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THE RESEARCH INSTITUTE OF THE FINNISH ECONOMY
Lönnrotinkatu 4 B, 00120 Helsinki 12, Finland, tel. 601322

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Pekka Ylä-Anttila

INVESTMENT STRUCTURE, PRODUCTIVITY AND TECHNICAL CHANGE - IMPLICATIONS FOR BUSINESS ORGANIZATIONS AND MANAGEMENT*

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1. INTRODUCTION

This paper concentrates on four points. First the process of industrial growth has significantly changed during the last 10-15 years in most industrial countries. That is due not only to various structural shocks, changes in relative prices and depressed aggregate demand but also to a great extent due to technological factors and changing competitive processes. Growth of industrial output in industrialized countries is based increasingly on total factor productivity, technical advance, capital deepening (or capital enrichment) and efficient utilization of information. Competitive advantages of business firms are becoming to a greater extent endogenously determined and country-specific exogenous factors (supply of certain factor endowments etc.) are losing their importance. The changing patterns of industrial growth are illustrated with brief analysis of the Finnish manufacturing sector.

Secondly it is argued that changing technological opportunities are reflected in firms' investment behaviour and competitive strategies in such a way that all kind of intangible capital spending has increased at the expense of fixed investment (machines and constructions). In advanced industrial countries and especially in sophisticated engineeering industries and machinery the product oriented R&D has been the activity to which a growing share of total resources of firms has been devoted. Competitive edge is created through customer

oriented product design and marketing and the manufacturing firms are entering the field of extended competition, which means internalizing part of the market processes previously handled by several independent agents.

Thirdly we shall roughly sketch strategic alternatives for firms operating in a small open industrial country. It is pointed out that these alternatives differ from those prevailing, e.g., in big countries due to factors inherent in technological progress. Set of feasible competitive strategies is constrained by huge capital requirements of large scale technological research, which is possible only to giant firms and big nations. Firms in small countries may search for competitive advantages and temporary monopoly rents by investing in specialized knowledge, utilizing effectively technological diffusion (fast second strategy) and investing in marketing efforts in narrowly specified markets.

The fourth point to be made concerns the implications of the above described technological developments and subsequent strategic alternatives for the organizations and management of manufacturing business firms. It is argued that the implementation of new strategies - increasingly determined by technological factors - is associated with reorganization of activites within business enterprises. Main features of this reorganization are setting up foreign subsidiaries to operate on customer oriented markets, increasing R&D activity and adjusting the organization for growing requirements of risk management and financial operations.

2. SOME TRENDS IN THE OPERATIONAL ENVIRONMENT OF MANUFACTURING FIRMS

During the last 10 years the markets for many traditional industrial products have stagnated or declined, firms have faced a situation of international over-capacity in their branches of production and price competition has tightened as new producers from newly industrialized countries have entered the market. The slowdown of aggregate demand can be illustrated by the following figures: GDP volume in OECD countries grew in 1974-84 at an average annual rate of 2.5 % whereas the growth rate for the period 1960-73 was about 5 %; the corresponding growth rates for the volume of world trade of industrial products were about 10 % and 4.5 %, respectively.

A closer look at international trade patterns shows, however, that foreign trade in respect of high-tech products i.e. products with high research input, has increased considerably more rapidly than the average and growth has been strong also during recessions. International studies show also, that rather strong correlation exists between the research intensiveness and internationalization of different industrial branches and that research intensive industries tend, on the average, to be more open to international competition. In other words exports' share of production in high-tech industries and companies is generally high.[1)] That is, among other things, due to small home markets for most of the highly sophisticated products. An obvious reason for high internationalization of high-tech companies is, that knowledge intensive products are often marketed in the form

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1) See Vuori - Ylä-Anttila (1985) and OECD (1985).

of "packages" including various kinds of services (training, installation, maintenance, project management etc). Prerequisite for this kind of operation is setting up an international marketing network and/or establishing foreign production units for part of the production.

The growing international trade of services is an important feature in transition to the postindustrial economies. In 1985, world services exports was about 25 % of total merchandise exports and the share is expected to increase quite rapidly. New technologies and increasing deregulation will affect the expansion of service trade especially in the fields of telecommunication and information-based services.[1)] The interdependence of services and manufactured products will be strong. Manufacturing firms in advanced industrial countries will find it more difficult to gain competitive advantages by hardware differentiation, which will lead to expansion of production of "secondary" services - i.e. services "bundled" with goods.[2)] Hence, these developments are eroding the border-line between goods and services.

In the technological front the emergence of information technology is among the most significant features of development. The introduction of new applications of these technologies are just in the initial stage and the development of new products in this sector is highly dynamic. The growth of information technology is based on the fact that in the fields of its applications it has an additive and only to a minor extent a substitute effect. Applications of information

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1) See Trondsen (1985).

2) See Trondsen (1985) pp. 21-23 for detailed description.
See also Eliasson (1985) and Pousette-Lindberg (1985) analysing the Swedish manufacturing and increasing service content of production.

technology and micro-electronics are introduced in most of the traditional industries - both in manufacturing and services - enabling setting up flexible manufacturing systems and expanding potentials for variations in existing products according to specified needs of customers.

3. CHANGING PATTERNS IN THE SOURCES OF INDUSTRIAL GROWTH

The process of economic growth has in most industrial countries considerably changed since the mid-70s. The growth rates across countries and industries have varied a lot. Some industries have been labelled as crisis industries due to serious profitability problems and gloomy propestecs even in the long run, productivity growth has slowed down etc. Significant reduction in employment and abnormal obsolesence of capital stock in many branches of traditional manufacturing industry started the discussion on the process of deindustrialization in the late 70s. This restructuring is likely to go on although some of the negative tendencies have become less significant and new potentials have emerged especially in the technological front. From the point of view of an individual industry or firm these changes in operating environment have meant weakened demand, increased uncertainty and bigger risks and movements in the cost structures, but at the same time new technological and market opportunities and subsequent needs of adjustment and reorganization of activities.

Although being an object of accurate measurement and widely used as economic policy target, economic growth is not well understood. There

are several reasons for this. One of the most important is evidently that economic growth is a complex dynamic phenomenon, which is far more difficult to analyse and describe than properties of static equilibrium. It is also evident that the steady rapid growth in the post-war era up to mid-70s affected to some extent the ignorance of growth process in economic analysis. Recently, after the turbulent, disorderly period of the late 70s and early 80s, it has in many occasions been argued that economic growth can only be understood and explained at fine levels of aggregation and in a market disequilibrium context.[1] In this type of framework innovations and new technologies are central disequilibrating factors. The dynamics of the growth process is based on productivity differences across industries and firms as a result of introduction of new technical and organizational innovations and institutional combinations.

When looking at economic growth at an aggregate level it is evident that only a part of the measured output growth can be accounted for increased use of conventional factors of production. The rest, usually estimated as a residual, is due to total factor productivity (TFP).

Total factor productivity changes are usually assumed by economists to be accounted for technical progress, but it is, of course, only one possible explanation. Measured TFP growth might as well be due to improvements in organizational setting, nonmeasured quality changes (either in inputs or in outputs), increasing returns to scale etc.

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1) See, e.g., Eliasson (1984).

In Table 1. standard calculations on total factor productivity developments in Finnish manufacturing industries are presented. The period under survey has been divided into two subperiods (1961-74 and 1975-84) in order to see how the growth pattern has changed after the mid-70s. Some interesting observations can be made. In the period 1975-84 total factor productivity has accounted for almost all the industrial growth in Finland, whereas the corresponding contribution in the 1961-74 period was about 50 % at the level of total manufacturing.

The sources of industrial growth in Finland have clearly changed. The increase of volume of capital and labour inputs are negligible and growth is based on gains in multifactor productivity. The same applies to many other industrial countries, although there are some exceptions as well.[1)]

There is not very much in the standard economic theory to explain changes in total factor productivity (or technical progress). Yet, we have some recent empirical studies indicating that at least part of these changes can be explained by innovative activity or R&D inputs.[2)]

According to studies carried out, for example, in United States the rate of return on R&D in various industrial branches generally varies between 20 and 40 per cent. The results for Finnish and Swedish manufacturing industries indicate to the same

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1) See, e.g., OECD (1983).

2) See, e.g., Terleckyj (1980) and Vuori (1984).

Table 1. Growth of manufacturing output in Finland and contribution of labour and capital input and total factor productivity (TFP), average annual changes

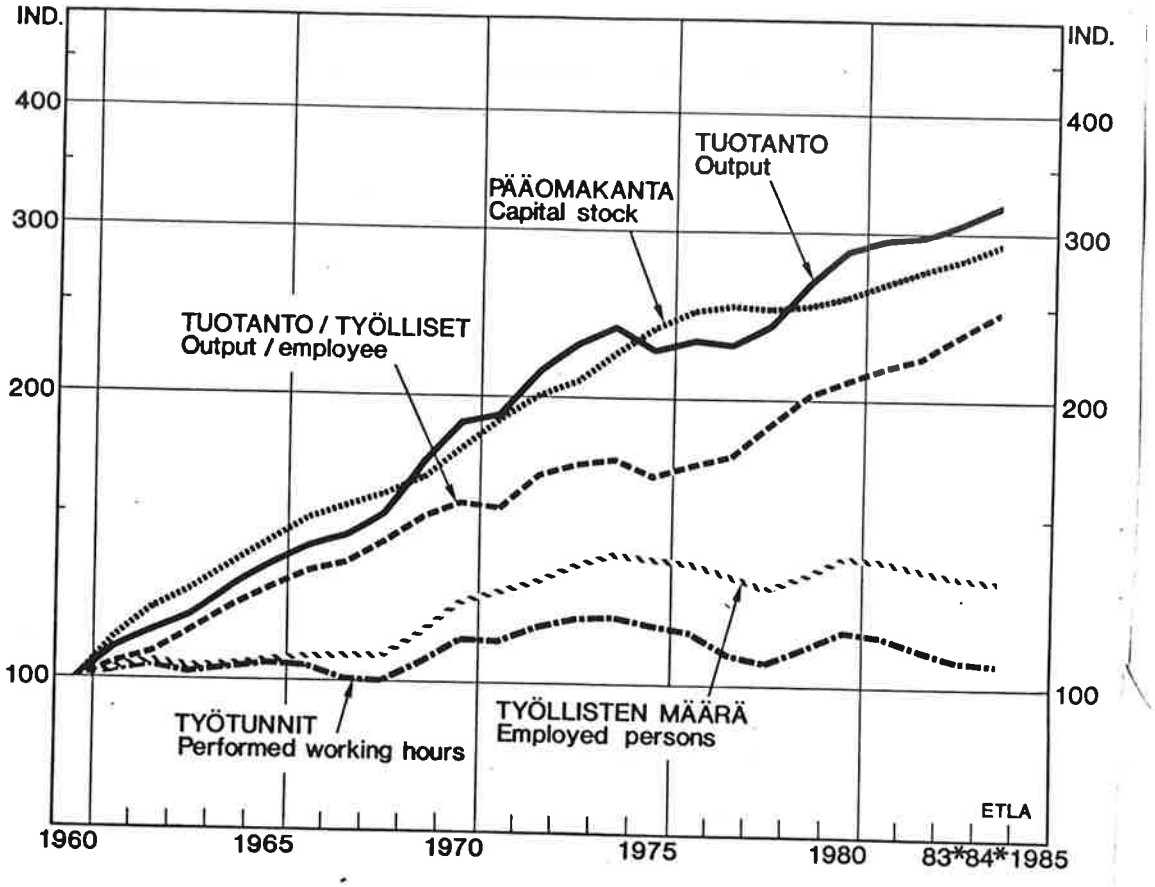
Industry	Output growth	Contribution of labour	Contribution of capital	Contribution of TFP
Food manufacturing				
1961-74	4.7	0.5	2.2	2.1
1975-84	2.4	-0.7	1.0	2.1
Textile, wearing apparel and leather industries				
1961-74	3.9	-0.8	1.1	3.6
1975-84	1.0	-2.3	0.3	3.0
Wood industry				
1961-74	3.0	-0.7	1.7	2.1
1975-84	1.0	-2.2	0.5	2.8
Pulp and paper industry				
1961-74	6.5	0.7	2.0	3.8
1975-84	2.2	-1.7	0.6	3.3
Chemical industries				
1961-74	11.4	2.0	5.5	4.0
1975-84	3.0	-0.2	1.1	2.1
Basic metal industries				
1961-74	9.0	2.2	3.7	3.6
1975-84	6.1	-0.5	0.5	6.1
Machinery and engineering				
1961-74	6.9	1.6	1.6	3.8
1975-84	4.5	1.0	1.1	3.3
Total manufacturing				
1961-74	6.2	0.7	2.2	3.3
1975-84	3.1	-0.7	0.9	3.0

The change in total factor productivity ($\hat{T}_q$) has been calculated as follows:

$$\hat{T}_q = \hat{Q} - \Sigma w_i \hat{x}_i \ , \quad \text{where}$$

$\hat{X}_i$ ($i = K,L$) is the relative (logarithmic) change of labour input and capital input, weights (w_i) are so-called Divisia-weights, i.e. value added shares of remunerations to labour and capital respectively. Labour input has been measured as hours worked and capital input as volume of net capital stock. The numerous theoretical and index number problems related to measurement of TFP are neglected here and we only refer to, e.g., Kendrick and Vaccara (1980) or Wyatt (1983) for detailed reviews.

Figure 1. Volume of output and net capital stock, labour inputs and labour productivity in Finnish manufacturing (1960=100)



direction.[1] Although there is quite a lot variation in the research results, a general conclusion has been that R&D activity clearly raises productivity and thus increases industrial output.

In the next section we shall look at the developments of R&D investment in relation to fixed investment (investment in construction and machinery) in Finnish and Swedish manufacturing as well as the orientation of R&D expenditures (product development vs. process development) in the two countries. We shall also consider through what kind of mechanisms product innovations and process innovations contribute to productivity performance and what kind of strategic choices the orientation of R&D activity imply.

4. STRUCTURE OF INVESTMENT AND ORIENTATION OF R&D ACTIVITY

In many industrial countries R&D expenditure has increased relatively rapidly since the mid-70s at the same time as traditional fixed investment has decreased or increased only very slowly. In Finland (and Sweden) too a marked change in the investment structure has taken place in favour of R&D investment (see Figures 2-3). The volume of R&D expenditure in Finnish manufacturing has undergone an almost 2.5-fold increase since the mid-70s whereas fixed investment has remained at more or less the 1975 level. The growth in R&D investment has been substantial in all the main manufacturing industries (with the exception of the forest industry, see Table 3). The amount of R&D

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1) See Vuori (1984).

Table 2. Volume of R&D expenditure in business enterprise sector in selected countries, % changes

	Average annual change in volume, %	
	1969 75	1975 81
USA	-1.6	5.4
Japan	7.6	9.2
Germany, FR.	5.6	6.2
U.K.	-0.1	4.0
Sweden	8.5	5.1
Norway	10.0	4.7
Finland	10.0	8.5

investment in the Finnish manufacturing was in 1985 about 15 % of fixed investment and the corresponding figure for Swedish manufacturing about 40 %. When taking into account also other types of "soft" capital spending (education, marketing, design etc.) the soft investment in relation to fixed investment amounts to over 30 % in Finnish manufacturing, to over 50 % in Swedish manufacturing and to even about 100 % in the group of largest Swedish manufacturing firms.[1)]

Studied from a global standpoint R&D activity has been strongly concentrated in the big countries and large units, frequently in multinational companies. Of the funds invested in research and development in the OECD countries during the 1970s roughly 90 per cent were spent in five countries (United States, Japan, Federal Republic of Germany, France and UK), United States alone accounts for almost

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1) See Eliasson (1985).

half of the total spending. The major corporate investors are also of US origin. The amount invested in R&D by e.g. General Motors is about four to five times the total amount invested in Finland.

Table 4 presents data on the orientation of R&D activity in Finnish and Swedish manufacturing. The table shows that product development clearly dominates the R&D activity in both countries. In Sweden the share of product development in total R&D outlay is more than 80 % and in Finland about 75 % and the share has rapidly increased during the last few years.

Table 3. Industrial fixed investment and R&D expenditure by industries in Finland

	Fixed investment		R&D expenditure	
	Share of total manufacturing %	Average annual change in volume, % 1975-84	Share of total manufacturing %	Average annual change in volume, % 1975-84
Food industry	13	1.6	6	9.8
Textile, clothing and leather industries	5	-2.5	1	8.0
Forest industry	27	-1.2	9	1.7
Chemical industry	12	0.1	19	9.7
Metal and engineering industry	25	-2.4	62	9.5
Other industry	18	6.9	3	9.6
Total	100	-0.4	100	8.7

Source: National accounts, Research statistics and Bank of Finland's survey.

Figure 2. Volume of R&D exenditure and fixed investment (machinery and construction) in Finnish manufacturing, 1975-85 (1975=100)

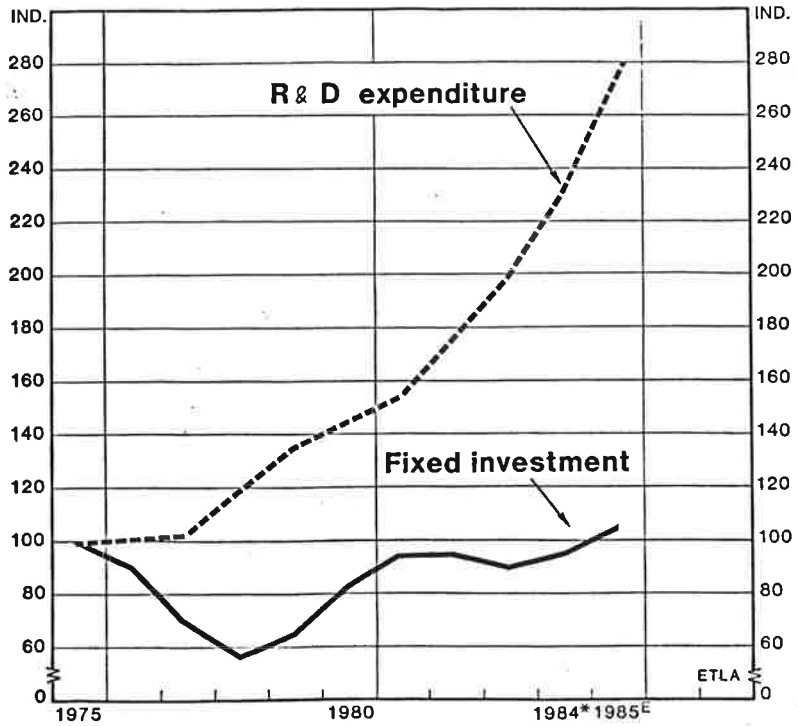
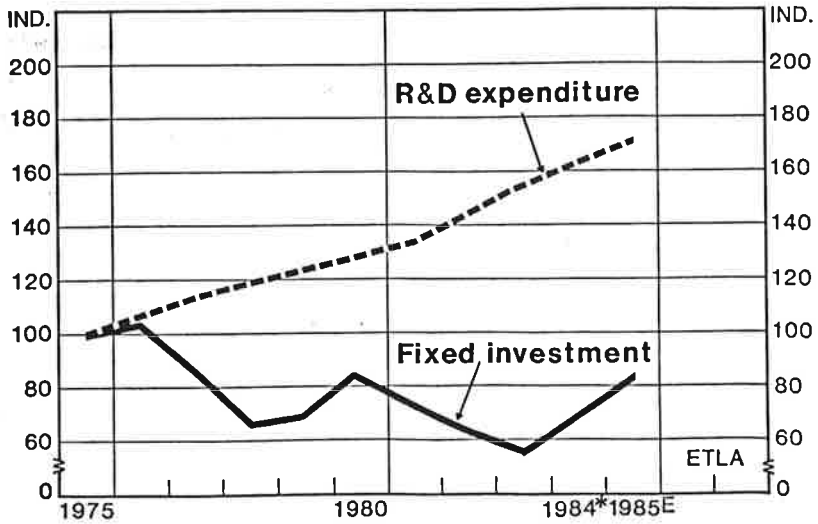


Figure 3. Volume of R&D expenditure and fixed investment (machinery and construction) in Swedish manufacturing, 1975-85 (1975=100)



From the point of view of a firm process development is usually regarded as a means of cost reducing. As a strategic choice process oriented R&D activity implies a strategy of cost efficiency. On the basis of Table 4 one may conclude that cost efficiency as a strategic alternative is of minor (and decreasing) importance for firms operating in a small industrial country.[1] One obvious reason for that is the huge capital requirement often connected to large scale process development projects. Another reason could be that the interenational transfer of process technologies is usually quite easy.

Product innovations (product oriented R & D) are a means of affecting firm's existing demand function. Improving or differentiating products is a way to increase price inelasticity of demand and to get market power in order to search for (temporary) monopoly rents. Shifting demand function rightwards is possible by effectively responding to evolving special needs of customers and thus attracting new buyers.[2] The strategic choice is that of product differentiation and specialization or competing on quality rather than costs.

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1) See Eliasson (1985), who very strongly and in an interesting way puts this argument on the basis of several studies using Swedish data. See also Luchs (1986) who looks at the cost efficiency strategy from the point of view of an individual firm.

2) Cf. Airaksinen (1986) who investigates different R & D strategies in the framework of a neoclassical theory of the firm.

Table 4. Orientation of R & D activity in manufacturing in Finland and in Sweden, 1979 and 1983, % of total R&D outlay

Activity	Finland		Sweden	
	1979	1983*	1979	1983*
New products	20	26	21	22
Products already on market but new to firm	19	25	20	24
Improvements of existing products	28	25	38	36
Product development, total	67	76	79	82
Development of new processes	15	13	8	7
Improvements of existing processes	14	9	9	8
Process development, total	29	22	17	15
Other	4	2	4	4
Total	100	100	100	100

It is evident that process development activities are mainly devoted to productivity improvement (cost reduction) - but how do product innovations affect productivity developments? It can be argued that new products are of equal or even greater importance for productivity gains than process innovations.[1)] There are two mechanisms at work. First new products supplied to an industry from outside (capital goods) improve productivity. New products produced within industry also affect its productivity. After introduction of a new product,

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1) See Baily and Chakrabarti (1985) who present detailed analysis on two industries: chemicals and textiles.

productivity usually rises rapidly when the scale of production increases and the firm moves downward along the learning curve.[1)]

Linking current innovative activity with current productivity performance - as we have implicitely done above - might be misleading, because of the obvious lag between innovation and productivity. There are quite many econometric studies giving information of lags associated with effects of R&D expenditure on productivity growth. Common results is that there is a lag of several years, the mean being about 4-6 years. The lag structure seems to be quite complicated and varies across industries, but the general conclusion holds.

The change in the structure of investment (soft investment vs. machinery and construction) and the shift from process oriented R&D towards product-based technology seem to be important features at least in small industrial countries like Finland and Sweden. On the basis of these developments Eliasson (1985) argues that technical change has been gradually moving into a more capital saving direction in contrast to the results of standard production functions analysis, according to which technical progress in most industrial countries has been - and still is - predominantly labour saving. In other words, the nature of technical progress has probably changed implying that skilled labour force, effective utilization of information management skills etc. are relatively more important for technical advance than fixed industrial capital.

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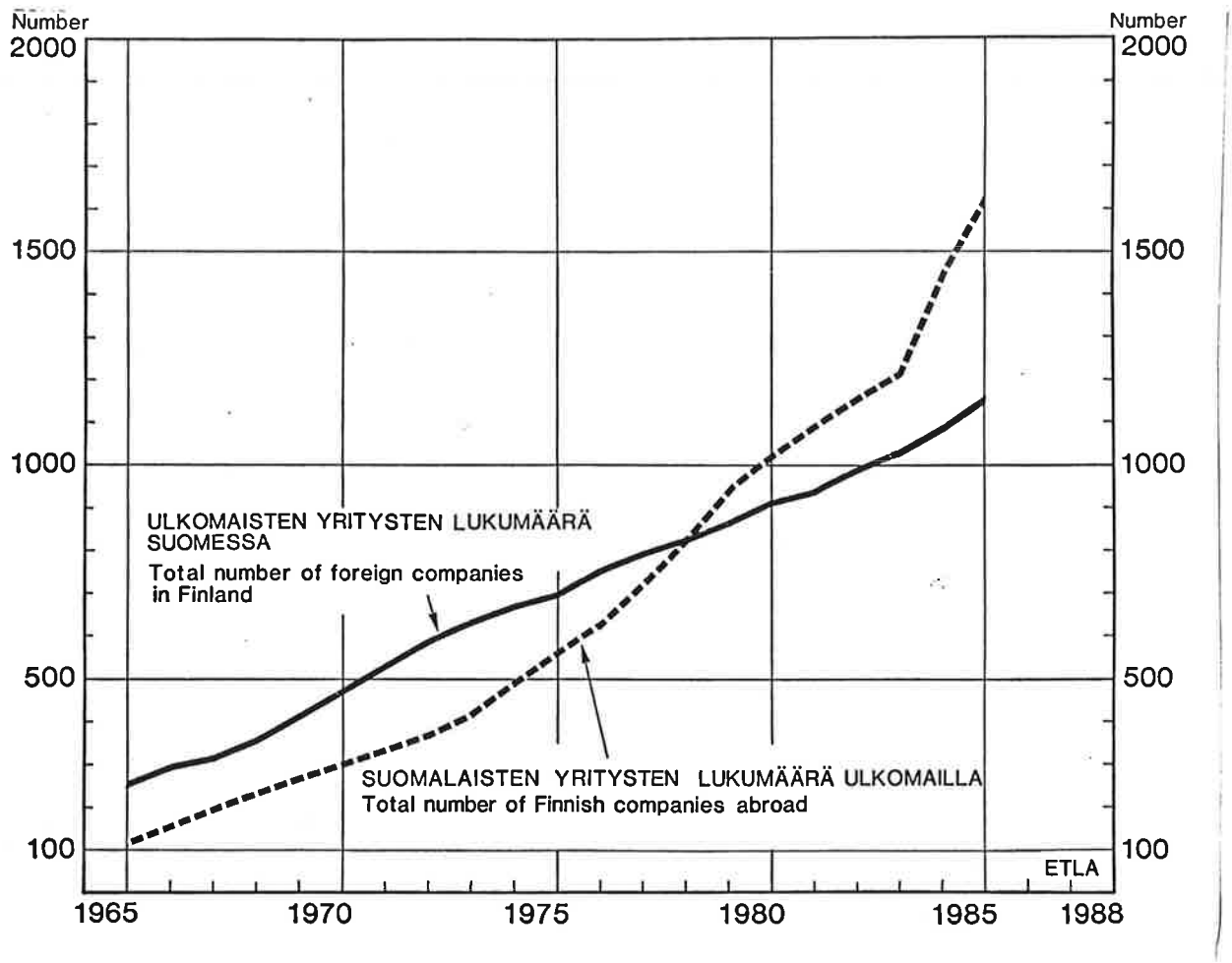
1) Cf. Baily and Chakrabarti (1985).

Figure 4. Number of Finnish companies abroad and foreign companies in Finland, 1965-85



5. CONCLUDING REMARKS

On the basis of the preceding sections some general conclusions can be made about the reorganization of manufacturing companies and the changing role of the management. Growing share of resources in firms will be devoted to acivities other than productions of goods, i.e. to research and development, financing operations, marketing efforts and to production of "secondary" services (consulting, installation, maintenance, repair, training etc.). Establishing and acquisitions of foreign subsidiaries (both production and marketing units) change the existing organizations as a result of customer oriented and product technology based business srategies.

Growing internal production of secondary services in manufacturing companies may lead to forward integration into primary service industries and hence new kind of multibranch corporations. On the other hand applications of information technology and microelectronics in production will allow further decentralization of some activities, and flexibility of manufacturing systems is becoming of increasing importance and economies of scale in production processes of decreasing importance.

In management the role of operational management is likely to weaken in accordance with diminishing importance of cost efficiency as strategy alternative in many industries. The situation varies, however, greatly depending on industry and country (e.g., in some branches of electronics there are still huge cost reductions to be achieved with only small incremental investments).

In contrast, the innovative function and the function of information processing of management will be accentuated, since all companies face the information revolution[1)] in one form or another. Large, internally financed R & D projects, uncertainty and low predictability of business environment pose new role to risk management of firms.

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1) Information revolution is often associated with totally new technological paradigm, which includes the combinations of micro-electronics, computers, telecommunications and information technologies. (See, e.g., Luc Soete and C. Freeman (1984)). These technologies provide enormous productivity potentials in the form of more efficient information handling and coordinating of activities at all levels of organizations.

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