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# THE RISE OF SMALL BUSINESS: CAUSES AND CONSEQUENCES

by

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# THE RISE OF SMALL BUSINESS: CAUSES AND CONSEQUENCES*

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## I. Introduction

There is now increasing evidence that the share of small business (firms and plants) in industrial output and employment has increased in most industrial countries during the last two decades. To the extent that this evidence is a true reflection of reality, it represents a reversal of the trend during several previous decades. This is of interest for its own sake, but it is particularly interesting in the context of the completion of the European internal market in 1992. Does the new trend towards small business mean that economies of scale are weakening and that therefore one of the fundamental arguments for further European integration is no longer valid?

The claim that the role of small business is increasing is surrounded by considerable controversy. Because of the fact that different indicators yield different results, there is justifiable doubt as to the robustness of the findings. But even if a convincing case can be made, there is reluctance on the part of many people to accept it because such evidence flies in the face of much conventional wisdom concerning the importance and pervasiveness of economies of scale.

The purpose of the present paper is to examine the evidence supporting the claim that there has been a shift towards small business in recent years both in Europe and elsewhere, to consider what the causes of this shift might be, and to discuss the consequences for industrial structure and competitiveness as well as the implications for public policy, particularly in the

context of further European integration after 1992.

The role of small business has been investigated in several recent studies. Acs & Audretsch (1990a and b) and Loveman & Sengenberger (1991) provide excellent surveys. For analyses of particular issues or countries, Small Business Economics (a new journal, the first issue of which appeared in 1989) is a good source.

Several measures of small business activity are used in the literature. Most studies have focused on the manufacturing sector or sub-sectors thereof (mainly because of easily accessible data, at least compared to other sectors), while others have examined broader segments of the economy. In some countries, data are available on both firms and establishments (plants), but in most cases data are available for only one or the other. Because of the fact that the overwhelming majority of firms are quite small and also operate only a single establishment, it is not surprising that the measures of average establishment size and average firm size tend to be highly correlated. But it needs to be recognized that it is quite possible for plants to be getting smaller while companies (through multiplant operations) may be getting larger. This is a point to which we will return in the analysis below.

The most commonly used indicators of firm and plant size are based on employment data, while others utilize output data (in the form of sales, shipments, or value added). Whenever output data are used, the difficulties of evaluating output may cause

problems with respect to comparisons over time and/or across countries.

Because of the limited availability of internationally comparable data, the present study focuses on the manufacturing sector, primarily using data for plants (rather than firms). To the extent possible, both employment and output data are used.

The paper is organized as follows. In the next section, international data are presented on the changing shares of small plants in manufacturing employment and on the development of plant size in manufacturing industry. In Section III, several hypotheses concerning the causes of these changes are considered. In Section IV, the most persuasive of these hypotheses, namely that pertaining to flexible specialization, is set out in detail. The implications for the future, particularly in the European context, and the issues raised both for further research and for public policy, are discussed in Section V which concludes the paper.

## II. International Evidence on the Rise of Small Business

### II.1 Share of Employment in Manufacturing

Figure 1 summarizes some of the best and most comprehensive data currently available on the long-term changes in the share of manufacturing employment in plants of various sizes in several countries. Figure 1a shows, on the whole, that the shares of small plants (those with less than 200 employees) declined in the largest European countries, the United States, and Japan during

the entire post-war period, until about 1970. Figure 1b gives a similar picture for small and medium plants (with less than 300 employees) (The only exception among the countries represented in the Figure is Italy, where the overall trend has been increasing, although with some fluctuations.) But around 1970 or so, there was a reversal; since that time the share of small and medium plants has shown an increasing trend, with the possible exception of Germany where the share of the smallest plants has fluctuated around the 1970 share, while that of small and medium plants has trended upwards. Thus, over the post-war period as a whole the development of the share of manufacturing employment in small plants has been characterized by a V-shaped pattern in these countries -- first falling and then rising -- the turning point occurring somewhere around 1970. It is not an isolated event in one country alone but is characteristic of all the world's largest industrial countries -- and, as we shall see, the smaller ones as well.

The Figure also shows that the shares of small and medium plants vary considerably from country to country. In Italy, Japan, and France, small plants represent 45-60 % of manufacturing employment, while in the U.K., Germany, and the U.S. their share is between 18 and 28 %. These differences seem to persist over time; there seems to be a kind of bifurcation with no tendency to a narrowing of the differences. The dichotomy is not between large economies on the one hand and smaller economies on the other. Instead, there are large and small

countries in both groups, with Japan and Italy at one extreme and the U.S., U.K. and Germany at the other. Whatever the determinants of the share of small business are, the size of the economy apparently is not among them. This makes the universality of the observed "V-shaped" pattern all the more remarkable -- and intriguing.[1]

But despite the persistent differences among countries in the share of small plants in industrial employment, the increasing trend during the last decade or two seems to be fairly universal. This result is confirmed by the findings by Acs & Audretsch (1990a, 3-4) that the percentage of sales contributed by small manufacturing firms in the United States increased between 1976 and 1986 and that the employment growth in small manufacturing firms by far exceeded that in larger firms. Similarly, Thurik (1990) found that the average firm size in Dutch manufacturing generally decreased and the small business share generally increased during the period 1978-89.

## II.2 Average Plant Size

The results presented in the previous section require data on the size distribution of plants or firms. Can corroborating evidence for a larger set of countries be found in other sources with less stringent data requirements? For example, if employment has been shifting towards smaller plants, this should be reflected in shrinking average plant size, APS, which can be computed from aggregate data.

The changes in the APS (measured in terms of employment) of five selected countries are shown in Figure 2 for the post-war period. Since the methods used to estimate data on establishments with less than 20 employees vary considerably among countries, the figure refers only to establishments with more than 20 employees.[2] There was a tendency for APS to increase in the early post-war period until the late 1960s and early 1970s. But after that time, with the exception of Sweden (where the change occurred somewhat later), all the countries included in the figure have experienced a decline in the APS, corresponding to the increase in the shares of small plants in manufacturing employment after 1970 in Figure 1. The decline in APS has been particularly strong in the U.K.[3] The data also reveal significant inter-country differences corresponding to those in Figure 1. Thus, the APS in the Japanese manufacturing industry is extremely small, while that in Germany is particularly large.

Figure 3 is based on more comprehensive data for a larger set of countries but for a shorter time period. For each of nine industrial countries, data on output,[4] employment, number of establishments, and average plant size (in terms of both employment and output) in manufacturing industry are reported in index form (1975 = 100).[5]

Even a cursory examination of the Figure shows that there are substantial differences in most countries between changes in $APS_e$ (measured in employment terms) and $APS_o$ (measured in output terms). In all cases (except the United Kingdom), $APS_o$ increased

over the period observed, particularly in Belgium, Sweden, and Germany.

$APS_e$ shows more mixed results. It declined fairly steadily throughout the period in Denmark, Japan, and the United States, and quite sharply in the United Kingdom, while it increased at first and then fell in Belgium and Finland. It rose over the period as a whole in Germany and Sweden. (Data on the number of establishments are not available for Italy prior to 1975; since then $APS_o$ increased rapidly, while $APS_e$ remained constant until 1980. After that, there have been slight declines in both measures.)

Thus, the picture we get is rather complicated. In all of the countries included in Figure 3, manufacturing employment peaked some time during the early 1970s; the only exceptions are the United States and Finland, where the peak occurred around 1980. Manufacturing output increased over the period as a whole in all the countries, except in the U.K. where it declined slightly; the increase was quite modest in Sweden. Thus, the differences between the two plant size measures largely reflect changes in labor productivity: plants have generally increased their output at a higher rate than their labor force. In fact, for the most part, employment has been constant or declining. In other words, for the average industrial worker, the work place has been getting smaller, while productivity has increased in small plants and firms with the result that their share of economic activity has increased.

In the countries where the number of plants stayed relatively constant (Denmark, Italy, U.K., and U.S.), $APS_o$ tracked output and $APS_e$ employment, for obvious reasons. In that sense, the change in the number of plants is the most interesting variable to analyze. Where the number of plants declined most sharply (Belgium, Sweden, and Germany), APS increased in terms of both output and employment. Where it increased, APS stagnated or declined (U.K. and Japan prior to 1975, Finland after 1975).

This reflects the fact that the development of APS (and of the share of small business generally) depends not only on what happens to surviving units but also on entry and exit. Unfortunately, changes in the aggregate number of plants represent only the net changes, not the gross entries and exits. In fact, aggregate data of the sort reported here reveal only the aggregate result and none of the dynamics of the transformation processes taking place within the aggregates. Behind the changes in the aggregates are numerous other changes. For example, it is possible to obtain the same decline in average plant size (or rise in the employment share of small enterprises) in several different ways. It may be the result of declines among large firms while existing small firms remain constant in size; it may result from births of small firms and stable size in large firms, from growth among existing small firms at a rate exceeding that of large firms, and from substantial declines on the part of large enterprises that over time move downward through the size distribution into the small firm sector, etc. (Loveman &

Sengenberger 1991, 11). In addition, there is the possibility that a change (or difference) in the small business share results from changes (differences) in the composition of output.[6] In order to analyze such underlying factors more systematically, it is necessary to have more detailed and disaggregated data than are currently available.[7]

Summing up the results of the analysis thus far, we can conclude (1) that the share of small business in manufacturing employment and output has increased since the early 1970s in most industrialized countries, reversing the previous trend. This change has been pervasive, regardless of whether the country is large or small or has relatively large or relatively small plants. (2) The differences among countries in the share of small business persist, i.e., there does not seem to be any tendency towards convergence of plant size or small business share. (3) Consistent with the increasing share of small plants in manufacturing employment and output, there has been a decline since 1975 in most countries in the average plant size as measured by employment during the last two decades. After 1980, the decline has been universal in the countries studied here. However, (4) average plant size in terms of output has continued to increase in all countries (except the United Kingdom), reflecting increasing labor productivity. Thus, the average manufacturing work place has fewer workers but larger output now than it did a decade or two ago.

Does the fact that the two APS measures diverge mean that one cannot talk unequivocally about declining plant size or rising importance of small business? Not really. In a growing economy, units which do not grow have difficulty surviving; it is relative performance that counts. A unit which doubles its output over a certain time period may still be small, if other units grow at the same (let alone higher) rate. From this standpoint, absolute measures such as total employment are not only practical and convenient to use; they also conform to common sense. After all, most people tend to think of the size of their work places in terms of the number of people working there. The finding that output has tended to increase in all plants, large and small, cannot obscure the fact that the share of small business in total output (and employment) has been rising.

From a more purely European perspective it is noteworthy that there seems to be no distinctive European profile or pattern as far as these developments are concerned. For example, in Figure 1b above, the United States and Japan are in the middle of the figure, while European countries are at both extreme positions: Italy and France with extremely large shares of employment in small businesses and Germany and the United Kingdom with extremely small shares. Similarly, it is difficult to find any "European pattern" in the various panels of Figure 3. The experience in individual countries varies, regardless of whether or not they belong to the EC. It appears likely that these differenses will persist in the future as well.

## III. Possible Causes of the Observed Changes

What are the driving mechanisms behind the increasing share of small business reported in the preceding section? For example, are the changes due to the breakup of large units into smaller ones? Are they attributable to such a fast labor productivity increase in large plants that they shrink into smaller size classes? Or do they stem from especially high rates of labor productivity increases in smaller plants so that they become more competitive compared with larger plants and attract more business, perhaps forming new relationships (networks) with them in the process? These are interesting questions which, unfortunately, cannot be answered without access to more disaggregated data than are currently available.

However, several more macro-type hypotheses have been put forward in the literature concerning the possible causes of the rising share of small business. A convenient survey of these has been provided by Loveman & Sengenberger (1991). They discuss five different explanations. The first is that there has been no real shift to smaller units and that the observed changes are merely a statistical illusion due to sectoral recomposition, i.e. changes in the mixture of output towards industries where the operating units are traditionally smaller, while the operating units in each sector remain constant in size. The primary counterarguments to this "explanation" are (1) the fact that the shift to smaller units can be observed in a wide variety of countries with quite different institutional arrangements and existing size

structures, and during an extended time period, and (2) that in the cases where the sectoral recomposition argument can be tested it has been found that such structural change accounts for only a portion, at best, of the observed change.

The second hypothesis is that the rising share of small business is due to transitory changes in connection with the business cycle.[8] While there is certainly an element of truth in this, again the observed change is pervasive enough in a variety of countries and has been in progress long enough to render the hypothesis largely unsupported by the evidence.

A third potential explanation is that wage costs are lower in small units, thus making it profitable to shift production to smaller units. Such differences do indeed exist -- but they have existed for a long time. Furthermore, the reasons for them are not known. Why should they suddenly lead to a shift in production towards smaller units? To make the argument persuasive, one would have to show either that the cost differential has increased in recent years, or that whatever impediments to such a shift which existed in the past have recently been removed. Also, the size of the differential appears to bear no relation to the growth of small unit employment shares. Italy, for example, has relatively small wage differentials yet shows relatively large employment share gains by small units (Loveman & Sengenberger 1991, 26).[9]

A fourth hypothesis is that liberalization in the form of a variety of tax reductions and deregulation initiatives have lifted restrictions which historically impeded small business and

that, related to this, decentralization has occurred as part of management attempts to reduce the power of labor unions. While, again, the argument may be valid, Loveman & Sengenberger find that the research which has been done on these issues has not been sufficient to warrant such a conclusion (ibid., 27).

The argument that Loveman & Sengenberger find most convincing --and in this I concur -- is that the shift to smaller units has occurred as a result of technological change leading to a transition from mass production to flexible specialization. This argument will be spelled out in detail in the following section which is based upon some recent findings concerning the use of flexible technology in the form of numerically controlled (NC) machine tools in U.S. manufacturing industry (Carlsson & Taymaz 1991). That study shows that there has been a significant and increasing concentration of machine tools in small plants and an increase in the use of flexible automation equipment (represented by numerically controlled machine tools, NCMTs) in plants of all sizes but particularly in small plants during the 1980s. One result of this is that the number of NCMTs per employee in small plants increased from 2:1 relative to that in large plants in 1983 to nearly 5:1 in 1989. Thus, it appears that small plants have been the main beneficiaries of the changes in flexible technology.

Unfortunately, no similar data on the distribution of flexible technology by plant size are available for other countries. But as will be shown in a later section, the U.S.

position with respect to the use of NCMTs is not unique -- in fact, it is very similar to that of Germany and the U.K., and other European economies. Thus, the development in the United States should shed some light on similar developments elsewhere.

The fact that the analysis is based on observations of the engineering (metalworking) industries rather than a broader spectrum of manufacturing industries may limit the applicability of the results to other sectors. The reason for limiting the analysis to the engineering industries is that that is where metalcutting machine tools are used. But it can be shown that the development of, say, APS is very similar in engineering industries to that in manufacturing industries in general. And flexible technology similar to that embodied in NCMTs is used in other industries. Thus, the discussion that follows should be replicable, at least in principle, in other industries and in other countries.

## IV.The Linkage between Flexible Technology and Plant Size

There are many possible explanations for the increase in NC machine intensity of all plants (but particularly small ones) during the 1980s on the one hand, and the shift in output towards smaller plants on the other. The essence of the argument presented here is that these changes are interrelated. It is argued that the technological change taking place with respect to machine tools and other components of flexible automation came about quite independently of the changes occurring in the global

economic environment, but once both were set in motion, they tended to reinforce each other.

There are three major changes which have taken place in the world economy in the past two decades and which are relevant here. These changes in the economic environment are i) intensified global competition as a result of the developments in transportation, information, and communication technologies and the resulting increased integration of the world economy; ii) a high degree of uncertainty reflected in a significant growth slowdown in all industrial countries triggered by the oil price shocks in the 1970s, exacerbated by volatility of exchange rates and reflected in high rates of interest, inflation, and unemployment; and iii) intensified fragmentation due to growing consumer demand for differentiated products, inducing firms to increase their emphasis on product differentiation.

Each of these changes has engendered micro-level responses as enterprises have been subjected to increasing pressure to adjust to the new conditions. Increased global competition tends to lead to increased specialization ("back to basics"), while uncertainty and fragmentation force firms to increase their flexibility and search for new ways to differentiate their products. Each of these responses, in turn, has been facilitated by the changes in flexible technology and has also involved a shift in output towards smaller units.

IV.1 Specialization

Specialization (which refers to both vertical disintegration and horizontal "de-glomeration" -- see Carlsson, 1989a) has increasingly been regarded as i) a way to cut overheads and fixed costs, ii) a mechanism to transfer uncertainty, iii) a means of accessing cheap labor sources,[10] and iv) a way to obtain new sources of supply of high-quality, specialized inputs. There are various observed forms of specialization or vertical disintegration:

1) Decentralization: large plants are broken up, but new small plants are retained under the same ownership.

2) Subcontracting: specific parts and components manufactured, and specialized processes performed in-house, are increasingly obtained from specialized plants by forming semi-permanent relations (not involving ownership).

3) Other outsourcing: parts and components are no longer manufactured in-house but are purchased from the market without any long-term relations with the producer.

As pointed out in a previous study (Carlsson 1989a), there is increasing evidence that firms are becoming smaller and less vertically integrated. Thus, for example, the largest 500 industrial companies in the United States ("The Fortune 500") have lost some of their share of manufacturing employment as well as output during the 1980s (ibid., 28). There is plenty of anecdotal evidence supporting this view. The trend towards specialization and vertical disintegration in the U.S. is shown

also by the rapid growth of the business services industry. This sector (SIC 73) had the highest average annual employment growth in 1969-1984 amongst the 2-digit SIC sectors (Kutscher and Personick 1986, 9).

In many cases, the end result of vertical disintegration is to achieve a flexible network of firms. Individual firms in this network may become highly specialized while the network as a whole is flexible (Carlsson and Stankiewicz 1990). Networks of specialized firms have long been developing in Japan (for a historical analysis, see Imai 1989). As shown above, Japan has a very low APS. Small and medium sized enterprises,[11] which account for 94.4 percent of the total number of enterprises and 81.4 percent of Japan's total workforce, constitute the basis for the subcontract-based division of labor between large and small enterprises. Of all small- and medium-sized manufacturers, 65.5 percent are subcontractors, accounting for 35.5 percent of the total shipment by small- and medium-sized manufacturers (KJS 1988, v).

The Japanese system of industrial networks has many peculiarities that stem from the historical development of Japanese industry and business firms; therefore, it may not be replicable in any other industrial country. However, the trend towards increased vertical disintegration, subcontracting, and networks of specialized plants is obvious in many countries.[12]

There are no specific data that can be used to determine definitively which form of vertical disintegration is the most important. However, data on multi-unit and single-unit companies can shed light on this issue. The share of multi-unit companies in U.S. manufacturing employment increased throughout the post-

war period until the late 1970s, rising from 60 % in 1954 to 76 % in 1977. But after 1977, the share of multi-unit companies declined for the first time; it was 74 % in 1982 (U.S. Bureau of the Census, Census of Manufactures, various issues). This suggests that subcontracting and outsourcing may have become more important forms of disintegration in recent years. The recent literature on subcontracting and supplier-customer relations in industry provides growing support for this hypothesis. (See Nishiguchi, 1990, for an excellent literature survey; see also Helper (1987, 1990 and 1991) and references therein.) There is also anecdotal evidence in industry journals to support this argument.

It is interesting to note that subcontracting is also the primary form of small business development in the Japanese manufacturing industry which already has a very high subcontracting rate. The share of subcontracting businesses in small and medium size enterprises (employing less than 300 employees) increased from 53.3% in 1966 to 58.7% in 1971 and 65.5% in 1981 (MITI 1983, 47). Consequently, the number of subcontracting businesses increased by 62% in this period, whereas the number of independent (non-subcontracting) small and medium size businesses remained about constant.

## IV.2 Increased Flexibility

The conventional response to increased uncertainty is diversification. Why would increased flexibility be a an appropriate response?

In discussing flexibility, it is useful to distinguish between risk and uncertainty. Following Knight (1921, 223), it is customary to use the term "risk" to refer to homogeneous, repetitive events whose relative frequencies can be calculated or measured, and the term "uncertainty" to refer to events which cannot be assigned numerical probabilities. Given that risks are calculable, it is possible, at least in principle, to guard against them via insurance, often in the form of diversification. Uncertainty, on the other hand, is not calculable and therefore not insurable.

During the first few decades of the post-war period, firms tended to diversify in order to reduce their exposure to risk. But with the events of the 1970s (oil shocks, the breakup of the Bretton Woods system, the emergence of Newly Industrializing Countries, etc.), the resulting volatility of world markets had more elements of genuine uncertainty than "mere" risk. Hence, diversification was no longer the strategy of choice; building defensible positions was. (See Carlsson 1989a.) This involved "flexible specialization:" specializing in a particular business area (trying to build up unique competence not easily acquired by competitors) but hedging it with increased ability to respond to new pressures, foreseen or unforeseen. This is done by an intensified watch for threats and opportunities, actual or potential, and by building up flexibility to respond when necessary. Obviously, the greater one's competence, the greater the probability of identifying threats and opportunities and taking timely and appropriate action. Conversely, the more diversified the firm, the less likely it is to possess unique competence in each business unit.

While networking may be seen as a way for firms to deal with uncertainty and to achieve flexibility by changing their relations with external units (increasing their monitoring ability, sharing know-how and freeing up resources), firms also must find ways to respond internally as well. Under the pressure of uncertainty, enterprises are intensifying the search for greater flexibility (Kanawaty et al. 1989, 294). A typical response of engineering firms has been to strive to increase their operational flexibility (the ability to change sequencing, scheduling, etc., in the short term) as well as their tactical flexibility (ability to change the rate of production, product mix, and product design in the medium term)[13] by investing in computerized, flexibly automated technologies. NC machine tools are the main component of these technologies.

In large plants, the adoption of NC machine tools is being driven by the ability of these machines to reduce the cost of manufacturing i) complex products (products with complex cutting shapes, large number of machining operations, etc.), and ii) a closely related family of products. NC machine tools are advantageous in the manufacturing of complex products because they can control the movements of cutting tools and/or work pieces rapidly and accurately. (Manual controls can be more flexible and economic for batch manufacturing of simple products.) However, the fixed costs associated with complex products are often high. For example, the design costs of a complex part may be so high that a high level of cumulative output is necessary for cost effectiveness, even if the equipment used in its manufacture is highly flexible. Although set-up time is short in NC machine tools through the use of "software",

initial programming and debugging of programs may take considerable time, especially for the machining of complex parts.

For these reasons, complex NC machine tools and other types of flexible automation equipment may be beneficial only when a large number of parts sharing the fixed costs of design, programming, etc., are manufactured in small batches. The manufacture of a variety of complex parts is typical of many large-scale plants, such as those manufacturing aircraft, construction machinery, and engine and turbine plants. It is not surprising, therefore, that these plants were the early adopters of NCMTs.

But when the Japanese introduced microcomputer-based numerical controllers in the mid-1970s, two important things happened. First, the programmability and therefore flexibility of NCMTs increased dramatically. This benefited all potential users, both large and small. Second, cheaper and more flexible numerical controllers in combination with other changes led to mass production of NCMTs, resulting in drastically reduced prices. This, in turn, opened up a vast new market, namely small and medium-sized metalworking plants. Suddenly, automation came within reach of small producers for the first time. Previously, they had a choice between highly sophisticated, productive, and expensive NCMTs on the one hand and much less expensive, manually operated conventional machine tools on the other. Thus, automation was often difficult to justify in small plants. This is why we observe that automation occurred initially almost exclusively in large plants. For them, the choice was not betwen automation and no automation but rather between mechanized systems (e.g. transfer machines) and flexible automation in the

form of NCMTs. In other words, the new Japanese NCMTs represented a change in kind for small plants but only a change in degree for large plants. Hence the dramatic increases in the number of NCMTs in small plants relative to large plants mentioned earlier.

With automation now becoming affordable also to small plants, they could compete for business with large plants in complex products which were previously outside their domain. At the same time, the tendency towards specialization on the part of large firms was strengthened; they now found it more advantageous to subcontract or outsource components to smaller plants and firms.

IV.3 Product Differentiation

Another factor contributing to changing working relationships and division of labor between large and small plants has to do with increased demand for product differentiation. By increasing the use of modular design (each product or part consisting of a number of modules, and each module being available with a variety of features), it is possible to achieve an almost infinite variety of characteristics of the final product. The key here is flexible automation: it makes it possible to serve a variety of customer needs while spreading the design costs over large output. The manufacturer then has the option of producing everything in-house or subcontracting or outsourcing all or some of the components and/or modules. The tendency in recent years seems to have been for the original manufacturer to focus on certain key components while subcontracting or outsourcing others. In the former case, the subcontractor may very well have on-line electronic exchange

of information (specifications, drawings, etc.) with the contractor, making use of the investment in design already made by the original contractor and making it possible to make design changes quickly and cheaply, and to coordinate production via just-in-time delivery systems. Such an arrangement allows increased specialization for both the original manufacturer and his suppliers, making it possible to exploit economies of scale for all parties involved.

An example from the car industry can be taken to clarify these arguments. Kaplinsky (1988, 456) points out that flexibility in production allowed the automobile producers to offer an increasing range of alternatives to customers. For example, when the Toyota Corolla was first introduced, it was available only as a saloon car. Today it is available in five body types (saloon, hatch-back, hard-top, van or coupe); when the various options are put together there are more than 10,000 potential variations. The new flexible technology thus allows the Toyota plant to produce a car in 10,000 variations; it does not require the existence of 10,000 firms, each producing a different type of car.

It is noteworthy that the increase in the number of variants came around 1980, just when the "new" NCMTs made their breakthrough. In the U.S. automobile industry, for example, the number of models offered by U.S. manufacturers fell during the 1970s (from 375 in 1970 to 247 in 1979), but it increased during the 1980s (to 313 in 1986). Similarly, the number of models sold by Japanese auto manufacturers increased from 46 in 1980 to 74 in 1985. (Carlsson 1989a, 34.) The proliferation has continued.

IV.4 New Division of Labor between Large and Small Plants

Thus, what we observe is a whole set of mutually reinforcing changes in the organization of manufacturing: large plants moving away from mass production into batch production; increased specialization causing large plants to shrink and allowing small manufacturers to shift towards higher volumes of production; subcontracting, outsourcing, and networking involving a new division of labor between large and small firms and between suppliers and customers.

In the 1980s, small plants appear to have prospered more than large plants under these new arrangements. Given their rapid accumulation of new NCMTs, it would not be surprising if the productivity gains of small plants were found to be greater than those of large plants. As has been shown by Kelley and Brooks (1990) and others, high labor cost is one of the most important determinants of adoption of flexible automation. While systematic studies are lacking, anecdotal evidence abounds. For example, the installation of a flexible manufacturing system (FMS) formed by 43 NC machines in the Yamazaki Machinery plant reduced the labor requirement from 195 to 39 (Usui 1984. For similar cases, see Jaikumar 1986).

Evidence of the type of change in the division of labor suggested here is provided in another study (Carlsson and Taymaz 1991). 44 manufacturing industries were grouped into two main categories: "final products" and "parts and components" industries. It was found that final products industries had significantly higher concentration and coverage ratios[14] in 1972 than did parts and components industries. Between 1972 and 1982, the average concentration ratio declined in both groups, but the

decline in parts and components was much greater. This means that production shifted from the largest to smaller plants in both groups of industries. The average coverage ratio for parts and components industries increased substantially. In other words, the fraction of parts and components produced by parts and components industries grew rapidly. Moreover, the average change in employment in final products industries was negative, whereas it was positive in parts and components industries. The increase in the number of firms and establishments was also greater in parts and components industries. Thus, the changes in general support the hypothesis suggested earlier.

Now we are in a position to re-examine the use of flexible automation equipment within the changing pattern of inter-firm relations towards increased specialization (involving both vertical disintegration and "de-glomeration") and formation of networks of closely related establishments. The low and unstable rates of growth in manufacturing and engineering industries, increased global competition, pressures for product differentiation, and the improvement of communication and information technologies have considerably decreased vertical integration of manufacturing and engineering plants. The intensified use of flexible automation equipment (including NC machine tools, robots, etc.) constitutes a part of firms' strategy to improve production flexibility. During the 1960s and 70s, NC machine tools were used primarily in large firms that tend to produce relatively complex products and a large variety of similar products and that try to keep high value added activities in their plants. The second major component of firms' strategies to achieve flexibility is to form a network of

specialized suppliers. Increased product variety is then achieved by using mostly standard, modular parts and components, and producing variants of only a few basic designs, and using multi-model and mixed-model assembly lines. Specialized suppliers need specialized machinery, as we observe an increase in the mass production machinery intensity of small, specialized plants in the U.S. engineering industries.

To what extent is this story, based mainly on U.S. data, representative of other industrial countries, particularly those in the European Communities?

It was shown in Section II that the development of the share of small plants in manufacturing employment and the changes in average plant size in manufacturing have been similar in the United States to those in Europe and Japan. The overall trends have been the same, although the levels have differed, and continue to do so, among countries: there was a decline in the share of small business during the first couple of decades after World War II, followed by an increase in the last ten-twenty years.

Table 1 shows that the density of flexible automation techniques in the United States is also, on the whole, similar to the corresponding densities in Europe. The numbers of numerically controlled machine tools, industrial robots, and flexible manufacturing systems (FMSs) per worker are about the same in the United States as in the European Community. The United States has a significant lead in the use of computer-aided design (CAD) equipment, while in the other technologies Japan and Sweden are ahead. Thus, there seems to be no reason to suspect that the U.S. development with regard to the changing role of small business

and its driving forces is fundamentally different from that in the European Community. A study of the changes in recent decades in manufacturing and manufacturing technology in the United States and Sweden currently being conducted by the author suggests that the U.S. experience is not unique. The starting points of these two countries during the 1970s were obviously different, especially in terms of the use of mass production techniques, but the driving forces behind subsequent changes are largely the same: those described in the preceding pages. While it was certainly true in an earlier era that much of the technological change originated in the U.S., technological change in manufacturing is now much more global in both origin and diffusion than earlier in this century.

## IV.5 Some Further Considerations

Summing up the argument thus far, we have observed that there is a shift of output and employment toward small business in most industrial countries, and I have argued that this shift is driven primarily by technological change (particularly involving flexible automation benefiting small business) in combination with changes in the global economy, and that these two driving forces are mutually reinforcing. It has also been suggested that the observed changes lead to a new form of industrial organization, namely networks of small plants or firms clustered around particular large enterprises.

Before the implications of this set of changes are explored within the context of Project 1992, two further issues need to be discussed. First, the observations that have been made here about technological change and changes in the size structure of plants

refer primarily to physical production, i.e. only a part of the total operations of manuacturing firms. For example, it has been shown in a recent study that the fraction of the total labor cost in large Swedish manufacturing firms attributable to goods processing is only slightly more than half (56.2 %), with marketing and distribution (21.3 %), administration (7.9 %), R&D (5.2 %), design, engineering, and documentation (4.6 %), pre-production planning (3.5 %), and other (1.2 %) making up the balance. (Eliasson 1989, 30.)

While the relative importance of goods processing is likely to vary among firms and industries, the point is that manufacturing firms are involved in a wide range of activities beyond physical production. In some industries, such as pharmaceuticals, the physical production represents only a small fraction (say, around 20 %) of total operations, while research and development constitutes a much more important activity and a larger fraction of total costs.[15] In other industries (e.g. consumer goods), marketing costs may be more important than physical production costs.

This makes the distinction between plants and firms all the more important. The non-processing activities tend to be associated with firms while goods processing takes place in plants. Thus, the observed shift of economic activity from large to small plants does not necessarily imply diminished importance of large firms nor that economic activity has become less concentrated. However, recent evidence for the U.K. indicates that the average concentration in British manufacturing industry has declined (reversing the previous trend) since around 1970, i.e., the period when APS began to decline (Hughes 1990). This is

similar to the development in the United States (U.S. Bureau of the Census). In fact, it is possible (although not likely, in view of the specialization argument above and the evidence on the development of business concentration in countries for which data are available) that large firms have acquired more small plants, thus increasing their share of total output. Certainly it is possible that firms have reduced the number of businesses in which they participate while at the same time they may have strengthened their position in each remaining business. At the very least it would seem warranted to look into this issue in further research.

The second issue is whether or not the decentralizing tendencies in goods processing implied by the recent changes in NC machine tools might be reversed at some time in the future, and if so, what the consequences might be. After all, from 1800 to 1950 the technological trend was clearly beneficial to large-scale operation, even mass production (see e.g. Carlsson 1984); the development in the last few decades clearly represents a new departure. Is it possible that the pendulum will swing back towards mass production and larger production units?

In my view, it is possible but not likely in the foreseeable future. But this is just a guess. It is based on the judgement that in order for such a reversal to happen, the driving forces described above (both technological and economic) would have to be reversed or supplanted by other forces.

## V. Implications for Europe - Issues for Further Research and Public Policy

What does all this mean in the context of Europe and Project 1992, and what are the implications for public policy?

If it is true, as argued above, that the shift towards small business is driven partially by technological change in the form of automation, it is useful to examine the European position with respect to flexible automation in somewhat greater detail. Table 1 demonstrates that the European countries are performing fairly well with regard to the use of flexible automation technologies. For example, in NC machine tools, Germany and the U.K. are on a par with the United States; in industrial robots, Germany and Belgium have higher density than the United States, and the U.K. has an advanced position in both FMS (flexible manufacturing systems) and CAD (computer aided design).

What about the supply side? Tables 2 and 3 give data on the production of computer numerically controlled (CNC) lathes and machining centers, respectively, in Japan, Europe and the United States in recent years. These are by far the two most important types of numerically controlled machine tools, not only because together they represent some 60 % of the total market for NCMTs (Ehrnberg and Jacobsson 1991, 8) but also because they form the basis for flexible manufacturing systems (FMS). The dominance of the Japanese in the production of both of these types of machines is evident, as is the disastrous decline of the United States. Europe's position is quite literally in between, with some market share gains in machining centers balancing some losses in CNC lathes. Overall, it seems as though Europe is holding its own in these important technologies.

The European position appears stronger if we examine the accumulated sales of multi-machine FMSs through 1988. Of the 627 such systems sold until that time, 395 were delivered by European suppliers (383 of which were sold in Europe). Japanese manufacturers had sold 154 systems (115 in Japan), and U.S. suppliers 78 (68 in the United States). (Ehrnberg & Jacobsson 1991.) Thus, nearly two-thirds of the world's FMSs had been sold by European firms and a slightly larger share installed in Europe. It is also quite evident that up until now, the markets for complex products requiring close collaboration between supplier and customer are still primarily national. Until the product has become more standardized, it is simply too costly for the suppliers to get involved with distant customers. Thus, having domestic, or at least nearby, suppliers of such products appears to be of fundamental strategic importance. However, there are signs that the systems have now become sufficiently mature that this is likely to change in the future. In other words, the market for FMS may now be in the same position as that for NCMTs in the mid-1970s when it began to grow much more rapidly than earlier. (For further analysis on these issues, see Carlsson & Jacobsson 1991 and Ehrnberg & Jacobsson 1991.)

A closer examination of the data shows, however, that of the sixteen European FMS suppliers, ten are German, four Italian, and two Swedish. (For comparison, the number of suppliers is five in the United States and twelve in Japan.) To the extent that primarily domestic markets are served, it is likely that potential customers in countries without domestic suppliers will not have access, or at least not timely access, to the technology, with the likely result that they will fall behind

technologically. Recent evidence suggests that indeed the German and Italian positions are being strengthened while other countries in Europe are lagging.

The implication here is that while Europe seems to have performed relatively well thus far in this area of technology, the experience in the last two decades may not be a good guide as to what might happen in the next decade. Secondly, it is clear that there are significant differences among the European countries which are likely to become even sharper in the future. Both of these implications are matters for public as well as private policy concern within Europe, particularly as they relate to small businesses.

In terms of diffusion and implementation of new technology, a closely related issue is the presence and density of networks of suppliers, leading users, research institutes, academic institutions, and government agencies and policies with regard to flexible automation as well as other technologies. A recent study (Carlsson and Jacobsson 1991b) on Sweden suggests strongly that such networks ("technological systems") have played a major role in explaining the high rate of automation in Swedish industry. (See Table 1.) A wide diffusion of technology requires involvement of small businesses as well as large. Carlsson and Jacobsson (1991a) show that while technically advanced users are necessary for the establishment and survival of technically competent domestic suppliers, such suppliers are essential in order for smaller and less advanced firms to be able to acquire and use complex new technology. Carlsson and Jacobsson (1991b) suggest that an appropriate role of public policy in this regard may be to facilitate the creation and smooth functioning of such

technological systems, in addition to providing the means for training of a sufficient number of engineers.

A similar issue concerns the nature of supplier-customer relations which can either help or hinder the diffusion of technology to smaller units. Braunerhjelm (1991) suggests that small, independent firms and subcontractors which have only arm's-length relationships with their customers face serious difficulties in keeping up with and acquiring new technology, whereas small and medium-sized firms with closer working (or networking) relationships with their industrial customers have a much better position both technically and financially. A further problem is that in small countries (particularly on the periphery of Europe), small firms easily become too dependent on a single domestic customer but have difficulty establishing similar relationships with large firms in other countries. Language, cultural, and geographic distance barriers are very much in existence, despite the progress that has been made toward European integration. These barriers are likely to remain long after 1992, constituting a problem both for public policy and (perhaps even more fundamentally) for private business. It might be highly beneficial for large private firms actively to seek out close working relationships with small suppliers in other countries.

A further issue which arises in the European context is what kinds of networking linkages exist generally, not only in terms of customer-supplier relations but also in technology and information sharing, marketing, etc., among firms in various countries. To the extent that such linkages are established exclusively among entities in the same country, they may breed

conflicts as customer firms try to integrate their activities at the European rather than the national level. Small suppliers may suffer particularly. It appears that not much research has been done on these issues, and it is even less clear what role, if any, public policy should play.

There are several European Community programs and policies in effect which relate to small business. Since 1983 the European Commission has supported efforts that promote innovation among small and medium-size firms, although with limited success. Language barriers and lack of information about firms interested in collaboration are included in the factors hampering the program (Housely 1987). An EC policy on small and medium-sized enterprises (SMEs)[16] was instituted in 1988 (Europe 1988, 24-26). Among other things, it promotes cooperation between firms in different member countries in training and research; EC loans and grants have also been made available to SMEs. The policy also established so-called Euro-Info Centers to help SMEs keep track of legislation and opportunities open to them. Numerous requests for partnership searches gave rise to another program, the Business Cooperation Network, which provides direct business-to-business contacts. It is the first network of its kind in Europe (Tigner 1988). In addition to these programs, there are efforts made in the interpretation and implementation of EC antitrust policy to promote small business.

It is difficult at this time to evaluate the effectiveness of these programs and policies. It is simply too early to tell. But it should be evident from the previous discussion that the shift towards small business started, both in Europe and elsewhere, long before these policies were in place. The forces

at work are much more fundamental, universal and pervasive than any policy can hope to be. The issues raised by the developments examined in this paper concern the nature and content of relationships among various entities rather than the formal structure of these relationships traditionally dealt with by antitrust policy. Indeed, the networking and supplier-customer relationships indicated above as conducive to and perhaps even necessary for a healthy small business sector may raise serious challenges to antitrust policy as conventionally interpreted. Thus, we are left more with an agenda for further research -- because these issues are simply not yet well understood -- than with a set of policy recommendations.

Notes

1. The persistence of international differences in the share and role of small business is an interesting topic worthy of separate study. Several hypotheses come to mind. The composition of industrial output differs among countries; if small business units are strongly associated with certain industries, such differences may result in persisting differences in the role played by small business. However, differences in the role of small units seem to remain even at very disaggregated levels. History probably plays a role in the form of different institutional arrangements (regulation, guilds, financial markets, etc.) leading to differences in how economic activity is structured. Also, the relationships which exist between business units of various sizes (e.g. whether they cooperate or compete, how supplier-customer relationships are organized, etc.) are probably also important. The degree to which firms in various countries perceive themselves as competing in interntional or even global markets as distinct from local or regional markets may also play a role.

2. In some countries the industrial statistics do not include plants with fewer than 5 employees. The cutoff varies between 1 and 20, and the methods of gathering the statistics also vary. In some cases a census method is used, while in others sampling techniques are employed. The result is considerable variation among countries in the coverage and reliability of data on the smallest categories

of plants. Also, given that most plants are quite small, the average plant size is extremely sensitive to the number of plants included in the smallest size classes.

3. There is a possibility that the decline in APS in the U.K. after 1983 is somewhat exaggerated in Figure 2. This is due to a substantial increase in the coverage of the U.K. census data between 1983 and 1983, resulting in an increase of around 31,000 businesses employing 80,000 people (Hughes 1990, 7-8). But since the APS of the added units was less than three employees, the impact on Figure 2 should be minimal due to the fact that it excludes plants with less than twenty employees.

4. The output measure used is the index of production for manufacturing.

5. No establishment data are available for France and the Netherlands. These countries are therefore not included here.

6. For example, based on data available to the author, it can be demonstrated that the large difference in plant size between Japan and the U.S. can not be attributed to differences in the sectoral

composition of manufacturing industry. In fact, if the U.S. manufacturing industry had the same structure of employment at the two-digit level as Japan in 1987, its APS would even be slightly larger than the actual level. Thus, average plant size seems to be generally and genuinely smaller in Japan than elsewhere, regardless of industry.

7. An international study on "Industry Dynamics and Small Firms," with EC funding and with participation by researchers in twelve European countries as well as the U.S. and Japan, addressing these very issues, is currently under way.

8. For example, if a business downturn has a severely negative impact on economic activity in heavy industries with large operating units, while smaller units in other industries are less sensitive to cyclical variation, one might get the impression that the role of small business in the economy is rising. But this would be only a temporary phenomenon which would presumably be reversed in the next business upturn.

9. Non-wage labor cost differences among small and large units -- e.g. having to do with the greater flexibility of small units in

hiring/firing decisions and in deploying labor -- are subsumed under the flexible specialization argument below.

10. In the U.S., the average wage rate in plants with less than twenty employees is around 25 % lower than the rate in plants with more than 500 employees. The corresponding wage disparity is more than 50 % in Japan.

11. In Japan, small and medium size enterprises are defined as business establishments with fewer than 300 employees (fewer than 100 for wholesalers, and fewer than 50 for retailers and service businesses).

12. For example, a survey on the U.K. manufacturing industry concludes that there is a "fundamental shift in manufacturing industry away from the all-purpose, we-can-tackle-anything approach of the past... Where subcontractors were used in the past to take up the peak loads, they are now being used more as an integral part of the manufacturing process" (Pullin 1986, 90). Moreover, "[a]s subcontractors increasingly use high-tech manufacturing methods, they are demanding a more formal role in the production process. ...subcontractors are insisting that in return [for their high-tech manufacturing] they must be integrated more fully into the firms

they serve, providing a real manufacturing function, and not just being telephoned on Monday and told to drill holes in 100,000 sheets of steel by Friday" (Ince 1986, 53).

For Italy, Murray (1983, 84) says that putting-out in the Bologna engineering industry "...has gone from a contingency solution of special problems to a more structured system. Initially [in the early 1970s] flexibility was found in putting-out to artisan workshops to get around rigidity in the factory. Now [after the late 1970s] it is the whole system, factory production and putting out, that works to give flexibility."

13. See Carlsson (1989c) for further discussion of various types of flexibility.

14. The coverage ratio refers to the fraction of the total output of a product produced by the industry in which the product is classified (as distinct from other industries which may also produce the same good).

15. The recent merger activity and R&D collaboration among the largest pharmaceutical firms suggest that risk considerations and scale economies are very much alive!

16. SMEs are defined by the European Community Commission as any firm with fewer than 500 employees and less than 75 million European currency units in fixed assets (Europe 1988).

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Table 1 Density* of Flexible Automation Techniques in Various Countries

| Country | NC Machine Tools* (1984) | Industrial Robots (1989) | FMS** (1988) | CAD (1985) |
|---|---|---|---|---|
| France | n.a. | 3.98 | n.a. | 2.89 |
| W. Germany | 11.38 | 5.84 | 19.2 | 2.62 |
| Italy | n.a. | 8.57 | n.a. | 0.31 |
| Japan | 22.40 | 43.50 | 31.7 | 0.72 |
| Sweden | 22.18 | 9.35 | 108.1 | 3.76 |
| U.K. | 10.51 | 2.87 | 43.7 | 3.17 |
| USA | 11.73 | 4.64 | 17.6 | 6.33 |

* Number of units per 1,000 employees in engineering industries (for NCMTs, industrial robots, and FMS) and in the manufacturing sector for CAD)

** per million employees in engineering industries

Sources: Numerically controlled (NC) machine tools: Edquist and Jacobsson (1988, 104).
Industrial robots: Karlsson (1991) and OECD (1989).
FMS: Ranta (n.d.) and OECD (1989).
CAD: Åstebro (1991).

Table 2 **The Production of CNC Lathes in Japan, Europe, and USA, 1975-1988** (in units and percent)

| Year | Japan | | Europe[a] | | USA | | Total |
|---|---|---|---|---|---|---|---|
| | Number | % | Number | % | Number | % | Number |
| 1975 | 1,359 | 30 | 1,535 | 34 | 1,640 | 36 | 4,524 |
| 1977 | 3,900 | 53 | 2,332 | 31 | 1,178 | 16 | 7,410 |
| 1979 | 8,065 | 58 | 3,505 | 25 | 2,354 | 17 | 13,924 |
| 1981 | 12,133 | 64 | 4,904 | 26 | 2,021 | 10 | 19,058 |
| 1983 | 10,020 | 65 | 4,106 | 27 | 1,203 | 8 | 15,329 |
| 1984 | 16,555 | 72 | 4,818 | 21 | 1,524 | 7 | 22,897 |
| 1985 | 19,804 | 73 | 5,564 | 21 | 1,420 | 6 | 26,098 |
| 1986 | 15,988 | 68 | 6,438 | 27 | 1,163 | 5 | 23,589 |
| 1987 | 15,241 | 69 | 5,271 | 24 | 1,626 | 7 | 22,138 |
| 1988 | 20,942 | 74 | 5,734 | 20 | 1,762 | 6 | 28,438 |

(a) 1975-1984: FRG, France, Italy, UK, and Sweden. In 1985 and 1986, Sweden is excluded and in 1986, Spain in included. 1987 and 1988: FRG, France, Italy and UK.

Source: Ehrnberg and Jacobsson (1991)

Table 3 **The Production of Machining Centers in Japan, Europe, and USA, 1978, 1982, and 1986-88** (in units and percent)

| Year | Japan | | Europe[a] | | USA | | Total |
|---|---|---|---|---|---|---|---|
| | Number | % | Number | % | Number | % | Number |
| 1978 | 1,377 | 39 | 649[a] | 18 | 1,486 | 42 | 3,512 |
| 1982 | 6,936 | 73 | 1,335[b] | 14 | 1,265 | 13 | 9,536 |
| 1986 | 10,882[d] | 70 | 3,784[c,d] | 24 | 918[d] | 6 | 15,584 |
| 1987 | 9,027[d] | 67 | 3,348[d,e] | 25 | 1,036[d] | 8 | 13,411 |
| 1988 | 11,474[d] | 69 | 3,997[d,e] | 24 | 1,277[d] | 8 | 16,748 |

a() UK, FRG and Italy. The UK data are from 1979. (b) UK, FRG and Italy. (c) UK, FRG, Italy, France and Spain. (d) Machining centers and transfer lines, numerically controlled. (e) UK, FRG, Italy and France.

Source: Ehrnberg and Jacobsson (1991).

Figure 1a

# Employment Shares in Manufacturing

## Plants < 200 Employees, 1948-1985

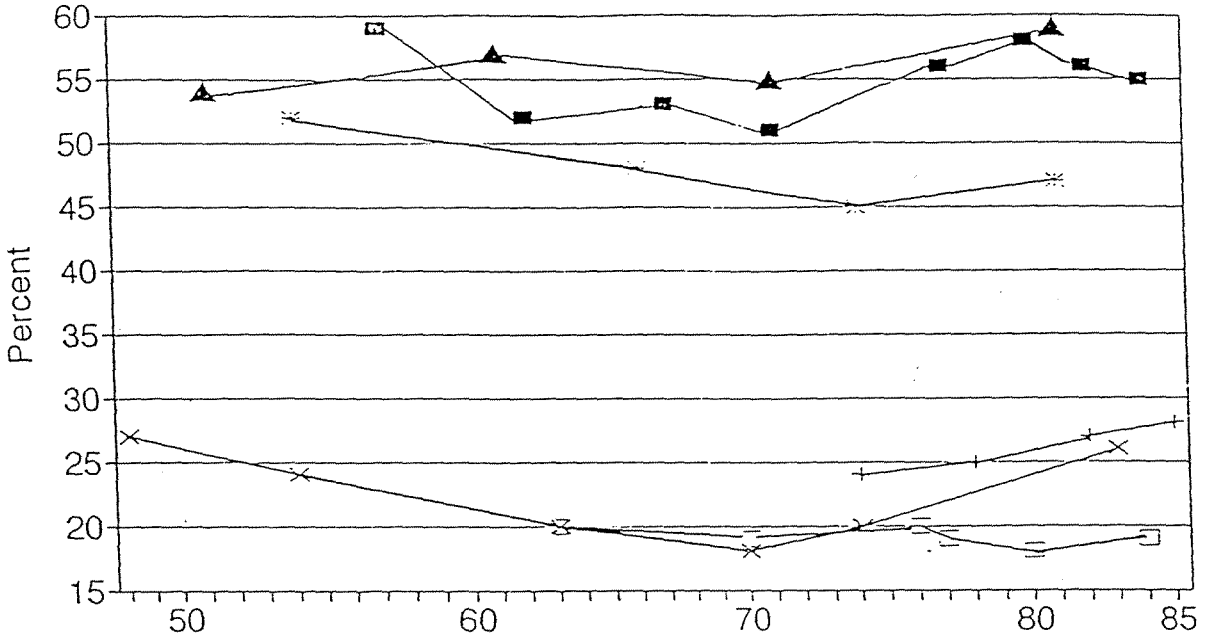
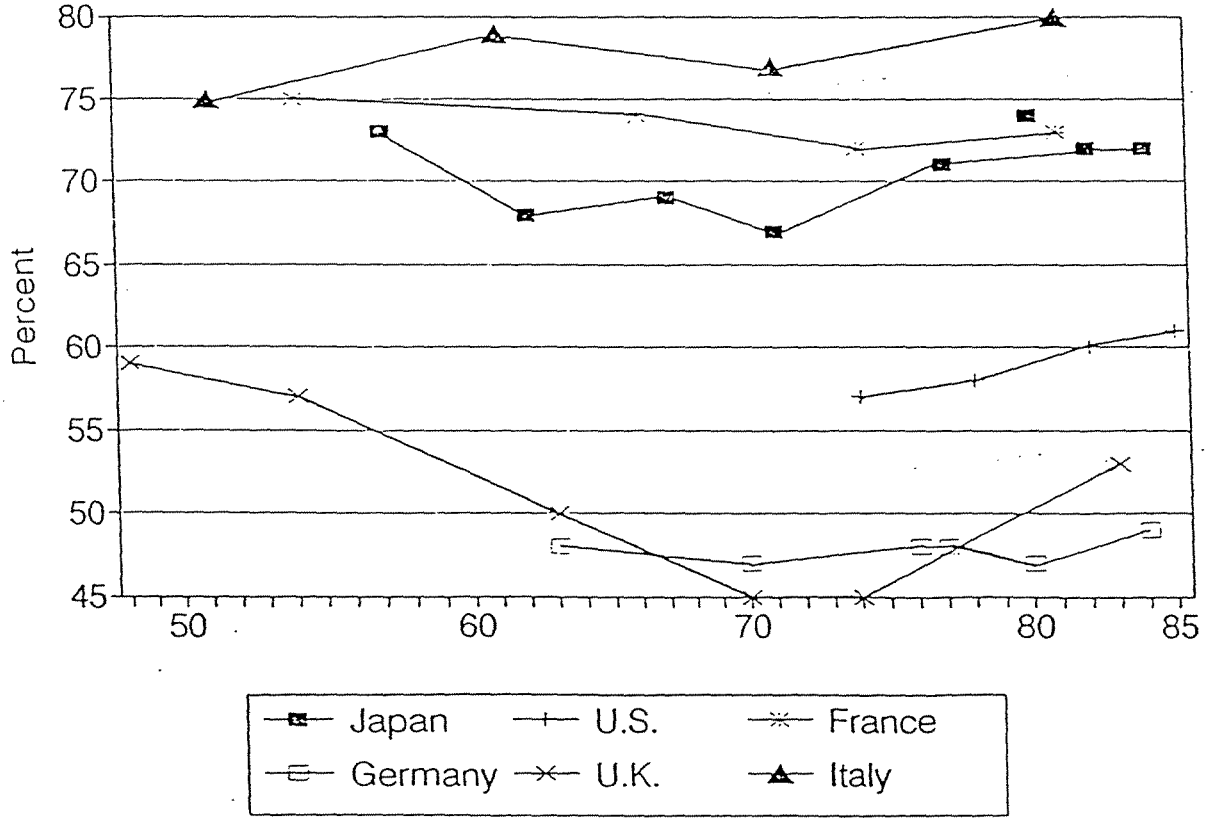



Figure 1b

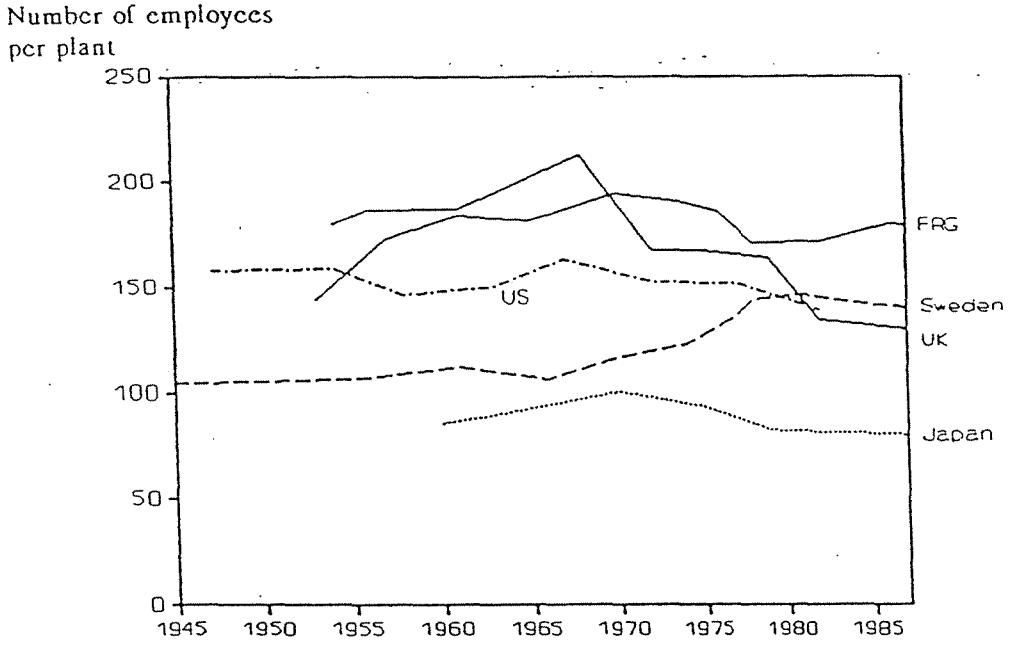
# Employment Shares in Manufacturing

## Plants < 300 Employees, 1948-1985



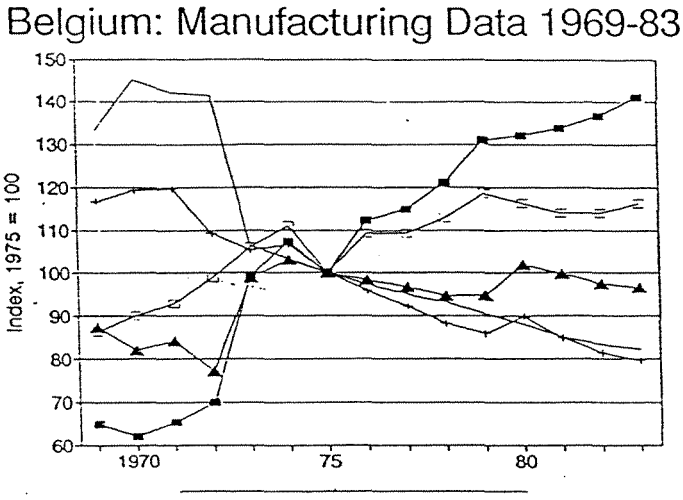

Source: Loveman & Sengenberger (1991).

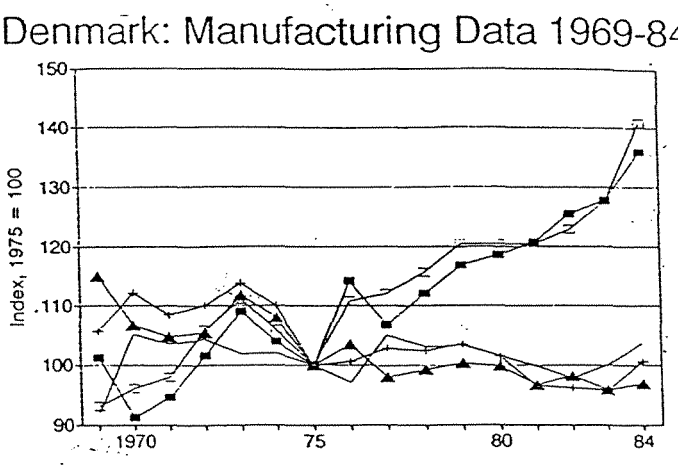
**Figure 2 Average Plant Size in Manufacturing, 1945-1987**
(plants with more than 20 employees)

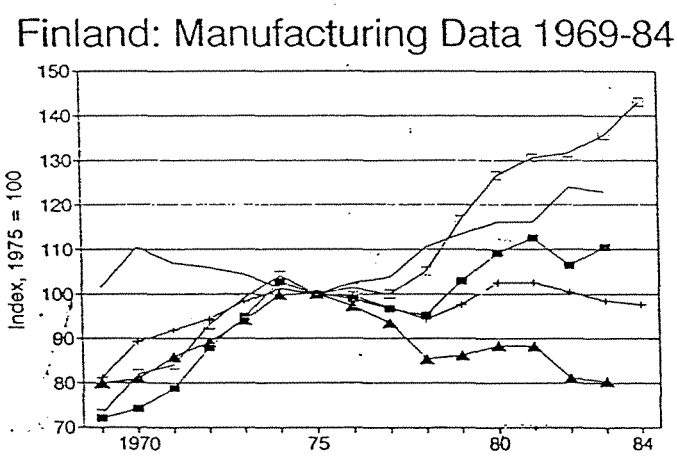


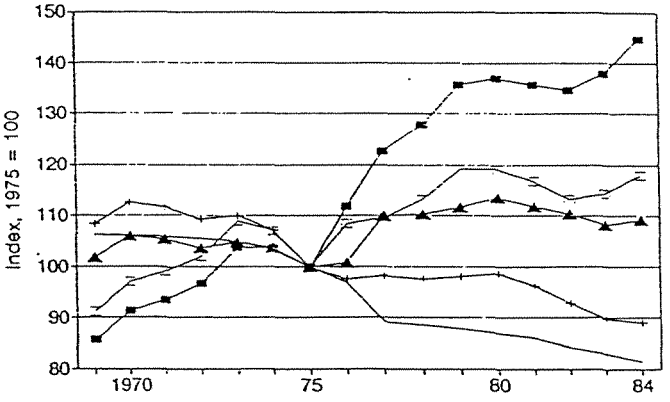

Sources: Various issues of the following official publications: Statistisches Bundesamt, Statistisches Jahrbuch (West Germany); Statistiska Centralbyrån, Statistisk årsbok för Sverige (Sweden); Statistics Bureau, Japan Statistical Yearbook (Japan); Bureau of the Census, Census of Manufactures (USA); Central Statistical Office, Annual Abstract of Statistics (U.K.).

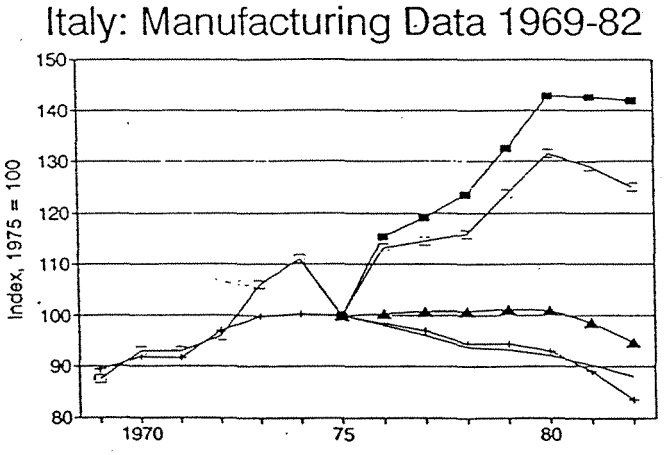
Figure 3 Output, Employment, Number of Plants, and Average Plant Size in Manufacturing in Various Countries, 1969-1987



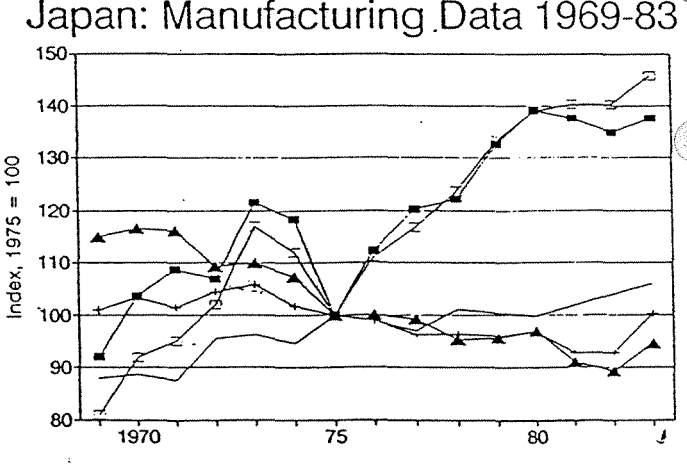
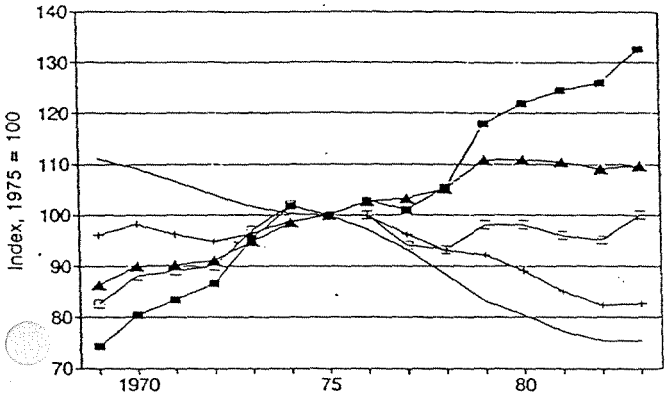
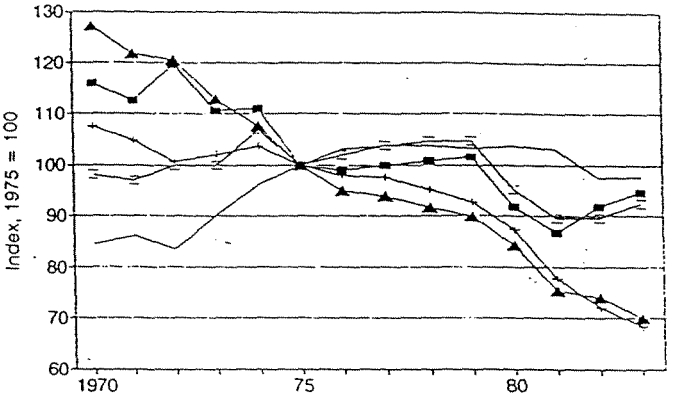



Figure 3 (continued)

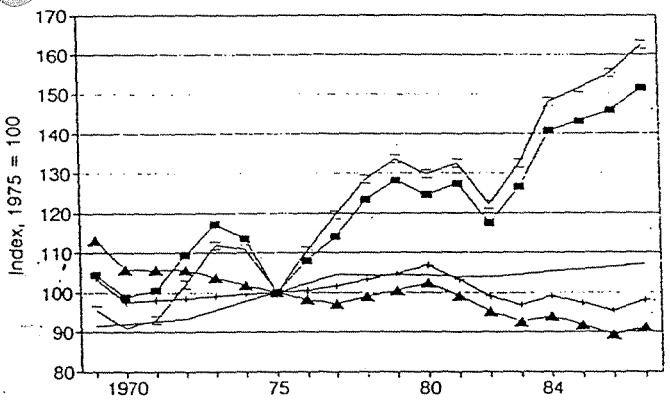
Sweden: Manufacturing Data 1969-83

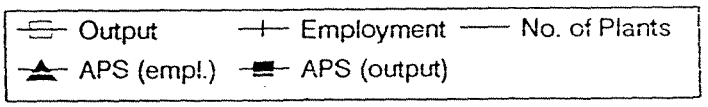



U. K.: Manufacturing Data 1970-83




U. S.: Manufacturing Data 1969-87




Source: United Nations, Industrial Statistics Yearbook, Vol. I, General Industrial Statistics, various issues.