changes play an essential role in the evolution of the performance level in the Finnish manufacturing sector. The stock of the plants is continuously subject to a renewal process: in each year 2-6 per cent of the labour hours are lost due to the closure of plants and in each year new plants emerge which cover 2-5 per cent of total labour hours. The average productivity level improves as low productivity plants are replaced by better ones through the entry-exit process. This becomes evident in the decomposition of both aggregate labour and aggregate total factor productivity growth, where in both cases the entry-exit effect appears to be positive. Furthermore, the relative importance of the entry-exit effect seems to have increased especially since the early 80's.

Entry and exit are the first and the last steps in a longer process. Although the average productivity level is usually rather low in the new plants, a part of them has potential to develop so that the relative productivity level improves and the share of input usage increases in the subsequent years. Consequently, the positive effect of entry process becomes visible over a longer period. Similarly the exit is ultimately a long process. The relative labour productivity level is rather low as early as a decade before the death. The decaying process accelerates a few years before the death: the relative labour productivity level as well as the relative capital intensity decreases and both the labour input and capital input shares shrink.

Thus also the micro-structures among the surviving plants are subject to continual changes. The stronger ones increase their input usage shares at the cost of the worse ones among the incumbents. The importance of this process is measured by the so-called share effect component in the decomposition of aggregate productivity. The calculations concerning Finnish manufacturing plants demonstrate that this effect has contributed positively to both aggregate labour and total factor productivity and this contribution has increased especially since the early 80's — very much like the entry-exit effect.

Quite interestingly, a number of results obtained here suggest that the mid 80's was a some kind of turning-point in the Finnish manufacturing sector. International comparison with aggregate data sets revealed that the capital intensity in Finnish manufacturing was the same magnitude with that of the United States up to the mid 80's but since then the relative capital intensity of Finnish manufacturing has increased substantially (see graph 1.2). At the time the entry-exit effect started to play a role both with respect to aggregate labour productivity and total factor productivity. The labour input share of the plants to disappear next year increased and the relative labour productivity level decreased, leading to an increase of the exit effect. Also the relative labour input share and the relative labour productivity of new plants increased slightly after the mid 80's. Furthermore, the importance of the share effect has increased considerably in labour productivity and total factor productivity since the mid 80's. To sum up, the micro-structural changes have become stronger after the mid 80's causing among other things the acceleration of aggregate labour productivity growth. This does not concern solely some rare industries but the importance of the plant dynamics rose in many industries.

The results obtained here demonstrates that micro-structural factors are of great importance for the performance level and competitiveness of the Finnish manufacturing sector. This seems to be the case especially when the economic environment is subject to significant changes. This is alluded by the fact that the importance of structural factors increased since the mid 80's when the Finnish manufacturing become more closely integrated into the Western markets and by the fact that structural factors were especially important in the manufacture of textiles, apparel, etc. and in the electrical machinery. The former can be described as the most typical sunset industry and the latter the most typical sunrise industry in Finnish manufacturing.

The decomposition of the factors affecting aggregate productivity growth points out that the plant level development can be described quite poorly with aggregate data sets in the Finnish manufacturing and its subsectors. Aggregate data sets seem to indicate that there has been some acceleration in the labour productivity growth in recent years, suggesting for example an acceleration in the technological change or improved efficiency within plants. However, there is very little indication that the medium-term labour productivity growth has improved at the plant level.

At the plant level the total factor productivity growth was extraordinarily poor in the period from 1987 to 1991, but was exceptionally rapid from 1991 to 1994. This turn in the growth rate can be explained at least partly by changes in the utilisation rates but, on the other hand, the acceleration of total factor productivity growth since 1991 has been so strong that plant-level total factor productivity exceeded clearly the long-term trend, as can be seen in graph 3.8. This finding suggests that technological evolution may have accelerated or the inefficiency among Finnish manufacturing plants has diminished. However, it should be kept in mind that structural changes may have taken place also within plants, which may be reflected in the total factor productivity at the plant level. The degree of outsourcing of service inputs by manufacturing plants has increased as the plants want to concentrate on the industrial tasks where the productivity level is high. Secondly, the structure of the labour force may have changed due to the downsizing of labour so that the share of high-skilled labour force has increased. In other words, the quality improvement of labour input may have accelerated because of some kind of micro-micro structural changes. In order to investigate this issue in a greater detail it would be valuable to link individuals to the plants so that labour input characteristics can be controlled. We have some plans of that sort for the future.

It is important that the resources are allocated efficiently to those activity units capable of using the factors of production efficiently and thus competitively. Institutional and other factors preventing entry, exit and the mobility of resources may be harmful particularly at the time when an economy or a sector is experiencing substantial so-called allocative shocks — shocks that make some plants or some worker-job matches profitable and some plants or worker-job matches unprofitable (see Davis et al., 1996, 104-108). The adaptation from this kind of shock requires the sufficient mobility of labour. Investments should be directed to the high productivity plants. The micro-structural evolution may be damaged when the investments of the low productivity plants are encouraged by subsidies or tax relief, for example.

In well functioning markets the exit-process is beneficial as more resources become available from poor plants to the stronger ones. In Finland as well as in the many other European countries the problem has been, of course, a large amount of idle resources. The average productivity level in Finland and in many other European countries may seem artificially high as a crowd of low-quality labour input is locked or lured outside the job market. In other words, the unemployment may have a positive effect on the aggregate productivity — the point emphasised by Gordon (1995).

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## APPENDIX

### Annual aggregate labour productivity and its components

| Year | Aggregate productivity | Within plants | Entry-exit | Labour input share | Cross-term |
|---|---|---|---|---|---|
| 1976 | 3.2 % | 2.7 % | 0.5 % | 1.9 % | -2.0 % |
| 1977 | 3.4 % | 4.0 % | -0.1 % | 1.3 % | -1.8 % |
| 1978 | 6.2 % | 6.2 % | 0.5 % | 1.2 % | -1.7 % |
| 1979 | 7.1 % | 7.9 % | -0.3 % | 0.2 % | -0.8 % |
| 1980 | 3.8 % | 5.1 % | -0.5 % | 0.5 % | -1.2 % |
| 1981 | 7.3 % | 6.5 % | 0.1 % | 1.6 % | -0.9 % |
| 1982 | 3.4 % | 3.6 % | 0.0 % | 0.7 % | -0.9 % |
| 1983 | 4.8 % | 5.2 % | 0.4 % | 0.5 % | -1.2 % |
| 1984 | 6.2 % | 6.4 % | -0.3 % | 1.0 % | -0.9 % |
| 1985 | 5.2 % | 3.3 % | 1.5 % | 2.2 % | -1.7 % |
| 1986 | 8.9 % | 7.2 % | 2.1 % | 0.9 % | -1.4 % |
| 1987 | 9.2 % | 8.0 % | 0.8 % | 1.4 % | -1.1 % |
| 1988 | 7.5 % | 5.9 % | 1.1 % | 2.2 % | -1.7 % |
| 1989 | 7.0 % | 6.5 % | 0.9 % | 1.7 % | -2.1 % |
| 1990 | 5.2 % | 3.6 % | 1.0 % | 1.7 % | -1.1 % |
| 1991 | 2.9 % | 0.2 % | 0.7 % | 2.2 % | -0.3 % |
| 1992 | 12.6 % | 10.6 % | 0.7 % | 2.0 % | -0.6 % |
| 1993 | 10.8 % | 8.0 % | 1.6 % | 3.8 % | -2.7 % |
| 1994 | 7.8 % | 6.4 % | 1.1 % | 1.9 % | -1.6 % |

N.B.: See text

### Structural factors by industries

| | 1980-1989 | | | 1985-1994 | | |
|---|---|---|---|---|---|---|
| ISIC | entry-exit effect | share effect | cross term | entry-exit effect | share effect | cross term |
| 310 | 3 % | 1 % | -12 % | 1 % | 5 % | -12 % |
| 320 | 10 % | 3 % | -7 % | 26 % | 0 % | 7 % |
| 330 | 7 % | -1 % | 6 % | -1 % | 3 % | -1 % |
| 341 | 14 % | 8 % | -29 % | 8 % | 9 % | 0 % |
| 342 | 8 % | 9 % | -9 % | 9 % | 15 % | -26 % |
| 35A | 4 % | 9 % | -9 % | 4 % | 15 % | -34 % |
| 35B | 0 % | -7 % | -20 % | 4 % | 1 % | -1 % |
| 35C | 8 % | 11 % | -28 % | 2 % | 6 % | -12 % |
| 360 | 2 % | 0 % | -17 % | 9 % | 3 % | -18 % |
| 370 | 12 % | 12 % | -1 % | 9 % | 16 % | -7 % |
| 381 | 13 % | 5 % | -8 % | 1 % | 6 % | 2 % |
| 382 | 7 % | 2 % | -8 % | 5 % | 6 % | -1 % |
| 383 | 0 % | -3 % | 2 % | 32 % | 18 % | 24 % |
| 384 | 3 % | 3 % | 0 % | 6 % | -3 % | 11 % |
| 390 | 2 % | 5 % | -1 % | 19 % | 1 % | 9 % |
| Average | 6 % | 4 % | -9 % | 9 % | 7 % | -4 % |

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