A list of Working Papers on the last pages

No. 74

ON THE OPTIMAL RATE OF STRUCTURAL ADJUSTMENT*

by

Gunnar Eliasson

December, 1982

ON THE OPTIMAL RATE OF STRUCTURAL ADJUSTMENT[x]

by Gunnar Eliasson

CONTENTS Page

[x] This paper has greatly benefited from discussions with Richard Day, Karl-Olof Faxén, James Henderson, Mark Sharefkin and Bengt-Christer Ysander. Fredrik Bergholm has been very helpful in running the somewhat tricky "historic experiments". We are very grateful to the Industriøkonomisk Institutt in Bergen, Norway for allowing us to use their computer.

ABSTRACT

The first concern of this paper is the time dimension of the adjustment process in an economic system characterized by various forms of monopolistic competition. We attempt to define notions, and measures, of stability that capture the macroeconomic consequences of shocks and disturbed price signalling in markets. We want to know if, when, where and how an economy settles down on a "steady" growth path and to what extent the answer depends upon the nature of the adjustment process itself.

It appears that a bounded space that is a subset of another bounded space is a more useful concept to deal with our problem than the conventional equilibrium and stability definitions. The bounds should be considered as welfare determining and as such they will be entirely arbitrary until we have determined how national welfare depends on the variation in and the predictive uncertainty associated with a chosen set of welfare variables. Optimal adjustment in our sense involves both (a) the time it takes to get back to a steady growth path and (b) the loss (or gain) in long-term growth due to the adjustment process itself.

The second concern of this paper is to demonstrate through micro simulation experiments how stability in that sense depends on the structural diversity of the economy. The paper is mainly exploratory, aiming at hypothesis formulation. Only a few of the experiments used in this study have been properly designed to allow strong empirical or theoretical conclusions in this context. We have found tentatively:

(a) that the less structural diversity (productivity or profitability) across micro units (firms) in the initial state of the economy, the less stable the macro economy vis à vis externally administered price shocks.

(b) that a certain level and distribution across firms of unused capacity (cyclical slack) is needed to maintain a stable relative price structure during a growth process.

(c) that the "Le Chatelier-Brown principle" is significantly at work in the micro-to-macro model economy. Reversal speeds depend importantly on the state as described by (a) and (b) and shocks of various kinds can "prematurely" trigger reversals. More particularly, the model economy can be made to perform excellently by short-term criteria (high utilization rates, currently and efficiently allocated labor, etc) for extended periods of time, only to develop eventually a more shock sensitive supply structure.

(d) that the simulation experiments imply a basic, underlying trade-off between macroeconomic and microeconomic stability. The closer to steady state output growth at the macro (industry) level, the more the "Brownian motion" over time in the growth rates among firms.

(e) that different (size, time, sign) price shocks require different market regimes for optimal adjustment.

(f) that it was virtually impossible to settle the micro-to-macro model economy used for simulation experiments down on a "steady" long-run macro state -- strictly defined -- for more than a couple of decades, except at the expense of a not negligible reduction of the growth rate. The reason seems to be the absence of sufficient micro "instability". The model features an endogenous exit of firms, but no entry. Hence the model is afflicted with gradual "structural decay" in the very long term, meaning less structural variation and more market concentration. The diminishing vitality in the competitive market process that followed appears to have been detrimental to steady growth in the very long term. This sensitivity may diminish when we have introduced market entry as a standard feature of the model.

(g) that output growth along an endogenously determined trend cannot be sustained if not associated with significant short and long cycles in economic activity around that trend.

This list of properties of the micro-to-macro economic model of Sweden (called MOSES) indicates our area of interest, namely the interaction of economic agents in a cyclically unstable growth process - an old Schumpeterian notion.

The model used is very complex, and the design and running of experiments is a costly procedure. Experiments have been carried out at different times and on somewhat different model specifications. Hence, at this stage we refer to our results as suggestions and hypotheses for further testing. If some or all of these hypotheses hold up, they will call for policies quite different from the conventional macropolicies.

1 THE NOTION OF STABILITY - THE PROBLEM

What do we want?

Superficial com arison of the behavior of macro tim~ series for any industrial nation during the steady 60s and the volatile 70s suggests the following two questions:

1) What kind of price system (p) will support a steady -- or stable -- macroeconomic growth trajectory over a period of several decades?

2) What kind of (supply) structure (q) and behavioral response pattern of an economic system will support that price system?

We have tried to analyze these problems experimentally within a micro-to-macro simulation model of the Swedish economy. This model endogenizes price and quantity determination across firms and over time -- and hence economic growth -- in a way described below. We try to formulate a theoretical concept of stability corresponding to the common-sense notion of stability that we need. We need a concept where time (durability) is part of the stability problem. The instability domain may occur soon, before the system has exploded or collapsed. We do not care very much if a disturbed system, because of the disturbance, does not return to the same point from where it began to move. (Equilibrium points, steady states and similar concepts appear to be of limited value in this context.)

What does economic literature offer?

A superficial glance at the literature of economic theory shows that stability problems have been treated in the following fashion. On the one hand we have the stability analysis of static competitive equilibrium situations associated with names like Arrow, Hurwicz etc. The problem has been to define the conditions under which the economy, when brought -- by exogenous forces -- more or less away from the equilibrium point, returns to the -- or sufficiently close to the -- same point; the fixed-point rubber-band analysis so to speak. Such analysis by definition is restricted to a limited set of models -- and corresponding problems -- with static fixed-point characteristics (Lindahl (1938), Arrow-Hahn (1973), Arrow-Hurwicz (1977) etc). Time has no empirical ontent in those models: it is just a scalar parameterizing the (fictitious) evolution of the system. Debreu's (1959) treatment is the ultimate in this respect; dates are attributes of commodities, leaving very little economic meaning in the tim- concept (cf Smale, 1976). A recent development along similar lines has been phrased in terms of so-called search equilibria, where no single price, but rather a dispersion of prices (due to imperfect information) in a timeless world signifies an equilibrium and perhaps a stable cluster (see Sharefkin's paper in this volume). We also have the large body of theoretical literature on monopolistic competiton. It is, however, partial in nature and cannot easily be applied and generalized to micro-to-macro analysis except in the way we have done it below.

The concept of practical stability suggested by LaSalle-Lefschetz (1961) in a sense recognizes time. Practical stability[1] means that a process eventually returns tolerably close to a point of equilibrium that has been disturbed, without necessarily approaching that point monotonically. A flying areoplane is a case in point. Its flight path is practically stable, whatever happens to it during flight as long as it eventually lands safely, tolerably close to its point of destination.

Hence, practical stability is defined by LaSalle-Lefschetz in terms of a point residing in a bounded region of a normed space (bounded orbit), a notion supported by Berlinski (1976) who argues that the notion of "stability makes sense only relative to some measure of distance" and that the same norm notion is sufficient.

The distance and the time

But there is a very different family of stability concepts that have originated in physical and engineering sciencies. They represent changing structural forms mathematically. Questions posed in this literature concern what circumstances make such forms stable and under what conditions they collapse. For instance, when inputs (causes, prices etc) pass slowly through a well defined domain, under which structural circumstances do various forms (systems) exhibit abrupt changes (discontinuities, cathastrophes etc) in the corresponding state spaces? The mathematics is often borrowed from natural science models (meteorology (Lorentz 1976), stress analysis, under which configurations does the bridge collapse, etc). Much of this discussion has been associated with Zeeman and Thom. There is, however, a variety of half-built bridges that connect these notions with the economist's preoccupation with the price characteristics of competitive equilibria -- even though the various authors reside in different academic and linguistic worlds and do not normally honor each other with cross references. The distinction between the short and the long run are cases in point. The short term presupposes a fixed structure. If the system is disturbed it returns to equilibrium without disrupting the structure. In the long run, somehow, structure changes. In Smale (1967), Thom (1972) and others the short and the long terms are submerged in the same structure and it becomes interesting -- as we will see in our later quantitative model analysis -- to talk about "structural stability" (Smale (1967), see also Ysander (1981)).

Recent theoretical work based on Lorentz (1963) has demonstrated that, with sufficient nonlinearities and tendencies to overshooting, random-looking system behavior can be deterministically generated. Such systems could very well be unstable even though they possess an equilibrium. Trajectories would be very sensitive to initial conditions and would move away from any periodic cycle that can be represented. Such behavior has been termed <u>chaotic</u> (Day, 1982, 1982b). In such systems both structural change, economic growth and "unpredictable" (by any forecasting method) events could be generated. As will be seen below, the micro-to-macro simulation model we use for illustrative purposes exhibits all these features.

When a system is inherently unstable or chaotic and remains far enough from any established steady state for sufficiently long periods of time, the distance suggested by Berlinski (1976), rather than the steady state or the equilibrium point, becomes the important criterion for evaluating the stability properties of the system. A disturbing degree of arbitrariness as to the choice of reference for measuring the distance[2] then enters the scene. Among other things, the analysis now requires an entirely new tool-box compared to the one that economists normally carry. Economists generally worry about the return of the system, at some future time, to a reference point called the equilibrium point or trajectory, not about when and how far away the process will be during the adjustment period. But during a deep depression or a runaway inflation, policy makers and individuals will worry about how fast they can get the economic system back into a tolerable operating domain, and not about the systems operating characteristics 10 years from now. Suppose we introduce a bounded domain, called the stability domain. It is bad for the system (an aeroplane, an economy etc) to be outside that domain. It represents danger, unpleasant social conditions etc. As soon as the system gets outside that stability domain, time becomes important, namely the time needed to get back.

Looked at through the new pair of glasses suggested in engineering literature, the important thing is that a perturbed process moves in a bounded orbit (say a band around a growth path) and stays there, and how long that readjustment takes. Quality and safety controls applied to engineering production systems offer a host of examples. Even though an explosion in the output flow of a chemical plant would eventually stabilize, the point is that explosions should not be allowed to occur at all. It is obvious that some practical stability problems of economics resemble this one.

Arbitrariness here also refers to the possibility that we don't know our system (model). We may be thinking in terms of a macro-economic model that describes the 60s well, to figure out what to do in the late 70s. Then, of course, we don't know the location of, or about the existence of a point of equilibrium very well.

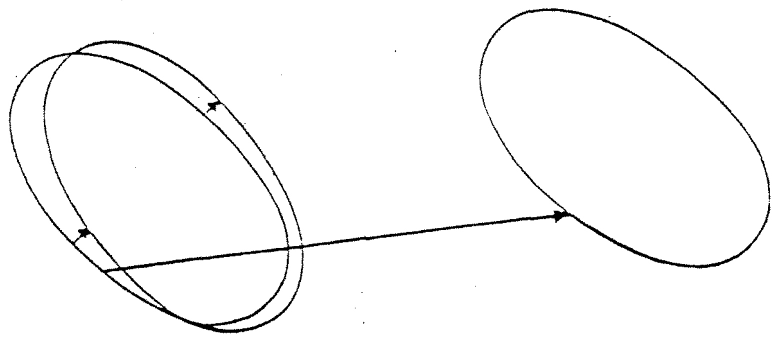
Second, the new pair of analytical glasses allows a host of interesting and natural notions of distance. The introductory questions suggest some historic benchmark. For instance, instability could be said to prevail if the amplitude of the business cycle passes outside some preset limits -- if the level of output drops or falls significantly below an established growth trend or if the unemployment rate reaches 6 percent or more. By such standards the so-called high market response experiment in Figure 5 would be in an instability region most of the time after year 30. The economic circumstances then prevailing would certainly warrant the label unstable, crisis, depression or collapse in common language. The concept of an equilibrium in the economists' sense then does not offer much help as a reference for measuring distance and especially in the general class of models that we consider, where it often does not exist. Third, the equilibrium point may be a very erratic object, especially if the system (the process) normally operates at some distance from that point, calculated by some method. The stability of an aircraft in flight is again a case in point. Even if an equilibrium flight path could be calculated, during flight the distance from the ground is really what matters.

Boundedness and response strategies of actors

Boundedness thus appears to be the interesting concept to use in defining a notion of stability. What can we draw upon in defining that notion?

Resilience, originating in the biological sciences (Holling 1973, May 1973 and Grumm 1976), is a concept we can try. Resilience obtains when an external shock does not move the operating characteristics of the system more than marginally (small rightward movement to the left in Figure 1).

Figure 1



Suppose you shock the system with external si nals like those of the 60s and the 70s. The oil shock of the 70s would not have brought the system down as it did with the real economy, if the system would have been resilient. An economic model, a real life economy or the Northeast U.S. power grid (that collapsed in the middle 60s) can be designed to be more or less resilient vis-à-vis events like the oil shocks of the 70s. One does not want to build infinitely resilient (or stable) systems. One would, however, like systems designed to be resilient vis-à-vis shocks that are likely to occur. In that sense, it is interesting to discuss the resilience of various systems (say the three models described in this conference volume and the real economy) in the context of price developments of the kind described in Josefsson's-Örtengren's paper.

Suppose now that we have an economic model the state of which is currently and endogenously updated through the dynamics of the ongoing economic process. The micro-to-macro model described below exhibits exactly those properties. One clear conclusion then follows. The state of the economic system will depend critically on the actual path the economic process has taken. In policy terms this means that if the economic process is set in motion at some point in time, one could, in principle, move the system differently up to a later point in time (everything else the same), and the breakdown characteristics (the resilience) vis-à-vis particular shocks would differ accordingly. One feels inclined to demand such properties from any theory claiming, to explain the events of the 70s.

Controllability is a key notion for macropolicies. Most macroeconometric models up to the middle 70s were resilient to even extreme price shocks by assumption (cf the simulation runs in Sarma's paper) or any departure from desired activity paths could be easily corrected by the informed policy maker in charge. On the other hand, the micro-to-macro model economy to be discussed later in this paper appears not to be resilient if shocks are sufficiently large and resilience appears to depend significantly on the micro characteristics of the state of the economy. Resilience can, however, be enhanced by improving behavioral strategies by the various actors in the economy. In macro models the only real agents are the macro policy makers, and in this setting the concept of controllability of the system naturally arises. Arrow-Kurz (1970) discuss controllability from a centralized point of view, and this is the notion applicable to most macro models of a Keynesian type.

In dynamic, micro-based models the controllability concept becomes much more complex. Both firms and individuals act in response to price signals that they interprete individually, and may act both in accordance with policies and against policies. In the noncooperative game situation that follows, inconsistent behavior develops easily and normally at the micro level. Actors in an economy (firms, individuals, governments etc) are equipped with rules designed to help correct locally bad situations within the normal operating domain of the system. Such was also the case for the operators of the Northeast U.S. power grid in the 60s and at the Three Mile Island nuclear reactor in 1979.

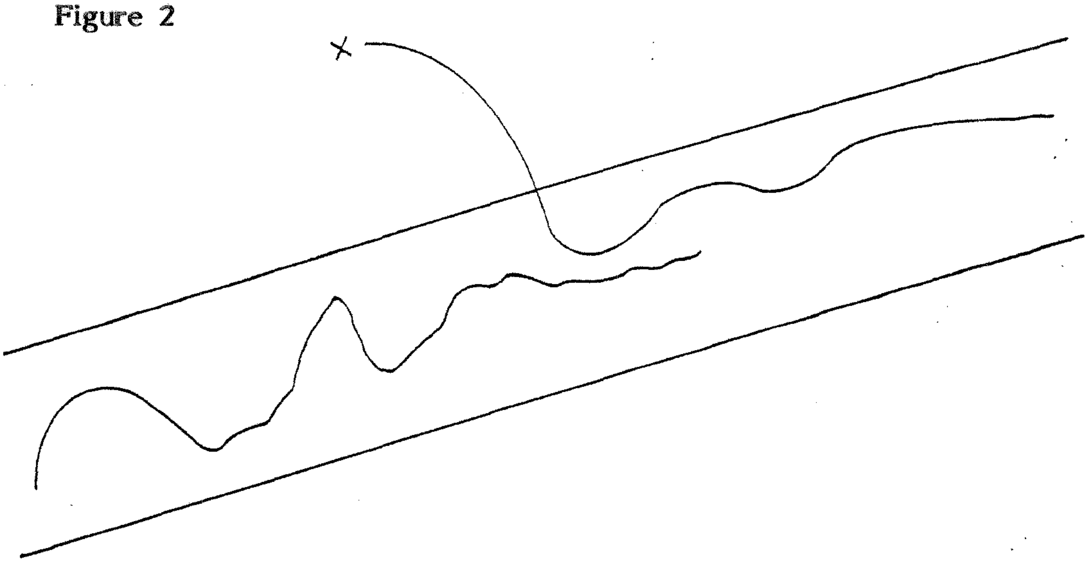
A system can also be equipped with rules to improve rules of behavior, emergency operating rules, learning by doing, information gathering and so forth. To some extent this is the case in the micro-to-macro model economy used for illustration in this paper. It is very much the case in the real world. There are, however, limits to what can be in implemented in the form of such safety devices. Time -- to observe, to learn, to understand and to act -- is a very practical constraint in designing and implementing good behavioral strategies.

The complexity of most real-world systems makes improvements in operating rules an individual, iterative procedure that may even be destabilizing, in the sense of lowering the resilience of the system. Firms or households in the micro-to-macro economy respond to mistakes by being more cautious, thus causing trouble for the system as a whole in the form of rising unemployment. Micro units are also equipped with expectational devices that are rational for them as individual actors. Combined with quantity responses in the economy and secondary price adjustments, prices of the economy sometimes "overshoot" significantly, occasionally causing serious collapses of parts of the economy (Eliasson, 1978a, pp 105 ff). In this perspective, governments trying to correct the course of the economic process in the seventies on the basis of experience from the 60s may, in fact, have been the cause of the economic distress experienced (direct intervention in markets, legislation, subsidies etc), because they did not understand or predict the response of the economic system.

Stability as a welfare notion?

No one of the stability notions described above appears to be sufficient for our purposes. An economically relevant notion of stability must have some welfare content. We are looking for a bounded region in the space of goal variables of an economic system. Some of those variables (say unemployment) must stay within the same bounded domain indefinitely if the system is to be considered stable. Mathematically the process would be uniformly convergent. Whenever outside the band or the tube the process has to return to be called stable (cf Figure 2).

Figure 2



For other variables (like output) the "domain of stability" can change over time as the system evolves. Dramatic departures from some normal range, say normal cyclical variations, are called instabilities. If such a departure occurs, the important point for stability is not that the variables return to earlier stability regions, but that all goal variables return to regions that are called stable. Rather than comparing two equilibrium situations we would prefer to study the systems in two stability regions (the two tubes in Figure 3).

Figure 3

One would expect normal economic systems to contain several such, possible "stability rated" regions to return to.

Thus, even though the Swedish economy was thrown into a "destabilized phase" after the 1973/74 oil shock, there is a range of choices of future stability regions (including growth bands) within which to stabilize eventually. Swedish policy makers could take their pick from the international, experimental policy theater of the 70s, and their choice would determine which stability region would be the ultimate outcome and how long it would take to get there. A normative (or ethical) welfare function for the nation, or at least its policy makers, is needed to make this choice. With such a welfare function, a unique growth band can be chosen.

2 STRUCTURAL COMPARABILITY

The man in the street might say that the performance of the Swedish economy was "stable" during the 60s and "unstable" in the 70s. The implicit notion would be that the two developments g(60) and g(70) had been generated by the same underlying economic structure ψ. Do we understand, and know how to characterize, the nature of ψ in sufficient detail? Suppose we do; then

- at what "distance" (= g(70)-g(60)) from the empirically known (and measured) g(60) does development become "unstable", and

- what causes that departure?

Alternatively, one could ask whether the talk about a growing structural instability in the Swedish economy during the 70s rather refers to a change in the underlying structure? To an economist that last possibility must be very disconcerting. He must replace his earlier concept of the general economic structure with a new concept h. We then cannot give meaningful answers to the two introductory questions. Comparability requires that g and h be subsets of a general class of structures that can generate both g(60) and g(70) or any g(i) that would be of interest to compare with or to explain g(70). A general class of structures ψ that is capable of generating both a business cycle and a variety of structural developments is re~uired for, e.g., a good growth model. Obviously such a model has to be based on very extensive information. Is it possible to formulate and estimate a model with such powerful explanatory capacity? We must if we want to understand (and be able to recognize) such turbulent economic behavior at that of the 70s. The only informational basis for such early recognition would have been data generated during the 60s and earlier.

Prices

In the standard theory of competitive economic equilibrium, both sides of the market take prices as given. This theory can be extended by introducing expected prices, also taken as given from the Walrasian auctioneer. But what happens if expectations are mistaken?

Suppose mistaken expectations have moved the actual price p to a point arbitrarily distant from the market clearing point $\bar{p}$. We assume that this can happen without disrupting the process or the system, i.e., the structure of the system (g) remains unchanged. Standard competitive analysis is concerned with the conditions under which p returns to $\bar{p}$ again without changing g. First, only a limited set of structures g allow p to vary around $\bar{p}$ without changing g. Second, even if variability in p is allowed in some neighborhood of $\bar{p}$, $|p-\bar{p}| < \varepsilon$, additional restrictions apply to g if return of p to $\bar{p}$ is to be guaranteed. If not, we have a basic inconsistency between economic structure and price dynamics. Or rather: are structures g with nonconverging prices economically interesting, and of practical importance? Traditionally, structures g for which an equilibrium point does not exist and for which convergence of p to $\bar{p}$ is extremely slow, have been considered theoretically uninteresting and of no practical importance. Expressed differently, if the existence of an equilibrium in the conventional sense cannot be proven, we should reject the theory or the model! One could argue, however, that such rejected structures would be the relevant ones if we want to take up Schumpeter's challenge, and try to explain business cycles as an integral part of an endogenous growth process.

There are two important reasons for attempting that task. First, instability in the traditional sense of non-convergence to p may be the normal characteristic of economic systems when sufficiently disturbed. If, for instance, decision makers repeatedly traverse the same "cobweb" cycle, they will eventually learn and change their decision strategies. If the situation is very complex they may stick to their old rules of thumb as long as the variation in outcomes are acceptable ("stable"). If not, a complex situation with many actors offers a very large number of possible strategy choices, meaning a structure g(70) very different from g(60). Perhaps this is the normal tendency of an economic system. (See Sharefkin's paper in this volume.)

Second, convergence to $\bar{p}$, or to an entirely new $\bar{\bar{p}}$ may not occur within this new system or within any typical economic structure. Instead, structures g and prices p may keep oscillating in a mutually dependent fashion. $(g, p) \varepsilon \psi$. This is one way to describe the behavior of the micro-to-macro model that we use for illustrative purposes below. As long as g stays within a bounded region, we call the system stable. The second objection is the more important one. It covers the first and, if valid, it rules out the above theoretical procedure as unsound, because it excludes many important economic phenomena.

An extensive literature on systems stability exists in which no explicit price system parameterizes the response surface of the model. The economist should merge the two approaches. The engineering model, with no explicit prices or market clearing, and the economist's model that responds to God-given prices should be merged into a new model, where both structure g and prices p are endogenized. At least three aspects of economic reality can then be recognized in the model. First, decision makers have to recognize that prevailing prices may be non-clearing prices and unreliable predictors of future prices. Second, market interdependencies have to be allowed; a disturbance in one market may spread to other markets. Third, the speed of market responses may be such that disturbances keep growing, at least for some time ("overshooting", see Eliasson (1978a, pp 105 ff), and Genberg's paper in this volume). To accommodate these features, the model or theory must meet at least three requirements. Disequilibria or instabilities will have to be normal, endogenous parts of the economic growth process, that is also endogenous. The endogenization of supply and capacity growth requires a micro representation at the level where supply decisions are taken (establishments, firms). These three requirements summarize Schumpeter's view of "Business Cycles and Economic Growth" as a process in which entrepreneurs figure importantly as agents of innovative change and creative destruction. The micro-to-macro model used below in this paper builds in these three features. Under certain circumstances such models are not "structurally stable", and part of our analysis is devoted to this particular property.

Such modifications of our world concept, however, make for much more complicated mathematical formulations. Since prices depend on quantities, stable aggregation functions no longer exist, except in unusual or peculiar circumstances (Fisher 1965, 1969, 1982). Assume that agents in the market respond to a perceived price signal by adjusting quantities at different rates. Then those agents will not act in an identical fashion over time, and any cross section in time would find different actors striving to adjust their positions to different prices. Inconsistent behavior, more or less, is the normal state of affairs. There is no way of obtaining stable aggregates, and we must resort to explicit micro-to-macro process analysis; supply must be modeled at the micro level. The only remaining question is whether we should try to restore mathematical tractability by a stochastic device (see Sharefkin's paper) or be satisfied with a cumbersome numerical analysis. It appears as if simulation will be the most efficient, and perhaps the only possible analytical technique to perform interesting economic modeling.

How should we go about modeling the dynamic properties of an economic system?

One has to introduce

(1) the time (t) it takes for prices to respond to the response of actors to perceived prices, and

(2) the magnitude of response it takes to move prices (p) within the chosen period of time, and

(3) the magnitude of quantity response initiated by a particular price signal (= q).

Time can be modeled as continuous or discrete; the discrete version involves the choice of proper time unit. A particular requirement to note is that only a restricted set of response patterns on the part of decision makers are compatible with a stable system ψ . There must always exist some classes of response speeds and response steps that will confront the system with an even larger, needed adjustment the next moment or period and so on. (The non-explosive or non-collapsible class may not include optimizing behavior on the part of the individual decision makers in response to perceived prices.)

A second aspect is that such a system deals with actors (decision makers). To be "aggregable" it must exist in a state resembling static equilibrium. The system can collapse to a static equilibrium in certain special cases. But are those special cases of any interest?

Any other state would involve quantities (q) changing at different and changing rates.

Does there exist, within the system

$$\psi \quad (t, \dot{p}, \dot{q}, \ldots)$$

defined in some space, a state where all quantities move at the same, stable rate? What would the trajectories of p be in the corresponding space?

Does the system tend to remain in the domain defined by these trajectories, and do those trajectories remain roughly in place if the system is dist rbed by some outside shock?

The conventional presumption is that the p vector stays put if all quantities change at a constant rate. Stability of quantity aggregates and of the price vector are then guaranteed, and aggregate quantities will change at the same rate as its component quantities. I conjecture that if the parameters regulating adjustments of type (1), (2) and (3) above differ across micro units, then a system that has been pushed out of a (q, p) micro steady state (strictly defined) will never return to such a state.

Initial structures

A common procedure for studying the stability properties of an economic model is to position the system in equilibrium and then to shock it. That procedure is believed to isolate the effects of the shock from other features of the dynamics of the system.

This procedure assumes two things. First, it assumes that the system's response does not depend upon the initial position in relation to the perceived equilibrium position. Suppose, for example, that the system moves to very different equilibria which depend critically on the initial departure from equilibrium; or that the time it takes for the system to return to some common equilibrium depends critically on its initial state. Second, such an analytical procedure assumes that an equilibrium position exists from which to depart when shocked. If we have a dynamic systems representation of our economy, it may be difficult to find an initial equilibrium. Exogenous price signals driving the system may be incompatible with its initial and updated structure for a very long time. Once started on a particular, initial structure, that structure may for ever drive the (q, p) $\varepsilon\psi$ system in a fashion that now and then takes it out of the bounded orbit, and into an unbounded orbit that passes outside the stable region.

Say that we define "economic stability" to mean that GNP moves within a predetermined maximum amplitude around a smooth growth path. If the economic system cannot be manipulated, by varying initial structures and/or policy parameters, to maintain such a smooth growth path, then the system would be called unstable or uncontrollable. One question that we must ask after having performed the simulation experiments to follow is whether such an instability should not be considered normal, or unavoidable, behavior of any economy. It is easy to demonstrate that a large class of models with dynamic features (feedbacks) exhibit cyclical properties. Why should models be restricted to the class that generates periodicity? Should not a good economic model generate (endogenously) a real depression occasionally? (Cf Day, 1982, 1982b. Also see simulation experiments below.)

A special case of the initial structure problem is the cyclical problem of capacity utilization. Capacity utilization is part of the initial state that determines the production and investment decisions of firms each quarter. Capacity utilization is also part of the actual as seen against the potential productivity specification of each firm. Local scarcities -- insufficient labor or machinery, for example -- may generate local price and wage escalation. If more widespread, those price and wage escalations may destabilize the relative price structure in a cumulative way. If this is a valid hypothesis[3], then there is a tradeoff between the overall degree of capacity utilization and the long-run growth rate. A certain level and distribution (across firms) of slack is needed to maintain a stable relative price structure, which in turn is needed for a stable growth rate. Thus there may be a conflict between trying to stabilize quantities q (like business cycles) and prices p. The more stable q the more erratic the p structure. The more stable the p structure, the more prone to erratic adjustments the quantities q. Ill-timed expansionary policies, and perhaps stabilization policies in general, would then be undesired events from a long-term point of view. They may reduce long-term growth rather than increase it (as conventionally believed), because they affect the dynamic (across micro units and over time) allocation process negatively. Perhaps the policies of the 60s had something to do with the limited ability of the economy of the 70s to absorb the exogenous shocks then delivered.

Micro versus macro stability

Thus far we have talked vaguely about structures. Stability has been defined in terms of one particular dimension (variable) of that structure. Choose a simple structure, say a very simple macroeconomic model. Any chosen macroeconomic model can be disaggregated further into substructures. We have many sector models and a few micro models based on decision units (firms, households).

Suppose we have a time trajectory of aggregate industrial output and its components in terms of individual firm outputs. To what extent should one expect compatibility between component stability and aggregate stability? Is stable and uniform microeconomic growth supportive of macroeconomic stability or is there a conflict?

Nobody really knows, since neither a micro stable nor a macro stable system in the above senses have ever been modeled simultaneously (cf Sharefkin's paper. Burton Klein (1983) has also addressed this problem.). We argued above that variation across micro agents (firms) in the dynamic specification of the model would make attainment of a steady state (q, p) situation infeasible. The problem can, however, be studied "experimentally" within a micro-based macro model. We can try to obtain macro stability and study what that state looks like at the micro level, and vice versa. We will do some of this in what follows.

In such a context, however, it becomes important to represent <u>aggregation</u> exactly. Even if the behavior of individual firms can be modeled, the number of units change through <u>exit</u> and <u>entry</u>, and surviving units change in size. Macroeconomic models are based -- explicitly or implicitly -- on the "static" equilibrium assumption because such an assumption is required for stable aggregates. Departures from that assumption require that very peculiar additional assumptions be imposed if stability in aggregate relationships is to be preserved. This is, of course, a very unsatisfactory state of affairs.

The dynamics of a market pricing system can be expected to depend upon concentration tendencies. This becomes more important the longer the time period we study. The evolvement of micro structures over time must therefore be a part of our inquiry. In each time (decision) period a new micro structure represents the initial structure for the next period. Structural stability then becomes important. Structural stability as here defined captures a particular type of micro stability in the growth process, namely how initial structures evolve over time.

As an introduction to the next section, suppose we have two systems g(60) and g(70) that both belong to ψ. Their properties differ in the sense that g(60) describes a choosen period (the 60s) well and similarly for g(70). We can think of g as a dated, macro model, g(60) being estimated on macro data for the 60s and similarly for g(70). The shift from g(60) to g(70) is what we call "structural change". It can be "quantified" in terms of the changes in the matrix of estimated coefficients. To explain the shift, however, we must understand the underlying common structure ψ, which includes a micro representation of the supply process.

3 EXPERIMENTS AND NUMERICAL ILLUSTRATIONS

We have argued that, when demand and supply relationships are interdependent, at the micro level the concept of an equilibrium gets blurred and mingles with the concept of stability (also see Sharefkin's paper). We asked whether the notion of a stable equilibrium carried any useful information at all in an analysis of a market economy with an endogenized price system subject to shocks. One particular aspect of this problem is under which circumstances structural (q) adjustment driven by induced price change ($\dot{p} = F(g)$) is a stable process in our particular meaning of uniform convergence, namely when it takes place within a bound-region in the space of particular target variables. In what follows this problem will be investigated and illustrated through experimentation with a micro-to-macro model of the Swedish economy, called MOSES. (This model economy endogenizes both relative price change and structural responses.) Economic growth is endogenous under an upper technology constraint on individual firm investment. Firms consistently strive for higher profits on the basis of adaptive price expectations ($\dot{p}^{*} = E(\dot{p}(t-1), p(t-1)..)$). This will lead to maximum profits if and only if price expectations are realized over the indefinite future.

Our analysis is carried out in three stages. Two versions of the model are used: one initialized in 1968, using predominantly synthetic firms with unrealistically equal labor productivity, profitability, and capacity utilization characteristics across the firm population, and one initialized in 1976, with 150 real firm units covering some 80 percent of value added in Swedish manufacturing industry. In the latter case, the micro performance distributions are very accurately represented across the firm population in the initial year 1976.

In step one we run an extensive series of experiments on "one shot" price shock experiences on the 1968 firm distribution, using a variable market and individual firm parameter design to mimic different market regimes. This set of experiments, reported in some detail in the appendix, also gives us some familiarity with this, still unconventional model economy. The firms in the model economy are subjected to the 1969 through 1973/74 price experience associated with the "oil crisis". From 1976 on, foreign relative prices (exogenous) are returned to the earlier, stable trends of the years 1963 through 1972. Some of the experiments are then rerun with identical parameter specification on the more realistically structured 1976 data base and results are compared.

Step two contains a series of relative-price induced structural adjustments (price pivoting) under variously specified market regimes on the 1968 data base. This time, the relative price trends that began with the oil crisis are either continued through 1987 or accelerated.

Step three, finally, reports on attempts to move the realistic 1976 model economy onto a steady-state macro-level time path by enforcing a set of internally consistent exogenous assumptions on inter alia foreign prices, the interest rate and technical change embodied in new investment vintages. Those exogenous assumptions are imposed in a fashion that should not disturb the system unduly. It should be observed, however, that the Swedish economy in 1976 (the initial year) represented a substantially disturbed economy.[4] Hence, the initial state from which simulations began underimposed, external (foreign prices etc.) steady state conditions, means a significant initial disturbance.

The purpose of these "historical" and very long (50 years) experiments is to investigate the long-run stability and convergence properties of the micro-to-macro model. We want illustrative answers to the question: do we want stability and convergence, and if so, exactly in what sense?

The optimal rate of structural change

Price shocks

In the first set of experiments we found:

I:1. For the 1968 initial structural specification of the production sector (with little structural diversity between firms), and for trend projections of exogenous variables there seems to exist a firm and market behavior parameter region within which the economy adjusts to a long-run growth trend with fairly long swings in output and employment. The amplitude of those swings is within long-run historic experience; this is our definition of stability. (Also see Figure 5 and the accompanying text.) The market and firm behavior parameters determine whether the generated trend can be supported in the very long "historic" term.

I:2. The ability of the economy to stay within the stability region for a particular shock and a particular parameter specification depends very much on the initial efficiency distribution of production units. Generally speaking, the more equal the firms, the more likely that large chunks of the population of firms will collapse in response to a large relative price change. The economy will then be thrown outside the boundaries of the "stability" region, and will be thrown further the speedier firm and labor responses to price impulses. (Cf Eliasson 1978a, pp 105 ff, Eliasson 1978a, pp 72 ff.)

I:3. The more unstable the relative price structure, the more erratic economic development and the lower the rate of trend growth generated.

I:4. We infer that for each initial, "structural" representation (state) of the micro units there exists a response parameter specification that ensures approximate stability (boundedness) and a higher growth rate (the optimal structural adjustment speed).

This set of experiments suggests that long-run stable growth at the macro level requires a rich variation in micro structures. Such an observation runs counter to the idea of generally stable growth patterns at lower micro levels. Two conclusions follow from this. First, growth models in which growth is endogenized, have to be rich in micro specification for a stable long-run growth trajectory to be generated. Second, that richness in micro-variation also has to be dynamically unstable. In such a model set, to which the MOSES model economy belongs, one should perhaps not be able to prove the existence of a competitive equilibrium, even as an ex ante state.

Price pivoting

In the second set of experiments we change the competitive conditions affecting Swedish model firms in foreign markets. The experiments are carried out on three different initial structures;

(1) all synthetic firms with little between-firm diversity (1968 initial year),

(2) half of the sample of real firms, but with a data base that is incomplete in important respects. Somewhat more between-firm diversity (1968 initial year).

(3) Most firms (150) real. Complete micro data base. Very good quality representation of initial micro structures for initial year 1976.

In all three experiments, relative prices were pivoted in favor of engineering industries against raw material industries, or vice versa. The same aggregate manufacturing-industry price development was employed in all the experiments.

The experimental results support our earlier findings. Changes in competitive conditions in foreign markets require an adjustment of domestic supply structures; capital must be scrapped and new capital accumulated. There is an intermediate period of output losses and a slow-down in economic growth that persists, at the end of the experiment period (30 years), in all runs.[5] This loss is fairly small, in the long term, when foreign relative price change is slow. When "price pivoting" is rapid, on the other hand, the relative price structure of the economy is disrupted (see Josefsson's-Örtengren's and Genberg's papers in this volume). Under those circumstances, we must recognize and distinguish between two kinds of dynamic, allocative losses. First, there is an "allocation loss" due to faster scrapping of output capacity (remember that no subsidies etc were introduced in these experiments) than the compensatory accumulation of new, competitive capacity. Second, the market price disturbance generates errors in both employment, production and investment decisions at the micro level. The effects of those errors on prices and capacity linger on for many years.

Historic experiments

The <u>third</u> set of experiments on the new 1976 real firm data base was designed to investigate the feasibility of moving a "real-life model economy" onto something that resembles a steady state macroeconomic growth path. That path should stay close to some exponential growth path, given a set of internally consistent input "signals". The initial 1976 state was a state of disrupted supply conditions ("disequilibrium"). Forcing long-term, consistent external steady state conditions on the firms of the model economy (different from those that had prevailed on the average for the 20 or so years preceding 1976 and definitely at variance with the 1976 supply structure) amounts to an additional shock to the firms. The experiments were carried on for 50 years by quarter, and the reader should note carefully that these experiments were only for analytical purposes. We do not pretend to have made any kind of forecast.

We were also interested in the behavior of individual firms in the macroeconomy when positioned on that sort of steady path.

III:1. We were only partly successful in obtaining a steady state representation of the economy. It appeared as if both cyclical and very long macro fluctuations are needed for sustained economic growth to occur. If an extended boom without cycles was engineered for a long period an equally extended collapse or period of stagnation tended to follow. Such long boom periods forced "equality" and more parallel growth pattern on the firm population -- and vice versa -- by forcing the low performers to exit. More concentration followed.

III:2. The model has endogenous exit. But there is no "entry of firms device" in the current version of the model. In experiments of 50 years (200 quarters) or more the model is effectively subjected to a gradual, structural decay in the sense of diminishing micro (structural) variation. After 30 years between 78 and 97 of the 150 initial firms shut down. We conjecture that this may be the reason for the apparent macroeconomic collapse in some of our experiments. With steady entry of new firms, some of them more innovative and competitive than the best existing firms, industry structure would be updated. We hypothesize that this would have made the model economy more robust against external shocks. Such long-run experiments are very costly and we did not have the opportunity to rerun the model with an entry feature (see Eliasson 1978a, pp 52-55).

III:3 If the market regime is very responsive to external market changes a medium term allocative ("static") efficiency improvement can be obtained. In the longer term, however, competitive fall-out and "structural equalization" (due to such "forced short-term optimization") makes the whole industry very sensitive to small disturbances. If too much feasible efficiency is squeezed out of the economy in the short and medium term, the economy becomes more vulnerable to disturbances of various kinds.

One concluding hypothesis (not yet satisfactorily demonstrated through simulation experiments) is that competitive equilibrium conditions may be a non-attainable state in a dynamic micro-to-macro model economy. As model economic performance approaches this state the competitive process weeds out low performers and diversity decreases. The entire economy grows increasingly unstable (collapse prone). If you manage to steady the price structure you destbilize quantitites and vice versa.

Our conclusion is that long-term stable economic growth at the micro level in the micro-to-macro economy that we are investigating requires a wide and constantly changing performance dispersion among the participating micro units. Wide but realistic dispersion was assured initially (in 1976) through the real firm data base. Continued and changing dispersion, however, requires that no structure g of ψ be a proper subset of g(t-1). Since model structures at various points in time are proper subsets g(t-1) ε g(t), the model structure is gradually losing structural content during the 50 year (quarterly) runs reported on in the next section, and the whole model gradually converges to a very simple one-sector, one-firm model (concentration tendencies) where the whole price mechanism becomes unsettled and finally breaks down, generating strong cyclical fluctuations at the macro level. We have not had the time and resources needed to activate the entry module (see Eliasson 1978, pp 52-55) of the economy to test the interesting hypothesis that persistent structural dispersion (as opposed to convergence upon simpler and simpler structures) is a prerequisite for steady, long-term macroeconomic growth.

4 POSTSCRIPT ON OUTPUT COLLAPSES, CONTROLLABILITY AND THE NON-ATTAINABILITY OF AN EQUILIBRIUM STATE

If designed properly, the MOSES economy can be made to stay fairly close to a steady-growth trajectory for a few decades. During that period, productivity and other performance measures improve at a steady rate. But then some endogenous disturbance causes the system to "collapse" -- to fall far below the previously steady growth trajectory. In those cases where we have identified the cause of the collapse, either some large production unit has gone bankrupt or a sudden scarcity has developed in some market. The labor market and local or global wage formation is particularly critical in this respect. Sudden scarcity makes prices and/or wages rise rapidly, creating a chain reaction of output reductions in other markets. That collapse is, however, always endogenously slowed. Prices increase due to scarcities, investment and output slowly recover. The economy eventually returns to its previous steady-growth path or a new growth path and the reason has been a realignment of factor and product prices. Normally steady growth then persists for several years. If the experiment is allowed to continue, however, prices and quantities will eventually be incompatible and again the situation may be resolved by another collapse.

We call such collapses "instabilities" even though they are of limited duration and even though the economy -- the goal variables -- recover and resume their steady growth. In some simulations on some market specifications ("regimes") they appear only as short and long cycles around an endogenously determined trend.

This account of the MOSES simulations suggests an explanation of the disorderly economic behavior in the world economy after 1973. The late 50s and the 60s saw a gradual smoothing of the business cycle, and a gradual increase in capacity utilization rates throughout the production system of the industrialized world. The maintenance of countercyclical and slowly-increasing excess-demand pressure through Keynes inspired demand policies was undoubtedly at least partly responsible. The production efficiency of the industrialized world increased. This was manifested in higher total-factor productivity growth rates. We know from our simulation experiments that such a development breeds inconsistencies between quantity and price structures and is usually accompanied by an increasing sensitivity of the (real) economy to both external and internal (endogenous) price disturbances. Such inconsistencies ("tensions") may be gradually released if both the price system and quantity structures are flexible and align in the right proportions to produce long and moderated swings around a steady (endogenously determined) growth path. Flexibility can, however, be both too slow -- creating rigidities -- or too fast -- creating erroneous adjustments (overshooting etc). The conjecture would be that 10 to 20 years of successful demand management in western economies coupled by institutional and legal change that fixed both prices and quantities in past structures had eventually fostered a fragile, inflation- and collapse-prone global economic system. That system was thrown into a state of disorder by various disturbances, the most important being the 1973/74 oil price hike. On top of this came the apparent inability of policy authorities and their advicers to understand what was going on.

Analogies from much simpler physical systems may be useful here. The Northeast (U.S.) electricity blackout in 1965 is a case in point. Let us describe that collapse in terms suggestive of the economic mechanisms at work in MOSES.

The electrical power grid of the Northeastern U.S. is (and was at the time) automatically interconnected. A failure in part of the system was automatically compensated for by supplies from elsewhere or by the activation of reserve generating capacity. Two general properties of such systems are relevant here. First, the more efficiently tuned (the less spare capacity, or slack), the less the ability of such systems to cope with component failures.

Complex systems of the kind we are discussing are not well understood in all their details, and that was even more the case in 1965. They can usually be controlled only in some normal operating domain. Simplified, operating rules then apply and can control the system. The entire system (our ψ above), however, requires such a large number of combinations of rules to cope with all conceivable incidents that a listing of rules for all contingencies is infeasible. Not even extensive computer simulation studies of the entire system can identify event sequences that may be catastrophic. Such an unlikely sequence led to the 1965 blackout.

An economy is vastly more complex than a large, modern power grid. Economic blackouts are even more likely for the national economy; only their timing can be surprising.

One might then argue by analogy, that the extensive political manipulation with the Western industrial economies during the rise of their welfare state systems has carried those economies out of their normal operating domains and into inflation- and collapse-prone domains. Contemporary economic science has only a rudimentary understanding of those domains.

Within large, complex systems, the distinction between exogenous and endogenos triggering mechanisms becomes blurred. An oil price shock, or the failure of a power generator in a complex grid, would normally be called exogenous; but the consequences, which arise in ill-understood ways, arise from intrinsic features of the system.

Returning to the MOSES economy, one might say that even though the Swedish economy is vastly more complex than the 1965 Northeast power grid, the MOSES representation of it is not. Still, the MOSES economy exhibits instabilities of a similar, structural kind.

SUPPLEMENT

EXPERIMENTAL DESIGN AND RESULTS

a) The micro-to-macro model (MOSES)

This article does not allow a satisfactory description of the micro-to-macro model used as analytical instrument.

The principal idea behind the model design, however, is that long term investment financing decisions within each firm are organizationally separated from short term production and employment decisions according to what we call the additive targeting theorem (Eliasson 1976a, p 291ff). A stylized version of the production and employment machinery with a stochastic interpretation added can be found in Sharefkin's paper in this volume.

Investment spending follows a rate of return dependent cash flow that is held back by an acceleration (capacity utilization) regulator as described in Eliasson-Lindberg (1981).

The most important exogenous variables are:

- The domestic interest rate (in these experiments),
- foreign market (relative) prices (see Eliasson (1978)),
- technical change in new investment vintages at the firm level (see Eliasson (1980)) and
- the labor force

The economy is driven forward in time by these exogenous inputs only. Technical change in best practice vintages is projected forward from estimates made in Carlsson-Olavi (1978) and Carlsson (1980). Technical change is transformed into productivity growth through the individual firm investment decision each period and the current (endogenously determined) operating status of that additional capacity. Hence, economic growth is endogenously determined under an upper, unattainable technical constraint. In the short term this constraint is determined by the best alternative allocation of labor over existing vintages of capital in firms. In the long term the upper constraint is defined by the best of all possible allocations of investment resources in the model over some chosen "long-term period".

The macro household consumption system builds on modified estimates from Dahlman-Klevmarken (1971) and the income tax system is based on marginal macro tax rates estimated in Jakobsson-Normann (1974) with indexation from 1975 and onwards. This closes the demand and supply sides of the MOSES economy.

A principal presentation and overview of the model is found in Eliasson (1978a and 1983). Bergholm (1983) presents the current operational status of the model and Albrecht-Lindberg (1983) the micro data base used for initializing the model runs.

b) The 1973/74 oil price shock accommodation under various market assumptions - step one

In the first experimental round we designed a set of experiments on a real firm data base, but with incompletely specified initial, structural conditions. Most importantly, the spread in production efficiency - measured by labor productivity - under normal capacity utilization across firms was unrealistically small.

As exhibited in some detail in tables 1 through 3 we had four different experiments set against a reference run and reality; high, semi-high, slow and very slow response. To get familiar with these "market regimes" the reader should first consult table 3. The market response parameters are explained in table 2. In table 3 they have been varied, one at a time, and the macroeconomic outcome has been compared with a chosen reference run. The results are commented upon in a separate text accompanying the table. Each of the four market regimes in table 1 represents a certain combination of response parameters in tables 2 and 3.

We ran the real foreign relative price scenario through these four economies for the years 1968-1975. Relative prices then took on a continued stable trend together with all other exogenous variables from 1976 through 1988. Tables 1 and 3 show simulation results for the first 8 years only.

This meant that relative price experience, interpreted by firms in the data base from 1963, was a fairly reliable predictor of future price change through 1970. There is a brief recession experienced by all in 1971, followed by a dramatic disruption of past price experiences, both relatively and absolutely, especially for basic industries through part of 1974, followed again by a complete and unexpected reversal. Price expectations in firms are formed in an adaptive, error correcting ("learning") fashion. If price development follows a stable cyclical pattern, firms are gradually learning to predict with some reliability. When this pattern in price behavior disappears - as it did after 1974 - firms first projected past patterns and made production and investment mistakes. When the error learning mechanism failed to predict well they became confused and adopted a cautious stance, in the sense that prices were underestimated and wages overestimated compared to what the same price signals would otherwise suggest.

High or fast market response means that a firm puts heavy weight on recent experience and responds very rapidly with quantity adjustments. Slow is the reversed situation. High (fast) response would guarantee rapid approach to a steady equilibrium point, if it exists. All actors in the market would learn the signalling code and expectations would appear to be rational. If the equilibrium is not stable because firms are adjusting too rapidly according to erroneously perceived future prices, the price system that determines the "equilibrium position" is disrupted again. The same expectational assumptions at the micro level would generate price expectations that, for instance, would not approximate -- within a meaningful time horizon -- what a rational expectations hypothesis would predict.

Macroeconomic behavior of the model is illustrated in the table. Over the "real time" period the normal and the semi-high market response patterns generate the highest growth rates that are also reasonably close to reality, as shown in the left hand column. The fast and the slow response patterns are not so good. The industrial sector loses almost half of its growth momentum during the 8 year period ending in 1975. Hence, extreme market regimes (very speedy or very slow) do not seem to be conductive to growth in this experimental setting of the model economy.

However, when the exogenous environment is allowed to stabilize on past trends from 1976, things are reversed again under some market regimes. Firms gradually learn to interprete price signals and to predict. Under other regimes a destabilized economy never gives domestic prices a chance to stabilize even though foreign (exogenous) relative prices are forced back (exogenously) on a steady state development.

The high response economy (called 822 in Table 1) is in a bad shape, exhibiting rapidly adjusting investment and production decisions along tangential expectations, that turn out to be all wrong. The economy collapses over the next 10-15 years, registering a steady decline in industrial production of 7 % per year.

However, the very cautiously-responding decision makers of experiment 831 that have not adjusted their structure very much and that have remained faithful to historic, pre-crisis price experience, of course benefit from the return to past price trends. Their old assets suddenly became profitable again. They win out substantially in the overall 20 year run.

To judge from Josefsson-Örtengren's (see their paper in this volume) historic price study, relative domestic prices on manufactured goods, in fact, more or less returned to pre 1973/74 positions by the end of the decade. When that relative price structure is imposed in the experiment on foreign prices towards the end of the 80s, the results mentioned above were obtained. In reality, on the other side, a new OPEC price shock occured in 1979, and threw the economic system into turmoil again.

Table 1 Shock accommodation under different market regimes. Eight year experiments beginning 1968 (endogenous variables)
Percentage change per annum, when not otherwise indicated in variable list

	REAL	REF 800	LOW LOW 831	LOW 821	SEMI HIGH 832	HIGH 822	1000	REF 1035
Q	6.4	5.0	3.7	4.5	3.1	-7.1	5.9	5.6
L	-1.3	+0.8	-0.2	-0.5	+1.8	-10.3	0.8	-0.2
PROD	5.5	4.8	4.4	5.5	3.0	11.0	5.9	5.8
PDOM	6.1	7.0	5.8	7.0	8.5	9.1	7.0	7.7
W	12.7	13.0	2.8	16.7	13.7	28.1	14.0	15.7
M	31.5	40.9	47.4	37.9	43.5	29.5	40.8	33.0
A21	7.8	4.4	8.6		4.7		4.1	3.8
A22	6.4	14.1	15.0		15.1		14.5	13.2
RU	(2.0)	6.3	8.9		6.7		5.9	3.3
CON	2.7	-0.2	-1.7		-1.5		-	6.0
GNP	3.1	3.7	2.2		3.2		4.6	5.7
CPI	6.4	6.7	6.0		7.7		6.5	7.2
DI	11.1	6.9	4.4		6.5		7.2	13.1
SAVR	3.0	3.3	2.0		3.1		5.0	8.3
RI	7.3		-		-		2.6	6.3
X	31.6	33.3			-		33.4	29.0
IMP	28.6	24.5			-		25.0	27.4
BW	13.5	14.4	11.2		13.8		19.1	17.7
NW	10.4		5.9		8.6		-	5.4
X(vol)	6.2		7.5		7.5		10.1	8.8
M(vol)	(6.2)		2.6		2.0		6.8	9.8
Production by subindustry								
(1) RAW	6.5	6.4	5.4				7.3	7.1
(2) IMED	3.2	5.5	4.7				6.6	4.8
(3) INV	6.8	4.1	3.0				5.1	4.9
(4) CON	2.5	4.6	2.9				5.5	5.7

Note: Symbols are explained on next page. Numbers in headings are identification numbers for experiments. We have kept them for easy reference both in text and back to sources.
A reference case (REF) is a carefully calibrated model specification that reasonably well tracks the trends of the real national accounts variables (see Eliasson, 1978a, pp.32-51). The main difference between REF 800 and REF 1035 is that experiments with numbers above 1000 have a monetary sector with an endogenized domestic interest rate turned on -- the foreign interest rate is exogenous. Note, however, from Table 2 that some other parameters also had to be changed to obtain satisfactory tracking performance. Since experiments in tables 1, 2 and 3 were run a couple of years ago -- partly for other purposes -- all data have not been computed on the format of the table. Too much work to be practicable was needed to recompute all runs to complete the entire table.

Table 2 **Parameter specification**

	800	821 (Low)	822 (High)	832 (Semi-high)	831 (Low Low)	823	824	825	826	827	828	829	830	1000	1035	1036
NITER	9	9	18	12	5	12								9	9	
KSI	0.15	0.15	0.5	0.3	0.1		0.3							0.15	0.25	
IOTA	0.5	0.5	0.9	0.6	0.3			0.6						0.5	0.5	
SKREPA	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	
MAXD	0.06	0.06	0.18	0.18	0.03				0.18					0.06	0.06	
MARKETITER	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	
GAMMA	0.1	0.3	0.1	0.1	0.3					0.1				0.1	0.1	
THETA	0.01	0.01	0.05	0.03	0.005						0.03			0.01	0.01	
TMX	5	5	1	3	7							3		5	3	
TMIMP	5	5	1	3	7								3	5	3	

Variable list

Q; industrial output
PROD; labor productivity
M; profit margin (percent of value added)
A22; unused machinery capacity
GNP; Gross national product, constant prices
DI; disposable income, current prices
RI; rate of interest on industrial loans, (exogenous in all experiments except 1000 and 1035)
BW; borrowing in manufacturing sector
X(vol); export volume

L; industrial employment
W; industrial wage cost level
A21; labor hoarding (percent of employed, measured in hours)
RU; unemployment (percent)
CPI; consumer price index
SAVR; household savings ratio (percent of DI)
X; export ratio (percent of gross output)
IMP import ratio
NN; net worth (nominal) in manufacturing sector
M(vol); import volume

Table 3 Sensitivity analysis, single parameters
Trends 1968-75 for manufacturing (8 years)

	REAL	REF 800	831 Low Low REF	823	824	825	826	827	828	829	830
DO	6.4	5.0	3.7	3.8	3.8	4.4	3.8	3.7	3.7	4.7	4.3
DL	-1.3	+0.8	-0.2	0.3	-0.1	0.4	+1.3	-0.2	0.4	0.4	0.3
DPROD	-	4.8	4.4	4.1	4.5	4.6	2.8	4.4	3.8	4.8	4.6
DPDOM	6.1	7.0	5.8	5.8	5.8	5.8	7.6	5.8	5.8	6.6	5.8
DW	12.7	13.0	2.8	4.4	4.9	6.3	4.3	2.8	3.2	8.8	4.4
M	31.1	40.9	47.4	46.6	46.6	43.9	49.1	47.4	46.8	46.0	46.8

Explanation to Table 3

The reference for the single parameter sensitivity analysis is the low-low market response case in Tables 1 and 2. Note that the table only exhibits 8 year runs. In the longer term some of the effects may not be sustainable, for instance, the positive output effect in experiment 825. For such experiments see Historic experiments below.

First (823) we more then double the number of searches each firm is allowed in the labor market each quarter (from 5 to 12 = NITER, see Table 2). Obviously most labor is being reallocated and industrial employment increased compared to the reference case. A substantial increase in wages over the reference case is observed, but only a very small, positive output effect. Profits suffer.

Second (824) the propensity of (the extent to which) a firm in search of labor to upgrade its own wage level when it meets another firm a with higher wage level is increased from 10 percent to 30 percent (=KSI). Again, only an extra wage escalation that eats into profits can be observed.

Third (825) we double the fraction of the expected next year wage increase that the firm uses as its initial offering bid when entering the labor market (from 30 to 60 percent = IOTA). This time wage escalation is even higher and the profit margin decrease larger, but a stronger positive output effect from the reallocation of labor can also be observed. Total manufacturing output grows .7 percent faster per annum 1968-75 than in the reference case. The reader should note here that model specifications are such that firms needing more labor for profitable expansion enter the labor market first.

Fourth (826) the imposed restriction on product price dispersion (fraction by which price increases are allowed to differ from expected values during one year = MAXDP) is lifted from 3 percent to 18 percent. The result is higher product prices, higher profit margins and more employment, but no more output. Labor productivity growth is almost halved.

Fifth (827), the reservation wage of the worker is lowered. He now moves in response to a wage offer only 10 percent (=GAMMA) above his correct wage, rather than 30 percent as in the low-low response reference case for these experiments. Everything else being the same, there is very little macroeconomic change to observe in the table.

Sixth (828), we raise the proportion of a firm's labor force that is allowed to quit in response to a generous wage offer from one raiding firm from 1/2 percent to 3 percent (=THETA). The macroeconomic reponse is higher wages, smaller profit margins, more employment and less productivity growth, but no positive output effect.

Seventh (829). Export price elasticities are raised. Firms aim at adjusting their export ratios to levels motivated by foreign domestic price differentials in 3 years rather than in 7 years (=TMX). This time a strong output expansion propelled by export growth sets in. It is, however, inflationary in both domestic prices and wages, and the cost for firms is somewhat lower profit margins (a higher wages share).

Eight (830). The same variation is now imposed on import price elasticities. The effect on output and domestic employment is the same. Increased foreign price competition, however, leads to no extra domestic price increases.

c) **Price pivoting - step 2**

In this set of experiments the structural adjustment of the economy to post 1973/74 (oil shock) relative price signalling is studied under three initial structural specifications. External conditions ("price pivoting") are imposed by pivoting relative foreign prices against, or in favor of, certain markets, while preserving the time development of the aggregate industrial export price index.

In the first simulation round - shown in Figures 4 - structural variation across the initial firm population is small. The micro firm data base is all synthetic. The productivity spread across the firm data base was very narrow. In the second round of experiments we used the new real firm data base with half the number of firms being real and with more across-firm diversity in terms of initial productivity. A more elaborate set of experiments, with both differing tax and market regimes, on exactly this second experimental set up has already been reported in Eliasson-Lindberg (1981). The two sets of experiments were initialized on the 1968 data base. 1968 was a fairly normal recession year of the 60s.

A third set of experiments (not reported on) has been run on the new 1976 data base with 150 real firms. Practical reasons and costs prevented an identical experimental design. Nevertheless the results from the third set of experiments emphasize the differences observed between the two first experiments, namely that structural variability is imperative for economic systems stability when the economy is subjected to exogenous disturbances. If this is a normal property of an economy it indeed warrants further empirical inquiry. This same 1976 initial data base will be used in the historic experiments to be reported on in the next section. It was also used to analyze the shock-like interference in the Swedish economy of an extreme industrial subsidy program and the imagined (MOSES simulated) withdrawal of these subsidies (Bergholm-Carlsson-Lindberg, 1981). The 1976 real firm data base is described in Albrecht-Lindberg (1983).

From this also follows as a supplementary suggestion that, if you do not properly specify and measure your initial conditions, you cannot say very much about the results of any policies or parameter variations. Initial conditions dominate the dynamic nature of the effects. Comparing two equilibrium situations does not appear to be a very interesting or fruitful exercise at all after this inquiry.

Some results from the first set of experiments on all synthetic firms are shown in Figures 4. The second set is reported on in much detail in Eliasson-Lindberg (1981. To get the exact meaning of price pivoting, see Figure 2, page 402.) Because of that we only report briefly on the results. In both cases relative prices are pivoted slowly (5 years) and rapidly (one year) against and in favor of basic industries respectively. After pivoting, the realized relative price spectrum is preserved throughout the 20 year period studied. It appears that rapid relative price pivoting

Figure 4 Sector outputs, profit margins and labor productivity developments in price pivoting experiments
Index 100 = Reference Run

Figure 4A Output (Q) with relative foreign price pivoting in favor of raw material industries (RAW)

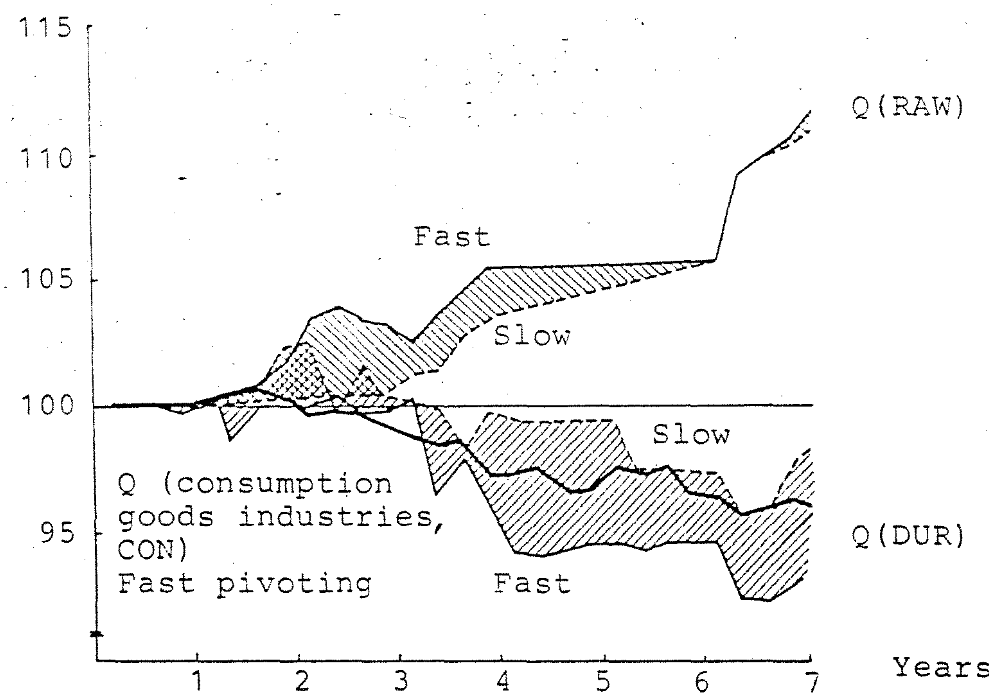


Figure 4B Ditto, pivoting in favor of durable goods industries (DUR)

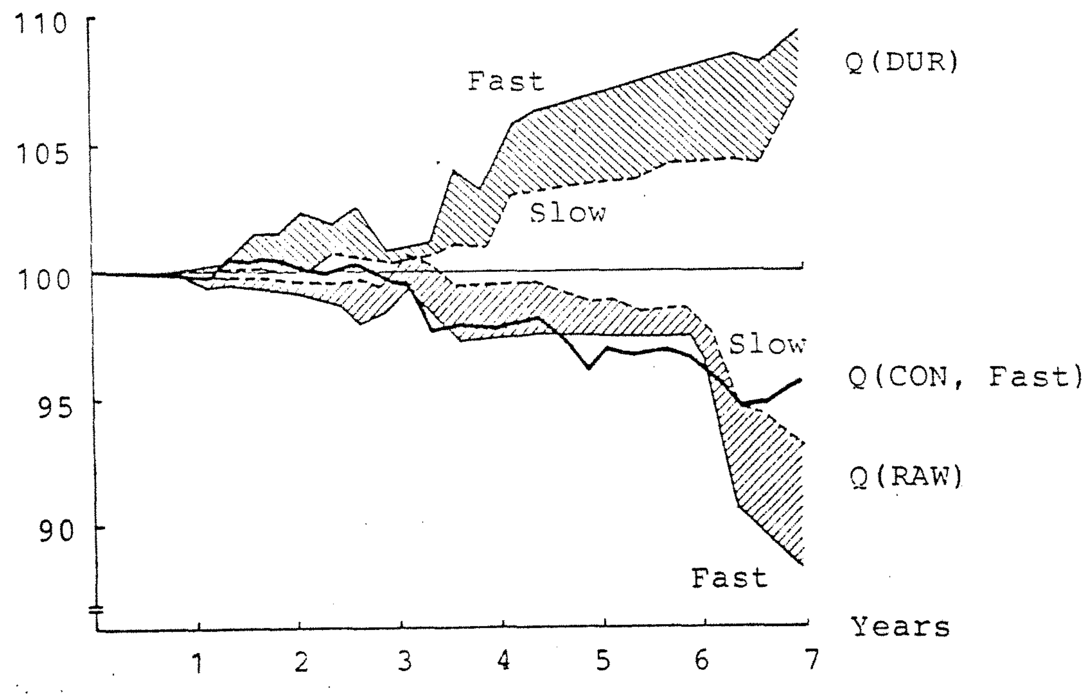


Figure 4C Profit margins in fast and slow pivoting experiments

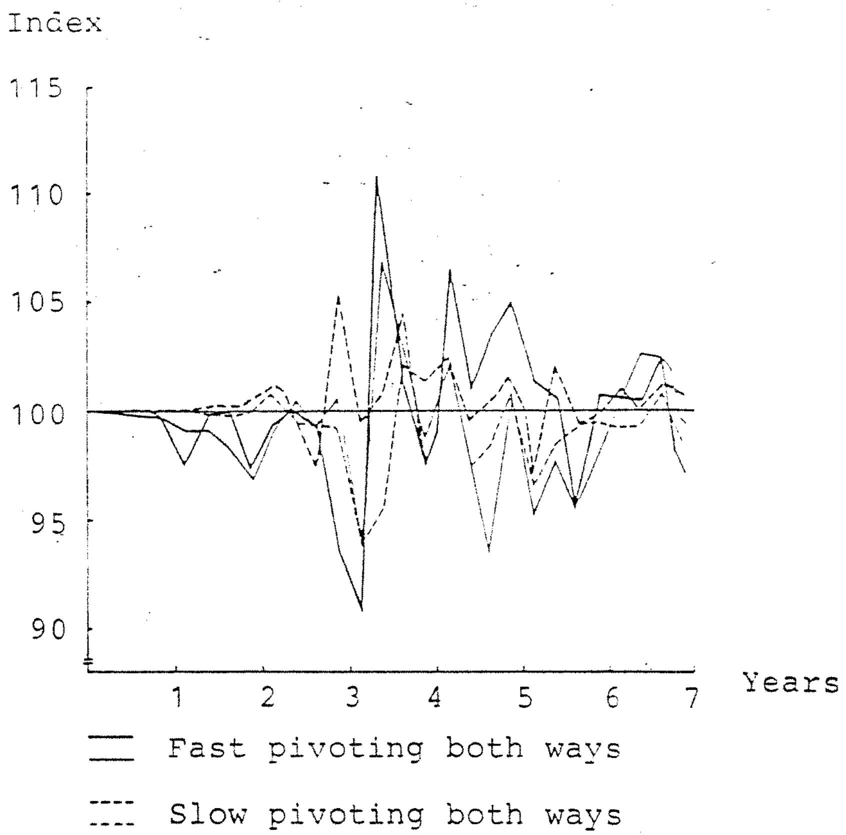
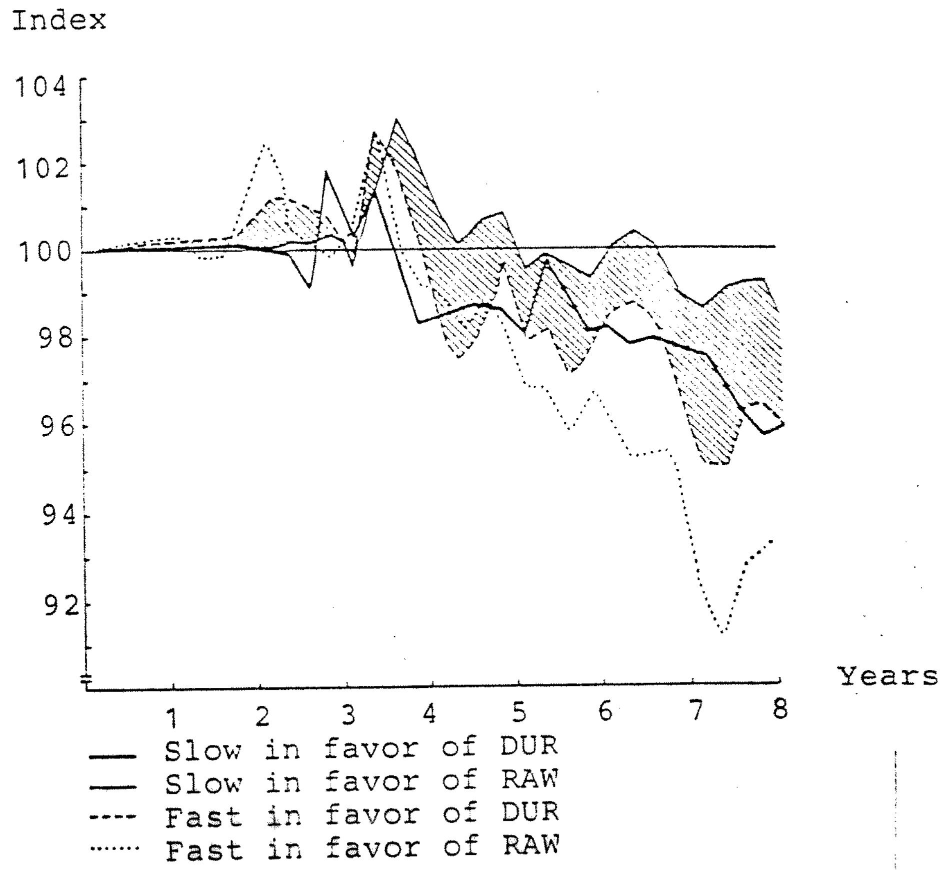


Figure 4D Labor productivity developments, all manufacturing



under a fast market response regime is an unstable combination that makes the economic structure prone to collapse. Total output decreases.

One expected result is clearly exhibited. The price-favored sector gains in output growth and vice versa. Overall manufacturing output growth decreases for all of the 20 years of the experiments, but more so the faster the pivot. The decrease appears larger when pivoting is in favor of raw material producers, probably because raw material producers were relatively less efficient in the initial 1976 state.

Average manufacturing productivity declines in all experiments relative to the reference case (Figure 4D). Profit margins, however, stabilize in all experiments around the level of the reference case, even though the ups and downs are larger in the fast pivoting experiments (Figure 4C).

The less across-firm variability in productivity performance, the more likely that a large fraction of output capacity in the sector that is hurt by the market development will be forced to exit at an early stage, generating a sudden supply vacuum in that market. A temporary increase in the domestic price level much above the foreign price level, and an excessively rapid expansion in the remaining firms, are consequences. Then follows a sudden influx of imports that takes the domestic price level down below the foreign price level. This instability keeps repeating itself and spreads to other sectors.

The more initial, structural variation and the smaller (slower) the quantity responses of the system per unit of time, the smaller the total output loss over the entire experiment.

d) **Historic experiments - step 3**

The goal of this experiment was to define a set of consistent external assumptions for the model and then attempt to engineer a steady growth path of output determined by the underlying technology assumptions on productivity change in best-practice, new investments. The external assumptions were set up as follows:

		Annual change (percent)
(1)	Foreign price (each sector DPFOR)	5
(2)	Labor productivity in new investment (each firm, DMTEC)	2,5
(3)	Credit market loan rate	7,5
(4)	Labor force (net)	0
(5)	Public sector employment	1

These exogenous assumptions were imposed "for ever" after an initial adjustment period from "real" data 1976 of 2 years. No relative price change was assumed, and all firms drew upon a pool of equally specified investment objects.

Initial conditions end of 1976 are as observed in the IUI-Federation planning survey. Hence, as introduced in this set of historic runs, they are far from any kind of"equilibrium" state. Any change in external market conditions back to normal or back to a consistent and steady long-term input of exogenous variables would mean something like a shock for the firms residing in the initial state of the experiment.

Furthermore, the period preceeding 1976 is one of abnormal change, due to the oil price disturbance. This shows up in the data base that defines the last 5 years of experience of the firms. Hence, the market environment of the firms at the end of 1976 has a very different interpretation and appears -- to them -- very difficult to predict. Generally speaking, firms' expectations (learning) functions would not generally predict well.

Wages are endogenously determined within each firm under a constraint: that firms try to maintain a profit margin determined from a long run profitability target as long as this does not mean that they plan to lower profits below a level that they expect is feasible. This means that firms allowing wage change to exceed

DPFOR + DMTEC = 7.5 percent

for many years will experience cash flow problems. If they continue they either have to shut down or dwindle away, since they cannot finance continued investments.

The long-run profitability target is imposed through the credit market (exogenously here). Firms invest in the long run in proportion to their real rate of return, and they borrow to invest in excess of internal cash flows in proportion to their excess rate of return above the market loan rate.[6] Hence the exogenously applied loan rate will eventually dominate both the investment and the short term (quarterly) production decisions.

Since individual-firm profitability will eventually depend on the "equalitarian" productivity assumption in new investments, one would expect that very similar rates of return will eventually obtain across firms, namely when all pre 1976 vintages have been replaced by new investment. In the longer term a 7.5 percent nominal rate of return equal to the interest rate should prevail.

Thus, in the long-run all firms should be very similar, it appears.

Three differently-specified market regimes are sufficient to illustrate our arguments. In the low or slow market adjustment regine (specifications are identical to those in Table 2) firms are slow (KSI is low) to upgrade their own wage level when they learn about firms that have higher wage levels. Firms are slow in looking for new labor, when they need it (NITER is low). Even though firms expect a wage increase next year they offer only a small fraction of the expected increase when they enter the labor market to hire people (IOTA is low). Firms are slow to adjust prices above or below expected levels when the market is expansive or in recession (MAXDP is narrow). Workers have a high reservation wage: they require a fairly large increase above the current wage to move (GAMMA is high). Finally, only a very small fraction of a firm's labor force leaves each time the market (other firms) offers generous wage increases (THETA is small). In the high or fast market response case (822) all those parameters are changed in the opposite direction, as specified in Table 2. There is a normal market regime (REF = 800) identical to the low case except for the reservation wage. Workers leave for the same wage increase offer (more than 10 percent) as in the high response case.

What do the simulation experiments tell us? The story is very straightforward (see Figure 5).

The high market response case generates an initial period of fast output growth. For thirty years, output growth is close to what is feasible. (The upper line (MAX) defines maximum output growth with no additional labor input and all installed capacity replaced by new vintage capital each period.) Firms are very competitive, and each sector is restructuring very fast in response to the adjustment in foreign prices imposed by the experiment. A large number of firms are competed out of business, and the remaining firms (in each sector) are beginning to take on very similar performance characteristics. Laid off labor is not rehired because the achieved industrial organization is very efficient. The reason for this high performance up to the year 30 is essentially the high utilization rate of existing capital. Apparently this steady, fast growth situation is not very stable. A few large firms need more labor just after year 30. To get it, they increase their wage offers more than had been normal earlier, and other firms start losing workers (because of fast response assumptions). All other firms rapidly adjust their wage levels, and a whole range of similarly profitable and productive firms suddenly find themselves in a distressed situation. A wave of bankruptcies and exits follows, and the economy goes into a tail spin. 30 years of fast growth is replaced by an almost 15 year period of complete stagnation until the economy begins to recover. In the high-high market response case (not shown), the growth period is terminated even faster and the the following depression is extreme.

In the low response and the normal cases there is no initial, fast growth period and no collapse. The low response case yields a long run 50 year terminal output level almost equal to that of the high response case after the collapse. The normal case (REF) yields a substantively (30 percent) higher terminal output level, corresponding to roughly 0.7 percent faster output growh per year.

One can note from the diagram that average profit margins are lower and more unstable in the high market response case, although the business sector manages to restore long run profitability at the expense of less investment, less growth and higher unemployment.

Long-run manufacturing output growth is increased even more if the governmnet abstains from drawing one percent extra from the labor force every year (REF 2). Manufacturing output now grows almost 0.9 percent faster per annum for 50 years than in the normal market case. More firms remain at the end of 50 years, and productivity growth is slightly slower (since the manufacturing sector now employs practically all people that went to the government sector in the earlier case). Unemployment was slightly higher in the beginning, then roughly the same (below 2 percent all years after 30 years). Profitability is the same as in the normal case but the output level is 50 percent higher, and 75 percent higher than in the low response and high response market regimes.

On the other hand, if the public sector pulls two percent, rather than one percent, extra from the labor market every year (i.e., if public employment increases exogenously by two percent every year) while the labor force does not increase at all, the industry sector collapses very soon, due to an extreme wage cost inflation that throws all firms, except the very best out of business (not shown).

A semi-high market regime (same as 832 in Table 2, simulation results not shown) produces expected results. The early, first 30 years' upswing and the following collapse are not as pronounced as in the high-response market regime. The economy has recovered substantially and much more than in the high market response case by the year 50.

An extreme low-low market response (same as 831 in Table 2, results not shown) produces an assymetric set of results, fully compatible with our idea of an optimal rate of structural adjustment. In the high- and semi-high market response settings, adjustments of structures were too fast, and generated instabilities in the model economic system. This time adjustment is too slow, and the "steady state resemblance" of the REF and low experiments (see Figure 5A) disappears. After 20 years of fairly slow expansion, 20 years of complete stagnation in industrial output follows. During the last 10 yearsof the experiment, the industrial structure has finally adjusted to the steady state conditions imposed exogenously and a rapid catching up effect in output can be seen. By year 50 output has reached the level of the REF case.

The reader should note that assumptions about initial conditions and technical change embodied in new investment have been identical in all historic experiments reported. Experimental designs differ only by market regime. This should be sufficient to demonstrate the extremely important role of the market regime in explaining long-term macroeconomic growth.

Figure 5 Historic experiments 1977-2027 (50 years)

Figure 5A Industrial output
Index 100 = 1976

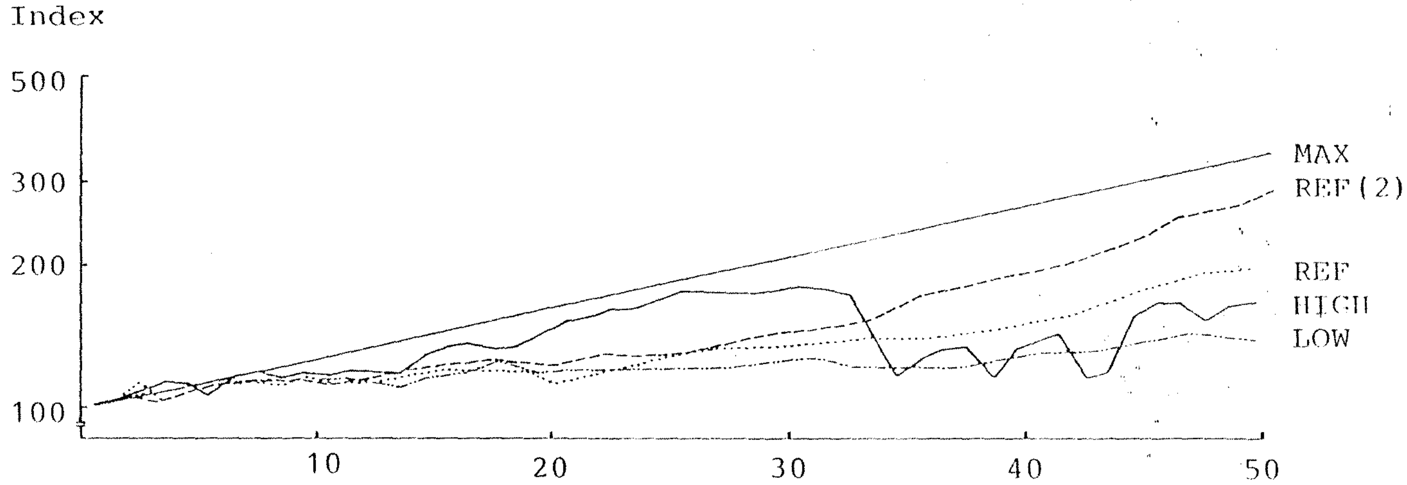
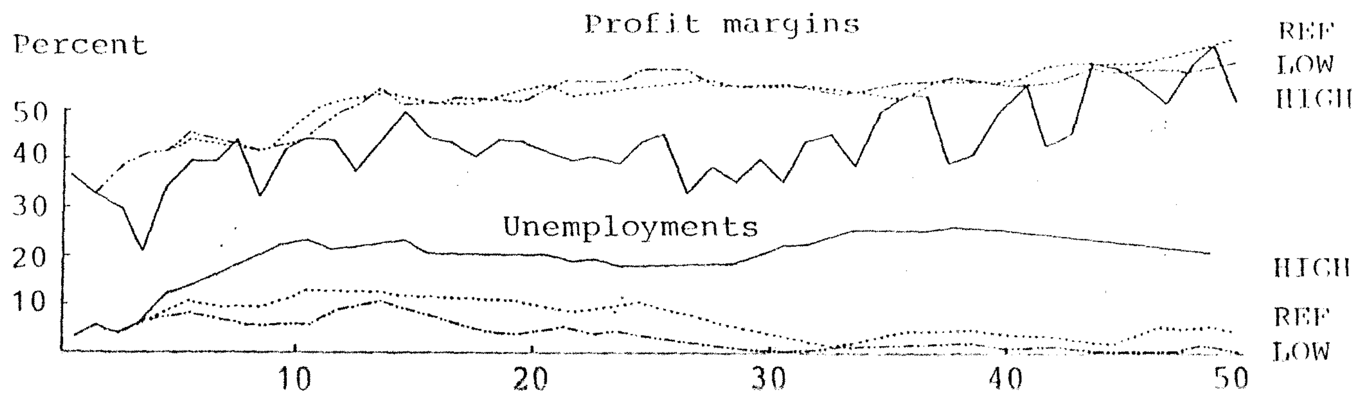


Figure 5B Profit margins (percent of value added, upper part) and unemployment (percent, lower part)



Two additional things should also be mentioned here. First, technical change at the plant level has been set roughly at the rate of growth that we have observed for best practice plants during the period 1955/75. Nevertheless, manufacturing output growth is only at about half the rate observed during that period or during the preceeding 100 years. If the rate of output growth in Swedish manufacturing had continneed for the next 50 years along the 100 year trend established 1870-1970, output would have been more than four times larger -- and the index in Figure 5A at just above 1400 -- in the year 2027. Two factors help explain this difference. This time best practice investment have identical characteristics throughout the manufacturing sector, and there is no growth in the labor force. Hence, there is much less potential for structural change than has normally been the case. When we introduce more diversity, larger long-term growth rates are normally obtained. But structural change, induced by different market regimes, nevertheless, manages to generate a growth difference of 1.5 percent per annum on the average for 50 years in the four cases reported on.

A second factor may, however, be an even more important explanation. The MOSES model as currently set up has an endogenous exit feature but no market entry. Lacking this innovative potential typical of a capitalistic market economy, the Swedish economy as described by the model is subjected to a gradual, structural decay. In short period (up to 20 years) runs this does not matter so much. In 50 year runs it matters a lot. Market competitive vitality is lost (as we have demonstrated in a few experiments with entry (Eliasson, 1978a, pp 52ff). Firms tend to become very similar, and grow in phase. The economy gets very sensitive to disturbances. The loss of diversity (to many exits) was what brought the MOSES economy down after 30 years in the high-market response case.

BIBLIOGRAPHY

Albrecht, J.-Lindberg, T., 1983, Micro Initialization of MOSES, IUI, Stockholm (forthcoming).

Arrow, K.J., 1971, "The Firm in General Equilibrium Theory" in Marris-Wood (eds) The Corporate Economy: Growth, Competition and Innovative Potential, London.

Arrow, K.J. - Hahn, F.H., 1971, General Competitive Analysis, San Fransisco, Edinburgh.

Arrow, K.J. - Hurwicz, L., 1977, Studies in Resource Allocation Processes, Cambridge, London, New York, Melbourne.

Arrow, K.J. - Kurz, M., 1970, Optimal Growth with Irreversible Investment in a Ramsey Model, Econometrica, Vol. 38., No. 2.

Bergholm, F., 1983, How to Run the MOSES Model, IUI (forthcoming).

Bergholm, F.-Carlsson. B.-Lindberg, T., 1981, Industristödspolitiken och dess inverkan på samhällsekonomin, IUI, Stockholm.

Berlinski, D., 1976, On Systems Analysis: An essay concerning the limitations of some mathematical methods in some social, political and biological sciences, Cambridge, Mass., London.

Carlsson, B., 1981, The Content of Productivity Growth in Swedish Manufacturing, in The Firms in the Market Economy, IUI 40 Years, Stockholm.

Carlsson, B.-Olavi, G., 1978, Technical Change and Longevity of Capital in a Swedish Simulation Model, in Eliasson (1978a).

Dahlman, C.J.-Klevmarken, A., 1981, Den privata konsumtionen 1931-1975, Stockholm (IUI).

Day, R.H., 1982, Irregular Growth Cycles, AER (June).

Day, R.H., 1982b, Dynamical Systems Theory and Complicated Economic Behavior, Working Paper 8215, Department of Economics, USC, LA.

Debreu, G., 1959, Theory of Value, Cowles Foundation Monograph 17, New York.

Eliasson, G., 1977, Exchange Rate Experiments on a Micro Based Simulation Model, Industrikonjunkturen, spring.

Eliasson, G., 1978a, A Micro-to-Macro Model of the Swedish Economy, IUI Conference Reports 1978:1 (Stockholm).

Eliasson, G., 1978b, "Relative Price Changes and Industrial Structure - the Norwegian case", in Carlsson-Eliasson-Nadiri (eds), The Importance of Technology and the Permanence of Industrial Structure, IUI Conference Volumes 1978:2.

Eliasson, G., 1983, The Firm and Financial Markets in the Swedish Micro-to-Macro Model (MOSES), IUI (forthcoming).

Eliasson, G. - Lindberg, T., 1981, Allocation and Growth Effects of Corporate Income Taxes, from Eliasson-Södersten (eds) Business Taxation, Finance and Firm Behavior, IUI Conference Reports 1981:1 (Stockholm).

Fisher, F.M., 1965, "Embodied Technical Change and the Existence of Aggregate Capital Shock", Review of Economic Studies (32).

Fisher, F.M., 1969, The Existence of Aggregate Production Functions, Econometrica (37).

Fisher, F.M., 1982, "Aggregate Production Functions Revisited; the mobility of capital and the rigidity of thought, Review of Economic Studies (158).

Grümm, H.R., 1976, Definitions of Resilience, IIASA, RR-76-5.

Holling, L.S., 1973, Resilience and Stability of Ecological Systems, Ann Rev. Ecol., Syst 4, 1-24.

Jacobsson, U.-Normann, G., 1974. Inkomstbeskattningen i den ekonomiska politiken, Stockholm, IUI.

Klein, B.H., 1983, Prices, Wages and the Business Cycle: a Dynamic Theory, New York and London (Pergamon Press).

LaSalle, J. - Lefschetz, S., 1961, Stability by Liapunov's Direct Method, New York, London.

Lindahl, E., 1939, Studies in the Theory of Money and Capital, New York.

Lorentz, E, 1963, "The Mechanisms of Vacillation", Journal of the Athmospheric Sciences (Sept.).

May, R.M., 1973, Stability and Complexity in Model Eco-systems, Princeton.

Simon, H.A.-Bonini, C.P., 1958, The Size Distribution of Business Firms, AER (Sept.).

Smale, S., 1967, "Differential Systems and Structural Stability", Bulletin of the American Mathematical Society, No. 73.

Smale, S., 1976, Dynamics in General Equilibrium Theory, AER (May).

Thom, R., 1975, Structural Stability and Morphogenesis, Reading, Mass.

Zeeman, E.C., Catastrophe Theory, selected papers, London etc. (Addison-Wesley)

Ysander, B-C., 1981, Taxes and Market Stability in Eliasson-Södersten Business Taxation, Finance and Firm Behavior, IUI Conference Reports 1981:1.

NOTES

[1] Or a "generically stable process", as they are also called.

[2] A similar kind of arbitrariness afflicts the choice of "lag length" in economic modeling.

[3] (in ca sid 18) This property has been observed frequently in the MOSES micro-to-macro economy, for instance when simulating exchange rate changes under variously composed initial conditions as to capacity utilization (Eliasson, 1977). Another example of this is that when an entry of firms module was added to a series of simulation experiments, relative prices stabilized compared to the case with no entry, because local bottlenecks disappeared at various points in time during the simulations. As a result of a more stable relative price development also economic growth was somewhat increased (Eliasson, 1978a, p 52-55).

[4] For reasons of cost or time we have been unable to design the experiments in such a fashion that all results can be neatly exhibited and compared. There are several open ends and practical considerations made impossible a revamping of the 1976 data base to a new base with more similar firms, which would have been the preferred experimental procedure. The results are, however, of such a nature as to warrant an exploratory presentation of this kind.

[5] Note that we have later fed the model with the real price development 1973 through 1976 and simulated future development of the Swedish economy on the basis of real price development through 1980, on the 1976 real data base with and without the Swedish industrial subsidy program fitted in exact amounts to the actual firms that received subsidies. The results support the above conclusions. See Bergholm-Carlsson-Lindberg (1981).

[6] The **profit targeting** and **investment** decisions can be briefly described as follows:

For the sake of simplicity, assume no dividends.

Goal variable = value growth of firm $= \Delta NW/NW$

NW = net worth (replacement valuation of assets).

$$\frac{\Delta NW}{NW} + \frac{DIVIDENDS}{NW} = RNW = M * \alpha - \left(\rho + \frac{\Delta p}{p}\right) * \beta + (RRN - i) * \Phi \quad (1)$$

$$\alpha = \frac{sales}{assets}$$

β = fraction of depreciable assets in total assets.

ρ = depreciation factor

ϕ = ratio of debts to net worth (NW)

RRN = Nominal return to total assets

i = nominal loan rate.

Profit margin = M = 1 - $\frac{W}{P}$* $\frac{1}{Q/L}$ (2)

Targeting applies to M.

A target on M can be determined by the help of (1) from a target on RRN (the rate of return). This target in turn can be derived from the nominal rate of return on net worth (RNW).

Given expectations on W (wages) and p (product prices) and a target on M, a labor productivity requirement follows from (2). This is the way the production decision in a firm is taken.

The decision to acquire further debt is linked to the difference (RRN - i) in (1). When new borrowing is determined also total available finance for investment is given from the production-profit plan. The investment - financing plan is realized if not held back by the existence of unused machinery capacity in the firm (endogenous variable).

WORKING PAPERS (Missing numbers indicate publication elsewhere)

1976

1. Corporate and Personal Taxation and the Growing Firm
   by Ulf Jakobsson

7. A Micro Macro Interactive Simulation Model of the Swedish Economy.
   Preliminary model specification
   by Gunnar Eliasson in collaboration with Gösta Olavi

8. Estimation and Analysis with a WDI Production Function
   by Göran Eriksson, Ulf Jakobsson and Leif Jansson

1977

11. A Comparative Study of Complete Systems of Demand Functions
    by N Anders Klevmarken

12. The Linear Expenditure System and Demand for Housing under Rent Control
    by Per Högberg and N Anders Klevmarken

14. Rates of Depreciation of Human Capital Due to Nonuse
    by Siv Gustafsson

15. Pay Differentials between Government and Private Sector Employees in Sweden
    by Siv Gustafsson

1979

20. A Putty-Clay Model of Demand Uncertainty and Investment
    by James W. Albrecht and Albert G. Hart

1980

25. On Unexplained Price Differences
    by Bo Axell

26. The West European Steel Industry - Structure and Competitiveness in Historical Perspective
    by Bo Carlsson

27. Crises, Inflation and Relative Prices in Sweden 1913-1977
    by Märtha Josefsson and Johan Örtengren

33. The Demand for Energy in Swedish Manufacturing
by Joyce M. Dargay

34. Imperfect Information Equilibrium, Existence, Configuration and Stability
by Bo Axell

1981

35. Value Added Tax: Experience in Sweden
by Göran Normann

36. Energi, stabilitet och tillväxt i svensk ekonomi (Energy, Stability and Growth in the Swedish Economy)
by Bengt-Christer Ysander

37. Picking Winners or Bailing out Losers? A study of the Swedish state holding company and its role in the new Swedish industrial policy
by Gunnar Eliasson and Bengt-Christer Ysander

38. Utility in Local Government Budgeting
by Bengt-Christer Ysander

40. Wage Earners Funds and Rational Expectations
by Bo Axell

41. A Vintage Model for the Swedish Iron and Steel Industry
by Leif Jansson

42. The Structure of the Isac Model
by Leif Jansson, Tomas Nordström and Bengt-Christer Ysander

43. An Econometric Model of Local Government and Budgeting
by Bengt-Christer Ysander

44. Local Authorities, Economic Stability and the Efficiency of Fiscal Policy
by Tomas Nordström and Bengt-Christer Ysander

45. Growth, Exit and Entry of Firms
by Göran Eriksson

47. Oil Prices and Economic Stability. The Macroeconomic Impact of Oil Price Shocks on the Swedish Economy
by Bengt-Christer Ysander

48. An Examination of the Impact of Changes in the Prices of Fuels and Primary Metals on Nordic Countries Using a World Econometric Model
by K. S. Sarma

50. Flexibility in Budget Policy. Changing Problems and Requirements of Public Budgeting
by A. Robinson and B.-C. Ysander

51. On Price Elasticities in Foreign Trade
by Eva Christina Horwitz

52. Swedish Export Performance 1963-1979. A Constant Market Shares Analysis
by Eva Christina Horwitz

53. Overshooting and Asymmetries in the Transmission of Foreign Price Shocks to the Swedish Economy
by Hans Genberg

54. Public Budgets in Sweden. A Brief Account of Budget Structure and Budgeting Procedure
by Bengt-Christer Ysander

55. Arbetsmarknad och strukturomvandling i de nordiska länderna
av Bertil Holmlund

56. Central Control of the Local Government Sector in Sweden
by Richard Murray

58. Industrial Subsidies in Sweden: Macro-economic Effects and an International Comparison
by Bo Carlsson

59. Longitudinal Lessons from the Panel Study of Income Dynamics
by Greg J. Duncan and James N. Morgan

<u>1982</u>

60. Stabilization and Growth Policy with Uncertain Oil Prices: Some Rules of Thumb
by Mark Sharefkin

61. Var står den nationalekonomiska centralteorin idag?
av Bo Axell

63. General Search Market Equilibrium
by James W. Albrecht and Bo Axell

64. The Structure and Working of the Isac Model
by Leif Jansson, Thomas Nordström and Bengt-Christer Ysander

65. Comparative Advantage and Development Policy Twenty Years Later
by Anne O. Krueger

67. Computable Multi-Country Models of Production and Trade
by James M. Henderson

68. Payroll Taxes and Wage Inflation: The Swedish Experiences
by Bertil Holmlund (Revised, September 1982).

69. Relative Competitiveness of Foreign Subsidiary Operations of a Multinational Company 1962-77
by Anders Grufman

70. Optimization under nonlinear constraints
by Leif Jansson and Erik Mellander

71. Technology, Pricing and Investment in Telecommunications
by Tomas Pousette

72. The Micro Initialization of MOSES
by James W Albrecht and Thomas Lindberg

73. Measuring the Duration of Unemployment: A Note
by Anders Björklund

74. On the Optimal Rate of Structural Adjustment
by Gunnar Eliasson