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SCHUMPETERIAN INNOVATION, MARKET STRUCTURE AND THE STABILITY OF INDUSTRIAL DEVELOPMENT

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ABSTRACT

Starting from the postulates of limited information about a set of business opportunities and, on local, partly incommunicable ("tacit") competence to identify and communicate these opportunities, I present the capitalistic market process as fundamentally experimental and largely unpredictable. The successful experiments are the driving forces behind macroeconomic growth. Hence, it is important that the economy is institutionally organized such that good experiments are stimualted and selected ("entry") and that the exit process is efficient in the sense of forcing exit of bad experiments.

We link the early Schumpeterian notion of the exogenous entrepreneurial, or innovative process to the idea of a vast set of commercial and technological opportunities and combine it into the market dynamics of a micro-to-macro model, to come up with a three phased growth cycle theory. In this theory the potential for economic growth is vast, but actual economic growth depends on the availability of local competence and the ability of the political and social system to cope with the structural adjustment at the micro level. This is where "institutions" enter and we refer to the old Swedish policy model as an efficient institutional regime to cope with the positive and negative sides of rapid economic growth.

1. THE EXPERIMENTAL NATURE OF THE CAPITALIST MARKET PROCESS

The name of Joseph Schumpeter is intimately associated with entrepreneurial activity, technological development, technical change and the "creative destruction" of economic structures;[1] in short, the dynamics of structural change. Economists grew increasingly disinterested in the problems of structural change as Keynesian economics took roots in neoclassical micro theory from the mid-30s. The macro version of Joseph Schumpeter's theoretical structure is the growth cycle, but it has become too asociated with technological innovation in Schumpeterian literature. It it is the inner dynamics of aggregates (market allocation processes) and the institutional organization of the market that move the growth cycle. Market processes and institutional dynamics is lacking in classical and modern received theory, and not explicit at the micro level in Schumpeterian theory. And you need both to formulate an aceptable growth theory. The concern of this paper is to take a few steps towards remedying this situation by bringing behavioral economics to bear explicitly and quantitatively on macroeconomic development. Institutional dynamics, broadly defined, is concerned with the

selection processes in the market, notably the entry and exit processes, meaning that a market regime analysis has to pay special attention to the deregulation issue. This integrated theory of economic growth can be illustrated through the Swedish micro-to-macro model. The new intellectual structures that emerge have clear policy implications, especially as regards the optimal design of (market) decision processes in society.

1.1 Dynamic market coordination

This paper will explore the micro-macro link between innovative activity and macroeconomic dynamics. I emphasize;

(1) the transformation of manufacturing firms from predominantly factory oriented producers towards information processors with their competitive base in product technologies, and

(2) how economic intermediation is organized, linking entrepreneurial activity and technological change at the micro level, and economic growth at the macro level. This is often referred to as the transmission, or diffusion of technology. I prefer to discuss it more broadly in terms of the organization of market competition and pricing in an economic regime characterized by innovative technological change, or dynamic coordination across agents and over time in the market economy - the Smithian invisible hand at work, if you so wish.

Information processing occurs (1) between firms in the market and (2) within firms in the form of administrative coordination. Innovative activity is carried out by (Schumpeterian) entrepreneurs, that as a rule change the internal structure and outer forms of firms. Traders of all sorts play a dominant role in coordinating all agents' activities in the market. We observe already here (Eliasson 1985b) that information processing makes up the bulk of total resource use in a modern firm. This means that productivity growth - as it is measured at the macro level - is market determined, rather than technically determined.

Economies of scale move the growth process

The Schumpeterian notion of technological change was that of creative entrepreneurs that saw and implemented "new business combinations" and forced "creative destruction" on old, inefficient activities through competition. Such new combinations take place at all levels and constitute the transformation process of firms mentioned above. At some level it can always be regarded as an instance of Smithian division of labor, allowing new combinations (joint production) to be formed thus generating economies of scale within firms, and joint rents to be distributed. (But to be credible, the Schumpeterian model needs two additional features. It needs a clear process representation both of the ways micro influences macro behavior and how macro behavior feeds back into micro decisions. It needs a mechanism that keeps economies of scale from generating unlimited concentration.)

1.2 The diffusion of innovations

This formulation of our modeling problem introduces what I have earlier called the experimental nature of the capitalist market process. Even though careful reading of Schumpeter's works does not support the simplistic view I will now restate, it is "the common version" of him in literature. The young Schumpeter (1912) saw innovations and entrepreneurial activity as predominantly unpredictable, something that came down upon the economy as a Deus ex Machina. The old Schumpeter (1942), having observed the emergence of giant corporations, began to believe that innovative activity could occur in a routine fashion through planned R&D. This simplistic distinction between unpredictable and planned innovative activity carries a strong didactic content. The implications of each are far-reaching and fundamentally different but they can be empirically evaluated against each other.

The "young Schumpeter" corresponds to my notion of an experimental economy.

The "old Schumpeter" is closer to the centrally policed, socialistic economy. Arrow's (1962) article implying that socialization of innovation may be efficient argues a related theme.

On the basis of a set of postulates supported by empirical observations I will argue that the young Schumpeter was fundamentally right. He captured the basics of the economics of very long run growth, while the old Schumpeter departed from that understanding.

To argue that point, three notions are made cornerstones of my reasoning.

(1) Knowledge

The first notion is that of an experimental economy that is intrinsically unpredictable[2] as to micro outcomes. I develop that notion by introducing (in the same fashion as Pelikan, 1986), Simon's (1955) concept of "bounded rationality" and Polyani's (1967) concept of "tacit" knowledge. People and organizations form simplified decision models in order to cope with environmental complexity and be able to draw conclusions. This ability to create intellectual order out of a complex environment is part of their local competence. This competence is nevertheless - in an industrial context - so complex and involved that it cannot easily be communicated. It is "tacit". Bounded rationality, furthermore, means that decision makers' perceptions of the same reality are different are often incorrect, and are ad hoc in the sense of being only temporarily relevant. Taken together - as we shall see - the two notions of reality remove the convexity and market clearing properties necessary to derive "optimal policies" in the way characteristic of the literature based on general equilibrium theory.

(That critical knowledge is, in fact, tacit and that decision making is "rational", but typically bounded, is something that I have frequently been confronted with in my own research (Eliasson 1976a).)

(2) Stability

The second notion is Darwinian (Winter 1964) in spirit. It postulates (Eliasson 1984, 1986c) that stability of long-term macroeconomic growth requires a steady turnover of quasi rents in the economy, generated through innovative entry at all levels.[3] New entrants compete old rent receivers out of business, thus preventing concentration and preserving a healthy, but variable diversity of structure in the economy. To achieve this, free competitive entry must

be allowed and barriers to entry must be kept low.[4] One implication is that the capital market can never be in equilibrium[5] in a growth economy. Hence the notion of equilibrium in other markets becomes undefined in the interdependent process economy we are discussing. (In fact, the implication is that if you force the economy closer to equilibrium in the capital market, the macro economy becomes increasingly unstable.) I have developed this argument in (Eliasson 1984 and 1985a) and we are carrying on further research in that direction at IUI.

(3) Market coordination and intermediation

The third notion bringsin institutions as intermediators in the economic process. They facilitate the economic process, and they make its output and its consequences desired and accepted in the market. Institutions are endogenously self-organizing (see Pelikan 1986). This takes us somewhat beyond Schumpeter. To make my point clear I will introduce what I have frequently referred to as Åkerman's four fundamentals of economic theory:

- interdependence
- welfare
- process
- institutions[6]

Åkerman (1950) argued that these have to be the four fundamental elements of any useful economic theory.

The first notion of the experimental economy can be introduced analytically. The second notion can be quantified, as it has been within the M-M modeling framework. This, however, takes parameterized institutions for given (including entry and exit, see Hanson 1986). When we now introduce the concept of endogenized institutional change, we leave the domain of quantitative analysis - but in the systematic fashion I prefer - and must resort to language as the tool of analysis.

The third notion was that the institutions are paramount in facilitating both the innovation process and making its consequences acceptable in society. The first aspect of institutions is the incentive problem. If the market economy is fundamentally experimental the innovative problem amounts to organizing the rules of the economic system in such a fashion that enough of a broadbased experimental, innovative activity occurs to filter out a sufficient number of winners (Dahmén-Eliasson 1980), and to contain the concentration that would follow from economies of scale; this is the result fromefficient routinized R&D in large companies that the "old" Schumpeter worried about. (We will conclude below that with vast business opportunities and local competence, Schumpeterian competition will check such tendencies, provided competitive entry is not restricted by the political system or barriers to trade. This is really what Schumpeter (1942) worried about. Entrepreneurship, on the other hand, as he saw it, does not have to be restricted to small firms or individuals. Unlimited growth of IBM through competence developed through routine innovative activities is checked both by small competitive entrants and by innovative activities of other large firms. But this process generates a lot of change at the micro level.

The second aspect corresponds to the argument (Day, 1984) that institutions make it possible for the economy to operate out of equilibrium. To operate out of equilibrium means - if you excuse my use of the term - that "pareto incompatible" income and capital transfers become acceptable and can occur without any detrimental effects on dynamic production efficiency. Through evidence of the long-term beneficial effects, and through indoctrination, people are willing to accept the short-term sacrifices. To make this happen was the idea of the "old Swedish policy model" that we will return to at the end of this paper.

Before starting the analysis I will illustrate my theoretical notions with some historical statistics.

2. THREE THEORIES OF ECONOMIC GROWTH SEEN THROUGH A LONG HISTORIC PERSPECTIVE

2.1 Questions asked

Beginning in the second half of the 18th century in England and continuing through the 19th century in some additional countries, the industrial revolution created an economic elite of nations, which currently make up the OECD world. Roughly speaking, those countries who did not make it from the beginning have not really made it later. The standard explanation of this is technical innovation.

The question raised in economic historical analysis has been whether the initiation of the industrialization phase was due to the sudden emergence and diffusion of new techniques of production that started up the industrial revolution and/or whether the burst of exogenous innovative activity in some nations was related to some country specific factors.

Recently, many of the elite, industrial nations - notably the first industrial nation - have been subjected to severe economic problems of stagnation, unemployment and inflation. Terms like deindustrialization, or some sort of reversal of the industrialization process have been used to describe what is happening.

A more disturbing possibility is that perhaps the industrial revolution was initiated by a unique constellation of factors (local competence) at different places, that made it possible to exploit a technological potential that had existed for a long time. North-Thomas (1973) also emphasize different institutional rule systems to explain the different levels of innovative activity, and the initiation of the industrial revolution in Holland and England on the one hand and in France and Spain on the other. This suggests that such local, human capital, and institutional factors determine the potential of a nation, or a region to seize upon new, internationally available technologies. The implication is that a new wave of growth may

occur very selectively and according to the distribution of these specific factors of local competence. Thus, there is no quarantee that growth must continue to occur among the already wealthy industrials.

More precisely, if we can demonstrate that specific human capital factors were at play in the mid-19th century to move the currently wealthy industrial nations to where they now are, this argument gains in credibility. We will look more closely at this "story" in what follows.

Figure 1 for Sweden is the result of heroic statistical work. Despite the doubtful quality of statistical observations over the 450 year time span, the kink observed sometime just before the middle of the 19th century is a more or less accepted empirical fact. Something dramatic happened about that time in the Swedish economy. The little kink at the upper right hand corner reflects the current "crisis" in a 450 year perspective.

This diagram is useful for one reason. It demonstrates the impact of the industrial revolution in terms of its effects on output. The nations that missed the revolution followed the old trend. While it took 300 years for Swedish manufacturing to reach 50 times its initial production volume between 1549 and 1850, it took less than half that time to increase output volume about 250 times from the mid 19th century. Had Sweden missed the technological opportunities and followed the old trend, we would currently be enjoying significantly less than one fiftieth of our current per capita national income, or roughly the difference currently recorded between Sweden and India.

2.2 Three different stories

At the time of the "kink" three fundamental changes occurred, each corresponding to a particular, often voiced theory of economic development.

(1) For several nations, including Sweden, import demand from the firs industrial nation was growing very rapidly.

(2) The level of technical and organizational innovation increased sharply during the late 18th century.

(3) Regulation of economic activities was generally removed.

For purposes of exposition I am going to associate John Maynard Keynes - or Karl Marx - with the the first observation, Joseph Schumpeter with the second and Adam Smith with the third explanation. We have a demand pull, an innovation supply push, and a deregulation, release of incentives explanation, respectively. There is a rich literature advocating each in turn and simple statistical analysis would support each story individually; a demand pull that generated incentives for innovators, a Schumpeterian type exogenous innovative process, and a release of fettered economic forces. Each story carries widely different implications for the role of Government in economic development.

My argument is that parts of all three processes have to be at work simultaneously to generate sustainable macroeconomic growth. This - indeed -takes simplicity out of economic policy making. It forms the rationale for less policy and much caution in arguing for centralist manipulation with the economy. This revelation will probably be the main thrust of the "Schumpeterian revolution" that currently appears to be replacing the "Keynesian revolution" in economics. Let us go through the three "theories" in turn, beginning with the deficient demand story.

(1) Deficient demand

The deficient demand story originated with Marx, who argued - as we do - that the productivity potential of an industrial economy for all practical purposes is unlimited, but that demand may be insufficient. Depressions and stagnation will occur regularly, and capitalists will aggressively look for new markets to unload their surplus products. Keynes borrowed that notion. His deficiency of "effective demand" became a rationale for government to boost demand through taxation and public sector growth. It was analytically

presented as a difference between ex ante investment and ex ante savings, or a non-clearing capital market. As Morishima-Catephones (1986) elaborate, this is synonymous to saying that Say's law does not hold and that non-market clearing has to be a typical characteristic of Schumpeterian thinking. As we point out this is, however, also the backbone of the Wicksellian (1898) cumulative process. Hence, instead of the Keynesian investment and savings gap, the gap between the ex ante rate of return that drives investment decisions, and the rate of interest that controls the amount of saving in the economy is used to represent the capital market disequilibrium.

There are, however, two important aspects to the deficient demand argument in our context. First, when transformed into a capital market imperfections issue we are confronted with a micro problem of relative prices. A non-clearing capital market, or a deficient demand situation can quite well exist, even though the average expected marginal return to capital equals the average loan rate in the market (see Figures 5). Second, as Schumpeter emphasized, capital market imperfections - or depressions - are needed to clear markets from inefficient producers (creative destruction). Taken together we have an extensive form of game (Shubik 1985) with a variable number of players that forms the basis for the "growth cycle" (see more below).

As a consequence, the macroeconomic demand pull explanation (item 3 above) of the industrial revolution can be ruled out from the beginning as a general explanation of the industrial revolution, or of macroeconomic growth. Demand is preceded by innovative activity, by the entry of superior technology that forces bad performers to exit. However, at all aggregation levels below the national level, demand pull effects are key elements in any growth process. Without demand feedback, no growth process can be sustained. Part of this takes the form of domestic demand through income generation. Part of it comes through foreign trade which depends on relative prices. In the latter case it becomes apparent that the demand explanation can never be separated from price and cost considerations, or the ways relative prices are set in the market.[7]

(2) Innovative activity and the entry of new technologies

What sustains innovative activity and entrepreneurship that is needed to maintain the capital market disequilibrium and fuel a fast growth cycle? Empirical evidence on the origin of innovative activity is scant. What can be observed is later successful outcomes of the innovative process, but we miss most of the failures, especially those that do not survive long after their conception. Figure 4 gives some hints of the extremely differentiated performance picture at the micro level. As Jagrén (1986) demonstrates, the aggregate growth of output of a random sample of 115 firms from a population of firms in the 20s for a 60 year period was pulled along by only two winners (Electrolux and Bofors, see Figure 4). Other survivors led a stagnant life and the majority of the initial cohort has been eliminated. If this is the normal picture, one is inclined to believe that a very broadbased and intense innovative activity has to be going on all the time to keep the economy growing steadily 50 years from now. The nature of this innovative activity must have a lot to do with societal incentives and the way society at large is organized. If we leave culture, attitudes and values of society outside our explanation, then we perhaps have to be satisfied with the young Schumpeter's notion of an exogenous innovative activity. If we want to explain such activity, we should not look primarily at the way R&D is organized within large firms, but at the institutional organization of society at large.[8]

(3) Market deregulation or technology

The question now is how technology and the organization of an economy affect each other over time. Should we take economic organization as the exogenous datum and make changes in the institutional rules of the market system the policy issue?

Thus, for instance, some would argue - against Heckscher (1953) - that deregulation of the Swedish economy (item 3) in the mid 19th century, did not really release innovative forces in society (item 2). It was the other way around, innovative forces were breaking down regulatory barriers in so far as they mattered, This, if true, is a clear example of endogenous institutional

change (the last item in Åkerman's earlier listing), but to understand economic growth it requires that one explains how technological advance arises in the first round.

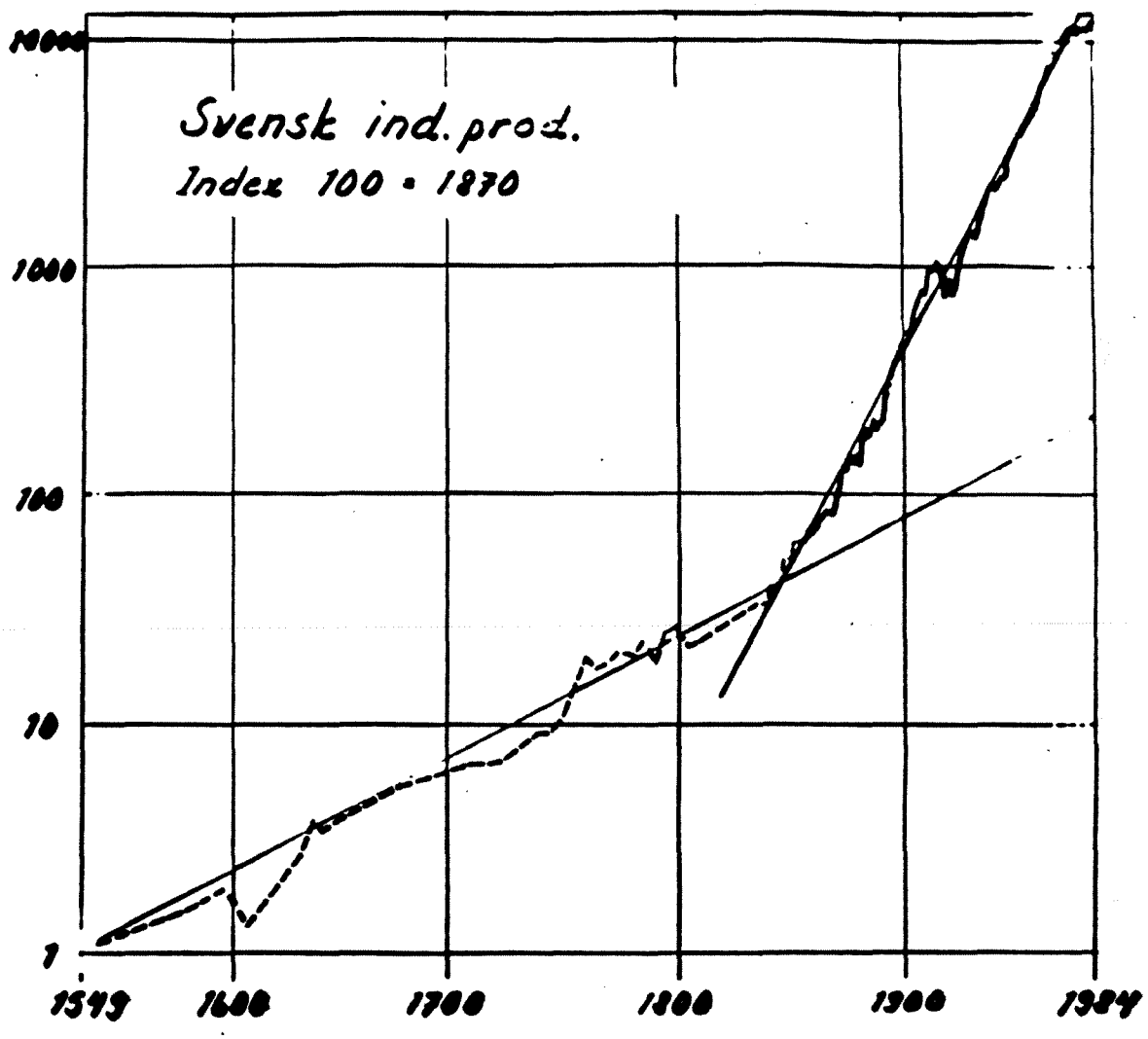
The deregulation hypothesis is nevertheless compelling. In the first half of the 19th century the straightjacket of industrial regulations was gradually taken off. Earlier in Sweden, every form of innovative, commercial activities required a permit; from the establishment of a new firm, to the introduction of a new product or even a better product. The name for that permit - a privilege - reveals its monopoly based nature. The king of Sweden was the supreme industrial policy ruler. At least in those days exogenous technology was not strong enough to break down his rule. Hence, institutional rules can be interpreted as one form of technology. As to its effects it cannot be distinguished from other forms of technologies. From a scientific point of view efficient procedure is to define our concepts such that whatever has to be left exogenous is allocated to the institutional rules category. This includes policy making as well, if it is going to be treated as an exogenous factor. We achieve this taxonomy of our theory through introducing the concept of the international opportunity set, and through linking it up with a stylized micro-to-macro theory.

Micro-macro theory captures the market regime

As a consequence the micro-to-macro model that we have (see Supplement) allows us to illustrate the theory of growth we are asking for in a way that integrates all three stories. For a given state of internationally available technology (the opportunity set) and a given parameterization of the market processes (the market regime) that can be manipulated through policies, the micro-to-macro model integrates all three stories together by closing the economy through income generation-demand feedback that constrains price and quantity setting behavior of individual agents. One illustration of the use of the model as an explanation of growth is that it has been possible to generate macro growth paths of manufacturing output for 50 year periods that differ almost as much as between the "new" and the "old" trends in Figure 1. The only difference between simulation experiments has been a resetting of the "market regime" determining parameters, that regulate the speed of price and quantity adjustments of agents in response to the same

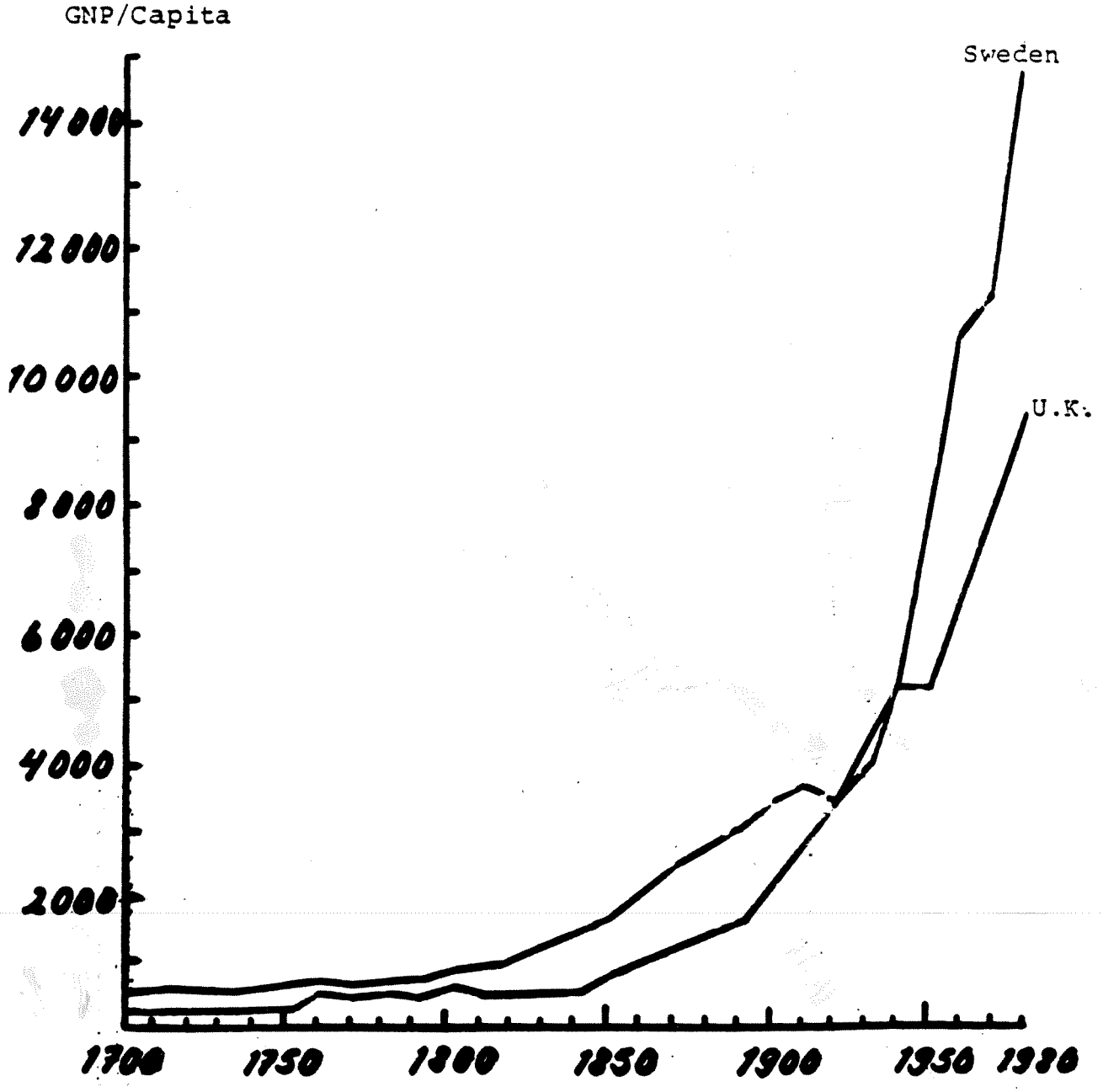
price and quantity adjustments of all other agents. The only qualification needed is that the technology potential - or in our jargon, the international opportunity set - is sufficiently large (see e.g. Eliasson 1983). Deregulation is a change in market regime, releasing the technology potential. We will return to this below. The important thing to note here is that the typical convexity assumptions of traditional theory have been removed, and replaced by the extent and speed of the exploitation of the opportunity set. This sets the upper boundaries of economic growth, and controls the market processes. Having said this, we also have to define the international opportunity set more clearly.

Figure 1 **450 years of manufacturing growth in output in Sweden.**



Sources: IUI/Jagrén

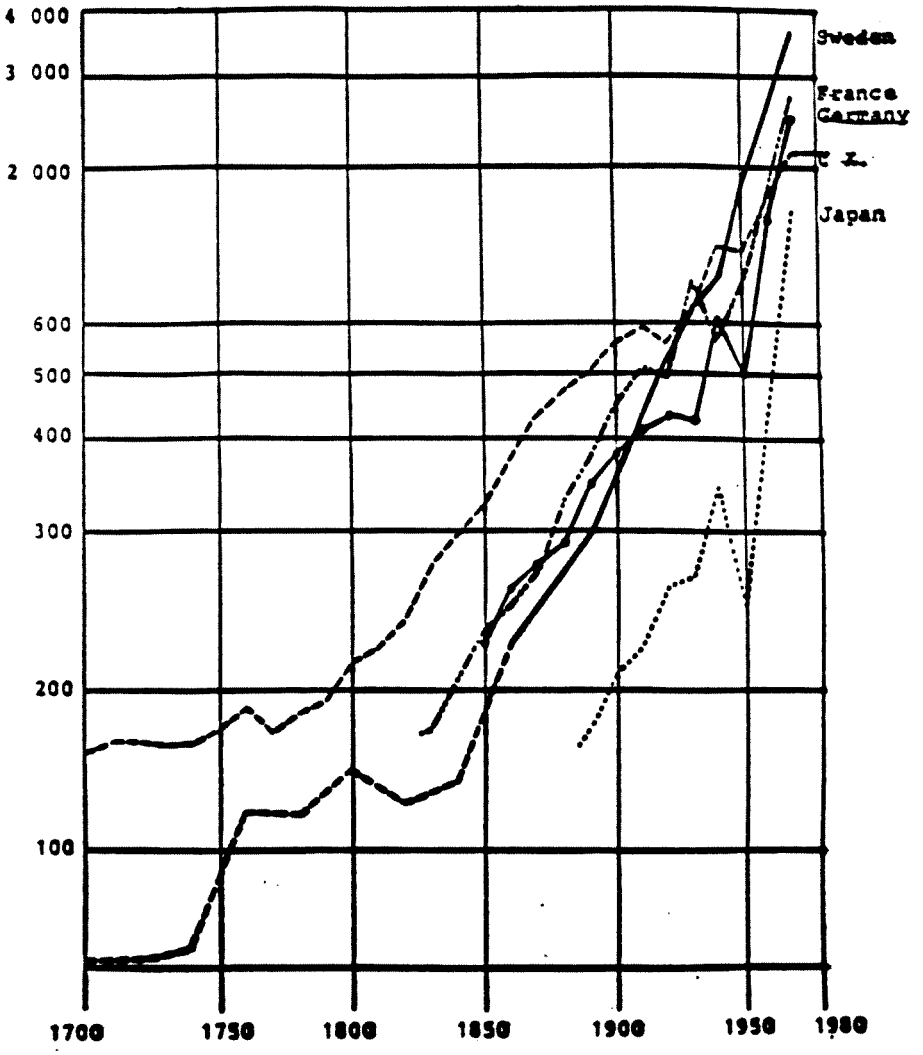
Figure 2 **Relative GNP development in Sweden and the first industrial nation since 1700**
in $ 1980 prices



Sources: IUI/Jagrén

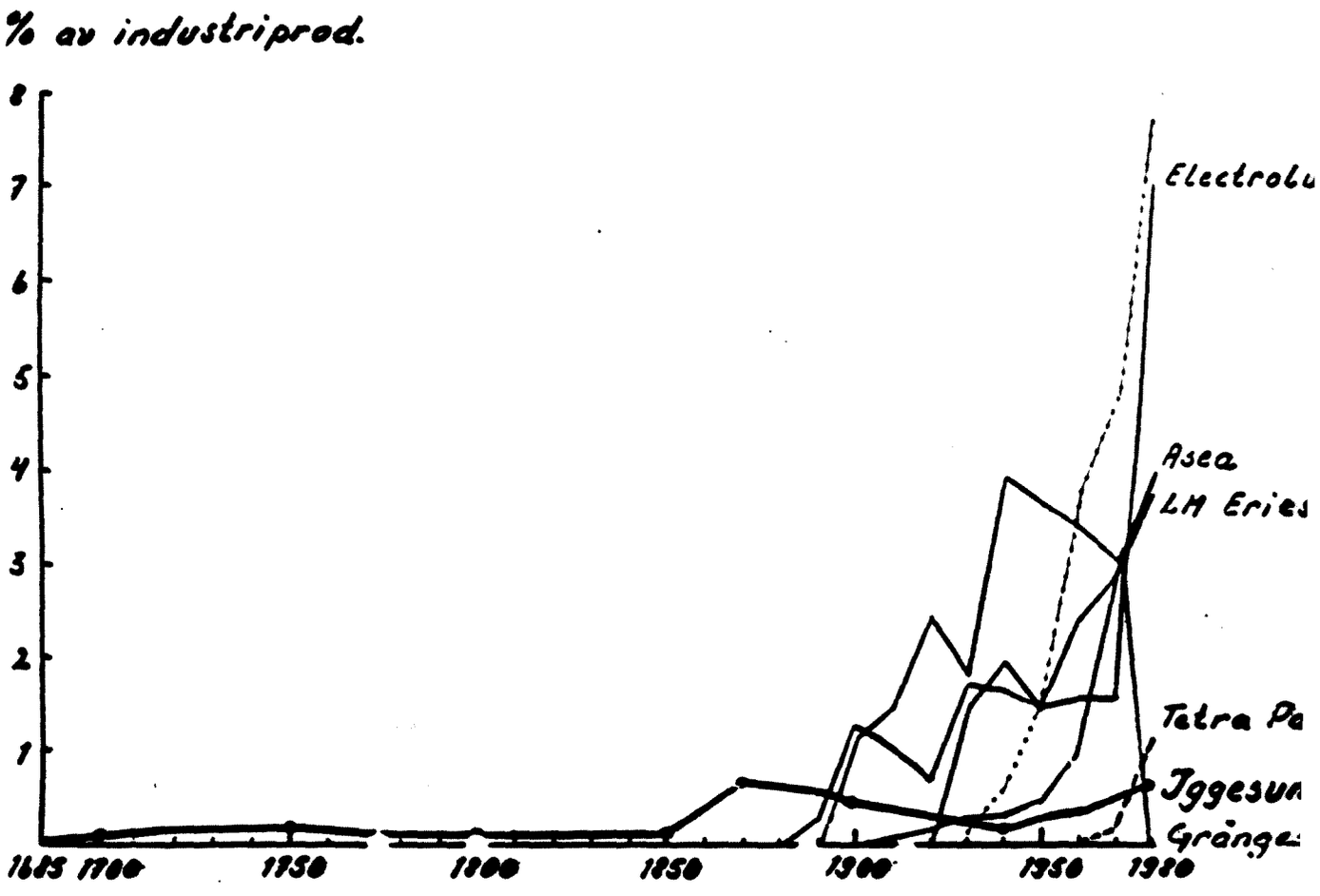
Figure 3 **GNP per capita in Sweden, France, Germany, U.K. and Japan 1700–1980 – in U.S. $ 1967**

Five year averages



Sources: Rostow (1980), Maddison (1962, 1977) and OECD Statistics.

Figure 4 The share of value added in Swedish manufacturing generated by some chosen large business groups 1685 through 1985



Note: Firm value added is group (global) value added. The diagram was put together for a lecture I gave at the 300 year anniversary of Iggesund on September 18, 1985.

Source: Jagrén (1986).

3. THE ECONOMIC NATURE OF TECHNOLOGICAL CHANGE - THE OPPORTUNITY SET

Joseph Schumpeter's name has long been associated with the notion of an exogenous stream (wave) of innovations that is diffused through the production system and gives rise to a delayed long wave of production growth. This notion of economic growth - when applied in empirical research - often becomes quite mechanistic and closely related to the macro production function approach. It reduces technology to discrete, measurable (by e.g. patents) factor inputs. It makes international technology feed right into the shift factor of the local macro production function, and I don't think Joseph Schumpeter would at all have liked to be associated with this idea of a growth process. The problem with this approach is that it disregards the fact that technology is a necessary, but not a sufficient factor behind growth. Local competence is needed to transform technical opportunities into economic (commercial) action.

3.1 The international opportunity set defined

Marx introduced deficient demand as the limiting factor to the exploitation of what he believed was an unlimited set of technical opportunities. W we add technical and commercial competence as a local factor that bounds the economic process from above. Competence is acquired through education, and hence, like other forms of capacity expansion, is an endogenous investment process. I prefer to emphasize the experimentational (boundedly rational) participation in the market process - not formal schooling or institutionalized research - as the important competence expanding process.[9] By assuming that a virtually unlimited set of combinatorial possibilities to search, try and learn from exists at any point in time, we have both defined and introduced the international opportunity set. Economic historical studies, indeed, support this idea and we will provide both further evidence and argument below.

Technology plays an important role in the Schumpeterian growth process. But Schumpeter's notion of technology was broader than represented in many econometric applications, and the diffusion process is accordingly diffuse. It

is better seen in terms of an experimental learning process, where technology is internationally available and competence is local, bounded, tacit and difficult to communicate.

Erik Dahmén's (1950) concept of development blocks is particularly useful here. It emphasizes the productivity potential, or the synergy effects of technical and commercial complementarities that the entrepreneur seizes upon. Dahmén's development blocks do not have to be far-reaching and revolutionary like the steam engine and the automobile. We can think of them at all levels. Quite often a firm is formed around a development block. And Schumpeter (1912) himself saw "a new combination" as a setting up of a firm. Tetra Pak (see Figure 4) and Pharmacia are good examples for Sweden. This broadened notion of technical change is capable of explaining the differential impact of technology on various nations in a historical perspective.

3.2 Technologies with universal applications may create giant expansions of the opportunity set, but also expos firms and nations to increased competition

With this broad notion of technical advance the degree of universality of technologies begins to matter. The opportunity set was introduced above as the union of all possible combinations of technologies and organizational structures into development blocks. Only a fraction of these possible combinations are being exploited commercially, and each exploitation (an innovation, a new combination, a new firm) is probably adding to the opportunity set.[10] However, certain technologies are more universal in their applications than others and therefore contribute more forcefully to the infrastructure pool of possible combinations.

The waves of innovation commonly referred to as generators of long-term economic growth are innovations of wide applicability, infrastructure type. The steam engine, railroads, electricity and automobiles are the standard examples. These all dramatically widened the international opportunity set, allowing for a great range of new commercial combinations to develop. But the economic outcome of this expansion of opportunity depends on the local competence.

Bring western high technology into the midst of Africa. Very little will happen since local competence is lacking. England is an example of a country that despite a high level of formal education, lacks the competence to commercially exploit technological opportunities at the level the economy is currently operative. Sweden, perhaps, provides the opposite example of relative excellence (Pavitt-Soete 1981), but many would argue that Japan is the best illustration of a nation organized for efficient economic exploitation - not imitation - of the commerical and technological opportunity set available internationally. This illustrates the complementary relationship between international technological opportunities and the local competence to exploit their economic potential.[11] But it also epitomizes the danger indicated early in this essay for a firm or a nation that lacks the necessary competence. If the assumption of the vast opportunity set is accepted it also provides for the strong, local argument in favor of the "young" and against the old Schumpeter. With free competitive access to the opportunity set and locally bounded competence, there is no way for centralized, routine R&D in large corporations to beat the multitude of competing entrepreneurs in the long term except in three arenas; (1) through breaking through the assumption of bounded rationality (assumed not possible), (2) where scale effects in financing are enormous, or (3) by teaming up with the political system to close down free competitive entry. The latter was really what Schumpeter (1942) worried about.

3.3 Limited local knowledge of the organization of production - a shopfloor illustration

That this exploitation process is piecemeal and bounded can be amply illustrated from the shopfloor. Robotization - it is agreed - has a tremendous rationalization, labor saving potential. In fact, however, (Eliasson 1985b) this new technique appears to shift technical change in a relatively more capital saving direction. This is understood as soon as one looks at the context in which automation devices are introduced. However, the introduction of robotics and automation always requires complementary knowledge (a code or explicit program to run the process) at central levels that did not exist in the old factory organizations. What has held back the rate at which extensive factory automation is introduced is to some extent deficient measurement and sensor techniques. Surprisingly enough, however, the real obstacle

to the introduction of robotics, has not been robot technology per se, but the lack of local competence in the form of precise, centralized knowledge of the production process itself. This knowledge has traditionally been diffused (decentralized) to individuals throughout the factory and been linked together through an organizational structure (Eliasson 1980). The communication of that knowledge to a central production monitor has been very costly and time consuming. The "language" has been the limiting factor (Pelikan 1969). In most of Swedish engineering factories operations knowledge is still decentralized and "tacit". The potential that is currently beginning to be exploited is, however, not to automate an existing production process, but to change the entire factory organization in conjunction with a change in product designs. New materials in combination with new machines and centralized process control is currently breaking industrial society loose from a 150 year old machine and materials technology and the associated worker culture. This is only the beginning of the exploitation potential of new information technology, but the availability of local competence will set the pace of exploitation.

3.4 The universality of communication technology - the case of the printed word

It is interesting to observe in this context that an earlier innovation of even broader applicability than the common examples has not attracted the attention it deserves, namely the "technology" of the printed word, dramatically upgraded some 50 years before the beginning of the historic curve in Figure 1. In many treatises of economic growth this "technology" is not even referred to; in some (Parker 1984, Braudel 1981, North 1981, Rosenberg-Birdzell 1986, etc.) only referred to in passing, or in a special context. In a few its importance is placed in focus (Eisenstein 1979). There is a great similarity in broadness of application to the new electronically based information technologies, and there should be ample opportunities to learn about the possible impacts of electronics from historical studies.

The effective economic use of the printed word did not come faster than the corresponding local competence to read and to write developed. The lags are so long that it is impossible to ascertain quantitative relationships. However, if the printed word had significant economic effects through its

potential for organizing, coordinating and communicating technical and commercial knowledge, the new information technology associated with the "electronics revolution" appears to offer a potential of a much greater magnitude as well as of a strong differential impact on economic growth.But it will take such a long time that it should rather be called the "electronics evolution" (Eliasson 1981). My conclusion that the effects will be large and differentiated comes from two observations; the electronics based information technology is spreading much faster than the printed word did, and nations are much more economically integrated today than they were 500 years ago. Hence, great opportunities are certainly opening up, but the differential, competitive impact from the introduction of this technology may be large on long-term economic growth among firms, regions and nations.

3.5 The non-technical side of economic growth

This takes me back to the title of this section; the economic content of technical change. Even with normal rates of pure technical change at the firm level, the reallocation of resources between firms appears to account for more than fifty percent of macro productivity growth (see i.a. Carlsson 1981). Furthermore, as emphasized by many economic historians, there would not have been much of an industrial revolution were it not for a matching institutional and organizational development that provided the incentives for competitive exploitation of technical and commercial opportunities. Ashton (1948) even suggests that the development of new financial institutions is what made the industrial revolution possible. It made possible the pooling and redistribution of large volumes of saving at reasonable loan rates to innovative and growing industries. In short, venture capital became available. This exemplifies the fourth and last of Åkerman's four fundamentals. "Institutional technology" may be what really matters, and I will come back to it in the last section.

4. THE ECONOMIC DYNAMICS OF GENERAL MONOPOLISTIC COMPETITION

This section explains why the market economy needs a steady innovative input to generate stable macroeconomic growth long term. The next section explains why the capitalist market organization with free competitive entry

and exit may be the only viable institutional superstructure capable of delivering the needed innovative input - in short, the experimental economy. It also explains why a matching social superstructure is needed to handle the social consequences of the experimental economy. The points of this section can be condensed into the question; What happens when you make general equilibrium theory dynamic, or into a process model?

(The next section will demonstrate how the consequences of unpredictable change at the micro levels can be made politically and socially acceptable.)

4.1 Making market theory dynamic

Once competition is introduced as an experimental, profit driven search activity the question arises: can this dynamic process be formalized so that we can quantify the interaction of agents in markets that together generate macro behavior? Will differences in the organization of market processes make any difference for macroeconomic growth? The Swedish micro-to-macro (M-M) model - developed at IUI - makes such formalization possible. And and this model, the ways market interaction is organized and timed, make a significant difference for long-term macro economic production in the model. The reason is the dynamic effects on resource allocation of profit driven investment and labor allocation at the micro market levels. This makes it possible to quantify some of the market interactions we have introduced above, and to relate the results of this quantitative analysis verbally to the broader picture of economic progress that we are interested in.

The M-M model includes core parts of the three theories introduced in the "historical analysis" above; they were the demand pull story, the innovation supply push story and the deregulation story, respectively. Technology is "internationally available" and enters firms through their local, investment behavior. This means that the economy will always be operating below the upper limits set by the introduction throughout the economic system of the most efficient technologies at each point in time.[12] The model captures - I will argue - the dynamics of general monopolistic competition of Schumpeter and of Clark (1961). It combines innovative competitive activity à la Schumpeter (1912), a Wicksellian (1898) micro disequilibrium in the capital

market, that drives the investment process[13] and dynamic market coordination à la Smith (1772). The welfare implications of this economy are also those of the invisible hand of Adam Smith, and not those of Pareto. It is rather so that the social technology of the capitalistic market system has always been to find efficient and accepted ways of - if I again may use that term - "overcoming Pareto". This is why institutions enter, and why institutional action is such a resource using activity in modern society, so resource using that the costs associated with it and its efficiency have to be considered when analyzing the performance, and equilibrium characteristics of the entire economy. To this we return in the next, concluding section.

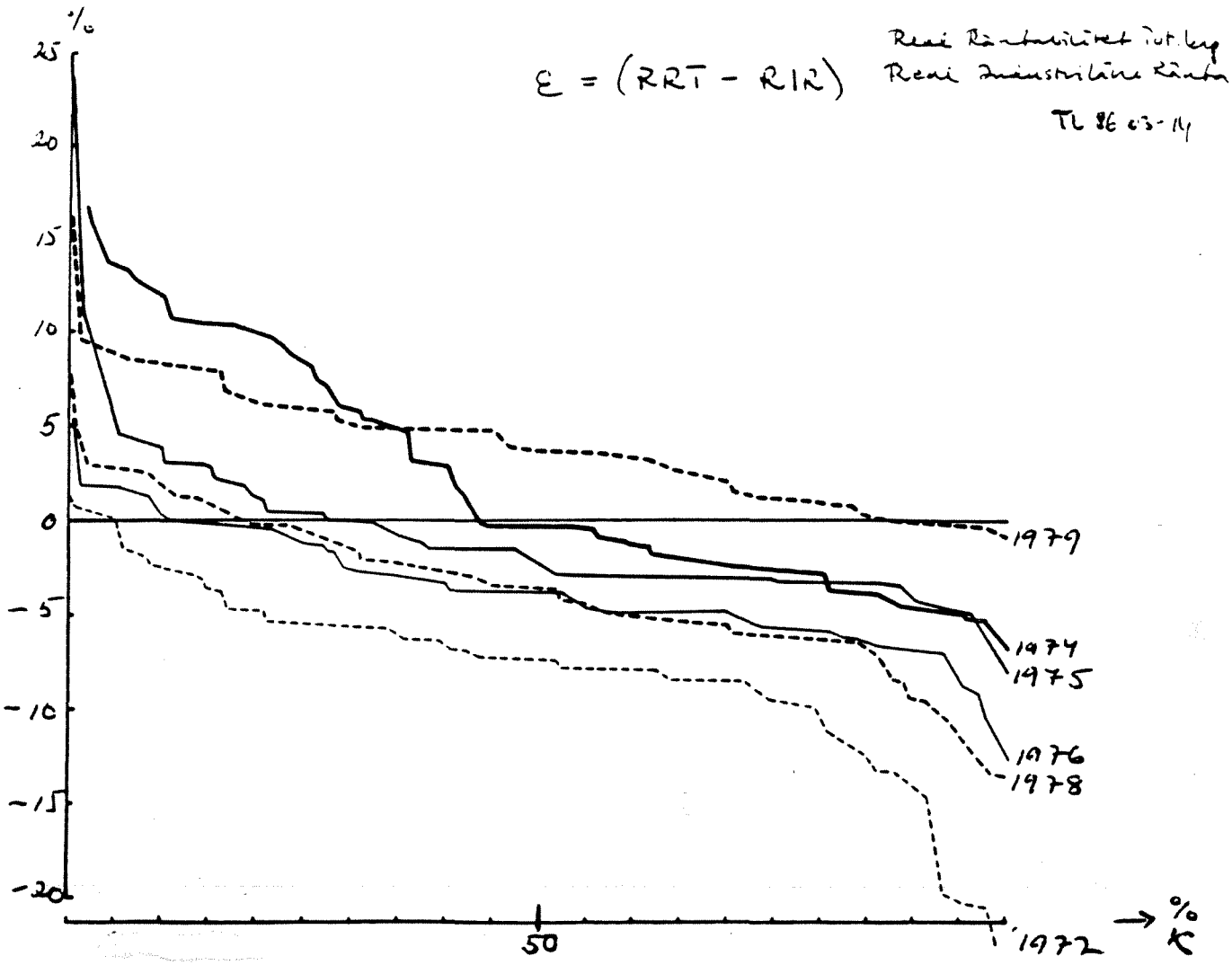
4.2 Why stable macro economic growth requires micro instability

Constant experimentation keeps pushing both the upper limits (the opportunity set) of the M-M model economy outwards and actual production ahead. This experimental process is exogenously fueled through entry of new competitors, through the upgrading of old investment and through forced exit of low performers. This activity of agents is reflected through a constant turnover of rents from temporary monopoly positions, that also drive the investment process at the firm level. Agents respond to prices and profit targets and there is a demand feed back in the dynamic coordination of the economy. Hence, self regulation occurs through the endogenization of price setting at the micro level - not through a central auctioneer or policy maker.

The welfare problem associated with free dynamic coordination through the price system - in a process model - is the stability over time of quantitative activity. The dynamic market processes controlling the development of quantities over time have to be reined in such that the economy stays in a preset, bounded region - an n-dimensional tunnel (see the discussion in Eliasson 1983). Classical macro theory associates that task with macro policy makers. However, once M-M dynamics has been introduced such notions are no longer convincing. To make the Smithian invisible hand operational in a dynamic M-M model, something that corresponds to the convexity assumption in static theory has to be introduced.

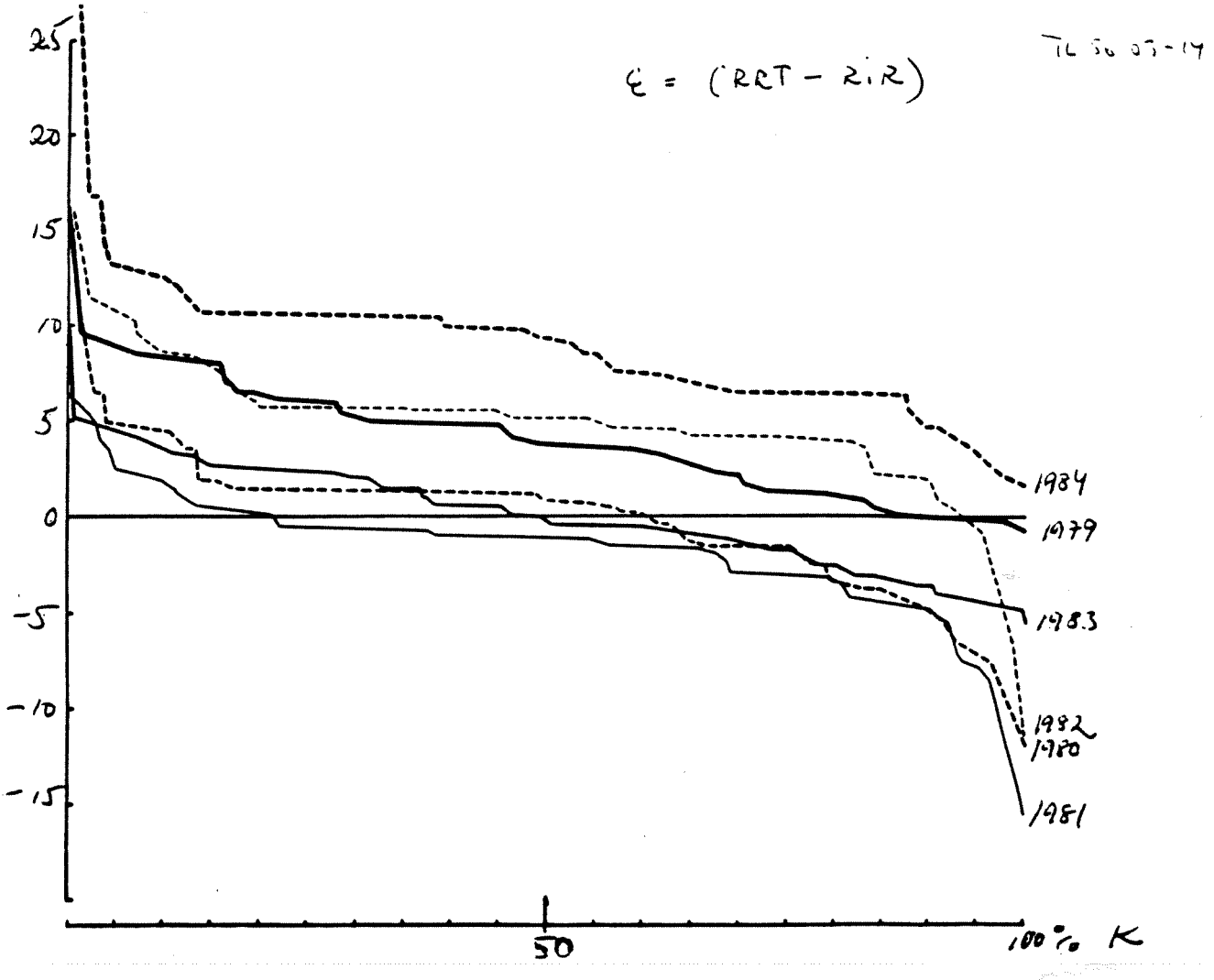
Figures 5 Rate of return over loan rate distributions over the firm population for various years - part of the initial state description of the Swedish M-M model

A. Years 1974-79



Source: MOSES Database/Thomas Lindberg

B. Years 1979-1984



In any dynamic micro-to-macro system each period is characterized by a final state description of distributions that are carried onwards in time through the economic action in the model. These distributions matter for the properties of the model. In a macro model these states would include for instance, the cyclical position of the economy, e.g., capacity utilization. In a M-M model there is a tremendous wealth of information on which the economy operates. We have distributions over firms of capacity utilization, actual and potential productivity, size by various definitions, profitability (see Figures 5), wages, prices, financial ratios etc. These factors all influence decisions at the micro level and hence macro behavior of the model. For an economy not operating in equilibrium prices for the same product, wages for the same labor input and returns to capital vary across the firm population. The shapes of these states, as they are carried forward in time, control the period to period stability of the behavior of quantities like output, employment etc.

Simulation analysis on the Swedish M-M model suggests that a significant variation over time, and diversity in time in performance and price structures of individual agents have to be present for the model to generate stable macroeconomic performance. If not, small disturbances can be very disruptive. For instance, if all financial decision units (firms and divisions) are operating at the same rate of return equal to, or close to the market loan rate ("capital market equilibrium"), a small increase in the interest rate can force a large proportion of the firms simultaneously to drastically reduce investment. (In mathematical terms this notion can be likened with optimization on a horizontal plane. It is difficult to find a stable position that is better than all other positions. The economy begins to behave in a disorganized manner and price signals loose their information content. See further Eliasson 1985a, pp. 333 ff.)

The problem of stable economic growth in the Swedish M-M economy is to keep a significant spread of performance characteristics alive in the economy. Since competition makes low performers exit this can only be achieved through vigorous innovative entry.[14] The micro variability to macro stability problem that we have discussed is in principle the same as that of

cyclical diffusion among sectors in an economy, and between nations in a world economy that have been observed and quantified in a number of NBER-studies. See for instance Hickman (1959) and Moore (1965).

Since the adjustment of quantities is not immediate, some of the immediate adjustment has to be carried by flexible prices. A dynamic growth process will always be a mixture of the two quantity and price adjustment processes. Since markets are not cleared, and prices not fully adjusted the information carried by market prices will not be reliable indicators of scarcity. This is not only the result of the exogenous innovative process that moves the growth process. It also depends on the interdependency of the price and quantity adjustment throughout the entire economy.

As a consequence policy makers are confronted with the choice of accepting the unpredictability that comes with viable innovative activity, or imposing an institutional superstructure that restores order and predictability and - presumably - reduces innovative activity. This is the topic of the next section, It is. however, interesting to observe that top executives of large business groups experience exactly the same problem, and for the same reasons (Eliasson 1976a).

5. THE WAY INSTITUTIONAL RULES MATTER

When seen through the glasses of the conventional economist the problem of economic growth is how "capitalism administers existing structures", whereas the relevant problem is how it creates and destroys them", noted Joseph Schumpeter (1942, p. 84). He continues: "As long as this is not recognized, the investigator does a meaningless job".

5.1 Endogenous institutional change

The point of this section can be condensed into a question: What happens when institutional change is made endogenous, and Åkerman's fourth fundamental falls into place in theory?

The problem is that with the recognition of endogenous self reorganization immense complexity enters economic analysis. We have managed - in the previous section - to get entry and exit of given, parameterized agents into our quantified M-M model. This endogenizes part of the change in the structural composition of macro aggregates. Now much more is demanded. The two critical properties arising out of the earlier discussion are, briefly speaking, the ability of the economic system to perform and the willingness to adjust. Within the intellectual framework of this paper it is all a matter of how institutions are organized. Can the production organization of the economy generate sufficient innovative activity and competitive entry needed to maintain a stable long-term growth process, and are individuals and organized interests willing, and able to endure the exit process that follows.

The first aspect concerns primarily the allocation of resources (capital and labor) over the production system. The second is the political part of the economy and all the vested interests that are disrupted in the process. Since the second "function" draws by far the largest share of resources in the economy, the analysis of institutions as intermediators of information and interests cannot be neglected any longer. The technology of this intermediation, including shifts in this technology, causes difficult both theoretical and empirical problems. It is obvious that the intermediation carried out by institutions, if badly organized, can exercise a strongly negative effect on overall economic performance. This is a general problem of economic analysis that is increasingly becoming associated with the problems of the modern welfare state (see Eliasson 1986a, b, Meyerson 1985.)

5.2 Efficiency of the filter

When introduced in this way the market process is presented as a filter and the institutions constitute the organizational design of that filter. One property of the filter refers to the rules regulating participation in the game of exploiting and updating the international opportunity set. The more limited access to the game, the smaller the number of losers, and the more orderly the game, but also the larger the probability that the scarce winners will be rejected. With a hierarchical design of the economy, as in a firm, or in a planned economy the central filter will limit the entry process in the name of stability. The more broad based access to the game (free entry) the

more bad players in the game that will later be forced to exit (welfare is affected), but also the higher the probability that the few good players will be let in. We now have a free market economy. Stated in this way a market economy is characterized by the degree of free entry (on this argument also see Pelikan 1985). The market lets in more players, good or bad. Since the bad players are forced to exit the free market system will outperform the centrally filtered economic system, since it has more good players, but it will also have to find ways to cope with the welfare side of the exit process. North-Thomas (1973) had a similar notion in mind when they concluded that without the right configurations of institutional rules, innovative activity will be on the low side.

5.3 Inertia of the institutions

To complete the introduction of institutions as the technology of efficient filter (market process) design we make two additional observations. First, institutions (filter designs) change more slowly than the rate at which other forms of technology change the economic environment and the commercial opportunities. This is a Marxian view of industrial action. Hence, the political system will often be in defensive conflict with the capitalistic economic organization fueled by technological - in a broad sense - change. Coming back to North-Thomas' (1973) again we can reinterprete their argument by saying that because institutional rules are slow to change, institutional rules will actively control innovative activity. If they depress innovative activity, innovative activity will not be potent in breaking up rules. Hence, the interactions of institutional rules and technology must be a matter of centuries, not years and decades. Historians have to be brought into economics, a conclusion Joseph Schumpeter would have been happy to acknowledge.

Second, the political system is normally designed to reduce the unpredictability associated with the experimental economy.[15] If not checked by market forces, for instance individuals breaking the rules, or the laws in creating an underground economy (Feige 1986) or technology simply eliminating the effects of controls, control will eventually be imposed to the extent that predictability prevails, allowing reasonably straightforward and transparent policies to be carried out. This is the rationale for the existence and the

size of the political system. If uncontrolable, market forces reduce the powers of controlability of the central authority, its existence measured by its present size is threatened. Arguments - on similar grounds - for a significantly reduced scope of action and authority on the part of Big Government are currently taking roots in a large part of the western world. The rationale behind such argument is partly that Big Government impairs democracy - an old Schumpeterian (e.g. 1942) argument, but also - and perhaps more forcefully - that overall economic performance is impaired. The reason for lowered economic performance is the same as the policies enacted to increase "order and predictability", namely restrictions on entry and/or reductions in the number of independent players. As we have shown, such policy also reduces macroeconomic performance. To achieve such paradoxical policies, simplified abstractions ("theories") of the economic system that conform with policy makers' desires have been developed. They reflect the economy more or less well, and give different advice about how to run it. The organization of the economy cannot be seen as independent of the "theory" by which it is run.

Hence, the political system in a broad sense sometimes, and sometimes often can gain control of the economic system in the sense of being able to impose control on the economy by legal force or by indoctrination. If beliefs or ideologies are forced on the economy its organization will change. This is one instance of the endogenization of institutions within Åkerman's (1950) framework. However, the experimental economy that I am proposing in this paper can never be modeled in such a fashion that simple, central policy making will replace the Smithian invisible hand in a way that improves economic efficiency. Policy regimes that want to interfere extensively with their economies need much better theories to intellectually support argument and policy than mainstream economics can provide. Whether such analysis will support or reject centralistic policy, is still beyond theoretical evaluation (Axell 1985). However, the more central interference desired, the more simplistic and hierarchical the representation of the economy. And the more unlikely - it appears to me - that the immense complexity of adjustment needed for the observed acceptable performance of a capitalistically organized market economy that can be reproduced in an alternative, centrally planned design. I have argued that the particular formulation of an equilibrium developed in economic theory based on Walrasian postulates means

imposing a monolithic hierarchy on the policy model, bringing the entire master decision together to one point in time.[16] The more of such notions imposed - this is my argument - the more the innovative process is thwarted and economic growth stalled, something that eventually undermines the power structure of the centralist political system itself.

My conclusion on policy can now be summarized as (1) the need for micro instability as a source of macro stability and growth in output and (2) the willingness of vested interests to accept painful adjustments. The political problem boils down to designing institutional rules that inhibit forces that impede the adjustment process from gaining political control. Some would call this undemocratic, others would say that this is a form of coercion needed to make democratic practice workable. And whatever the morale we can observe how each national state has found its own practical solution to the dynamic balance of these forces. I will conclude by a brief discussion of how this policy problem was solved - and then inadvertently "dissolved" - in Sweden through what has come to be called the Swedish policy model.

5.4 The old Swedish model

The Swedish policy model is a particularly interesting example of the intellectual policy control of an economy, because it has features of both the planned and the market economy, because it was extremely efficient in its earlier use, and finally because its successful use changed the institutional foundations for its continued successful use in a way that Olson (1982) has touched upon.

The old Swedish model can be said to epitomize the capitalistic market regime in the production organization and - in its old days - a soft version of a planned regime on the distribution side.

The old Swedish model had the following four characteristics:

(1) non-interference with the production decision,

(2) free innovative entry (free trade, free technical change and forced exit through solidaric wage policies)

(3) active labor market policy (move people to the jobs)

(4) redistribution through taxes and public sector growth (equity)

The four items correspond to decentralization of production and ownership, efficiency through free trade and competitive entry and exit, full employment through labor market mobility and equity through redistribution via the public sector.

The four items were more or less explicitly formulated as an understanding between the unions, the employers and the (social democratic) Government. The understanding was mostly implicit but partly coded in agreements and in other forms of documentation.[17] Items (1) and (2) very much represent a recognition of the Schumpeterian notion of economic dynamics that we have outlined above; Items (3) and (4) are the institutional setting - call it the indoctrination part - that made adjustment consequences of the Schumpeterian economy acceptable to people at large.

One could safely say that the model was a success in terms of facilitating superb economic performance through the depression and until the end of the 60s. What happened can be formulated in economic terms.

The Successful Phase I: The "entry" and active labor market policies (items (2) and (3)) forced people to adjust. It was simply not part of the socio-economic mode not to adjust to the market. At the time there was no place to ask for help (item 1) except help to move (item 3). This was especially the case for firms. Public ownership in manufacturing was very low. Until the beginning of the 70s there was not even a Department of Industry (see Eliasson-Ysander 1983). If you did not adjust, the consequences were yours and since most people are not capable of taking deliberate decisions to adjust ahead of time, the consequences of market moved structural change were quite unevenly distributed. To buy yourself insurance from these consequences is a luxury good and as the level of economic well-being rose protection from the vagaries of the market economy were being demanded.

Phase II. Excessive Public Sector Growth: It could perhaps be called a market-failure that a private insurance system did not develop rapidly enough to take care of the demands for such insurance. As a consequence, insurance to a large extent became part of the political system. To make a long story short, the rapid growth of the public sector financed through a rapid growth of the private sector gradually undermined the institutional

regime that had facilitated the successful non-interventionist, free trade Swedish production system (Eliasson 1986a). To begin with, this was all a form of gradually addicted public consumption and as everybody knows, you cannot unload consumption habits easily, when public income unexpectedly stagnates. The worst part, however, was probably the departure from the non-interventionist open economy conceptualization of a working economy (item 1). It occurred in two ways. First, the relatively faster growth of the public economy meant that the non-interventionist, open, free entry economy was diminishing in relative size. The sector that absorbed the bulk of adjustment grew relatively smaller forcing an inequitable distribution of the adjustment burden and creating instabilities in the economy. The second phase began in the late sixties as part of the rather aggressive egalitarian policies - that required - it was argued - increased centralization and standardization of production both in public and private domains.

However, once attempts are made to control the micro outcomes of innovative change on equity grounds the individualistic picture of economic action of the young Schumpeter (1912) gives way to the worries about concentration, and threats to democracy of the old Schumpeter (1942). Schumpeter of 1942 believed that this development would be moved by the emergence of new and efficient organizational techniques for planned innovative activity. The empirical evidence, however, is still with the young Schumpeter and political institutions[18] trying to control the economy through limiting access to the international pool of opportunities appears to simultaneously reduce commercially successful innovative activity (see Eliasson 1984b). Thus, after having recognized a possible failure of the growth machinery of the economy as a consequence of ambitious welfare, policiesfor a couple of decades or so, the Swedes are currently trying to find ways and excuses of getting back to the old Swedish policy model. It at least seemed to generate economic growth. But the political process is not easy to reverse, since it requires that the non-market sector be significantly reduced against the will of well-entrenched vested interests and the reversal process itself is essentially tacit (Eliasson 1986a,b). The task of developing the kind theory brought before you on the first page of this essay still remains to be achieved.

NOTES

[1] I will try to be consistent in my use of the term technology as the knowledge of techniques, and technical change as the result of the application of new technology.

[2] This, however, does not necessarily preclude predictability at aggregate levels.

[3] In this presentation I use the very broad definition of entry needed to capture innovative activities that sometimes occur through the entry of parameterized firms (as in the Swedish micro-to-macro model), sometimes through the development and launching of new products (see Granstrand, 1986) and sometimes through improvements of products and processes at even lower levels.

[4] This has long been the theoretical foundation of US antitrust policy.

[5] Dynamic market coordination means that agents may be chasing a moving ex ante equilibrium position that they never reach because the chase itself affects its position. This is how we interpret equilibrium in the Swedish micro-to-macro model in section 4. Also see Eliasson (1983).

[6] I will use the term "institutions" in Åkerman's dictionary sense as covering both the set of rules that monitors the economy and its organizations. The broad concepts discussed in this paper unavoidably make for terminological problems, when we get down to an operational level. This we have to do, when the quantitative aspects associated with the Swedish micro-to-macro model are integrated into the broader conceptual framework of institutional change. I am departing from the definition of an institution used in modern economic literature, and staying with the common dictionary content of an "institution". To avoid confusion when context does not clarify the meaning I use Pelikan's (1985) distinction between "institutional rules" and "organizational structure". Sometimes I refer to an institutional "regime" instead of "rules". The "institutions" of the dictionary, however, cover all these concepts and I am not throwing out that general term, since it is apt to confuse the reader that is not familiar with the fine distinctions of literature, and these fine distinctions are only needed at times.

[7] It is nevertheless interesting to ask to what extent a rapidly growing demand from the first industrial nation pulled a growth process along in other nations (cf. Figure 2). Basic raw material exports from Sweden (iron ore, forest products and (Carlsson 1980) even agricultural products) into the British industrial machine, certainly helped to finance industrializaton. This happened successfully in Sweden. Why has it not happened at all other places, notably in the developing countries? Under what circumstances can we then talk about industrialization? What difference is there between Norwegian oil fuelled growth, South Korean profit generated export growth

(Chen, 1979) and Japanese growth said to be dependent on U.S. demand. Norway has been attempting to transform oil wealth into industrial knowledge capital with limited success and now has to cope with the opposite situation; a blown up political demand for consumption, while resources are disappearing. South Korea is doing it, and Japan has done it without a raw material resource to finance the transformation process.

[8] One has to observe that outside the refined context of textbooks, the great economists often agreed on the basic economic mechanisms. Thus, an optimistic Keynes (1930) argued that man would solve the problem of economic growth if she organized the economic system accordingly.

[9] In fact, this argument has been built on the basis of extensive observations and argument in Eliasson-Carlsson-Deiaco-Pousette-Lindberg (1986).

[10]The Turbo engine is an example. The turbo had been installed in Diesel truck engines for many years. The Scania engine people in the truck division came up with the solution for the Saab-Scania automobile engine people. It partly had to do with the availability of heat resistant materials and more demanding requirements in automobile, than in truck engines. After some time Volvo came up with a turbo engine complemented with an "intercooler". Now a large number of automobile manufactures offer different "turbo" solutions.

[11]I have developed this at length in a separate paper (Eliasson 1986c) and refer to it for further elaboration.

[12]Hence, a narrow version of the "international opportunity set" is explicit and exogenous in the model in the form of labor and capital productivity assumptions associated with new investment. The unexploited part of this narrow opportunity set is represented by the difference between a macroeconomic development with all firms continuously using best practice methods, and actual economic development. (Which is the difference between the straight max line and the simulations in Figure 5A, p. 317, in Eliasson 1983.) Local competence is represented by the ability to introduce these productivities profitably through the investment decision. That this process takes time and that economics plays a role has been demonstrated i.a. in Eliasson (1981).

[13]For details and specifications see Supplement on "The Swedish M-M Model Economy" at the end.

[14]The more vigorous entry, the more forceful competitive exit and the faster stable long-term growth in macro output. However, if innovative entry is not keeping up with exit, performance distributions may flatten, as they did (see Figures 5) in the second half of the 70s, and macro instabilities develop. This was my argument in Eliasson (1984).

[15]The liberals should be the exception, but if you look at liberal political configurations in the western world, they are often as keen on restricting the experimental economy, as are their socialist or social democratic opponents.

[16]Technically in this model, the general equilibrium model, transformed into a centralist planning model by e.g. Malinvaud (1967), the sequence by which the planning solution is arrived at does not matter. In such a conceptual

framework dynamics is effectively removed.

[17]The Swedish policy model had a much broader focus than is usually assumed. It definitely goes much beyond the narrow focus on the labor market (item (3) above) with which it is usually associated (cf. Lundberg 1985). All four items above can be extensively documented in the context of what has come to be called the Swedish policy model (see further Eliasson-Ysander 1983).

[18]In this respect there is no principal difference between political control and the control of the market exercised by a private monopoly. An enormous literature exists on bad private (monopolistic) behavior and the need for anti-trust policies. However, no corresponding literature exists on similar bad policy practice on the part of governments, because we somehow think that is has been sanctioned by a democratic political process. Government economic action is neither controlled by the market (except through illicit or wrongful activities) nor by external legal forces, only by "itself" (see Ysander 1986b).

6. Supplement:

Dynamic Disequilibrium Adjustment Modeling
- a Brief Presentation of the Swedish Micro-to-Macro Model Economy

6.1 The Micro-Macro Economics of Information

Information and knowledge are obvious elements in economic theory. This fact, however, has mostly been ignored. Information has been assumed freely available and everybody has been assumed to be fully informed, or at least fully knowledgeable about the costs of being fully informed. In deriving aggregate dynamics from micro behavior theory has to be explicit about the ways information is gathered, analyzed and put to use for market transactions. Consequently, markets should be treated as a process rather than an equilibrium condition. Following Stigler (1961) I call this intelligence gathering in the Swedish micro-macro model a "search" activity, even though search in the M-M model is more broadly defined to include both the gathering and use of information and the actual implementation and later evaluation of decisions.

This supplement introduces the Swedish micro-macro model from the point of view of its use of information related to the information activities discussed on the previous pages. The dominant intelligence gathering and intepretation activities of a manufacturing firm concern technical information put to use for product development and marketing. Information activities in the market is a major investment and resource using activity in large manufacturing firms (see Table 6). If this is not somehow explicitly accounted for the firm is grossly misrepresented and - I claim - aggregate dynamics misspecified. Lack of data on, and lack of academic insight in the nature of information use in business organizations so far means that we have had to be crude in modeling this search phenomenon.

The ultimate problem associated with introducing information processing explicitly in economic modeling - and hence with economics - is when technical change in information processing is allowed. If such technical change has to be assumed unpredictable on empirical grounds, as to micro outcomes, the results of mainstream economics will have to be revised fundamentally.

Table 6 Investments[1] in the top 5, and the 37 largest, Swedish manufacturing groups, 1978. Firms have been ranked by foreign employment (Percent)

	The 5 largest groups		The 37 largest groups	
	All group	Foreign subsidiaries only	All group	Foreign subsidiaries only
R&D[1]	25	10	21	6
Machinery and buildings	45	41	52	42
Marketing[1]	30	49	27	52
TOTAL	100	100	100	100

[1] Investments in Marketing and R&D have been estimated from cost data.

Source: Eliasson (1985b).

6.2 Aggregation through dynamic markets

M-M theory is concerned with aggregation through markets. There are two dimensions to this; (1) the sequence that goes from micro decisions to macro and (2) modifying micro theory to make it respond to macro behavior. The latter is "missing in general equilibrium micro models" (Diamond 1984).

The first notion to get rid of is that transactions take place between agents in the market, not between each agent and "the market" - or the auctioneer - as in general equilibrium theory. This defines the market as the combined action of all agents, which is the only meaningful definition of a market. The agents spend time and other resources when attempting to upgrade their positions in the market. We have observed (see Table 6) that resources spent on "search" within the firm may be larger than factory production costs. If we introduce costs for all institutions engaged in intermediation between individuals and firms (as discusses in Section 5) factory goods production costs may even become a minor part of the total.

The discussion in this supplement departs from classical Walrasian analysis, or classical search theory in two additional respects (cf. Diamond 1984, p. 2); First, agents (firms) do not explicitly apply maximizing routines in their search behavior, they strive for ex ante improved positions. I have called this MIP targeting.[1] Second I remove the additional role of the auctioneer in Walrasian economics, namely that of achieving consistency and making correct forecasts possible. Agents in M-M theory normally misperceive their environment and make forecasting mistakes. This means that trade will not take place at market clearing prices, or price distributions. Thus, analysis in M-M theory deals with dynamic market coordination out of equilibrium, not only - as in search theory - with information costs associated with costly coordination towards an equilibrium. The two departures from Walrasian economics - upgrading behavior and incorrect forecasting - can probably be seen as two sides of the same thing. This means that the notion of equilibrium has to be redefined and that perfect information is not normally an achievable state, even at the application of unlimited costs. To my mind this is the dividing line between classical, Walrasian based theory and the new, let us call it Schumpeter-inspired M-M theory. We have a dynamic extended economic game implied by the experimental economy, to play. I will return to this briefly at the end.

6.3 Introducing technology, intelligence gathering and bounded rationality

How do we model the firm as an information processor in the dynamics of long term economic development. The earlier text has introduced innovative activity by way of three concepts; (1) the international opportunity set,(2) local "tacit" knowledge and (3) "bounded rationality". The opportunity set is available to all players in the market to a degree determined by their ability (knowledge), which is limited ("bounded") and "tacit", and hence cannot be treated as information communicable and tradable in markets. This makes industrial knowledge local and assures that only a fraction of the opportunity set is exploited at each point in time, and in a not foreseeable way. Bounded rationality is enough to ensure frequent forecasting mistakes. Kenneth Arrow (1982, p. 7) - acceding that standard notions of rationality may not stand up to empirical evidence - gives a bizarre illustration from the medical field of how the content (the "interpretation") of the same information may change "with the frame of reference". The micro consequences of knowledge application become unpredictable under tacit knowledge, i.e. when the choice of frame of references is left unexplained.

Profit incentives keep firms searching for ways to exploit this opportunity through imitation and piecemeal innovative improvements, generating innovative activity and updating the opportunity set such that it constantly keeps well

abreast of its exploiters. It is an empirically unsettled issue, whether any additional "basic" technological development of the kind associated with collective subsidized government activity (Arrow 1962, Dasgupta-Stiglitz 1981) is needed to make this come true. I enter a negative conclusion at this point as a prior, until we know better. (The unpredictable micro activity causes painful social adjustments. The willingness to put up with these adjustments has been discussed in the text but is not part of the model, and is hence left out here.)

Information processes in the Swedish micro-to-macro model occur in two dimensions; through analysis and interpretation (prediction), and through search and risk taking. Some form of intelligence (interpretation) precedes all decisions. This activity enters through expectations functions related to product prices, wages and to sales (market development) and targeting, and is most elaborate in the short term production decision (see more below). However, expectations are often wrong and in an economic environment where critical knowledge is "tacit" you cannot choose until you have tried and observed the outcome. In fact, much of intelligence gathering in real life is experimental "learning by doing". All business organizations are designed to cope with such experimental learning (Eliasson 1976a) and I call the whole sequence analyze - try - evaluate - learn and analyze again search.

It is important to understand that while expectations are concerned with predicting the external environment of the firm, targeting focuses on bringing interior information up to corporate level with the sole purpose of setting reasonable performance criteria, not too high, and never below what is feasible. This is a typical instance of bounded rationality (Eliasson 1976a, pp. 39 ff.), highlighting the fact that top management in large firms may be as uninformed about the interior of their firms, as they are about their external environments.

Since rationality is bounded and past experience differs, correct predictions at the micro level are rare and randomly distributed. Search, hence, is followed by more or less success, including failure, and the experience feeds back in the form of learning, updating and improving of interpretation methods. (Expectations functions in the M-M model are to some extent updated and improved through learning from experience).

In the particular context of this paper the information side is rather crudely modeled. The international opportunity set is represented by new, better exogenous technology embodied in new investment vintages. What distinguishes this from a traditional vintage production function approach is the endogenous investment decision of each individual firm, that for one thing represents its ability (local technical competence) and secondly - together with

the endogenous production decision underneath the production frontier - ensures that no "classical" production function can exist over time.

The past business success of the firm determines financial resources to invest through the profit flow and through "credibility" with external sources of finance. Long term "expectations" determine the forecasts which guide the willingness of the firm to take on risks. What we do not have - but are working on (see Eliasson 1985a, pp. 280 ff) - is explicit intelligence gathering as to the nature of the international opportunity set, beyond "search", or the learning experience of actually trying through investing.

6.4 The M-M Model Economy[2]

When seen "from above" the macro mapping of the Swedish micro-to-macro model is a Keynesian-Leontief eleven sector model with a non-linear, Stone type consumption system, wealth creation being treated as one separate consumption category, ("saving") with complete feedback through demand and investment capacity growth. Underneath the macro level exogenous Schumpeterian innovative activity upgrades the characteristics of new investment of individual firms, à la the young Schumpeter.[3] New technology is brought into firms through their individual investment decision determined by a Wicksellian disequilibrium in the capital market, related to the return of the firm over the market loan rate (see Eliasson 1986c). Hence, rate of return criteria imposed through the capital market dominate long-term dynamics in the model. A Smithian invisible hand coordinates the whole economy dynamically through monopolistic competition in the product, labor and capital markets. Foreign prices, the foreign interest rate and the labor force are exogenous.

Referring back to the main text the "three theories" discussed in the context of the long, historic diagram are represented; Schumpeterian innovative activities (exogenous), and the efficiency of the Smithian invisible hand (more or less regulation) through the Wicksellian disequilibrium adjustment process. Together these mechanisms determine the dynamics of resource allocation. The Keynesian demand feedback needed to keep the economy growing enters in three ways; through endogenous income formation and demand feedback (the system is complete), through government, exogenous fiscal and monetary policies and through foreign trade. The M-M economy is regulated by the interaction of domestic endogenous and foreign (exogenous) prices. Hence, Marxian demand deficiency (or excess demand) situations of varying length occur all the time in the model through failures of demand plans to meet supply plans. Markets do not clear and stocks and later prices adjust. Experience from model work tells that cycles of different length occur as a consequence, and occasionally they develop into severe depressions of long duration.

One should also note that M-M theory as represented by the MOSES model can be regarded as an extended game of infinite duration with a variable number of players, forming and enacting decisions on the basis of "intermediated information" from the markets. In retrospect the latter is particularly interesting but crudely represented in the model. Since each firm cannot be in touch with all other firms individually, it interprets various items of aggregate information generated by the market process, provided with a delay by the traders, intermediators and institutions that are not explicit in the model. On this point interesting theoretical development should be possible considering the two facts that this intermediation is the dominant resource using activity in an economy and that practically nothing seems to have been done in this area of research.

Model Overview

The M-M model is oriented mainly toward analyzing industrial growth. Therefore, the manufacturing sector is the most detailed in the model. Manufacturing is divided into four industries (raw material processing, semi-manufactures, durable goods manufacturing, and the manufacture of consumer nondurables). Each industry consists of a number of firms, some of which are real (with data supplied mainly through an annual survey) and some of which are synthetic. Together, the synthetic firms in each industry make up the differences between the real firms and the industry totals in the national accounts. The 150 real firms, or divisions, in the model cover 70-75 percent of industrial employment and production in the base year, currently 1982. The model is based on a quarterly time specification.

6.5 **Markets as a Process**

The fact that all firms together take inconsistent decisions on the basis of limited knowledge (bounded rationality) means (1) that expectations rarely come true and (2) that the firms always operate well below what is feasible. Hence, neither the firm nor the economy ever comes to rest on a steady growth path.

Endogenous Pricing Decisions

In contrast to most econometric macro models, domestic prices and wages are determined endogenously and by individual agents in MOSES. These in turn influence the firms' profits and therefore their production plans, the allocation of sales to the domestic and export markets, their investments, and therefore their productivity. This is the main mechanism through which resource allocation is determined. These features make the model especially suited for analyzing the effects of policy measures, which can be expected to influence the expectations and plans of firms and the development of prices and wages. The

advantage of a micro-based simulation model is that one can introduce various policy measures affecting individual firms, rather than industries and analyze the effects. In a more traditional macro model one is usually forced to make assumptions regarding the resource allocation effects, i.e. one has to assume "structure", i.e. a large part of the results.

The Labor Market

Firms in the model constitute short and long-run planning systems for production and investment. Each quarter they decide on their desired production, employment and investment. Armed with these plans they go into the labor market where their employment plans confront those of other firms as well as labor supply.[4] The labor force is treated as homogeneous in the model, i.e. labor is recruited from a common "pool". However, labor can also be recruited from other firms. Hence, even though labor is homogeneous in the sense that the productivity of one unit of L is completely determined by the job on which it is allocated, each unit of L has a different wage experience that affects its willingness to move in the market. Hence, labor is heterogeneous in MOSES in the sense of having different reservation. Wages that are constantly updated and significantly affect labor supply. This process determines the wage level, which is thus endogenous in the model. Wages vary significantly among both firms and industries, and tendencies of wages to converge depend on the way the labor market regime is parameterized. Since the labor market is only subdivided into industries, not regions, mobility in the labor market is probably overestimated. This is important in interpreting the results.

The micro-to-macro model features an endogenous firm exit device. It is activated when net worth of a firm goes below a certain minimum level in percent of total assets (bankruptcy) and/or when the firm runs out of cash (liquidity crisis). The firm, of course, gradually fades away through lack of investment if its cash flow diminishes and if it cannot borrow in the capital market at the going interest rate.

Domestic product prices and the production volume in the four product markets are determined through similar processes.

Anti-Say's Law

Rather than coming to rest on a growth trajectory (q) with market clearing prices (p) that accurately reflect equilibrium the M-M process model is characterized by a sequence of states in the form of distributions of (p, q), carried forward in time, quarter by quarter. When we discussed the need for diversity of structures to maintain long-term macro stability, we meant sufficient diversity of

these state descriptions to keep the macroeconomic process reasonably bounded. Since boundeness is a form of welfare criterion (see Eliasson 1983), diversity of structure corresponds to the requirement of convexity in static analysis to obtain equilibrium properties. Another difference in the MOSES case is that diversity is maintained through endogenous adjustment processes in the model economy.

The state distributions that we talk about include wages, productivity, rates of return (illustrated in Figures 5). The model is started on an initially measured such state, not on a construed equilibrium state. And over any foreseeable future the model exhibits initial state dependent behavior, suggesting that equilibrium and welfare analysis on such models cannot use conventional concepts. A market that cannot clear without causing disruptions at the macro level is represented (in Figures 5) by the price distributions (R-i) in the capital market. Following Morishima & Catephores (1986) this means that Say's law does not hold up. Investment and savings plan do not clear the market and a deficit, or an excess demand situation of the kind discussed both by Marx and Keynes, but most succinctly by Wicksell (1898) - the cumulative process - arises. This situation must also be characteristic of a Schumpeterian type model.

6.6 Profits and the Allocation of Capital - the Investment Decision

To outline the capital market dynamics of the M-M economy we derive the profit targeting and profit monitoring formulae used for both production and investment decisions. It guides the firm in its gradient search for a rate of return in excess of the market loan rate. To derive these formulae we decompose total costs of a business firm, over a one year planning horizon, into:

$$TC = wL + p^I \cdot I + \left(r + \rho - \frac{\Delta p^k}{p^k}\right) p^k \cdot \bar{K} \qquad (1)$$

w = wage cost per unit of L
L = unit of labor input
p^I = input price (other than w and p^k) per unit of I
I = units of input
r = interest rate
ρ = depreciation factor on $K = p^k \bar{K}$
p^k = capital goods price, market or cost
$\bar{K}$ = units of capital installed

In principle the various factors (L, I, $\bar{K}$) within a firm can be organized differently, yet achieving the same total output. Depending upon the nature of this allocation the firm experiences higher or lower capital and labor productivity, as defined and measured below. In what follows

we investigate the capital/labor mix as it is achieved through the dynamic market allocation of resources between firms.

The firm is selling a volume of products ($\bar{S}$) at a price p^x ($S = p^x \cdot \bar{S}$) such that there is a surplus revenue, ϵ, over costs, or profit:

$$\epsilon = p^* \cdot \bar{S} - TC \qquad (2)$$

The profit per unit of capital is the rate of return[5] on capital in excess of the loan rate:

$$\frac{\epsilon}{K} = R^N - r \qquad (3)$$

In this formal exercise K has been valued at current reproduction costs, meaning that ϵ/K expresses a real excess return over the loan rate, but that r is a nominal interest rate.

In the MOSES M-M model firm owners and top management control the firm by applying targets on R^{EN}, the return on equity-capital. This is the same as to say that they apply profit targets in terms of ϵ. Hence, we have established a direct connection between the goal (target) structure of the firm and its operating characteristics in terms of its various cost items.

The Control function

Using (1), (2), and (3) the fundamental control function of a MOSES firm then can be derived as[6]:

$$R^{EN} = M \cdot \alpha - \rho + \frac{\Delta p^k}{p^k} + \epsilon \cdot \phi = R^N + \epsilon \cdot \phi \qquad (4)$$

$$M = 1 - \frac{w}{p^x} \cdot \frac{1}{\beta} \qquad (5)$$

M = the gross profit margin, i.e., value added less wage costs in percent of S
R^{EN} = $(p^*\bar{S}-TC)/E$ the nominal return to net worth (E = K-debt)
α = $\bar{S}/\bar{K}$
β = $\bar{S}/L$
ϕ = Debt/E = K-E/E
ϵ = $(R^N-r)K$

Management of the firm delegates responsibility over the operating departments through (4) and appropriate short-term targets on M (production control) and long-term targets on ϵ, that control the investment decision.

$\epsilon \cdot \Phi$ defines the contribution to overall firm profit performance from the financing department.

At any given set of expectations on (w, p^X) in (4) determined through individual firm adaptive error learning functions, a target on M means a labor productivity target on $\bar{S}/L$. Hence, the profit margin can be viewed as a price weighted and "inverted" labor productivity measure.

Long term objective function

The objective function guiding long term investment behavior is to select investment projects that satisfy (ex ante):

$$\epsilon = R^N - r > 0$$

where r is the local loan rate of the firm. The local loan rate depends on the firms financial risk exposure, measured by its debt-equity position.

The ϵ of an individual firm is generated through innovative technical improvements at the firm level (Schumpeterian innovative rents) that constitute Wicksellian type capital market disequilibria defined at the micro level. The ϵ drives the rate of investment spending of the individual firm. The standard notion of a Wicksellian capital market equilibrium is that of "average" $\epsilon_i = 0$ for the market. As a rule this state is not achieved. Unused capacity may prevent the firm from expanding capacity even though investment long term is expected to yield $\epsilon > 0$. More importantly, however, is the fact that realized investment comes much later than the current quarter and that firms keep making mistakes.

Technology

A new investment vintage can be regarded as a "new firm" with exogenous capital productivity ($\alpha = \bar{S}/\bar{K}$) and labor productivity ($\beta = \bar{S}/L$) characteristics. A new investment can be seen as a new vintage of capital with these particular technology (α, β, ρ) characteristics in the profit control function (4) that mix with capital installations in existing firms.[7] Technology is exogenous and embodied in new investment vintages. Hence, the international opportunity set introduced earlier is represented by current (α, β, ρ) specifications of new investment vintages, while local competence is defined by the local investment process (and - of course - the short term production decision) that upgrades the technical specifications (the "frontier") of the firm, under which quarterly production decisions are taken.

6.7 The Quarterly Production Decision

This decision determines where production occurs underneath the production frontier, moved by the investment decision. Each quarter the firms determine their production volume in two steps. First, they determine their desired production volume, taking into account desired changes in their inventories of finished goods, based on their expected total sales (including exports), which are in turn based on the firms' historical experience.

MIP-targeting

The production decision is typically boundedly rational in the sense of Simon (1955). Top level management does not know enough to impose the flow structure that maximizes ϵ in (2) through the components of M in (4), given capital installations.[8] It resorts to MIP-targeting. Expected (p,w) are applied to historic data on β, and suggested to lower level management, thus initiating an internal negotiation, called production search, eventually resulting in a preliminary agreement (a plan). The negotiation process continues as long as management believes M will stay above targets without resulting in a lowering of ex ante profits. Concavity is thus preserved, and decisions correspond to a gradient approach to maximum ex ante profits, which will be reached if other environmental conditions remain ceteris paribus. The latter is, however, normally not possible to impose on a dynamic micro-based model of this kind.

This first production plan is revised by the firms with regard to profit targets, capacity utilization, and the expected labor market situation. After this revision, the production plan is executed.

Interaction with other markets (Interdependence)

The production volume is distributed to the export and the domestic markets according to an export share, which is dependent on that from the previous quarter, but which also depends on the difference during the previous quarter between the export price and the domestic price. If this export price (which is exogenous) was higher than the domestic price, the firms try to increase their export share during the current quarter. However, the adjustment takes place over several quarters, not instantly. If the export price is lower than the domestic price, the firms do not try to lower their export share but rather maintain it at a constant level. In spite of this asymmetri concerning the effect of positive or negative price differences between exports and the domestic market, it turns out that the export shares in the various markets can both increase and decrease. This depends on whether firms with high export shares fare better or worse than other firms in the market. The import share in the four markets is also determined by the difference between the export and

domestic prices with a certain time delay. High domestic prices relative to foreign prices lead to increasing import shares.

There is also a capital market in the model where firms compete for investment resources and where the rate of interest is determined. At this given interest rate firms invest as much as they find it profitable to invest, given their profit targets.

Public sector employment is determined exogenously, and the rate of wage increase in the public sector has been set equal to the average wage change in manufacturing, preserving the relative, average salary and wage differential between the two sectors.

NOTES

[1] Eliasson 1976a, p. 236 ff. MIP for Maintain or Improve Profits. Also see pp. 175 and 291 ff. (same reference for more detail).

[2] Also called the MOSES model. Both the micro-macro model used and the experimental designs are too complex to be fully described in this paper. For more detail, we have to refer the reader to other publications (Eliasson 1976b, 1978, 1985a, and for a short presentation of the labor market process, in particular 1986c, Albrecht-Lindberg 1982, Bergholm 1983).

[3] Even though work is in progress to endogenize it partly at the individual firm level. See Eliasson (1985a, pp. 280 ff.).

[4] Eliasson (1985a, Chapter II) includes a rather detailed account of the labor market pricing process.

[5] The rate of return is then defined as

$$R^N = (p^X \cdot \bar{S} - TC + r \cdot K)/K.$$

Also observe that (... p^k in (1) is the standard, neo-classical definition of the cost for a unit of capital service $\bar{K}$ as valued in the external markets for credit. Observe, when the capital market is in equilibrium - the standard assumption in general equilibrium theory - then all $\epsilon = 0$ and TC completely exhausts total value produced. $TC \equiv p^X \cdot \bar{S}$ in (2). Say's Law holds. There is no investment-savings gap.

[6] For proof of (4) and (5), see Eliasson (1976a, 1985a, pp. 110 ff.).

[7] In a fashion described in Eliasson (1978, p. 63ff).

[8] Observe that β represents the structure of the entire production organization.

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