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TECHNOLOGY, ECONOMIC COMPETENCE AND THE THEORY OF THE FIRM

by

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TECHNOLOGY, ECONOMIC COMPETENCE AND THE THEORY OF THE FIRM

– discussing the economic forces behind long-term economic growth[1]

by Gunnar Eliasson

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[1] This paper summarizes the results of a number of recent studies of mine, notably Eliasson (1987, 1988a,b, 1990a,b,c, 1991b,c, 1992a.

1. Introduction

To understand economic growth in a historic perspective one has to take three factors into account; *first*, the *technology* that sets the upper limits on growth in output, *second*, the *rents* created by the application of new technology, or the incentives to invest in new technology, and *third*, the *principles by which total rents are distributed*. These principles affect both the incentives to invest in new technology and the willingness of people to accept the changes in their local environment that always accompany the introduction of new technology.

(1) A steady and faster growth rate in manufacturing output established itself among the industrializing countries after what has come to be called the industrial revolution (see Figure 1). Growth was disrupted in a regular cyclical pattern and, now and then, by a more severe depression. The steady trend, however, continued for so long that it became almost commonplace to take for granted that it would continue forever. The welfare state was built on this premise of an assumed steady, underlying, exogenous, technological trend, that generated a surplus value (a rent), that could be appropriated and distributed freely by political choice.

(2) By the early 18th century, concluded North and Thomas (1973), the necessary institutions for a decentralized market economy had been established in England and the U.S. The two economies were ready for economic take-off – the industrial revolution. The most critical institution in the North and Thomas' analysis was the property rights system. The most important property right in a developed market economy (Eliasson 1993a) is the entitlement to future profits from investment (today) in new technology and in other forms of economically valuable knowledge. This property right is the basis for the stockmarket. The right to manage this property, to access its profits and to trade in the entitlements in the stock market, were much more difficult and took much longer to develop legally than the same rights to physical property. Property rights legislation has also been a typical ground

for political manipulation, and the distributional ambitions of growing welfare states were partly engineered through attempts to control financial markets.

As we know now (Eliasson 1992a) these rents stand in a direct mathematical relationship to the driving force in neoclassical macro production function "growth" analysis, namely the technical shift factor, or total factor productivity growth. Growth in industrialized economies also disappeared almost parallel to the growth in ambitions to appropriate the technological rents displayed through trade in the stock market.

(3) We often give radically new organizational stages in the evolution of civilization special names, like the transition from a hunting to an agricultural society some 10 000 years ago, or the industrial revolution. And politicians of mature, stagnating industrial nations are currently waiting for the electronics revolution to solve their problems by setting the economy on a new, fast growth path, like in Japan in the early fifties (see Figure 1). One problem of this paper is what it means to achieve such a positive result. Who knows what to do? Radical transformations of the organization of economic activities always signify a radical change in the principles by which economic rents are created and distributed. While economic growth, based on a given organization of production is relatively slow, involving modest structural change, the transition from one organizational structure to another is dramatic, throwing the members of the economy into new, unusual and unpredictable situations. While each one may know that total income, as a result of such organizational change, will be much larger than before, they have difficulties comprehending the distributional consequences of the same change on themselves. The principles determining the distribution of income are the most difficult to understand and to accommodate socially (see Block 1966). Hence, the natural response is to resist radical organizational change affecting the principles of distribution. Sometimes political institutions or vested interests (Olson 1982) manage to prevent change and push the economy into a trajectory of low performance. Sometimes technology breaks down political resistance, but this is of less frequent occurrence. Normally

stagnation and even economic decline follow a long period of success. This shifting of phases of economic development of nations is all reflected in macroproductivity development, a variable often, and mistakenly given a pure technical interpretation.

The above presentation, however, suggests that such productivity advance is something much broader than change in physical hardware technology. It is intimately associated with changes in the organization of production, its incentive system and the principles of distributing income. Above all, the way markets are organized, notably financial markets, determines how efficiently the total knowledge base of an economy is allocated on productive uses.

The hypothesis of this paper is that the Swedish economy, and possibly all of industrial Europe, is currently challenged by a radical transition, driven by new technology, and that it is not obvious that Sweden, and for that reason much of Europe, will manage this transition very well.

The logic of this paper is as follows. I first (Section 2) introduce the mechanisms of economic growth emphasizing selection, and the critical importance of the business firm. I then continue to discuss (Section 3) the experimental nature of economic activity among market economies characterizing the environment of modern firms. Technical change becomes synonymous with change in information technology, which is again synonymous with change in the organization of markets and hierarchies. We will find that the changing mix between markets and hierarchies, between large and small firms, between the public and private sectors, etc. are important determinants of technical change at the macro level. This section concludes with a reformulation of the market concentration problem. We are not worried about reduced competition as a result of concentration of production to a small number of firms, but about the possible negative effects on innovative behavior and new entry in radically new technologies, because of the dominance of old technologies in the large firms and the protected, non-innovative climate surrounding a large public sector. We rather ask: is it possible to radically reorganize an economy dominated by a huge and centralized public sector and a few very large firms, in response to new long-term technological opportunities? To answer these questions an alternative to the standard economic model has to be formulated in which dynamic technological competition is represented in a relevant way. The theoretical foundations of the model of this *experimentally organized economy* (EOE) are established in Section 4. Section 5 identifies the nature of the firm in the EOE. In Section 6 the accumulation of firm based knowledge (*organizational learning*) is made the source of business competence and the driving force behind macroeconomic growth (the aggregation problem). The Swedish micro-macro model MOSES is used to illustrate. The nature of learning in the EOE is explored empirically in Section 7 where I return to the original question addressed; did the dominance of large multinational firms in the Swedish economy represent the right economic structure for the 80s. Will it for the 90s? Is the extreme dominance in Sweden of large firms established on a 150 year old engineering technology a hindrance to the innovative transformation of the Swedish economy that is needed for continued growth? This section is illustrated by examples of how large firms have failed in acquiring new technology. Such failure is a natural element in a viable economic growth process in which success will turn up in the most unexpected places. But is the number of business experiments sufficiently large and varied in an economy dominated by a few large firms and the non-competitive influence of a very large public sector? Are too many business opportunities left unexploited? This is discussed in the final Section 8.

2. The Mechanisms of Economic Growth

Apparently the mechanisms of financial markets, notably the stock and venture markets are central for the successful operation of a growing capitalist market economy. In financial markets rents are created, traded, distributed and lost. However, neither the rents nor total factor productivity growth can be treated as exogenous phenomena. Rents are created through the use of competence. They are critical factors behind the thousands of economic processes that together generate macroeconomic growth and they come and go as they are created in, and competed away by the actors in the markets, the business firms. This is the nature of Schumpeterian competition, the driving force behind economic growth.

2.1 Competition matters

Competition takes place among the live agents in markets, called business firms. The existence of a firm is based on its competence to generate organizational synergies, needed to earn a rent above production and financing costs. To explain *how* the firm captures its rent both a theory of the firm and a theory of the market environment in which the firm is supposed to operate are required. The deep problem in economics is that the characteristics of the market needed to explain firm behavior is totally dependent on the dynamics of all business agents. Mainstream economic theory has no live firms and, thus, offers very little in the form of a useful theory of the market to explain the dynamics of firm behavior. Dynamic micro-macro theory is needed, embodying an explicit representation of competition as a dynamic process. This process does not necessarily converge to an equilibrium determined outside the economic system. The direction of change of the macro economy depends on the micro structures developing along the way, and on how competing agents react to, and change them. This is the theory of the market.

2.2 The four mechanisms of economic growth

The *intensity of competition* depends on the spread in the capacities of business organizations to generate synergies, or scale economies, or rents, or productivity. A ranking of such capacities, sometimes called Salter (1960) curves (see Figures 4), is made up, not only of existing firms, but also of what every firm expects existing firms to be capable of doing, like the consequences for market competition of investment, of exit and of not yet existing firms, that may come into existence (entry). The combined "carrots and whips" of markets make up the incentives and the dynamics of the macro economy.

Economic growth is created by the live agents of the market that enter to compete with existing firms, or respond to competition through building and exploiting their organizational competence, or exit if they fail. As I will demonstrate below (see also Eliasson 1992d, 1993b), there are four mechanisms of economic growth:

(1) Innovative entry
(2) Reorganization of existing firms
(3) Rationalization of existing firms
(4) Competitive exit

Each mechanism operates in different time dimensions. Innovative entry takes *very long* to exhibit direct effects on output and employment, but affects competition in markets directly, and thus forces incumbent firms to reorganize, rationalize or exit. New, innovative entry, hence, is the driving force in the economic growth process and Adam Smith (1776) was very right in putting prime emphasis on the importance of entry as the moving force behind national economic wealth and for the maintenance of competition, forcing contraction or exit among low performers, thus releasing resources at reasonable costs for expanding industries.

Behind successful entry and expansion lies some form of competence, and my whole story will be about the way live agents build and apply that competence to compete in markets.

2.3 The competence embodied in firms drives competition

Economic analysis, economic forecasting and economic policy making has a strong hardware tradition that has difficulties dealing with the *quality dimension* of economic activity, especially the importance of the human competence contribution to production. The tradition from Marx to think of productivity as being embodied in physical capital still persists. Without intelligent coordination of physical machines and man-hours based on human competence, however, there will be no production. Such competence is embodied in hierarchies of competent teams. If you cannot explain *how* such competence is created and organized and affect innovative behavior and competition you will have nothing interesting to say on economic growth. Therefore, I will view the firm for what it has to be, namely "a competent team" (Eliasson 1990b).

My story on economic growth therefore will be about micro firm behavior, but with particular attention being paid to how firms manage to stay in business in a competitive landscape that they themselves create and change. My notions of the firm as a competent team (1990b) and of the *experimentally organized economy* (1987, 1988, 1991c) will be fundamental for my explanation of how firms create and maintain the competence they need to do that. It determines the nature of firm behavior as "experimental learning machines" that operate in the imperfect intersection of the product, labor and financial markets (see Figure 2), making up a *path dependent* economic system. I need this "picture" of the dynamic market organization of an economy as an alternative to the classical economic model in order to address the problem of technology and firm based economic competence in a macroeconomic perspective. The behavior of firms in dynamic markets is therefore central to my understanding of macro. The constant competitive struggle of agents to beat each other, induced by the incentives of the economic system and enforced by competition, moves the macroeconomy. The means of the firms to stay competitive is their efficiency in upgrading their competence through organizational learning (Eliasson 1990a,d, 1992a). The theory of the firm, to be relevant for my analysis, has to incorporate such organizational learning. This paper is partly about how this competence is learned and put to use in competition and what firm dynamics means for macroeconomic performance.

One result is that technological change, as traditionally measured in production function analysis and interpreted as machine-based technological improvements, in fact mostly originates as organizational change between firms and establishments (Carlsson 1980).

2.4 Local competence determines the capacity to exploit the global business opportunity set

This means that hardware (machine) technology sets the upper physical limits to the capacity of the economy to grow, capacities that are moved outwards through investments and technological innovations. But technology is a global phenomenon, while the organization of the economy, and of its firms represents a local organizational technology that limits the capacity of the firm, or the economy to exploit globally available new technology (the *business opportunity set*). The efficient organization of the economy, for instance, has long been a source of dispute among market proponents and planners, and the discussion has taken on new intellectual forms in the wake of the economic collapse of the former Soviet empire. We can also observe how some economies soar alone in excellence, despite an obvious absence of new technology, and how some economies stagnate in the midst of soaring technological advance and/or global economic expansion. Such economies and firms cannot be helped by simple policy medication with new technology. There may already be enough around. The problem is that if firms in other countries know better how to exploit the new, globally available technologies, government innovation policy may even work to the disadvantage of the subsidized firms (Eliasson 1991d).

Human competence organized in teams (Eliasson 1990b) dominates economic performance in firms. The organization of such competent teams in markets defines the industrial competence of a nation. Hence, the organization of its markets is part of the national competence specification. The hallmark of competence or knowledge capital is heterogeneity to the extent that – in each agent – certain dimensions of it are unique and not (directly) imitable or communicable. Redundancy is the characteristic feature of human capital and only a fraction of it is engaged at a time, which explains the enormous flexibility in application of human beings and of organizations. Hence, the focussing of that competence for the particular problem to be solved by an individual or an organization is in itself an instance of human competence.

Each of us walks through life with strong opinions of what is the best, whether it be our views about how to run a firm, which economic theory to use, or on how to organize family life. We all need a theory to feel comfortable, and whether good or bad we have to believe in what we have chosen. We need a theory to restrict our vision to make it possible to organize the facts we think we know and our thoughts, to get a coherent picture of the whole, without getting lost in the complexities of our entire economic environment. Theory is just a more sophisticated name for the "bounded rationality" of Simon (1955) and others which in turn define the competence. There are many possible "theories" to guide firm behavior, which means that although some of them will be right, most of them will be more or less wrong. This is one characteristic feature of what I call the *experimentally organized economy*.

3. The Experimental Nature of Economic Activity

The experimental nature of economic activity is best understood if we look at the economy as a decentralized system of knowledge-based information activities, the organization of which is changed through the four mechanisms of the previous section. The size distribution of the actors of the economy then becomes an important problem. Even though concentration may not matter for competition, perhaps a knowledge base dominated by a few players restricts innovative activity to established areas and exerts a negative influence on the creation of the radically new industrial knowledge needed to make the economy competitive in the very long run?

3.1 The four activities of the knowledge-based information economy

Adam Smith (1776) laid down the principal design of a decentralized market economy in which division of labor made economies of scale "in the small" possible and the realization of large macro productivity effects feasible. This benefit, however, came at a significant cost, a fact that "modern" mathematical representations of the invisible hand have missed. The organization of the division of labor is an instance of *innovative behavior*. The knowledge to reorganize profitably evolved gradually in the market. Once realized, economic activity had to be *coordinated* physically (transports) and through communication.

Once an innovative design, whether being technical, organizational, or commercial has been accomplished, competitors will be "on your door lock" to *learn* (imitate). If your organization is large enough you will want to diffuse the new knowledge throughout your organization. You may also want to sell your knowledge at a profit ("consulting"). *Learning*, hence, becomes a general and resource using economic activity (Eliasson 1990a, pp. 13ff).

Even very simple and tiny production tasks (you soon learn) can normally be solved in a large number of ways. The higher up, the more complex the decision problem but also the larger the number of possible solutions. Some of these solutions have to be better than other. The problem, however, is that *you will never know until you have tried them. This is the essence of the experimentally organized economy*. The number of solutions defines the very large business opportunity set that faces each agent, who has to search his way into the opportunity set by trial and error, being directed by a limited vision ("theory") of all possibilities ("bounded rationality"). Since each agent has his or her particular vision as guidance, there will be strong limitations on communication because of limited and differently composed *receiver* *competence* (Eliasson 1990a p. 17, 1990b). The result will be, at each point in time, a heterogeneous structure of competence, defined by the organization of people in the economy.

Much of the knowledge put to use in a firm, especially high level knowledge, vested in the top competent team of a firm is difficult, or impossible to communicate on coded form, as information. It is *tacit*. Tacit knowledge is acquired through on-the-job learning and filters through the economy (*selection*); through innovative entry, through the acquisition of the whole of, or parts of firms in the M&A market or through the mobility of people or teams of people with competence in the labor market (Eliasson 1991e).

I have now introduced four general, knowledge-based information activities; *coordination*, *innovation*, *learning* and *selection* (see Table 1, and Eliasson 1989b). Together they can be defined to cover all economic activity representing the intellectual superstructure (the memory) of economic activity that controls all other activities.

The economic classification base, hence, should begin from the information side, which dominates all other activities. If you want to capture the substitution of physical labor for automation technique, this is necessary, since this substitution means replacing one information system for another. For instance, any hardware factory process can be broken down into a sequence of coordination processes, being controlled by an information system. If you change the information system you change the productivity properties of the whole production sequence. *Automating a workshop* means substituting a decentralized production organization, built on the local competence of skilled workers for a centralized control of physical flows of production. The problem is that it is almost impossible to construct statistical systems with enough fine detail for this kind of complete information accounting. You have done it, however, when you have a fully automated plant (Eliasson 1990a, p. 57).

From a practical measurement point of view, at the level of the top competent team of a firm, however, this degree of fine detail in measurement becomes impossible (Eliasson 1976). It is, nevertheless, perfectly possible to quantify large parts of the input structure of the economic information activities, using readily available data in firms. Using these data we can then uncover how the soft and the hard parts interact. We will also find that even with standard definitions of the content of production, information processing, broadly defined is a dominant resource using economic activity. Hence, productivity advance as measured at the macroeconomic level, and usually identified with improved hardware performance, is significantly influenced by competence induced technical change in economic information processing. Such technical change in economic information processing originates in the changing organization of institutions that control the market processes of the economy.

3.2 Technical change is moved through innovative organizational change

A reasonable modification of the traditional economic measurement system is sufficient to demonstrate the economic importance of knowledge-based information activities. We can establish that most of what we call technical change, as observed through macro production function analysis, really is composed of changes in the technology of economic information processing, which in turn originates in *innovative organizational change*, including innovative change in the organization of learning to accumulate new competence. To account for this a very broadly based definition of innovation is needed. Innovation becomes something far beyond hardware technical matters. Innovation also occurs at the level of the top competent team in the form of *innovative organizational change* (Eliasson 1990e, 1992a).

On this score we can learn three important things from research carried out by Bo Carlsson. *First*, in an early IUI study (Carlsson et al. 1979, p. 34, Carlsson 1980) Carlsson demonstrated that when stripped down to the level of a division or an establishment more than 50 percent of total factor productivity change at the manufacturing industry level originated in structural adjustment between existing establishments, most of it being due to exit of low performing units, and the transfer of resources to high performance units. *Second*, Carlsson (1989) reports that technological change in manufacturing is generally making smaller scale production more economically viable than earlier, this being reflected in a general reduction in the average size of both plants and firms among the industrialized countries. This observation is strengthened by the relatively faster advance of private service production observed above. Carlsson notes that Sweden is the only important exception to this development. Smaller scale, service oriented and competence intensive production will increase the importance for macro performance of structural adjustment at the plant and establishment levels. It is also interesting in this context, to recall Pratten's (1976) results from an analysis of comparable Swedish and U.K. manufacturing firms. While the U.K. firms were generally larger (by a financial definition) than their Swedish counterparts, the Swedish production plants were then generally much larger and much more productive than the corresponding U.K. units. The predominant concern with process cost efficiency in Swedish firms was also obvious from a comparison between Swedish and U.S. budgeting practices in the early 70s (Eliasson 1976, p. 227). Apparently the Swedes have continued to enjoy increasing such economies of scale through the 80s, in contrast to a contrary development in the rest of the world. This time, however, the base for such economies has been broadened to include also financial (group) size, meaning that R&D, product development and global marketing have come into play in a relatively more important way (Eliasson 1985b).

Third, Carlsson (1991) observes that in a 20-year perspective total factor productivity growth is almost all a matter of reallocation of resources within existing plants. This tallies nicely with my own results on entry and exit (1991a). Beyond the 20-year horizon the introduction of new technology through entry and through new investment begins to exhibit sizeable macro economic effects. I will return to this conclusion below.

The deviant pattern of development in Swedish industry structure, however, raises a number of interesting and worrying questions.

3.3 Does an industrial knowledge base vested in large, dominant firms hold back the development of new technology?

A particular instance of high level organizational knowledge is the competence to build, to efficiently operate and to reorganize large business firms on which many advanced economies, that cannot fall back on generous raw material sources, base their economic wealth. The Swedish economy currently very much bases its economic prosperity on a small number of giant international firms (see Table 2). In the experimentally organized economy, however, future wealth increasingly has to be based on new technology. New technology is largely created outside the large firms and introduced through new, innovative firms. The critical question for the future, hence, has a competence and a policy side. The competence question is to what extent countries like Sweden can continue to base their economic wealth on the organizational learning technology of the large firms to stay ahead, as the rest of the advancing industrialized world learns to do the same thing. If large firms cannot acquire radically new technology and reorganize to adopt it the policy question is how new competence and innovative entry can be created to replace volumes lost in failing large firms, or large firms moving their investments out of the country. Another, more operational policy question is how a nation (like Sweden) should be organized to continue to enjoy the presence of highly mobile, value creating multinational business firms. What is the proper mix of these large firms, based on traditional technologies and new innovative entry based on new technologies for the future, and how is the economic environment best organized to achieve that balance (the policy questions)?

4. The Open Economic System Bounded by Local Competence

Karl Marx, observing the impressive economic performance of the industrial revolution did what economists have always done; he extrapolated what he saw and, hence, saw no end to the production potential of the "modern" industrial (factory) organization of work. The problem was that his mind, like the minds of economists in general, was shaped in terms of the firm as a factory, producing increasing tonnage of a homogeneous product ("steel"). Marx, then of course had to explain why production was limited, and, hence, borrowed an old idea from Adam Smith, again restated by Stigler in 1951, about the market as the limiting factor. What Marx missed was the *quality dimension* of output. Quality removed the market restriction to economic growth. There may be a limit to how much "quantity" ("steel") you can consume, but not to how much quality you *can* consume (French village wine vs Chateau Margaux), only a *competence limit* to how much you can enjoy the quality.

This revised notion of output changes the unlimited productivity potential of Marx into an for all practical purposes *unlimited set of business opportunities*, where unlimited quality differentiation constitutes the important expansionary element.

The Smithian market limit is now replaced by a *local, competence limit on the supply side*, namely the local competence of the firm

- to create new qualities, including new competence (*innovation*), and
- to receive new competence (*learning*.)

Also this competence is characterized by extreme heterogeneity, making its quality dimension virtually incommunicable on coded form, i.e., as *marketable information* (type "instruction books").[2] This introduction of competence, rather than the market, as the limiting factor, is more compatible with facts.

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[2] This is the only type of knowledge recognized by classical economic theory, including so-called "efficient market theory".

It allows me to keep an open economic system very much as the pre-marginalist economists did (see Loasby 1991), but still bounding the economy by local competence and known technology.[3]

4.1 The three fundamental assumptions of the experimentally organized economy

Having come this far we can summarize the fundamental assumptions of the experimentally organized economy as follows (Eliasson 1991c):

I State space, or the (international) opportunity set, is for all practical purposes unlimited.[4]

II Behavior of agents is characterized by
- bounded rationality
- tacit knowledge

Add to this (remember my introduction)

III *Free access* to state space or the set of business opportunities (free competitive entry)

and the model of the experimentally organized economy emerges. The free entry clause is imperative. It allows anyone who feels competitive to enter the market and take on incumbents. Only barriers to entry based on competence are acceptable, even though some physical size barriers will always be

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[3] This is also the design of the Swedish micro-to-macro model on which much of my reasoning is based (Eliasson 1991c). The reader should note that with the marginalists in the late 19th century the business opportunity set has been defined such that local agents are on its frontiers (fully informed agents). This takes all dynamics out of the economy, except the exogenous shifting of the opportunity set or the production frontier.

[4] For a discussion, see Eliasson (1987, 1988, 1990b, 1991c).

unavoidable.[5] This deregulation of markets was exactly what happened in Europe just about the time the industrial revolution started, which it did, only in those economies where the lid was taken off (Eliasson 1991a).

In the experimentally organized economy a large number of *locally competent* firms search into (or compete their way into) a vast space of opportunities. The individual outcome of such *technological competition* depends on their initial competence endowment and how they search.

The competitive situation is such that the firms often are wrong *business mistakes* being the important cost to society to make room for business successes ("creative destruction"), needed to achieve economic growth. In addition, mistakes are part of the on-the-job (economic) learning process of firms, and of society contributing to the updating of the *organizational memory* of firms and the economy at large.

4.2 Concentration is inevitable, and inevitably converges to zero firms

In this competitive market environment no firm, no (small) economy, not even IBM is safe.

The experimentally organized economy is borne out of statistics. Jagrén (1988) demonstrates how even the largest firms, when observed over a sufficiently long time disappear from the "Fortune list", and even altogether as independent firms. He selected a random sample of some 150 Swedish firms from a register in the 20s and followed them into the 80s. By the mid-80s only 21 independent firms remained and most of them (19) had not grown very much in terms of employment during the period. Despite this, total employment of the remaining firms each year had grown faster than aggregate

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[5] It is interesting to note here, that innovations in financial markets during the 60s have effectively removed many such size barriers to entry. The junk bond revolution should, therefore, be regarded as something positive by the anti-trust advocates.

manufacturing employment (and output). The reason was that two firms that Jagrén had selected by chance – Electrolux and Bofors – had grown extremely fast. We would, however, on the basis of the EOE, expect total employment or output of a randomly selected sample of some 100 to 500 firms some 50 to 100 years ago to grow somewhat more slowly than the corresponding total of all manufacturing, the difference being accounted for by entry. The theory of the experimentally organized economy, however, predicts that most of the incumbents at the time of the random selection some 50 to 100 years ago would no longer remain as independent firms. Some would have been shut down, some would have been acquired by other firms. The bulk of output would be accounted for by new firms and by a small group of remaining firms that eventually dwindels to zero (Eliasson 1991a). The case of Stora (Figure 3) has to be very rare. In addition to this (Eliasson 1992a) the growth of the total industry aggregate is not independent of the "business mistakes" occurring along the way.

The point of my argument is that no individual firm can feel comfortable and safe in the creative, destruction process of the experimentally organized economy. An economy in which the majority of firms remains after a 50 to 100 year period is not a viable growth economy. It is *extremely risky to base policy* on the assumption that the current set of large firms will provide the industrial base in the very long run. The long-term future of an economy has to rest on new technologies in new firms, not yet seen. This policy proposition sounds risky, but it is the only safe one.

5. The firm in the experimentally organized economy

The managing director of each firm would prefer to look forward to a long and successful business life, without the hazards of the EOE. Even though the expected life horizon of his firm is considerably shorter than the life already realized by Stora (see Figure 3, the world's oldest joint stock company) survival and growth (for ever) as a portfolio of wealth is a normal goal of a firm. The method to achieve this objective is to make more informed and scientifically based decisions. Management, however, prefers a pace of competition that is comfortable and not unduly risky. Hence it doesn't feel at ease in a viable, experimentally organized economy. In the classical model the firm could plan (in principle) to achieve the state of full information, and this theoretical possibility of the classical economic model exerted significant influence on business administration literature of the 60s and early 70s, which abounded with treatises on "business planning" (see Eliasson 1976), until reality struck back in the form of a series of macroeconomic crises. This literature, and its promotion of formal, long range, business planning is now gone.

In the experimentally organized economy, and in reality, each firm has to reckon with the presence of many competitors aiming for its market niche through technological product competition (Eliasson 1987). The set of business opportunities is huge and mostly non-transparent to the individual firm. A firm that wants to survive, cannot wait to compute its fully informed plan of what to do. Such a plan is unfeasible by definition (in the experimentally organized economy). More to the point, however, if the firm does not act prematurely on a very incomplete information base, it can be sure that one of its many competitors will score a success, because he happened to approach the opportunity set from the right angle.

So top firm management had better be equipped with a good *sense of direction*, which is the first, dominant competence requisite for success at all (see items in Table 3). If it doesn't, it will fail anyway. Hence, a firm will have to demonstrate itself to outsiders as a gambler, taking on seemingly large risks. With a good "sense of direction", however, the true risk exposure to the insider management is very much smaller. It should in fact be normal to define the competence of the firm in terms of its ability to transfer uncertainty in Knight's (1921) sense, into (for its own management) computable risks.

There are nevertheless learnable administrative techniques to minimize the costs of mistakes. Techniques can be developed that make it possible to take on (reduce the risk of taking on) large risks, i.e., a technique to manage in situations when the first competitive requisite (intuition) has failed. This management technique consists of two elements; to identify mistakes early, and to correct mistakes immediately (Eliasson 1990a). Once these tests (elements 3 and 4) have been passed and the firm can set out to sea, a quite different competence has to be clicked on; the ability to *operate* the firm *efficiently* on a day-to-day basis and to feed experience back to the top (*learning*). A different group of people is normally responsible for managing this task. This orientation of administrative techniques is apparent from an ongoing study of business information systems in practice (Eliasson 1990c). This organizational technique dominates when firms have found themselves in the right market for a long time and in high volume activities. The large Swedish multinationals have been very successful in this field in the 80s. The problem is that too much success in routine volume management is normally detrimental to the earlier "innovative" tasks, and even very large firms are at peril in the EOE.

6. Market Dynamics and Macroeconomic Performance

We have been convinced to believe that "perfect markets" and the fully informed "competitive markets" represent the invisible hand of the market economy. This is wrong. The competitive market of mainstream theory is nothing but a set of conditions describing the resting point of, the equilibrium of, or the solution to an equation system, representing an economy in which no innovative behavior occurs. This is not Adam Smith's idea of the invisible hand. But it has gradually become the idea of the invisible hand among economists after Jevons and Walras. Even Schumpeter embraced the market representation of Walras. He liked to start his analysis with a disturbance (by the entrepreneur) of a Walrasian equilibrium. His worried conclusion about the non-survival of a competitive market economy because of the ever increasing concentration that would come out of its successful performance has so far been refuted by reality. With the notion of the EOE in the background, it can be safely concluded that Schumpeter's notion of for ever successful routinized or planned innovation is not of this world.

Market rivalry à la Smith (1776) and Schumpeter (1942) through innovative product development, i.e., through innovative *entry*, contrasts clearly with the classical Ricardian idea of markets, where prices are set at the margin where the worst performer earns no profit. In the experimentally organized economy the best performers raise product quality through innovation or lower prices such that the worst performers have to leave the market. Since this is an ongoing process and innovations cannot be predicted by definition, there is no well defined equilibrium in the EOE. I will use the Swedish micro-to-macro model to illustrate the incentive and competitive push mechanisms that keep a sufficient number of agents all the time on tip toe, competing for improved wealth positions in markets, and why they cannot lay back and relax, or in short, to understand the process of economic growth (Eliasson 1991c).

6.1 A Generalized Salter curve analysis of innovative learning and enforced competition

A market, or the entire economy can at each point in time be represented by a distribution of potential performance characteristics, like the rates of return over the interest rate ($\bar{\varepsilon}$) in Figure 4A. These types of distributions – especially if presented as productivity rankings of establishments (Figure 4B) – are often referred to as Salter (1960) curves. Each firm is represented in this curve by a ranking on the vertical axis (the columns in Figures 4), the width of the column measuring the size of the firm in percent of all other firms. Figure 4A shows that even though the firm in the model has increased its rate of return between 1982 and 1991 it has lost in ranking. Figure 4B shows the same firms's labor productivity and wage cost positions. Finally,

Figure 4C shows where, underneath its own productivity frontier, the firm was operating to position itself on the productivity and rate of return rankings of the market. This is still actual ex post performance 1982 and (simulated) 1991. The dynamics of markets on the other hand is controlled by the potential ex ante set of distributions, that capture the planned action of all other firms, including new entry.

There is still another set of Salter curves that tell how *each firm sees itself positioned relative to other firms*. The real world of the experimentally organized economy, as well as its model approximation, the Swedish micro-to-macro model shows large *divergences between actual and perceived positions*.

The ex ante distributions tell the potential for the firm to outbid all other firms in wages, or in paying a higher interest rate.

Learning about one's competitive situation – in reality or in theory – occurs in different dimensions. Prices offered in the market tell something about how other firms – notably the best firms – view their competitive situation. Competition, production, hiring, etc. can also be directly observed. The firm, finally, learns directly itself, when it enters the market. The critical learning experience to observe in this context occurs when firms observe that competitors can do better. Firm management then knows that this can be done and that it had better improve in order not to be pushed down, right along the Salter distribution, and, perhaps, out.

Similarly, when the firm finds itself at the top, or close to the top, it knows that a whole lot of "closely inferior" firms feel threatened, and are taking action to better their positions through innovation or imitative learning.

The conclusion is that if potential Salter distributions are sufficiently steep and if all firms know it, firms – and especially the top left-hand group – will feel sufficiently threatened to actively aim for improving their positions on the Salter curve through innovation. If such innovative activity, notably through innovative entry in markets, is freely allowed, necessary conditions for maintaining sufficiently steep Salter distributions to move the entire economy through a selfperpetuated competitive process have been established (Eliasson 1985a, 1991a, c). These conditions become both necessary and sufficient if the opportunity set is sufficiently large. This also establishes the link between dynamic competition through the Schumpeterian (1912) entrepreneur and innovative entry, argued by Smith (1776) to be the critical factor behind economic growth, that perpetuates a disequilibrium economic process type Wicksell (1898) – the SSW connection (Eliasson 1992a). A sufficiently large and heterogeneous state space, boundedly rational behavior on the part of agents, and sufficiently free innovative entry are the small modifications of the classical model that create the experimentally organized economy.

6.2 The very large productivity potential

The Swedish micro-to-macro (M-M) model features firms or divisions as well defined decision units operating i dynamic markets. Figures 4 show that very large productivity gains are potentially possible through a recombination of factors, especially if the bad performers can be forced to shut down. This is so even though no new entry or no new investment in the best firms occur. Carlsson (1991) also demonstrated that the by far largest productivity improvements in the short and medium term were achieved through such reallocations. The structure of the opportunity set of the micro-macro economy, represented down to the level of resolution of the firm or the division is sufficient to create the virtually non-transparent business opportunity set of the EOE (see Eliasson 1991c). Predictability is for all practical purposes removed. The theoretical point I want to make, however, is that if we allow for similar reallocations also within firms and divisions taking the analysis down to the very fine level where allocation and technical reallocation decision are made, the number of possible combinations within firms and *also* between firms expands without limit, as does the productivity potential. Predictability vanishes at the micro level. As a consequence the notion of a macro productivity frontier cannot be upheld. There is either no way of defining the main production function or, if you do, the agents will always be operating *very far below* it, where being dependent upon their temporary location in a dynamic process coordinated by endogenous prices. This in turn means that price signalling, as shown by Antonov and Trofimov (1991) will never be able to disclose any efficient equilibrium or convergence trajectory of the model. We can also learn from this analysis, that if there are no social problems, or political constraints relating to the reallocation process, the potential for productivity improvement in an economy is enormous.

The Swedish Micro-to-Macro (M-M) model, hence, exhibits all features of the EOE. Dynamic competition as described above determines entry and exit and hence the selective processes that create a path-dependent evolution, and non-stationary behavior that prevents classical learning. This is so even though the M-M model for all practical purposes is deterministic. If you have the code of the M-M model, you can of course predict through a deterministic simulation. The question is whether you would be able to learn the structure of the model (to perform that prediction) without access to the code from observing the output from a large number of simulations, and with such precision that it would predict over a chosen future period, barring a predetermined stochastic error. This question reduces to the problems; (1) to find an acceptable, estimable approximation of the M-M model, and (2) to estimate the parameters of that approximate model. If (3) the error terms between the M-M simulation ("reality") and the corresponding computed model values pass a test for randomness over any chosen simulation period, classical learning is not feasible and the particular behavioral characteristics of the firm of the EOE should exhibit themselves. The seemingly erratic behavior exhibited by the model economy like major macro collapses that occur out of the blue (Eliasson 1983, 1984a, 1990c) all originate in the endogenous changes of the Salter distributions, characteristics that are impossible to reproduce in a predictable way by known estimable modeling techniques. This is sufficient to rule out classical learning in the experimental setting of the M-M model, as shown by the learning experiments of Antonov and Trofimov (1991). Forcing individual firms to use a neoclassical or a Keynesian learning model to search their way into the complex MOSES Salter landscape means imposing too simplistic intelligence structures on firms. It narrows their minds such that they are not capable of exploiting the rich business opportunities offered in the MOSES environment. The efficient long-run procedure from a macroeconomic point of view is to allow each firm to search *the opportunity set of MOSES* according to its own mind. This close to random, experimental procedure increases the failure rate, but it also makes some firms capture opportunities that were closed to them in the narrow, enforced scenarios restricting them to preset search mechanisms. The wider, "randomized" search proves superior for macroeconomic performance.

I could also add the amusing experience we have had over the many years of modeling work. If you sit down at the computer and attempt to correct unexpected, disruptive and "socially undesirable macro behavior" by using its almost full assortment of traditional policy parameters, you tend to create more and stronger disruptive macro behavior of the same kind at some later period (Eliasson 1985a, pp. 78 ff.).

The M-M model is a highly simplistic dynamical systems representation of the real market economy. Even though individual mechanisms are traditional and can be understood partially, the dynamics of the evolving system prevents classical learning. Reality, of course, requires that much more complexity be coped with.

6.3 Innovative entry is the key to macro dynamics

The critical understanding of markets, hence, comes with understanding the nature of competitive, innovative entry and the dynamic market process outlined in Section 3 that innovative entry keeps in motion. This understanding requires a broad definition of innovative entry, from the launching of a new product, via the establishment of a new company to the merger of two large companies, with the purpose of improving long-run profit performance.

Experience would suggest that small firms are superior to large firms as innovators, even though the consensus is not 100 percent (cf Holmström 1993 with Granstrand and Sjölander 1993). The large firms, however, together spend significantly more on R&D than do small firms. New entry is not always in the form of new firm entry. It can occur through the establishment of a new business activity within a large firm or, through the introduction of a new product. As I said, the merger of two large firms exercises market effects similar to that of new entry (Eliasson 1991a).

The role of small firms and new entry therefore should be seen in the context of the following three observations:

1) The direct macroeconomic effects will be very slow in coming (Eliasson 1991 and Taymaz 1993). Empirical evidence shows very small effects even after a 15-year period. Simulations on the Swedish micro-to-macro model show a significant direct macroeconomic influence only after some 20-30 years.

2) New entry in a broad sense preserves structural diversity, making faster growth feasible (Eliasson 1984a, 1991a). Even if entrants are on the average no better than incumbents, the spread in performance among them is larger. Since only the best survive in the long run, viable entry and exit preserve diversity of structure.

Above all, however,

3) new innovative entry in a broad sense serves as a competitive force to shake up incumbents and move the market from Ricardian to Schumpeterian type competition.

Hence, understanding competition requires understanding the forces that drive new entry, and this is not easy. With the average new entrant being rather somewhat inferior to the average incumbent – if performance is measured by labor productivity or the rate of return (Granstrand 1986) – but the spread in performance being much wider, most new entrants will soon fail and exit.

The Swedish micro-to-macro model (Eliasson 1977, 1978, 1990c) embodies the type of competition that is generated by new entry and exit in the EOE. Such competition occurs in the "broad-based Salter (1960) landscape of firms" described above, depicting the distribution of productivities or rates of return over the firm population. Entering firms are represented by a "smaller such Salter distribution" with a much wider spread, disrupting the balance on the margin in the tail end of incumbent firms, where the marginally worst producer just covers wage costs.

Marginal incumbents exit and new product and factor prices are established at levels where most of the new entrants will soon perish and exit.

Many large incumbents will, however, be shaken by the remaining supreme entrants and be forced to shape up their competitive performance in order not to lose market shares, which presumably correspond to the size of their invested capacity to produce.

In the very long run the remaining, superior new entrants will begin to exercise a direct influence at the macro level. Performance characteristics after a 30-year simulation shows the upper left, "supreme" corner of the Salter distribution to be occupied by the new, now old entrants (Eliasson 1991a).

As most analytical results, this one is, however, obvious from the assumptions I have made. The critical issue is to understand why firms enter the market in large numbers despite being inferior, and do it repeatedly.

Such phenomena cannot be explained within the static, full information general equilibrium model, and not within an asymmetric information version of the efficient market theory, so popular in financial economics. It fits, however, nicely into the EOE. Under the assumptions of the EOE the entrants perform an experiment the outcome of which cannot be assessed until it has been tested. The EOE has to possess a sufficiently large number of such potentially competent and optimistic entrants or experimentators for the growth process to occur.

At first sight it is tempting to approach this problem as a lottery, with known, or exogenously given odds. This is the standard procedure in R&D rivalry games which address similarly formulated problems. This is unacceptable for two reasons. *First*, the inclination of actors to play the lottery has to be explained. *Second*, the business lottery is a game where you can learn to improve your odds, and this learning will affect the willingness to participate in the game. The standard lottery of economics (R&D rivalry and efficient market theory) has no learning of that kind. It is a stationary process, that is unaffected by the ongoing business. Once learning to improve your competence to participate in business is introduced, a path dependent, non-stationary process emerges.

7. How Big Old Firms Learn

The above is the essence of the EOE and the growth machinery of a decentralized macro economy. This, however, is still only a statement of the assumptions needed to generate macroeconomic growth. To understand, you have to explain *how* the innovative market organization is created. The socialist countries are just trying to perform the trick of transforming themselves from centrally planned command economies into dynamic market economies, but they lack the knowledge and the experience. What could an economist of the viable west tell them?

7.1 Big versus small

Adam Smith argued that small, optimistic entrants drive competition and growth in the very long run, not so much because of their technical prowess, but by moving the dynamic market allocation machinery of the economy. Some economies, and the Swedish economy in particular, are dominated by large firms, often *very* large firms. Large firms, almost by definition operate in markets for mature products, employing old established technologies.

I would argue that an economy, dominated by big firms, run through deep administrative hierarchies of routine managers is the wrong setting for viable innovative entry, and that big firms themselves are bad innovators, even though they spend a lot on R&D, and even though Joseph Schumpeter was worried about the political consequences of the effective, innovative capacity of giant, international combines.

At each point in time an economy is dominated (more or less) by a small number of very large producers of goods and services. One of these producers is the public sector. My hypotheses could therefore be presented in three parts. The larger the part of total production occupied by the twenty largest corporations and the public sector together, the less of innovative entrepreneurial activity and entry in the economy. In addition, the larger the individual decision units the less of truly innovative activity within them. Finally, and hence, no country can count on the existing large firms and the public sector to provide for prosperity for more than a limited time. Hence, the probability of long-term future growth and prosperity diminishes with concentration of production.

I have also argued, however, (Eliasson 1990a) that economies like the Swedish one always live on the past successes of now large firms, and that these large firms will dominate the economy for the intermediate term, i.e., the next decade or so. Swedish multinationals, furthermore, emerged out of the 70s as viable volume production organizers in markets for mature products, emphasizing exactly their innovative organizational competence. Part of this temporary success story of Swedish manufacturing, however, is the sequence of devaluations up to 1982, designed to bolster employment of blue collar workers in rather simple production. The big firms of the 80s are, however, unlikely to pull the Swedish economy along during the 90s, if they cannot radically reorganize themselves again. Let us therefore see how large routine operated firms attempt to innovate through acquiring new competence, facing aggressive competitors that are rapidly learning their old skills.

7.2 How do large firms learn to stay ahead?

Big firms devote increasing resources to internal learning activities. Some are directly measurable, other are integrated with work, like on-the-job training and systematically organized executive careers (Eliasson 1990c, 1991c). The large resources are, however, expended when firms try to upgrade their commercial and technological competence fast through large R&D investment programs or other, even more difficult experiments, that either succeed or fail. At the local level this spells disaster. At a higher, aggregate level failure can be regarded as a normal cost for learning. It will be obvious from the examples presented that too ambitious, or too fast "learning programs" create strongly diminishing returns through raising the failure rates. For the large firms to succeed in the long-run innovation race, learning will have to be a steady, routine activity. The question arises whether this is most efficiently organized in many small firms or in a few, very large firms. Let us survey the learning techniques often tried.

Analytical learning methods – technology management

1) The close to steady state world market conditions that developed during the 60s gradually lulled firms into a steady state idea of the future market economy. While national authorities increased ambitions to plan entire

economies, and to tell firms from their position of "superior overview" what technologies to choose, the same ideas took root in large corporations that established long-range or strategic planning departments, also with growing ambitions to substitute bureaucratic staff procedures for the creative process of shaping business ideas (Eliasson 1976). This came to an abrupt end during the crisis years of the 70s. The costs in the form of major business failures created by the increased reliance on simple analytical information tools were enormous. Formal long-range planning was learned neither to predict well, nor to be of any help to tell what to do when reality departed from plans. Formalized planning is now more or less eliminated from strategic business decision making. *Instead analytical methods have been geared to the task of monitoring ex post development for the purpose of identifying and correcting mistakes.* This is a good example of organizational learning (Eliasson 1984b, 1990c). However, the old planning idea has returned in a more restricted version under the title of *technology management*, reflecting the idea that technology can be approached as a problem of optimal choice. This is very similar in principle to industrial policy making, and hence contradictory to the idea of the experimentally organized economy. But technology management makes more sense than strategic planning. For instance, top management of firms like IBM, in the case told below, now and then has to make major technology decisions. One would expect these decisions to be systematic and incorporate all the relevant knowledge available at the time of the decision to those who make the decision. In the EOE firms have to act prematurely on the basis of very incomplete and possibly erroneous information, to prevent competitors from gaining headway. They therefore have to reckon with the possibility that their choice may be completely wrong (see Table 3), and be prepared for dramatic corrections. The method is not, however, as strategic planning was seen in the past, namely as an analytical method to derive the business choice.

External learning in markets

2) Stepped-up global competition in markets for sophisticated engineering products in particular, and dramatic developments on the international financial scene have made firm executives acutely aware of "the potential steepness of Salter curves in their market". Stepped up attention to innovative learning exhibits itself everywhere. One aspect of technological (Schumpeterian) competition is the competence to combine different technologies. The Swedish multinationals have combined international marketing and domestic product development (R&D) successfully with a flexible global production system. To do this they had to learn what they lacked, notably international marketing. And it took a very long time, for example for Sandvik, to develop and establish itself as the dominant producer of hard core metal (at least 40 years) and for Volvo to establish a position in the U.S. automobile market. During the last 10-20 years the competence to introduce sophisticated electronics in mechanical engineering products has spelled success. Today the pace is faster, and many firms cannot afford to spend decades to develop the complementary competence internally. They have to rush it and resort to external learning, even without possessing the necessary *receiver competence*. This time, for instance, Volvo acquired White Inc. to enter the U.S. truck market fast. It needed the marketing organization and the associated knowledge, not the factories. The experimental nature of this learning is all too obvious. There has been a rush among automobile producers to acquire – for some reason – electronics and aviation technology. GM has bought EDS and Hughes Aircraft. Mercedes Benz has acquired Dornier and Messersmith. Saab-Scania was already producing both warplanes and civilian aircraft, but it did not help automobiles. The whole mechanical engineering industry was on tip toe during the 80s to acquire electronics competence it did not possess, on the notion that it was needed to stay innovative on the product development side. The experience of such ventures is yet to be evaluated. In most cases the new acquisitions are not performing in ways intended. The difficulties of blending different corporate cultures and communication and learning codes exhibit themselves in these experiments. Judging from past major failures, most such attempts will constitute the ex post macroeconomic costs for achieving one or two accidental success stories.

3) There is a growing evidence (Eliasson 1991d) that the international organization of a firm is not only a "technique" to overcome trade barriers to earn rents from international trade, but also – as the firm grows in size – an efficient technique of *international learning about the global opportunity set* or "the global Salter structure" in the relevant markets. Part of the technique is to establish R&D units in areas with intense industrial and university research in related areas, like in Silicon Valley, along Route 128, or in Southern California (the new biotechnology). Evidence from Swedish multinationals is that significant resources are spent on such "innovative" learning within the large firms and that it may be successful if the necessary implementation and receiver competence exist.

4) The demand for rapid "acquisition of", rather than for "learning of" new knowledge can, however, become close to impossible to solve. Xerox learned early and the hard way how difficult computer thechnology was when it acquired Scientific Data Corporation (SDC) in 1969 for $100 million to integrate copying and computing, only to write off the whole acquisition in the 80s. The business idea was, however, in principle very sound, as we now know.

IBM realized very early that large scale distributed processing, networking and digital switching technology would be the key to success in the future networked information systems market. IBM did not possess, however, the necessary telecommunications and switching technology, neither did it understand that telecommunications technology was as difficult as computer technology. It first tried learning it through inhouse R&D development, but found this method too slow. In the late 70s IBM tried a joint Satellite Business Systems (SBS) venture, but later swapped its partnership for shares in MCI corporation, only to sell off these shares, before MCI recovered and began making profits. Parallel to this IBM invested unsuccessfully in Canada's MITEL corporation to learn the same telecommunications technology. The situation was getting acute after the break up of MaBell, allowing AT&T to enter the computer market with its superior telecommunications technology. In 1983 IBM bought 15 percent of Rolm and the rest of it in 1984, even though it appears (*Business Week*, July 10, 1989, p. 45) that an internal study suggested no, because Rolm was no longer the number one technology competitor in its field. Merging IBM and Rolm cultures proved to be too much, and in August 1988 IBM agreed to run Rolm together with Siemens – a large German telecommunications manufacturer – later to sell Rolm to Siemens. Essentially IBM still lacks the needed telecommunications technology. The successful innovator in this technology appears to be NCR that originally came out of mainframe business; so successfully that AT&T has (paradoxically) acquired its knowledge base through acquiring the whole of NCR through a not altogether friendly takeover. It should also be observed that AT&T has experienced the same problems, and tried similar solutions going the other way, to learn the computer side. The ultimate learning experience is still unclear for both. Swedish Ericsson learned a similar lesson attempting to enter – on a logically sound, but too simple idea – the entire business information systems market (excluding large computers) from its base in a superior telecommunications technology. It misjudged the scope and variety of new technologies it had to learn and operationally merge and sold out to Finnish Nokia in 1988, which has recently "learned" and unloaded the whole computer business to ICL in 1991. The network is now beginning to be the computer, which IBM understood early, but has yet not managed to implement in practice.

Internal learning

5) An important part of the competitive situation of a firm lies in its choice of product and market. Many firms in particular markets, for instance defense products, now see a dead market up front and attempt to finance their way into new products and markets with the cash flow from already awarded contracts. This is not an easy, and not a cheap learning experience.

Evidence is that – barring pure luck – such strategies will not succeed if the necessary experience and receiver competence in the new markets do not exist from the beginning.

6) A more systematically organized version of such learning prior to perceived needs is the classic example of *greenhouse diversification* programs (notably of successful firms with large cash flows) for the firm to be prepared whenever its main business line begins to weaken. For principal reasons to be elaborated below, such systematic forms of organizational learning have usually failed. Swedish firms doing this on a large scale in the 60s managed to survive during the bad years of the 70s by rapidly selling off all non-synergistic (profitable or lossmaking) activities and focus back on their old mainline business on which they had a global superiority in product technology, processing and marketing (Carlsson et al. 1979). The reason for this refocusing was partly losses, but mainly the need to economize on the most scarce of all resources, top management competence and attention (Eliasson 1989a). Examples are AGA, Atlas Copco, ASEA, Sandvik, ASTRA etc.

7) A different but more successful form of organizational learning that fits the experimentally organized economy takes place in well managed firms in mature product markets that have specialized in efficient operations management (routine product development, factory processing and global marketing). This appears to be the specialty of some large Swedish multinationals. Such business organizations have the capacity to rapidly take a new product to global industrial scale in their markets, but they are rarely creative when it comes to developing new, innovative products, and they know this. The standard story tells how such firms fail not only to develop new products but also to introduce already developed new products into their flow efficient business organizations (Eliasson and Granstrand 1985). A systematic, organizational, learning activity that can be increasingly observed in such firms is to *develop the receiver competence*, to efficiently introduce new, alien products into their organization, and to shop for new innovative firms with products ready and tested in external markets, being prepared to rapidly step up volumes to global industrial scale. If well organized, such acquisitions can

grow rapidly on the cash flow of the large corporation, supported by its experienced operations management and globalizing rapidly through an already existing marketing and distribution organization. Granstrand and Sjölander (1990) show that a broad internal technology base makes the firm more efficient in acquiring and implementing new complementary knowledge. Swedish Electrolux and (more recently) ASEA-Brown Boveri (ABB) are good examples. So far such acquisitions have been picked up rather cheaply because there are few competitive buyers in the markets for innovations. As this "learning activity" of large corporations grows, one would expect and hope to see increased competition for innovating firms, which will not only raise their market price, but also the incentives to start and build such firms (Eliasson 1986a).

8) Japanese superiority over U.S. and European competitors in manufacturing automation is the standard story of today. One observation related to technological learning sheds some light on the nature of this problem and on organizational learning itself. While the few successful European and American manufacturers of robots seem to be earning their money from downstream applications services with customers, Japanese firms are more focused on selling standard robotics equipment to customers, almost from the shelf. This approach makes the Japanese superior price competitors from a base in large-scale production. The reason for these differences in competitive approach appears to be (Dahlin 1990) that Japanese robotics customers have the necessary inhouse receiver competence to install robots, while this is not the case in U.S. and European engineering firms. Incidentally (see *Business Week*, July 2, 1990, pp. 69 ff.) the exact opposite situation appears to prevail in computer software and information systems installations. This observation tells a revealing story. When new basic process technology does not reside in a firm, process technology cannot be the competitive edge of this firms. What then is it? Product development, design and styling? Marketing? Can production be conducted efficiently and profitably without a solid base in process technology? It is ominous to remember that once the knowledge to design, install and operate textile machines was moved from textile firms to

specialized textile machine manufacturers, and became generally available in the market, this also spelled the end of a large textile export industry in the advanced industrial nations. The knowledge could be acquired in the market by firms in the developing world. It came embodied in the machines.

The varied career

9) The tacit nature of critical top business competence, being vested in teams of people with a varied composition of talents, rather than in individuals, calls for particular learning mechanisms. Above all the content of competence cannot be prescribed in advance. It may reveal itself through attempts to acquire it – as described above – or through trying it in the market (experiments). Thus, the career organization of the firm is, perhaps, its most important learning activity. It is of "the second order type" since it aims for improving the individual or team capacity to learn in the other dimensions mentioned above. This organizational learning activity is the most important factor behind the development of the heterogeneous, organizational characteristics of firms. For the firm, the ability of its employees to develop, shape and to operate in teams is often more important than specialized skills. Hence, learning at this level is necessarily experimental, and occurs as a consequence of a *varied career*, which reveals intellectual capacities both to the individual and to his or her superiors. The bulk of measured educational costs in a large firm is allocated on talented people in the career.

I am not talking of investments in education or about the upgrading of a well defined stock of knowledge the way we often see it from an academic perspective, even though this of course also matters. I am talking about – I repeat – the development of a team capacity for intellectual retooling. It is significant in this context to note the observation of Stafford and Stobernack (1989) – contrary to prior expectations – that high-tech industries are not characterized by a rapid turnover of people, but rather by unusually long employment spells, supporting the above idea. That the capacity for "intellectual retooling" is more important for coping with technical change than bringing in fresh and recently updated (at school) people, whenever something new shows up on the business horizon has been reported frequently in my interviews with firms. The latter would not work if the firm has not developed. internally already, the necessary receiver competence to put the fresh, specialist human capital – very much like the robots above – efficiently to work. A few additional observations on the career organization of firms should be made.

7.3 Coping with diversity

The first observation is the enormous variation in skill composition needed to carry out various tasks in large firms. Complexity and variation increase with advancement, but the exact needs are never the same. This means that the ability to organize one's mind to get a messy business situation structured is highly valued. Such abilities only exhibit themselves by testing people on increasingly difficult tasks. Many large firms are doing this deliberately, arguing that the risks, and the cost of getting the wrong person too high up in the organization are larger by several orders of magnitude, than of low level decision mistakes made by people on their way up. To dare to decide and act is a necessary element of high level competence but also the ability to identify, accept and brutally correct a mistaken business situation. The latter only comes with practice. And without the knowledge that you can deal with mistakes, you rarely dare to act daringly. Hence, part of the "education" provided by a varied career is to learn about yourself, and for the top competent team to learn about you. This selection mechanism exhibits certain similarities with the principal agent monitoring literature even though you would not, having read this literature, go and look for the things I am telling you about. Part of the educational technique, furthermore, is to establish the appropriate internal business mentality and attitudes to risktaking. Obviously, what is appropriate varies from firm to firm and from market to market. Compare for instance the need for experimentation in the U.S. Supreme

Court with the corresponding needs in the PC market.

The balancing of specialized skills and generalized knowledge among high level executives is a particular management problem. Should the top people be engineers or economists? Earlier, leaders normally rose out of specialized technical jobs and gradually exhibited their additional qualities, one such quality often being the ability to intellectually break loose from the harness of the specialty to be able to communicate and work within or form a competent team, of varied composition. In many ways the successful business leader is exactly the opposite to the successful scientist, or specialist.

An interesting characterization of team leadership therefore is how team members are recruited. Is the recruitment path such that teams become homogeneous ("only engineers") and introvert, or are they based on variety. As Meyerson (1990) observes, introvert teams have difficulties taking in and apply the new information needed to deal with new and difficult business situations.

Finally, an interesting observation from two large Swedish firms. The recent move towards an extended application of the division idea, by making divisions or part of divisions subsidiaries, has consequences for the internal learning of top executives. People no longer move as much across the entire business organization but stay within the subsidiaries. This has had two observable consequences. Talented engineers tend to get stuck in their technical specialties, where they happen to begin their job. Economists, on the other hand, normally cannot be directly placed on specialized operational duties, but rather begin their career on a headquarter staff job. This means that they begin "higher up" than the engineers and consequently have greater opportunities to exhibit themselves to superiors. On the other hand, well managed firms often show a healthy disrespect for specialized, acquired knowledge; and rather look for talent and/or the ability to relearn, recognizing the fact that the higher up the position in a business organization the more competence acquired on the job matters in total competence. Thus for instance, one of the most hardcore engineering firms among the Swedish MNCs has observed very satisfactory performance of economists as heads of two of its engineering process plants.

In fact, most of the examples of learning given above tell one clear story, namely that learning is *on-the-job learning* or *organizational learning*, a joint production activity (Rosen 1972) producing both value added and (an intermediate product) added competence. The technology of learning is therefore embodied in the organization of people in the firm. This organization is in turn constantly changing and hence means that even the knowledge to organize improvements in organizational learning is subject to further improvements. Experimental, organizational learning of different orders is the adequate term to identify this intellectual process in large business organizations.

7.4 Focus vs overview – the general problem of receiver competence

Business leaders are constantly made aware – through unexpected competitive action – of the enormous pool of industrial knowledge residing in the experimentally organized economy. Even though "winners" usually build their success on combining old and/or *new* technologies in a new way, such new contributions *normally* occur within a narrow range of technologies.

The potentially exploitable commercial technology space (the opportunity set) of each firm may be virtually infinite. Access to these opportunities are, however, limited by the local competence of the firm. Even the very large firms abstain from even attempting to monitor the entire range of technologies that may affect their products in the future. To understand this the distinction between *access* to academically defined, coded knowledge and the operational implementation of new technologies has to be understood. As the IBM–Rolm case illustrates, *even though* it was perfectly clear that IBM needed the telecommunications technology to stay competitive in the new information product market, and even though the technology was "available" in other firms, it is quite another thing to acquire and integrate that knowledge within your own firm.

The technology system available at each point in time is a mapping of what is known of the opportunity set. This is still a huge *technology library* with books in different languages (codes). To access it for operational purposes proficiency in the required languages is needed. The demands on *receiver competence* are enormous. This mirrors the fact that the competence superiority of some firms in the short run is often invincible.

To acquire receiver competence demands – as we have illustrated above – very large resources. It is simply not economical to keep a staff of experts ready in each possible field. Furthermore, such staff, not "on active business duty", soon loses whatever operational competence they may once have had. It is more practical, and more speedy to hire the necessary people or teams of specialized people in the market when needed, even at the risk of failing.

This is done correctly only when you sense your needs in time and only when you have the higher orders of competence to know what competence to hire and so on. As a consequence the hiring and acquiring decisions are both critical and subject to large and costly errors.

The task is further complicated by the enormous variation in the increasingly differentiated and heterogeneous knowledge capital put to use in industry that affects the communicability of knowledge! This is illustrated in the following examples (see Eliasson 1989a);

a) *Mechanical engineering* industries are based on a huge, slow-moving knowledge base. A significant part of that knowledge base has been "routinized" to the extent that it is being taught at advanced technical institutes. General know-how in this field is not tacit. The pool of knowledge is reasonably diffused through the advanced industrial world.

New technological developments occur in universities. Firms specialize in moving these technological developments through production to the market.

b) In *pharmaceutical industries* the knowledge base is moving fast. Academia lags behind. Because of the clinical orientation of medical research, universities can still offer significant product knowledge to firms. Hence, firms enter into joint research ventures with universities.

c) In *electronics* the situation is different. The knowledge base is moving even faster, and academia rarely has the competence to offer advanced knowledge, except at the very early stages of inventive activity, if a talented, creative person happens to be "in place". Furthermore, major technology areas in electronics are general in application and extremely abstract and advanced in any academic sense. As a consequence, basic research, technological development as well as market introduction take place in the firms. Frontier knowledge is typically "tacit", since receiver competence is lacking.

The organization of the learning process is what determines the long-run success of firms, but the variety of possible organizational solutions is enormous. One organizational principle observed in most firms is to keep the "technology system" or "competence system" rather narrowly focused, for operational teams to be able to form, and not to encourage excessive, creative ventures into peripheral domains. You often hear formulation such that "company policy is to be in the transport market". This illustrates the difficulties of "technological planning". It is possible to plan in a narrow technology domain, but that contradicts the purpose of planning, namely to avoid being caught unprepared by new, competing technology. If effective technological planning narrows your mind in a conservative direction, it is dangerous for long-run survival.

The exact balance of overview against operational focus, however, varies and in fact defines the competence characteristics of a firm. This balance is in turn always founded on the selection of people that controls "the mind of the firm". The actual selection (the balance) and its changing composition are *rarely* the result of deliberately studied efforts. People gain a varied experience through following varied career patterns in firms in an experimental manner, and the experience acquired by the top competent team normally sets the criteria to be followed in future selections and so on. The whole competence accumulation of a firm becomes an exercise in experimental, organizational learning. The resulting knowledge base is truly tacit. It constitutes a tacit "competence memory" of the firm.

8. The Unexploited Opportunities

Nobody would have dreamed about the economic opportunities represented by electronics-based information technology at the early stages of the industrial revolution. Today, when we know quite well about the new technology we still find it well exploited in a few economies and hardly at all in the production system of other economies.

The experimentally organized economy, in contrast to the classical economic model, presumes a very large state space or set of business opportunities. The size and non-transparency of that state space originate in its heterogeneity and in complexity. The number of ways to combine and recombine technologies available makes it possible to create a virtually unlimited set of business opportunities, and the exploration of that entire state space is not only costly. It is also time consuming. Since the number of possible, unexplored business combinations expands with each new combination state space expands in pace with its exploration. It is a positive sum game (Eliasson 1987, p. 28 f). These assumptions of the experimentally organized economy are difficult to refute on empirical grounds. If accepted a number of deductions follow. First of all, a firm or an economy is normally operating very far below what is potentially possible, but there is no way of ascertaining the location of the outer possibility frontier by analytical methods, since all the data on which to base such an analysis have been generated by the current, less than optimal production system. In reality then, each firm in each national economy is capable of producing the same and more employing only a fraction of its current staff, if its organization can be radically reorganized and the staff more carefully selected. This radical reorganization, however, requires competence that is not likely to be available in the short run.

The current, less than efficient mode of operation is only partially reflected in relative factor compensation. A radical change is therefore normally profitable, if the necessary business competence can be learnt or acquired. But it will not be accommodated voluntarily. Under normal business circumstances it will be resisted, and transition costs will be prohibitive. It can, however, be forced by competition, if the opportunities of the experimentally organized economy are open to everybody. This is the critical access clause emphasized in Section 4 and by Adam Smith. Free entry is a necessary condition to achieve long-run economic growth, both in the sense of exploiting the set of business opportunities and of expanding it.

While the set of business opportunities for individuals, firms and nations is enormous, risks for failure are accordingly large. A fairly high rate of business failure at the micro firm and individual levels is a sign of high performance. At higher levels of aggregation it should, however, be possible to organize the economy such that it can both exploit opportunities efficiently and cope with the consequent change in a socially acceptable way. But there are also many opportunities to organize an economy such that it fails on both accounts, achieving neither economic growth nor a socially acceptable environment.

The important choice concerns the mix between the experimental, market mode and the degree of imposed order (regulation, central planning) to achieve efficient economic coordination and to reduce unpredictable welfare consequences at the micro level. Too much order squelches innovative behavior. Too little order means disorganization. The institutions of the economy define the choice, notably the degree of centralized decision making imposed.

The conclusion reached in this paper is that long-term economic progress is inevitably dominated by selection mechanisms, and that existing producers can only continue to prosper through learning, as long as they are not threatened by radically new technology. Radically new technology is created as part of the ongoing competition and experimental search into the immense business opportunity set enacted by millions of agents in the market. The innovative outcomes, hence, are largely unpredictable. The theory of the experimentally organized economy predicts that in the long run every existing producer will be threatened, sooner or later by radically new technology and that only few will survive even their first exposure.

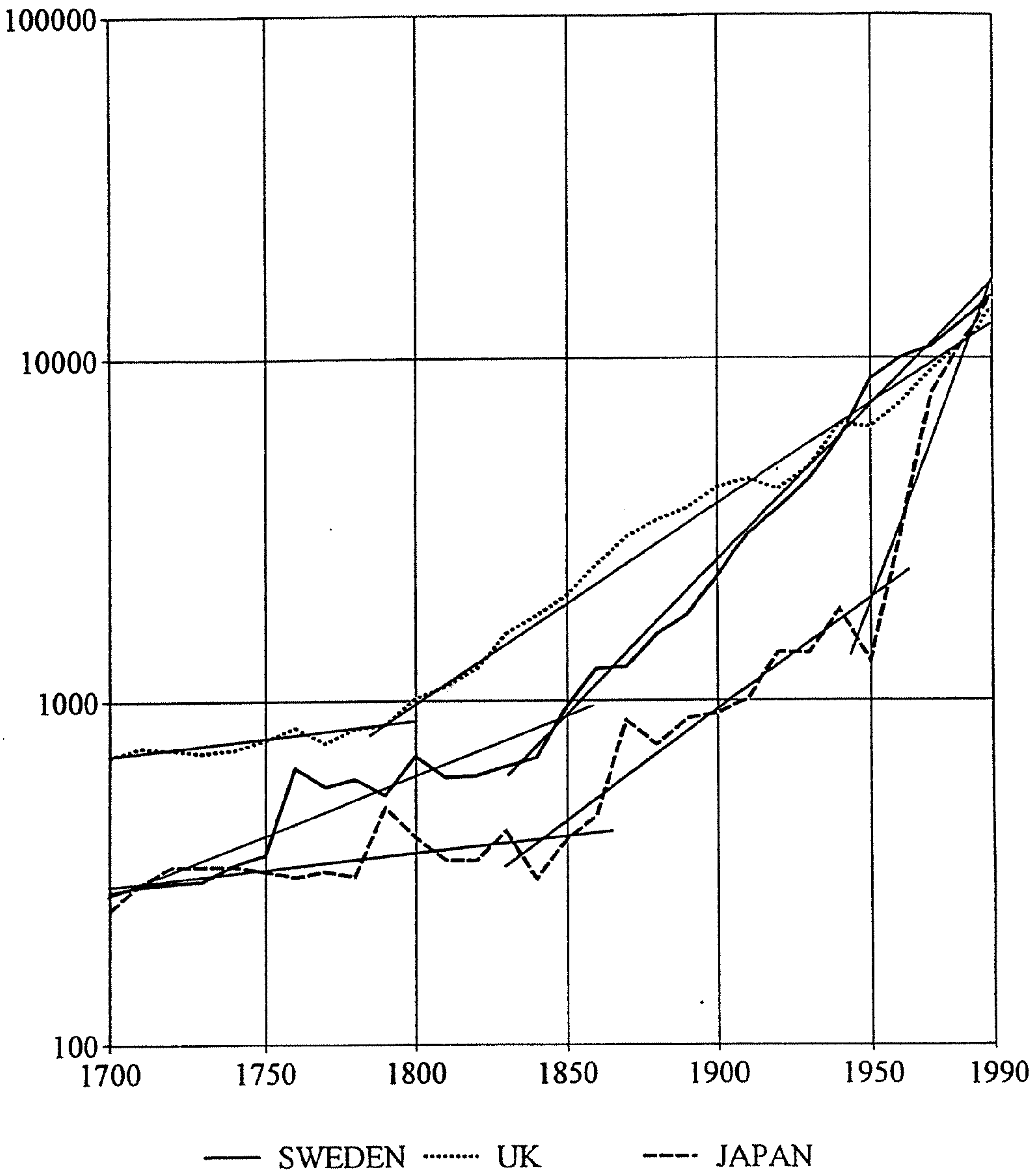
The possibility for an incumbent firm to counter this long-turn challenge of radically new technological competition through efficient learning and systematic innovation is extremely small. The possibilities for Government to support the same attempts with success through industrial policy are equally small. To pursue such methods systematically will rather preserve existing structures and technologies and hence decrease the capacity of the economy to reorganize. We have therefore understood that in the long run there is no simple instrument-policy target solution to this social dilemma in the well known sense of Tinbergen (1952). In the long run the unpredictable outcome of the experimentally organized market process dominates, with all its rough social consequences.

Radical technological change, like the PC revolution, not only destroys the rent creating capacity of incumbent ("mainframe") producers. It creates new rents in different places and hence also radically changes the principles for distributing income. This is the essence of the innovation, creative destruction growth process of a capitalistically organized market economy outlined in Section 2. While everybody would be happy to enjoy the fruits of that process, there is no popular policy vote for the competitive process per se. The policy makers will attempt anticipate that and act to constrain it. Hence, a successfully organized economy keeps politicians out of the decisions of the production system. This is, however, difficult to achieve in a nation concerned about obeying democratic political principles, but it was one important, organizing principle of the old Swedish policy model, while it worked (see Eliasson 1986b).

Radical technological and organizational change, hence, will normally be resisted by a democratic, political system, as witnessed in the public sector and in large business bureaucracies. Unemployment is created in the wake of the competitive process and/or relative incomes are changed in unpredictable and non-negotiable ways. For this to be accepted a viable social insurance system has to be in place. But also a social insurance system has to be innovative to provide for the variety of insurance services needed. Hence, it has to be established in the market. While efficient public social insurance is threatened by moral hazards, there are other difficulties associated with establishing private market-based insurance arrangements, notably associated with the problems of the disadvantaged. Hence, there are plenty of instances of both Government and non-Government failure. We can only observe here that countries that have not succeeded in establishing viable social insurance systems do not belong to the exclusive group of rapidly growing industrial economies for long. But it is also instructive to observe that the well known welfare economies no longer seem to belong to that group.

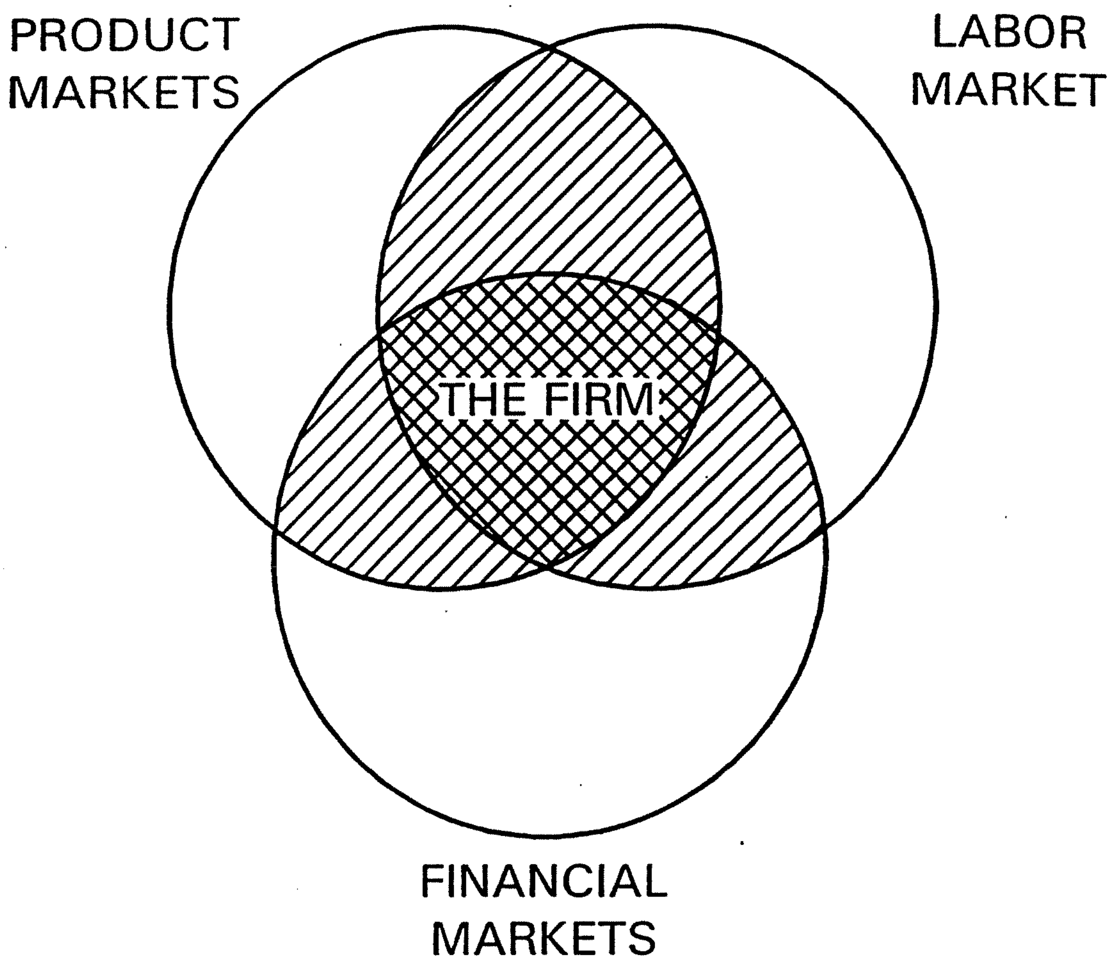
The proposition that began this paper was that the mature industrialized economies, notably those with an overextended public welfare system, i.e., the European industrial economies, are currently facing a double challenge; *first competition* from new industrialized countries, including the former planned economies that are rapidly learning to organize fairly simple production, requiring only fairly uneducated labor; *second* the *necessity* to dismantle and reorganize the public social insurance system, such that the necessary radical reorganization of production is accepted. The prediction of the model of the experimentally organized economy is that the majority of these economies will fail in the long run and be passed by new up-start economies, that do not have to bother politically about the resistance of vested interests based in the old principles of income distribution.

Figure 1 Growth in GNP per capita in the U.K., in Japan, and in Sweden, 1700–1990 (USD 1988)



Source: MOSES Database, IUI.

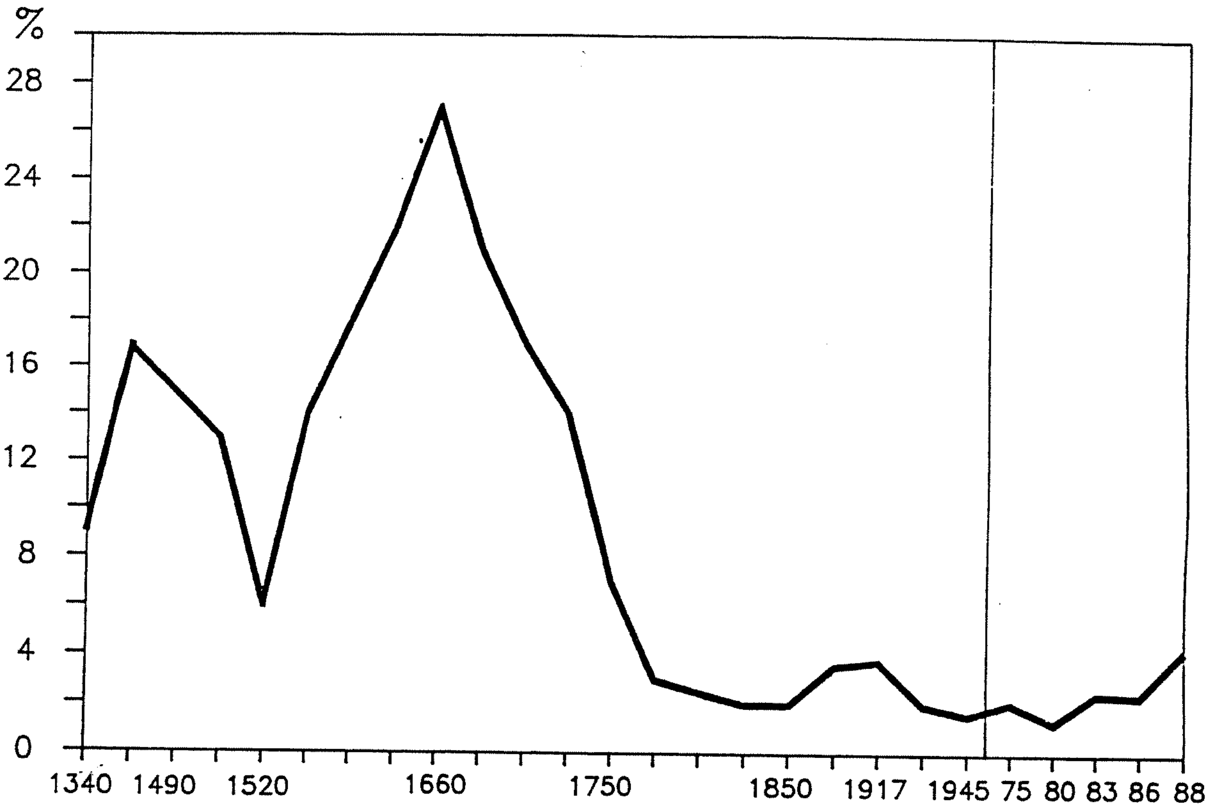
Figure 2 The firm in the intersection of the imperfect ends of the markets for products, labor and financial resources



Source: Eliasson (1989b).

Figure 3 Share of total Swedish manufacturing employment of STORA, 1340-1988

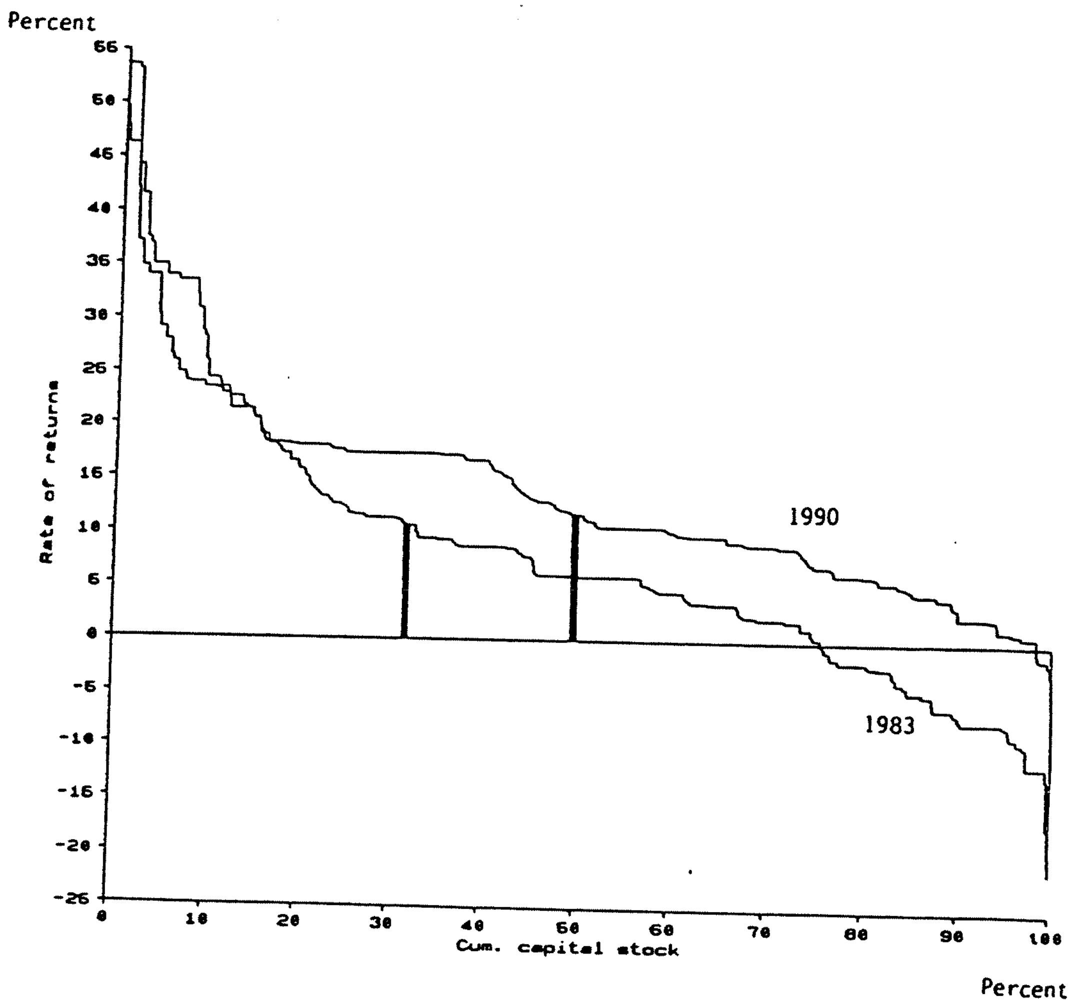
Company turn-over in percent of total manufacturing & mining production



Source: See *Introduction* by Gunnar Eliasson to R.H. Day, G. Eliasson and C. Wihlborg (eds.), *The Markets for Innovation Ownership and Control*, IUI and North-Holland, 1993.

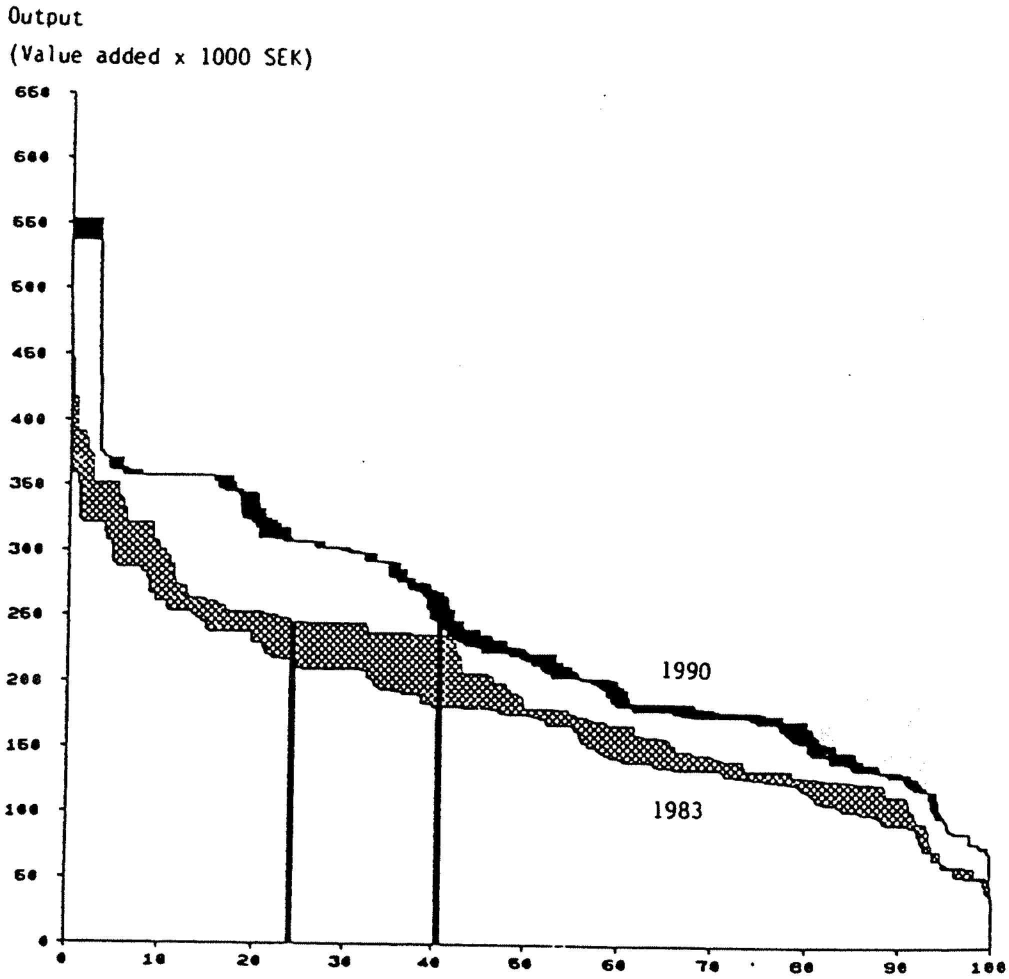
Figure 4 Salter curve structures illustrating the dynamics of the Swedish micro-to-macro model

4A Rate of return distributions in Swedish manufacturing industry 1983 and 1990

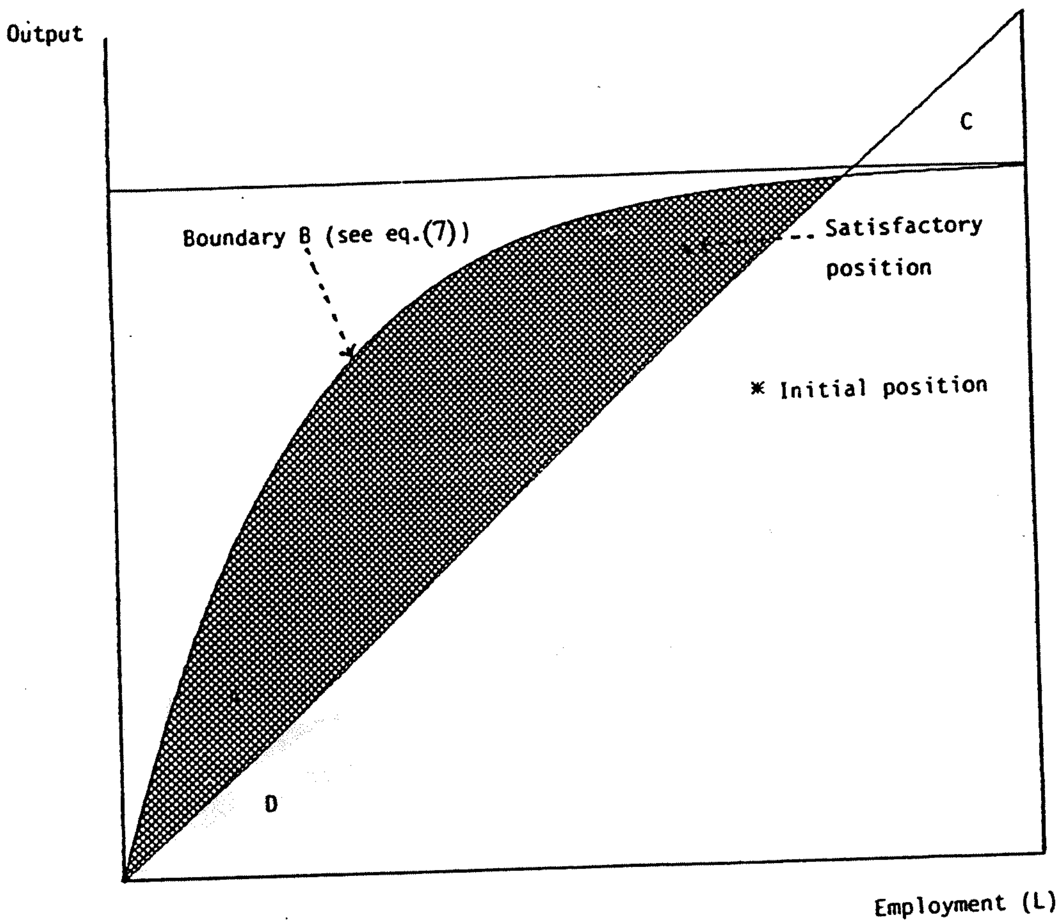


Note: The rate of return measure (= $\bar{\varepsilon}$) is the nominal rate of return on total capital over the nominal interest on industrial loan.

4B Labor productivity distributions in Sweden's manufacturing industry 1983 and 1990



4C The productivity frontier of one firm, first quarter 1983



Note: Boundary B represents the upper output level per unit of labor input. The straight diagonal corresponds to the minimum labor productivity levels compatible with the minimum targeted profit margin, given expected wages and prices. (For an explanation, see the Source and B. Carlsson, E. Taymaz and K. Tryggestad (1993).

Source: Eliasson (1991c).

Table 1 The four basic economic activities in the knowledge based information economy

1. **Coordination** (organizational structure)	*The invisible and visible hands at work* – competition (in markets, Smith 1776) – management (of hierarchies, Chandler 1977)
2. **Innovation** (exploring state space)	*Creation and exploitation of new business opportunities* (Schumpeter 1912) – innovation – entreprenurship – technical development
3. **Selection** (organizational change)	*Incentives for change* – entry – exit – mobility
4. **Learning**	*Knowledge transfer* (Mill 1848) – education – imitation – diffusion

Source: Eliasson (1990a), p. 73.

Table 2 Dominance of the 10 largest Swedish corporations
Percent

	1965	1970	1974	1978	1986	1990
Swedish goods exports	19	25	27	31	37	34
Foreign Swedish employment	78	73	75	69	75	85
Manufacturing employment in Sweden	16	19	23	24	31	27
Including also indirect employment with subcontracters	--	--	--	31	--	--
Total manufacturing R&D	--	--	52	44	74	72

Note: Data on the ten largest firms by total employment each year. ABB excluded 1990.

Source: Eliasson (1991d), *MOSES Database*, and 1990 IUI survey of Swedish multinational firms.

Table 3 Competence specification of the experimentally organized firm

1. Sense of direction (intuition)
2. Risk willing
3. Efficient identification of mistakes
4. Effective correction of mistakes

- -

5. Efficient coordination
6. Efficient learning feedback to (1)

Source: Eliasson (1990b).

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