A list of Working Papers on the last pages

No. 222, 1989

THE MOSES MODEL – Database and Applications

by

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August, 1989

PRELIMINARY

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Content

Paper presented to the IARIW Conference in Lahnstein, West German August 20–25, 1989.

1. The design of the knowledge based information economy

Adam Smith (1776) coined the concept of productivity advance through division of labor. By breaking the work process down into finer and finer elements economies of scale in the small could be achieved. These scale effects became the drivers of the macroeconomy.

Work specialization, however, came at a cost. It required innovative knowledge to be created.

The more elaborate work specialization the more resources needed to coordinate production. Hence, there are explicit transactions costs associated with organizing a specialized economy. Such organization can be achieved through the market by what Adam Smith called the invisible hand, and through management or administrative method in production units ("hierarchies"). The relative efficiency of the two methods determines the size structure of administrative units, or firms in the economy, as suggested by Coase (1937), and hence the market structure.

Determining the division of labor and thereby the information technology to coordinate economic action is also a prime function of markets. It includes the entry and exit of firms, or the recombination of firms, the movement of people with competence between firms and within firms (internal labor markets). The complexities of the sorting and selecting mechanisms of the markets, the filter in a large measure characterizes the economic system.

Finally, knowledge, once created (innovation) is diffused through the economy through imitation, or through various educational arrangements. Learning, is an important fourth category of economic activity that has to be considered to capture the whole economy at work (see Table I).

The first conclusion coming right out of Adam Smith's original idea is that macroeconomic growth theory has to be based on a theory of the organization of markets and of hierarchies to capture what goes on in a growing economy.

This is also the key philosophy behind the growth theory to be sketched, that in turn serves as the design for the MOSES micro simulation model, and the systematic micro–to–macro database upon which this model operates. The theme of my paper is that theory, model and measurement cannot be separated. Thus, I have to devote considerable space to presenting the micro–to–macro model from the point of view of database design. Since the model as such has been recently documented in several publications (Albrecht et al. 1989, Eliasson, 1977, 1978, 1985a, 1986, 1989b) this presentation will be sketchy and I will concentrate on the definition, place and use of certain critical variables in the model, and conclude with a few applications in Section 5.

The organization grid of the model economy that coordinates economic action can be viewed as a complex structural memory that is continually updated by the ongoing economic process. This memory makes the model economy path dependent. Simulations on the model hence become sensitive to initial conditions that keep influencing future model behavior for years. This path dependence I consider a desired property of the model economy. I believe economies to be strongly path dependent. This is part of their dynamic characterization, and they should be modelled accordingly. The important empirical question is the degree to wich the organizational memory that controls the coordination, innovative and learning mechanisms of an economy, has its roots in the past, how it operates, and to what extent it can be decoded, understood and manipulated (policy).

The problem is that path dependence and sensitivity to initial conditions, pose special demands on quality of measurement. Empirical studies become sensitive to errors of measurement in the initial state description of the economy from which all analysis of a path dependent system has to begin. This is our key empirical problem, not parameter estimation. This also illustrates – I repeat – the importance for economics to integrate theory, modelling and measurement systematically, something the economics profession has painstakingly avoided by prior designs of models (theory) that make them invariant to initial state descriptions. In doing this economics has avoided benefitting efficiently from the learning process that characterizes all scientific progress; theory guiding measurement design, improved measurement and testing forcing a redesign of, sometimes, a radical change in theory.

The organizational memory of the economy, that also embodies its state of technology, is complex and for all practical purposes intractable to the individual agent participating in the economic process; it is "tacit": A large part of resources used by the agents are devoted to "decoding" this memory to be able to improve their positions. We call this "learning" or intelligence gathering. The ability of decision makers at large to capture the structure and development of the memory in an unbiased way gives the economy its important dynamic properties. We do not assume agents to be capable of learning immediately and fully at no, or known costs, as in rational expectations and efficient market theory. We rather study the consequences of costly information biases in the economy.

We observe already here that the four types of information processing activities in Table I account for the bulk of cost applications in the advanced manufacturing firm (see Figure I).[1]

Finally, please remember when reading this essay that the ambition of the micro–macro modelling project never was to forecast the economy in greater detail, but to understand macroeconomic behavior better through systematically using the wealth of internal micro data constantly collected, analyzed and used by decision makers themselves operating in the economy. Systematically here means formulating a relevant theory through wich micro data can be dynamically and explicitly aggregated to macro.

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[1] Since the design of the MOSES model unavoidably had to be guided by existing economic theory and measurement, we completely missed the extent of resources used up in the information processing categories of Table I. This was so despite my own prior interview work (1976a). We became aware of this embarrassing oversight when collecting data to test the model. We are now modifying the model to accommodate the new information. Its design fortunately makes this easy.

Table I The statistical accounts of the knowledge–based information economy

1. Business opportunities exploring state space	The creation of new knowledge (Schumpeter 1911) – innovation – entrepreneurship – technical development
2. Dynamic coordination	The invisible and visible hands at work – of specialized production flows through competition in markets (Smith 1776) – of investment through dis–equilibrium capital markets (Wicksell 1898) – through demand feedback (Keynes 1936) – through management in hierarchies
3. Filtering	– entry – exit – mobility
4. Knowledge transfer	Education (Mill 1848) – imitation – diffusion of knowledge – information design

Source: Modified version of Eliasson (1987, p.12)

2. The organization based experimental growth model

The Swedish micro–to–macro model – called MOSES – is structured on the design of the knowledge–based information economy of Table I. It explicitly integrates theory and measurement. All information activities, except one, education, occur in the model.

2.1 The unit of observation

The idea of the model is to represent the autonomous behavior of agents in markets, through their own statistical (information) systems and the ways they interpret and decide on these data. It is, hence, desirable to identify agents that are reasonably stable entities. We have chosen the firm and/or the division as the smallest, financially defined and most stable decision unit.

Even a division will, however, not exhibit a stable internal structure, since internal reorganization is the essence of poductivity advance (Eliasson, 1985). The division, and more so the firm, however, represents the consistently most stable measurement unit you can obtain, since it maps reasonably one–to–one into a well defined group of products, representing a common product market know–how, a monolithic set of financial objectives, and (hence) also into a reasonably well defined incentive and compensation scheme (labor market). This information system classifiction of behaving units relating their objectives (the rate of return) directly to the corresponding price (the interest rate) in the capital market (financial objectives) is the fundamental idea of the micro–to–macro model. The financial units, however, also break up and recombine (mergers, acquisitions etc.) illustrating the arbitrariness of any measurment system you may devise. This recombinatorial technique may also be the most forceful factor behind macroeconomic productivity advance (see Jagrén 1989)[2]. Again, however, (see Eliasson 1989c) the financial unit called

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[2] Until a dynamic theory of mergers and acquisitions has been formulated it will, hence, be impossible to properly capture the aggregation process between factor inputs and macro productivity change. At the IUI we have organized our productivity studies on the design of the model. This means that productivity advance originating in reorganizations within firms is studied separately from productivity advance originating in entry, exit and investment in given firms. (see Eliasson 1980, Carlsson 1989, Hanson 1986). Interior firm productivity ("management") and external ("market allocation") efficiency are so to speak studied separately.

a division or a firm, the information system of which links together financial objectives of the firm with its incentive and production system, is a provisional technique (an "information technuiqe") to install a higher level order on market activities, in a Coasian (1937) sense, a higher efficiency, and a higher rate of return than feasible through "market coordination".

2.2 Representation and updating of structures

One way to illustrate the dynamics of the micro–macro model economy is to start with a set of actual and potential Salter (1960) productivity and rate of return distributions of firms (see Figures III and IV)

(a) The place on the potential Salter distribution of an individual firm indicates its competitive position (potential).

(b) The shape of the potential Salter distributions, or rather the performance spread between the best and worst agents measures potential competition of domestic producers and the degree of competitive exposure of those positioned on the tail end of the distribution.

(c) The actual intensity of competition depends on the pressure brought on each actor by the same action of all actors, as reflected in price and quantity decisions. Rate of return demands imposed by the capital market, the position on the Salter curves and the potential to do something about its own situation determine the competitive action of each individual firm.

(d) The propensity and the potential to do something depends on what the firm knows about its own position relative to other firms. The firm hence engages in various kinds of learning activities. If it finds that its position is superior to that of other actors it may relax, even through a successful past tends to have generated high internal rate of return standards (Eliasson 1976a). If the firm finds itself in a precarious position it both knows that higher performance is feasible and that it has to do something about its situation.

(e) Performance is upgraded through the investment decision. New entry, competitive exit and investment (dependent on the expected rate of return) introduce new technology and phase out econonomically obscolencent technology, thereby upgrading the Salter structures continuously and endogenously.

The main experimental process machinery of the model is concerned with economic learning for coordination (internal and external through markets) and filtering. In the MOSES model ready made "innovations" are brought into the firms with new investment. The innovative process per se is not modelled. On the other hand, productivity growth through organizational change is explicitly modelled, including the organization of market competition and the development of a "tacit" systems competence embodied in the organization of the entire economic system – the competence memory.

The MOSES model as it is currently implemented empirically presents the firm as a financially defined organization, represented by its financial accounts and its internal, financially based statistical information system (Eliasson 1976a, Ch.XI). The whole model can be seen as a dynamically coordinated computable disequilibrium adjustment model of economic growth. Agents in markets (firms and labor) make quantity decisions on the basis of perceived profit or wage opportunities, but adjust prices, price expectations, and quantities as they learn about actual opportunities from participation in the ongoing market process.

Economic growth builds on dynamic coordination of micro (firm) behavior, which is, in turn, restricted and influenced by the ensuing macro feedback. Micro (firm) behavior is explicit in the form of an experimental learning process. Hence, it is not optimizing behavior. Competition is technologically based (through process efficiency).

2.3 Firm behavior

The firm intelligence system exhibits bounded rationality and tacit knowledge. Firms are characterized by rent (profit) seeking on a hill climbing (not optimization) mode guided by perceived profit opportunities. The landscape of immediate rent opportunities is, however, constantly changing as a consequence of all agent behavior.

Ex ante plans normally fail to match the constraints imposed by the plans of all other actors and the characteristics of the environment of opportunities. Individual mistakes are frequent and unpredictability at the micro level the normal situation. The market environment is what I have called experimentally organized (Eliasson 1987). Firms, as a consequence, are organized as experimentators and specialists in fast identification and effective correction of errors (Eliasson 1988b,c, 1989c).

Failure of agent plans shows up in unused capacity, undesired stocks and price adjustment. This explicit plan realization function is the source of dynamics in the MOSES economy. Constant failure of ex ante plans to match at the micro level causes a constant ex ante–ex post dichotomy. (The realization process).

Out of equilibrium there is no way to tell how prices and quantities will move if you only have an equilibrium model. You need a process representation of economic activity in which learning behavior and expectations forming, decision making and the realization processes are explicit in time. The nature of the plan realization process determines the state of information in the economy, the potential for learning reliably about its fundamentals and the feasibility of a state of full information. From a database point of view this means that firms at each point in time read off and interprete state space, their internal accounts and their local environment from which they all together construe an ex ante inconsistent state space for the next period. All ex ante positions are then confronted in markets, to generate a consistent new state, that is measured by us, and read and interpreted by all actors, and so on.

2.4 How do MOSES firms learn and exhibit competence?

MOSES firms accumulate and exhibit competence in two principally different ways.

(1) They learn dynamically through reading off market signals and orient themselves in their market environment. They also have the capacity to modify their learning algorithms, incorporating signalling patterns of the past.

(2) They are subject to selection through competition, which upgrades the average productive capacity of surviving firms.

(3) They make internal investment decisions through which new technology is brought into the firm.

Since MOSES economic development is characterized by endogenous market induced reorganization of micro structures, the evolving micro state is a "tacit" memory of competence, that determines the ability of the firm to exploit the opportunity set and at each time bounds the feasibility of future states (path dependence). Unexploited business opportunities are abundantly available to firms willing to engage in risk taking through trial and error (experimentation). Hence, price and profit expectations are enough to move the MOSES economy. By exogenously changing the market regime characteristics, very different growth paths can be generated from the same initial states.

Since each firm cannot be in touch with all other firms individually, it interprets various items of aggregate information ("indices") generated by the market process, provided with a delay by traders, intermediators, and institutions that with a few exceptions are not explicit in the model. The nature and efficiency of this learning process depend on how the economy is organized into markets and hierarchies, but learning also affects this organization and hence the future efficiency of economic learning, and so on, creating a path dependent evolutionary process, that cannot be predicted due to the complexity of the combinatorial organizational possibilities facing the agents of the economy. On this point, an interesting theoretical development should be possible considering the two facts that this intermediation is the dominant resource using activity in an economy and that practically nothing seems to have been done in this area of research.

2.5 Market dynamics

The standard setting is that firms can compete freely in their markets, hire people in the entire labor market, including raiding competing firms for labor and borrow money freely. The intensity by which they pursue this competition affects the competitive situation, including market prices of other firms.

Various forms of dynamic feedback, hence, characterize the MOSES economy. There is direct interaction – through firms – between different markets (multimarket interaction). Demand feedback occurs through the macro expenditure system. Without efficient demand feedback domestic economic growth is affected.

However, demand feedback is complicated by price feedbacks making firms both price makers and quantity setters.

Even though the "domestic" MOSES model economy is in constant market disequilibrium, the model economy is placed in an assumed steady state global market environment, with competing firms embodying best–practice technology and taking world market prices so as to achieve capital market equilibrium, i.e. rates of return equalizing the exogenous world market interest rate. Hence, the capacity of domestic firms to compete technologically, the efficiency of markets in allocating labor and capital, and the capacity of the economic political system to control the level of wages and the domestic interest rate also controls the macroeconomic growth rate (Eliasson–Lindberg 1986).

Long–term economic development is dominated by the capital market. Investment and growth of potential capacity at the micro level is driven by the difference between the perceived rate of return of the firm and the interest rate. The interest rate imposes a rate of return requirement on the firms in the market.

Firms enter markets on the same profit signals, and exit upon long–term failure to meet profit targets and/or when their net worth is exhausted.

The overall outcome is a micro(organization)–based economic process model driven by profit seeking firms, characterized by some endogenized institutional change (entry, exit), but with other major technology–influencing reorganizations within firms being exogenously determined.

While the capital market controls firm profit performance the labor market reallocates people. Depending on the market organization this reallocation can be potentially destabilizing through wage overshooting. The reason for this is partly asymmetric, downward rigidity in nominal wages (see Applications in Section 5).

2.6 Relation to the standard general equilibrium model

Personally I would say that the micro–macro theory upon wich the MOSES model has been designed puts life into the General Equilibrium Model and – with the complements suggested here – makes it an ideal theoretical base for studying industrial organization problems. Looked at from the perspective of economic doctrines it combines (exogenous) entrepreneurial activities à la the young Schumpeter (1911), and the Austrian tradition with Smithian (1776) dynamic coordination in markets, notably the capital market, characterized by a permanent state of Wicksellian (1898) capital market disequilibrium (see Table I). Innovations generate economies of scale through innovative activities. Concentration is checked by technological competition among all agents in the market. Salter curves are so to speak truncated at one end by Schumpeterian "creative destruction" (exit) and updated at the other end through innovative activity, including competitive entry. This general competitive game among a limited, but variable number of players is endogenously carried on.

The capital market disequilibrium is defined as the expected return of the firm over the market loan rate. Hence, rate of return criteria imposed through the capital market dominate long–term dynamics in the model. A Smithian invisible hand coordinates the whole economy dynamically through monopolistic competition in the product, labor, and capital markets. Foreign prices, the foreign interest rate, and the labor force are exogenous. Together these mechanisms determine the dynamics of resource allocation. Keynesian demand feedback is needed to keep the economy growing. It enters in three ways: through endogenous income formation and demand feedback (the system is closed), through exogenous government, fiscal and monetary policies, and through foreign trade.

The micro–macro economy is regulated by the interaction of domestic (endogenous) and foreign (exogenous) prices in four markets for manufacturing goods. Hence, Marxian demand deficiency (or excess demand) situations of varying length occur all the time in the model through failure of local demand plans to meet local supply plans. Markets do not clear and stocks, and later prices adjust. Disequilibria then feed back into next period decisions. The dynamics of the macroeconomy originates in this failiure of ex ante plans to match through the realization functions of markets. (Modigliani – Cohen 1958, 1961; Eliasson 1967, 19968). This notion can be traced to Wicksell and Myrdal (1926, 1939), the Swedish School of Economics (also see Palander 1941) but for some reason was lost to economics in the postwar era, heavily influenced as it has been by the classical, static model.

Experience from model work tells that the realization function is a critical factor behind macroeconomic dynamics. Endogenous Growth Cycles of different length occur as a consequence, and occasionally they develop into severe depressions of long duration.

All theory has to be parsimonious in one way or another. Which way, however, depends on what analytical problem one has in mind. I look at theory as a way to organize your thoughts and your facts. There are always a large number of such ways. Hence, scientists, and especially social scientists, are all boundedly rational in Herbert Simon's (1955) sense. Once the notion has been accepted that the problem chosen determines the analytical method ("theory"), the ultimate scientific problem becomes the tacit art of choosing the relevant item from a menu of ad hoc theory.

3. A brief mathematical introduction to the model

This section presents the mathematics of the Swedish micro based growth model on short form. Some mathematical presentation is needed to understand the measurement design. (For details see Eliasson 1978, 1985, 1989c). Focus is on the evolutionary features of the model. (I thus exclude the intermediate goods, input/output structure of individual firms and all other production sectors than manufacturing (see Bergholm (1989) and MOSES Code, IUI 1989)). Hence, all labor work in manufacturing and manufacturing firms produce the investment goods. Gross production value and value added become identical).

3.1 Deriving the control function of the firm – the information and short-term targeting system

The firms of the model are controlled through the rate of return requirements imposed by the capital market. Rate of return targets control both production and investment decisions. Ex ante rate of return targets guide the firm in its gradient search for a rate of return in excess of the market loan rate.

Defining the rate of return

To derive the control function we begin by decomposing total costs (TC) of a business firm, over a one year planning horizon, into:

$$C = wL + (r + \rho - \frac{\Delta p^k}{p^k})\, p^k \cdot \overline{K} \qquad (1)$$

w = wage cost per unit of L
L = units of labor input
r = interest rate
ρ = depreciation factor on $K = p^k \cdot \overline{K}$
p^k = capital goods price, market or cost
$\overline{K}$ = units of capital installed

In principle the various factors (L, $\overline{K}$) within a firm can be combined differently, and still achieve the same total output. Depending upon the nature of this allocation the firm experiences higher or lower capital and labor productivity, as defined and measured below. In what follows we investigate the capital labor mix among firms as determined dynamic markets.

Firm sales ($S = p^* \cdot \overline{S}$) over total costs generate surplus revenue, ϵ, or profit:

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

Net profit per unit of total capital R^N is the rate of return on capital in excess of the loan rate:

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

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

In this formal presentation K has been valued at current reproduction costs,

ϵ/K expresses a real excess return over the loan rate, but r is a nominal market interest rate. Ex post $\bar{\epsilon}$ distributions over firms are shown in Figure V.

In the micro–macro model firm owners and top management control the firm by applying targets on R^{EN}, the return on equity capital. This is to say that they apply profit targets in terms of ϵ. Thus, we have established a direct connection between the goal (target) structure of the firm and its operating characteristics in terms of its various cost items. The main purpose of the internal information system of a firm is to establish these links, so that top management can control and stimulate internal efficiency reliably, without having to get involved in details (Eliasson 1976a, 1989c).

The control function of the firm

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

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

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

where:

M = the gross profit margin, i.e., value added less wage costs in percent of S

ρ = rate of economic depreciation

α = $\bar{S}/\bar{K}$

β = $\bar{S}/L$

ϕ = debt/E = K–E/E

ϵ = $(R^N - r)K$

Management of the firm delegates responsibility over the operating departments through (4) and appropriate short–term targets on M [production control through (5)] and long–term targets on ϵ, which control the investment decision.

$\bar{\epsilon} \cdot \phi$ defines the contribution to overall firm profit performance from the financing department.

A target on M means a labor productivity target on $\bar{S}/L$ (see Figure 3 and 4), conditional on a set of expectations on (w, p^X) in (4) determined through individual firm adaptive error learning functions (see below). Thus, the profit margin can be viewed as a price–weighted, "inverted" labor productivity measure.

3.2 Long–term objective function (investment selection)

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

$$\epsilon/K = R^N - r_i > 0$$

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

$$r_i = F(r, \varphi) \quad \frac{\partial F}{\partial \varphi} > 0 \tag{6}$$

The $\bar{\epsilon}$ of an individual firm is generated through innovative technical improvements at the firm level (Schumpeterian innovative rents) that constitute Wicksellian type capital market disequilibria defined at the micro level. The $\bar{\epsilon}$ drives the rate of investment spending of the individual firm. The standard notion of a Wicksellian capital market equilibrium is that of "average" $\epsilon = 0$ across the market. As a rule this state is never achieved (see Figure 5). Unused capacity may prevent the firm from expanding capacity even though investment long term is expected to yield $\epsilon > 0$. More important, however, is the fact that realized investment comes much later than the current quarter and that firms continue to make mistakes.

3.3 How do firms upgrade their performance – four kinds of boundedly rational behavior

I. Creation of knowledge (innovation and reorganization)

Innovative and reorganizational activities based on tacit, experience–based knowledge are exogenous. They include basic restructuring of the financial organization of the firm as described above. Also, major investment programs, particularly those into new areas, belong here. Costs are normally insignificant in comparison with the profit consequences of successful reorganization.

The dominant, "measured" intelligence gathering and interpretation activities of a manufacturing firm concern technical information processing creating new knowledge, mostly associated with product development. (This activity is driven by investment in R&D and shifts the technical specifications of the firm's production system). If this activity is not somehow explicitly accounted for, the firm is grossly misrepresented and – I claim – aggregate dynamics misspecified. Lack of data on (and lack of academic insight into) the nature of information use in business organizations thus far means that we have had to be crude in modelling innovative behavior.

II Learning behavior in markets (coordination through boundedly rational expectations forming)

Self–coordination in markets is achieved through intelligence gathering and learning behavior. Firms interpret price signals (prices, wages, interests and profits) and transform them into expectations. These transformations include correction learning from past mistakes and attitudes toward risk. The self–coordinating properties of the entire economy depend significantly on the specification of these intelligence gathering and expectations functions.

There is, however, also the theoretical problem of whether the representation of the underlying fundamentals of the economy – the quantity structure – through prices can be seen as a stationary process that will allow rational agents to learn, with the exception of random mistakes and eventually place themselves (and the economy) in a stable expectations equilibrium. As I write this I don't know.

III Competitive selection (the filter)

The Salter (1966) curves of each market are constantly upgraded endogenously through competitive exit ("creative destruction") and entry. Only firms which have acquired superior performance characteristics through innovative creation of new knowledge (item I above), through learning in markets (item II) and through interior process efficiency (item IV below) survive in the long run.

IV Learning about interior firm capacities[3]

No firm management is fully informed about its own capacity to produce (see Eliasson 1976a). A boundedly rational search procedure that I call MIP targeting (MIP = **Ma**intain or Improve **Pro**fits) is applied from top management to force upward improvements in interior firm performance.

The MIP targeting principle rests on three facts of life in all business organizations (Eliasson 1976a):

(1) The difficulty for top CHQ managers to set accurate targets for the interior of the organization, close to what is the maximum feasible.

(2) The importance for target credibility and enforcement that targets be set above what is conceived to be feasible, but not unreasonably high. A 'reasonable' standard is performance above that achieved in the recent past. 'It was possible then!'

[3] A complete description of the firm from a database point of view requires that the character and estimation of the production frontier is presented. This is also where some of the most interesting features of the database design is to be found. There is not room for this presentation here. See Eliasson (1978, 1985) or MOSES code, IUI Stockholm 1989, pp. 48 ff and Figures I.4 and I.5.

(3) The general experience that a substantially higher macro performance of the firm can normally be obtained if a good reason for the extra effort needed can be presented ('crisis situation') or if a different, organizational solution is chosen ('other firms do it better!'), if time to adjust is allowed for. MIP targeting establishes an acceptable profit plan to constrain and force efficiency on production planning.

MIP targeting assumes that top management knows that the firm always operates somewhere below the feasible level of capacity. Past experience determines the level from which top management knows that an upward improvement in its profit rate can be achieved. The psychology of targeting is that top management knows that some improvements can be achieved. However, knowing that excessive, impossible targets are never taken seriously even if slack is quite large, it is ineffective to impose grossly infeasible targets. Hence, targeting is organized only to push for gradual improvements. Targeting, then, becomes a form of learning, or transferring knowledge of potential capacities within the firm organization. Top corporate management is probing for the limits of capacity, information that lower level management wants to conceal. If new technology is not being created, targeting will eventually push activity onto the feasibility (production) frontier.

4. The MOSES database

The database demands of the MOSES micro simulation model are sizable. This section summarizes the principal problems. The fundamental idea of the model has been to systematize the wealth of microdata that exists through the MOSES model for improved understanding of macro behavior. Hence aggregation is made dynamically explicit through markets. MOSES is a dynamic micro–to–macro model that provides a satisfactory theoretical base for a consistent micro–to–macro database design. This is especially so when it comes to integrating production data and financial data. The manufacturing sector is currently (the 1982 database) populated by 250 individual, real firms or divisions, that set prices and wages, plan output, sell goods at home and abroad, recruit people and borrow money to invest and increase capacity. Firms act within the restrictions of rate of return targets that depend on the interest rate development (see above Section 3), demand from households and competition from all actors in the markets. In making their plans each firm attempts to predict the behavior of markets (intelligence gathering and expectations forming). They always fail more or less. Hence, the realization of plans in the market confrontation where all ex ante–ex post inconsistencies are sorted out provides the real short–term dynamics of price making and quantity adjustment of the MOSES model. We have found that the initial state description matters importantly for the dynamic simulation results. Internal database quality (consistency) is imperative for avoiding peculiar macro instabilities in simulations due to statistical errors. However, the internal information systems of firms are afflicted with the same kind of quality problems. Hence, adjusting database information to achieve consistency might mean that errors that in fact affect firm decisions are removed and that the corresponding effects also are removed from MOSES simulations.

The MOSES database recognizes several important business iformation functions in Table I, but not all. The most critical flaw, as we now see it, is the absence of data on educational activities. To my knowledge, no such data have been collected elsewhere.

4.1 General

The key problem of implementation has been to define a unit (of measurement), that operates reasonably autonomously as a price and quantity setting decision unit in all the three markets of the model – the product, labor and capital markets.

There is, however, also the practical problem of not taking measurements beyond a level of disaggregation where they can be carried out with reasonable precision; and precision is needed as we have learned.

The strategic decision taken was to use the statistical information system of the decision unit itself, designed on the format of the decision maker (Eliasson 1976a); a decision process we also try to mimic in the firm model. (This also means that real errors, inconsistencies and biases in measurement in firm decisions should be reflected in micro behavior).

The unit chosen was the small firm or a division of the large firm.

The statistical system of the MOSES economy can best be presented (briefly) as follows.

MOSES is a full scale macro system. When seen from above it appears as an 11 sector Keynesian–Leontief growth model with dynamic demand feedback through investment and consumption. A novel feature is price feedback through dynamic markets. To achieve that the manufacturing sector of the macro model has been replaced by individual firms that interact with one another in the three markets, under the constraint of the rest of the economy, and with a "steady state" price taking assumption for the international market environment.

Manufacturing is divided into four industries, raw material processing, semi–manufactures, durable goods manufacturing, and the manufacture of consumer nondurables.

Each industry consists of a number of firms, some of which are real and some of which are synthetic. Together, the synthetic firms in each industry make up the differences between the real firms and the aggregates of the four industries, or rather market totals in the national accounts. 225 firms inhabit the manufacturing sector, 154 of which are real firms, or divisions. The real firms cover 70–75 percent of manufacturing employment and production in the base year, currently 1982. The model is based on a quarterly time specification, corresponding to a common production planning mode.

The model runs on data from (essentially) three different sources; a separate, annual survey carried out jointly between IUI and the Federation of Swedish Industries (in fact designed to fit the model exactly), financial data for the firms, and a complete set of national accounts statistics. Complete GNP accounts are generated by quarter during experiments.

A very frustrating problem, discovered late, when the full scale model had just been implementied, was the "general inconsistency" between the three sets of databases; and internal inconsistencies within the national accounts statistics.

The sensitivity to initial conditions of a dynamic model of the MOSES kind means that the macro model economy reacts strongly to initial inconsistencies in the databases (errors of measurement) as if they were "real" ex ante inconsistencies in the perceptions of firms. Macroeconomic consequences often accumulated for many years. Phases of seemingly "Chaotic" behavior occurred.

At this stage we had to make a decision; to rely on the high quality micro database we had and give up using wellknown national accounts data as a benchmark to establish the statistical size of the entire economy; or modify micro data to achieve initial state consistency. I preferred the first alternative, but nevertheless used the second. The national accounts presentation of the economy is the officially authorized statistical presentation, and we thought it wise – for the time being – to stay with it.

There is a practical limit to the number of firms that can be both accommodated in model runs and constantly maintained on a panel format in the database.

This means that the firm population residing in the MOSES model is dominated by divisions of the large firms (operating as individual decision makers) and some medium sized firms, a few small firms and, some large, synthetic residual firms that make up the difference to the national accounts data for each market.

Each firm operates in three markets. Hence, the accounts of the macro system have been reclassified to reflect market categories. The OECD end use classification code has been used. This has required a radical reorganization of all macro accounts, including the input output table (see Ahlström 1978, Nordström 1988).

The market–product reorganization of macro accounts have also uncovered a host of related definitial problems, many of which still remain to be attended to. First of all, one completely misses both the importance and the dynamics of manufacturing industry when viewing it through the goods processing taxonomy of the standard statistical accounts of the national economy (Eliasson 1989a).

Manufacturing firms are increasingly operating across both the private service and manufacturing sector accounts, and within several subsectors, simultaneously. Their statistical denominations change continually as a consequence of the relative efficiency of operating various activities within the firm relative to hiring the services in the market. We have already shown that the manufacturing firm itself essentially is a private service producer. Mergers acquisitions and divestments add to complications, and while a firm may carry about the same name and a reasonably consistent set of financial accounts for 50 to 100 years, its interior life is constantly being revolutionized. Maintaining a set of panel financial life stories for divisions, hence, is very difficult, and for firms as a whole, we get stranded with the group that happens to have survived.

When all horisontal and vertical resource use associated with making the goods of the manufacturing sector and distributing them to their final use in the household sector in Sweden or abroad (including associated services and qualities) has been accumulated, the traditional manufacturing sector (3000 in the National accounts code) making up almost 25 percent of GNP today, has been boosted to a "production engine" that (including related services) generates almost half (48.7 percent) of GNP. While manufacturing as traditionally measured, and especially if you include Basic industries (1000+2000), has been steadily decreasing since 1950 (not shown here; see Eliasson 1989a), the extended manufacturing sector has in fact increased its GNP contribution slightly since 1950, and significantly if you add in foreign manufacturing production. (This should eliminate the deindustrialization issue. The only thing of any significance observed in that context is the diminishing share of blue collar workers, notably unskilled workers in the labor force. Not only external, manufacturing related services increase, Internal service production within the manufacturing sector in fact accounts for more than half of total labor (cost) inputs and has been increasing. Most of it is very knowledge intensive service production).

4.2 Sources of data

The MOSES data base attempts to cover systematically the most important business activities and to do it consistently with the corresponding macro data, that are also being brought together on a modified sector design (see Ahlström 1978, Nordström 1988). The design of the micro database has been formatted on the MOSES model. In fact, as has been mentioned, one statistical survey has been designed to suit the needs of the MOSES model exactly. This survey has been carried out annually since 1975, and also provides useful information for a variety of other research activities (see Albrect 1978, 1979, 1987, and Albrecht–Lindberg 1988).

The complete database, however, requires that several databases be merged. This is the way we have organized work. The following four databases have been merged:

1. Financial data for business groups; panel beginning in 1965
   Source: Internal data from corporate accounts, by year.

2. Division data, production process oriented; panel beginning in 1974.
   Source: Separate surveys (the "planning surveys") carried out annually by the Federation of Swedish Industries and IUI on all large divisions and (separately) on a sample of small firms. The small firm sample began in 1986.

3. Foreign subsidiary operations
   Source: Three special surveys by IUI covering all subsidiary operations of Swedish companies 1965, 1970, 1974, 1978, and 1986.

4. The content of manufacturing production, covering resource use according to Table I but at a somewhat more aggregate level.

5. Macro, national accounts

The planning survey is not a random sample. Data are collected on all large manufacturing divisions (establishments) in Sweden of all firms with more than 200 employees. This means a coverage of some x percent of Swedish domestic manufacturing employment. We use the planning survey sample as a base point for the other databases. Divisions and foreign subsidiaries can be grouped together to fit the financial groups under 1. Coverage on foreign subsidiary operations is 100 percent for the years in question. In practically all instances we do not have a complete coverage on the division side. Some divisions are simply missing or they are engaged in non–manufacturing activities [wholesale distribution of other products, commercial cleaning (Elextrolux), banking, data processing etc.]. Our procedure has then been to define a residual up to the corporate group level. This consolidation work is just being completed.

To create life histories of individual divisions is difficult. The response rate is reasonably high – consistently in the neighborhood of 85–90 percent – and particularly so if we consider the extent of questioning and the confidential nature of several questions.[4] [For details, see Albrecht (1987)]Non–response, however, varies from year to year and the life history sample, consequently is much smaller than the number of responding firms of one particular year. The current life history sample consists of some 100 divisions and is used to initiate MOSES simulations beginning in 1976 and in 1982. The MOSES model, however, has been designed to avoid being dependent on this particular problem. Besides the initial state description which is not very demanding, only five historic (5 years) variables are needed; prices (for the market), sales, wage costs, and profit margins. These data are fairly easy to maintain for a rather large sample on a life history panel basis.

The problem of sample representativity in MOSES analysis is handled in what we call the initialization process. Each divison is placed in one of the four manufacturing final product markets; (1) raw materials, (2) intermediate products, (3) durable goods for manufacturing investment as well as household durables, and (4) non–durable household consumption goods. Consistent aggregation up to the levels of official national accounts is

[4] There are two reasons for the high response rate, the most important reason probably being the good contacts with the firms of IUI and the Federation of Swedish Industries. However, we also believe that our database idea, to ask questions on the format of the internal statistical system of firms, matters significantly for the high response rate. The questioning reveals that we understand what the firms are doing.

imposed. A residual firm (division) is computed for each of the four markets. To achieve this consistency through all levels of aggregation has been no minor task. The aggregate national accounts data have been redefined to fit "market format" and "massaged" significantly to fit together at the macro level. Even so, the residual firm, or rather firms, since we cut the residual into several synthetic firms, in MOSES simulations, tend to be afflicted with peculiar characteristics, reflecting, we believe, the quality of official statistics (see further Albrecht–Lindberg 1982).

The MOSES model is, of course, not a sufficient reason (motive) for carrying on a major micro–to–macro database activity like this one. We have also chosen not to make MOSES dependent on a full–scale database activity year after year. The full–scale format is, however, directly matched by the input and output format of MOSES.

There have always been supplementary users of the MOSES database, especially the planning survey, which is currently a main information input in business cycle forecasting at the Federation of Swedish Industries. Current research at IUI, to a large extent, also leads a symbiotic life with the MOSES database. For a project to draw on the database it also has to chip in on complementing and updating of the base and on carrying out estimation work on the model.

The Supplement gives more detail on the content of the MOSES firm/division database.

The macro database and the macro part of the model is not presented in this paper. The macro accounts, as mentioned, have been reclassified to fit the OECD end user classification. This has been done to make it possible to classify firms in markets – in a meaningful way – and to link their accounts systematically with the macro accounts. The input/output table has caused most trouble in this respect (see Ahlström 1978, Bergholm 1988). For details on the macro database, see Nordström (1988). For information on how the micro units interact through markets with the rest of the economy, the non–manufacturing part, modelled as a traditional Keynesian–Leontief secctor model, see Eliasson (1978, 1985), and MOSES code, (IUI, Stockholm 1989).

4.3 The firm, its statistical information system and the MOSES micro database

Control and coordination are the key purposes of internal information systems of large business firms (Eliasson 1976a). This has to be recognized when firms are asked to give statistical information about themselves. The quality of the data received will be best when one understands why and how the firm organizes its own internal statistical system, how it uses the information and asks the questions the data are supposed to answer. This is the way we define and use micro databases in the MOSES context. Separate and elaborate formal (statistical) systems are needed to control and to guide the various activities of a large business organization. We tap them directly and model the use of these data for decision making within firms.

At this stage it is not difficult to see why a financial definition of the firm, as the observation unit is the natural one. The financial group operates under a fairly well defined and tight, monolithic control system. Responsibility upwards is towards owners and the capital market. Downwards and inwards the firm is run by administrative controls that transform the externally imposed rate of return requirement into more detailed operations criteria. A statistical system related to the same entity exists and can be tapped directly. It is bad empirical methodology to cut the unit of measurement some other way and to lose this source of high quality data. And the main purpose of MOSES modelling has been to tap the existing wealth of internal firm data for a better understanding of macroeconomic behavior.

Theorizing and research then naturally divide into understanding the interior decision machinery of the financial unit, on the one hand, and how the financial unit interacts in markets with each other and households, on the other. Together this is micro–to–macro theorizing. And for research to be properly and relevantly conducted economics, business administration and engineering have to join forces.

It is finally worth observing, what I observed already in my 1976 study on Business Economic Planning (1976), that the information system by which large business groups are run, can be characterized by what Simon (1955) called "bounded rationality"[1] and that the art of interpreting and running the firm is most appropriately called "tacit knowledge" (Polanyi 1967). To attempt to extract more information from firms than corporate management finds useful to collect, and to go beyond the explicit knowledge that can be communicated outside the business organization means asking for data of doubtful information content, which the statistical investigator might as well cook up on his own.

Table 2 The functions of a large firm

0	Executive
1	Finance and control
2	Market
3	Product/process
4	Distribution
5	Administration

The MOSES model applies the same set of algorithms to a large number of firms. These algorithms mimic the capital budgeting and production planning process of a firm as financially controlled (from levels 0 and 1 in Table 2) production systems (levels 2, 3, 4, 5).

The databases used provide quantitative measurement to specify and initiate these algorithms and to place them in the macro market framework of the rest of the economy.

To look through the various layers of management – to make the firm interior transparent – is almost as much of a problem for the central management of the firm as it is for us. It is completely wrong (Eliasson 1976a) to assume, as was standard practice in economics for many years, that

[1] Even though I did not use that name.

top firm management is fully informed about interior firm life.[2]

Complexity and "muddled insights" rule when it comes to running big corporations, and interior statistical reach from Corporate Headquarter is very limited indeed. In general CHQ has reasonable control down to product group level (see Table 3), not more. The product group is the finest classification level where well defined interfaces with both final goods and factor markets (input goods, labor) exist. In fact, product groups are defined accordingly. At this level profit responsibility can be monitored without synthetic transfer pricing arrangements. Most decisions, except investment and finance can be delegated. Finance and investment decisions are kept central largely because of the difficulties of measuring capital inputs and monitoring rates of return (Eliasson 1976a).

In fact the concept of capital is as badly defined as capital theory tells. Data on capital inputs are more or less useless for control purposes and corporate headquarter management avoids such concepts.[3]

There is one additional element of complexity that frustrates corporate managers, namely the impossibility of maintaining a reliable centralized information system when the institutional (organizational) structure of the firm changes.

The difficulty has to do with the identity of our observation unit. Internal reorganization is the main vehicle for achieving productivity gains at corporate levels. Internal reorganization, however, diminishes, or even destroys the information content of internal databases. There is no general solution to this problem. Corporate managers have simply learned to work with "deficient" information systems, which to my mind preclude generalized (all purpose) database designs. I will leave the subject at that (see further Eliasson 1989c).

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[2] The break in this tradition did not emerge from theorizing about the firm, but in the (principal agent) literature concerned with efficient monitoring of public utilities.

[3] This is the reason why profit margins rather than rates of return are used for internal profit control in large corporations (see Eliasson 1976a).

It appears that firm management, the survey people and the theorist have a common problem here, if the theorist has done a good job.

Figure 2 gives a principal illustration of our problem. The firm organization and the measurement system overlap partially (taxonomy level). The degree of overlapping depends on the purpose of the description, what it is supposed to be good for (use level). In general, the intended use should affect theory, and theory should guide database design, but this is only possible when your intended use is fairly stable. The feasibility of generalized measurement systems to cope with a multitude of intended uses is currently a topical concern in certain management circles (Eliasson 1984, 1989c).

The major ambition of top level executives is to control a complex business organization without getting involved in low level operations problems all the time. The executive level in Table 2 carries the ultimate responsibility to the owners of the firm. The task of managing the innovative function rests there at least in theory. Control (total systems coordination) is always managed at the next level and between levels 0 and 1 in Table 2. Effective coordination (control) is achieved through setting reasonable profit targets against which formalized reporting and control can be applied. At lower (process) levels (market, product/process, distribution) the executive people do not know how these processes run. They need information (database) support from the level below to set reasonable targets, i.e., not overly high and definitely not too low. This task is always engineered through the budgeting process (Eliasson 1976a) supported by the cost accounting system of the business units. The method is to learn from records of past performance to set targets for future performance on the same, similar or standardized activities. The finer the measurement grid – the more perfect the overlap in Figure 2 – the more precisely these targets can be set. However, the more dynamic the interior firm organization the more difficult to maintain a detailed measurement system, and the more difficult it is to precisely estimate what is reasonable performance. If dynamics, however, moves the right way, profitability is not the major problem. The further down into the organization one looks the more organizational float one encounters. The technique of efficient database design for control purposes, hence, is to find a rough compromise between precision in controls and costs associated with achieving control and curbs on reorganization to maintain a viable measurement system [4].

Table III gives an idea of how this compromise looks in practice. This solution also signals the technical limits of resolution that the outside economic investigator has to accept. There is no meaning in asking for more details since the corporate people do not know themselves, and have abstained themselves from attempting to get more detailed data because the measurement system of the firm is not reliable at lower levels of aggregation. (As a rule, confidentiality limits stop him long before that). In a large business entity Corporate Headquarter (top executive level in Table II) routine access to data never reaches below the product group level (3) in Table III. They often stop at the division level. At product group level standardized cost comparisons are possible. Factor prices normally are market prices. At the division or subsidiary levels all prices related to the physical side of production are normally market determined. The division, therefore, is the appropriate elementary unit placed in the external markets and with a well defined decision autonomy.

The product group sometimes can be used for the same purpose and one finds different solutions in different companies. It is impossible in practice (and theory) to base panel data on anything below the product group level. As a rule, access – from CHQ level – to data below division level is very difficult. The product group level sometimes corresponds to what is often termed a production "activity" in input/output analysis, but this concept is not very useful, because in a firm a process or an activity is only one part of a much more complex and integrated product group activity. The product group is rarely a stable unit from which firm management reorganizes new combinations. Reorgnizations of firm activities occur below level (3) in Table III.

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[4] It is instructive to see this from the side of (information systems) management of firms, when firms with different systems are merging. See e.g. xxx Datamation.

5. Applications and Illustrations

In conclusion I will demonstrate certain aspects of MOSES database work through two applications. First, a non–linear, dynamic economic system of the MOSES kind is path dependent and very sensitive to initial condition. It exhibits so to speak phases of chaotic, non–predictable behavior. I will discuss this verbally, with reference to several publications on the model. Second, one novel feature of the model is that it exhibits price and quantity setting behavior of firms. The model mimics a general monopolistic game among a limited but variable number of players (there is endogenous entry and exit), all of them being strongly influenced by the joint outcome of their dynamic interaction, transmitted through pricing in three markets, all activity being "dominanted" by pricing in the capital market. The applications will illustrate how ex ante rate of return targeting interacts with wage setting behavior of firms and affects production growth. I won't go through the analytical part. This would be a separate paper (see Eliasson–Lindberg 1986). But the presentation allows me to illustrate both the rich initial state description of the MOSES database, the nature of the competitive potential, as exhibited by the Salter structures of the economy, and one particular detail of the calibration of the model. First the dynamic properties of the model system.

5.1 Micro–macro dynamics

The total model exhibits endogenous new entry and exit of defunct firms. Hence, the composition of production structures and output (the organizational "state" memory) is affected by the development of relative (Salter curve) qualities of entering, incumbent, and exiting firms. Micro life is normally very dynamic (Eliasson 1984b, 1989b). We know that stable macro development requires Brownian motion type behavior at the micro level. We also know that if sufficient diversity of structure in terms of Salter curves cannot be maintained through simulations, latent structural instability develops (Eliasson 1984b).

We observed above that the endogenously evolving structural or organizational memory of the model defined its state of technology, or the "organization technology" that at each point in time coordinated all activities in the economy. Erratic price and quantity signals being transmitted back and forth between the micro and macro levels, of course affected the evolution of that memory through the learning mechanisms by which firms attempt to forecast future development of – for them – important variables. The normal macroeconomic effect of a disturbed and inflationary relative price system was lower predictability and lower productivity development.

Initial conditions keep playing a role for as long as we have managed to run the model (up to 88 years by quarter). Sometimes small variations in the initial setting cumulate in importance for long periods, than reversing themselves. Certain combinations of initial states and market characteristics, notably very fast price arbitrage (efficient markets) can generate a collapse of macro output and a long period of stagnation, a development entirely unpredictable from historic data generated by the experiment. The model appears prone to such volatile, unstable behavior the closer its operating range comes to what may be characterized as a static equilibrium (Eliasson 1985a). All facets of this exotic behavior have not yet been explored, neither numerically nor theoretically. Suffice it to note, however, that these results have been a persistant property of the model from its implementation (see e.g. Eliasson 1978, p. 118), but were looked at with scepticism at the time by 'besser wissers' of the profession. With unpredictable chaotic behavior having been demonstrated to be an expected mathematical property of a wide class of non–linear dynamic systems – to which MOSES belongs – these properties are now accepted. The important learning experience, however, is that such economic systems are not easily controllable entities from a central policy view. A host of policy conclusions associated with the controllable standard equilibrium model or the manipulable macro models of the 60s have to be revised.

Our growing set of micro–macro databases is currently used to calibrate the model in an attempt to ascertain the range of numerical structures of the model that is compatible with observed variations in micro outcomes, to establish the propensity of the so calibrated model to generate different, desirable or undesirable structural developments. This work so far has repeatedly indicated the critical significance of good quality measurement, especially of initial conditions. If you don't know "where you are" when you run a model experiment or carry out a policy measure on a real economy, as a rule you have no control of the policy results.[5] We have also learned that there is no end to such experimental work, from which a glimpse will be offered in the next, final section.

5.2 Price and quantity interactions

This experiment illustrates the macro sensitivity of the model economy to the nature of price–quantity interactions at the micro level; and the importance of a balance between stable and flexible relative prices to achieve stable macro economic growth.

Figure 3 presents three sets of data on Swedish manufacturing; value productivity (Salter 1960) and wage cost distributions ($p^*\beta$ and w distributions in (5) respectively), real initial state data for 1982, and real and simulated data for 1985. The reader should observe from equation (5), that the profit margin (M) is a linear function of the difference between $p^*\beta$ and w, and how M in (4) relates to various rate of return measures. The first observation is that the "calibrated" reference case of the model (see chapter VIII in Eliasson 1985a) projects Salter productivity and wage distributions quite well.

Second, and this was one reason for the experiments, firm's objective functions are to keep $\bar{\epsilon}$ in (3) positive and as high as possible in the long run. They strive to achieve that through ex ante hill climbing behavior. Hence the interest rate r affects both price and quantity decisions of firms. If the interest rate is high, firms have (1) to improve productivity or (2) hold back wage increases to maintain profit standards. This sensitivity of wage setting behavior to capital market conditions was the reason for the study from which the illustrations have been fetched. The shape of the Salter curves defines potential competition. You can design an aggressive MOSES market experiment in which firms compete fiercely between each other, and for labor in the labor market (fast markets), and a slower market scenario in which firms are not at each others' throats (REF). The fast market scenario creates a "mini cost crisis". When the best (top left on Salter curves) producers bid

[5] For policies – I hasten to add – on which standard macro models gave very precise answers in the past.

up wages to get labor, low end producers are killed and exit, forcing remaining producers to step up productivity ($p^*\beta$ in (5)), inter alia through laying off labor,[6] thus running up unemployment in the economy. The overall outcome is much higher productivity in the medium term (10 years or so), see Figure 4, higher output, lower average rates of return (lower average $\overline{\epsilon}$) and much higher unemployment. The economy is operating closer to "static equilibrium". In the longer run (ca 20 years), however, the output level suffers significantly relative to the "slower" reference case. The reason is less investment, because of a lower rate of return compared to the interest rate (see Eliasson–Lindberg 1986). If the interest rate is lowered, however, investment increases and long term output is higher (Eliasson 1984b, p xxx), provided cost inflation can be contained. The latter test has not yet been run in this particular experimental setting. It is, however, my conjecture – being rather familiar with the properties of the model – that if new investment, induced by a lower interest rate, is not sufficient to maintain sufficient diversity of Salter productivity distributions, the cost inflation generated in the fast market regime, reinforced by sloppy wage setting, due to the lower interest rate (see equation (5) again) may (will) generate inflation and a macro output collapse, when low end producers operating on the right end of the Salter curves exit 'en masse'. If and when this will happen is entirely an empirical problem, that can not be analytically resolved, only through improved measurement. This closes the circle. I only want to remind the reader that collapse scenarios ignited by price disturbances have been generated by the model "through its history".

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[6] Firms that want to continue in business cannot hold back wages, because then they will lose labor to raiding firms.

SUPPLEMENT

This supplement gives a summary of the various surveys together making up the MOSES database.

1. Production – planning survey

The core micro–unit of the MOSES economy is the firm or the division. A firm may be represented by one or more divisions that produce for a particular market. This survey is limited to domestic establishments. Data needed are:

<u>for historic period</u>
- value added
- sales
- profits
- market price
- wages
- investment

<u>for initial period</u>
- employment
- ingoing and outgoing inventories
- unused machine capacity
- unused labor capacity
- export ratio
- capital use per unit of value added
- etc.

This allows us to estimate a short–term production frontier from the unit (for production–planning) and a shift function of the production frontier in response to investment. This is described by Albrecht–Lindberg (1989).

2. Financial unit – the firm

We need a balance sheet, a profit and loss statement, and a cash flow balance for the financial unit.

The balance sheet distinguishes (on the asset side) between production assets (replacement valuation), inventories, and other assets. On the debt side, external debt is explicit and net with is computed as a residual between total assets and debt.

The financial database draws on an external analysis of company (group) accounts. There is significantly more dtailed data in the database than needed for the MOSES simulations. These data are, however, very useful to compare with the output of MOSES experiments for individual firms.

The group or unit of the financial database is viewed as the theoretical decision unit or basic measurement unit that we have discussed above. There is an elaborate initialization program, presented in Albrecht–Lindberg (1989), that initiates the set of real and artificial firms through wich the model is run.

3. Foreign subsidiaries

An extensive database on foreign establishments of Swedish firms exists for the years 1965, 1970, 1974, 1978 and 1986. (See Swedenborg, 1979, Swedenborg – Johansson–Grahn – Kinnwall, 1989).

The database includes data on:

- employment
- value added
- profit margins
- etc.

Investment data have been computed by Bergholm (1983).

Only a minor fraction of this database will (eventually) be used directly as inputs in MOSES simulations. The database will, however, be used as test material for model performance.

4. Content of establishments (division activities)

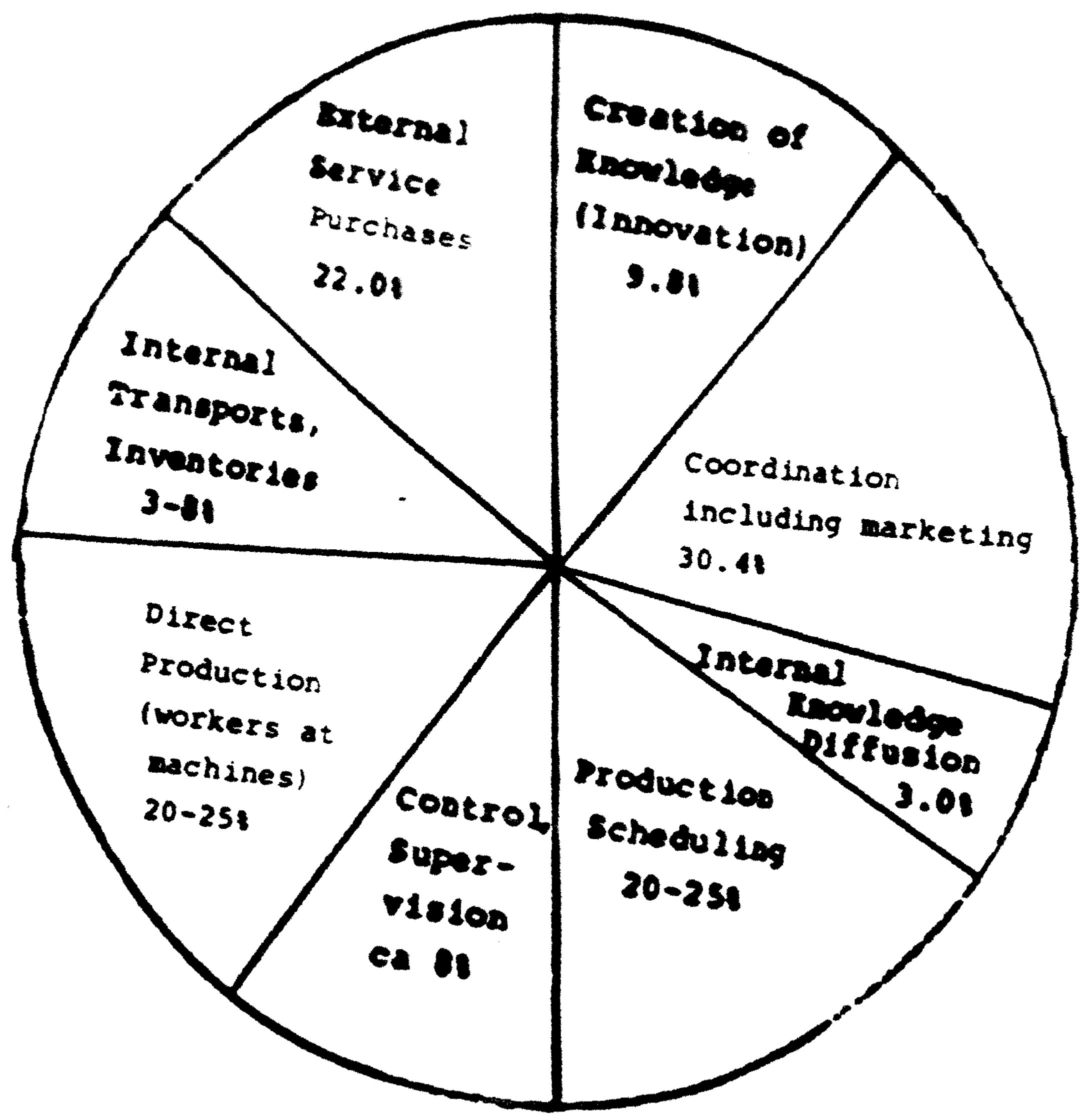
This database is new and not yet ready. A new survey is currently being collected and is not yet integrated in the MOSES model design. The survey was, however, initiated to make it possible for us to deal with the institutional characteristics that have been discussed in theis paper. The same establishments as in the planning survey have been questioned. See Eliasson–Fölster–Lindberg–Pousette (1989).

Table III Organizational hierarchies

(1) Level of aggrega–tion	(2) Organization	(3) Activity	(4) Target (performance criterion)	(5) Database (measurement system)	(6) Market contact surface
(1)	Group (concern)	Financial guidance	Rate of return on net worth	Balance sheet & profit and loss statement	I,L,P,K
(2A)	Division	Financial and profit control	Rate of return on total capital	Profit and loss statement and partial balance sheet	I,L,P
(2B)	Subsidiary	Profit control	Rate of return on total capital	Profit and loss statement and partial balance sheet	I,L,P
(3)	Product group	Factory production	Profit margin	Profit and loss statement	I,L,P
(4)	Product	Process	Costs	Cost accounts	I,L
(5)	Component	Process element	Cost element	Cost accounts	I,L

I = Market for intermediate goods
L = Labor market
P = Product market
K = Credit market

Figure 1 Distribution of labor costs
– Large Swedish firms
– Global operations
– Percent



Goods processing: 56.7%
Total: 122%

Source: Eliasson (1989a).

Figure 2 Integrated information and control system

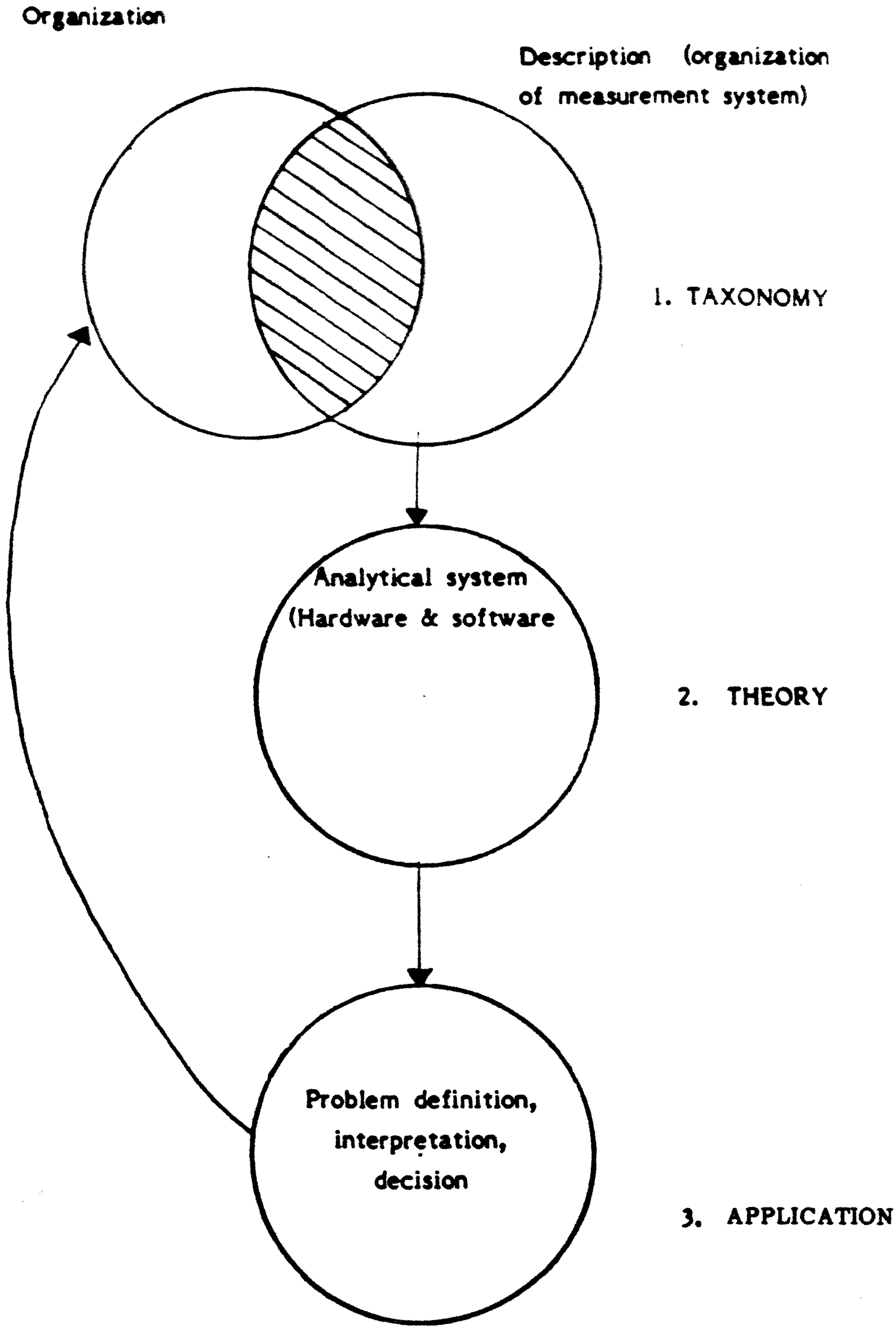
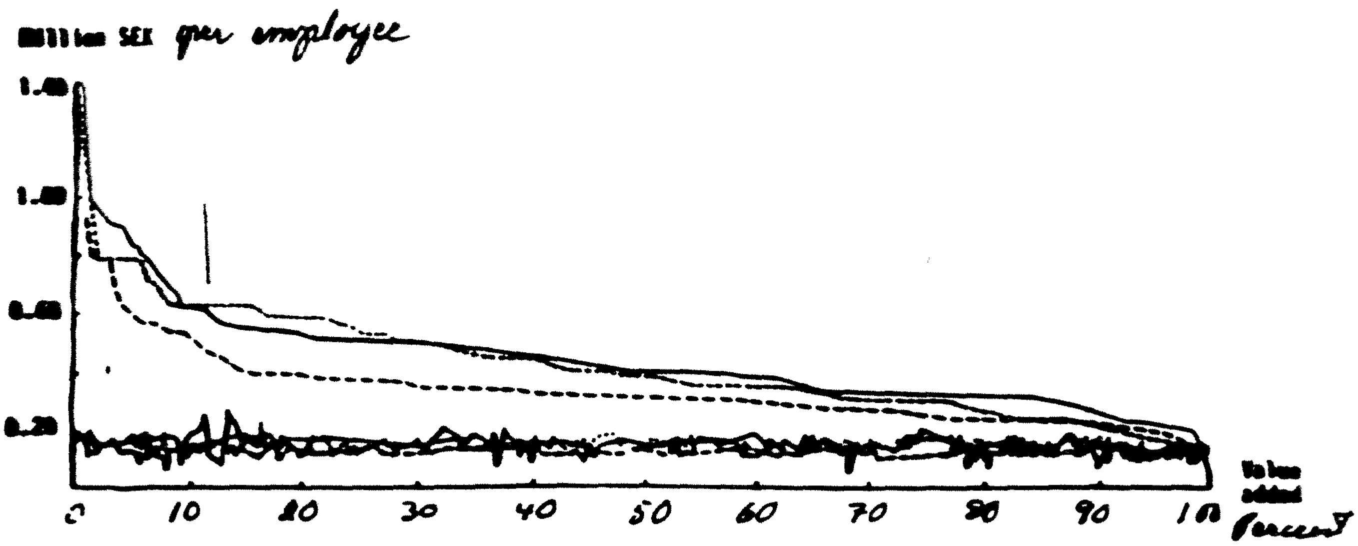


Figure 3 Productivity and wage distributions 1982 and 1985 and simulated distributions 1985

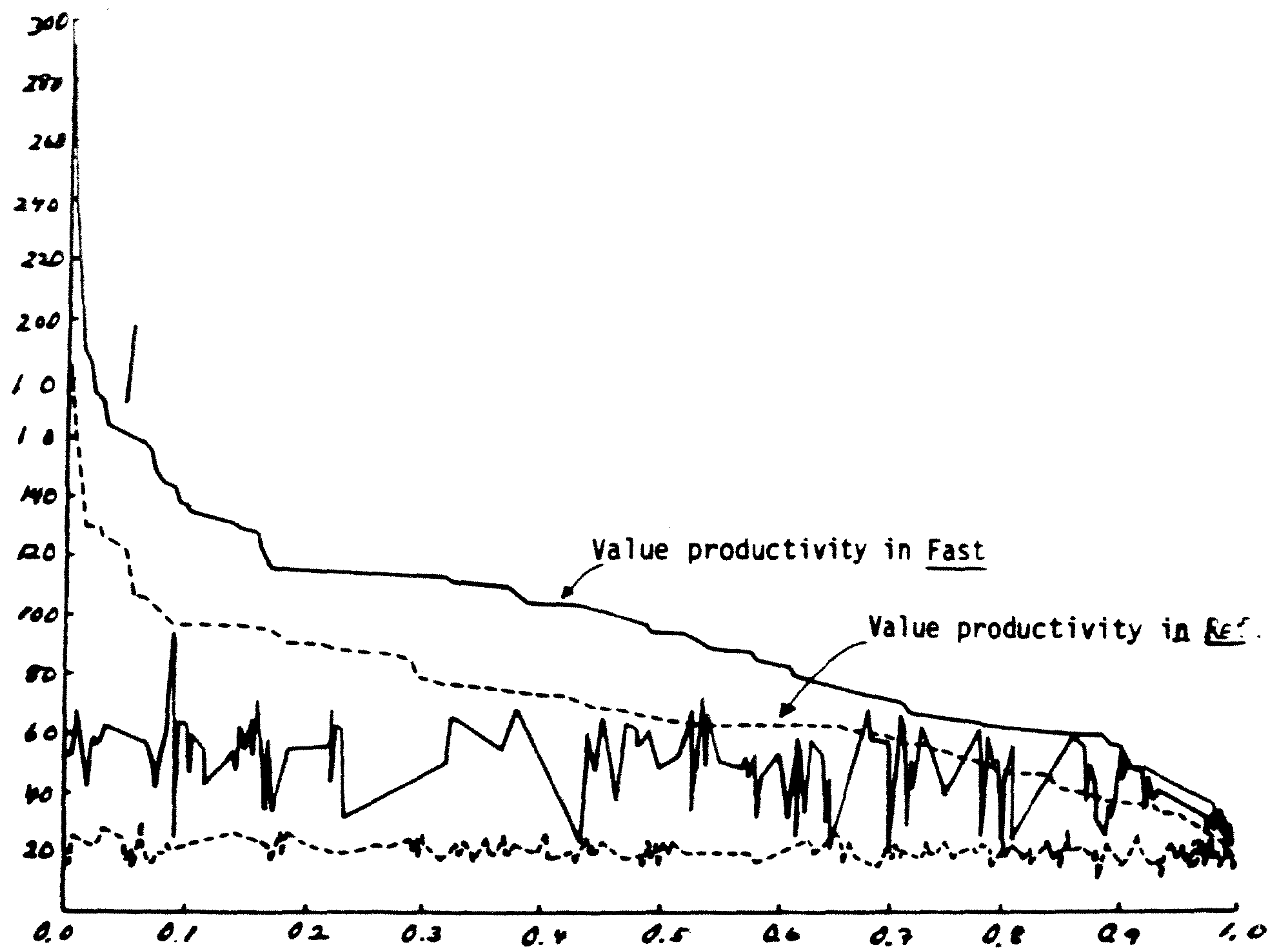


Note: The upper curves show distributions of value productivities, ranked in decreasing order over firms and weighted by value added. The lower curves show matching nominal wage cost distributions.

The simulation began on the 1982 initial database (———). The outcome of the simulation (....) can be compared with real 1985 state from the database (– – – –).

Source: MOSES Database.

Figure 4 Wage cost and value productivity distributions 1992 in reference case and in fast market experiment



———— Fast labor markets (No.3)

– – – – Reference case (No. 1)

BIBLIOGRAPHY

Ahlström, L., 1978, The Market Oriented Inter–Industry Stock and Flow Data Aggregation Scheme used in the Swedish Economy; in Eliasson, G. (ed..), A Micro–to–Macro Model of the Swedish Economy, IUI Conference Reports 19781, Stockholm.

Albrecht, J., 1978, Expectations, Cyclical Fluctuations and Growth – Experiments on the Swedish Model; in Eliasson, G. (ed.), A Micro–to–Macro Model of the Swedish Economy, IUI Conference Reports 1978:1, Stockholm.

Albrecht, J., 1979, Look at Capacity Utilization in Swedish Industry, Industrikonjunkturen (June).

Albrecht, J., 1987, Documentation of the Planning Survey Data: Cross–Section and Panel, IUI Working Paper No. 178, Stockholm.

Albrecht, J. – Lindberg, T., 1982, The Micro Initialization of MOSES, IUI Working Paper No. 72, Stockholm. Published in Albrecht et al (1989).

Albrecht, J. – Bergholm, F. – Eliasson, G. – Hanson, K. – Hartler, C. – Heiman, M. – Lindberg, T. – Olavi, G., 1989, MOSES Code, IUI, Research Report No. 36, Stockholm.

Alchian, A.A. – Demsetz, H., 1972, Production, Information Costs and Economic Organization, American Economic Review, December 19772, pp. 777–795.

Arrow, K., 1959, Toward a Theory of Price Adjustment; in Abramowitz, M. et al., The Allocation of Economic Resources, Stanford, Calif.

Bergholm, F., 1989, MOSES Code, IUI Research Report No. 36, Stockholm.

Bergman, B. – Eliasson, G. – Orcutt, G., 1980, Micro Simulation – Models, Methods and Applications, IUI Conference Reports 1980:1.

Browstone, B., 1983, Microeconometrics, in Microeconometrics, IUI Yearbook 1982–1983, IUI, Stockholm.

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

Coase, R.G., 1937, The Nature of the Firm, Economica, New Series, Vil. IV, Nos 13–16 (Nov)..

Day, R.H. – Eliasson, G. (eds.), 1986, The Dynamics of Market Economies, IUI Conference Reports 1986:1, IUI and North–Holland.

Eliasson, G., 1967, Kreditmarknaden och industrins investeringar, IUI, Stockholm.

Eliasson, G., 1969, The Credit Market, Investment, Planning and Monetary Policy – an Econometric Study of Manufacturing Industries, IUI, Stockholm.

Eliasson, G,. 1976a, Business Economic Planning – Theory, Practice and Comparison, John Wiley & Sons.

Eliasson, G., 1976b, A Micro–to–Macro Model of the Swedish Economy, Preliminary Documentation, Economic Research Report B15, Federation of Swedish Industries, Stockholm (with the assistance of Gösta Olavi and Mats Heiman).

Eliasson, G., 1977, Competition and Market Processes in a Simulation Model of the Swedish Economy, American Economic Review, No. 1.

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

Eliasson, G., 1980, Electronics, Technical Change and Total Economic Performance, IUI Research Report No. 9, Stockholm.

Eliasson, G., 1982b, The Sophisticated Saver – the Family as a Savings, Investment and Borrowing Institution, mimeo (Supplement 2, HUS Application to The Bank of Sweden Tercentary Foundation), IUI, Stockholm.

Eliasson, G., 1983, On the Optimal Rate of Structural Adjustment; in Eliasson–Sharefkin–Ysander (eds.), 1983, Policy Making in a Disorderly World Economy, IUI Conference Reports, 1983:1, Stockholm.

Eliasson , G., 1984a, Informations– och styrsystem i stora företag, in Hur styrs storföretag. En studie av informationshantering, IUI, Stockholm.

Eliasson, G., 1984b, Micro Heterogeneity of Firms and the Behavior of Industrial Growth, Journal of Economic Behavior & Organization, Vol. 5, Nos. 3–4.

Eliasson, G., 1985a, The Firm and Financial Markets in the Swedish Micro–to–Macro Model – Theory, Model and Verification, IUI, Stockholm.

Eliasson, G., 1986, The Swedish Micro–to–Macro Model:: Ideas, Design and Application; in Orcutt, G.H. – Mertz, J. – Quinke, H. (1986).

Eliasson, G., 1987, Technological Competition and Trade; in The Experimentally Organized Economy, IUI Research Report No. 32, Stockholm.

Eliasson, G., 1988a, The Knowledge Base of an Industrial Economy, IUI Research Report No. 3, Stockholm.

Eliasson, G., 1988b, The Firm as a Human Capital Filter and Information Processor for IUI Conference 1988: Markets for Innovation, Organization and Control.

Eliasson, G. – Fölster, S – Lindberg, T. – Pousette, T., 1989a, The Knowledge Based Information Economy, IUI, Stockholm.

Eliasson, G., 1989b, Modeling long–Term Macroeconomic Growth – as a Micro–Based, Path dependent, Experimentally Organized Economic Process, Paper prepared for the OECD International Seminar on Science, Technology and Economic Growth, Paris, June 5–8, 1989, IUI Working Paper No. 220, Stockholm.

Eliasson, G., 1989c, The Firm, its Objectives, its Controls and its Organization, IUI (mimeo)..

Eliasson, G. – Bergholm, F. – Horwitz, E.Ch. – Jagrén, L., 1985, De svenska storföretagen – en studie av internationaliseringens konsekvenser för den svenska ekonomin, IUI, Stockholm.

Eliasson, G. – Deiaco, E. – Pousette, T. – Lindberg, T. – Carlsson, B., 1986, Kunskap, information och tjänster. En studie av svenska industriföretag, IUI, Stockholm.

Eliasson, G. – Fries, H. – Jagrén, L. – Oxelheim, L., 1984, Hur styrs storföretag? En studie av informationshantring och organisation, IUI och Liber, Kristanstad.

Eliasson, G. – Fölster, S. – Lindberg, T. – Pousette, T., 1989, The Knowledge Based Information Economy, IUI, Stockholm (Forthcoming).

Eliasson, G. – Granstrand, O., 1986, Venture Capital and Management – A Study of Venture Development Units in Four Swedish Firms, IUI, (mimeo).

Eliasson, G. – Lindberg, T., 1986, Economic Growth and the Dynamics of Wage Determination – a Micro Simulation Study of the Stability Consequences of Deficient Variation in Factor Prices and Micro Structures, IUI Working Paper No. 170, Stockholm.

Feige, E., 1985, Sweden's "Underground Economy", IUI Yearbook 1986–1987, Stockholm.

Hanson, K.A., 1986, On New Firm Entry and Macro Stability; in The Economics of Institutions and Markets, IUI Yearbook 1986–1987, IUI, Stockholm.

Klevmarken, A., 1986, Collecting Data for Micro Analysis: Experiences from the HUS – Pilot Study; in Orcutt, G.H. – Mertz, J. quinke, H. (1986).

Modigliani, F. – Cohen, K., 1958, The Significance and Uses of Ex Ante Data; in M.J. Bowman, (ed.), 1958, Expectations, Uncertainty and Business Behaviour. A conference held at Carnegie Institute of Technology, 1955, New York.

Modigliani, F. – Cohen, K., 1961, The Role of Anticipations and Plans in Economic Behavioir and Their Use in Economic Analysis and Forecasting. Urbana III. (Studies in Business Expectations and Planning. 4.

Myrdal, G., 1927, Prisbildningsproblemet och föränderligheten, Uppsala och Stockholm.

Myrdal, G., 1939, Monetary Equilibrium, London.

von Neuman, J. – Morgenstern, O., 1944, Theory of Games and Economic Behavior, Princeton University Press, N.J.

Nordström, T., 1988, MOSES Macro Accounting System – Updating Procedures, IUI Working Paper No. 196, Stockholm.

Orcutt, G.H. – Glazer, A., 1981, Micro analytic Modeling and Simulation, in Bergmann–Eliasson–Orcutt (1981).

Orcutt, G.H. – Mertz, J. – Quinke, H., 1986, Microanalytic Simulation Models to Support Social and Financial Policy, Elsevier Science Publishers B.V. (North–Holland).

Palander, T., 1941, Om "Stockholmsskolans" begrepp och metoder, Ekonomisk tidskrift, Årg. 43 (1941:1), pp. 88–143.

Polanyi, M., 1967, The Tacit Dimension, Garden City, N.Y.; Doubleday Anchor.

Salter. W.E.G., 1960, Productivity and Technical Change. Second edition.

Schumpeter, 1912 (English edition 1934), The Theory of Economic Development, Harvard Economic Studies, Vol. XLVI, Harvard University Press, Cambridge, Mass.

Shoven, J. – Whalley, J., 1984, Applied General Equilibrium Models of Taxation and International Trade: An introductory and a survey, Journal of Economic Literature, Vol. 22, pp. 1007–1051.

Simon, H.A., 1955, A Behavioral Model of Rational Choice, Quarterly Journal of Economics, Vol 69, pp.. 99–118.ASwedenborg, B., 1979, The Multinational Operations of Swedish Firms, IUI, Stockholm.

Swedenborg, B., 1982, Svensk industri i utrlandet, IUI, Stockholm.

Swedenborg. B. – Johansson–Grahn, G. – Kinnwall, M., 1988, Den svenska industrins utlandsinvesteringar, IUI, Stockholm.

Södersten, J. – Lindberg, T., 1984, (Swedish authors), The Taxation of Income from Capital. A Comparative Study of the United States, the United Kingdom and West Germany (eds. M.A. King and D. Fullerton).

Wicksell, K., 1889, Geldzins und Güterpreise (Interest and Prices), published 1965 by AMK Bookseller, New York.