CHAPTER II

The Information Sector in Sweden

Recent Developments in Firm Education, R&D, and Telecommunications

by

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1 Telecommunications services, much more for much less

As machines increasingly outperform humans at rote production tasks a growing share of the workforce is instead occupied with the organization of production. Organization consists of acquiring and distributing information. In fact, the number of people handling information has multiplied so rapidly that pundits of national account figures are beginning to slice out the "information economy" as a separate sector, consisting of segments of the service and manufacturing sectors.

What is the information economy? According to the OECD classification it can be divided into four categories as shown in Table II.1.[1]

The purpose of this paper is threefold. First, the evolution and structure of the information sector in Sweden is sketched. Second, the impact of the information revolution at the firm level is analyzed using two surveys recently conducted under the auspices of the Industrial Institute for Economic and Social Research (IUI) in Stockholm. Third an attempt is made to estimate the future growth of the telecommunications industry and other segments of the information sector.

The impact of the information sector's rapid growth on the economy as a whole is analyzed in two different ways: First, information production and distribution at the firm level is examined using data from the two IUI surveys. One survey concerns firms' investment in education and "on-the-job" training. This leads to an estimate of the cost of such education. The other survey reveals how the character of firms' R&D has changed over the recent years. Together these surveys indicate that "soft" investments such as education, marketing, and R&D are rapidly becoming a weighty portion of total investments.

The second analysis in this paper is an attempt to forecast the long-term growth of the telecommunications industry and other segments of the information sector. This is done with a cross-country, time-series regression. The results indicate that in spite of large increases in the volume of telecommunications services to be expected the

[1] For alternative definitions of the information sector and early work see Machlup (1980), Porat (1977), Eliasson et al. (1986) and Eliasson's Chapter I in this volume. Stated simply Machlup distinguishes a number of industries that produce information or information services and goods, while Porat tries to look more at the prevalence of information activities within each industry. Eliasson emphasizes the distinction between information as an input into production as opposed to information as an output.

Table II.1 The information sector divided into occupational categories

I INFORMATION PRODUCERS

Scientific and technical

Chemists
Physicists nec
Physical scientists nec
Civil Engineers
Electrical and Electronic Engineers
Mechanical Engineers
Metallurgists
Mining Engineers
Industrial Engineers
Beginners, nec
Biologists, Zoologists and related
Bacteriologists, Pharmacologists
Agronomists and related
Statisticians
Mathematicians and Actuaries
Economists
Sociologists, Anthropologists and related

Market search and co-ordination specialists

Commodity Broker
Purchasing Agents and Buyers
Technical Salesmen and Advisors
Insurance and Stock Agents
Brokers and Jobbers
Business Services/ Advertising Salesmen
Auctioneers

Information gatherers

Workstudy Officers
Surveyors (land, mine, hydrographic, etc)
Inspectors, Viewers and Testers (various)
Quantity Surveyors
Valuation Surveyors

Consultative services

Architects and Town Planners
Draughtsmen
Medical Practitioners
Dietitians and Nutritionists
Optometrists
Systems Analysts
Computer Programmers
Accountants (except 1–10.20)
Barristers, Advocates and Solicitors, etc.
Education Methodology Advisors
Commercial Artists and Designers

Information producers nec

Authors
Composers

II INFORMATION PROCESSORS

Administrative and managerial

Judges
Head Teachers
Legislative Officials
Government Administrators
General Managers
Production Managers
Managers NEC
Government Executives Officials
Managers (Wholesale/Retail Trade)

Process control supervisory

Clerks of Works
(Flight and Ship Navigating Officers)
Transport and Communications Supervisors
Dispatching/Receiving Clerks

Supervisors: Clerical, Sales and Other

Supervisors and General Foremen (production)

Clerical and related
Auditors
Stenographers, Typists and Teletypists
Bookkeepers (general)
Bookkeepers (clerk)
Cost Computing Clerks
Wages Clerks
Finance Clerks
Stock Records Clerks (Material and Production Planning Clerks)
Correspondence and Reporting Clerks
Receptionists and Travel Agency Clerks
Library and Filing Clerks
Statistical Clerks
Coding Clerks
Proof Readers

III INFORMATION DISTRIBUTORS

Educators
University and Higher Education Teachers
Secondary Teachers
Primary Teachers
Pre-primary Teachers
Special Education Teachers

Communication workers
Journalists and related
Writers
Stage Directors
Motion Picture, Radio, Television Directors
Storytellers
Producers, Performing Arts
Radio, Television Announcers

IV INFORMATION INFRASTRUCTURE OCCUPATIONS

Information machine workers
Photographers and Cameramen
Teleprinter Operators
Card and Tape-punching Machine Operators
Bookkeeping and Calculating Machine Operators
Automatic Data-Processing Machine Operators
Office Machine Operators
Office Machine Repairmen
Sound and Vision Equipment Operators
Compositors and Type-setters
Printing Pressmen
Stereotypers and Electrotypers
Printing Engineers
Photo-engravers
Bookbinders and related
Photographic Processors

Postal and telecommunications
Postmen, Mailsorters
Messengers
Telephone Operators
Radio and Television Repairmen
Telephone and Telegraph Installers/Repairmen
Telephone and Telegraph Linesmen
Broadcasting Station Operators

industry's fraction of national product and of employment is not likely to change much. Since the prices of new telecommunications hardware falls rapidly after introduction total sales change relatively slowly.

2 Size of the information sector

Figure II.1 shows that there has been a steady growth in the size of the information sector, possibly decreasing slightly in recent years. The large differences between countries are explained mostly by variations in the number of "information processors," the managerial and clerical professions. The U.S. also has a somewhat higher share of "information producers", such as scientists and market researchers. The information sector is decomposed in Figure II.2 to show the growth of each category up to 1980. Interestingly, the size of the information infrastructure category has remained virtually unchanged.

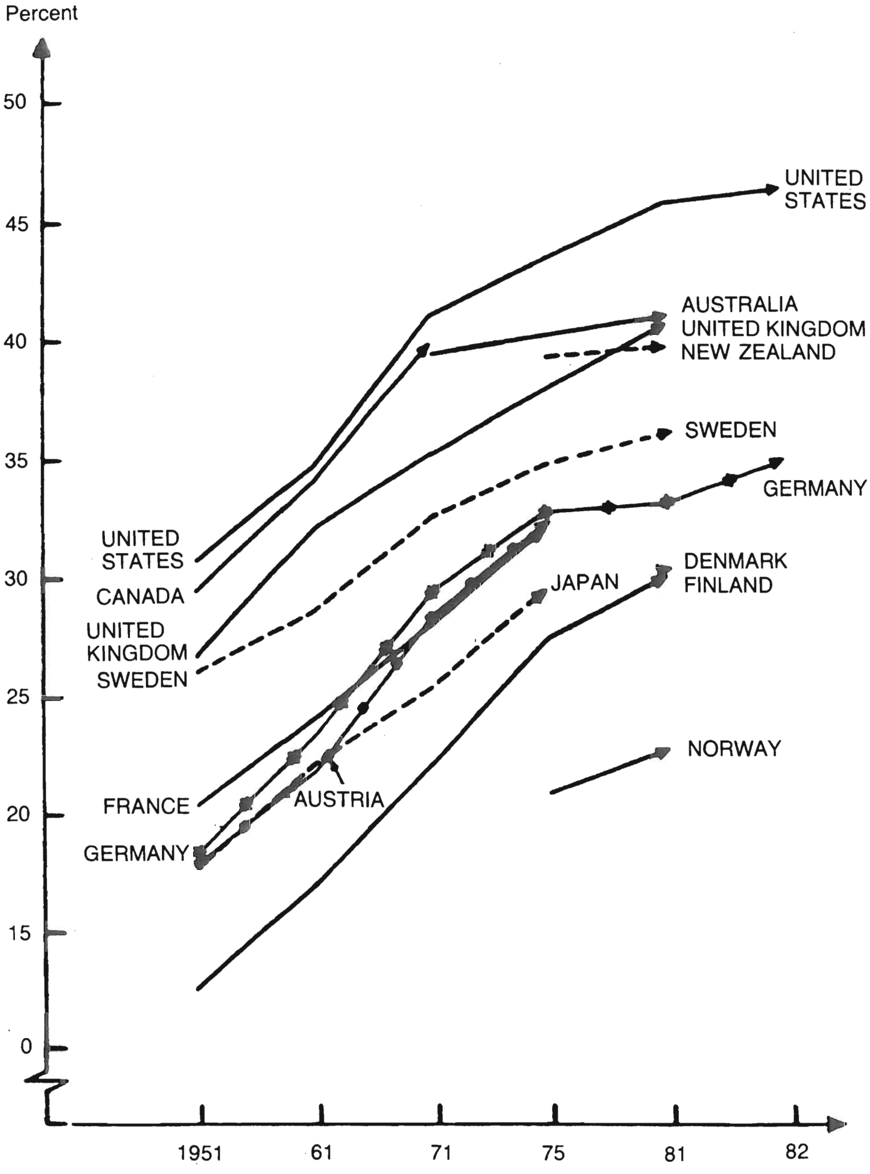
While figures concerning the information sector show that the character of production is undergoing a drastic change, it is also true that one is merely relabeling activities that previously were categorized as service or industrial production. It is not clear that such relabeling by itself leads to major insights. This is especially true of some attempts in the literature to estimate growth models of the economy with information as a product (e.g Jonscher 1983).

Instead we examine some specific aspects of the information sector and how it is likely to change over the coming decades.

3 Information processing and distribution

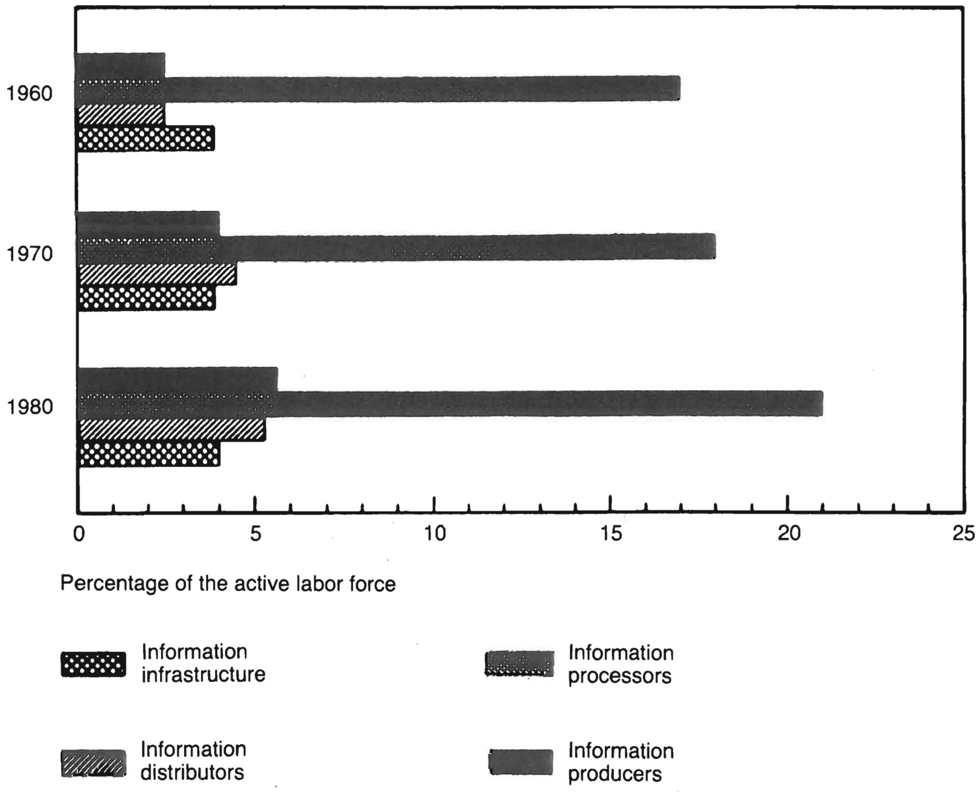
The information that is processed and distributed within firms can usefully be divided into two categories. One concerns administrative information needed for daily tasks. The other concerns stocks of knowledge that raise employees' efficiency. The former is part of

Figure II.1 Changes in the share of "information occupations" in "all economically active" since 1950
Information occupation as percent of economically active



Source: OECD

Figure II.2 Size of the information sector by category in Sweden, 1960, 1970, 1980



production while the latter is an investment. Consider one at a time.

Nearly all firms have computerized much of their existing administrative routines. That has brought large gains. Much more seldom do firms change their administrative routines to fully take advantage of new technology. This is where computerization will have its largest impact in the future.

One example of such changes in administrative routines that western firms are just beginning to realize, involves the Japanese concept of just-in-time production. Decentralized information transmission technology and decision making is used to reduce stocks of intermediate goods.

Modern information technology and data base management are increasingly put to use in large firms to make centralized profit control more efficient and reliable such that operations responsibilities can be delegated (decentralized; see Eliasson 1984, 1989).

Another example is changing accounting methods to produce more accurate cost and profit calculation. Most firms know their total costs and overall return-on-sales. Few firms, however, seem to be able to say what individual products really cost to produce. In fact there are ample anecdotes about investment decisions that turn out to be mistaken because costs were not properly calculated.

One main problem is that overhead costs are allocated to individual products according to estimates of direct labor costs. However, direct labor costs for many products today are extremely small, so misallocation of the overhead can lead to perverse decisions. For example investments in R&D or human capital are often counted as overhead costs and thus falsely allocated to current products.

Another problem is the calculation of marginal costs. Often, for example, the costs of operating a machine are averaged over the details it produces without recognizing that one type of detail is produced in lower volume and therefore incurs a higher per unit cost of switching the machine.

As yet these problems of cost calculation are rarely tackled by firms because information costs exceed the benefit of the extra integration. Eventually, however, progress in information handling will vastly increase the efficiency of these administrative tasks.

The other category of information distribution mentioned in the beginning concerns the accumulation of human capital. The traditional view in economics has been that the technology embodied in a firm's capital equipment determines its productivity. This view may be false in many industries. A number of studies show that firms sometimes can produce more efficiently with less advanced capital equipment (see e.g. Eliasson 1980). Consider a recent study (Krafcik 1988) comparing the effects of automation in 31 car plants in Europe, America, Japan, Brazil, Taiwan, and South Korea. The author concludes that there is no systematic relation between productivity and the levels of technology. Instead productivity depended on how decentralized decision making was which in turn depended on the level of education and experience of workers.[2]

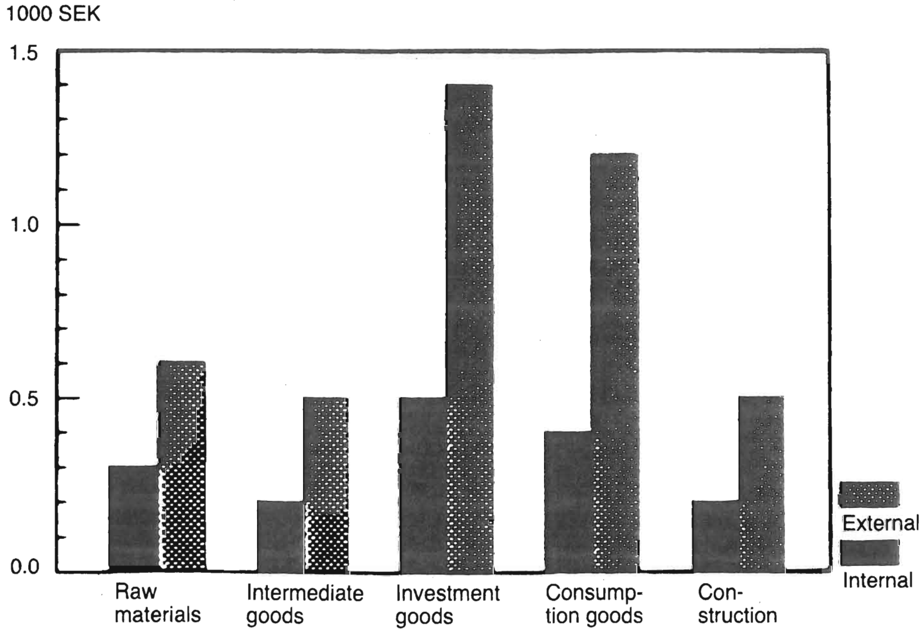
That this example demonstrates investment in human capital may now be a more important determinant of productivity than other capital expenditure. This is important for an analysis of the information sector because this sector then becomes the main conduit for investment. Raising the efficiency of information- and experience-transmission in effect lowers the cost of investment in human capital. In fact firms appear to have raised investment in human capital significantly.

[2] A related point is made by Carlsson (1981, 1987). He shows that large productivity changes usually are the consequence of some structural change rather than a continuous improvement of production technology.

In a recent survey of Swedish industry questions were asked that shed some light on the extent of on-the-job training.[3] Figure II.3 shows the reported costs of training divided into training within the company and training purchased externally.[4] These results are shown for five different groups of industries. Figure II.4 shows the percentage of working time that is used for training. Apparently technicians spend the most time being trained.

Interviews with a few of the sampled firms were conducted to control for biases that may have been induced by the way questions were asked in the survey. These interviews confirmed that the results in Figures II.3 and II.4 should be interpreted as time spent on courses and conferences as well as training for newly employed. However, costs of training that occur continuously during work is generally not accounted for. The interviewed companies themselves seemed to have a poor grasp of the extent of that type of training.

Figure II.3 Internal and external firm training



[3] The survey was conducted by the Federation of Swedish Industries (Planenkät 1988).

[4] These results are well in line with a similiar survey conducted by the Swedish Central Bureau of Statistics showing that employees on average received 2.8 days of training a year. Most of this was concentrated on computer related-, business-, and work-situation courses.

Figure II.4 Percentage of worktime used for training

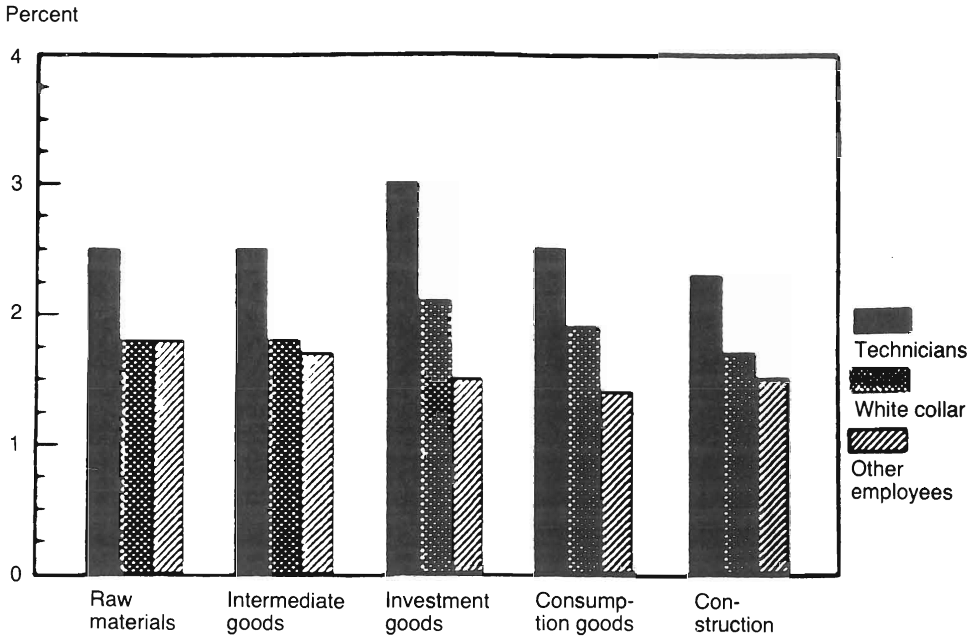


Figure II.5 Total training costs in industry per employee, 1987

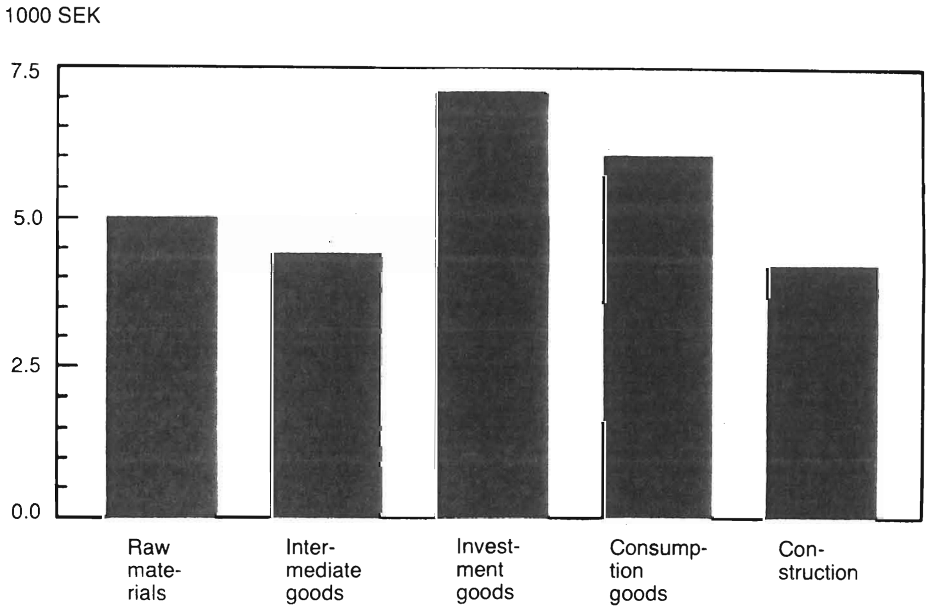
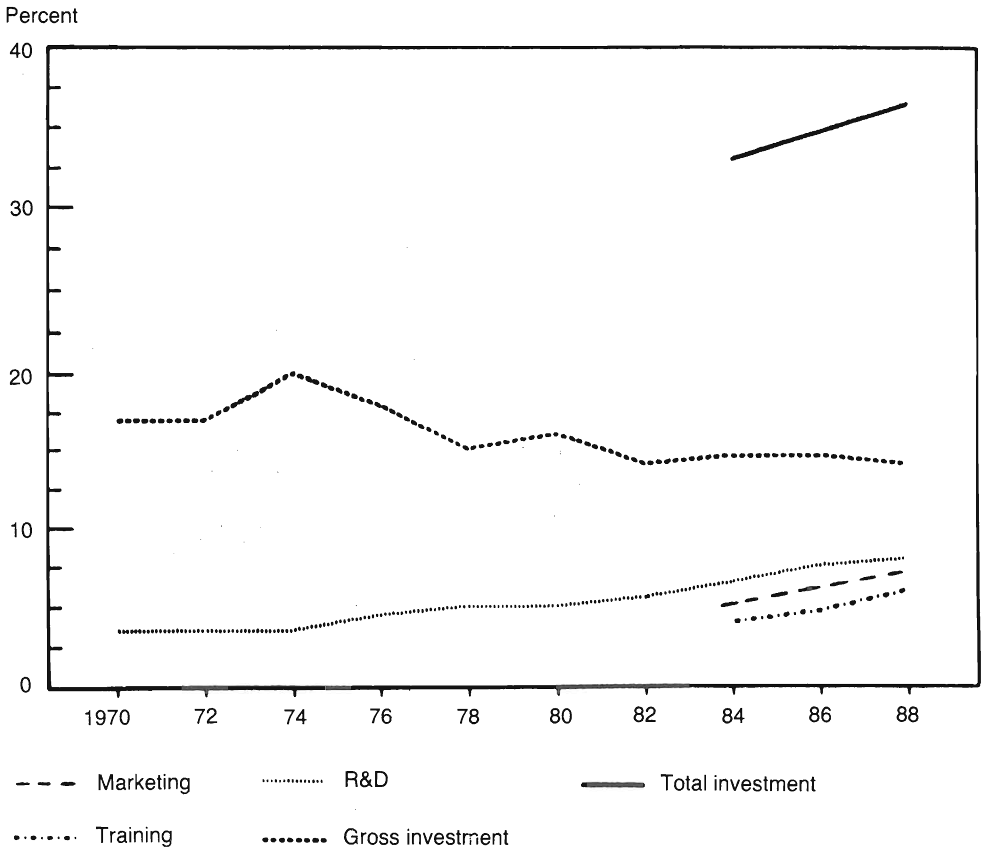


Figure II.6 Soft and hard investments as percent of value added, 1970–88



From these data one can even estimate the total cost of education to firms.[5] This is shown in Figure II.5.

In reality not all training should be considered investment. Some courses may represent hidden fringe benefits to employees; other courses are organized by unions to spread knowledge about worker representation and labor issues. Therefore counting all training as investment will lead to an upward bias. On the other hand some training occurs during work. A novice for example may produce much more slowly while gathering experience. This implies that we may underestimate investment in training when we base calculations on time spent at courses and in official training sessions.

[5] Apart from the direct cost for commissioning education, the indirect costs are calculated as the time spent on education times the average wage for each respective category.

Assume for the time being that these biases even out. Then we can compare investment in education to other investment. To make our figures comparable to other investment figures we express them as a percentage of value added and extrapolate to the industry as a whole.[6] In addition, by comparison with two previous surveys we can estimate the growth since 1984. These estimates are then compared to other soft and hard investments in Figure II.6.

One interpretation of Figure II.6 is that soft investments are replacing hard investments. This could be the result for example of structural shifts from machine-intensive industries to service industries. That interpretation implies that the poor performance of hard investments during the previous decade may not be any impediment to future growth. Critics of this interpretation argue instead that soft investments rise in non-productive ways. For example education costs may rise merely because firms are forced to use so-called educational funds in Sweden. These funds may then be used to prop up employee benefits rather than to spread useful knowledge.

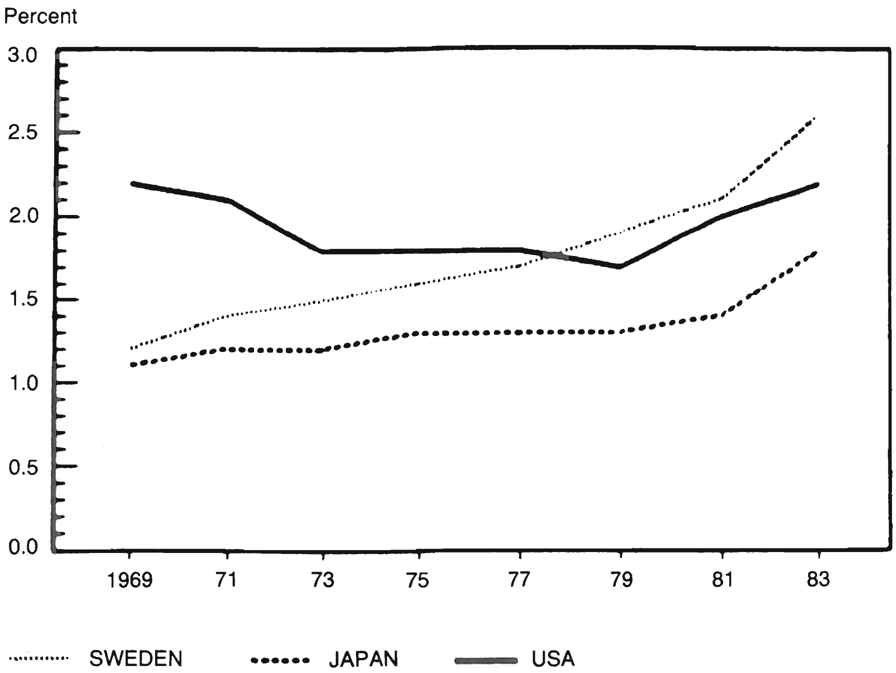
4 Information production

Information production, and primarily research and development, constitutes the second segment of the information sector. By all measures Sweden's total R&D investments have experienced a dramatic upswing. Research intensity in the private sector expressed as a fraction of value added is now the highest in the world. In contrast the public sector's fraction of total R&D has declined.

In Figure II.7 the U-shaped curve for U.S. R&D expenditure is usually explained with reference to the business slump in the aftermath of the oil crisis 1973. This is not a very satisfactory explanation however. It is clear that R&D expenditures deteriorated even before the crisis and that other countries were not subject to a similar simple connection between R&D and aggregate demand. A possibly more accurate explanation is that there occurred an ideological shift among company executives in the late sixties leading them to view large R&D investments, particularly those of a long-term nature, with increased skepticism. Whether this ideological shift reflected an actual decrease in research opportunities remains unclear.

[6] The sample for this survey consists of the majority of Swedish firms with more than one hundred employees.

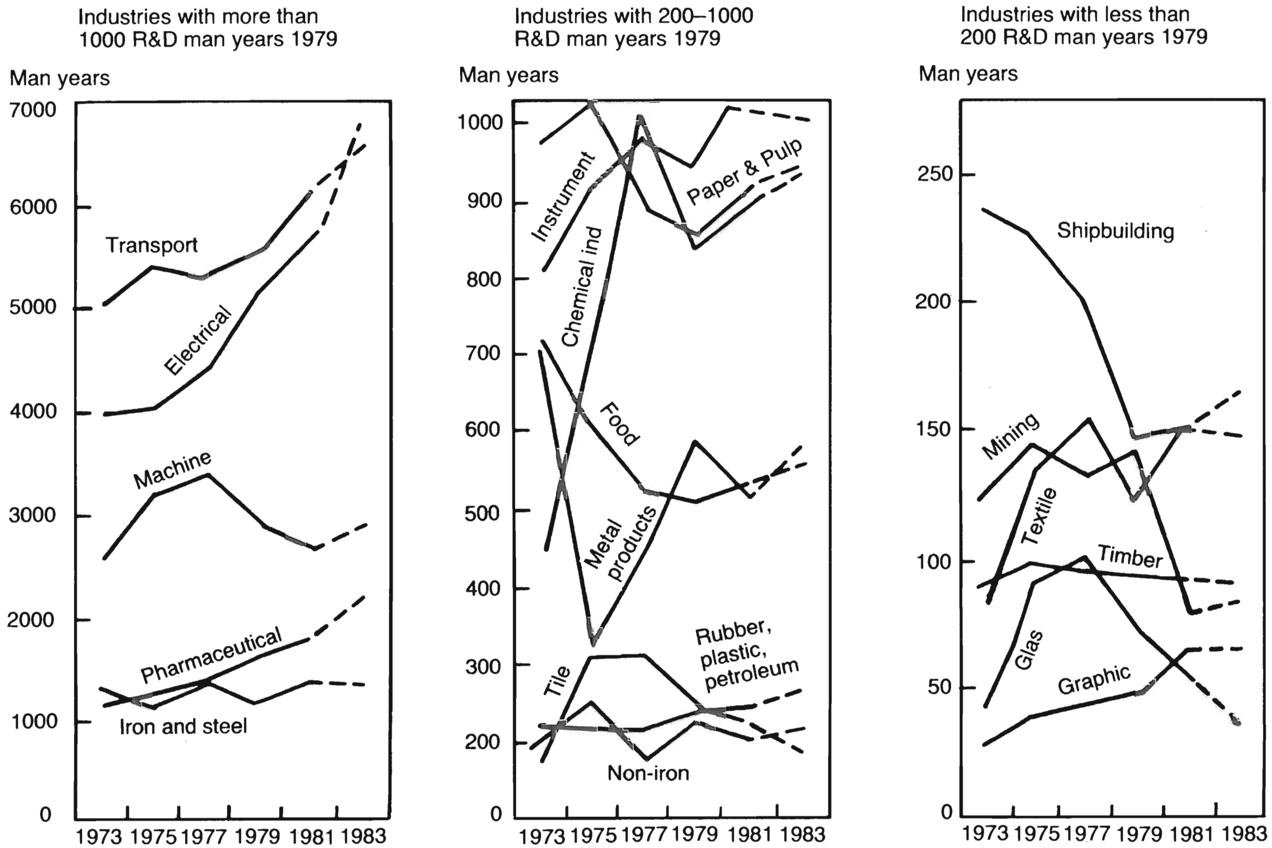
Figure II.7 R&D expenditure in the private sector as percent of value added, 1969–83



In Sweden the dramatic increase in private R&D spending is partly a consequence of the decline of low R&D intensity industries such as shipbuilding and the growth of the electronics, telecommunication, and transport industries. However even within these industries R&D intensity is rising. Figure II.8 shows the total number of man-years within each industry in Sweden. Changes in this measure reflect increases in R&D intensity as well as industry expansion.

The competitiveness of Swedish technological know-how is a moot issue. On the one hand profits are soaring and firms feel constrained by capacity limits; on the other hand alarmists foresee impending crises in a range of industries which, they say, are only propped up by the current boom in international demand. Indeed there exist reasonable scenarios of technological threats for most important Swedish industries. The pulp and paper industries fear invasions of South-American soft wood; the automobile and telecommunications industries face worldwide overcapacity. Machine tool manufacturers are under fire from cheap South-Korean and Japanese producers. The larger machine-tool firms may anyway be moving their research capacity out of the country.

Figure II.8 Growth of R&D input in some Swedish industries, 1973–83



Source: SCB

A common argument (e.g. Ohlsson – Vinell 1987) is that Sweden's technological competitiveness is poor, threatening future growth. This argument is based on the observation that very few Swedish firms can be classified as high-tech firms, following for example the OECD classification scheme. This view is however poorly founded. Many industries that are not high-tech as such incorporate high-tech features and specialized knowledge that can insulate them from competition from low-wage countries for a long time to come. As long as these industries perceive enough investment opportunities to demand more engineers than are available it is difficult to see why one should channel more engineers into beefing up high-tech firms.

In fact, as argued in Chapter I, the predominant high tech skill in Sweden may be the capacity to run large companies in mature industries (see e.g. Eliasson et al. 1985).

These issues are too wide to be exhausted here. We can however contribute to understanding them by reporting the results of a recent survey among research managers in medium-sized and large Swedish firms. This survey was conducted under the auspices of the Industrial Institute for Economic and Social Research (IUI). 26 research managers were queried about a total of 106 specific projects.

The picture that emerges from this survey indicates that research managers believe the following:

1. R&D costs, meaning the outlays required to reach a certain result, are low in Sweden compared to most other countries due to low researcher wages and decentralized decision making.

2. There is a scarce supply of highly talented researchers. There is a constant risk that these most skilled people are bought off by competitors.

3. Access to the latest high-tech knowledge is a problem, but often enough one can earn profits on adapting or imitating technology with an eye to market appeal.

4. Most research managers perceive their firm as being well placed in international competition and facing little threat from low-wage countries.

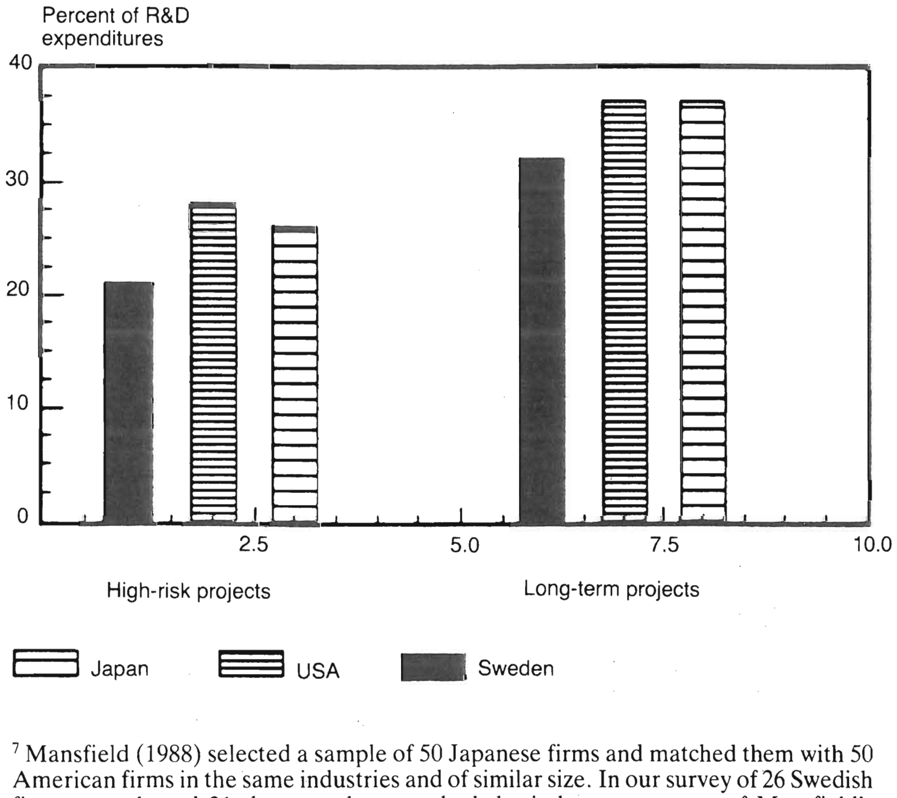
In the following the responses to some of the questions are shown. These questions are matched to a survey conducted by Mansfield (1988) in a comparison of Japanese and American firms.

Consequently we can show a three country comparison.[7] Figure II.8 shows the composition of R&D expenditure. The interesting part in this table is that Japanese firms, once known to concentrate on applied and short-term research (e.g Peck – Tamura 1976) now seem to differ from the other countries mainly in the amount of process R&D conducted.

This difference can be interpreted in different ways. It may mean that Japanese firms imitate products and pay more attention to costs and quality of production. Or it may mean that Japanese firms specialize on products for which process R&D is more important. The question is whether American firms (with apparently lower returns

Figure II.9 Composition of R&D expenditures

Figure II.9A Fraction of high-risk and long-term R&D among total R&D



[7] Mansfield (1988) selected a sample of 50 Japanese firms and matched them with 50 American firms in the same industries and of similar size. In our survey of 26 Swedish firms we selected 21 that together matched the industry structure of Mansfield's sample. However, we made no attempt to match the size of firms, although in both samples only large and medium-sized firms are considered. The percentage of firms in each industry are chemicals, 36; electrical and instruments, 20; machinery and computers, 30; and rubber and metals, 14.

Figure II.9b Fraction of basic and applied R&D of total R&D

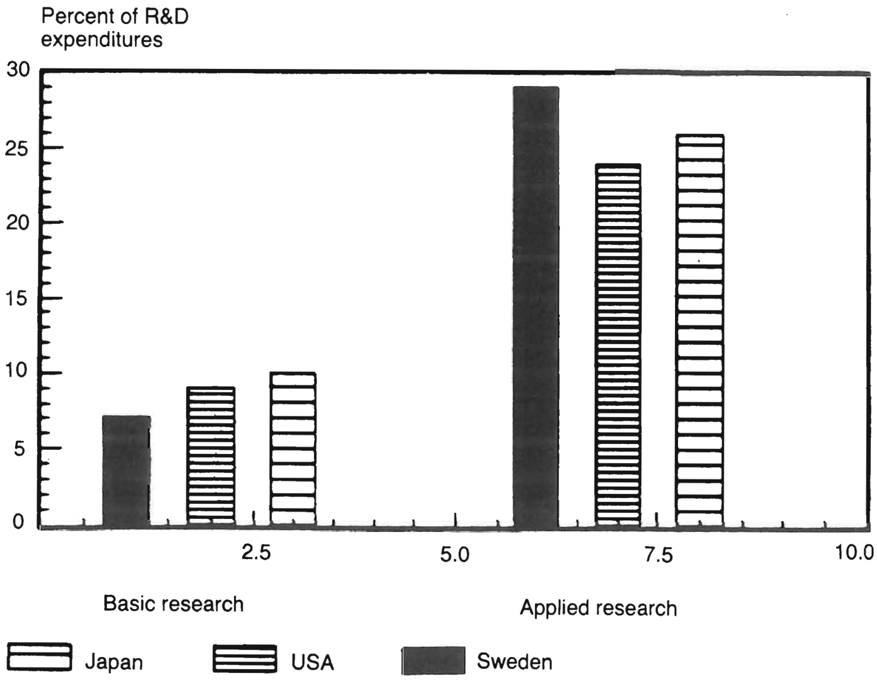


Figure II.9c Fraction of product development of total R&D, and fraction of new products or processes of total R&D (as opposed to improvements on existing products and processes)

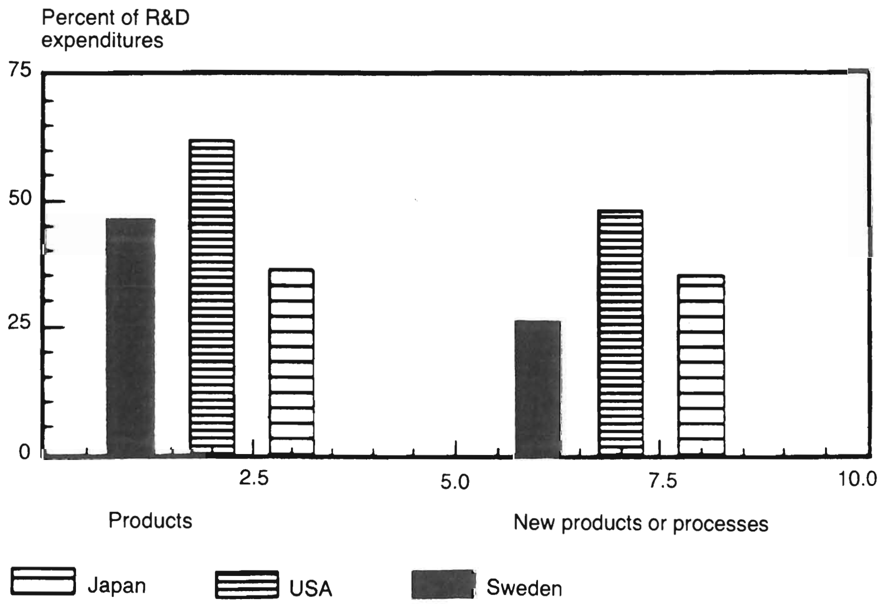
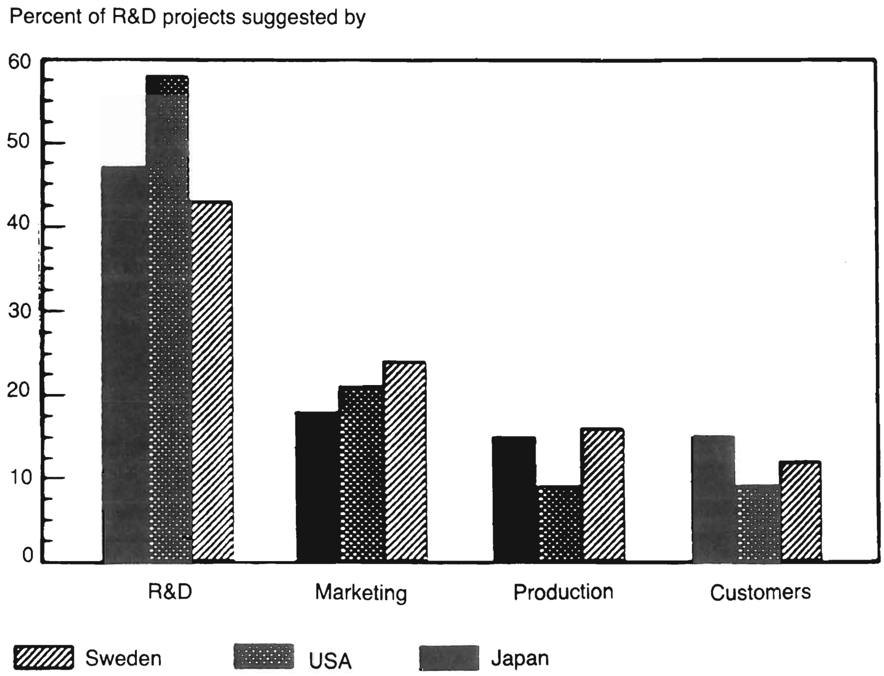


Figure II.10 Sources of R&D projects



on R&D) are making a mistake or whether there are reasons for this difference.

Figure II.10 sheds some light on this issue. It shows sources of R&D projects for the samples of firms. It shows that U.S. firms more often than Japanese or Swedish firms choose R&D projects that originate in the R&D department rather than with customers or production units.

5 Information infrastructure

The final segment of the information sector is the information infrastructure. The information infrastructure consists of information machine workers – e.g. computer operators – and postal and telecommunications occupations. Of these the telecommunications industry is the one undergoing the most rapid change. Telecommunications firms face a paradox. Their capacity and range of services is burgeoning at a phenomenal rate; yet their share of GNP and investment has become stuck and may even be declining. The same may be true for profit levels. The latest scare in the industry is the spectre of overcapacity caused in part by the returns to scale in fiber optics, which can cheaply be upgraded to higher rates of communication, and in part by the desire of many customers to substitute private networks for services offered by telephone companies.

These threats affect not only telephone companies but also the firms producing telecommunications equipment. Many of these firms that previously thrived on assured national markets are now being forced to compete internationally to survive. Worldwide ten companies compete to sell a full range of telecommunications equipment. Informed bets say that only a handful will remain in the next generation.

A number of attempts have been made to estimate the long-term future growth of the information economy. These come to very different conclusions. For example Imai (1987) develops an input-output table augmented by informed guesses about the future input requirements of the telecommunications, electronics, and information services sectors. For the case of Japan he forecasts the largest expansion for information services, followed by electronics and then telecommunications all of which grow faster than the remainder of the economy. In contrast Cooper (1983) argues that information services in the U.S. will grow only slowly as compared to information products.

Imai (1987) starts from predictions of increased domestic output by the year 2000. These are shown for the telecommunications industry in Table II.2.

He then finds input-output coefficients that are consistent with estimated output and estimated demand in the year 2000 and compares these to current input-output coefficients. Unfortunately this procedure suffers from a major uncertainty. Output and final demand can reasonably be estimated in volume terms. But prices and required employment depend crucially on the form technological progress takes. If prices fall rapidly then the value of output may decline even though more volume is produced. Thus it is quite possible that the share of GNP in current prices and employment remains constant for the telecommunications industry even though its output becomes ever more important for other industries. The question is whether the figures in Table II.2 are based on current prices or future expected prices.

Instead we approach this problem more carefully by estimating the likely growth of the volume of information transmitted, the share of GNP of the telecommunications industry, and its share of employment separately. Furthermore we try to separate the income effects

Table II.2 Prediction of telcommunications domestic output by subsectors
Billion yen

Subsectors	1985 (A)	2000 (B)	(B)/(A)
Telephone	4,234	11,002	2.6
Exclusive use	251	1,025	4.1
Data communications	153	958	6.3
Data transmission	10	1,188	118.8
Wireless call	70	507	7.2
Cellular telephones for automobiles	15	1,582	105.5
Total of domestic telecommunications	5,091	17,142	3.4
International telecommunications	216	1,397	6.5
Total	5,307	18,539	3.5
Percent of GNP	1.6	2.8	1.75

from the technological effects and to provide estimates for different assumptions about technological progress.

In the following we estimate a cross-country, combined cross-section and time-series, regression. There are three dependent variables. These are the postal service and telecommunications expressed as a percentage of GNP, a percentage of employment, and finally a volume index showing the growth of certain telecommunications services. These variables are regressed over GNP per capita in each country and for each of the eleven years and over a variable t expressing the respective time period. The time trend coefficient is interpreted as expressing the effects of changing technology. The regression equations are shown below.

Postal & telecommunications as % of GNP = 0.4 +
0.23 GNP/capita–0.079 t

Postal & telecommunications as % of employment = 0.51+
0.16 GNP/capita–0.041 t

Postal & telecommunications by volume = 0.003 + 0.068 GNP/capita + 0.038 t.

These equations can then be used to forecast the development of the postal and telecommunications service up to the year 2000. This is shown in Table III.3. In the first column we show Imai's estimates for

Table II.3 Size of the Postal and telecommunications industry under different assumptions

	Imai Japan 2000	Sweden 1984	Sweden normal tech.p 2000	Sweden double tech.p 2000	Sweden half tech.p 2000
Postal and telecommunications as:					
% of GNP	2.8*	3.9	4.9	4.5	5.0
% of employment	–	4.0	4.3	3.4	4.7
Volume index	–	100.0	188.0	248.0	158.0

* Only telecommunications.

the case of Japan (assuming a 5% annual rate of GNP growth). In the second column we show our estimates for Sweden (assuming a 2% annual rate of growth). We show these for three different assumptions about the rate of technological progress. First, the same rate as prevailed between 1960 and 1980, second, half that rate; and third double that rate. Note that the character of technological progress is assumed constant. For example no allowance is made for a development that is more labor-saving than previously.

Table II.3 should be interpreted in the following way. Technical progress has apparently been labor-saving and has led to price reductions that decrease the percentage of GNP. This tendency is counteracted by rises in GNP that increase demand.

6 Conclusion

The information sector is a vaguely defined conglomeration of activities. Here we have analyzed new survey data to shed light on three segments of the information sector and to analyze their importance for future growth.

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