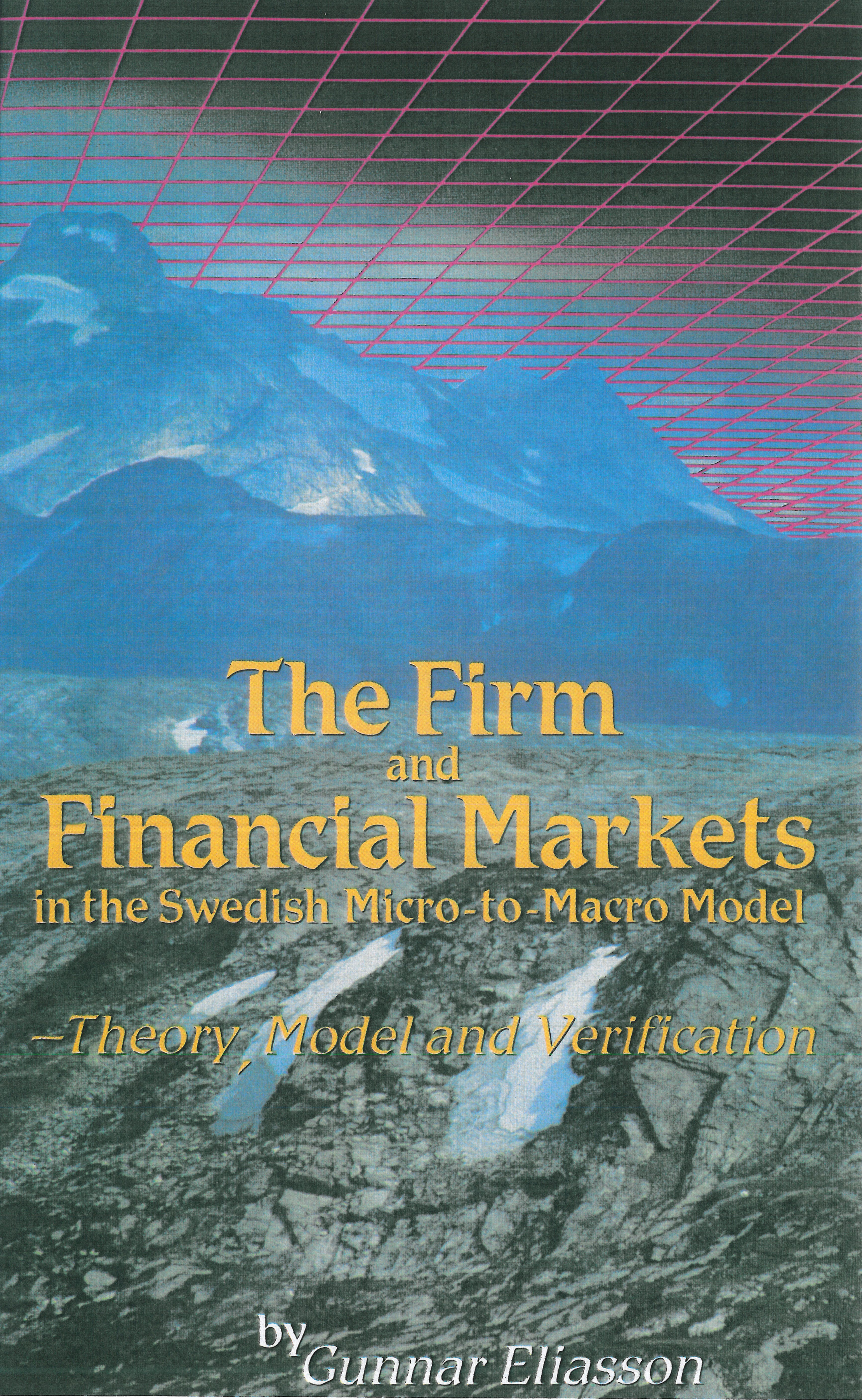

The Firm and Financial Markets in the Swedish Micro-to-Macro Model

–Theory, Model and Verification

by Gunnar Eliasson

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"The man of science like the man in the street
has to face hard headed facts that cannot
be blinked and explain them as best he can".

James Joyce

Distribution:
Almqvist & Wiksell International, Stockholm, Sweden.

ISBN 91-7204-245-1

Cover picture: Stefan Lehtilä Tecknare AB

gotab Stockholm 1985

Foreword

The IUI micro-to-macro modeling project began almost ten years ago as a joint research venture between IBM Sweden and the University of Uppsala.

At the outset, the major research activity took place at the Federation of Swedish Industries. In 1977 the project was transferred to IUI. The first technical phase of the project was concluded with the joint IUI-IBM conference on microsimulation modeling in Stockholm 1977. The conference served as the basis for two IUI reports (1978 and 1980).

Since then project resources have mainly been devoted to building a micro-to-macro database for the model and retooling it for empirical applications. There is essentially no end to such work. Since the current model design is significantly different from what has been described in earlier publications we have decided to publish a set of intermediate reports on the current state of modeling design and database work. This is the first publication in that series presenting the ideas of micro-to-macro theory and the overall structure of the model. Later publications will cover technical aspects of the modeling technique, database design, model related econometric work and applications. Much of this work is already available in IUI Working Papers.

Stockholm in June 1985

Gunnar Eliasson

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I Project Background

This book presents a general micro-based model of a national economy with applications on the Swedish economy.

The micro-to-macro (M-M) economic system[1] focuses on the dynamically efficient coordination (allocation) of factors of production, and the adjustment of output to market price signals. The model treats the modern business corporation in a crude way. The model firm competes with cost efficient production of physically homogeneous goods. We are not explicit about the importance of knowledge and labor education in the production process (E 1985e)[2], of service input in the production process (E 1984a, Lindberg-Pousette 1985) and of the dominant orientation of advanced manufacturing firms towards specialized customer markets, where competition is through product quality change rather than through aggressive price setting (Eliasson–Bergholm–Jagrén et al. 1985).

These important aspects of industrial activity have been investigated in several parallel IUI studies. Lack of quantified information and difficulties in measurement explain our reluctance to bring such factors into the model system, although some attempts to use data on R&D spending and foreign subsidiary operations are reported in Chapter III. Hence, product quality change is assumed to be reflected in a larger volume of output.

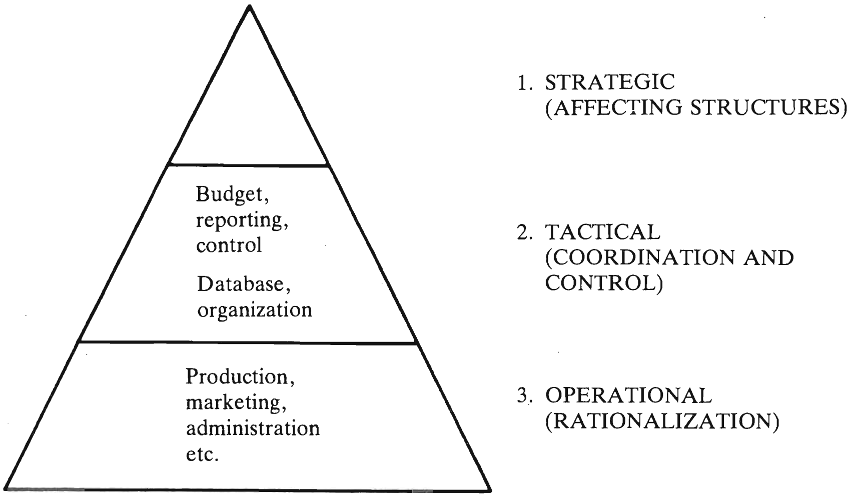
Product markets are characterized by a complete arbitrage for quality differences each period. In this type of analysis the M-M economic system is classical.

Dynamic factor coordination, in fact, offers enough of a theoretical challenge. Figure I:1 illustrates three levels of decision making within a modern business organization. The bottom level represents

[1] The empirically implemented version is called MOSES for *M*odel *O*f the *S*wedish *E*conomic *S*ystem.

[2] References to publications by "Eliasson" will be abbreviated by "E" throughout the book.

Figure I:1 Levels of Decision-Making within a Business Organization



operational decisions, i.e. decisions related to a more efficient local factor use ("rationalization"). In the model this takes place in the quarterly production decision (Chapter II) and in the current application of investment to upgrade a local production process (Chapter III).

The middle *"tactical"* decision level is concerned with coordinating local factor use over a given set of activities within the firm. Such coordination takes place at all levels within a firm. From an analytical point of view with a financial definition of the firm unit, the Corporate Headquarter coordination of a divisionalized firm is the appropriate dimension. At that level capital is allocated over a *given structure of activities,* generating structural change through a different mixing of given activities at the aggregate level. This function of the individual firm is not yet operational in the model.

The most important dynamic coordination of activities in MOSES, however, occurs *between firms* in the markets for labor and capital.

At the third, *strategic* decision level, structures are changed through *innovative* behavior. Firms change their internal structures, either through investment (in Chapter III), or through recombinations of external and internal activities (mergers, purchases, exits, etc. Currently only exits of whole firms are modeled explicitly) or through new entry which is not yet a standard feature.

With this introduction we can establish some genealogical links in the development of the M-M model. The *innovative function* in the production system is represented by *Joseph Schumpeter*. It is exogenous, as the young Schumpeter (1911) suggested, although we recognize the possibility of endogenizing it in terms of the frequency of innovative behavior across the firm population (E 1981, 1985a).

Market coordination is represented by the invisible hand of *Adam Smith*. However, we avoid the development of static coordination from Smith via Walras to so called "modern" competitive eqilibrium theory. We want instead to introduce dynamic market self-coordination through endogenizing both price and quantity behavior. Thus we enter dynamics into the Walrasian system, making the speed of such endogenous market adjustment a central analytical and empirical focus. By keeping market agents in persistent *search for improved positions* we obtain a *dynamic disequilibrium market process*. I like to call this part – as suggested to me by Erik Dahmén – a reinterpretation of Wicksell's cumulative process in a micro setting.

Schumpeterian innovative behavior provides injections of new quality into the economic system and creates temporary monopoly profits across the system. These profits, represented as Wicksellian capital market disequilibrium (micro) variables feed the investment and new entry processes. Old innovative rents are competed away by new innovative rents through product and factor price adjustments.

Hence, from the point of view of economic doctrines we recognize four levels of allocative efficiency;

(1) static efficiency (competitive equilibrium theory)
(2) static, neoclassical efficiency (steady state or turnpike economics)
(3) dynamic efficiency
(4) Schumpeterian efficiency.

The first two levels are not particularly interesting. *Static efficiency* prevails when a firm operates on its production function. It is achieved in the M-M model through the quarterly production and labor market decisions. *Neoclassical* (static) *efficiency* is the special, standard version thereof, when one assumes static expectations that always come true and steady state or possibly, turnpike approach behavior emerges. We find, paradoxically, that as you improve static efficiency in both senses you destabilize the micro-to-macro economy through its price system.

Dynamic efficiency is what the M-M model was originally designed to analyze. It is achieved through market coordination (Adam Smith type) with innovative change assumed away, and operates through the investment process among firms (middle coordination level in Figure I:1). If "dynamic" market adjustment in that sense is speeded up, the system moves closer to static efficiency; but if too fast, the system is destabilized and is vulnerable to collapse.

Schumpeterian efficiency comes on top of dynamic efficiency. It is achieved through innovative behavior and it allows – we hypothesize (E 1983, 1984, Hanson 1985) – a faster dynamic adjustment without instabilities.

We find that when Schumpeterian dynamics is introduced, *controllability* of the economy is a doubtful proposition in the traditional policy sense based on Keynesian theory. A dynamic M-M economy is simply too complex to understand with the kind of quantitative precision required for policy control. If viewed from a long-run perspective the natural vehicle for reasonably stable and fast economic growth appears to be a policy that promotes: 1) long-term environmental predictability for micro decision-makers; 2) incentives for innovative behavior or the introduction of new technology in existing firms or through new establishments; 3) competition that forces exit of inferior producers and supports continued diversity in performance and prices throughout the economic system (Chapter VII).

The market is, however, little more than its institutions. Institutions are linked together by legal, moral and behavioral rules that form – so to speak – institutions themselves. Institutions (firms, households, public institutions, policy bodies) change internally and in size. Rule systems change or collapse as a normal part of socio-economic development. It is instructive to look at the normal response of a business firm to competitive challenges in the market. The firm changes its organization. Such changes can be demonstrated [see E 1985b] to be a fundamental productivity enhancing vehicle.

Similar "redesigns" of market organization occur, to some extent, by way of policies *and* through endogenous self-regulation (E 1985c). Looking at an economy from this perspective economic theory and research organization appear somewhat contradictory. Micro analysis of institutional behavior, the introduction of micro behavior and rules of the game, the stability of the rule system – in short "the regime" – and the aggregation problem become the focus of concern. It becomes distorted research procedure to exclude sciences like business administration, engineering, political science, sociology, psychology, etc. from the economist's concern. There is little to learn from an isolated theory of public choice, because political bodies are micro units with their own – just for simplicity – utility maximizing drives that operate together with firms, households and others, that form parts of a more general theoretical structure of market self-regulation.

The promise of economics is that all these bodies and rules could be studied within one unified analytical context. Lacking the conceptual device to do *it all,* we do what we can on a formalized or quantified format and accompany the formal analysis with the necessary, well rounded thinking that promote understanding and prevents the researcher from being fooled by simplifications of theory. The consistent underestimation of factor allocation effects within static theoretical frameworks is a useful illustration.

The dynamic allocation effects on output appear to be huge. Holding technology constant at the micro level, the parameters defining the organization and speed of the market processes – the "market regime" in MOSES – can in fact be varied so as to produce output growth rates that differ as much as between the industrial nations during the past 50 years (Chapter VI). And this analysis is still extremely simple, and quite static in dealing with the dynamics of institutions and organization.

1. Why?

The moving force behind this large and lengthy project has been the desire to realize a vaguely conceived goal: to model the dynamics of a capitalistic market economy.

All existing advanced industrial nations have been through an early formative phase of unregulated and privately organized capitalism, that has been instrumental in moving the economy onto a fast growth path. It is paradoxical that economics lacks a systematic theory capable of capturing the economic processes of a dynamic market economy. It is also worth noting, that this was not "discovered" in the literature until the Western economies began to experience serious problems in the late 70s – in proportion, it appears, to the extent that the capitalistic elements of their economies had been removed. I am thinking in particular of the "exit function" that was effectively reduced by industrial policies.

One ambition of this research venture has been to take a few steps towards remedying this situation.

But it is not enough to make static theorizing a bad word in economics. Something has to be put in its place and this is no easy task.

Indeed, the alternative is a seemingly complex, non-transparent and unfamiliar intellectual structure that cannot be handled with the standard mathematical tools.

Of course, large scale modeling has been and will continue to be needed. The economic policy problems confronting nations increasingly require large scale models: partial and static analyses are clearly insufficient, and may even be grossly misleading. The analytical difficulties and the deficiencies of econometric techniques are not insurmountable and must not be used as excuses to avoid such research in dynamic economic theory.

Our method means approaching economics from the perspective of the *decision-makers* (firms, households, policy-makers), and modeling their market behavior on the basis of the information they in fact have and use. This makes it possible to treat *time* realistically in both a planning and a historical context. This allows us to exploit the wealth of micro data that exists. The latter is a principal objective of the project – to use more detailed and reliable information to better understand the workings of the entire economy. It cannot be helped if that ambition draws us out of the mainstream of traditional economics. In the long run empirical evidence always decides what is the best theoretical approach.

Micro-to-macro process models may appear to fall between two stools; the theoretical and the empirical. On the theoretical side two things are sometimes bothersome. A micro-to-macro model of some quality simply cannot be analyzed without a substantial input of quantitative information. To be meaningful, this input has to draw on data from the real world. Hence, the distinction between theory and empirical analysis gets blurred from the outset. Secondly, the improved treatment of time means that micro-to-macro models often depart significantly from standard macrodynamic modeling in dealing, for instance, with the concepts of equilibrium. On the empirical side, models of this complexity are beyond the reach of ordinary macroeconometrics, and the relevant microeconometrics techniques are not yet available. Recourse to simulation is not only necessary but also appears to be useful for understanding real life economies.

The broad idea behind the micro-to-macro model is the possibility of integrating economics with business and engineering knowledge into a model structure that explains the growth process. This can, of course, only be achieved at the expense of the simplicity of classical economic models.

It has, in fact, always disturbed me that economics draws such strong conclusions from such a meager empirical base. Do we really possess the well organized intellectual structures that warrant the detailed proposals to national policy-makers that have been offered by the profession, and sometimes followed by the politicians? Should the policy-makers rather not ask for a more richly endowed theory, one requiring a more elaborate knowledge input on the basis of empirical research at the micro level – a shift of research emphasis away from theoretical sophistry towards more hard work?

2. The Background of Doctrines

Even though the main source of inspiration for this project is my own fieldwork with real companies (E 1976a, 1983a), the main lines of thought embedded in the model draw on three distinct areas of economic inquiry. It merges (1) the Schumpeterian concept of the innovative firm, or entrepreneur, as the generator of temporary rents with a (2) long-term micro interpretation of the Wicksellian idea of a cumulative process moved by a capital market disequilibrium (E 1983b). Innovations in firms fuel the macroeconomic growth process and keep the economy in disequilibrium. Finally (3), the self-coordinating market forces embedded in Adam Smith's (1776) notion of the "invisible hand" coordinate all agents' actions dynamically.

The creative forces vested in the dynamics of the capitalist market process compete away temporary rents by driving inferior producers from the market and by stimulating new entrants of superior competitors and innovative behavior in existing firms. New innovative entry is the main check on concentration. This Darwinian or Schumpeterian scenario of competitive rivalry is visible in Smith (1776, pp. 77–79 in 1976 edition) as the efficiency determinants behind "the invisible hand".

It remains to explain the positive side of the competitive process through the entry of new solutions to old industrial problems in the form of innovations and new combinations. Adam Smith, in fact, regarded freedom of entry as the essential element of the competitive process. By treating the introduction or the creation of new technologies at the firm level as exogenous, we are in a sense subscribing to the school of thought that emphasizes non-economic factors in explaining innovative behavior in an economy. In the current formulation of MOSES, non-economic factors enter exogenously in two ways;

(a) the degree to which the economy *accepts change* caused by anonymous competition,

(b) the degree *of curiosity* and extent of ambitions of firms to try new things in commercial areas and not being prevented by laws and rules to pursue new ventures.

Non-economic factors like (a) and (b) are embedded in the model parameters that define the *market regime.* Such exogenous factors relate directly to the cultural setup of the nation, circumstances that are entered in the model by exogenously set parameters. By this formulation sympathetic attention is given to a host of well-known social scientists of the past that have worked with economic problems outside mainstream economics; Veblen, Weber, again Schumpeter and also (!) Marshall. Current representatives would be Winter (1964), Nelson & Winter (1982), Olson (1982), Williamson (1975) and several publications by Simon. I would have liked personally to see more institutional change explicit in the model.

Wicksell (1898) treated a departure of the rate of return expectations of producers from the market loan rate – a capital market disequilibrium – as the moving force behind a short-term inflationary process. I follow Erik Dahmén's (1984) suggestions and reformulate this as the motivation for investment at the firm level, with long-term implications for capacity growth.

Only through this complex merger of theoretic devices is it possible to realize the old Schumpeterian idea of an *endogenous growth cycle*. Growth, as exhibited through long-run differences in national wealth creation, requires that the dynamics of the allocation process be made explicit at the micro level. Thus certain elements of thinking associated with the Austrian and Stockholm schools of economics have been brought together into an empirically formated, theoretical system.

Above all, monopolistic competition becomes a natural market characteristic when time is properly treated. Various forms of temporary monopolies created by innovative behavior and destroyed through competition by new innovators become natural, positive vehicles in a growing economy.

The conceptual framework of Coase (1937) forms the base for modeling interior, institutional change of market agents. We add one special reinterpretation (E 1976a, Chapter XI, especially p. 256). The firm in MOSES is a financially defined institution that leaks and attracts funds – thereby defining its outer boundaries – as its interior performance on the margin compares with external market performance.

There is a strong similarity between the interior rules of behavior of the MOSES firms and various behavioral models of the firm by Simon, Cyert, March, etc. This includes the rapidly growing field of principal-agent analysis, that has so far not really extended into the territory of the theory of the firm. The relationship between the shirking public utility and its relatively uninformed regulator studied recently by Radner (1981) has in fact been implemented in a dynamic version, called the MIP profit targeting criterion, which is frequently used in large business organizations (E 1976a, p. 236 ff.). It exists already as an integrated part of the MOSES firm decision machinery.

The now traditional notion of the market process as a one-sided or possibly two-sided search by the agents in the market – the producers (firms) and the individuals – for improved positions that we also use, is grossly oversimplified and probably misleading. Contrary to standard beliefs, service production, consisting mostly of information processing, is the dominant production activity within a modern manufacturing corporation. A major part of firm production – we are learning from ongoing IUI studies – consists in gathering, analyzing and using information about technologies and markets to make search more efficient. This is a very costly activity that can take place within firms or be rented out to special traders. To model the firm as an information processor (E 1985b) which would be the natural next step in MOSES development, would loosen up the organizational and institutional limits between the agents that together make up the market process. A realistic account of this is probably necessary to properly understand the nature of markets. It would require that we model institutional change, and perhaps even more important, bring the concept of the household and the firm closer together.

Thus far we have opened up the structure of the system, called an economy, and have in fact effectively removed its traditional equilibrium properties. Culture, available technology and the objectives of agents permitting, the upper limit of economic performance is way above the current operating performance of the economy.

With these new efficiency notations, a distinction between feasibility, optimality and equilibrium develops and the introduction of time also makes the notions of equilibrium and stability become indistinguishable. At any time it is known that economic performance could have been better, and agents aim for more, or better, or improvements of objective positions rather than the best. This causes problems for any welfare analysis on the MOSES system, that requires the existence of a well defined equilibrium.

Time being a factor to reckon with for economic agents makes it also necessary to accept that those who benefit from economic growth may not be the same as those who have to adjust and that the current working population may pay for the welfare of future generations, or draw benefits from future generations.

This is so difficult to handle that we have left welfare analysis entirely aside, even though a dynamic market model is the kind of instrument that might have something interesting to say on welfare.

Finally, with all these qualifications on realism entered, M-M theory, or the MOSES model developed within this project, should be regarded as a dynamic factor coordination market economy, that tells a straightforward story about the dynamic allocative efficiency over a given economic structure and given technologies. Considerations of the nature of new technologies and new organizational combinations, change in the nature of production, beyond what is exogenously assumed – just as the young (1911) Schumpeter suggested – will have to await new knowledge, new theory, and new measurement methods, and be applied ad hoc to our intellectual structure. The problem is that this has to be done, in order to say something truthful about the real economy.

I hope that I have also convinced the reader of this book, that static analysis is normally a misleading method in economics. Static analysis is economic description, a snapshot of the economic state. Comparative statics means comparing pictures of the same system at different states. It is still description. For this you can use a cheap box-camera, that would, however, give blurred pictures of a dynamic economic process in motion. It is no longer a matter of comparing states, but of comparing different economic evolutions over time and to understand how principles of economics are at work to guide and to push the motion of the entire economy. This is a much more abstract form of understanding than looking at pictures.

3. When?

The Swedish micro-to-macro modeling project began in 1975 as a joint research venture between IBM Sweden, on the one hand, and the University of Uppsala and the Federation of Swedish Industries, on the other, with myself as project leader. When I left my position as chief economist of the Federation of Swedish Industries and took the position as Director of the IUI in December 1976, the IUI also entered into the research venture.

The initial objectives were to model and analyze:

- the micro processes of inflation
- the relationships between inflation, profits, investment and growth
- the technical feasibility of micro-to-macro process modeling.

We have not only conceived, formulated and calibrated a new model type, but also organized and collected a large micro-to-macro database of firm and establishment life histories around the model, that will be described in a later volume (also see MOSES database in Chapter VIII). The latter has absorbed most of the project effort since 1978. We are happy to report that a new real firm database covering 70 percent of value added in Swedish manufacturing 1976 was finally initialized in late 1982 (see Albrecht-Lindberg 1982, Bergholm 1982). This database has recently been updated for 1982. It has served as the initial state description for the IUI 1985 long-term assessment of the Swedish economy, using the MOSES model as an instrument for systematic interaction of the medium-term plans of the real firms in the database and studying macro development.

4. The People

Many people have been involved in the project. I specifically want to thank Thomas Lindberg, then at IBM Sweden who pushed me to get involved in this highly uncertain research venture. The foreseen work effort, then gravely underestimated, did not look altogether appealing. Since then, however, I have begun to appreciate IBM research policy. It acknowledges that true scientific inquiries should aim for the more or less unknown and untried, and need not have a high probability of success. One important policy was to support *unique* projects with a sizable risk element, rather than routine variations of what is already more or less standard research. What matters for a high macro probability of achievement at the national (or firm) level is that a sufficiently large number of competent, high risk research ventures are in progress simultaneously. This is certainly a Schumpeterian idea that we have incorporated into our analysis and it acknowledges that in business as well as in research, mistakes, failures, and exits should be regarded as normal and frequent phenomena. Hence, curiosity should take precedence over criticism. I do not think, however, that this is typical of academic research.

I also want to thank Thomas Lindberg's collaborators and his successors at IBM Sweden; in chronological order they were Ingemar Hedenklint, Håkan Kihlberg, Ulf Berg and Lars Arosenius. Without their initial support and interest very little would have come of this project. Special thanks also go to Mats Heiman and Gösta Olavi, both at IBM Sweden at the time, who worked together with me, translating the model from a concept into a mathematical code and a computer program; and also to people at the University of Uppsala and at IBM Scientific Centers in Peter Lee and in Pisa, who participated in early seminar stages as the model took on a more concrete shape. I want to mention Ragnar Bentzel, Carlo Bianco, Paolo Corsi and Bal Wagle, in particular.

Special thanks go to Axel Iveroth, the president of the Federation of Swedish Industries, under whose auspices a major part of the early formative model work took place – a true laboratory environment for a research project like this. In fact, much of my research on business economic planning (E 1976a) also took place at the Federation. It turned out to be a necessary preparatory study for this project, without which the firm model would have been very different, and to my mind not much like the real-world firm I always wanted to capture.

Since 1977 several new researchers have appeared in the MOSES team. They have worked both on the theoretical side, and have used the model in various applications. Above all, however, they have been involved in the painstaking effort of improving the database, the computer program and the estimation and calibration of the model relationships. Louise Ahlström was responsible for adjusting demand, supply, financial and input/output macro national accounts onto a consistent framework for the model. She has reclassified the sectors according to the OECD's recommended classification for final use of products in order to fit the market orientation of the individual firm database that we use for the model. Thomas Lindberg, IUI, has been working on the individual firm, financial database, and has incorporated these micro data into subindustry financial accounts. Jim Albrecht of Columbia University has spent much time at the Institute improving the firm production system in the model, and analyzing and integrating the planning survey of the

Federation of Swedish Industries with the other statistical sources. The planning survey was initiated in 1975 during my time at the Federation of Swedish Industries. It was specifically designed to supply data for the model on the individual firm production system. We currently have a large set of 10 year life histories of divisions that aggregate into the financial firm units. Ola Virin and Kerstin Wallmark at the Federation have spent considerable time during these years checking and processing these data.

Bo Carlsson, then at IUI, now at Case Western Reserve University, made an important contribution to the analysis of technical change in the MOSES economy. He designed and carried out together with the Swedish Academy of Engineering Sciences, a special survey of productivity change in best practice installations in various industries 1955/75, data that could be directly used in calibrating the model over historic periods. Bo Carlsson also headed a research group, using the MOSES model to quantify the macroeconomic consequences of the Swedish industrial subsidy program (Carlsson-Olavi 1978, Carlsson-Dahmén et al. 1979, Carlsson 1981, 1983a,b, Carlsson-Bergholm-Lindberg 1981).

Fredrik Bergholm entered the project at a fairly late stage. He has reworked a large part of the data initialization program and the model code and program itself. He has also integrated a separate data set of foreign production units in the MOSES firm database (see Albrecht-Lindberg 1982, Bergholm 1982).

Finally, Ken Hanson, who has recently spent more than a year at the institute, has significantly contributed to the dynamic equilibrium analysis of the MOSES economy. He has also dusted off, remodeled and analyzed the entry module of the model, the importance of which we all underestimated at the beginning, as we were still caught in the remnants of static thinking, where such things are simply odd features of little consequence.

5. Model Vintages

The core of the model – the firm short-term production planning models and their product and labor market environments – has remained basically the same since 1977 (see description in E 1976b and 1978a). However, since 1978 a great deal of additional work has been invested in the MOSES micro-to-macro model. For one thing, it has been transformed from a theoretical construct into a working empirical model. The huge database work, which was never planned, is now nearing completion and will be presented in a separate publication.

Secondly, several extensions of the model were made between 1976 and 1978. The version now used in preliminary empirical work is not adequately represented in earlier publications, even though the core short-term micro-to-macro market processes have remained more or less unchanged.

The micro specified manufacturing sector has been submerged in a complete 10 sector input-output framework. That means that the individual firm in the 4 manufacturing sectors purchases inputs from both the 4 manufacturing sectors and the 6 other sectors. Firms have their own "standardized" input-output tables (see Bergholm 1984). A complete government sector has been added as an 11th (macro) sector, with the complete tax structure of the Swedish economy specified (see E 1980a). The government can manipulate the traditional fiscal policy instruments. Moreover, the principal policy variable of the public sector is new recruitment of public employees, to the extent that people are "available" in the labor market at the wages offered.

Potentially more important than this, however, are two other extensions: a nontrivial monetary sector of the entire system in which the interest rate is determined, and a long-term investment planning model of the individual firms. These extensions are presented in full detail for the first time in this volume.

Earlier extensions of the model have been empirically tested to allow policy simulation experiments (see Chapter VIII). These earlier extensions add well-known Keynesian features to the system but do not change the core short-run processes of the model, and therefore do not change its dynamic properties. But the newer extensions to be described in this volume – the monetary system and long-term business planning at the firm level – do affect the dynamics of the entire model economy. We are still working to incorporate the new money and financing dimensions, and to move the extended model from a theoretical construct to a working, empirically validated model.

Properties of the earlier version of the model were critically dependent on the *short-term production decision* and the pivotal roles played by endogenously determined wages, profits and prices. The new version endogenizes the *long-term* growth decision, the interest rate and the trade-off between today and the future.

Since 1977, the bulk of our work effort has been devoted to building a systematic micro-to-macro database, and to calibrating the model. This has been made possible by access to the resources of a large research institution and by designing other micro-oriented projects at the Institute to share in the database work. During the last few years very few have, however, objected to the good sense in diverting a substantial part of research resources away from macro analysis to micro-based studies.

Even so, much remains to be done to complete the database. And far too little has been accomplished in utilizing the database for estimation of micro relationships (see Chapter VIII).

6. This and Other Publications

This research project represents an intersection of (1) theory, (2) panel data analysis and (3) micro simulation. It is an exercise in *dynamic general market analysis,* where equilibrating mechanisms are explicit but the nature or even existence of a stable equilibrium is an open question. The M-M model represents a combined Schumpeterian and Wicksellian approach, linking micro behavioral analysis with the macro levels through the "invisible" coordinating hands of markets.

For the empirical application, a model version of this theory (the MOSES model) has been developed. And to apply the model a large database project (called the MOSES database) has been carried out on business firms.

So far all the theoretical inferences have been made on the basis of micro simulation analysis on MOSES model and database. It may be possible at some later stage to carry out "pure" analytical work on the mathematical principles and structures underlying the M-M system. However, I don't think one should rush into this kind of analysis. To my knowledge the needed mathematical tools are not yet in sight and my forecast is that pure analysis today can only be achieved at the expense of the interesting characteristics of M-M analysis – notably the dynamic properties of what I have called the Schumpeterian-Wicksellian growth process. Anyone that has done scientific work knows, that at the basic levels of principles, theory and measurement interact in a fashion that makes the idea of pure theory quite funny indeed.

Many practical problems are associated with presenting the project. First, there is the theoretical model (accounted for in this volume), and second, there is the coded program, various versions (subsets) of which have been used in the applied work (Book 2). A model like MOSES is always changing, so that any description (as Eliasson-Heiman-Olavi, 1976) will be a dated one. Furthermore, any model code, or the exact description of the model actually in the computer will be almost incomprehensible without the master principal design and the explanation in this book.

Hence, the MOSES presentation plan covers the following items:

Book 1. **THE FIRM AND FINANCIAL MARKETS IN THE SWEDISH MICRO-TO-MACRO MODEL – THEORY, MODEL AND VERIFICATION** (this volume) presents the philosophy (idea) of micro-macro theory, a detailed outline of the model plus theoretical analysis and summary of calibration methods and database work.

Book 2. **THE MOSES CODE** (Eliasson-Bergholm-Olavi) presents the operational model, the initialization program and the full updated code, (under preparation).

Book 3. **MOSES HANDBOOK** (Bergholm) *instructs* users how to run, modify and update the model, see Bergholm (1984).

Book 4. **MOSES DATABASE** (Albrecht, Lindberg et al.) presents financial database, planning survey, foreign establishment survey, production content survey and full macro database, (under preparation).

This publication (Book 1) is technically oriented. It aims at adding what the earlier publications lacked in model documentation. We have had to strike a compromise between necessary detail and overview. This includes a decision as to how much of model design not yet in the computer that it is proper to present here (see below). Shortcomings in transparency and overview will have to be made up for in a later, more popular presentation that does not aim at being complete. We begin, however, with a brief overview of the model to establish what is new. Then we proceed, in Chapter III, to a description of the long-term investment financing decision of the individual firm, and of the way that decision interacts with the short-term (quarterly) production decision. In a sense Chapter III describes the MOSES *firm* model in detail. Again, it draws on earlier drafts written in 1977 and 1978,[1] which were used as blueprints for the coding and programming of the model.

In the next chapter (IV) there is a fairly detailed account of the monetary sector and the process of interest rate determination. This chapter draws, more or less directly, on an earlier draft written in 1977.[2]

Part III collects the whole of MOSES, and in particular those parts that are new, to make possible the analysis of an endogenous growth cycle. It begins (Chapter V) with a mathematical abstract of the model.

Part IV (Chapter VIII) summarizes the state of empirical verification of the model system. A more elaborate account of the empirical work on MOSES will be included in Book 4.

Many persons have read this manuscript at various stages of completion. Beyond IUI researchers directly involved in project work, special thanks go to Jim Albrecht, Vsevolod Altaev, David Brownstone, Bo Carlsson, Richard Day, Hans Genberg, Ove Granstrand, Ken Hanson, Albert Hart, Anders Klevmarken, Tomas Nordström, Lars Oxelheim, Pavel Pelikan, Nicolai Petrakov, Mark Sharefkin, Frank Stafford, Ronald Teigen, Steve Turner and Bengt-Christer Ysander.

I also want to thank IØI in Bergen and its director Arne Selvik for generously allowing us to use their computing facility during several years.

Finally, this whole project has been conceived and scheduled much too ambitiously. For myself it has been an attempt to model a capitalistically organized market economy. Whatever the reader may think of the result, it has been an enjoyable and instructive experience for the author. In fact very few get the opportunity to build a complete micro-macro design of an economy according to ones own mind, to implement it empirically and to generate some rather provocative results. I hope the reader will be able to share with me, some of what I have learned about the functioning of a dynamic economic system.

[1] See E, IUI Promemorias dated November 18, 1977 and July 1978.

[2] E, IUI Promemoria dated 1977-05-27, revised.

PART I

SHORT–TERM PRODUCTION AND RECRUITMENT DECISIONS

II Overview of the Moses Economy [1]

1. Basic Ideas

In contrast to many traditional, large-scale macro models, the MOSES model is explicit in its treatment of long-term capacity growth, the short-term supply decision of individual firms, and the dynamics of market processes (labor, products, money). As should be the case in a growth model, long-term capacity growth is open-ended, and dependent upon the market investment allocation process. So far the model treats most of the demand side in a more traditional macro fashion. It combines (search based) price setting behavior of institutions with classical quantity adjustments to prices.

In the beginning the model economy may appear strange. It is fashioned much more in the mode of thinking developed by Joseph Schumpeter than in the mainstream of postwar microeconomics, and it deals explicitly with the nature of Adam Smith's invisible hand. Both the business cycle and the growth process are endogenized. Markets in MOSES are characterized by monopolistic competition, or even more generally as noncooperative games. A Wicksellian monetary disequilibrium is a normal working characteristic of the micro-to-macro model, and the old Stockholm School idea of a dynamic economic process is fairly visible on the pages to come. Economic life can be seen and understood in different ways. Here are some ways in which MOSES is different.

The first difference is that we are dealing with a large number of firm models, responding individually to their market environment within the constraints of a macro system.

The second difference is that MOSES is not an equilibrium model, but a process model. Firms do not jump in phase from one equilibrium solution to another. Such positions (solutions) do not normally exist in the model except as ex ante perceived positions of individual firms. Ex post, model firms can be observed on their way towards individual, moving targets.

Third, firms are not price takers except in a momentary (next quarter) ex ante sense. They interpret current-period price and quantity signals generated by the economic process, and form their individual decisions.

Fourth, in principle firms behave rationally, in the sense that they strive, on the basis of what they know, for an improved ex ante position. In doing so they do not generally make inconsistent decisions.[2] They do not necessarily optimize in the short term but rather search for improved ex ante profit positions (hill climbing) given what they know. This process recognizes search time, and is normally terminated before a global optimum is reached. Ex post, decisions can be proven to be both inconsistent and against the interests of the agent, and, hence firms can to some extent change their decision rules - learning new rules by doing. We call this a rules of behavior approach to modeling.

Fifth, considerable slack always exists, within firms and between firms. A systematic effort by all firms to minimize slack in a short period of time will generally disrupt the price system of the overall economy.

A particular aspect (sixth) of this slack is that firm management is assumed to know only a restricted domain of their own, interior structure and response patterns. This makes strict cost minimization on the basis of anticipated external prices impossible, except by search (trial and error). These assumptions about firm organization and behavior correspond to known and well established facts (E 1976a) about large firms.

An unusually large part (seventh) of the empirical information of the model (as a rule represented by a coefficient matrix) is embedded in the hierarchical decision process within a firm, the market process of interaction between firms, and the initial state variables (see Chapter VIII).

These, and other, novel features require a somewhat unfamiliar mathematical representation of the model. That representation may be difficult to understand, at least initially (see Chapter V).

Any large, national model must be fairly complicated. The MOSES economy, however, is in fact quite simple and transparent in principle. Each behavioral module can be understood independently. Complexity arises out of the interaction of simple, but empirically different, behavioral decision units.[3] The algorithm that aggregates the decision units is the dynamic market process and the endogenous price system.

A particular source of difficulty lies in the rules of behavior approach in specifying the model. We base decisions on information that we know decision-makers have access to. We introduce rules of behavior that we have observed in companies. We assume that firms aim at improving perceived profits, and that this is a time-consuming process that may often fail because of mistaken expectations. The market environment depends critically upon the combined search process of all agents in the market. This means that what is perfectly rational for the agent ex ante often appears as inconsistent behavior ex post. Some of our behavioral assumptions are based on accurate empirical observations. Several must be subjected to further empirical testing. This makes it interesting to experiment with the model, and to investigate why this or that behavior can be observed at the macro level, very much in the same fashion as one tries to explain what is happening in the real economy. The empirical foundations, and the realistic structuring of the model economic system can make this an enlightening experience from the point of view of understanding the real thing. The difference is that with the model you can always keep experimenting until you understand.

When facing a large-scale macroeconomic model, one instinctively asks the following two questions:

(1) What is this thing good for? I thought large-scale models had proven not to be so useful, and

(2) what about all these details? Are we interested? Can they really be predicted?

These may be relevant questions to ask, and normal reactions to the traditional macroeconomic models developed during the 60s. But when asked in the context of the micro-to-macro model to be presented here, they simply reveal that you have not got hold of the right idea.

Beginning with the first question: large-scale models are by no means out. The majority of questions that policy-makers have to face today can only be answered with the help of such intellectual constructs. Furthermore, the failure, demise or less than successful performance of large-scale macroeconometric models in the 70s is by no means a clearly established fact. Whatever one believes, it in no way carries over to the micro-to-macro model, which is entirely different in concept.

As for the second objection: the "detail" in the micro-to-macro approach is in the empirical input. We want to improve the micro measurement base for macroeconomic analysis. At the output level, we are not attempting to study the fine detail, even though it can be technically reproduced. In current macroeconometrics you construct aggregate measures from sample data. The micro-to-macro model takes the level of aggregation down to the decision unit (the firm) and endogenizes aggregation as an outcome of the market process. We are not dependent upon static equilibrium and other very special "market assumptions", to obtain and interpret aggregate behavior.

M-M modeling essentially has to do with improving the information content of data and facts. Theory provides the a priori assumptions needed to bring data into a coherent systems form, or into a reliable working hypothesis for policy-making.

We will try to ease the orientation process in the following overview. However, when reading the description, do not count equations and variables, and do not think in terms of a solution to an equation system. This is quite all right with traditional macro models, but not here. This is a process model. Look upon the model as a set of principles at work. Distinguish between the individual firm model and the model of market processes that "integrate" the firm units into macro aggregates. And remember that the national account identities always hold at the macro level, ex post.

2. The Firm, the Rate of Return Requirement and the Markets

The entire MOSES economy consists of (1) a variable number of individual firm, production-investment-financing planning models, that are (2) dynamically coordinated (and aggregated) through explicitly modeled labor, product and credit markets, all being (3) constrained by the state of technical knowledge vested in existing capital installations and in currently produced capital and (4) the imposed consistency of a macro accounting system.

The growth engine of the national economy is a population of independently operating business firms. Their behavior decides the future course of the economy. The micro-to-macro model economy appears not to be easily steered by the central power of a national government if its policies run counter to the objectives of the firms. If households had been modeled in micro, the same could have been said of them.

Firms' decisions are taken on the basis of price signals - not quantities. A business forecaster employed by a MOSES firm would be primarily interested in the long-run relative price structure and the time profile of the expected adjustment to that structure. Only to the extent that he expects his firm to exercise some degree of monopoly power, or if he is subjected to direct quantity constraints, would he be interested in aggregate income (quantity) variables.

The first and paramount price to consider for a MOSES firm "top executive" is the rate of return requirement imposed upon him externally by his Board or by the markets for finance. His concern for profits is monolithic.

In order of importance he is concerned about:

a) the value of the firm as assessed in the equity market that determines his debt capacity (not yet in program),

b) his current rate of return on assets as compared with alternative profit opportunities,

c) the loan interest rate, which determines when he should invest, and hence his long-term production and earnings capacity, and

d) his current price, wage and productivity combination that determines his current profits and cash flow.

The actions of all firms together determine all the prices in the model economy - product prices, wages, interest rates - in what we call the market process.

The firms, and ideally the households, are the moving forces in the economic system. We will introduce the behavior of firms as follows:

beginning in this Chapter is an overview of the entire MOSES economy. The short-term (quarterly) production decision, the labor demand decision, and the labor and product market interactions. These are all lower level operations management decisions taken on the basis of an assumed, fixed capacity endowment, the production frontier of the individual firm, being a function of labor input only. This has already been documented in E (1976b, 1978a), the former being more elaborated than the latter. The code (Eliasson-Olavi-Bergholm 1985) is fully updated on whatever changes that have later been introduced.

continuing in Chapter III, is the higher level (executive management) choice of the next period production frontier (the investment decision) and the financial commitment of the firm to a future investment plan.

concluding in Chapter IV is the dominant executive Board decision on what rate of return requirement to push down through the firm organization.

In terms familiar to management in real-world firms the three decision levels correspond to (cf. Figure I:1):

a) production decisions - the operating budget and production plan

b) investment/financing decisions - coordination through the budget and the long-term plan

c) strategic decisions - Board level.

To the extent possible, we used the results of a series of interviews with firms (E 1976a) in modeling the internal firm decision structure. A recent study of decision systems and information processing in large business organizations (E 1984a, Fries 1983) has allowed us to reconfirm a number of assumptions of the firm model.

Besides the agents (the firms), an initial structural description of the economy, and the reaction rules of the agents in the markets, the MOSES economy runs on a bundle of exogenous assumptions.

The most important exogenous variables are

a) foreign prices (one index for each market)

b) the foreign interest rates; one long term and one short term

c) the rate of technical change (embodied) in new investment

d) total labor supply

e) policy parameters, and

f) choice of market regime.

The model represents a general economic process moved forward in time by these exogenous factors, within the bounds set by the profit-based investment decisions and technical change in new investment vintages. Markets are, however, never fully cleared, and stocks are seldom kept at desired levels. The model economy can reside in different states, depending upon how it has been initialized and specified. Some of the states that we think are close to a realistic representation of the real Swedish economy may not be resilient to a number of plausible exogenous disturbances. Some disturbances will propagate the model economy into an extended state of chaos (see E 1983a) or into an unstable macro situation, as we prefer to call it. It is an interesting analytical problem to study the various market designs that confer general macro stability on the model (see Part III).

Macro dynamics depend on the paths all firms and other agents follow in their individual adjustments. The delicate balance between stability at the micro and macro levels is an intriguing theoretical (see Chapter VII) and a demanding empirical, problem. The process characteristic of the model means that there is no determinate state (solution) at a point in time where the model will come to rest or where it will remain if placed there. Despite the absence of random mechanisms,[4] - no stable "fixed point" or steady state growth rate seems to exist. Hence, the treatment of equilibrium and stability properties of the MOSES economy means a departure from common notions in economics. We have devoted an extra chapter (VII) to this topic.

The model has elaborately developed short-term and long-term supply sides embodied in the individual-firm planning process. There is a feedback, from the price and quantity outcomes in markets, through profit determination and cash flows via rate of return and borrowing considerations, to the investment decision in individual firms, that brings in new techniques of production. This makes structural change endogenous, albeit under an exogenous upper bound in each firm (see further Chapter VI). This short-run feedback on long-term decisions through financial markets constitutes the dynamic integration of the monetary sector with the real system (see Chapter IV).

Two observations should be made here. First, no single exogenous variable dominates the growth path of the economy. Each bundle of exogenous assumptions, including technical change in new investment vintages up to the horizon (we have tried 80 years or 320 quarters!), is compatible with substantial variation in long-term growth rates of the economy, depending upon the settings of the market-response parameters in (most importantly) the firms (see E 1983a).

Second, we have found, from experimentation on the model, that a fair amount of internal consistency between exogenous assumptions is needed if disruptive changes in the macro economy are to be avoided (see further Chapter VII). For instance, the initial micro productivity and rate of return structures have to be roughly in line with the exogenous development of foreign prices, the interest rate and the technical change assumptions for new investment. If not, structural adjustment may be abrupt. We know from Swedish experience during the middle seventies that the government then intervened in various ways, e.g. by changing the exchange rate or by industrial subsidies. Thus exogenous assumptions are also subjected to some endogeneity, in the sense that policy-makers have to change them to prevent macroeconomic behavior from becoming unreasonably disruptive. Even policy-makers are - to use Assar Lindbeck's word - endogenous. However, just as aircraft builders can design computer-simulated test flights in which wings collapse, we can design experiments on the MOSES economy that subject individuals to extreme hardships. From them, we can learn about optimal macro policy designs.

The initial state description of the economy warrants a chapter in itself. The whole idea of changing the initial state to design a simulation experiment, or to change the interior price structure of the model, everything else the same, appears to be close to an impossible exercise. Price and quantity structures are closely interlinked across micro units and over time. Each state is a snapshot of the dynamic process and even small modifications of the state, if not carefully calibrated, can create large local disturbances, that make the ideal of a controlled experimental design hard to achieve. Comparative static analysis has no meaning in a dynamic model like MOSES, and I venture the conclusion that such analysis, for the same reasons, tells the wrong story if carried over to real policy situations. It matters a lot for any policy conclusion, where you happen to be when you begin to enact policies. The initial description of the economy requires great care.

Statistical consistency at all aggregation levels, is an important property of the model. The model has been fitted into the national accounts macro framework. The manufacturing sector is broken down into (a variable number, currently four) sectors that are populated by individual firms.

In parallel with the model development effort, a time-series micro firm database has been developed. In the beginning, all firms were "synthetic" in the sense of being chiseled out of the aggregates, while preserving a) across-firm distributional characteristics, to the extent those were known and b) the consistent macro accounts when aggregating across firms. As additional data on real firms have been accumulated, they have been entered into the database. The real firms of each sector have been reconsolidated, and synthetic disaggregation has been applied again to the "synthetic residual aggregate firm" of each sector. There exists a computer program to perform this consolidation and disaggregation (Albrecht-Lindberg 1982, Bergholm 1983a).

3. Overall Macro Structure of the MOSES Economy

Another way to familiarize oneself with the MOSES micro economy is to look at its macro mapping in Figures II:1A,B. The macro lay-out is a ten sector Leontief input-output model combined with a Keynesian demand feedback, in the form of a Stone-type, non-linear expenditure system. The endogenous supply mechanism that is the model's prime unique feature resides at the micro level, and "disappears" at the level of aggregation of Figures II:1A,B. The novelty of the micro-to-macro approach is most easily visualized by seeing four manufacturing cells in the input-output system (shaded) as replaced by market cells inhabited by individual firms. They are the RAW, IMED, DUR and NDUR markets, respectively, in Figure II:1B. To obtain this, the statistical classification system of the input-output matrix and the national accounts had to be transformed onto a market oriented classification scheme[5].

Second, each firm is represented by a firm planning model, the outline of which is shown in Figure II:2.

Third, each firm is linked to all other firms and to the rest of the macro economy by explicitly represented market processes. The labor market process will be only briefly sketched below. It has been described in detail in E (1976b, 1978a). Together with the product market process the money market process will be presented in Chapter IV.

4. Technical Change at the Micro Firm Level

Technical change enters the individual firm (plant) through new investment. Each firm is indi-

Figure II:1A Macro Block Structure of Swedish Model

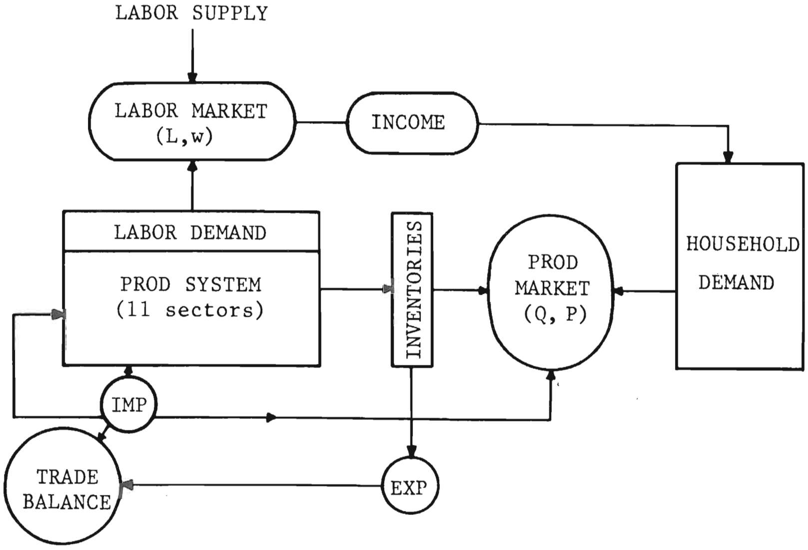
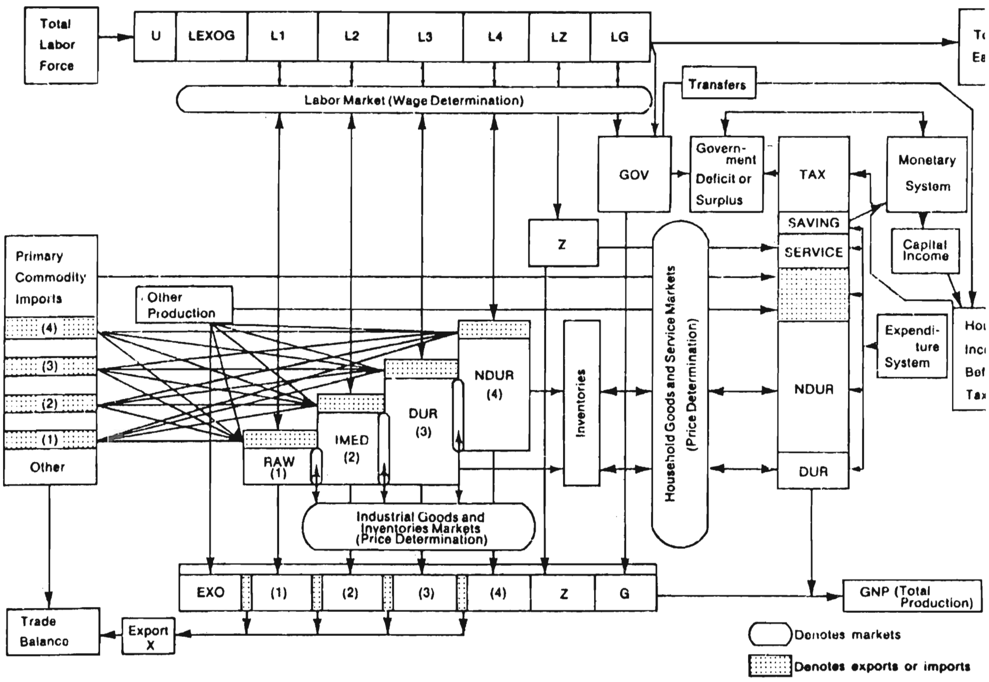
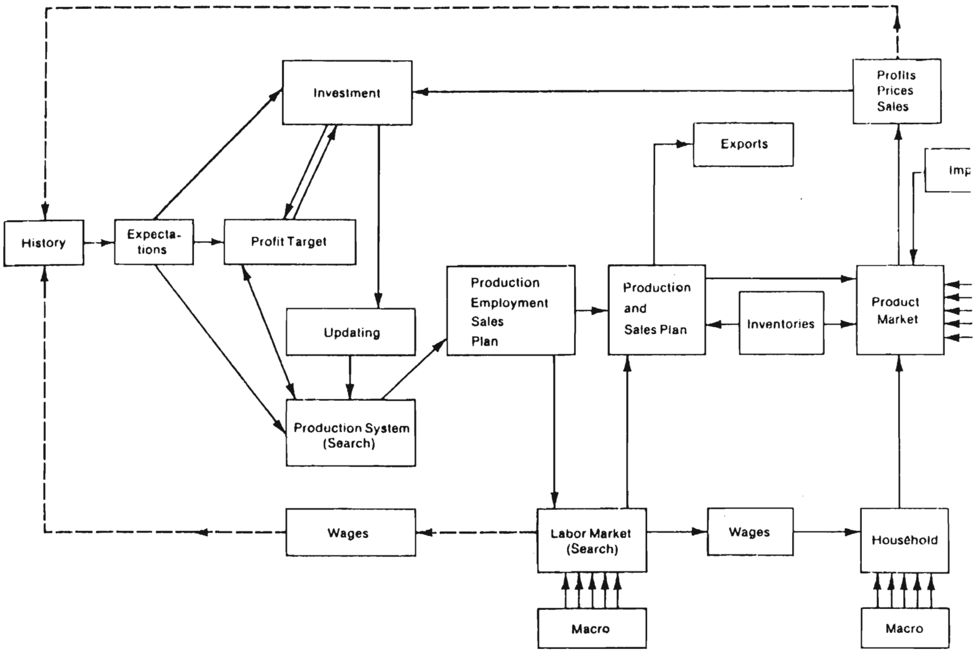


Figure II:1B Macro Delivery and Income Determination Structure of Swedish Model



Note: Macro delivery and income determination structure of Swedish model. Sectors (Markets): 1. RAW = Raw material production; 2. IMED = Intermediate goods production; 3. DUR = Durable household and investment goods production 4. NDUR = Consumer, nondurable goods production. Z = six macro production sectors. See Ahlström (1978).

Figure II:2 Business Decision System (one firm)



vidually characterized in the database. Parameterization of behavioral rules will also be individualized when enough panel data on firms have been accumulated to make this possible. Labor productivity (MTEC) and new investment expenditure needed to obtain one unit of output (INVEFF), both at full capacity utilization, are entered exogenously at the firm level. Hence the whole market-allocation machinery of the economy, most notably the firm investment decision, explicitly links technical change at the firm level with technical change, or productivity growth, at the industry level. The importance of this allocation machinery in the "real world" has been illustrated by two independent estimates (one through the model) that indicate that less than 50 percent of total-factor productivity growth, measured at the total manufacturing level can be explained by labor productivity growth in best-practice plants[6].

To explain exactly how "technical change" enters the firm we need a brief overview of the firm financing, investment and production systems.

5. The Firm and the MIP Principle

The firm or the entire business decision unit - to be expounded in full detail in Chapter III - is centrally controlled by a rate of return targeting formula that links rate of return requirements as expressed in the capital markets to the operating units of the business organization. Rate of return targeting applies to both the long-term investment decision (Section 6 below, and Chapter III) and to the short-term production decision (see below). The targeting formula integrates, in an additive fashion, contributions to overall profitability from different functional departments of the firm.

It will be demonstrated in Chapter III that

The Nominal Rate of Return to Net Worth(=RRNW) (II:1)

is a linear combination of

a) + profit margins in each of all production lines

b) - the rate of economic depreciation of assets

c) + the rate of inflationary appreciation of assets

d) + financial leverage (the company, or firm, nominal rate of return over and above its average borrowing rate, times the debt-equity ratio).

In the large, modern corporation each of those components has an organizational Counterpart. And each exerts a controlling influence on various in- and outgoing cash flow streams.

We will deal with d) and the long-term growth decision in Chapter III.

Our earlier model presentations have been preoccupied with the short-term (quarterly) production decision, exercised through short-term profit-margin targeting. The argument is that Corporate Headquarter (CHQ) managers impose top-down profit margin targets on operating divisions that are based on past profit margin performance. Targeted profit margins are gradually pushed upwards "from below" under the constraint that ex ante profits in monetary terms are not allowed to decrease. We call this the Maintain or Improve Profit (MIP) principle (see E 1976a, p. 291 f.).

It is well understood in any large business organization, that the major task of top management in a large firm is to apply well-calibrated profitability requirements to its constituent parts (divisions, profit centers). That is normally done without explicit knowledge of the underlying process of realizing these targets. The important rule is to locate the performance band above what is normally feasible, but below what is an unreasonably high target (E 1976a). Performance adapts automatically to the lower end of the target spectrum. Unreasonably high targets are not taken seriously within the organization. Such rules generate certain asymmetries in firm behavior that we also have in a MOSES firm. Slack targeting generates slack performance. Unreasonably ambitious profitability requirements push the firms to contract or close down, even though a well-calibrated target slightly above what is feasible may put the firm on a cumulative expansion path that generates rapid value "creation" and a high rate of return on equity. In unstable market environments that are "difficult to predict" well calibrated targeting is difficult.

The separation of decision-making within corporate organizations expressed in the separable additive targeting formula and the MIP targeting principle are empirically well-established practices in firms (E 1976a). A MOSES firm is modeled as a set of adaptive decision rules on the basis of these principles. They recognize the basic environmental uncertainty that currently faces each firm. We argue below (see Chapter VI) that this set of rules specifies a very rational, albeit cautious, profit-seeking entity. That entity will generate a performance that is indistinguishable, in econometric tests, from that generated by the classical profit-maximizing firm at the firm and industry levels.

Given the above conceptualization of the internal management problem, the setting of well-calibrated profit targets is a trial and error (search) process, even within the firm. The reason for this behavioral modeling is very simple. Top management in the firm does not, and cannot know what is technically possible to achieve! The procedure could be mathematically represented as search by trial and error for an optimum position. But in a dynamic MOSES economy that optimum, for the individual firm, changes from period to period as a consequence of the search process of all firms during previous periods.

Mathematically the internal trial-and-error process of a MOSES firm makes use of a gradient search algorithm. The firm seeks an improved position in terms of chosen targets (hill climbing) of a kind that is used in complex mathematical optimization problems to approximate a solution. Search in MOSES, however, rarely reaches the global optima which move endogenously from quarter to quarter.

Hence, in the micro-to-macro model aggregation is not performed under the assumption of static equilibrium. Aggregation functions - if we want to construct such things - are therefore not stable over time. The central mathematical devices that hold the activities of the model economy together, and perform the "aggregation function", are the separable additive targeting fomula, explained verbally above, the MIP criterion, and the market processes that link all firms together.

Since the profit targeting process is a dominant feature of the model, and affects both firm behavior and macroeconomic behavior, we add some further detail here, drawing on the extensive interview study that preceded this project (E 1976a). I do argue on the basis of those studies that anybody who wants to study, or model the dynamics of an industrial economy with the ambition to understand what is going on has to recognize the nature of the profit targeting process described here.

We begin by restating the salient, underlying features and conclude with a simplified mathematical formulation.

The MIP principle captures three facts of life true of all large business organizations;

(1) It is difficult for anybody, and especially for top CHQ managers, to set internal targets for the organization that are close to the global optimum. Management simply does not know the production frontier of their own organization well enough to do that.

(2) It is important for target credibility within the organization, that reasonable targets be set. If targets are unreasonably high, they are not taken seriously. One good standard for being "reasonable" is actual performance achieved in the recent past. It was possible then!

(3) A general management experience is that substantially higher firm macro performance can be obtained, if either a good reason for the extra effort needed can be presented ("crisis situation"), or if a different technical investment solution is chosen (other firms are better), - and time to adjust is allowed.

The scope of possible improvement and the time needed is always subject to different evaluations. The main point, however, is that operations management does not possess the information necessary to prescribe a better and workable solution, and there is no way for them to get that information. It is always in the interest of decision units within the firms, subjected to CHQ target pressure, not to reveal the information necessary for an accurate top level appraisal. Even if they happened to have all the information needed, there would be no practicable way to transform this information into a workable top down order or plan. Much "planning theory" is naive on this central point.

Hence, corporate management must act by persuasion, exhortation and coaxing.

It is, however, always reasonable to demand a small improvement in performance over and above what was previously achieved and measured. Exactly there lies the rationale of the MIP principle built on (1), (2) and (3) above.

It can be demonstrated (see Theorem 2 in Chapter III) that the additive component (a) in the nominal rate of return to net worth (RRNW) above is:

$$(a) = M \cdot \alpha \qquad (II:2)$$

where:

M = price-cost ratio or profit margin defined as gross operating profits/value added

α = value added/capital stock

and where:

$$M = 1 - \frac{w}{P} \cdot \frac{1}{Q/L} \qquad (II:3)$$

w = total wage (costs) per unit of labor input (=L)

Q = production volume

P = price of one unit of value added

Top management of the firm is now "pinched" by two facts. The Board and the share-owners are demanding a rate of return on their equity (=RRNW) expressed by the formula above: Just how will be explained in Chapters III and IV. Eqs. (II:2) and (II:3) also demonstrate that RRNW can be translated into a price-cost, or profit margin (M) requirement. This is the first fact.

The second fact is that demands for compliance with that top down requirement must be tempered by what is feasible and reasonable. If the difference is large and negative, there will be "market" pressure brought on top management to improve at lower levels.

If this improvment is too slow in coming, we will show (in Chapter III) that resources tend to leave the firm organization, to be invested elsewhere.

This situation of a differentiated information endowment between principal and agents or, between top (CHQ) executive and lower operational (division) levels has been shown to be very typical of large business organizations (E 1976a). The MIP-targeting device is applied to force information on the upper limits of the feasibility set to surface, and serves as an incentive for increased performance on the part of reluctant lower level operations management.[7]

We will demonstrate in this chapter that one major vehicle for profit improvement in the short term is improved productivity. That is all the more so if we adopt (which we will not do) the classical assumption of the firm as being a price (p) and wage (w) taker. Then [see Eq.(II:2) above] the only variable available to raise the profit margin is labor productivity (Q/L). As revealed by practically all short-term planning cases studied in E (1976a), this is also the variable that can in fact be improved upon in the short term.[8] There are two reasons:

First (mentioned above), there always exists slack of unknown extent in large organizations.

Second, the (a) component in (II:1) above can always be rewritten as a weighted average of profit margins of all profit centers, product groups and statistically separable production units within the company. This means that productivity improvements (and hence profit margin improvements) can not only be achieved by raising local productivity rates, but also by changing the product mix - and by shifting the production organization towards a mix with higher productivity and/or higher margin yields, because of better w/p ratios. Don't forget that average productivity improvement depends on the weights.

MIP targeting can now be represented fairly simply as:

$$MHIST := \lambda \cdot MHIST + (1-\lambda) \cdot M \qquad (II:4a)$$

$$TARG(M) := (1-R) \cdot MHIST \cdot (1+\hat{\varepsilon}) + R \cdot TARG(M) \qquad (II:4b)$$

$(\lambda, R) \subset (0,1)$, $\hat{\varepsilon} > 0$ but small.

:= is algol for make equal to.

HIST is a historic performance measure computed as in eq.(II:4a).

TARG(X) is an exogenous target requirement (e.g. of the best competitor) that can be weighted, to the extent desired, by $R \in (0,1)$.

ε is the improvement factor demanded.

This is all we need to proceed to the quarterly production decision to be enacted in a MOSES firm.

Approximate versions of this set of decision rules are used explicitly, or implicitly, in most large and decentralized corporations. Profit-margin targets are decomposed into cost and productivity targets. In turn reporting and control routines are run in terms of those variables.

6. Long Term - Investment Decisions

The short-term (quarterly) production planning sequence (see below) takes place within a given production feasibility frontier. This section is a preview of Chapter III, which deals with the choice among future production frontiers. An outward shift of the production frontier occurs through investment, prior to the production decision.

The micro-to-macro model has two alternative formulations of the individual-firm investment decision. One is a sophisticated investment financing version. The second is a less elaborate version. In this overview we don't have to distinguish between the two. Chapter III is solely devoted to the "sophisticated" firm model; the current operating version of the investment decision is presented in Eliasson-Lindberg (1981).

New production techniques are embodied in new investments, and affect the MOSES economy in at least five ways:

(1) The technical performance characteristics of a unit of new investment (called MTEC and INVEFF; see section 4), which are exogenous.

(2) The amount invested (endogenous).

(3) Allocation on firms (plants) of new investments (endogenous).

(4) The rate of utilization of installed investment (endogenous); and finally

(5) Through price competition from abroad (DPFOR), which is exogenous.

DMTEC (the rate of change in MTEC) is a central experimental variable in this volume. It is entered exogenously, and can be specified by quarter and firm. Figure III:2 illustrates part of the capacity-augmenting phase.

This makes the model "truly dynamic", in the sense that growth is endogenously determined, subject to an upper technology constraint. The micro model is combined with traditional Leontief input-output and Keynesian aggregate-demand systems. Thus price determination and income generation are combined in a theoretical (albeit numerical) model, the overall macro structure of which (excluding the monetary side) was shown in Figure II:1. The internal planning and decision process of one individual firm was pictured in Figure II:2.

7. Short Term - Production Search

Expected percent changes in sales, product prices, wages and targeted profits are used in the three micro specified market processes in which the firms interact. Each firm's expectations about prices and its profit target combine, with the constraints of technology and with the actions of other firms, to produce a final (quarterly) output. The reader should note that we have simplified our exposition by excluding purchases of services, intermediate goods and raw materials. We have done so throughout the bulk of this book, even though a very elaborate purchasing algorithm, involving a set of individual firm input-output coefficients applies to each firm (see Bergholm 1984). This means that, throughout the main text, value added and sales volume differ only to the extent that finished goods inventories vary in relation to sales.

Production planning is carried out individually for each firm, a preliminary planned output and labor combination (Q,L) is chosen, following the algorithm illustrated in Figure II:4.

Each firm faces a set of feasible (Q,L) combinations (a short-run production possibilities set) each quarter. That set is defined by

$$Q = QTOP \cdot (1-\exp(-\gamma \cdot L)). \qquad (II:5)$$

The feasible set is determined by the firm's past investments, as embodied in QTOP and γ. Investment between quarters pushes this set outward.[9] To the set of feasible (Q,L) combinations, corresponds a set of satisfactory (Q,L) combinations. A quarterly profit margin target, TARG(M), defines "satisfying". This target is calculated as defined above. The basic targeting is done on a yearly basis, with quarterly adjustments, and profit margin targets adapt gradually as experience on what is possible to achieve is accumulated.

As shown above (see eq.(II:1)), the profit margin target can be derived from the rate of return target. Bad profit experience can make the firm lower its target in the short term. That normally will affect long-term development negatively (see Chapter III); immediately through smaller cash flows and less investment and in the longer term through less investment and perhaps also less profitable investment that keeps future cash flows low.

Difficulties in meeting short-term profit targets are met by exploiting various kinds of slack within the company, in a way that might be called learning, or search for better solutions (see below and E 1978a, pp. 68-73).

Given TARG(M) and price and wage expectations, a planned (Q,L) combination is called satisfactory if the expected profit margin meets the profit margin target, i.e. if:

$$TARG(M) \leq (EXP(P \cdot Q) - EXP(W \cdot L))/EXPP \cdot Q \qquad (II:6a)$$

(II:6a) is exhibited by the straight line in Figure II:4. If we combine (II:5) and (II:6a) we obtain the feasible and satisfactory area (shaded). This can also be expressed as:

$$\frac{Q}{L} > \frac{EXP(W)}{EXP(P)} \cdot \frac{1}{1-TARG(M)} \qquad \text{(II:6b)}$$

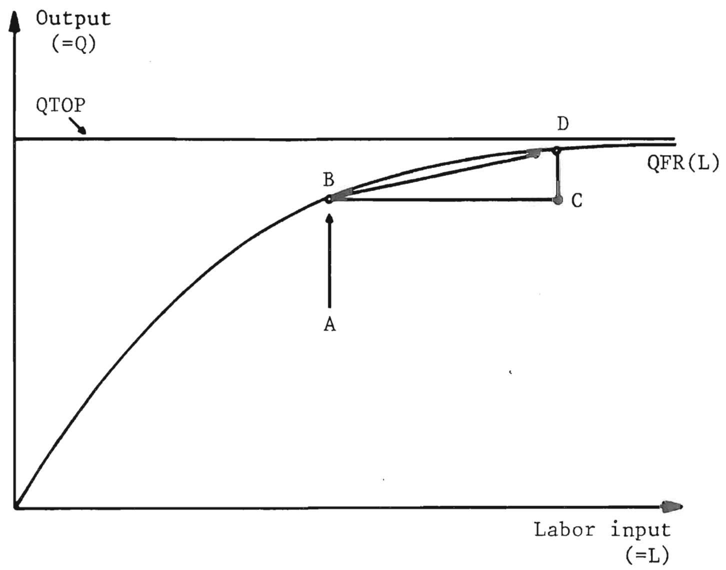
A shorthand expression for the satisfaction of this inequality is to say that SAT(Q,L) holds.

Expectations are of an adaptive error correction - learning type based on a smoothing formula, similar to (II:4a). Risk considerations ("aversion") are brought into expectations-forming through a standardized variance measure in the expectations variable. If variance in product prices increases, firm management tends to underestimate future prices, and vice versa for wages. This makes profit target satisfaction tougher, and forces (Q,L) closer to the frontier and possibly down left along it (contraction). The expectations side of the model is discussed in great detail in (E 1978a, Section 4.2).[10]

The firm now chooses a point within the "lens-shaped" area of Figure II:4 that is both feasible and satisfactory. This is done by specifying an initial set of (Q,L) points and the rules for adjusting those points if they do not fall within the feasible and satisfactory lens area. Note that it is labor productivity that is adjusted.

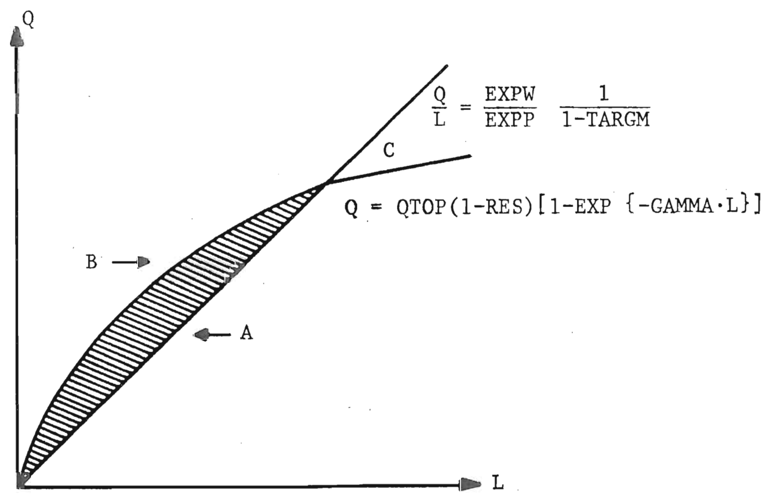
Search for improved productivity is a <u>learning</u> process that is activated and intensified by the difficulties of meeting profit targets. This is a well-recognized phenomenon in the business world. Firms do not know their feasible sets well even in the short term. Learning goes on all the time in a piecemeal but well structured fashion. This learning is speeded up when the profitability situation deteriorates. Under such circumstances internal resistance to change yields and improvements arise from little extra expenditures.

Figure II:3 Production System (one firm)



The function describing the production system of one firm at one point in time is QFR = QTOP • $(1-e^{-\gamma L})$. How this function is estimated and how it shifts in time in response to investment is described in E (1976b, Chapter 4) and in Albrecht (1978b).

Figure II:4 Profit Targeting (one firm)



Search for SAT(Q,L) continues under the constraint that expected profits

Q•EXP(P) - L•EXP(W)

do not decrease compared to an earlier, established position, including the initial one. If such a decrease occurs, search is terminated for this time (quarter) and the expected M position reached is accepted temporarily.

The first trial step is taken in the following way. The firm has inherited a labor force, net of retirements, from the preceding quarter. This is the initial level, L. The firm then computes a trial expected output volume[11] as

EXP(S)/EXP(P)

EXP(S) is the sales forecast for the next period contingent upon the expected price level EXP(P). Both expectational variables are derived as described above. Consistency between EXP(S) and EXP(P) is obtained through repeated trial and error from period to period (quarter to quarter). This output plan so derived is adjusted for desired inventory change.

Search is guided by comparison of the productivity ratio to an equally scaled expected cost-price ratio (see II:6B). The initial positioning of L, and a corresponding expected sales volume, establish an initial activity level of production. The search path into the shaded lens area may, however, lead onto B, and down along it, to a premature collapse of operations. This may not be incompatible with rational behavior in the sense that the firm deliberately chooses to lower its expected profits to find a quarterly (Q,L) combination within the shaded area. As mentioned, this is prevented by a <u>supplementary rule</u> that stops further search whenever expected profits begin to decrease.

For each L, there is an interval of output plans that are (1) either both feasible and satisfactory in the lens area, and/or (2) feasible but not satisfactory (Region B), or (3) neither feasible nor satisfactory (Region C).

When a feasible and satisfactory (Q,L) point in Figure II:4 is reached, the firm's preliminary plan is set such that SAT(Q,L) holds. If SAT(Q,L) does not hold, and if the point is in region A, then the firm adjusts by planning to lay off workers. If this does not help, the firm's preliminary plan is to set the minimum Q and the maximum L where SAT(Q,L) holds. If in B, the firm plans to increase employment. If this expansion moves (Q,L) into the lens area, then the firm establishes a preliminary plan at the minimum feasible Q and L.[12]

Production planning has now been completed. Expectational variables have influenced production plans in the following way. The ratio of wage and price expectations, constrained by TARGM, first defines the set of satisfactory (Q,L) plans. This set intersects the set of feasible (Q,L) plans to form the set of acceptable (Q,L) plans. Which plan is actually chosen within this set depends upon the initial trial (Q,L) plan, the adjustment for desired inventory changes and a set of search rules. That is because [M,TARG(M)] differences and the sign of CH(M) as a rule generate different search paths.

Each firm now has a planned employment and output level. But taken together those plans may not be feasible in the market. Firms must confront one another in the labor and product markets to resolve the remaining inconsistencies.

Why do firms often choose to operate at a level below the output frontier QFR? Why aren't the firms pushing on for higher profits? If this is your interpretation, forget QFR. We have made it explicit as a structural description of the firm and of the industry for you, not for the firm management. Firm management never calculates such things. CHQ generally manages the divisions under the presumption that:

$QFR(L) - Q > 0$, but small.

There are then two reasons for a large positive gap $QFR(L) - Q$, synonymous with labor hoarding.

(a) CHQ does not know, and takes no action
(b) Cyclical reason.

In the cyclical case CHQ knows that it can increase output with only insignificant additions to labor costs. In a recessionary situation there are still many reasons for not increasing output. The market simply won't take more. In the oligopolistic market situation that prevails, prices would only go down, and lowering price to temporarily capture a larger market share in a cyclical downswing could start a price war. The alternative to laying off labor is not good either if the firm expects future market expansion, since rehiring labor is usually associated with wage drift.

The proper way to model the case with explicit cyclical slack would of course be to make both adjustment costs and short-term expected relationships between demand (sales) and price explicit. We may eventually do that. Currently we deal with this adjustment as the short period trial and error process described above. With this interpretation short period adjustment costs are negligible but adjustments of any magnitude are time consuming. Furthermore short period price concessions to increase sales are expected to be so large as to become uneconomical, meaning that even for current output the firm is pushed out of the lens area in Figure II:4.[13]

With this interpretation QFR(L) technically functions as a stopping rule in the production-planning process. Work on improving productivity goes on all the time. It is time-consuming, and rarely "completed" within one period. Target non-satisfaction may force the pushing for higher efficiency to speed up a bit, but improvements normally stop when production plans hit QFR(L). The stopping point is, however, endogenized within each period, depending upon which way search goes, and over time since QFR(L) shifts because of investment.[14]

This target achievement process can be illustrated by real-world examples. First, labor hoarding or operations below what is feasible, given installed or employed resources, are phenomena that are always observed and measured at the micro level. Within a complex production system (e.g. a factory), one always finds numerous points of slack, because a complex production system cannot be made perfect and fully utilized, at all points, everywhere and always. Indivisibilities are cases in point. New investments that expand capacity cannot always be fully utilized during the first few years. But they require some minimum number of assigned workers to be used. Demand may be insufficient. The firm does not want to flood the market with its products (Nicolin 1983). This gradual utilization of initial slack may be an important explanation of the so-called Horndal effect (Lundberg 1961) or learning by doing phenomena (Arrow 1962), as it is in this model.

Smooth operation at the final output level requires that internal buffers be constantly maintained to accomodate interior flow disturbances. A similar analogy can be made of one firm as a part in a complex delivery system, an industry. Some firms are operating at full capacity, others are not and the state of slack across firms is measured every year in the planning survey on which the model is based (see Chapter VIII). Each year some firms are operating at full capacity, but most are not. We also know, from more or less crude empirical studies (see for instance E 1976a) <u>how</u> firms adjust their output plans in a stepwise fashion.

Production search has been tailored to mimic the procedures within firms. This suggests the empirical validity of the representation of a firm production system of the kind used in MOSES. One may, however, still want to know more about <u>why</u> firms do not make use of the existing short-term profit potential that comes with the slack. Such reasoning can be presented in two ways. One could introduce time-dependent adjustment costs. If we restrict our discussion to the time dimension of adjustments in output, we know that adjustments are made in discrete steps - as in the model. Those steps are bracketed in size, by what is technically feasible and what can be done without disrupting other aspects of firm operations. The time restriction could be interpreted as a formulation of how adjustment costs apply. This formulation amounts to introducing a lag structure. The adjustment cost can be indirectly estimated each time. Neither of those explanations is, however, convincing if management knows the exact shape and position of its production frontier. A rational management should then explicitly weigh the costs of getting onto it against the corresponding benefits.[15]

But, the important point is that the firm has to deal with the fact that it doesn't know its internal production structure with sufficient accuracy to get close to its production frontier - except by time-consuming trial and error procedures. Numerous examples can be reported on from the interviews in E 1976a. There is a world of difference between the state of knowledge that resides at Corporate Headquarters - the MOSES firm decision level - and on the shop floor. For example, in one case (see E 1976a, p. 199 ff.), Corporate Headquarters initiated the building of a production-programming model to reveal bottlenecks and to minimize costs by a more efficient utilization of resources. It appeared that the programming model spotted some, but not all, of those bottlenecks. Production management of the facility, however, knew about them all, and work was already under way to remove the most costly ones. Modeling work was terminated very soon, and Corporate Headquarter management felt confident in continuing drawing production plans without knowing the location of their QFR's more than very approximately. Not even management of a typical engineering work shop normally knows the process well enough to give orders on how to do the job (E 1980c). This management dilemma is solved very ingeniously by resorting to a stepwise search for improved positions (MIP). MOSES firms behave this way.

In fact, if someone could hold all price expectations fixed and equal to actual prices indefinitely (which both violates the basic idea of the model and is technically impossible), continued quarterly search might eventually take the firm to the (Q,L) combination that maximizes profits.[16]

8. Short Term - Labor Market Search

Each firm enters the labor market with a planned (absolute) change CH(L) in its labor force.

Firms are the active agents in search; labor waits passively. This is in sharp contrast to the mainstream of labor market search literature: Ideally, search should go on from both sides, the relative search intensities being a way of characterizing the labor market. However, if we have to choose one side, it is far more convincing empirically, for Sweden, to have the firms as the active search agents. Centrally set wage negotiations dominate and equalitarian ambitions have been pushed by unions.

Alternatively, think of search as the opening up of vacancies through a labor market agency, rather than as active search for people by firms. This information would then reach people unemployed or on jobs according to some specified diffusion process, for instance the stochastic one we use. The same comparison of wage levels would occur and people would change jobs.

As the labor market model is now specified, there are two problems. Workers may quit firms in a disruptive fashion, even though there are preset limits to the maximum fraction of quits per unit of time. This is a theoretical problem, though experimentation with the model does not suggest that it is a large problem.

The other aspect is that we have to preset the number of searches per period (=NITER) quite arbitrarily. NITER is estimated (or calibrated) when we try to fit macroeconomic model behavior to macro data, but that estimation procedure is unnecessarily crude. There is a simple way to remedy this. First, when the informational interpretation of SEARCH is used, only one person at a time (the one informed by, say, an ad) should leave or decide to stay. That would probably improve the specification of the model. Firms would respond by changing their wage structure in response to several losses of employees, rather than one big one.

Second, the number of allowed searches would have to be increased for each firm to be able to fill its vacancies. We would then interpret search as a time consuming activity, specified in real time, in the labor market part of the model. The maximum number of searchers from any one firm can be made dependent on total search going on in the market, which in turn is limited by a time constraint. It would be both formally and empirically easy to revise search specifications along those lines. It would, however, drive computer simulation costs through the roof. Hence, even if specifications are strictly as described initially it would be perfectly all right to interpret labor market search in the MOSES labor market as an approximation to the two-way information exchange just presented. Hence:

If CHL $\leq$ 0, the firm begins to lay off workers with the notification delays required by Swedish law.

If CHL > 0, the firm will start looking for additional labor in the pool of unemployed or, more typically, by trying to bid labor away from other firms.

Raiding of another firm for labor can be successful if the wage offer of the raiding firm sufficiently exceeds that of the raided firm. Expectations now enter directly into the labor market confrontation - the wage offer of a firm depends upon the wage level it expects will prevail, i.e. upon EXPW. The firm may restrain its expectations during the first quarter of search as it learns about wages in other firms. That search process eventually finalizes quarterly wage levels and employments for each firm.

What I have said implies that labor market search at each point in time always starts from a disequilibrium state. Even though (homogenous) labor is reallocated such that increases and reductions all cancel, when added together the process will always be inflationary in the sense that the average wage level increases and normally also inflationary in the sense that firms on the average will have to raise prices and/or productivity to prevent profit margins from decreasing. The latter reflects "implicit" transactions costs associated with the labor market arbitrage.

The dynamics of the labor market process are so important for the overall properties of the MOSES economy that we will add some detail to our earlier description.[17]

Let W be the wage paid by a firm in the preceding quarter. Then its wage offer [WW] is computed as

$$WW = W + \ddot{o}_1 \cdot (EXPW-W).$$

Firms are now ranked according to their relative demands for additional labor, as voiced by CHL/L.

They choose to raid either the pool of unemployed or another firm. The probability of being raided is related to the size of a potential target's labor force. As suggested above this relative size can also be interpreted as a measure of the probability of one employee receiving the information (the signal) that vacancies with the wage offer (WW) have been opened up in another firm. An upward probability bias can be (and normally is) applied to the pool of unemployed. "Raiding" can be global across all firms, or be selective, and restricted to a particular kind of firms, say in one sector[18].

Let i index the raider and let j index the target. An attack is successful if $WW_i > (1+ö_2) \cdot WW_j$, and labor in the amount of $MIN(ö_3 \cdot L_j, CHL_i)$ is transferred from j to i. If j indexes the pool of unemployed (which is of size LU), then the attack is always successful and $MIN(ö_3 \cdot LU, CHL_i)$ workers become employed in firm i. When an attack succeeds, (CHL_i, CHL_j, L_i, L_j) are adjusted in the obvious way, and the raided firm adjusts its wage offer upwards by

$$CHWW_j = ö_4 \cdot (WW_i - WW_j).$$

But if the attack fails, then it is the attacking firm that adjusts its wage by setting

$$CHWW_i = ö_5 \cdot (WW_j \cdot (1+ö_2) - WW_i)$$

The parameters $ö_i$ in the interval (0,1) determine the speed of response at each confrontation to wage discrepancies in the labor market.

When all firms (for whom CHL > 0) have gone through this search and bidding process a predetermined number of times, the search process has been completed for the quarter, and wage levels are set.

We have learned from repeated numerical experiments with the full model that the stability of the price system - and hence of structures and growth as well - depends critically on the intensity and scope of this labor market arbitrage (see Chapter VII).

One feature of the wage setting process is that at the firm level they are sticky downwards, even though bad economic times may lower the average nominal wage level through a change in the composition of labor. We thought of this as a realistic feature of the model, but it confers significant macroeconomic properties to the whole model economy, especially when it comes to engineering a fast recovery from a deep recession. It would be desirable to have the degree of stickiness of wages endogenous. For Sweden this would mean to repeal the union agreements and to offer a lower wage for everybody in the firm, or a substantial reduction of employment, if the offer is rejected. Technically this can be easily accommodated. Whenever target satisfaction forces larger layoffs than X percent, the firm instead offers the lower wage for everybody. This will allow it to keep Y percent of those threatened by layoff without impairing targeted profit performance.

Wage costs at the firm level can also be lowered through a decrease in payroll taxes.

The reader may have noted that the wage offer and labor search sequence embedded in the model seem to imply that the incidence of a payroll tax increase is 100 percent backward onto wages, in the sense that firms have already determined output plans and now offer a wage level that meets their profit targets.

This specification appears to contradict empirical evidence that suggests a 50-50 percent division between forward and backward shifting. But that interpretation of the model is wrong. Firms attempt in their plans to shift the entire increase of the payroll tax backward in the form of lower increases in (cash) wage increase offers. They may not succeed. Some of the adjustment is absorbed in the form of lower - than targeted - profits. Some in the form of higher prices and more inflation.

The final extent of forward and backward shifting of a payroll tax over a sequence of quarters depends on the action of all firms, and upon how those actions affect both demand, output volumes and prices. We know only that, in the long run the firms will have to comply, one by one, with a rate of return requirement set in the credit system.[19]

9. Foreign Competition, Foreign Trade and the Exchange Rate

The export and import functions of the model are supply-based.

Each firm changes its export ratio (X) in response to the differential between the foreign price (PFOR) and the domestic price (PDOM).

$$CHX = F\left[\frac{\mu \cdot PFOR - PDOM}{\mu \cdot PFOR}\right]$$

$F' > 0$

μ is the exchange rate

This formulation can be demonstrated to mean (roughly) that the ratio of deliveries to foreign markets and to the domestic market shifts toward exports as long as a positive difference persists (for the producing firm) between profit margins on export and domestic sales.

We do not want any other factors to influence the division of total supply between shipments abroad and to domestic markets; the speed of adjustment of relative profitability changes is the only relevant factor. The speed of adjustment may vary, and depends on a number of circumstances. Within a short-period, firm-based decision model like MOSES, with no quantity constraints imposed, it would be a misspecification to introduce quantity variables (like market growth) together with the price variables. Market size and market share can appear as proxies for profitability, or they can affect speeds of adjustment. For instance, if you have a large foreign market share, you do not rapidly divert all sales to domestic markets in response to a temporary price difference in favor of domestic markets.

Quantity (income) variables would enter if we remove the assumption that firms perceive themselves to be price takers in foreign markets, as some empirical work suggests (Horwitz 1983).

The above specification of the individual firm export function exhibits a particular feature that may not be desired. Negative PFOR changes in firms with large export shares may generate such large, next period drops in planned exports, that even next period sales at home drops, even though domestic sales are relatively profitable[20]. Firms with very large export shares (above 70 percent) are either operating in bulk markets (pulp, etc.) where no alternative domestic outlets exist and such abrupt, total sales decreases may be realistic, or are heavily established with large investments, abroad. The latter firms may rather take a temporary drop in export profits and maintain export sales in order not to endanger the value of their foreign market investments. Respecification of this feature is currently in progress (see Chapter III).

Two additional things should be noted here.

First, the main factor that keeps export ratios from converging towards 1 or 0 is that domestic prices respond (through quantity adjustments within the national economy) to the diversion (or vice versa) of supplies to foreign markets and hence diminishes the (PFOR-PDOM) difference. This (and the corresponding mechanism on the import side) is the main mechanism transmitting foreign prices into the model economy. One "equilibrium" property of the model is that, in the very long term, all prices and quantities in the economy will force PDOM to converge to PFOR. The duration of that adjustment is an empirical question. This is also the (only) way foreign business cycles are transmitted to the MOSES economy.

Second, the firm may appear to be a price taker in this formulation. It is in one sense: foreign markets absorb all that the firm can, and wants to deliver at the given foreign price (=PFOR). The firm responds to foreign price changes by adjusting foreign deliveries from quarter to quarter. The domestic price, however, responds to the volume of shipments of all firms and from abroad, both during the quarter and from quarter to quarter.

One might argue that foreign prices too should be sensitive to the volume of shipments. If this is considered important, one should insert an export price between the domestic price and the foreign price, and then make the departure of the export price from the foreign price dependent upon the sign of Swedish shipments relative to world shipments. That means introducing a downward-sloping foreign demand curve as well. Only under such assumptions would we want a quantity variable in the export function.

Again, the possibility for meaningful empirical specification depends on our access to individual firm data. At our level of aggregation (all manufacturing is divided up into 4 sectors), it makes little sense to expect the volume of foreign shipments of all firms in a sector to vary with the average price fetched in export trade in proportion to the foreign (world market) price. If it made sense, and empirical support could be presented, such an endogenous export price could easily be inserted. It should be noted, in addition, that we do not need this specification to generate situations like the 1975/76 cost crisis, when Swedish firms were said to be pricing themselves out of foreign markets. With our market concept, such an effect is nicely captured by declining relative export margins due to domestic inflation, and declining overall profit margins and rates of return due to a general domestic cost inflation. What we plan to do is to assume that firms can invest in production and marketing facilities abroad to obtain a higher individual price than PFOR. That price will, however, depend negatively on sales volume abroad at each given size of the foreign investment. All other firms will be assumed to be price takers. This refinement of the export function is not yet in the model. Hence, its presentation has been moved to Chapter III, Supplement I, where it is entered as part of the foreign investment decision.

Imports are treated in an analogous manner, but this time there is only one aggregate import ratio function in each market.

$$CH(IMP) = F\left[\frac{PDOM-\mu \cdot PFOR}{\mu \cdot PFOR}\right]$$

Also note that PFOR is always given in an "average" (tradeweighted) foreign currency that is translated into Swedish crowns through the exchange rate (see further Chapter IV).

10. Short Term - Product Market

The final quarterly, domestic product market confrontation is between firms as suppliers, on the one hand, and households and firms as demanders, on the other. That confrontation is specified at the market level: i.e. price and quantity adjustments are computed on a sectoral-average basis, rather than firm by firm. Demand is also affected by the total wage bill as determined in the labor market. This time, quantity demanded rather than quantity produced responds to price within each quarter. Consumers are the active agents in product markets within each quarter, and supplies are pre-determined from the immediately preceding output decisions, except for possible inventory adjustments. From quarter to quarter, however, supplies respond to prices, both in domestic and foreign markets. Thus firms' expectations directly affect final product-market outcomes only through the initial prices and quantities offered. Firms also indirectly affect the operation of product markets through the wages they offer and the total amount of income that consumers thereby have available for expenditure.[21]

Some clarifications of the product-market process may help at this stage. Firms observe differing average price levels on their products. That is because there are differing export and domestic sales mixes, and because the foreign domestic price difference of each market, and each firm's export ratio, are endogenously determined in the model. Moreover, the same domestic price is charged by all firms. The reason for that simplification is a real-world fact: the unavailability of price data for individual firms. It does not make sense to model differing price levels. (Note that we have data on, and model, individual firm wage levels). This particular specification means that firms compete, as a group, with prices against foreign producers, but against each other in terms of achieved price-cost margins, or rates of return. Even though wage levels differ across firms, this in practice means competing via production efficiency. Full-price arbitrage is assumed within each domestic market each quarter. In model terms, that means that output is properly adjusted for quality, and scaled to measure comparable "utils" across firms in each market. If a SAAB automobile is 30 percent better than a Volvo automobile, output measures are scaled to represent supplied automobile utils (or rather sector 3 utils) that each fetch the same price. (Note, however, that significant differences between the domestic and foreign price levels can be maintained for a long time, because of the slow quantity adjustment process.

11. Some Properties of the Model System

The distinction between theoretical and empirical analysis becomes blurred in a project like this. Compared to standard macroeconometric models built around an equation system, an enormous amount of empirical information resides in the specification of the micro-to-macro model. Furthermore, the MOSES system cannot be put into motion without first specifying initial micro structures. In macroeconometric models, estimated coefficients pick up most of the information embodied in the initial conditions. We will go over this again in Chapter VIII. This overview chapter is, however, the place to summarize the properties of the entire model system.

Until recently, most analytical work on the model had been concerned with sensitivity analysis aimed at ascertaining the properties of the overall economic system.

Thus far this analytical work has not been systematically organized, but has been exploratory. The summary results reported here, hence should be considered as hypotheses that are being subjected to further testing (see E 1983a). We find, 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; such shocks normally cause lasting damage in the form of lost growth in output,

(b) that the "domestic" price system, once significantly disturbed, takes a long time to stabilize (above 5, close to 10 years) even though the external (exogenous) market environment is artificially stabilized by assumption. Price "overshooting" appears to be a characteristic feature of the model economy (See E 1978a, p. 105 ff., Genberg 1983),

(c) 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,

(d) that reversal speeds are sensitive to the state as described by (a) and (b), and shocks of various kinds can "prematurely" trigger reversals (the Le Chatelier-Brown principle). Countercyclical stabilization policies normally generate expected positive short-term effects that are followed by reversals. The long-term effects of countercyclical policies on economic growth may well be negative, if policies have been biased towards demand stimulation. More specifically, the model economy can be made to perform excellently by short-term criteria (high utilization rates, efficiently allocated labor, etc.), only eventually to develop a more shock-sensitive supply structure (E 1983a),

(e) that if you attempt to stabilize quantities (q), e.g. through countercyclical policies, that policy eventually destabilizes prices (p), which distorts labor and investment allocation. Vice versa, if one attempts, through price controls etc. to "stabilize" prices (p), one removes incentives to adjust resources to meet demand, and hence, one eventually destabilizes quantities. The optimal mix is an empirical question that we will return to in Chapter VII,

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

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

(h) that it is virtually impossible to settle the micro-to-macro model economy used for simulation experiments down on a "steady" long-run macro state for more than a couple of decades, except at the expense of a significant reduction of the growth rate. The reason seems to be the absence of sufficient micro diversity and "instability" (see E 1984c). The model incorporates 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 follows 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 (see E 1983a, Hanson 1985, Granstrand 1985),

(i) that sustained growth along an endogenously determined trend is associated with long and short cycles in economic activity around this trend.

The micro-to-macro model - being a growth model - is especially well suited for studies of dynamic efficiency. If market price signalling is erratic, biased or unstable, strong negative allocation effects occur. They combine dramatically with supply structures characterized by deficient diversity. For instance, if the tail of the distribution of low-performing firms is too short, almost all firms in a sector can be forced to shut down in the model. That causes large and sudden disruptions in supply and demand conditions, which may be further aggravated by erratic relative price responses (through the allocation mechanisms).[22] In a study of the macroeconomic effects of the Swedish industrial subsidy program, these disruptive effects also appeared very strongly when subsidies to large, ailing basic-material producers were withdrawn.[23] This has helped to highlight the restrictive nature of traditional equilibrium assumptions.

One important part of dynamic resource allocation experiments is the time dimension of supply responses. Short-term (quarterly) supply (the production decision) depends on the expected profitability of employing people under a capacity constraint. Long-term supply depends on the expected profitability of investing, and in addition to the short-term profitability of producing. This means that long-term growth is sequentially guided by an array of expected, and realized, quarterly factor and product prices under an upper technology constraint associated with new investment. Long-term capacity to supply, hence, is open-ended, as it should be in a good growth model. We have found that the economy tends to operate well below output levels that are feasible, and that various interferences with the price system may lower growth below what is technically feasible (E 1978b, 1983a and Eliasson-Lindberg 1981), that technical change at the plant level only generates growth with a very long delay (E 1979), but that positive adjustment of prices - if substantial and smooth - generates a large and growing supply effect within a 2-5 year period (Eliasson-Lindberg 1981, Carlsson-Bergholm-Lindberg 1981).

Part of the reason for the negative growth effects are the long transmission times of price disturbances through the model economy. Those long transmission times upset the relative price structure, and make it difficult for individual firms to interpret and predict price and wage signals in the markets.[24] A brief period of high prices and profits easily turns into wage overshooting, and a cost crisis that may take years to correct itself. If the initial disturbance was strong enough, investments were hurt and firms grew cautious as a consequence of serious expectational errors. (As mentioned, the model has exhibited good performance in tracking price transmission through the economy and longer term growth rates. Calibration efforts within the subsidy project have also improved cyclical performance.)

Some of the less palatable conclusions that have emerged from model analysis can be traced to the initial conditions of the economy, emphasizing the importance of high-quality data for a proper understanding of economic phenomena. Econometrically speaking, the bulk of the information embedded in the estimated coefficients of a macroeconometric model appears in the initial conditions in a micro-to-macro model. For instance, economic policies - like changing the exchange rate (see E 1977) - produces widely diverging macroeconomic effects depending upon the extent and distribution of slack (the cyclical state) of the model economy when the policy is enacted.

Much empirical analysis of the life histories of individual firms remains, and some of this work will be published in the forthcoming database volume on the model. An estimation project on the positioning and shifting of individual firm production frontiers is in process, partly to make the model empirically useful as an instrument for analyzing the efficiency and stability properties of the Swedish economy.

12. Sundry Thoughts on Theory and Large Scale Modeling

Simplicity is a virtue in economics, as in all other sciences, but only if it is not obtained at the expense of relevance. Relevance is difficult to define but easy to recognize. Even though this book deals with an "artificial", mathematical structure that contains many intriguing economic mechanisms, we are studying a representation of a real national economy. Moreover, the model pretends to be a fair representation of the Swedish economy. When internal assumptions are found to be wrong, because they do not fit Swedish reality, we change them for something better - if we know what is better. Only insofar as it helps us in that endeavor, is economic theory of any use to us.

If you believe, for instance, that short-term price interdependence across markets strongly affects macroeconomic behavior for long periods when the economy is pushed by strong, erratic movements in foreign trade prices, then any theorizing on the economics of the 70s that does not recognize this must be irrelevant to you. Such across-market interdependencies can only be dealt with in dynamic large scale models, and preferably micro-based models.

Often you cannot discriminate a priori between excessive detail and relevant features and you have to keep both until empirical tests have allowed you to discard irrelevant parts of your theory. It is good to have a theory that is rich in potential empirical content if you plan to subject it to powerful tests. This is the essence of any learning process.

The "three equation model" can explain one or two partial phenomena. You can work with a large number of mutually inconsistent, small "educational" models to understand one problem at a time. To understand the "whole set of problems" you need a larger model, and one argument we are attempting to drive home in this project is that this comprehensive analysis will prove that your partial analysis is often misleading. This modeling project has aimed at bringing a holistic understanding of the whole economic process.

"Three equation models" furthermore evade empirical testing, by their very design, being far removed from any empirically relevant situation that can generate data. On this score one should advocate more large scale modeling, simply to force empirical discipline on the profession.

In the physical sciences you can approximate controlled experiments, keeping some aspects of reality unchanged. This allows you to test partial (small) models. The same thing is more difficult in the social sciences, although it can often be done in principle. You may want to simplify by highlighting certain "basic principles" to your students. That may be a viable argument in the classroom, although I take the liberty here of expressing my doubts. If simplification is by way of disregarding basic economic processes that are truly endogenous to the principle you are highlighting, one rather breeds misunderstanding. Fortunately, blundering in economic policy by industrial nations during the 70s has set up a tremendous data generating economic experiment. That experiment has dealt a devastating blow to large parts of received theory. We can only hope for appropriate "exits" of doctrines to occur. We have been fortunate to have this experiment to draw on, when testing our micro-to-macro model.

It does not follow that good theory has to be a non-transparent mess of details. The requirements on theory in economics that I want to lay down, however, probably mean that we have to part with the analytical ambition - at least until some breakthrough in mathematics has occurred. Numerical analysis, or simulation has already entered the scene in other sciences, and there is no reason why it should not do the same in economics. It needs not mean a departure from either analysis or simplicity, but it will mean a change of the way one approaches problems in economics.

Let me illustrate. A national economy is necessarily a complex machine. You cannot see through it in one glance. Hence our strategy has been to look at one piece of the machinery at a time, or at any larger part from a safe distance, where enough details can be discarded to allow a clear view. Walras' conception of the market auctioneer is a case in point. The auctioneer relieves you of the problem of explaining how the market was cleared and economists have skillfully avoided the how problem ever since by simply assuming that if the situation at hand offers economic incentives for change, then rational agents in the market will move the economy towards a state with no incentives for, and no, change. Eureka! That is all fine until one realizes - and surprisingly few have - that how determines how long this process will take and what it will demand in the form of transactions costs. In fact transactions costs seem to be the major cost component in Swedish manufacturing (see E 1984a), using up more resources than materials processing. Hence, transactions costs also affect the nature of equilibrium. If the time and resource using market process does not converge, then something very different from traditional general equilibrium theory is needed to understand what is going on. I take it that general equilibrium theory was never intended to serve the purpose of understanding the economics of a market economy. Macroeconomics was the ingenious solution for getting out of this stylized world of stable, optimal conditions of classical static economics that the empirically and historically-oriented economists could not accomplish at the time.

Keynes himself - the "innovator" - was quite aware of the shortcomings of his construct, essentially a statistical classification scheme upon which some simple "behavioral rules" were superimposed. That simple change of paradigm was nevertheless a tremendous leap forward in applied economics. It is to be deplored that academia has distilled out an IS-LM version for classroom and econometric exercises that is probably as far removed from Keynes' intentions as it is from the world around us.

The original Keynesian idea of forging theory and measurement is still as useful in capturing the idea of micro-to-macro theory. Theory and measurement are two integrated things. Measurement in economics can be performed today with much higher resolution than in the thirties. You don't have to mix structure and behavior to the same extent as has been customary in macro theory. This is the essence of micro-to-macro theory and measurement, together constituting a model. We aim at improving our understanding of macroeconomic behavior by relating it directly to a base of micro information.

NOTES to Chapter II

[1] This overview chapter is a modified version of E 1983b. Both are very much based on my model description, in E (1976b). Sections 7 and 8 on the short-term production decision, and labor market search also draw on the well-structured presentation in Albrecht (1978a).

[2] The decision process in the firm is hence of the gradient type. See also Simon's (1955, 1972) concept of "bounded rationality". This is the only meaningful way to define rationality, if each decision maker faces a situation where he or she or it cannot choose between a set of given quantified options. The same conclusion follows if the game situation is truly uncertain - as it is in the MOSES market world - such that you cannot meaningfully attach "subjective risk equivalents" to your expected outcomes. We will come back to this problem in Chapter VII, where we discuss equilibrium and stability concepts in the MOSES context.

[3] See also Simon in "The Science of the Artificial" (1969).

[4] There is one exception to this. See Eliasson, A Micro-to-Macro Model of the Swedish Economy, IUI Conference Reports, 1978:1, p. 74.

[5] See Ahlström (1978). The classification scheme corresponds to the OECD "end use" classification system. Also see Albrecht-Lindberg (1982).

[6] See Eliasson (1980b) and Carlsson (1981).

[7] This situation is similar to the bargaining design between a public utility and its regulatory authority analyzed by Radner (1981). Radner's target specifications, however, were static, and would lead to distortions in the long run, while the business targeting designs observed in E (1976a) are dynamic exerting a continuously upgraded pressure to perform as performance increases and vice versa.

[8] See also Grufman's (1982) study of the internal cost adjustment of a multinational company.

[9] The actual model production system is somewhat more complicated. For instance, it allows for a "soft" slack region (called RES) to be created above the feasibility set, that is "available" under certain, strained conditions. See E(1978a).

[10] Simplifying somewhat, the expectations function looks as follows:

$$\mathrm{HIST}(\tau) = \lambda_1 \cdot \mathrm{HIST}(\tau) + (1-\lambda_1) \cdot \tau$$
$$\mathrm{HIST}(\mathrm{DEV}) = \lambda_2 \cdot \mathrm{HIST}(\mathrm{DEV}) + (1-\lambda_2) \cdot [\tau - \mathrm{EXP}(\tau)]$$
$$\mathrm{HIST}(\mathrm{DEV2}) = \lambda_3 \cdot \mathrm{HIST}(\mathrm{DEV2}) + (1-\lambda_3) \cdot [\tau - \mathrm{EXP}(\tau)]^2$$
$$\mathrm{EXP}(\tau) = \mathrm{HIST}(\tau) + \alpha \cdot \mathrm{HIST}(\mathrm{DEV}) + \beta \cdot \sqrt{\mathrm{HIST}(\mathrm{DEV2})}$$

where $0 \leq \lambda_i \leq 1$

$$\mathrm{DEV} = [\tau - \mathrm{EXP}(\tau)]$$
$$\mathrm{DEV2} = [\tau - \mathrm{EXP}(\tau)]^2$$

:= is "make equal to" in Algol. Expectations on τ, called $\mathrm{EXP}(\tau)$, are generated out of the firms' own experience as determined by the conventional smoothing formulae combined with a quadratic learning function.

So far we have tried once to estimate some of the individual firm coefficients above, and several other coefficients by direct interviewing of executive staff people in one very large Swedish firm. The results turned out successful in terms of improving historic tracking performance of data for the same firm. Further efforts of this kind are planned.

In the context of the IUI 1985 long-term survey, all MOSES firms have been asked in 1984 to present their plans and price expectations for a future 5-year period, with explicit data also on the next year. These ex ante data will make possible some simple econometric analyses on expectations functions.

It should also be observed that expectations of individual firms can be imposed partially or entirely exogenously.

The profit-targeting function used in the model is very similar in form to $\mathrm{HIST}(\tau)$ above. The possibility of adjusting targets exogenously has also been added here as well as a device used sometimes in formalized profit-targeting systems in U.S. firms, namely always to raise targets slightly above what has been arrived at in the budgeting process (the maintain or improve principle, MIP) (E 1976a, pp. 236 ff.). For further detail on specification see E (1976b).

[11] Or rather sales volume.

[12] One extra complexity arises when there is no Q in the initial interval that is both feasible and satisfactory at any L. This always occurs in Region C and can occur in Regions A and B. The firm can reduce its planned output or shift its production possibilities set by the activation of "slack" or it can close down as a measure of last resort. It would take us too far to go into the complexities of this here. See further E (1976b, 1978a).

[13] Technically we could enter this by defining the elasticity of EXPS with respect to EXPP. It is currently assumed to be close to zero in a short period (quarter to quarter) context. See further Chapter V.

[14] It is still easy to agree that the simple search algorithms used (see E 1978b, pp. 185-192) are too simple. Search in many directions should be allowed. Given the nature of QFR(L) as seen from the CHQ point of view, randomized interior search would perhaps be a realistic procedure.

[15] But they do not, neither in the model nor in reality. True, they have supplied the data that have allowed us to estimate their QFR functions at a point in time. Those data originate in the firm's financially oriented costing and budgeting procedure. Such crude, aggregate measures are never used in actual production planning, in part because they have no operational meaning (see E 1976a). To firm production management, the QFR is a "soft upper limit" of the domain within which it can operate. Next period planning is carried out on the presumption that actual operations (Q) is below, but close to QFR. QFR can even be pushed through if the payoff is there. We have explicitly allowed for that possibility by introducing the concept of REServe slack (see E 1978a, p. 188).

[16] It is technically possible to investigate the properties of the entire model system in that respect through repeated simulations.

[17] A full description can be found in E (1978a) pp. 137-148 and 218-227.

[18] By identifying firms by regions search can also be confined within actual geographical areas. Such applications, to be meaningful, do, however, require a very large number of firms, more than the 150 firms we currently use in a simulation. For the time being, both access to firm data and prohibitive computer costs prevent such simulations.

[19] A series of experiments with payroll tax changes on an old version of the model produced results that appeared not to comply with these of Holmlund (1982). In E (1980a, p.73) a payroll tax was substituted for a value added tax. The immediate (one year) incidence was a higher consumer price index in the sense that the CPI level after VAT did not fall, and no effect on wages including the payroll tax was recorded. In the longer term the CPI level stayed put, wage costs came down and producers were able to increase their profit margins. An econometric analysis like that of Holmlund on time-series data generated by the model would then indicate both forward and backward shifting of the payroll tax increase.

When changing back to a VAT, removing the payroll tax, the effects were asymmetric.

[20] Fredrik Bergholm discovered this property during work on the industrial subsidy study by Carlsson-Bergholm-Lindberg (1981). At that time this property was eliminated by simply not allowing planned domestic sales to drop because of export decreases.

[21] The product market transactions processes are described in full detail in the code. See Eliasson-Bergholm-Olavi (1985). There is also a mathematical presentation in E (1978a, p. 79).

[22] See Eliasson (1978b, Norwegian case).

[23] See Carlsson-Bergholm-Lindberg (1981) and Carlsson (1983a,b).

[24] See E (1978a, 1983a, pp.105-126) and Genberg (1983).

PART II

THE LONG–TERM INVESTMENT DECISION

III The Investment – Financing Decision in a Moses Firm*

1. The Firm as a Financial Decision System

1.1 The Idea of a Long-Term Plan

This chapter introduces the core of the Corporate Headquarter (CHQ) growth decision. Short-term production planning as described in the earlier chapter was concerned with the utilization of existing capacity to produce a quarterly output (i.e. where to operate underneath QFR(L) in Figure II:3). We are now examining the decision to change the production frontier or production capacity, QFR(L). In the long-term planning process to be described here, CHQ picks its (ex ante) future production frontiers and arranges how to finance them under the constraint of a rate of return requirement passed down "from above".

Before we begin to describe what is going on in the individual firm, I want to mention a few empirical facts that have to be featured in a dynamic representation of firm behavior. They signify a

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* This book has been written to serve two purposes; first to introduce the ideas of the MOSES firm model and second to tell how it works. This dichotomy in purpose becomes troublesome in this particular chapter since some important aspects of MOSES firm life, albeith worked out, have not yet been programmed into the model. We have chosen to present the full MOSES firm design in the first part of the chapter, and to indicate which important features that still remain outside the programmed model. In the technical specifications supplement these departures are exactly noted. In the model code only the programmed part of the model is shown[1].

departure from received micro theory. One such feature is that firms behave rationally according to a set of learned and updated decision rules. To their knowledge they take consistent decisions and they strive to improve their value positions. Firms do not, however, optimize in the mathematical sense of the word. The firm operates according to a gradient, earning approach, which is not as demanding in terms of information requirements as the so called survey approach attempting to find a global optimum. In the non-cooperative game situation that describes markets in MOSES, differentiated and segmented knowledge, and the absence of a stable equilibrium makes complete overview (knowledge) by the firm, both of its external environment and of its interior firm organization infeasible. Decision-makers learn by making mistakes, and change their rules. This is part of the rationality postulate, namely that, if attempts to improve generate mistakes, firm decision makers shift to a different set of rules. There is never time to reach the best position within one period, and in the next period the best position has moved to an unpredictable new position due to the adjustment of all agents in the markets. Hence rules of behavior cannot be derived from optimizing principles. The rationality presumption, as we shall see is the only important matter to consider in this context.

From the CHQ view the problem is one of managing financial resources (assets, see E 1976a). The firm is a group of production processes each of which has a current and an expected future capability of earning a return to employed assets. CHQ attention is solely oriented towards the growth of future earnings capacity (value growth). Decisions as to the management of employees and machines are taken at lower levels. The firm attracts resources if it is relatively successful in terms of this overriding objective and tends to lose resources if not so.

Success is not always easily measured. People inside and outside (for instance investors in the stock market) tend to assess results differently and both sides normally have to make do on the basis of scant information. In particular, the current status of a firm cannot be comprehended without some expectations about the future, and here views differ a lot. We have to handle this when formulating the decision process within the firm.

CHQ decision-makers in large firms normally stay at a safe distance from the technicalities and routines of the shop floor production process (E 1976a). CHQ deals with operationally precise and well known financial criteria that we will develop in detail below. This makes CHQ a distant (remote) manager of real activities. These criteria indicate how available resources should be distributed internally (within the firm), how much should be invested elsewhere, or distributed as dividends and whether external resources could or should be attracted or reduced.

The top CHQ management organization is more or less a vehicle to foresee and to cope with unexpected events afflicting the firm.[2] Experience says that the ability to foresee with desired accuracy is extremely limited, and this knowledge is reflected in the set of decision rules of a firm. The long-term plan developed here is a means to minimize long-term commitments when heading in the directions that currently appear to be the right ones.

There is no such thing as "a firm decision". If not for other reasons, time consumed in searching for a decision makes a simultaneous decision of a firm entity an impossible ambition to pursue. The macroeconomic problems of aggregation are as obvious at the firm level as they are at the national level. The top executive team of a corporation may control the movement of its vehicle better than do the decision-makers in the ministries of economics, but control is still only a matter of degree. The micro-to-macro modeling technique means that the aggregation problem has been "solved" at the national accounts level, but it appears again in dealing with the unit of measurement that we have chosen, instead, the firm. Hence, our concern for the aggregation problem has to be reflected in the way we model firm behavior.

When drawing up plans for the future CHQ management has to be able to partition the growth decision conceptually into a series of partial decisions. This way CHQ can draw on various sources of information within the organization and make decisions in a sequential manner. There is practically no empirical evidence to support the traditional textbook view of a simultaneous, master solution that governs the entire firm.

The partition we will be concerned with in this chapter is between long-term investment and short-term operational decisions. This partition has an organizational (empirical) counterpart in the real firm.

We will adopt current practice among firms by assuming that CHQ each period makes a provisional, long-term steady-state growth projection to guide long-term commitments like investment spending.

This long-term projection is always subject to revisions but it has a guidance impact on one decision in particular, namely to attract long-term debt in advance of foreseen uses. Long-term debt affects the current liquidity position and hence the ability of the firm to carry out a long-term investment program. This is the important function of the long-term investment-financing decision block, which is new to the model compared to earlier published presentations. The quarter-to-quarter machinery of the MOSES economy goes on as described in the previous chapter and in earlier documentation, e.g. E (1976b).

The long-term steady state projection will be based on the criterion that past value growth rates in real net worth at least be maintained, unless external market forces make this rule unoperational.

The idea of this (MIP) criterion[3] is that CHQ managers do not scan all possible corners of a firm interior feasibility domain, digest it and come up with the optimal master solution. Rather they look back to see what is reasonable to demand of "the firm" in terms of past performance. They devise a spectrum of performance requirements (targets) that are consistent with this performance criterion and curb activities that do not meet the criteria. The reason for this seemingly uninformed control method is both lack of information of the internal mechanisms of their own firm and lack of analytical tools to hold all information that exists together in such a fashion that an informed master decision is possible. This procedure also recognizes the fact that unreasonable demands on an individual or an organization, based for instance on the performance of the best competitor in the market, seldom produces desired ends.[4]

It is entirely irrelevant to argue about whether CHQ firm management, by these standards, is "satisfier" or "optimizer". The distinction cannot be formulated analytically within our framework. It will, however, be intuitively clear that if all external factors governing the system (the firm) stabilize on some sort of a steady state, the MIP criterion may eventually push the firm into a state that is the best attainable under the steady, external circumstances. However, within the entire micro-to-macro model economy such steady external and internal circumstances are generally not obtained. Thus it is not worthwhile to explore the optimum or equilibrium characteristics either of the firm or the entire MOSES economy, until we have solved a series of more pressing, more interesting and more relevant disequilibrium problems.

The rest of this chapter has been organized as follows. We begin by discussing the concept of the changing firm organization and introduce the modeling idea with a case description. Then (Section 2) the basic profit targeting theorem is introduced. In Section 3 this theorem is used to model the long-term investment-financing decision of the firm, seen as a financial entity or an investment bank. Finally (Section 4) the investment-growth-financing decision is linked back to the short-term budgeting decision, that monitors the production decision (see previous chapter).

1.2 The Concept, Creation and Transformation of a Firm - Some Observations on Theory

Technical change being the combined result of entrepreneurial skills and technological advances defines the opportunities open to a firm. The technical change, and "business skill" variable - very much as Schumpeter argued in his Theory of Economic Development - is hardly predictable or explainable at the firm level by any general theory. Economics is the driving force. Consequently a set of behavioral principles based on a targeting formula makes up a theory of how the firm in a MOSES economy organizes itself as a financial entity. A firm combines physical (real) activities in a decentralized way, under the constraint of financial objectives.

Concept

We look at the firm as an investment bank that attracts or leaks resources according to how its profitability performance compares with alternatives in the market represented by the market rate of interest. Firm performance in turn is based on the above mentioned entrepreneurial-technical skills. To complete our conceptualization of the firm we have to go beyond what is currently in the model program and formalize the CHQ investment bank function. This will be done below and in Supplement I through the introduction of a multi-division firm. This conceptualization also provides the basis for a theory of the size of the firm, the size being determined by the interior (division) performance and the firm's ability to attract funds. This entity will be placed in a financial resources (credit) market environment in Chapter IV. The nature of "entrepreneurial and technical ability" within the firm will be explored in Chapter VI.

We will devote Supplement I to modeling the investment banking or CHQ functions of the MOSES firm entity, assuming an exogenously given technology factor associated with new investment. We will return in Chapter VII to synergy effects associated with the investment banking function of the firm and the overall corporate objective in terms of Eq. (III:11), of conglomerate formation, joining existing firms under a corporate Headquarter financial hat. Since this is not yet in the model program we will work out the specification in the following Supplement I, and discuss it in a context that is not directly tied to the existing model program.

Entrepreneurial Activity and Entry

Competition occurs in all markets; for products, for labor, and for funds. When firms cannot meet their profit standards for a long period and/or if they lose enough money to make their net worth negative, they go bankrupt and/or close down. In sufficiently long experimental runs of the model (see E 1983b) the economy - and some sectors in particular - tends to lose the majority of firms and a heavy tendency towards concentration manifests itself, despite continued demand growth. This is not realistic for the kind of dynamic, capitalistic economy we have in mind. The absence of entry in markets will lower competitive vitality and - in our model experiments - distort the "historic" simulations we believe (1) are necessary to understand the stability properties of the MOSES economy and (2) also are economically meaningful to help understanding economic growth processes in general. This problem is analyzed in some detail in Chapter VII.

To correct for this deficiency we have tried to specify an entry mechanism to each product market to maintain long-run competition in a realistic fashion. (See E 1978a, p.52 ff.) The obstacle to keep the entry feature as a permanent device in fact happens to be lack of data on the specification of typical entrants in the manufacturing sector.

In the beginning we did not realize the importance of this entry feature for the long-run vitality of market competition. Hence, in most experiments so far this entry module has been switched off. For reasons to be expounded in Chapter VII the entry feature is planned to be modified and turned on in the future (see Hanson 1985, Granstrand 1985). It works as follows. Each market is characterized by a particular entry frequency with the appropriate size and performance distribution. New firms establishing themselves in the market have no history of their own. They base their expectations on historic aggregate market data for the sector (market) they are entering. They hire labor in the market in the same fashion as, and together with, other firms. If the new firms are economically more efficient than the average for the market they will begin to capture increasing market shares and to grow faster than the average for the market, and vice versa. Even more important, if the new firms exhibit superior economic efficiency, they may be able to weather foreign competition and bad times better than other firms in the market. It has, however, been very difficult to establish the performance characteristics of new business startups, as compared with existing firms for the purpose of designing realistic entry functions in MOSES.

Already in the earlier, experimental runs with this device the entire model responded in the fashion expected. New entrants spurred competition and pushed prices down. Output increased because the less efficient firms (whether being new entrants or old firms) were forced to contract or shut down, forcing a reallocation of resources towards the relatively more efficient firms. One interesting property was that new entrants occasionally relieved bottlenecks that had forced a slump in the economy in earlier experiments, through local, sudden increases in prices on scarce resources (see E 1978a, pp. 52-55).

Even with exit and entry in the model we are also interested in the management and recombination of an existing set of business units. Much of the important dynamics of firm behavior has to do with breaking up existing business units and recombining them within the firm or between firms through merger activities. This is always a higher level executive activity closely linked to the owner function of the firm. It is, as we have learned in a number of studies at the Industrial Institute for Economic and Social Research, the main vehicle for structural adjustment and productivity increase (see E 1984a). The result of this activity currently enters the MOSES firm exogenously through a characterization of new investment that shifts and pivots or bends the production possibility frontier QFR(L) in Eq. (II:5). The economics of innovative entry and institutional reorganization will be discussed further in Supplement I.

1.3 How Does a Firm Do It - Case Description

Before we go on specifying what a MOSES firm does, we will briefly describe how an actual firm carries out its investment-financing decisions.

This firm (see case description in E 1976a, pp. 144 ff.) consists of several large divisions, each of which produces for a different type of market. The firm has designed a financial model of itself built up around its divisions in a fashion quite similar to the divisionalized firm that will be modeled in Supplement I. A breakdown of the rate of return on net worth of the kind to be presented in the next section is used to set targets and monitor performance.

In the first round of the long-term planning process, planners (a staff function) meet with top executives, a sub-committe of the Board. The purpose is to set the overall rate of return target for the medium-term future (in this case 5-10 years) and to agree on the expectations on the exogenous environment of the firm. In our terms this means formulating long-term expectations on the interest rate, and current expected prices, wages and sales. This takes place early in the year and the task of the planners is to translate top executive talk and discussion into quantified terms compatible with the corporate allocation model and with the corporate planning and budgetary process. As a rule there are no explicit technological assumptions made. They are embedded as trends out of the past in the "production functions" of the model and in the parallel planning procedure of the company (see below). Whatever is thought to be known at lower division levels is incorporated in the figures put together there.

This being done a new, but smaller, corporate executive group meets with the planners to finalize the assumptions for the plan. For each division there now exists a set of price assumptions EXP(DS,DP,DW,RIS), - where RIS is the short-term borrowing rate - an assumed financial frame for investments of the entire corporation and an individual profit margin target calculated by MIP from past performance.

Divisions are now asked to come up with their long-term plans on the basis of these assumptions.

Similarly, the same assumptions on the future have been fed into a computerized allocation model developed by the firm. Being a fairly simple device most features having linear or loglinear specification, the results can be quite easily foreseen. Without restrictions regulating the rate of contraction of physical activities, the model would allocate all investment resources to the highest rate of return activities.

The point of this procedure is to come up with a consistent, provocative offering bid for the negotiations that take place when division heads present their plan proposals. They do that together in a large meeting in early autumn. The procedure forces consistency on the first stages of division planning and exercises a sobering influence in the sense that it reveals clearly to all participants in the planning game their relative performance. Exorbitant demands for large investment resources from loss operations have to be well argued, or they are argued down at the round table by other division heads that also want their fair share or more of the investment pool.

This procedure divulges a lot of information to top CHQ executives that also participate in the meeting and allows them to move the discussion and negotiations towards feasible and reasonable but tough performance standards on each division. It is more difficult for a division head, after an open negotiation like this to solicit a generous or "soft" profitability standard on the basis of his superior knowledge of his own division. This was the whole point of the negotiation procedure. The plan and the budget are always a negotiated compromise between the division proposals. These negotiated results are what matter. They are what reasonable and responsible division heads have committed themselves to do. They are, hence, taken seriously, and all reporting on actual performance is set against this negotiated result.

We cannot of course model the negotiations into a MOSES firm, so we have had to rely on implementing decision rules that approximate the top down bottom up management confrontation that makes up the planning process, and results in a bottom up commitment to perform in terms of the corporate objective function. This case illustration should at least demonstrate that the negotiated plan stops short of the feasible maximum and that the interior parts of a large business organization are always run with considerable slack. Slack is known to exist, but those who want to see it gone do not know where it is. Hence, the key notion to improved top down leverage on interior corporate decisions and performance is improved information through trial and error learning over time. We have tried to recognize that in the MOSES firm model and we do not believe in models that do not!

2. The Objective Function of Firm Management

2.1 Objectives

Corporate top management in MOSES firms is concerned with the long-term value creation of the business as it accrues to the owners. We define the objective function of CHQ management as a Board requirement to maintain or raise the sum of the dividend payout of the net worth and the long-term growth rate in the net worth of the firm as valued by the stock market. The dividend policy is assumed to be supportive of the objective as to net worth. This particular aspect is important if top management and the stock market value the firm differently. If net worth of a firm as valued by the stock market grows at a slower rate than in other external allocations of financial resources, dividends will increase and vice versa. The exact meaning of this will become clear as we go along.

This CHQ objective is contained within and imposed upon the organization through what we call the Separable Additive Targeting Formula (see below). This formula regulates the inflows and outflows of corporate funds to the benefit of the value growth objective.

As already described (Chapter II), CHQ management does not push for maximum feasible value growth over time but rather strives to improve demonstrated past performance, following the MIP principle. This is in recognition of several aspects of business life. Firm management does not know the interior capacity potential of its own organization well. Nor does it know the future market environment and even less about the longer term consequences if it pushes for immediately improved performance up to as high limits as it occasionally perceives as feasible. Corporate management opts for following a set of conservative behavioral rules and criteria. Given what firm management knows about the firm and its exterior environment, it never makes decisions that are deliberately inconsistent or that go against its objectives in terms of the objective function. Hence the MIP principle can be shown (Chapter VII) to conform to rational behavior on the part of management under a realistic set of assumptions as to what information is in fact available to decision makers. It also tends to stabilize the rates of return and the cash flows over time.

2.2 Separable Additive Targeting Theorem

It now remains to formulate how decisions are taken for the firm and what it means to aim at the highest possible or "maximum feasible" value growth rate into an unknown future. To do this we will introduce a few theorems that link the Corporate Headquater objectives to various activity levels within the firm. In doing so it is important to distinguish between the divisional and the functional decomposition of the firm organization. The divisional decomposition always is market oriented. A division can be seen as "one firm" producing a set of products for a particular market. The current version of MOSES uses division data from the large business firms as decision units. The functional decomposition (cf. Table III:1 in Supplement I) has to do with a kind of activity (R&D, finance, marketing, processing etc.). We have recently begun to collect data on a functional format in the context of the regular planning survey (E 1985a, Lindberg-Pousette 1985). The additive targeting formula to be derived below from the cost accounts of the firm normally has a clear correspondence to both decompositions (E 1984a, 1985a). We will return to this aspect of targeting in Supplement I.

A natural way to look at a firm is to regard it as a set of lines of business ("divisions") engaged in direct production activities. The production activities are held together by an overriding system of CHQ functions, the most important being asset management and finance. Theorems 1 and 2 define the CHQ functions and how they link up to the central goal of the firm. For simplicity we here disregard (a) corporate income taxes and (b) procurement of raw materials and intermediate goods, (the purchasing function) in the main text.[5]

Theorem 1 (**The separable additive targeting function**)

In a consistent set of financial accounts the central goal of the firm, G, can be defined as below.

$$\mathbf{G}=RRNW=DNW+\theta=\underbrace{M\cdot\alpha}_{(A)}-\underbrace{\rho\cdot\beta}_{(B)}+\underbrace{DP(DUR)\cdot\beta}_{(C)}+\underbrace{(RRN-RI)\cdot\phi}_{(D)} \qquad (III:1)$$

provided no taxes and no intermediate deliveries exist.

G, the goal variable of the firm, is the sum of the rate of change in firm net worth (DNW=ΔNW/NW) and the rate of dividend pay out of the same net worth (Θ=DIV/NW).

Symbols Used

CH( )operator = Δ( ) = Difference per time unit
D( ) operator = Rate of change per time unit
:= = make equal to in algol. It is sometimes used to avoid time indices.
NW = Net worth residually determined from balance sheet as (NW=A-BW)
A = Total assets, according to replacement valuation (= K1 + K2 ≡ NW + BW)
BW = Total external debt

Θ = Dividends (DIV) in percent of NW
M = Gross operating profit margin, in percent of value added ($\Pi/p\cdot Q$)
Q = Output (deflated value added)
p = value added deflator
S = Sales = Qp + purchases + finished goods inventory change. In what follows purchases are assumed to be zero
α = Value added in percent of A
ρ = Rate of economic depreciation of production capital (=K1, according to replacement valuation)
β = K1/A
P(DUR) = Investment goods price index (determined endogenously in corresponding market in model economy)
RRN = Nominal rate of return on total assets (A). For definition, see below
RI = Domestic interest (borrowing) rate on debt (=BW), endogenously determined in financial system of model (see Chapter IV)
ϕ = BW/NW(=leverage factor)
Π = Gross operating profits, including depreciation
RI2 = Average deposit rate of interest[6]. In what follows we will assume for simplicity that RI2=0 and regard BW as net debt
K1 = Replacement value of production equipment on which the depreciation rate (ρ) is applied to obtain depreciation ($=\rho\cdot K1$)
$\bar{K}1$ = The corresponding volume measure obtained by deflating K1 with the investment goods deflator P(DUR)
K2 = All other assets (portfolio), replacement valuation
DIV = $\Theta\cdot$NW

Proof

Derivation of formula III:1 makes use of financial accounting identities of the firm, the definition of investment and definitions of various rates of return.

Note once again that for simplicity in the derivation of (1) we assume no inputs (purchases) of raw materials and intermediate goods. In the model, however, it is all there. Hence $p\cdot Q \cong S$.

Introduce the Cash Flow Accounting Identity:

$$\Pi + RI2\cdot K2 - RI\cdot BW - DIV + \frac{dBW}{dt} \equiv INV + \frac{dK2}{dt} \qquad (III:2)$$

and a definition of gross <u>investment spending</u>:

$$INV \equiv \frac{dK1}{dt} - \frac{dP(DUR)}{dt}\cdot\bar{K}1 + \rho\cdot K1 \qquad (III:3)$$

Now reshuffle terms in (III:2) and insert in (III:3):

$$\Pi-\rho\cdot K1-RI\cdot BW + \frac{dP(DUR)}{dt}\cdot\bar{K1} \equiv DIV - \frac{dBW}{dt} + \underbrace{\frac{dK1}{dt} + \frac{dK2}{dt}}_{dA/dt}$$

From the definition of the nominal rate of return to net worth then follows;

$$RRNW = \frac{\Pi-\rho\cdot K1 - RI\cdot BW + \frac{dP(DUR)}{dt}\cdot\bar{K1}}{NW} = \frac{DIV}{NW} + \frac{\frac{dNW}{dt}}{NW} \quad (III:4)$$

Note that A-BW=NW and that we assume - for simplicity - that RI2=0 (or equivalently, K2=0).

Now introduce Θ=DIV/NW as the dividend payout rate.

It follows that:

$$RRNW = \frac{\Pi-\rho\cdot K1 + \frac{dP(DUR)/dt}{P(DUR)}\cdot K1}{A}\cdot\frac{A}{NW} - RI\cdot\frac{BW}{NW} = \theta + \frac{\frac{dNW}{dt}}{NW}$$

Define the nominal rate of return on total assets as:

$$RRN = \frac{\Pi-\rho\cdot K1 + \frac{dP/dt}{P}\cdot K1}{A} \quad (III:5)$$

and it follows immediately that:

$$RRNW = RRN\cdot(1 + \frac{BW}{NW}) - RI\cdot\frac{BW}{NW} = \Theta + \frac{dNW/dt}{NW} \quad (III:6)$$

since

A/NW = 1 + BW/NW = 1 + ϕ

(ϕ=leverage factor)

Thus:

$$RRNW = \frac{dNW/dt}{NW} + \Theta = RRN + (RRN - RI)\cdot\phi \quad (III:7)$$

$$\text{But: } RRN = \frac{\Pi}{S}\cdot\frac{S}{A} - \rho\cdot\frac{K1}{A} + \frac{dP/dt}{P}\cdot\frac{K1}{A}$$

$$\therefore RRNW = \frac{\frac{DNW}{dt}}{NW} + \Theta = M\cdot\alpha - \rho\cdot\beta + \frac{\frac{dP(DUR)}{dt}}{P(DUR)}\cdot\beta + (RRN-RI)\cdot\phi$$

(III:8)

Q.E.D.

Theorem 1 demonstrates that the objective variable (G) at each moment equals the sum of the growth rate in the value of the firm (net worth = NW) and the value of dividends distributed in percent of the same net worth. The observant reader has already noticed that the value of the firm (=NW) is defined from the capital input side. Is growth in NW a good performance measure? This question cannot be properly sorted out until we have introduced a market valuation of NW (in the stock market) and the interest rate (see below and next chapter).

Each moment G can also be decomposed into four additive components (there will be more if we consider also corporate income taxes, purchases etc.), namely contributions from current production operations (=A), a deduction for capital wear and tear (=B), contributions from capital gains (=C) and from finance, and the leverage factor (=D).

Hence, at each moment in time four different activities within the firm contribute independently to the overall objective variable. They are production operations (=A), maintenance and inventory etc. management (=B), asset management (=C)[7] and financial management (=D). It is an empirical fact of life that these four (or six, if we add taxes and procurement) functions are organizationally separated in all large business organizations, (E 1976a). These functions are also central and vested in CHQ to control the entire corporation seen as a financial entity or an investment bank. Departments B, C and D (in III:1) and the purchasing and tax departments are normally located at CHQ. So is also overall coordination of production through department A, that normally supervises the business units or divisions. This aspect is further developed in Supplement I.

If we aggregate the goal variable G over time the components of the separable additive targeting function will become gradually more interdependent. We will be faced with the impossible task of defining what exactly to mean by a sustained, maximum G or (which is the same) maximizing the time integral of G. Obviously, this requires that we define future time patterns of its constituent components. The most important such interdependency of course is that the leverage decision (D) affects profit margins in (A) via borrowing and investment.

Theorem 2 (Profit margins and labor productivity)

We can reformulate a profit margin as:

$$M = 1 - \frac{W}{P} \cdot \frac{1}{Q/L} \qquad \text{(III:9)}$$

where W is the wage cost level, P the output (value added) price level and Q/L labor productivity of the production activity considered. This formula is used extensively in the behavior of the production department (see Chapter II).

Proof:

$$M = \frac{P \cdot Q - W \cdot L}{P \cdot Q} \qquad \text{(definition).}$$

The above then follows immediately. **Q.E.D.**

(There is a more complicated equation that relates the rate of return to total factor productivity growth. We will return to this equation in Chapter VI on allocation and economic growth.)

The problem of making something meaningful out of these theorems really has got less to do with their internal (accounting) logic than with the problem of establishing a useful measurement system to associate with the symbols.

The most tricky problem - which we leave for the end - is to measure value growth or net worth. To transform net worth into something else, like consumption by a share-owner, we have to impose an intermediate "valuation system", ("a market") if the transaction is to be real. At this point we are only concerned with accounting prices, not market prices. Thus P and W in Theorem 2 could be the accounting price in a planned economy or a market price notation in a western economy. If a large business organization chooses to divisionalize into units, some of which engage only in internal firm deliveries, the P would also have to be an accounting (transfer) price. The important thing, however, is that Theorem 2 provides a direct link from the physical concept labor productivity to the goal variable. At some low enough level within the firm - the "machine" level - Q/L can be identified as a physical concept like "number of screws divided by number of hours of work of some well defined quality". The problem is that at this level the concept of capital has ceased to be a measurable quantity. This is well recognized in the corporate world and explains why capital as a physical quantity never enters the important, internal accounts of a business organization. It is not stable, intelligible and interpretable enough a measure to serve an operational purpose. This is why Theorems 1 and 2 will be the backbone for the "theory of the firm" that enters the MOSES micro-to-macro model. The key to the endogenous growth machinery of the model, however, is how the market valuation of NW and the interest rate continue to force a rate of return requirement on the investment decision at the firm level.

Theorems 1 and 2 together also "control" decisions related to short term production planning in Chapter II. Theorem 1 controls the long-term investment-financing decision that we will develop in this chapter. Theorem 2 controls the short-term production decision in Chapter II. As soon as we enter this stage (decision making) we will have to be much more explicit and all variables used will have to be well defined by reference to a measurement method used within the firm.

2.3 The MIP Principle Extended

The separable additive targeting device (Eq. III:1) provides an organizational format to divide up the business functions that contribute to overall profitability in an additive fashion. It can also be described as a central Corporate Headquarter grid through which an overall corporate rate of return target can be imposed systematically through a decomposition of the entire organization into lower level performance criteria. This is done in the fashion illustrated in the above case description. This is current practice in several large business firms. It is predominantly done in short-term budgeting and production planning through the

$$(A) = M \cdot \alpha = \left(1 - \frac{W}{P}\frac{1}{Q/L}\right)\alpha$$

part in (III:1), much in the same way as we have modeled it in Chapter II. For a given (α, β) this profit margin criterion can be said to correspond to an adjusted real rate of return standard on production decisions that implies a particular choice of profit deflator (see next section).

The extended targeting formula that applies to the long-term investment financing decision has to take all the other components of (III:1) into account as well - inflation, economic depreciation rates, borrowing and the decision to distribute dividends.

2.4 Inflation, Capital Gains, the Real Return to Assets - What Do We Mean by Depreciation?

On the whole we are viewing short and long-term decisions in firms as a flow process that generates growth in stocks (assets). Stocks, however, are also affected by changes in real and absolute prices that enter the profit (flow) accounts of firms in more or less predictable ways. Sometimes, and especially in inflationary times, these capital gains or losses dominate the profit accounts. One of the most tricky problems for decision-makers, accountants and theorists alike is to decide how to deal with the stock valuation problem. This is particularly important in designing profit targeting systems within firms. Unclear definitions and measures are systematically used by division heads to keep CHQ management uninformed about losses or potential profits (see E 1976a). CHQ management responds to this problem by using crude but reliable criteria instead of theoretically correct, unmeasurable quantities. Using profit margins rather than the rate of return, looking after inflationary gains and capital costs in short-term (quarterly) production management in an ad hoc manner are cases in point. Such criteria were, however, not the best guides during the inflationary 70s. So far no good alternative solutions have been developed.

The standard stock valuation problem is how to determine depreciation rates on physical assets. In the MOSES firm we do this in the way used in the standard costs accounts, through applying preset life length estimates to various types of assets. We then apply the investment goods price index determined endogenously in the INV sector to upgrade the value of the remaining stock to current prices.

Capital gains from inflation appear through the inflationary component (C) in (III:1). This capital goods price may develop very differently compared to the prices that share-owners are personally concerned with. As to the choice of proper deflators economic theory does not give a clear answer. The traditional, Anglo-Saxon assumption is that share-owners are potential consumers that consume from the same basket as the average consumer. Hence, they will respond to differences in price movements in company assets, in consumer goods and in other assets that the share-owner may be investing in. If low capital gains within the firm are not compensated by large production profits or shrewd financial maneuvering they may opt for higher dividends. This being the case, we could introduce the consumer price index as deflator for the nominal rate of return on net worth, and impose that the real rate of return criterion be:

$$\bar{\mathbf{G}} = \text{RRNW-DCPI}. \qquad (\text{III:10A})$$

In this simplified setting we could pick either $\mathbf{G}$ = RRNW or $\bar{\mathbf{G}}$ as the variable to compare with alternative rate of return measures to determine dividend policies. The separable, additive targeting formula would have to be somewhat reformulated as to the evaluation of capital gains in the portfolio choice decision (see further Chapter IV). This could have an effect on the borrowing decision and the determination of the opportunity cost of investment. We will come to that.

There will, however, be a problem if share-owners in a firm abide by a different deflator. This is in fact a plausible assumption to adopt for the very large share-owner capitalist for whom future consumption is not the main criterion for wealth creation. He may take a very long-run view arguing that, even if inflation favors a different portfolio choice right now, the very long-run prospects for a particular company may nevertheless be good. And if he wants to be in control and "run" the business, he has to keep his shares. Alternatively, he might argue that this company has a higher than average production performance even though it cannot reap immediate capital gains. The choice of rate of return standard to use in a firm is the same thing as the time preference of the majority of owners. For some large share-owners the relevant rate of return to compare with other alternatives could well be (see III:1):

$$\hat{\mathbf{G}} = RRN = A + B = M \cdot \alpha - \rho \cdot \beta \qquad \text{(III:10B)}$$

$\hat{\mathbf{G}}$ is a frequently used "hybrid" real rate of return measure on total assets that can be rewritten as follows:

$$RR = \frac{\Pi - \rho \cdot Kl}{A}$$

and that differs from **G** above in that it does not include a relative price factor.[8]

The true capitalist, aiming for the very long term might argue that I will participate in a new issue of shares in this company, because its future is undervalued, and I will be immensely remunerated in the form of capital gains when the market realizes that. The small consumption-oriented owner, or the raider argues that within my (short) time horizon I will not see anything of that, and signal a higher rate of return requirement, forcing management to divest or close down low profit activities with, perhaps, good long-term prospects, and distribute the cash flow from high rate of return activities. This balancing of the short term and the very long term in fact is a critical notion in the organization of a viable capitalistic market economy, that we will return to in the following chapters.

Problems of assessing the value of capital stocks nevertheless serve as a second rationale for firms to stick with simple M criteria in their internal guidance system. The profit margin in fact approximates an index of the real rate of return on total assets and as long as the mix of activities doesn't change significantly, it appears to be a fairly robust measure when it comes to choosing the appropriate deflator (see E 1976a).

The nice thing about the MIP principle as it is stated above also is that it is expressed in nominal terms and whatever the rate of general inflation, the firm will want to keep each of its components as high as possible. The problem with real versus nominal profit criteria appears when there are strong relative price movements and the firm has to choose between expanding through external finance and/or distributing profits rather than plowing them back into the company.

The MIP principle suggests both that the profit margin criterion should apply to all ongoing production, and that the firm should be concerned with exploiting capital gains and inexpensive external finance.

3. The Investment Financing Decision of the Firm - First Approximation to What Goes on in the Firm Model

So far we have mostly been concerned with the criterion for investment-financing decisions. We now proceed to the long-term plans. The procedure for determining the investment plan and for realizing investment spending in a MOSES firm is described in all necessary detail in Supplement III to this chapter.[9] This is a less technical approximation told in terms of Figures III:1 and III:2.

The reader should note that this section only deals with investments in hardware, process installations in the firm. The portfolio choice is entered here as an alternative rate of return opportunity, but is discussed further in Supplement I and in next chapter. Investments in marketing and product development are considered in Supplement I.

In determining the capacity to produce over the planning period a sequential decision order is used in long-term planning (see E 1976a). Step one computes divisional sales growth plans and CHQ profit margin targets. They are matched roughly through insertion in production system in step two and a preliminary plan is negotiated.

Step three computes the capacity expansion plan through entering investment data in the production system. The fourth step enacts a final profitability check. On the basis of this (step five) a future dividend path is determined, and a financial risk assessment is taken in step six. This may mean some further reductions in the growth plan and foregone expected profits due to financial risk aversion. Finally the long-term plan is ready and feeds into short-term budget work.

Step one (setting **targets** and **expectations**) begins when CHQ forecasters form their long-term expectations about sales (S) product prices (p), investment goods prices [P(DUR)] and wages (w) for the next five years. The operator is called EXPL( ) and incorporates a smoothing function with error learning correction and adjustment for variations in historical experience, much along the same principal lines as in short-term expectations formation. The exact formula is found in Supplement III, Section 1.

In a similar fashion other CHQ staff people work out a long-term profit target from the real rate of return target on equity passed down from the Board in terms of (DNW,Θ) in formula (III:1). The MIP principle applies. We can calculate a target on M much in the same fashion again as in the short-term planning procedure. The code in Supplement III gives this derivation with company taxes included (Section 3).

$$TARGL(G) = TARGL(DNW+\Theta) = MAX(GHIST,X) \qquad (III:11)$$

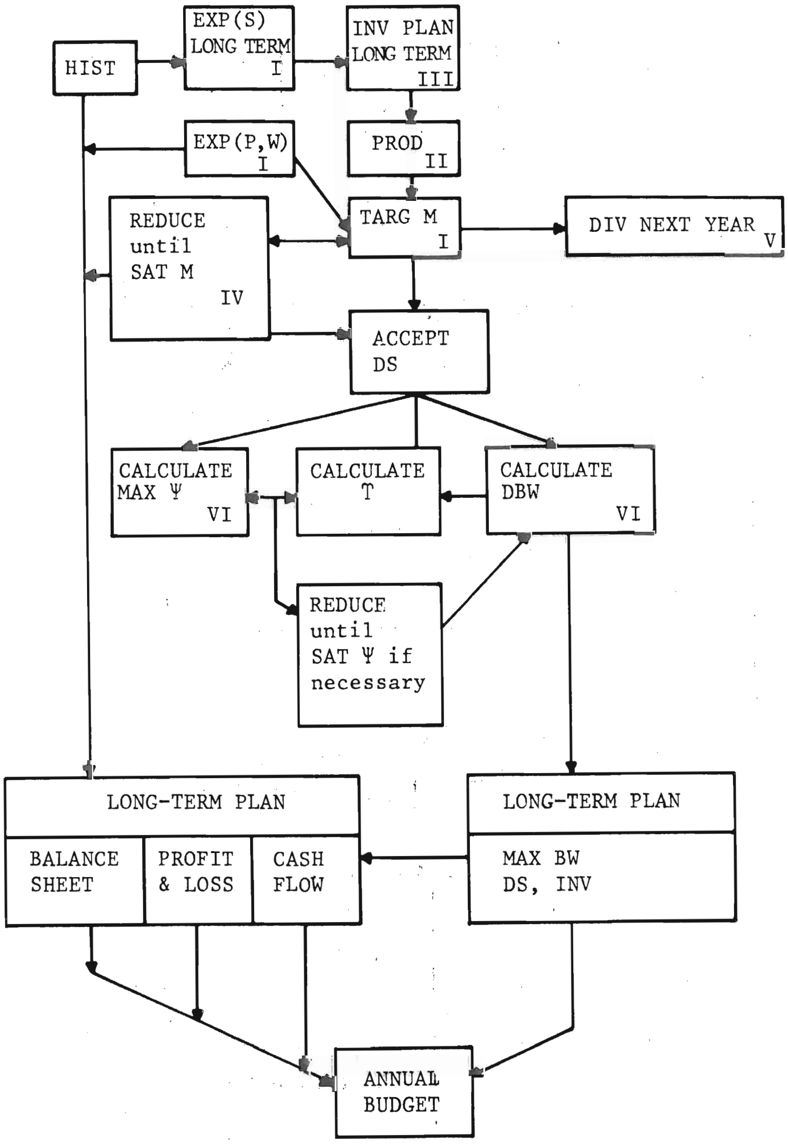
$$GHIST = \lambda \cdot GHIST + (1-\lambda)G$$

$$X = \text{Exogenous}$$

Long-term targeting goes on at the upper part of Figure III:1. It constitutes the first planning round in the earlier case description and it applies to all divisions, even though we won't present the divisionalized firm (not yet in program) until Supplement I.

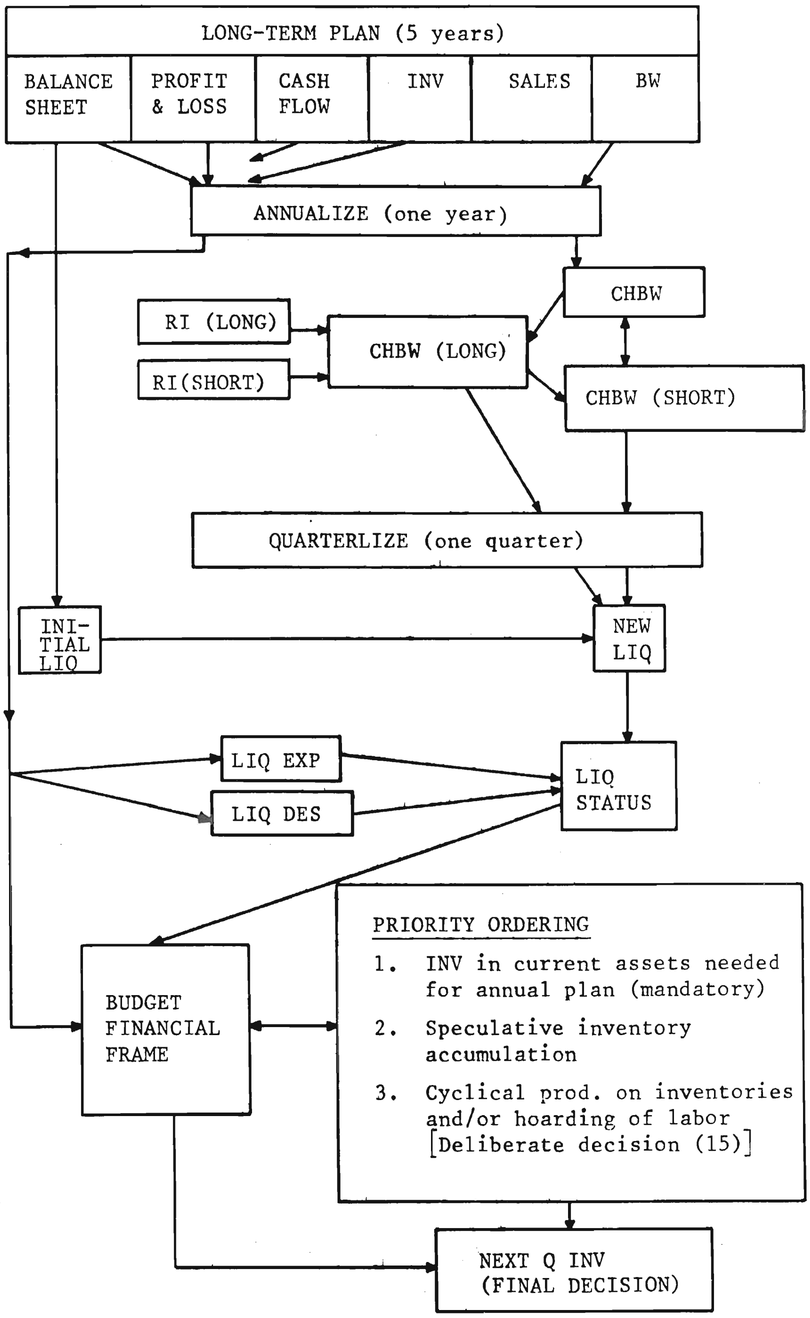
This targeting round enters the investment decision. Even in the one division firm the targeted rate of return has to reflect other opportunities available than expanding production.

Figure III:1 Long-Term Plan



Step I : Targets & Expectations
Step II : Production system
Step III: Investment plan
Step IV: Profit check
Step V : Dividend decision
Step VI: Borrowing check

Figure III:2 The Investment and Borrowing Decisions



There is the option to invest in property that yields both a current income and a capital gain, in shares in other firms, in Government bonds or in bank deposits. Taxes furthermore affect the real rate of return to the owners of the company. This more complex portfolio choice problem will eventually be endogenized. For the time being we have simply entered X in (III:11) to indicate that if expected returns on current corporate production based on past performance is not regarded as the proper target you can plug in any outside target that you wish, and wait and see what happens to the firm.

Whatever the final choice may be, apply:

TARGL(G(AT)) := MAX[TARGL(G(AT)),(1-t)RI,...] (III:12)

(where AT or (1-t) stands for after tax), enter an assumption on the leverage function D in the targeting formula (III:1) and expectations as to P(DUR) and solve for M to obtain:

TARGL(M)

Step two is to apply this set of expectations and targets to data on the **production system**. The theoretically most appealing way would be to make technical assumptions as to new investments, and to calculate the optimal capacity accumulation path up to some chosen horizon[10]. That is, however, not the way investment planning is carried out in real firms (E 1976a). Long-term planning starts at the CHQ level with a preliminary financial frame for investment within which the fine details can be fitted later, at levels below CHQ. Since the plan is revised at least every year, and by no means is a "holy" number, rough approximations are used. We have approximated actual, observed procedures in the MOSES model.

To calculate the total asset (A) accumulation needed we apply two fixed proportions; The ratios between total assets and value added ($1/\alpha$ in the separable, additive targeting function (III:1)) and between production assets and total assets, β in (III:1), are assumed constant throughout the planning period. They do, however, change endogenously over time.

Excepting periods of large relative price adjustments this appears to be reasonable enough an assumption. Firms use it in their own calculations[11] (see Section 1 in Supplement III).

Investment needed for any chosen activity path can now be calculated from the definition:

$$INV/K1 \equiv DK1 - DP(DUR) + \rho \qquad (III:13)$$

In the third step, an assumption on the normal rate of capacity utilization (1-Average(A21+A22) =NU) is made and the approximate **investment plan** is entered to shift the production frontier QFR(L) in Eq. (II:5), according to technical change in production technology, vertically along a given L. Here the firm assumes technical change to be of the labor-saving type.[12]

The fourth (**profit check**) step (Section 3 in Supplement III) now is to make certain that this growth plan tallies with the profit targets.

Apply expectations on (P,W) to (III:9) and check whether

$$M > TARGL(M). \qquad (III:15A)$$

If not, keep reducing sales along QFR(L) on horizon reducing also L per unit of Q until profit margin check on new investment is satisfied. Recalculate INV needs, assuming α also for new investment and that INVEFF remains unchanged.[13] This is the first loop in the upper end of Figure III:1.

The fifth decision determines the **dividends** (Section 5 in Supplement III). Again this could be viewed as an entirely exogenous decision. We do, however, expect the dividend payout rate (Θ in III:1) to depend positively on the rate of return of the business operation and negatively on the planned rate of sales growth. Hence, using the symbols of (III:1) and (III:6) and ignoring taxes for the time being

$$\Theta = f\left[\text{TARGL(G)-RI,EXP(DS)}\right] \qquad \text{(III:15B)}$$

$$f'(\ ) > 0,\ f'\left[\text{EXP(DS)}\right] < 0$$

We assume the rate of dividend payout of net worth (NW) to increase with increasing targeted profitability as defined in (III:11) but to decrease with the planned growth rate. For (1) a 100 percent production company that (2) is 100 percent self financing its investment and (3) manages to realize a constant RRNW forever this means that the present value of all future cash dividends will increase in direct proportion to realized performance in terms of RRNW. This is an operational way of using the standard dividend assumption, that firms distribute dividends in proportion to the difference between its discount rate and its rate of return.[14]

The sixth (**borrowing check**) implies a complete overhaul of the decisions reached so far.

Each firm is assumed to have its own borrowing rate in the bank that deviates from the market deposit interest rate by a fraction, the size of which depends on the financial position of the firm.

$$RI_i = f(RI, \phi_i) \qquad \text{(III:16A)}$$

$$\partial f / \partial \phi_i > 0.$$

The checking procedure so far has been organized to secure minimum revisions under normal circumstances. As long as the long-term profit check has been flagged with a margin, only an unusually bad debt position would signal a revision at this point.

The firm is willing to expand debt (CHBW>0) as long as this contributes to overall target fulfillment. This holds as long as from (III:11):

$$TARGL(G) > RI_i$$

which is the same as:

$$RRNW > RRN > RI_i \qquad \text{(III:16B)}$$

The maximum debt-equity ratio ϕ is reached when an extra \$ of investment spending increases ϕ in such a fashion that RI_i pushes above RRN on new INV (cf. Supplement III, Section 11.1).

The normal procedure in firm planning is not to maximize G with regard to investment, but rather to establish an acceptable maximum ϕ ratio that applies traditionally over long stretches of time. Although many factors enter the determination of maximum ϕ, some simple approximation will be empirically superior to maximizing G in (III:10A) by increasing investment (this in fact is the classical way of handling the investment-financing decision in literature).

We adopt the following procedure.

The cash flow balance (III:2) is used to calculate borrowing needed to finance the INV plan just established above.

This borrowing estimate allows us to establish both debt (BW) and the leverage ($\phi=\frac{BW}{NW}$) at the horizon (say 5 years from now).

Enter ϕ_i in (III:16A) and calculate RI_i. Check back on TARGL(G) so that (III:16B) is satisfied.

If not, cut back on BW, INV and Q until (III:16B) is satisfied, or INV=0, whichever comes first. Then stop. We have arrived at the preliminary long-term (budget) plan, with yearly entries, shown in the middle loop in Figure III:1.

4. Short-Term Budget Check on Investment

4.1 Principles

The investment financing model primarily concerns the acquisition of long-term debt and the ability to carry out a desired long-term investment spending program.

No decisions are taken in context of long-term planning. It only alerts top management to potential future financial needs that can be prepared for now. Actual decisions take place within the short-term budgeting procedure. The closest one comes to actual financial commitments is the preparation for long-term external finance to facilitate planned investment spending. An impending financial crisis should, of course, also be dealt with in the context of the long-term plan.

Long-term finance is acquired in anticipation of future investment needs. Hence, we begin with the long-term borrowing decision, continue with liquidity planning, consider a financial crisis situation and finally clear the actual investment decision.

The long-term plan contains the full accounts for the firm year by year up to the horizon. We think in terms of a 5 year horizon. We now pick the first year. Section 8 in Supplement III specifies how to insert (exogenously) a cycle in the variables of the long-term planning.

Annual investment determined in the budget is spread over the quarters of the first year by some mechanical procedure that mimics actual budgeting practice (see E 1976a). This completes the (annual) budget at the bottom line of Figure III:1 or upper line of Figure III:2.

4.2 Long-Term Borrowing Decision

Firm management at this stage takes a look at the credit market. The long-term plan suggests that the amount of external funds that will be needed over the next five years is Y:

$$Y = CHBW(PLAN) \qquad (III:17A)$$

The firm now decides to borrow <u>long term</u> next year up to:

$$CHBWL = Y \cdot F(RIS_i, RIL, \ldots) \qquad (III:17B)$$

$0 \leq F(\ ) \leq 1.$

Depending upon the relationship between long and short-term interest rates the firm can decide this year to borrow nothing (long term), or the whole "five year amount". If the long-term interest is low compared to the short-term rate firms stock up on liquidity to meet future needs for expansion. If the long-term rate is high, firms wait while tidying up their balance sheets. Any funds needed up to the annual borrowing requirement are borrowed short term.

We expect the long-term interest rate to be the same for all firms. It is thus a question of obtaining long-term finance at all.

4.3 Liquidity Management

The next step in the planning procedure of the firm is to calculate its expected liquidity position by quarter (LIQE) over the next year, using the cash flow balance (III:2).

Then the firm establishes its desired liquidity (LIQD) by some chosen formula. Liquidity is needed to meet varying demands for payment. We assume that payment demands on the average should be proportional to sales and we calculate them as:

$$LIQD = f(S) \qquad \text{(III:18)}$$

We hence disregard both economies of scale in cash management and the sensitivity of S to the interest rate. The argument that this assumption will not affect firm behavior is based on the observation (E 1976a) that liquidity management aiming at minimizing the cost of holding liquidity is a management routine separated from the comprehensive control function excercised at CHQ. The budgeted LIQD is calculated at CHQ very much as above. Separate liquidity forecasts are made up on a monthly, weekly or even daily basis and estimated temporary cash surpluses are invested in the short term and in overnight markets. If liquidity management appears to be more important than we currently believe, (III:18) can be easily modified later when we have the empirical information needed.

A liquidity check is defined as:

$$CLIQ < \frac{LIQE-LIQD}{LIQD}$$

Whenever the above criterion is not satisfied the long-term investment spending plan is adjusted downwards in the following sequence.

(1) Reduce investment until

$INV = \rho \cdot K1$

if not sufficient to meet liquidity standards, then:

(2) Dump

STO-MINSTO

in market at any price offered. If this does not clear CLIQ criterion by next quarter a crisis is looming ahead.

If the above remedial action is not sufficient to meet CLIQ target

(3) Cover remainder in **short-term borrowing** and stop all new recruitment.

4.4 Crisis and Bankruptcy Proceedings

The "life" of a MOSES firm is controlled by three criteria.

First, whenever net worth (NW) as calculated on an economic replacement value basis[15] turns negative the whole operation closes down. The NW-value can be propped up, e.g. by Government subsidies.[16] This instruction is dominant and overrides the other two.

Second, whenever no (Q,L) combination that meets profit margin targets can be found in short-term planning the plant is shut down. This procedure is described in passing in Chapter II and in all necessary detail in E(1978a, p. 72).

This shut-down rule can be overridden by a short-term target modifier that aims at bridging a cyclical period of difficulties (see Section 15 in Supplement III). Production for inventories, hoarding of people over a recession or a countercyclical timing of investment are possible reasons for this. The profit target modifier brings the shut-down rule 2 closer to rule 1.

Third, if new recruitment and advance layoffs of people do not restore short-term liquidity after CRITER (a chosen number) quarters, declare bankruptcy if this has not happened before according to rule 1 or 2. Bankruptcy in the MOSES economy today is always followed by shut-down of operations, all labor is transferred to the status of being unemployed, all physical capital is scrapped at zero alternative value,[17] i.e.

$$K1 = 0.$$

If any net value remains afterwards; i.e. if

$$NW \equiv A - K1 - BW > 0,$$

stocks of finished goods are sold off in market at next period's price. Net proceeds and all financial assets are transferred to household savings deposits.

4.5 Taxes

The firm pays a corporate income tax on declared profits. There are ample opportunities in Swedish firms to carry over profits and losses from year to year by adjusting declared asset values on the balance sheet. We will enter this possibility and assume that firms only declare income for taxation in order to distribute dividends. This means that

DECLARED INCOME = DIV+TAX

Setting the tax rate to t we have

$$TAX = \frac{t \cdot DIV}{1-t} \qquad (III:19)$$

and the DIV decision becomes the prime decision that also determines taxes.

Many observers would argue that this specification of the corporate income tax function is an empirically acceptable approximation. We used it in our earlier corporate income tax allocation experiment on MOSES (see Eliasson-Lindberg 1981) and it appears to be an acceptable approximation to judge from the recent results in Södersten-Lindberg (1983).

4.6 The Final Quarterly Decision

Funds available next year for investment (INVF) are now calculated as [18]

$$INVF := M \cdot S(PLAN) - \frac{(1-\beta) \cdot CHS(PLAN)}{\alpha} + \qquad (III:20)$$
$$+ \left(\frac{DBW}{BW} + RAM\right) \cdot BW - (RI+RAM) \cdot BW - DIV - TAX - CHLIQD$$

where RAM is the rate of pay back (amortization) of debt set exogenously. M is calculated as targeted:

M = TARG(M)

TAX comes from (III:19) and CHLIQD from (III:18).

Next quarter INVF is calculated by entering quarterly sales plan data from short-term production planning as well as finance needed for the next quarterly stock adjustment.

S(PLAN) = EXP(P)$\cdot$(PLAN(Q)−OPTSTO+STO)

When ready, investments (=INV) for next quarter are obtained from the long-term plan (Section 9 in Supplement III) and **final investment** is determined as:

INV:= MIN(INV, INVF, REDINV)

(III:21)

INVF − REDINV > 0

is deposited in bank.

REDINV is a fraction of INV that is determined after short-term capacity utilization has been checked. Whenever the current rate of capacity utilization is running below the normal utilization rate (NU) by a certain margin (X), the long-term investment plan is temporarily shelved in the following fashion:

If $\left(\frac{Q}{QTOP}\right)/NU < X$ (III:22)

then INV = REDINV = $Y \cdot \rho \cdot K1$

$Y > 1$

Suppose:

X = .6
NU = .8
Y = 1

This algorithm means that investment is taken down to replacement investments ($\rho \cdot K1$) if current capacity utilization falls below 48 percent (0.8$\cdot$0.6). This is below a level of 60 percent of the normal rate of utilization (48/80).[19]

Supplement I

LONG-TERM INTERNAL RESOURCE ALLOCATION AT CHQ[20]

The MOSES firm as it is currently implemented in the M-M model can be seen as a theory about a representative Marshallian firm that behaves in a predictable fashion in a stable market environment (stable relative prices). This firm can be modeled to grow progressively more and more skilled in organizing itself (internal organization and efficiency) around a given structure. Similarly, we can envisage an economy that gradually grows more efficient in its allocation of resources as long as the external and internal environments are stable and predictable. The harmony of one such representative firm can be preserved in the case of erratic changes in competitive conditions outside the economy, and among firms within the economy, as long as they are known in advance. One argument of Schumpeter was that none of these changes, representing the entrepreneurial function and represented by future values on MTEC and INVEFF are at all predictable from a general theory at the firm level. Nor is the response of the firm itself in coping with the new situation.

1. Entrepreneurial Function

The MOSES firm operates according to behavioral principles which can be logically traced back to a set of objectives and rules of adjustment. Realism requires that we explain the entrepreneurial factor by some general principles, or that we declare it to be random (see e.g. Simon-Bonini 1958). If business success distributions can be demonstrated to be compatible with a stochastic explanation this would be all we need to have for satisfactory predictive performance in a number of macro analyses. Sharefkin has argued recently (1983) that with a sufficiently large number of firms with different characteristics, and with a sufficiently complex internal and external search machinery of the individual firm, the behavior of a set of MOSES firms may appear as if approximately random.

There are both advantages and disadvantages associated with viewing the entrepreneurial function at the firm level as the result of a random process. For one thing it is a testable proposition and the proposition has not been rejected by the evidence that we have seen (see E 1976a, p.241). Secondly, predictability or not at the firm level is of no consequence if we are concerned with macro behavior only, as we mostly are in MOSES analysis. Then we could view entrepreneurial skills as a randomly distributed skill, the frequency of which can be related to (explained by) economic, cultural and other environmental factors. This was a provisional argument adapted in E (1980b, p. 71 ff.).

2. Firm as an Investment Bank

However, this is not a satisfactory theory until properly tested, and it is not consistent with the large number of large firm organizations that perform above average decade after decade. The argument we will return to in Chapter VI is that a firm (management) technology may exist which (1) can be formulated in general terms, and (2) is capable of predicting entrepreneurial, innovative behavior at the firm level. The explanation relates both to the ways firms are organized and to the environment of the firm.

Using my earlier taxonomy (E 1984a, 1985b) the main operational tasks of a large manufacturing firm are roughly those listed in Table III:1. The current operating MOSES firm model is an aggregate representation of the eleven tasks listed in the table, but several of these tasks can be readily incorporated if we believe we need more elaboration to understand structural development and the macroeconomic growth process.

Table III:1 Main Operational Tasks of a Large Manufacturing Firm

1) Innovative
2) Internal reorganization

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3) Product development
4) Investment (bank) allocation
5) Commercial bank (cash management)
6) Insurance, risk reduction
7) Materials processing (the hardware function)
8) Purchasing
9) Marketing and distribution

---

10) Education and knowledge accumulation
11) Welfare provisions

In this supplement we will sketch a model of the internal organizational dynamics of a MOSES firm. The Corporate Headquarter internal investment allocation over divisions (the investment bank function, task 4 in Table III:1) will be the main concern. For that reason we need to develop the distributional equations below (next section) based on the cost accounts of a firm. In fact practically all items in Table III:1, and subitems have their separate entries in the taxonomies that make up the accounts of a large firm (see E 1984a, 1985b, Lindberg-Pousette 1985). Since CHQ of business organization should be viewed as a manager of a set of activities also the innovative functions, represented here by R&D investment, entry and exit must be part of the discussion. Even though we will not attempt to model this activity explicitly, an important part of innovative or entrepreneurial activity consists in changing the content of production activities. Thus, the advanced Swedish manufacturing firms during the last ten to twenty years, have moved the composition of their resource use heavily in the direction of information processing and service production - mostly market-oriented product development (item 3 in Table III:1) and global marketing and distribution networks (item 9) - to achieve improved competitive positions.

3. The Distributional Equation

A market makes decentralization of decision making among financial units (firms) possible. An ambition to decentralize decisions also prevails within any large organization and a critical question is when the non-market allocation mechanisms of the internal business organization cease to be superior to those of the market (Coase 1937). Superiority here has to be defined in terms of organizational ability to generate a return to funds compared to what can be earned elsewhere in the market. For us this profitability manifests itself in the ability of the firm to attract funds to and/or to keep funds within the business organization. One aspect of this problem is the availability of reliable measures of achievement for the non-market allocation within the organization (E 1976a).

In this supplement we will extend the separable additive targeting formula (III:1) to a multiple division firm. But note that this extended firm concept does not yet reside in the MOSES economy. Several large Swedish firms are in fact represented in the model economy by more than one entity. (A special "dialogue" facility for a real firm - MOSES firm interface along the lines of the sophisticated (investment-finance) planning system in Chapter III has in fact been developed. See Supplement II.) A simple formula that monitors the allocation of resources and outputs within a business organization which follows directly from the definition of RRN (for proof see Chapter VI) is:

$$\overset{j}{\Sigma} p \cdot Q \equiv \overset{j}{\Sigma} w \cdot L + \overset{j}{\Sigma} (RRN + \rho \cdot \beta) \cdot A \qquad \text{(III:23)}$$

j lists profit centers.

This <u>distributional equation</u> belongs to the set of equations that makes the separable, additive targeting equation (III:1). Summation is across profit centers j. In the case of no joint production within the firm, (III:23) represents a one to one classification of inputs over outputs. Again we disregard all inputs but (L,A). This means that we disregard intermediate goods purchases for the time being. We will generalize our formulae later on. Identity is enforced through the definition of RRN, which makes all "residual" value created above wages and the explicit and/or the implicit rental of capital accrue to the equity owners. This is the neoclassical way of looking at the business accounts. It does not disturb us at the macro level, but it departs from our "micro" idea of an entrepreneur (a management technology) that manages (A,L). The entrepreneur and the equity owner have so far been made identical. Whether they are, or not, we do not want to have the entrepreneurial function in a broad sense identified with A neither as an input nor as an output - except for a short while in this formal excercise.

Use (III:1) and (III:9) to rewrite (III:23) as:

$$\sum^{j} \varepsilon \cdot A \equiv \sum^{j} [M \cdot p \cdot Q - (RI + \rho \cdot \beta) \cdot A] \qquad (III:24)$$

where

ε = RRN-RI

ε_i is the difference between the realized rate of return at profit center i and the reference interest rate.

It is instructive to note that (III:24) can immediately be reformulated as Additive Targeting Theorem I,

$G = RRN + (RRN-RI) \cdot \phi$

or

$G = RRN + \varepsilon \cdot \phi$

where

$RRN = M \cdot \alpha - \rho \cdot \beta + DP(DUR) \cdot \beta$

The current profit contribution $M \cdot \alpha$ to RRN in Theorem 1 or (III:1) furthermore is a weighted average of the profit contribution of each constituent production activity, the current asset endowment A_i serving as weight. Hence[21]

$$\alpha \cdot M = \frac{1}{A} \cdot \Sigma M_i \cdot \alpha_i \cdot A_i$$

With a given M_i on each activity RRN of the entire firm can, hence, be raised - via $\alpha \cdot M$ - through allocating investment to the high ε_i activities, such that their shares (weights) a_i in the aggregate profitability "index" of the firm (RRN) increase. It is interesting to observe already here (see further Chapter VI) that this is synonymous to raising total factor productivity, illustrating the important economic content of that measure, as it is achieved through the allocation process.

The ε, hence, is the critical variable in our dealings with the internal allocation process of the firm. In defining its long-term profitability target TARG(G) in the previous section (III:11) firm management has indirectly decided to demand an average ε of the organization. This decision was shown to affect the borrowing capacity of the firm. In a multidivision firm it could be modified and be made dependent on MAX(ε) within the organization. But in the internal allocation budget, equal ε targets should be demanded from all divisions.

The multidivisional firm can be departmentalized in several ways. The normal thing is that some assets are centrally managed and some assets managed by the divisions. The mix differs between firms and even though we will have the necessary empirical information it would be awkward to model all aspects of portfolio management. We simply assume that all assets related to production and sales are managed by the divisions.

The CHQ unit controls portfolio (financial) assets (Bank deposits, Bonds and Shares in other companies). It also controls equity (Net worth=NW) and all debt(=BW). Production assets (=K1), inventories (=K3) and trade credits (=K2) will be held by divisions. For technical reasons all foreign denominated trade credits will be discounted in the

Commercial Bank (see Chapter IV) and replaced by bank deposits at CHQ.

Investments in property will be modeled as a separate division represented by an exogenous profitability factor, simply to establish an internal opportunity cost term.

Similarly, foreign subsidiary operations, which are important and sizable for most firms in the model, will be represented as separate divisions.

This means that we can use our algebra from the earlier part of this chapter when making the internal investment allocation process explicit.

4. Internal Investment Allocation

Each firm now consists of a bundle of smaller firms like the ones we have already dealt with, plus a CHQ investment bank that divides up the pool of financial resources available after the borrowing decision (III:17) between

(a) INV in divisions
(b) investments in financial assets
(c) investments in property.

The financial portfolio part and property investments are not yet explicit in the model. Such investments, however, have to be implicitly handled and we do it in the following fashion.

If investments of type (b) or (c) yield a higher return than investments in (a) the highest return appears in the long-term targeting function (III:11), that controls the amount of INV (type (a)) as a discount rate or an opportunity cost. Note, that this means that returns higher than those expected on INV may in fact make the firm increase borrowing above what is needed for expansion of production.

Besides, the type (a) INV decision comes first and cash flows in excess of what is needed for INV and financing that comes with production growth, are allocated to the financial portfolio. This is explained in Chapter IV.

The total amount of INV decided on in the one division firm was explained above. In the multi-divisional firm we simply repeat the profit check (III:15A) on each division using the same target.

The borrowing check is replaced by an investment budget check. Maximum amount of finance available for INV has been decided as before in the borrowing check (III:17).

The internal allocation on INV in principle begins by taking the most profitable division, calculating INV on the basis of its long-term sales plan. If the profit check is passed the division gets what it wants and the same is repeated in a decreasing order of profitability until the investment budget is exhausted.

This "linear" procedure is not a fair representation of what goes on in a real firm. For one thing firms often invest in low profit operations now on the presumption that higher rates of return will be achieved in the longer term. This is almost impossible to model as long as we have no theory that predicts such outcomes from historic data, except applying a stochastic planning scheme. We do, however, need a set of decision rules that gives also low profit divisions some investment money since this is what we observe to happen.

Secondly, a budget squeeze is one way of forcing low profit divisions to become profitable by doing something with themselves. One such way is of course not to give them any investment money. However, there is a certain convexity in all performance frontiers in the model. The long-term plan proposal from the division (see case description earlier) is a simpleminded projection into the future. If the profit check fails it can decrease Q and L along the production frontier, thus raising M and RRN.

These profit checks even out RRN among the divisions to some extent, but large differences usually remain. However, we know, and firm management knows, that the market situation may very well have turned around in a few years. Hence, they want to slow down the investment adjustment process towards what currently appears to be the optimal structure by setting a maximum allowed annual departure from a distribution of investment funds that is proportionate to installed assets.

This more or less transforms the proposed interdivisional allocation of investment money out of a total investment budget into a constrained, stepwise programming problem. We will formulate it mathematically below, after we have introduced the other types of assets as well.

5. Foreign Investment Decision

Foreign subsidiary operations have to be treated differently for many reasons. Much of the activity in foreign establishments in reality belongs to the distribution and marketing side. Some late stages of production and the final distribution of goods and services from all domestic operations (divisions) are run through the foreign subsidiaries. The international marketing organization is an integrated part of domestic operations. We hence want to push beyond a simple input-output representation of the foreign unit. Its size should be an integrated part of the overall investment allocation process of the firm.

There is only one straightforward way of modeling this:

(a) by removing the price-taking assumption from exports. Firms with foreign subsidiaries earn an extra return on their assets and pay a higher price than PFOR on deliveries from Swedish plants.

(b) by exploiting economies of scale in receiving, processing and distributing a larger volume of goods from Sweden.

(c) by exploiting economies of scale in domestic operations on fixed inputs that are not part of the production plan described so far. R&D spending would be one example.

To model this we would have to make both marketing and R&D investments explicit in the model.[22]

In addition, the foreign unit confers economies of scale back to the Swedish divisions by selling more of their goods, thus making them invest and grow. In so far as the Swedish production specification incorporates economies of scale they can now be activated.

The foreign subsidiary linked to our particular division can be seen as consisting of two parts:

- one production establishment that purchases goods from the corresponding Swedish division, processes them and passes them on to the foreign market;
- one marketing agent that adds value to both finished goods for the Swedish division and the semi-manufactured goods that are processed further at the Swedish subsidiary.

Some firms only have marketing subsidiaries. Others have both production and marketing activities.

The value added achieved through the marketing investment can be formulated as an increase in the price over and above the exogenous foreign market price (PFOR).

This price difference could be made proportional to the size of the foreign marketing investment relative to the size of the production assets K1. Technically it could be entered as a corresponding increase in the profit margin on all deliveries from Sweden to the foreign subsidiary.

The meaningfulness of adding this feature to the MOSES firm depends on the availability of data to estimate a submodel (division) in which the growth of foreign activities relative to Swedish activities is explained. Work along these lines is currently in progress in a separate project at the IUI initiated by research for the 1983/84 Government long-term survey. Questions on the price elasticity of exports related to the 1982 devaluation have been asked to the firms of the MOSES sample in the 1983 planning survey (see further in database section in Chapter VIII).

6. Financial and Other Investments

Other asset categories to consider are property, bonds and short-term bank deposits.

For the time being the MOSES firm does not invest in property[23] but simply responds to the profitability of property investments by placing stiffer profitability standards on regular investments.

Bonds and bank deposits enter in a similar capacity, although this time actual purchases or deposits are made and exercise a liquidity effect on the firm.

All this belongs to the money Chapter IV, and is explained in some detail there.

7. The Capital Budgeting Procedure

The capital budgeting problem of the 5 year plan can be formulated as a step-wise programming problem.

The preferred procedure would have been to allow for upward sloping supply curves for investment categories of individual firms, as we do for borrowing. This is not possible for two reasons. First, data are not available for empirical applications. Second, firms do not have this kind of information themselves. Even large firms go about this decision in a period to period search fashion, much as described in the case illustration above (see Section III:1.3).

Hence, the procedure is to decide whether at all to go for financial securities and/or property, or to concentrate on investment in production facilities. Higher expected returns across the investment spectrum decide the extent of borrowing and the total investment budget.

In firm i with divisions j the decision problem can be expressed as follows.

Step I

Pick MAX $[RIS_i, RIS, RIL, RIF, MAX[RRN_j], T_i, \tau]$
MAX( ) lists also foreign investments

T_i = rate of return on share investments in other firms by firm i

τ = nominal rate of return on property investments

RIL = Long-term bond rate

RIF = Foreign investment rate (exogenous)

RIS = Short-term domestic deposit rate

RIS_i = local borrowing rate for firm i

Step II

If $Max(RRN_j) < RI_i < \tau$

then (see III:21)

INV < INVF, CHBW = 0.

Borrow until (see III:16B);
$RI_i = \tau$

and invest the remainder of

INVF - INV

in property (fictious investment item).

Step III

If $MAX(RRN_j) > \tau > RI_i$

then borrow (see III:16B) up to:

$RI_i = \tau$

(Split INVF on INV and property investments).

Step IV

If $MAX(RRN_j) > RI_i > \tau$

then borrow up to

$RI_i = MAX(RRN_j)$

and distribute all INVF on INV_j in the various divisions by solving the following programming problem:

$$\underset{\{INV_j\}}{\text{Maximize:}} \quad \Sigma RRN_j \cdot \beta_j \cdot A_j$$

$$\text{subject to:} \quad \frac{INV_j}{INV} - \frac{A_j}{A} < \xi$$

$$\Sigma INV_i = INVF$$

where ξ is a small number.

Supplement II

FIRM MODEL PLANNING DIALOGUE

The sophisticated INVestment FINancing module forms the base for designing an interactive Firm Model Dialogue. The sophisticated INVestment FINancing model has a structure that is very similar to a normal long-term planning and short-term budgeting sequence as they have been carried out in large corporations (see E 1976a).

The sophisticated INVestment FINancing model interacts with the entire model (through the markets) exactly as the more simple investment module currently in the standard program. Hence, by adding the dialogue interface a firm manager can interfere with the long-term decision machinery of the model as he does in a typical long-term planning sequence. He can set and revise his own coefficients, targets and assumptions as plans are being realized. The manager of a large business group can also bring his divisions together, and carry out the same administrative action on each of them.

With this set-up we have designed a quite sophisticated business game. The firm manager can make up a 5 year plan and a budget every year and revise both; the plan every year and the budget every quarter as he watches his firm interact with its model market environment. In a way this dialogue facility is similar to an expert system or a special language to apply "artificial intelligence" to business problems. The manager can automatize the decisions. He can place alert signals on some variables and manage the rest of the system himself.

For the time being the program technically allows only one firm to interact with the model at a time. But in principle there is no limit (except the number of firms in the model and computer capacity) to have all firms being manipulated on line by their managers. Then the business game would be a true market game in the sense that everybody would be responding to an environment determined by everybody's individual actions. In such a game as a rule there is no solution that can be foreseen. Multiple outcomes are possible depending upon the strategies of the players.

If our firm manager interacts alone with the rest of the model, he may gradually learn the model properties such that he eventually may be able to predict his environment with some precision, and also - if he is large enough - the effects on this environment of his own manipulations of his firm.

If a large number of "managers" are interfacing through their firms, and if these managers exhibit substantial irregularities in behavior, compared to the endogenous behavioral design of the model, environmental predictability will be more difficult.

However, the firm model has been designed to be realistic and the overall model is quite complex, which means that whichever alternative we choose, a firm manager participating with his firm in a game interface is liable to meet with surprises as he guides his firm through the model environment.

The main point with the model interface is not to use it for forecasts but rather to allow managers to practice (simulate) to cope with unexpected business events. A more detailed account of the

Firm Model Dialogue is in progress.

The Firm Model Dialogue has been used in one particular instance, namely to calibrate a firm model. Staff planners from one large firm were invited to "play" with the divisions of their firm and set their own assumptions. We plan to do more of this in the future.

Supplement III

TECHNICAL SPECIFICATION OF INVESTMENT-FINANCING BLOCK[24]

This is the sophisticated version of the investment-financing model. It is not part of the standard code and program. The standard program has gradually been augmented with features from this sophisticated investment module (for symbols see pp.110 f.).

This technical specification is the design for coding and programming the sophisticated Investment-Financing block of MOSES. On the whole this design is the same as that of the text of the chapter although some reordering has been done for didactic reasons.

Long-Term Growth Plan

[Note that we will use the algol notation := or make equal to, throughout this supplement.]

Section 1 - Expectations

Timing: Once a year in 4th quarter for 5 future years

1.1 Long-term expected changes in sales:

$$EXPL(DS) := HIST(DS)+\alpha\cdot HIST(DEV)+\beta\cdot\sqrt{HIST(DEV2)}$$

$$HIST(DS) := \lambda_1\cdot HIST(DS)+(1-\lambda_2)\cdot DS$$

$$HIST(DEV) := \lambda_2\cdot HIST(DEV)+(1-\lambda_2)\cdot[DS-EXPL(DS)]$$

$$HIST(DEV2) := \lambda_3\cdot HIST(DEV2)+(1-\lambda_3)\cdot[DS-EXPL(DS)]$$

where[25]

$0<\lambda_i<1$, $i = 1, 2, 3.$

$$DEV := DS-EXPL(DS)$$

$$DEV2 := [DS-EXPL(DS)]^2$$

Note: To project the 5 year future we use a 5 year historic background. In the current initialization, starting 1976 only 3 years of experience are used the first year, namely 1974, 1975 and 1976. The planning survey started in 1975 with data for 1974. See Albrecht-Lindberg (1982). When the simulation has run for 2 years a 5 year history has been generated and is put to use.

1.2 Change in total assets is equal to change in sales

DA := DS

1.3 Change in production capital is equal to change in total assets

DK1 := DA

Note: These are assumptions for the long-term plan only. They do not have to be realistically computed since they are to be used for a rough, ex ante calculation in a planning context.

In the future we may want the firm to plan for the future on the assumption of substantial changes in (MTEC, INVEFF) i.e. in α and β in Eq. (III:1). See Supplement to Chapter V. Then we would not have simple proportionality in 1.2 and 1.3 but a more complex relationship.

1.4 Note: On any long-term planning occasion it is possible to impose DS exogenously for an individual firm, or to impose a cycle in DS.

Section 2 - Depreciation and Scrapping

2.1 Investments in production capital accounts for capacity expansion, depreciation and price change

INV/K1 = DK1-DP(DUR) + ρ

2.2 Endogenous determination of ρ
Optional ON and OFF routine (not yet in program).

Note: The problem with the present specification is that ρ is fixed and exogenous and that output of average, rather than lower end quality, is scrapped. We do not want to enter all the cumbersome algebra of a full vintage formulation but we want to keep the idea. Hence:

Assume:

a) INV/P(DUR) has been invested at a steady rate. Keep that rate updated currently through cumulation. Hence, current capacity to produce (on QFR(L), A21=0), is spread over vintages of declining MTEC qualities according to a declining exponential curve.

b) MTEC qualities are allocated on these vintages according to a known DMTEC (exogenous) time profile. If INV/P(DUR) has in fact grown at a steady rate this formulation would be identical to a vintage formulation.

c) Calculate

$$\text{MIN MTEC} := \frac{\text{EXP(W)}}{\text{EXP(P)}} \cdot \frac{1}{\text{1-TARG(M)}}$$

Each period, scrap all vintages below MIN MTEC[25]

Shift QTOP down accordingly.
Pivot QFR(L) by recalculating TEC.

MIN MTEC means the labor productivity (Q/L) of a vintage when A21 = 0. Vintages are scrapped when they yield an expected M lower than TARGM.

(This has been done in a "backward" fashion, in (4.1.7) in the technical code in Eliasson-Heiman-Olavi (1978). We cannot retain a truncated vintage series but have to mix what remains, and stir well.)

Next period (quarter) a whole new synthetic vintage constellation is calculated as above and the procedure begins all over again.

With this formulation ρ is endogenously determined as CHQTOP due to scrapping in percent of QTOP.

Section 3 - Capacity Growth and Profit Check

3.1 Calculate from 1.3
K1 year by year to horizon (= H = 5 years)

3.2 Enter EXPL[DP(DUR)] and ρ from block 2.2 (exogenous, or endogenous average of past 5 years)

3.3.1 Calculate INV year by year to H from (2.1)

Note: We choose to obtain the "trial" INV paths this way rather than feeding the preliminary EXP(DS) etc. into the production block to derive (indirectly) investment requirements.

3.3.2 Option: exogenous specification of INV. Same as 1.4.

3.4 Enter QFR(L) with last period L from (4.01) in old code. (Eliasson-Heiman-Olavi 1978, p.183).
Enter NU = normal expected long-term capacity utilization rate = (1-Average SUM) = [1 - Average (A21+A22)] for last 5 years
or = Exogenous (optional).
Calculate NU·QFR(L).
Assume no change in L and that DTEC=DQTOP.

3.5 Enter INV from 3.3.
Quarterlize INV. Deflate by EXPL[DP(DUR)].
Enter in (4.1.3) in technical specifications, old code (Eliasson-Heiman-Olavi 1978, p.184).
Calculate DQTOP1 each year to H.

3.6.1 $$D(NU \cdot QFR(L)) := DQTOP1 + \frac{L \cdot \exp(-\gamma \cdot L) \cdot CH\gamma}{1-\exp(-\gamma \cdot L)}.$$

3.6.2 Calculate

NU·QFR(L) on Horizon year (L same as now).

3.7.1 Calculate

$$TARGL[G(AT)] := \lambda \cdot TARGL[G(AT)] + (1-\lambda) \cdot GL(AT)$$

$$TARGL(G(AT)) := (1-R) \cdot TARG[L(G(AT))] + R \cdot TARGL[XG(AT)],$$

$R \in (0.1)$ using formula (E) in (3.7.3) below.

TARGL[XG(AT)] is an external reference, say G(AT) of the market leader, the best performer in the market, a long-term interest or some other reference that can be optionally imposed.

Go to additive targeting formula (3.7.3 below). Enter (A) and (B) in (3.7.3) into (C) and

SOLVE for

M = TARGL(M) with TARGL(G(AT)) in (E)

Note: This is needed to make TARGL(M) dependent upon changes in corporate income tax parameters.

3.7.2 On H (expansion of current operations)

$$M := [(EXPLP \cdot NU \cdot QFR(L)) - (EXPLW \cdot L)]/(EXPLP \cdot NU \cdot QFR(L))$$
(Same formula as (II:3) in Chapter II).

3.7.3 Calculate

$$RR = M \cdot \alpha - \rho \cdot \beta \qquad (A)$$
(see p.50 in E 1976b)

and

$$RRN = RR + DP(DUR) \qquad (B)$$

<u>and</u>

G(AT)=[(1-t)•(RRN+(RRN-RI)BW/NW)+
+ t•(DP(DUR)+d-ρ)•K/NW] •NW/(NW-TC) (C)

d = fiscal rate of depreciation.
TC:= (NW - NW(BOOKED))•t each year. (D)
AT signifies <u>after tax</u>.
To apply TARGL to G(AT) means that firms strive to maintain their after tax growth rate in nominal net worth. An even better formulation would be to formulate G(AT) in real terms after tax as in (E 1976a, p. 292). This would mean replacing (C) with:

G(AT) = (same as before)-DCPI (E)

and to apply TARGL operator to G(AT).

TARGL[G(AT)] as defined in (E) stands for a long-run real, after tax rate of return requirement on net worth. It signifies a corporate head quarter (CHQ) objective and can easily - through (A)-(E) - be transformed into an M-requirement each period, that depends on inflation rates, tax rules etc. M-requirements in turn can be used as a criterion in long range planning.

3.7.4 <u>Investment in bank deposits</u> at RI deposit rate.
Enter from Money system period (quarter) before.
Never considered as an alternative to INV if
CHBW > 0 in (5.2) below.
G(ATBDEP)=(1-t)•RI.

3.7.5 <u>Other investment options</u>

[EMPTY]

<u>Note</u>: If we decide later to split the firm into a set of production units held together by a financial CHQ function, this is the place to enter a rate of return screening across production units as discussed in Supplement I.

3.8.1 Choose
TARGL(G(AT)):= MAX(TARGL(G(AT)), RI•(1-t), ...)

3.8.2 Solve for
TARGL(M) using (3.7.3)

3.8.3 Check for SAT using (3.7.2)

3.9.1 If SAT go to Section 4

3.9.2 If not SAT lower EXPL(DS) with X percentage points and repeat from (1.2) until SAT

3.9.3 Calculate new INV from 2.1.

Section 4 - Borrowing and Leverage Check

4.1 EXP(RIL) := EXOGENOUS (Expected long-term RI)
EXP(RIS) := EXOGENOUS (Expected short-term RI)

4.2 Enter EXPL(DS) from (1.1) (or final value) from (3.9.2)
whichever is MIN.
EXPL[DP(DUR)] from (3.2) and M from (3.7)
in (4.3) below to obtain MAX ϕ.

4.3 Calculate

$$\text{MAX } \phi = \text{optimum gearing ratio} := \frac{\text{MAX( )}-RI_i}{\gamma},$$

$$\text{where } \gamma = \frac{\partial RI_i}{\partial \phi} \text{ in } RI_i = F(RI, \phi)$$

This expression is derived in Chapter IV. See Eq. (IV:15).

(Also see derivation in E 1976b, pp. 102-103).

Section 5 - Liquidity Check and Dividend Determination

5.1 Calculate CHDLIQ:=LIQD-LIQ. LIQD is defined in section (13) below.

5.2 Calculate for next year
CHWB := [INV+CHS$\cdot$(1-β)/α+RI$\cdot$BW(LAG)-M$\cdot$S+DIV+
+ TAX+CHDLIQ]/(1-RI)

5.3 and then for following years making
CHDLIQ:= CHLIQ

5.4.1 DIV:= $\Theta\cdot$NW(LAG)
Θ:= EXOGENOUS or endogenously determined as below.
Note: that LAG refers to the previous year. DIV after tax adds to total income in household sector.

5.4.2 Alternative

Dividend policies cater for two interdependent purposes:
a) to keep stockholders happy;
b) to maintain a stable growth rate in the market value of NW. This last ambition is very

much supported by success under a) and depends as well on the ability to keep Θ constant in the long run at a steadily growing NW, after tax and net of inflation.

By entering Θ as an exogenous constant we are fairly realistic. We should then, however, allow for the fact that successful companies often tend to have somewhat below average Θ and vice versa.[27] Hence it would be good if Θ could be made endogenous. Let us assume, that:

$$\Theta = f(G(AT) - RI, DS), \quad f_1' > 0, \quad f_2' < 0$$

G(A) is the after tax and inflation determined profit objective of the firm as specified in (3.7.3). With this formulation a firm that expects a CHG(AT) > 0 for the long-term future could plan - at each RI - for a lower V and vice versa. If the interest RI increases, on the other hand, everything else the same, firm management will have to up the pay out ratio to keep stockholders happy.

5.4.3 Stock market and capital gains taxation

[EMPTY]

Section 6 - Gearing Ratio

6.1 Calculate (from 5.2)

BW:= BW + CHBW
K1 from 2.1

$$K2 := K2 + \frac{1-\beta}{\alpha} \cdot CHS$$

6.2 Hence

NW:= K1 + K2 + LIQD - BW

6.3 Calculate

$$\phi = BW/NW$$

Section 7 - Financial Risk Assessment and Maximum Borrowing

7.1 CHECK for $\phi \leq$ MAX ϕ each year
(Alternative: Check for (7.1) only year H).
IF SAT go to (10)
IF NON SAT take away as much net borrowing as needed (no more) to satisfy ϕ-target each year.

7.2 Add up reduction in CHBW each year 0 to H and divide by H to obtain annual average: = X.

7.3 Reduce EXPL(DS) with the help of formula:

Reduction (in percentage points) of planned long-term annual growth rate in S. :=Y:=X•(I-RI)}{S(LAG)}

7.4 Reduce INV/K1 by:

Reduction in investment Value planned per year: $:=Y\cdot S(LAG)\cdot\beta/\alpha$

7.5 CHBW:= CHBW - X for each year.

Note: CHBW so calculated for first year defines maximum borrowing allowed for next year (long and short term) under normal circumstances.

7.6 A formal rate of return check across production units (3.7.5) is very unusual. Such considerations are normally taken more intuitively. In a model like this with no explicit interface, if a firm is split into production units, (3.7.5) has to be specified. However, at this point we could establish a direct interface. We have obtained total DBW on a 5 year basis for the entire firm. CHQ growth management usually means allocating investment money and no more. CHQ can now call in data from all operating units (operating as individual firms) and split DBW among them as they please. That fixes investment in money terms above what can be internally generated.

Section 8 - Short-Term Budget

8 (Tentative). Enter business cycle in long term-S by applying the optional instruction.

EXOGENOUS CYCLE

Calculate consequences for M in (3.7) and LIQ (see later) in H-year plan.

The rate of capacity utilization together with current cash flows will later be added as a determinant of quarter to quarter INV or rather to explain deviations from long-term INV in (8) above.

Section 9 - Quarterlization of Budget

9 We now have the long-term (H-year) plan + the annual budget by quarter:
INV from (7.4) and (2)

Kl ditto
DS from (7.3)
DA from (1.2)
DBW from (7.5) and so on.
Quarterlize INV as in (3.5) and whatever else that is needed by quarter.

Section 10 - One Year, Long-Term Borrowing Decision (Final)

10 Add CHBW in (9) for all years 0 to H
ADD(H) CHBW:= Y (= total borrowing, new, long term)
Note: Y is expressed in expected current prices each year.

Section 11 - Quarter, Short-Term Borrowing Decision (Final)

11.1 CHBW(H) is total borrowing from (7.5) for entire planning period.

Calculate long-term borrowing for year immediately ahead as:

CHBWL:=[$1+\gamma \cdot$ (RIS-RIL)/RIL]$\cdot$(CHBW(H))/H

$\gamma > 0$

Note:

RIS = short-term interest rate
RIL = long-term interest rate
In some model versions the short-term interest rate RIS_i is firm-local, e.g.:

RIS(i) = RIS + $T(\phi)$

such that $T' > 0$, $T'' > 0$

(see (IV:14) in next chapter).

Alternatively we could be more conventional and assume that firms borrow, invest and grow up to the margin where:

EXPL(RRN):= EXPL(M)$\cdot\alpha-\rho\cdot\beta$+EXPL(DP(DUR))
EXPL(RRN):= RI_i on the margin

Subject to $\phi < \text{MAX}\ \phi$ from (4.3)

Note: ε in (V:2B) in Chapter V would then be = 0 on the margin.

11.2 If CHBWL in (11.1) for first year is smaller than CHBW in (9) make up for difference by borrowing short term (CHBLS).

11.3 Same as (1.4).

Section 12 - Liquidity Management

12 Add one quarter of CHBW (total) to cash position beginning of each quarter and calculate EXPQLIQ from the long-term plan.

Note: For the time being we use this simple device.
The determination of EXPQLIQ per quarter is as follows:

EXPQLIQ:=QLIQ+M•S+CHBW-RI•BW-RAM•BW-DIV-TAX-CHSTO-CHK2-INV

All entries from (8) (above)
DIV from (5.4) and TAX from (3.7).

Section 13 - Determine Liquidity Position (Final)

13.1 Calculate desired LIQ as:
LIQD = F(S, expected excess cash outflow)

13.2 Same as (1.4).

Section 14 - Liquidity Crisis and Bankruptcy Procedure

14.1 Calculate expected LIQE from (12)
Expected cash position:

Ω = (LIQE-LIQD)/LIQD

defines the firm's short-term (next year) liquidity status as seen from within the firm. Ω measures expected deviations from desired LIQ.

14.2 LIQ-crisis

Whenever

Ω < CRITLIQ
or (see below)

Ω actual = (LIQ-LIQD)/LIQD < CRITLIQ
CRITLIQ $\in$ (-1,0)
The long-term growth plan is abandoned.
Then:

a) reduce INV until
Ω = CRITLIQ

b) if not sufficient
dump STO-MINSTO in market immediately until
Ω ≥ CRITLIQ

c) if not sufficient
cover the rest as short-term loan in bank.

Enter 5 percent of labor force in AMAN.
All new recruitment is stopped.

d) Repeat c) every quarter for a maximum of CRITER quarters. Whenever Ω requirement satisfied return to normal.

Bankruptcy occurs as follows:

1) Dominant. Whenever net worth turns negative or

2) if Ω actual < CRITLIQ
after CRITER periods, declare Bankrupt.

When bankruptcy occurs:

The one plant firm shuts down.
All L to LU (unemployment).

Scrap all capital (K1).
Make K1:=0
and cancel all debt.

Note: One possible modification would be only to scrap unprofitable capital. The procedure would then be to find the point on QFR(L) (see Figure II:3), where

M corresponds to RRN = RIS (see Formula III:1)

and then reduce L correspondingly.

Financial reconstruction of the firm would then imply that QTOP is run through a new point. Some x percent (say 5 percent) vertically above and QFR(L) is recalculated and a new firm entity with no debt is established.

This firm could be defined as a new firm or merge with another firm.

The above modification is technically easy to enter, but it would not change model behavior more than marginally. This procedure could be used to handle say, the addition or separation of parts manufacturing to or from an integrated production system (= division).

The preferred procedure would, however, be to use a multiple division firm within which entire divisions can be added or subtracted. In fact most real, large firms in the MOSES system are currently represented as several entities.

The multiple division firm is not yet coded. A preliminary conceptual presentation is found in Supplement I.

Section 15 - Short-Term Profit Target Modifier (Exogenous)

15.1 $\Omega = \frac{LIQE - LIQR}{LIQD}$

and/or

Ω (actual) $= \frac{LIQ - LIQD}{LIQD}$ (per quarter)

determines the extent to which short-term operations M-targets can be temporarily modified downwards because of unexpected or excessively strong profit influences that are not believed to be permanent.

Such modifications also relate to specific decisions:

(a) production for inventories
(b) hoarding of people and overtime
(c) contracyclical timing of investment.

This short-term modifier is to be operated exogenously on a chosen number of firms, or endogenously (not yet specified). One way to do it would be to instruct the machine to stop and print out necessary information whenever current INV, L and Q are down more than five (say) percent below the long-term plan. Then the operator (the chief executive) can decide what he wants to do.

15.2 Production for inventories

When a preliminary Q-plan has been determined after TARG(M) check (see 3.7.1), override further TARG considerations this quarter and raise the preliminary (Q,L) plan so that an exogenously set optimum final goods stock (OPTSTO, see code), can be realized during the same quarter. The only factor that can now prevent the corresponding Q level from being realized is non-availability of needed labor in the labor market at the offering wage (determined as before).

15.3 Hoarding of people and overtime
(Not yet in program)

Whenever there is a choice to get rid of people or an immediate need for more hours of work the firm consults its long-term plan to decide whether it expects any need for the people in the long run.

Calculate L = RFQ(Q) (see (4.02) in code in Eliasson-Heiman-Olavi (1978)) for H = 2 (years) at NU operations. The result is L(2).

Let go from AMAN

If L(2) > L + AMAN content
keep redundant labor in AMAN as before.

Overtime

if A21 = 0 and
CHL > 0 in (5.4.1.0 in code).

THEN contemplate overtime

if

$$EXP(P) \cdot \frac{dQFR}{dL} > (1+OVER) \cdot EXP(W)$$

but make CHL = 0
if (in addition)

$(L(2)-L)/L < FRAC$.

If overtime needed to fulfil Q-plan, pay

$(1+OVER) \cdot W$

for all work above initial L that quarter.

Note: These devices are inserted to handle real life mechanisms. Firm management:

(I) may want to behave rationally in the long run but dares not because of a perilous LIQ position.

(II) may find it economically rational to take drastic action, but social and other considerations suggest otherwise. Hence, we make a distinction between firms that deviate upwards and downwards from a normal or average M-trend. I consider this device empirically important when the model is used to analyze short-term economic behavior.

15.4 Countercyclical timing of investment (exogenous)

Section 16 - Short-Term Liquidity Reserves

16. Calculate from (14) and (15) the maximum contribution from LIQ next quarter as:
CHLIQP: = LIQE - LIQD

Note: CHLIQP may be negative.

Section 17 - Investment Decision (Final, if not already aborted in 14.2)

17.1. Investment finance allocated next quarter (final decision):

INVF:=M•PLAN(S)-PLAN(CHS)•(1-β)/α-
- (RI+RAM)•BW-DIV-TAX-CHLIQD

or (more easily recognized)

INVF:=M•PLAN(S)-CHK2-CHK3-(RI+RAM)•BW-DIV-TAX-CHLIQD

Quarterlize INVF to QINVF.

17.2 PLAN(S) is obtained from (4.3.10) in PROD planning block of code as:

PLAN(S):=EXPP•(PLANQ-OPTSTO+STO)

(17.3.1 Calculate planned intermediary inventory build up over and above next quarter planned use. Call this CHTESS).

17.4 Check for capacity utilization

If

(1-Q/QTOP)/NU < CAP.

Then

RED(INV):=RED•ρ•K1
RED > 1.

17.5 Enter INV from (9) in

INV:=(INV,INVF-CHTESS,RED(INV)).

Deposit (INVF-INV+CHTESS) in firm bank account.

Section 18 - Different INV Categories

[18.1 (Tentative). Split QINV into various types of INV, depending upon whether they affect QTOP or TEC in production block].

18.2 SPLIT INV into construction and machinery investments. SPLIT factor is exogenous coefficient. INV construction goes to dummy I/O production sector. INV machinery enters as before as demand in INV-sector.

Section 19 - Final Investment Goods Demand from Micro Units

19 QINV from (17.4) enters as final money demand in capital goods markets (next period).

Endogenous market DP(DUR) used to calculate volume QINV that updates production system.

Section 20 - Investment of End of Quarter Residual Liquidity

20.1 Residual LIQ invested currently (each quarter) at (RIS - ξ) in The Bank.

ξ:= Exogenous (difference between short-term borrowing and deposit rate and equal to profit margin in banking system. See Chapter IV).

NOTES to Chapter III

[1] This chapter is a substantially rewritten and enlarged version of Chapter 3 in Eliasson (1976b). Since then I have worked out a technical specifications paper (a preliminary code) in various stages to serve as a code for the programming of the INVestment-FINancing module. This paper is based directly on a version of that code written down in a paper dated June 1978.

[2] See the dialogue interface facility in Supplement II to this chapter.

[3] Maintain or Improve Performance = MIP. See Eliasson (1976a, p. 236 ff.).

[4] Such demands can be introduced exactly as described in the model. The results usually are that the firm finds no solution that yields the required performance, and shuts down.

[5] The full targeting formula that incorporates the MIP idea as it appears in a MOSES firm has been derived in Eliasson (1976a, Supplement section). See also Eliasson-Lindberg (1981, pp.293 ff.).

[6] Calculated on K2 that includes deposits in bank, earning RIS minus bank margin ξ and long-term bond rate RIL. See Chapter IV.

[7] In this formulation "assets" mean only capital goods that appreciate in value at the rate (DP-ρ). Inventories as well belong here, and financial assets if we had made them explicit - as we will do in Chapter IV.

[8] See Eliasson (1976a, p.291).

[9] The complete code will be published separately.

[10] The possibility of making special productivity assumptions on MTEC and INVEFF and entering them $\left(\text{INVEFF} = \frac{\alpha}{\beta}\cdot\frac{P(DUR)}{P},\ \text{MTEC} = \frac{Q}{L}\right)$ in III:1 to evaluate their rate of return consequences <u>on the margin</u> is discussed in Chapter VI.

[11] One should observe that firms can make forecasts on those coefficients bringing in all the information available. They in practice update the coefficients whenever they believe they should (see Eliasson 1976a) and we could of course do the same if we know something about (α,β). For an economic interpretation of (α,β) as productivity measure, see p.299 f.

12

$$CHQTOP = \frac{INV \cdot INVEFF}{P(DUR)} \qquad (III:14A)$$

$$D(NU \cdot OFR(L)) = DQTOP + \frac{L \cdot \exp(-\gamma \cdot L) CH\gamma}{1-\exp(-\gamma \cdot L)} \qquad (III:14B)$$

vertically along a given L. (A) is in effect the definition of INVEFF, which measures the additional value added feasible for an extra unit of investment at a given labor input. In terms of the targeting formula (III:1) it can be said to be a "marginal" α in (III:1) corrected for relative changes in the price on products and investment goods.

In practice we estimate the initial value of INVEFF by dividing potential value added Q/(1-A21) in Figure II:3 by K1 from the replacement valued balance sheet that we use. From then on INVEFF is an exogenous factor like DMTEC.

The assumption implied in (A) hence is that the average level of technology expands at the same rate as

QTOP, i.e.

DTEC = DQTOP

and that capital depreciation takes place at the assumed rate $CH\gamma$. If $CH\gamma$ is assumed to be zero for simplicity, the second part of the right hand expression in (B) vanishes.

The assumption of labor saving technical change originally came from Bentzel (1978). Recent empirical research, however, suggests that technical change has not only been labor augmenting. It is technically easy to allow for capital augmenting technical change by varying INVEFF, or entering a growth trend. Since we have no empirical information to go on, we have simply assumed that firms - in their planning procedures - assume INVEFF to be a constant. However, evidence collected in other IUI studies, especially those associated with electronics in industry (see e.g. E 1982b and 1985b) suggests strongly that at least technical change in the future will be relatively more capital saving.

13 No capital saving is possible as long as INVEFF is constant.

[14] Assume a constant discount factor i that is higher than the constant RRNW by a margin signifying the extra risk of investing in the company. Then Θ is a constant and the present value of all future dividends(=Y) is

$$Y = \frac{\Theta \cdot NW_0}{(i-K)}$$

NW_0 is the initial value of NW. Hence $dY/dK > 0$.

This result can be naturally extended when allowing for external financing and assuming a forever constant interest rate i. See also expression (IV:23) in Chapter IV.

[15] As total assets at replacement values minus debt. See further Chapter IV. Also see specification in Lindberg (1981) and in Carlsson-Bergholm-Lindberg (1981).

[16] See Carlsson-Bergholm-Lindberg (1981).

[17] This specification relates to the present one firm - one plant specification in MOSES. With multiple plant operations as in Supplements I and II, shut-downs can be restricted to some of the plants.

[18] Or reformulated somewhat:

INVF:=M•S(PLAN)-CHK2-CHK3-(RI+RAM)•BW-DIV-TAX-CHLIQD.

Also note that the model contains what we have called a REServe slack component (see E 1978a, pp.66-68 and p.188 ff.) that we have deleted in Chapter II to keep the algebra clean. In the full model specification hence QTOP really reads

QTOP•(1-RES)

[19] See further Supplement III where investment spending has been split into different categories.

[20] Not yet in program.

[21]

$$M \cdot \alpha = \frac{\Pi}{S} \cdot \frac{S}{A} = \frac{\Sigma \Pi_i}{A} = \frac{\Sigma \frac{\Pi_i}{S_i} \cdot \frac{S_i}{A_i} \cdot A_i}{A} = \frac{1}{A} \cdot \Sigma M_i \cdot \alpha_i$$

Q.E.D.

[22] This makes a lot of sense. The R&D budget in turn could also be made to affect DMTEC!

[23] Except as part of the general investment process. Total INV are split by a technical coefficient (see Bergholm 1982) into machinery to be purchased in the investment goods markets and buildings that are simply forthcoming upon demand in a truly Keynesian tradition. Again this constitutes a partial endogenization of the input-output matrix.

[24] From a circulated draft dated May 1981 (Revised from November 18 and December 1976, June and July 1978 and February 1981) by Gunnar Eliasson.

[25] Irregularities in historic data lower the predictive power of our EXP-functions. This factor is supposed to make firm managers cautious. The larger the standard deviation the more inclined to underestimate prices and overestimate wages are firm managers ("risk aversion").

[26] This criterion for scrapping vintages is very similar to the one used by Bentzel (1978) on macro data.

[27] Our data suggest that Θ should be in the range 2 to 3 percent.

IV Money in the Moses Economy – the Determination of the Interest Rate

1. The Actors and Their Accounts

The money side of the model connects all savings in the economy in the sector of origin (households, firms, government and abroad) with all demands for funds (households, firms and government). In the process the domestic interest rate is determined.

The credit market provides the link between the sources and uses of financial resources. This linkage can be modeled in a more or less complex manner. When consolidating these links within the financial market, a direct accounting relationship appears between the **real accounts** (demands and supplies of goods and services) and the **financial accounts**. An important part of monetary theory is concerned with the extent to which the organization of financial market processes affects the dynamics of investment allocation and how this manifests itself in the entries of the real accounts. The main vehicle in this respect is the rate of return requirement imposed on all investment decisions through the interest rate. With this the determination of the interest rate becomes important.

We have argued strongly earlier that micro specification in labor and product markets is essential to capture the dynamic market process, and to understand a real, "live" economy. We argue the same for the money markets. Money is a very special "good" to model, and to do it meaningfully at the micro level we have to enter a micro-specified household sector in MOSES as well. This is still some way off, mainly due to the lack of systematically collected data.[1]

For the time being much of the intricate intermediation that goes on in the credit system of an industrialized economy has to be assumed away. We will concentrate on the determination of two domestic interest rates; a short-term rate (RIS) and a long-term rate (RIL). There are explicit links to the outside world, which means that the domestic interest rates are dependent on two foreign (exogenous) interest rates.

Part of the interest determination problem lies in the organization of credit market arbitrage and how the rate of return requirements of household savers (their time preference) are brought to bear on the investment decision in the firm. Household rate of return requirements are determined by alternative investment opportunities available, e.g., in foreign markets or in real assets, where inflation plays a role. This arbitrage can be more or less efficient, more or less affected by government intervention and regulation, more or less visible to the statistical eye, etc.[2] One particular question concerns interest regulation. For how long can a low interest rate policy be supported through the tax system without destabilizing the economy? Another question concerns the extent to which such things as "quantity constraints" affect the price signals in the market.

One important feature of the financial system has to do with the absorption of risks on ownership entitlements associated with the supply of finance. The model contains a sophisticated, industrial firm submodel operating in both product, labor and credit markets. At least a rudimentary equity market should be entered,[3] its main function being to transmit information and/or to impose rate of return requirements on firm management.

The money system programmed (since 1980) into the MOSES economy currently consists of a narrowed down version of a money market model outline[4]. It can be turned off for an exogenous determination of the domestic interest rate. When turned on all real and financial accounts are made dynamically interdependent and the domestic interest rate is determined in the process.

Simplifying, we can say that the whole MOSES economy revolves around an exogenous foreign interest rate assumption which affects the rate of return requirements in the domestic economy through the intermediation of the credit market. This is a key determinant in the dynamic allocation machinery of the micro-to-macro model economy. The government can affect the domestic interest through various monetary and fiscal actions. Somehow the MOSES economic structure has to adjust to these price assumptions, and the time structure of the price and quantity adjustment is an important part of the MOSES theory. Loosely speaking a price and interest parity mechanism describes the relationship between the model economy and the rest of the world. A good quality database guarantees that initial conditions are not out of line with rest of the world price assumptions based on recorded prices in the recent past. The domestic, expected rates of return at the micro (firm) level respond to these data through the investment decision. The domestic exogenous constraint on total economic growth is the productivity of new investment goods as it applies to investments of individual firms at one point in time (see Chapter VII).

We begin by describing the outline of the money model, which is based on a portfolio choice idea for firms and households. The approach is stimulated by, but departs in several ways from the ideas of Tobin (1969). Ours is a micro model. It is not an equilibrium model. Unexpected capital gains are normal and as in real agent behavior, action is taken on the basis of nominal information. Different types of claims in the market signify different levels of risk, differentiated by different rates of return. After discussing the theoretical model we specify the narrowed down version currently operating within the programmed model.

All real transactions in the MOSES economy are recorded in a set of financial accounts. Each firm has its set of accounts, and so do the household sector and the public sector. All financial transactions are cleared through The Commercial Banking system. This clearing constitutes the credit market in which the interest rate is determined. The accounts can be consolidated into a set of national accounts. To obtain a better overview, let us look at the balance sheets of all five agents - firm, household, commercial bank, Central Bank and Government. They are shown in Tables I through V.

Through these accounts and in period to period interaction with the real accounts the interest rate is determined. What remains is to specify the credit market machinery that links the accounts together.

FINANCIAL ACCOUNTS IN MOSES

Table I Balance Sheet of ONE FIRM

ASSETS	DEBTS
(1) Production capital (=K1)*	(1) Borrowing (=BW)
(2) Liquid assets (=K2=DEP(B))	-long term -short term
(3) Inventories (=K3)**	(2) Net worth (=NW)
(4) Trade credits net (=K4)	
(5) Bonds (=BO)	
(6) Shares (=SH)	
(7) Property (=PROP)*	
Total assets = A	Total debts = A

* A distinction is made between:
K3-IN = input materials inventories
K3-OUT = finished product inventories.

Inventories classified as K3 consist of goods produced in the model economy. We do not separate out goods in process from K3-IN. Such data are currently not collected. See further Chapter VII.

** K1 is hardware assets ("Machinery") produced in Sector 3 ("INV") in the model and invested in the business firms.

PROP are goods not produced in the model. We think in terms of a fixed endowment of land. We may later change our mind and cumulate all output in the macro input output-cell of the construction sector into a PROP volume measure.

Table II Households

ASSETS	DEBTS
(1) Stock of durables a) property (=PROP(H)) b) other durables(=STODUR)	(1) Borrowing in commercial bank (=BW(H))*
(2) Deposits in bank (=DEP(H))	(2) Future, perceived tax burden**
(3) Bonds (=BO)	(3) Net worth calculated as a residual (=NW(H))
(4) Shares (=NW(B)=SH)	
(5) Notes and coins (=N)	
Total wealth of households (=WH)	Total household debt (=WH)

* Note that in the current macro version of the household sector and flow specification of the money system DEP(H) = (-1) BWH. It does not make sense yet to keep both assets and debt accounts for "the household".

** Barro (1974) type perceived debt that has to be paid back through higher taxes in the future.

le III The Commercial Bank

SSETS	DEBTS
1) Borrowing by firms (=BW(B))	(1) Deposits by firms (=DEP(B))
2) Ditto Government (=BW(G))	(2) Ditto Government (=DEP(G))
3) Ditto Households (=BW(H))	(3) Ditto Households (=DEP(H))
4) Foreign assets discounted by firms (=FASS)	(4) Foreign debt by firms (=FD)
5) Liquidity, domestic (=CBR=BLIQ)	(5) Central Bank Borrowing) (=CBB)
	(6) Net worth of Bank (=NW(Bank))
Total assets	Total debts

ble IV The Central Bank

ASSETS	DEBTS
(1) (Government) securities (=BO(G))	(1) Notes and coins (=N)
(2) Borrowing by the Commercial Banks (=CBB)	(2) Commercial Bank Reserves (= CBR)
(3) Foreign liquidity (=LIQFOR) (Exchange reserves)	(3) Net worth (Residual)
Total assets	Total debts

Table V The Government

ASSETS	DEBTS
(1) Real Assets (=K1(G))*	(1) Borrowing in the bank (=BW(G)=G)
(2) Deposits in bank (=DEP(G))	(2) Government Bonds (=BO(G))
	(3) Borrowing abroad (=GFOR)
	(4) Social commitments**
	(5) Net worth (=NWG)
Total assets	Total debts

* Cumulate INVG as INV in industry (firms).

** The extent of future "social" commitments should be entered as a future claim on real resources of the economy to be expropriated via the tax system. The calculated claim (see Barro 1974, and for Sweden Palmer 1981) should be corrected for the political probability that future claims will be honored.

More generally, the rate of change in Government net worth, as suggested by Barro (1974) should enter households savings decisions under the presumption that a deteriorating public net worth position makes households more concerned about their own future, i.e. increases their savings propensity.

(4) is assumed to be zero in the current version of the model.

Table VI National (consolidated) Asset Position

ASSETS	DEBTS
(1) PROP(B+H)	(1) GFOR
(2) K(B+G)	(2) FD
(3) STODUR	(3) National Wealth (=NW(CB+G+H))
(4) FASS	
(5) LIQFOR	
Total assets (=WN)	Total debts

<u>Note (1)</u>: The foreign net debt position is defined as: GFOR+FD-FASS-LIQFOR.

<u>Note (2)</u>: This consolidation assumes:
(a) SH(B+H) = NW(B+Commercial Bank)
(b) BO(B+Central Bank+H)=BO(G).

Figure IV:1 The Monetary System

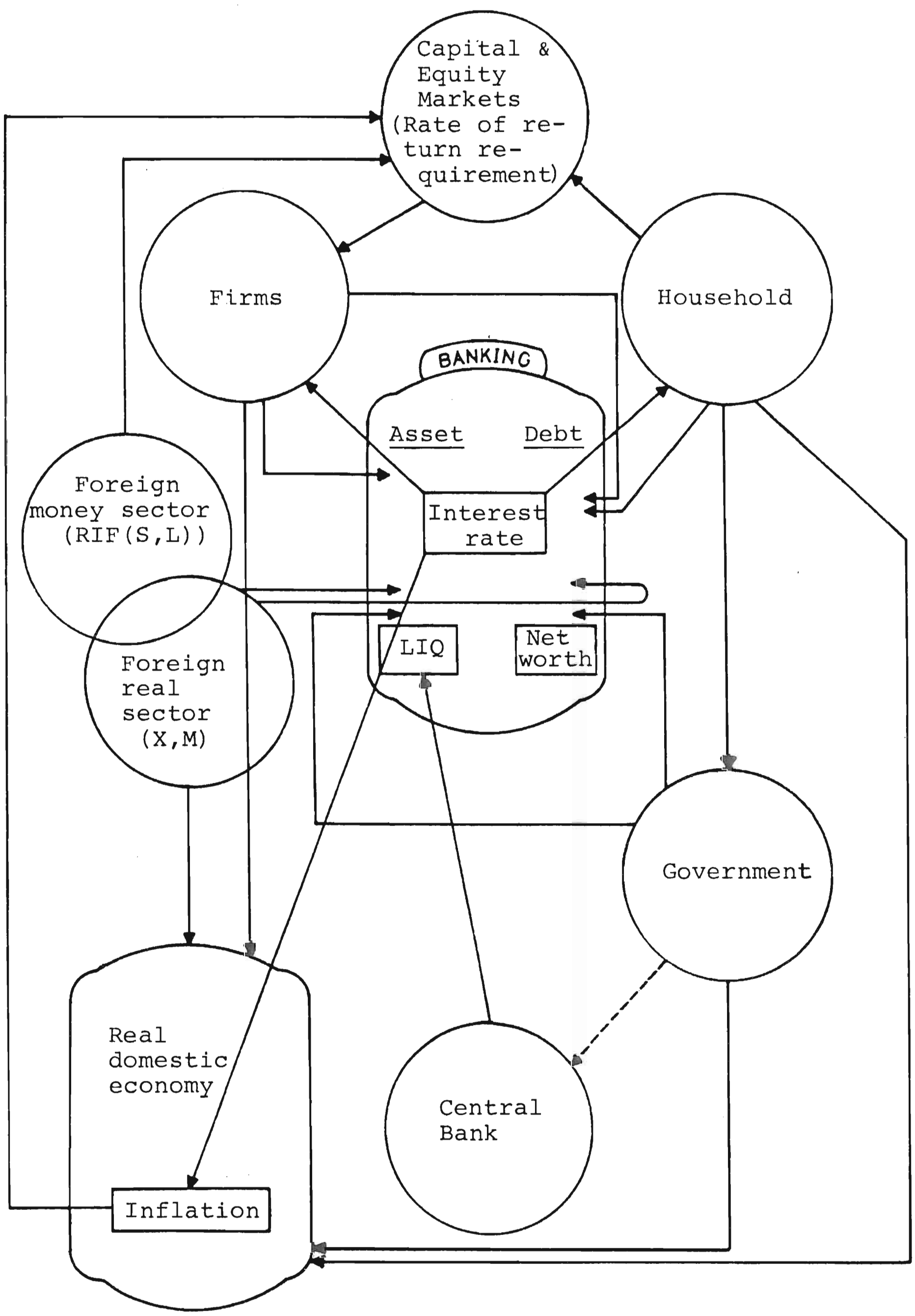

Figure IV:1 gives a simplified overview of the financial system of the model. At the center you find the Banking System made up of the accounts of the Bank, also exhibited in the balance sheet in Table III. All actors in the markets (firms, households and the Government) have their accounts in the Banking System. All foreign credit accounts are supposed to be carried by "the Bank".[5] They are sensitive to the short-term foreign interest rate (RIFS), as indicated (middle, left).

The Government interacts with the Banking System through its fiscal parameters, defining its debt asset structure vis-à-vis the Bank. A complete tax and transfer payment system links the Government together with all real agents in the economy.[6] The Government is assumed to excercise political authority over the Central Bank (indicated by dotted line, bottom, right).

The Central Bank excercises "monetary control" of the Banking System through liquidity requirements and as a lender of last resort. (The model system also recognizes the possibility of direct regulation of credit flows).

The ultimate monetary authority, however, is the Capital Market (top of figure) which interacts with the world capital market in which rate of return requirements are set, that influence (directly and indirectly) all real and financial decisions in the economy.

The short-term domestic interest rate in the Banking System is determined as the Bank adjusts its supply of credit:

(1) to meet demand from all actors,

(2) to secure needed deposits,

(3) to meet Central Bank liquidity requirements, and

(4) to secure a required rate of return on its own net worth.

The latter is dominant in the longer term and determined in the equity market, as are rate of return requirements of firms.

This describes the determination of the short-term domestic interest rate (RIS).

This market process has been preceded by the capital market process determining rate of return requirements in the system, based on

(1) the short-term interest rate for the previous period,

(2) the foreign long-term interest rate,

(3) portfolio adjustments of firms and households based on initial data, beginning of period, and

(4) alternative investment opportunities available.

The most important exogenous alternatives are property investments, entered exogenously simply as the rate of change in the capital goods price index. All this takes place in the upper part of the figure and the highest rate of return feeds back as an endogenous rate of return requirement in the firms and in the Bank.

The long-term interest rate is there to reflect long-term investment opportunities abroad and at home and to ensure some stability in the credit market process. The foreign, long-term interest rate is simply set exogenously. Domestically I think of the dominant firm owners, or business groups as the carriers of long-term commitments, which they can do if buffered by sufficient financial reserves. Household time preferences to my mind, are more short term and subject to erratic influences. This part of the model is still very rudimentary. I bring it up only to emphasize how I prefer to look at the interest determination process in the MOSES model.

2. How Does the Capital Market Tie in with MOSES?

Ours is not an equilibrium model at any level of aggregation. Stocks are needed to bridge flow "disequilibria". Stocks have to generate a return to warrant capital being tied up in the production process.

Table VII Balance Sheet of The Firm (market valuation)

Assets	Debt
K	BW
DEP	
BO	SH [= q$\cdot$(A-BW)]
OTHER	
Total Assets=qA-(1-q)BW	Total Debt = qA-(1-q)BW

Look at the required rate of return (RRN) on industrial assets (A). Again the foreign interest rate is an important determining factor. RRN is a rate of return requirement determined in the financial system and imposed on the investment decision in firms. If realized immediately ex post on all A (assets) in the economy, these firm assets (A) would be the market value of industrial capital as determined in the stock market and be identical to the replacement (reproduction) value of A that is dependent on the rate of return to new investments. It never is! This violation of Walras' law institutes a most important dynamic feature of the MOSES theoretical system. A constant Wicksell type disequilibrium in the capital market generated through unexpected technical (innovative) change and other factors at the micro level keeps investment and the growth process in motion (Chapters VI and VII are devoted to this aspect).

Chapter III should now tell us that the market rate of return requirement will rarely be realized in the production sector. Hence the market value of industrial assets will be determined in the market for firm ownership entitlements (shares). Let us call the market value of all industrial assets less debt SH, for "shares". SH of a particular firm will normally deviate from (A-BW) because assets of the individual firm rarely happen to be invested at exactly the return the market uses to evaluate its assets. Hence there will be a difference between RRN and the return T to investors in shares. Tobin (1969) called the ratio between the two q = RRN/T = SH/(A-BW).

3. Why is Money at all Interesting in the MOSES Economy?

The proposed interaction between the monetary system and the rest of the economy takes us back to the question: Why is money in MOSES at all interesting?

With no notes and coins in the economy (and no bonds) there is no way to exercise a monetary policy on the MOSES economy, as it is generally understood, only fiscal policy. Public budget deficits (surpluses) are covered by variations in Government debt that simultaneously change private wealth. Monetary policy can be introduced by changing the composition of Government debt, i.e., by open market operations.

Why is there a difference in economic effects when the Government covers its deficit through the printing of money and when it borrows in the bank, or issues securities? The interest on notes and coins paid by the Central Bank is institutionally set at zero while all the other rates of return vary depending upon demand and supply conditions in the market. These conditions are changed if the supply of any asset is changed, but differently if money is being printed or if Government securities are being issued. Hence, monetary policy in the conventional sense works through open market operations and affects the rate of return (interest) structure in the capital market. The only feature that distinguishes pure money from other assets is that its interest is institutionally fixed, so that variations in supply force adjustment in the interest on other assets. Hence, the fixing (or regulating) of any interest rate would have similar implications. This is also exactly how we want to have monetary policy operating in the economy. It affects the real, non-monetary parts through policy induced interest rate variations.

4. The Aggregate Asset Structure

We will now use the balance sheets shown in Tables I through IV to formulate a consistent macro portfolio choice system à la Tobin (1969). This is only to facilitate understanding by introducing familiarity. Some readers may already be familiar with this system. For them the aggregate specification to follow may be helpful as a frame and guide into the micro credit machinery to be described below. Readers who are not, may want to return to this summary overview after having seen the micro formulations. Asset categories are explained in the earlier balance sheets. They are all in nominal terms. This is a first and important departure from Tobin's formulation which allows capital gains to enter decisions related to the real economy, notably in profit targets of firms.

I have symbolically entered the balance sheet of both the Government and "the Nation" to obtain a complete asset structure. Conventionally the latter is deleted and the former is replaced by a flow equation of the Government operating surplus or deficit. For future extensions of the model, including micro specification of the household sector (their saving, insurance and retirement schemes) it makes sense to introduce - already at this stage - a "slot" for Barro's (1974) idea that accumulated Government Commitments and liabilities is a debt and a negative income for future generations that will become manifest in the form of future taxes. Individuals and organizations take steps today to counter this negative possibility. Such counter moves affect the scope for action open to policy-makers. In the extreme version, where economic processes through learning eventually become transparent to all actors ("rational expectations") Government policy-making based on debt financing of Government expenditures is made impotent. Hence, the direction of change in Government net worth, measured somehow, should feed back into households' savings decision.

The point of departure in Tobin's analysis was to (1) assign a rate of return to each asset and to (2) assume a net demand for each asset that depended on the rate of returns and other exogenous variables.

After introducing Tobin's overall general equilibrium scheme with our notations, we proceed to indicate where this monetary structure ties in with the MOSES non-monetary sectors, and then go on to detail the actual MOSES monetary process.

The reader should also know from the beginning that we will depart later from this simple set of equations in several significant ways.

The equations of the monetary system are exhibited in Table VIII (for explanation of variables see Tables I through VI).

Note from Table VIII that contrary to Tobin (1969), and most variations on his idea, we have all items expressed in <u>nominal</u> terms. This means that we have a problem in interpreting the time dimension of monetary adjustments, since monetary adjustments affect the real side (the quantities) in the MOSES economy, which in turn affect both inflation and relative prices including the interest rate. Hence, we have to face various kinds of money illusion in the model, because no actor in this game is able to see through all consequences of his actions and the actions of all other agents. This feed back we disregard in this didactic exercise.

Table VIII The Macro Monetary Equation system

Notes and coins (=N);	$F_1(RIF, RIN, RIS, RIL, RRN, \frac{Y}{WN}) = \frac{N}{WN}$	(IV:1)
Commercial Bank Deposits (=DEP);	$F_2(RIF, RIN, RIS, RIL, RRN, \frac{Y}{WN}) = \frac{DEP}{WN}$	(IV:2)
Bonds (=BO);	$F_3(RIF, RIN, RIS, RIL, RRN, \frac{Y}{WN}) = \frac{BO}{WN}$	(IV:3)
Industrial (firm) production assets (=SH=the market value of K in Table I)*	$F_4(RIF, RIN, RIS, RIL, RRN, \frac{Y}{WN}) = \frac{SH}{WN} = q \cdot \frac{A}{WN}$	(IV:4)
Foreign Assets (=FASS);	$F_5(RIF, RIS) = \frac{FASS}{WN}$	(IV:5)
Foreign Debt (=FD);	$F_6(RIF, RIS) = \frac{FD}{WN}$	(IV:6)
Bank Borrowing (=BW);	$F_7(RIF, RIS, \frac{Y}{WN}) = \frac{BW}{WN}$	(IV:7)
Total wealth is defined by	$WN \equiv N+DEP+BO+K-BW+FASS-FD$	(IV:8)

* Note that this disregards debt in the business sector, cf. Table I.

Y stands for nominal income, or GNP in current prices.

The left hand sides of F_1 and F_2 ($F_1+F_2=M^D$) is the demand function for money.

The price vector

(RIN,RIS,RIL,RRN,RIF(S and L)) (IV:9A)

represents rates of return on the holding of assets and debt

(N,DEP,BO,SH,FASS,FD,BW) (IV:9B)

respectively.

In Tobins models both Y (total income), and inflation are determined outside the money system, not in the MOSES model. This means that we can interpret (here) assets and rates of return as either nominal or real, as we prefer. RIF (the foreign interest rate) is exogenous. Consequently, we have seven asset categories and four domestic prices as unknowns, and eight equations.

Tobin's analysis is a macro equilibrium analysis, and this most obviously shows in the absence of capital gains. Our micro disequilibrium approach raises a fundamental question: What is the relation between flows and stocks? In static general equilibrium no stocks are needed. All flows are perfectly matched.

In imposing a market clearing condition (IV:8) - Walras' law - one price variable is made a function of all other price variables. Capital gains are restricted to those expected, and respond to interest rate changes through an immediate adjustment of the value of the base on which the interest is calculated. The asset pricing formula is of the console type, where the market value of all outstanding nominal "promises to pay $ X every year to eternity" can be expressed by X/r•P. P is a general price index and r is the rate of interest.

We have 7 asset categories and 6 rates of return variables. The short and long-term interest rates are given exogenously, and the holding of notes and coins yields no interest, RIN=0.

RRN, or the nominal rate of return on industrial assets (reproduction value), is determined outside the system, as is inflation and total income Y.[7]

We recognize Government bond issues (=BO) and Notes and Coins (=N) as exogenous policy parameters.

Hence we have seven equations and seven unknowns (DEP, SH, FASS, FD, BW, RIS, RIL) and we can in principle solve the equation system for equilibrium values.

We can dichotomize three sets of balance equations (IV:1+IV:2, IV:3+IV:4+IV:7 and IV:5+IV:6).

The first set of two equations defines the demand for money (M=N+DEP). This is the well-known quantity relation:

$$v \cdot M = P \cdot Q = Y \qquad \text{(IV:10)}$$

where the velocity of circulation for money is:

$$v = \frac{Y}{(F_1+F_2) \cdot WN}$$

Notes and coins (N) in our version of an economy are only used by households (see balance sheet). Since we are not modeling the payment process we do not really need N.

Deposits are held by households (for the time being formulated in macro), and Government. Already at this stage, hence, the simple macro formulation breaks apart. The income concept to use differs and the problem is whether individual firm deposit holdings should at all be related to income.

Equations (IV:3) (IV:4) and (IV:7) define a condensed, market valued asset and debt structure of a firm in which all foreign debt and assets have been discounted in the bank and transferred into Swedish currency.

F_5 and F_6 show that the levels of domestic interest rates depend on the foreign (exogenous) interest rate (RIF), a policy variable (BO) and an income variable (Y) determined in the real part of the MOSES economy.

Also note in passing that once you have RRN and SH, then q is determined.

In brief, the overall asset structure and monetary equations are conventional, when seen in macro, but the micro based parts of the MOSES system require considerable respecification, to which we now turn.

5. The Portfolio Decision of Actors in the Markets

The demand for funds originates in all real sectors. Firms (at the micro level) may need external funds to invest and to finance the growth of current assets. Households both save and borrow at the micro level.[8]

The Government can cover its deficits through the printing of money. It can obtain external finance in the Commercial Bank, in the bond market or in foreign markets at the going interest rate. Government demand for external finance, as we see it, is interest inelastic.

The Commercial Bank itself, finally, may refinance itself in the Central Bank and/or exercise an internal demand on its own funds through own or imposed (policed) liquidity requirements.

5.1 Firm

Chapter III presented the investment decision of a MOSES firm, where the real part of entrepreneurial activity combined with financial considerations, the rate of return requirement being the principal intermediator. This section completes the financial system of the firm by introducing its full balance sheet and its portfolio decision problem. Decision making in organizations is a hierarchically layered process that is managed by different people in different parts of the company. The investment decision comes after the portfolio decision (to be discussed here), in which the rate of return requirement to use in the investment decision is determined.[9] In a sense then our presentation comes in the wrong order compared to the presentation in Chapter III. The end decision on quarterly production, was discussed in Chapter II, the intermediate investment decision in Chapter III and the first and dominant decision is presented here.

The firms connect with the credit system in several steps.

The firm may decide to borrow long term to build up its liquidity in advance (see Section 4a in

Chapter III). This decision affects the supply of short-term funds in the same period.

The firm automatically accumulates trade assets and debts. This affects its decision to borrow the same period (see below).

Some of this trade asset/debt accumulation may be in foreign currencies. It is then immediately transferred to the commercial bank in exchange for domestic currency (see below).

What remains for the individual firm is the short-term borrowing decision taken each period after all real and monetary adjustments have been made in response to the interest rate the period before.

We begin with a case description from real life firm behavior to illustrate what we have in mind.

a) A Case

Practically all large firms in industrial economies have extensive profit control systems. The portfolio management and financing functions are generally organized separately. The typical arrangement in firms studied in E (1976a) was that large, long-term portfolio decisions were taken separately on their long-term profitability merits, before they appeared in any way in the planning process. These decisions included departures from current production activity and going into financial investment business. Long-range planning and budgeting was normally restricted to the ex ante management of established operations.

Profitability prospects in new ventures coupled with estimated cash flows from current operations were then used in the financial department of the company to estimate total financing capacity or, more exactly, the Φ capacity available.

Thereafter a formal decision on funds available for expansion of current activity and funds available for new activities etc., was taken.

This financial "decision" then fed into the preliminary stage of the budgeting process. CHQ managers compare investment proposals from the various divisions as they appear in the long-term budgeting process in Chapter III. If the sum of all investments proposed is too large - as it usually is - then "the investment proposals are negotiated down", and set preliminarily at lower values.

Left is a residual of funds available for non-process "new" investment. As a rule there are no formal plans that break the portfolio mix down further. New venture decisions are normally taken spontaneously when an opportunity appears. Essentially, however, when process innovations in existing activities have been filtered out the residual funds available are invested very much according to the expected relative profitability merits of investment objects.

One could perhaps argue that it would make little difference both at the firm and the macroeconomic level if a more simple, simultaneous decision process is modeled instead. Not necessarily. If our hierarchical procedure is a reasonable representation of what goes on, it is certainly richer in empirical content than any alternative, in which no ordering of decisions exists. A simultaneous decision process requires that the information contained in the ordering be replaced by estimated (average) parameters that will always contain less information. In our modeling context our chosen alternative would even be computationally simpler. Finally, I do hypothesize that the formulation we have suggested is both superior and yields <u>different</u> macroeconomic simulation results when the economy at large is moving through a period of unstable price experience. These are exactly the kind of situations we are interested in investigating (see Chapter VII). To decide on which specification to believe in, however, very careful simulation studies have to be carried out. Until then, we should stick with the more general formulation proposed here.

b) <u>Computation of the Portfolio Mix</u>

This section in a way repeats parts of Supplement I to Chapter III. It treats the internal investment allocation of a firm (the choice of portfolio mix) as a rate of return dependent stock adjustment process. This process can cover the whole portfolio or part of it.

To make the portfolio mix decision of one firm compatible with the macro choice system (IV:1)-(IV:8) it can be formulated as a linear, homogeneous selection model:

$$\frac{A_i}{A} = \sum^{k} \alpha_{ik} R_k + \sum^{K} \beta_{iK} X_i + \gamma_i \qquad \text{(IV:11A)}$$

The share of assets of type i in total assets A is a linear function of returns to all assets (R_i) and a number of other factors X.

We assume $\overset{i}{\Sigma}\alpha_{iK}=0$, $\overset{i}{\Sigma}\beta_{iK}=0$ and $\Sigma\gamma=1$. The homogeneity constraint assumes the portfolio mix to be invariant to growth in A at unchanged relative rates of return R_i.

(IV:11A) allows us to compute desired stocks A_i^* for each (R_i) vector. A common behavioral assumption (Friedman 1977) is that each stock will be adjusted in proportion to the gaps so computed:

$$CHA_i = \overset{K}{\Sigma}\Pi_{ik}(A_k^* - K_{k,t-1}) \qquad \text{(IV:11B)}$$

where $\overset{i}{\Sigma}\Pi_{iK}=1$ and all $\Pi \in [0,1]$. The lower Π_{ik} the higher transactions costs associated with rapidly adjusting A to A*. It is a constrained programming problem to compute the portfolio mix but this will do here. The main point is that <u>something holds back a complete reshuffling each period of all stocks</u> in response to small relative rate of return changes.

There are two problems associated with this formulation of portfolio selection:

<u>First</u>, we have the homogeneity assumption. Is the size of A really independent of the (R_i) vector? Should not MAX(R_i) affect the leverage ϕ decision in the previous section? It should and it has already in the MOSES firm decision process. The portfolio choice in the MOSES firm comes after the total investment budget and after the INV budget decision has been taken.

<u>Second</u>, we have the problem of determining the (Π_{iK}) vector and how to treat capital gains in the rate of return calculations.

The reader should now note that one way of handling the time adjustment process is to split assets into two categories. The first to consider are stocks of production assets (K) which can only be changed very slowly in response to perceived long-term rates of return. We devoted Chapter III to that, and the maximum perceived alternative rate of return appeared in that decision as well as in the determination of the total investment budget in the previous section. It corresponds well with established business practice to have the investment decisions separated both organizationally and in time (E 1976a).

The next portfolio choice is to compute a new mix of stocks, excluding production capital;

(DEP(B),BO,SH,PROP)

corresponding to the rate of return vector

$$\psi = (RI, RIL, T, \tau). \qquad \text{(IV:12)}$$

As mentioned we don't have this aspect of real life in the model yet. To include it we need a bond and a stock market. Firms would have to estimate the capital gains component of T and τ. We would have to design a matrix of Π coefficients that makes money flow very rapidly out of bank deposits in response to small rate of return differentials, but very slowly out of shares in order not to affect stock values and capital gains too heavily.

c) The Value, Risk Level and Proper Leverage of a Firm

The firm value can be calculated if we make some (simplifying) assumptions about the future. We assume that present rates of change in prices, sales etc. can be projected forever and that current performance and dividend ratios will last forever. Then (see for instance Lerner & Carleton 1966) the present value of the firm will be the sum of all discounted future dividends:[10]

SH = Market value of NW = q•NW =

$$\frac{DIV}{i-DDIV} = \frac{\Theta\cdot(\Pi-\rho K-RI_i\cdot BW)}{i-(1-\Theta)RRNW} \qquad (IV:13)$$

i is the appropriate discount factor. (Note that we use RI_i rather than RI as above to signify an appropriate local borrowing rate.)

Such a calculation only makes sense in a particular and narrow context. Suppose firm management - as expounded in Chapter III - makes up plans for the long-term horizon conditional on (RI,i,RRNW) being constants, and that stretching this assumption towards infinity would be an acceptable approximation.

Then the size of i that top management imposes would determine its dividend policy (next section) and the actuarial value of the firm. The corresponding i of the investors is determined in the market and indirectly determines the market valuation of the firm (=SH). In equilibrium competition in the capital market would presumably push the i's together.

Borrowing is associated with an extra <u>risk</u> element, the probability of not being able to meet interest payment commitments. Creditors normally charge for that in the form of a higher interest on borrowing in proportion to the risk they believe they assume. The risk factor is traditionally assumed to be proportional to the debt/equity ratio and shows in the individual firm borrowing <u>rate</u>.

$$RI_i = f(RI, \Phi_i) \qquad \text{(IV:14)}$$

$$\Phi = BW/SH, \ \partial RRI_i/\partial\Phi_i > 0$$

and RI is some sort of going market rate for low, or no risk lending.

Our first problem is to define the discount rate of share owners (i) that appears in (IV:13) and refers to firm i. In a macro, general equilibrium setting this discount factor should equal the marginal efficiency of investment (see the end of Section 3). Within the complete MOSES economy framework we have to recognize that such equilibrium conditions do not prevail and that there are many individual discount rates. Under such circumstances we should introduce the maximum rate of return

MAX(   )

obtainable from the set of investment opportunities (IV:9A) as the discount factor in (IV:13) signifying the marginally best investment opportunity available to the firm. If opportunities to earn a return are equal and also equal to the "risk free" credit market interest rate RI, then only the amount of financial risk taken on differs. We temporarily adopt that assumption, make $i=RI_i$ and take the derivative (IV:13) with respect to Φ. Make $\partial SH/\partial\Phi = 0$ and solve for Φ; to obtain the proper leverage:

$$\Phi_i = \frac{RRN_i - RI_i}{\partial RI_i/\partial\Phi_i} \qquad \text{(IV:15)}$$

which is the Φ compatible with the highest steady state dividend pay out ratio. Somehow, it is very, very peculiar to carry out such a risk evaluation under the streamlined, steady state, full future visibility assumptions assumed in this exercise. But this is the state of the art. Firms use much cruder rules of thumb. These rules happen, however, to be more or less the same as the end result of the above exercise. We have carried it through. Let us now try to interpret it.

The market interest rate, free from the "local firm financial risk" is determined in the monetary system. If it goes up, it lowers (through (IV:13)) the market value SH of the firm. To support SH compared to NW (or q) dividends have to be increased. However, at each expected future steady state development of (RRN_i, RI_i) the firm can compute the optimal (steady state) leverage factor $\Phi = BW/SH$ compatible with the maximum present market value of the firm, which is identical with the maximum present value of all future dividends. The firm with a high expectation on RRN can raise its present value by borrowing more. It thereby takes on a higher financial risk - because the RRN expectation may be wrong - which is covered by the lender through the interest premium (RI_i-RI). The higher RI_i the less money available to reinvest at RRN to produce future dividends and so on.

If RI in (IV:14) in fact is:

$$RI_i = RI + \alpha \cdot \Phi; \qquad a > 0 \qquad \text{(IV:16)}$$

then (IV:15) becomes:

$$\Phi_i = \frac{RRN_i - RI_i}{\alpha} \qquad \text{(IV:15B)}$$

This is an expression frequently met with in the theory of finance. It appears in the current version of the MOSES firm borrowing decision in the special case when $\phi=\Phi$, or when the reproduction value of net worth (=NW) equals the market value of net worth (=SH),[11] i.e. q=1.

However, once you depart from steady state assumptions all this will have to be reconsidered. Make the interest rate endogenous, or difficult to predict. If you expect a variable interest RI over the future you could always approximate numerically (IV:13) and (IV:15), using (IV:15B), in a more complicated fashion. But if your expectation of RI is associated with uncertainty then you would have to recompute your optimum Φ every time you change your expectations and there could be a wildly gyrating development in Φ. If the lenders have a different expectation as to RI, then the problem gets so complicated that we have difficulties modeling it. We will simply assume that lenders evaluate the firm each moment through applying a steady state RI assumption in (IV:13) and then impose the corresponding RI_i through (IV:14). Firms respond by recalculating their optimal leverage and regulate their finances accordingly through the borrowing decision.

In the more general formulation where top management in a firm faces a whole range of investment opportunities we should use the best rate of return option MAX( ) rather than RRN_i and the optimum gearing ratio becomes:

$$\Phi_i = \frac{MAX(\quad)-RI_i}{\alpha}. \qquad (IV:17)$$

In determining MAX( ) we will introduce capital gains and inflation among the rate of return items, knowing quite well that this traditional formula has been derived on the presumption of a steady state continuation of current inflation and no capital gains beyond what comes from that inflation. We know (E 1976a) that corporate routines in calculating ϕ, derive from such simple formulae. To enter more sophisticated capital gains expectations would take us to a point where we have no way of empirical verification.

d) Dividend Decision

One way to formulate the dividend decision in a steady state situation is to assume that firm management on each long-term planning occasion has a steady state perception of its (RI,i,RRNW) vector; and that it wants to adjust its quantities accordingly in the long term. The (i,RRNW) relationship would then decide its dividend policy, assuming that firm management also wants to see the value of the firm maximized in the longer run.

The RRNW variable to choose would be the one used in the long-term plan. It is natural to choose a RRNW that firm management believes it can support in the longer term, so it may opt for a cautious estimate, somewhat lower than RRNW. Hence, cash reserves can be accumulated to bridge possible, unexpected deficit periods.

From (IV:13) we have:

$$SH = \frac{\Theta \cdot RNW \cdot NW}{i-(1-\Theta)RNW} . \qquad (IV:18A)$$

This expression can be rewritten as:

$$i = RNW \cdot \left(\frac{\Theta \cdot NW}{SH} + (1-\Theta)\right) . \qquad (IV:18B)$$

Take the derivative with respect to the dividend pay out ratio Θ, and make $dSH/d\Theta=0$. Under the simplifying assumption that RNW is a time constant we obtain[12]:

$$\Theta = \frac{i-RNW}{\frac{\partial i}{\partial \Theta}} > 0 \quad \text{since} \quad \frac{\partial i}{\partial \Theta} < 0, \quad i < RNW \qquad \text{(IV:19)}$$

If $\partial i/\partial \Theta$ is negative the firm should distribute dividends in proportion to the difference between its discount rate and its rate of return on equity. The dividend distribution function then looks as follows:

$$\Theta = A(RNW-i) \qquad \text{(IV:19B)}$$

A is a positive constant.

e) Market Value of Firm Shares

The valuation of stocks presents special problems. Most, or all, theorizing on this matter - originating in Tobin's (1969) portfolio formulation of the financial system of an economy - has been modeled in macro and within a static equilibrium framework where (unexpected) capital gains, or gains due to various forms of money illusion are simply assumed not to exist. We do not like such assumptions, and since we are moving along a micro process we cannot really see why financial stocks are at all needed if equilibrium assumptions are strictly imposed at the micro level. The MOSES economy generates both financial assets in firms (=K1), and financial assets like shares (=SH) and bonds (=BO) since markets are not in equilibrium.

It is also a doubtful procedure, as is conventionally done to assign rates of return to assets. When markets are perfect, adjustments immediate and when you have consol type assets that never mature (no amortization) one could argue that the obligation to pay \$ 1 per year for ever, would capture a value in the market of \$:

$1/r \cdot P$

where r is the current interest rate and P is a general price index, set at 1 the year the nominal \$ commitment was made.

This asset pricing formula does not hold up. The market may not be perfect or well informed, and the interest may not be the right one, whatever that means. We will return to the concept of a capital market equilibrium in Chapter VII.

Enter <u>ignorance</u> or <u>uncertainty</u> about future payments, and the formula does not hold.

Enter assets that depreciate, or "wear out", and things get really difficult. What does depreciation mean in a context like this? Let us bring all difficulties in - because then we have the case that really concerns us; the valuation of business assets - and see where Tobin (1969) takes us. Then we will enter the final complication and discuss the disequilibrium process. Tobin conveniently invents q to account for the fact that the actual market value of a firm departs from its "reproduction" value. In our notation (using Table I):

$SH = q(A-BW)$

If the firm had no debt (BW=0) and only physical capital ($K=\sum_i^4 K_i = A$) we would obtain Tobin's case

where:

$SH = q \cdot K$

and

$$T = \bar{R} = \frac{RRN}{q}$$

T is the rate of return on shares and should be:

$T = DSH + \bar{\Theta}$

where $\bar{\Theta} = \frac{DIV}{SH}$

$\bar{R}$ is Keynes' "marginal efficiency of capital" applied to reproduction cost (i.e. K is measured at replacement values) or the "rate of return over cost", using Fisher's formula.

The marginal efficiency of capital is the $\bar{R}$ that satisfies:

$$P = \int_0^\infty e^{-\bar{R}t}\left(P(t)\ \frac{\partial Q}{\partial K} - \rho \cdot P(t)\right)dt \qquad \text{(IV:20A)}$$

P(t) is the price index for products or producers of Q. K is capital input and ρ is the depreciation factor.

Assume that the marginal product of capital and ρ are constants and that prices grow exponentially at rate DP. Then we can solve (IV:20A) as:

$$P = P_0 \cdot \left[\frac{\partial Q}{\partial K} - \rho\right] \int_0^\infty e^{-(\bar{R}-DP)t}dt \qquad \text{(IV:20B)}$$

or:

$$\bar{R} = \frac{\partial Q}{\partial K} - \rho + DP$$

Since $\partial Q/\partial K$ is the marginal volume output of adding an extra amount of capital, holding all other factors constant, $\bar{R}$ is also the marginal, nominal rate of return. Keynes asserted (see Chapter 11 in General Theory) that firms would trade the capital goods until

$RIS = \bar{R}$.

This would then define some sort of capital market equilibrium where the rate of interest equals the marginal rate of efficiency of capital, which is also the discount rate. We have:

$$P \cdot \frac{\partial Q}{\partial K} = P \cdot (RIS+\rho-DP) \qquad \text{(IV:20C)}$$

or the marginal product value of capital equals the "price of capital service" (right hand expression), using a conventional formula.

In capital market equilibrium the marginal nominal return to investment equals the nominal interest rate.[13] So far everything is fine. When Tobin's monetary system is in equilibrium, the market rate of interest will be equal to the marginal rate of return on new investment. Since the value of business assets installed may diverge from their reproduction costs (on the margin) by a factor q, we should adjust the return measured on these assets accordingly, and we have:

$$T = \bar{R}/q \qquad \text{(IV:20D)}$$

$$SH = qA$$

where K=A under our temporary assumption of no debt and replacement valuation. Hence A=NW. So q (which is endogenous in the monetary system) essentially converts all installed capital stock to its market value, and makes the market return to corporate assets T equal to the interest rate, which in turn is equal to the nominal rate of return to assets at reproduction value, divided by q. For the marginal capacity augmentation invested at $\bar{R}$ = RIS, i.e. in equilibrium, q should be = 1.

Arriving at this conclusion we immediately smell a principal problem. ρ in (IV:20A) is the depreciation rate that adjusts asset values, after price correction, to their reproduction values.

We now also have a second depreciation factor that is endogenously determined, namely the one that equates asset values measured from the cost (reproduction) side to their "right" value, as it is determined in the equity market.

The first depreciation principle is what we want to use to estimate capital stock in a "technical" production function analysis. The latter principle we apply to determine the value of the firm, or the growth of the value of the firm, for instance, in the targeting formula (III:1) in the previous chapter. But this one is also what matters in the investment decision (Chapter III) and in the scrapping decision (cf. discussion in section 2 in Supplement III to Chapter III) and hence affects the amount of capital that can be used for productive purposes.

The market based depreciation principle may generate very erratic capital stock estimates depending upon the sentiments prevailing in the markets. And what about the rate of return? In the latter case, where values and depreciation rates are determined in the market, rates of return will always equal the interest rate (as in the console formula), and hence carry no useful additional information. In the former case, the rate of return will be heavily dependent on production costs for capital. A bad investment in the past will keep the shipyard unprofitable for a very long time, even if new investments on the margin are highly profitable. If you try to correct for that you obtain a capital valuation similar to the market method. There is only one solution to this dilemma: to decide arbitrarily on a valuation method in between the two extremes, and to learn how to interpret the numbers.

f. Profit Target Pressure from Owners

The market valuation of business assets obviously should play a distinct role in the MOSES economy. It concerns the setting of corporate profit targets and the mechanism is selfregulating. Whenever q departs from 1, or rates of return deviate from the market rate, target pressure or relief is beginning to be administered from the shareowners.

Rate of return requirements in firms that enter long-term targeting in Chapter III (Equation III:1) are set in the equity market. The equity market is the playground for shareowners that scan the investment horizon for the best rate of return opportunities as they are manifested in the vector (RRN, RIS, RIL, T, τ).

In the model the shareowner is a passive agent of the household sector whose only action is to add a particular stock to his portfolio, or to sell to invest in something else. He and she vote with their feet. This, however, is enough to make them influential. Shareowner action - especially if many, or all, shareowners do the same thing - influences the valuation of the stock compared to its reproduction value (=q). This means a number of things to firm management. The valuation of stock SH compared to its reproduction value A affects its financing potential through ϕ and the rate of interest (in IV:18). If q = SH/A becomes too low it subjects the firm, and its managers, to the possibility of a hostile take-over, on the presumption that a firm that performs so badly on a current basis, in a market where other firms are doing all right, should be able to capitalize upon through reorganization and removal of management.

In principle the rate of return requirement on a firm is set through the determination of q in (IV:4) in Section IV:2.

Let us call the rate of return on a share investment T. It is then defined as:

$$T = DSH + \frac{DIV}{SH} \qquad \text{(IV:21A)}$$

which from (IV:20D) becomes:

$$T = Dq + DNW + \frac{\Theta}{q} \qquad \text{(IV:21B)}$$

Each shareowner looks at all the rates of return available to him or her, picks the highest and uses it as his or her discount rate (i) when making decisions as to where to invest. This affects the valuation of the firm in the market [see (IV:13)]:

$$SH = \frac{\Theta \cdot RNW \cdot NW}{i - (1-\Theta)RNW}$$

or

$$q = \frac{\Theta \cdot RNW}{i - (1-\Theta)RNW}$$

This valuation affects the ability of the firm to borrow, and/or to keep its financial resources, through its gearing ratio

$$\Phi = \frac{BW}{SH}$$

and this valuation affects its local interest rate

$$RIS_i = F(RIS, \Phi_i) \qquad \text{(IV:21C)}$$

and also dividends (IV:19).

In equilibrium the discount rate, the interest rate and the marginal efficiency of capital are the same. In disequilibrium the discount rate means something different. In the typical, real situation of a MOSES simulation, market discount rates and the discount rates of management differ. The market is usually more cautious due to less information, and applies a higher rate. If the firm chooses its own time preference, and if this deviates from the time preference of the market, the market valutation of the firm will be affected and hence its debt capacity. So the firm should pick the market rate i, which may be higher than its own, and raise borrowing to pay dividends, if it believes strongly in a high, future RRNW.

Obviously the firm can boost its SH through distributing more dividends (raising Θ) but this further reduces its cash flow. This is a rational policy only for a firm that plans to close down and pay back its net worth to shareowners.

If furthermore SH depends on the expected long-term growth in dividends, (in the numerator in (IV:13)) rather than Θ, the market valuation may be negatively affected by raising Θ.

The only positive way to support a sagging market valuation SH of firm net worth, and to be an attractive borrower, is to raise the rate of return to net worth (= RNW). At this stage shareowners are beginning to excercise a real influence on the firm. RNW normally cannot be affected - after all the financial arrangements have been made - without raising real profit performance RRN (in IV:15) or the marginal efficiency of capital ($\bar{R}$ in IV:20B). Part III discusses <u>how</u> this can be achieved.

By how much must RNW be adjusted in a firm aiming for long-run steady value growth? Make T in

(IV:21A) equal to the best investment opportunity in the market

T = i = MAX( ) (IV:22)

If MAX( ) has changed, it takes the same relative adjustment of RNW

DRNW = Di

to preserve the q value (CHq = 0) at a given dividend pay out rate.

The required change in DRNW immediately translates into a changing rate of return requirement, through the targeting formula (III:1) in Chapter III;

G = DNW + Θ = RNW.

This in turn (see Chapters II and III) translates into a profit margin requirement that monitors supply decisions, wage offers, employment decisions and indirectly, pricing decisions in firms.

How be it, that firms were not operating at maximum RNW to begin with?

Answer: They may have been, and then the increase in i does not affect RRN. It is as high as it can be for the time being. The increase in i only lowers the future credit capacity and investment propensity of the firm and its present market value.

But if there is a potential to reorganize the firm to increase its performance in terms of RRW and RNW, this is normally the way attempts to exploit that potential are forced (see E 1976a). This is also the way the owners can excercise their power through the capital market.

g) Foreign Accounts

For every krona of exported goods (EXPORT) a corresponding asset on foreign account is created and added to foreign assets (FASS). FASS in turn is being amortized, at the rate:

F_5(RIS-RIF) (IV:23A)

$\frac{\partial F_5}{\partial(\ )} > 0.$

$1/F_5$ can then be said to approximate the foreign trade credit period, estimated to be 2 to 3 months on the average in the 60s.[14] Hence foreign trade assets accumulate as:

FASS := FASS+EXPORT-F_5•FASS+RIF•FASS (IV:23B)

This formula reads as follows. Foreign assets at the end of a period are equal to initial foreign assets, plus new assets created through export deliveries during the period (EXPORT), minus what has been amortized during the period (F_5•FASS) plus interest receipts on FASS.

Similarly, every krona of imported goods (IMPORT) adds to the foreign debt of the country (FD) and this debt is currently being paid off at the rate[15]

F_6(RIS-RIF) (IV:24A)

$\frac{\partial F_6}{\partial(\ )} < 0$

Hence

FD: = FD+IMPORT-F_6•FD+RIF•FD (IV:24B)

The net foreign credit position of the BANK then becomes:

$$FNASS = FASS-FD$$

and

$$FNASS = EXPORTS-IMPORTS+(1+RIF)\cdot[FASS(t-1)-FD(t-1)-F_5\cdot FASS(t-1)+F_6\cdot FD(t-1)] \quad (IV:25)$$

Hence, end of period net foreign debt (=FNASS) is equal to initial net debt plus interest, minus amortization (net), plus new debt creation (negative or positive) through the trade deficit (surplus).

As we see it the rate of paying off these two stocks ("the international mobility of capital") is very sensitive to fluctuations in the foreign-domestic interest differentials through F_5 and F_6, and will affect the supply of, and the demand for, funds in the domestic money market. In the aggregate representation in Section 4 above this influence works through Equations (IV:5) and (IV:6).

h) Comprehensive Financial Decision of a Firm

The setting is very much as in the earlier version of the MOSES firm model. We begin with the current gross inflow of funds. It consists of a cash flow from current operations and new borrowing. New borrowing is determined as before by:

$$DBW = F_7(RRN-RIS,\Phi) \quad (IV:26)$$

$$\Phi = \frac{BW}{SH}$$

Earlier RRN referred to the nominal return to manufacturing operations. We viewed the MOSES firm only as a production unit. This means imposing a restriction on the scope of activities that many large corporations have in fact lifted. A large firm could quite well consider increasing its leverage (borrow more) to extend its operations through investing in bonds or shares or through purchasing other firms. Then the rate of return variable (RRN in IV:26) used in the borrowing decision of the firm should be that of the <u>most profitable</u> activity open to the company. This is not necessarily a manufacturing activity. It is fairly easy to change the RRN specification used in Chapter III to cover the possibility of many internal firm activities (as in Supplement III in Chapter III) and external investment opportunities known to the firm. In doing so we have introduced the concept of an investment portfolio. Let us now assume that RRN refers to the (expected) most profitable activity which the firm entity envisions.

The gross cash inflow or the investment budget of the firm for the period then consists of:

$$\Psi=\Pi+(\text{interest income})-RI\cdot BW-T-DIV-CHK3-CHK4+CHBW \quad (IV:27)$$

where T and DIV have been decided on as described in Chapter III (main text and Supplement III. Also see below). As before, all trade assets have been discounted in the Commercial Bank and are replaced by a bank deposit denominated in the domestic currency.

The firm now has the choice[16] to invest this flow in:

- paying of dividends (DIV)
- production assets (INV)
- shares (SH)
- property (PROP)
- long-term financial assets, yielding the long-term interest rate RIL. We call them bonds, or for short (BO)
- pay back of loans [BW(B)] at RIS
- and/or deposit the money in the bank (DEP(B)) at $RIS(1-\xi)$.

ξ represents the profit margin of the bank, or the difference between the average lending rate (RI) and the deposit rate $[RI(1-\xi)]$.

The total portfolio decision is a stock flow process which follows the MIP-principle. It progresses as follows:

First, the firm can decide to cash in on financial and other assets (SH, BO, DEP and PROP) to finance a major expansion (INV) program. This is a stock adjustment decision that precedes the cash flow decision of fixing Ψ above. It occurs when long term expected RRN in own manufacturing operations significantly exceeds returns to investments in SH, BO, DEP and PROP. This has been dealt with already in Chapter III.

Second, the firm can decide to borrow a lot long term now, to be well covered financially for a large INV expansion project. Also this decision precedes the determination of Ψ. The firm that has done so is well supplied with short-term bank deposits that are available, if needed, to break through the Ψ restriction. Also this decision has been dealt with already in Chapter III. It involves a decision as to the degree of risk ("leverage") to take on. We will return to this in the next section.

Third, the decision that remains from period to period is to allocate Ψ on INV, CHSH, CHBO, CHPROP and on deposits in the bank.

The third investment choice procedure is also stepwise. The sign of the investment budget Ψ was marginally determined in (IV:26) by the rate of borrowing CHBW, which in turn depended on the marginally "best" internal rate of return over the going interest rate. In current model practice it is, however, only symbolic. Rates of return on investments in SH, BO and PROP raise rate of return requirements on INV. Investments of this kind, however, are not actually carried out. Excess liquidity created through a lowering of INV spending because of a higher rate of return requirement, because of higher rates of return on "outside" investment opportunities, is simply deposited in the bank.

If RRN in production activities is higher than any competing investment activity, then the normal investment cash flow accelerator mechanism of Chapter III is engaged.

Let us now summarize the general financial decision process compatible with the sophisticated MOSES Investment Financing decision of Chapter III that we eventually would like to see in the programmed version of MOSES. The decision sequence is illustrated by the firm balance sheet in Table I.

Step I. Determine maximum (optimum) leverage
ϕ = BW/SH from (IV:15)
of firm i conditional upon MAX(RRN, RIS_i, RIL, T, τ), (to be elaborated in the next section). RIL is the domestic long-term borrowing rate. T is the return to investment in shares in other companies and τ is the return to investment in property (see below).

Note that each firm has its own leverage dependent, short-term loan rate (RIS_i). This leverage is, however, set by the lender at Φ=BW/SH. If shares are valued in the market at "reproduction costs" then $\phi = \Phi$ (see Section 5c above).

Step II. Compute dividends from (IV:19).

Step III. Calculate the optimum size of total assets A* compatible with Φ above. This gives maximum borrowing allowed. If the situation changes and investment opportunities disappear or if capacity utilization is low, despite high rates of return, and the firm does not want to expand capacity, excess liquidity is paid back to ("deposited in") the bank, and net borrowing is automatically reduced.

Step IV. Calculate the optimum portfolio mix (K*,DEP(B),BO,SH,PROP) the sum of which is conditional on a corresponding rate of return vector[17]

(RRN,RIS,RIL,T,τ)

This is described below in technical terms. As before RRN is the nominal rate of return on total assets (reproduction valued) engaged in the manufacturing operation (K*).[18] In the tax free world we are currently discussing, we could simply use:

$T_i = DSH_i + \bar{\theta}_i$

as determined ex post for firm i in the model. (Cf. separable Additive Targeting Formula (III:1) in Chapter III. Also see Section 6 below.)

Step V. Calculate desired stock changes in money terms: CHK*=(K*-K), etc.

Step VI. Check CHK* against INV and Ψ conditional on ϕ and MAX(RRN,RI,RIL,T). Adjust downward to INV position taken in Chapter III.

Step VII. Recalculate new $\hat{\Psi}$ available for investments in bank deposits, bonds and shares and recompute a new

[(DEP*-DEP),(BO*-BO),(SH*-SH)(PROP*-PROP)] portfolio change mix as in Chapter III above.

Note the hierarchical decision ordering assumed. Investments in current production activities come first. MAX(RRN,RI,RIL,T,τ), however, has already been used in Chapter III to scale the desired medium-term investment program. Second, a leverage, or financial risk, calculation is performed to establish the total financing potential. Third, funds available for financial investments (size and mix) are determined residually. Note, however, that if such investments yield a higher return than investments in current production lines, this circumstance has already curbed planned INV spending in the first round. If other, financial investment opportunities happen to be extremely good (e.g. in property) this may in fact have suggested an increased leverage position in the second decision round.

Is this a reasonable way to model the investment decision process of a firm?

For one thing decisions in large business organizations normally are ordered in a fashion like this. This process has already been elaborately modeled in Chapter III on the basis of a large number of interviews carried out in E (1976a).

5.2 Household

The household sector is normally a net supplier of funds. To support its long-term consumption levels it can occasionally turn a net dissaver. If, at some later point in time, a micro specification of the household is worked out we will have to distinguish between households as being both savers, investors and borrowers simultaneously.

To begin with I argue that the natural observation unit is the household as a financial entity - as with the firm - and not an individual. Strong family ("technical") links hold the members of a family together, and we are talking of the extended family (including future and past generations), not the subset that inhabits the same house or apartment. I also argue that the supply of labor - to firms in the model - cannot be properly modeled except as a joint leisure, lifetime consumption and savings decision.

This being a macro based model, the households will also have to be recognized as carrying out production work (market or non-market) that substitutes for employment and work for wages in the firms. Hence the concepts of a firm or a household tend to be blurred.

Since a macro household sector with endogenous saving is already in the model and has been documented in E(1976b, pp.164 ff, 1978a, pp.76 ff.), it is appropriate to enter here a brief sketch of how the micro specification of the sophisticated saver-investor-borrower might look. We will do this in terms of his household balance sheet in Table II above, and then go on to specify how the household acts in the model.

The MOSES household, as presented in the original (E 1976b, 1978a) formulation was concerned with constantly upgrading, or maintaining its current consumption standard. Part of that consumption standard involved possessing a real wealth balance that insured the household from at least short-term shortfalls in the expected disposable income flow. The insurance premium was saving. We never worked through the utility mathematics of this but went right on to specify a non-linear "habit formation", expenditure system with saving as one ex ante expenditure category. In the long term, saving was related to disposable income in a way that corresponds to the Friedman (1957) permanent income-consumption concept. In the short term, it varied according to the real return to saving on a bank deposit for future consumption purposes, and a certain risk factor (unemployment). Saving, hence, was more or less oriented towards maintaining a steadily increasing or reluctantly decreasing consumption pattern. The life cycle Modigliani and Brumberg (1955) consumption model was more or less the idea put to work.

Since we are discussing the money system in this chapter we have to tell more about what we have in mind for the household as a systematic saver-investor-borrower, to get the household supply of funds in the credit market properly specified.

In a few words then, the household in MOSES is accumulating wealth to support a long-term steady consumption growth. It is perfectly all right in our view to enter the real balance as a separate utility item of the household (E 1982, Lindbeck 1963). The purpose may be to pass on wealth to heirs or to enjoy extra wealth as extra financial security on a potential resource to put to use sometime in the future. Hence, also possession of wealth is habit forming, and enhances the demand for more wealth.

The real balance can be held in property or other durables. It can be invested in bank deposits, bonds or shares or simply be kept in non-interest bearing coins and bills. The composition of the household portfolio would change as relative returns to the various investment alternatives change. The gross size of the portfolio would depend on the returns to investments compared to the borrowing rate. Net worth (total assets less debt) would enter the household's utility function. In micro household terms, and with access to micro household data, this would make sense to model.[19] In the aggregate household approach implemented so far we have restricted the household's investment ambition to the traditional one of stabilizing expenditures on various consumption categories over time and its portfolio choice to deposit in a bank and the purchase of durable goods (called STODUR). Sophisticated portfolio accumulation to earn a high return by leveraging the balance sheet is thus no longer possible. However, the household does borrow to sustain or stabilize its consumption over time.[20]

Since the household, or households as a group, both deposit their savings and borrow at the prevailing short-term market interest rate, the net supply of saving in the market is easily modeled.

The household aims at a real long-term wealth balance that is proportional to its trend development in disposable income. There are short-term ex ante variations in this ambition that depend on the real (Fisher) interest rate on bank deposits. This ex ante savings ambition is instrumental in determining the household consumption budget for the next period (quarter). The distribution of budgeted expenditure over consumption categories is dependent on perceived prices, based on past prices, that will be finally determined every quarter when total supplies and demands in the market have met and sorted out a set of prices. Hence saving may deviate from plans. When purchases have been finally made and incomes earned "residual saving" is deposited in the bank, a new stock of wealth is calculated and enters next period's saving and consumption decision.

In the current version of the model, hence, household wealth appears as a stock supply in the credit market through the direct intermediation of the Commercial Bank only (see E 1978a, p. 79).

In the standard version now in use households plan to save more and buy relatively less durables if the real rate of return to saving (RIS-DCPI) increases, and if unemployment (RU, reflecting labor market uncertainty) increases. The specification is such that households plan to maintain a stock of wealth (WH) relative to disposable income (DI) that depends on (RIS-DCPI, RU). This means that if inflation lowers the real value of savings and/or if disposable income increases, households keep trying to increase wealth through saving to maintain the ratio. If they fail, the desired ratio gradually falls through a "habit formation" adjustment. Note that the tradeoff is only between durable goods purchases and saving. Non-durable goods and service consumption are not affected by this mechanism. This furthermore, is an ex ante plan. It guides household spending plans as they are revealed to producers in the product markets. The final amount of consumption of households depends on the response of producers and final prices. Savings adjust as a residual.

What we should add are two wealth factors in the ex ante savings decision.

First, household wealth as measured by the ratio of wealth to disposable income (WH/DI) should have a habit forming effect in the sense that the higher the WH/DI ratio achieved the higher the WH/DI ratio desired.

$$\frac{WH}{DI} = F\left(RI\text{-}DCPI,\ RU,\ \frac{WH}{DI},\ \phi(GOV)\right)$$

$$\frac{\partial(\ \ )}{\partial(RI\text{-}DCPI)} > 0$$

$$\frac{\partial(\ \ )}{\partial RU} > 0$$

$$\frac{\partial(\ \ )}{\partial(WH/DI)} > 0$$

Furthermore, following Barro's (1974) suggestion, we expect households to be worried about Government borrowing policies, extra Government debt position measured by $\phi(GOV)$ or the presumption that a deteriorating Government debt position somehow will be a liability of future generations. It will have to be paid back in the form of higher taxes and/or in the form of a decreasing macro performance of the economy. Technically this can be handled by entering Government net wealth, or change in Government net wealth in Table V, or national wealth creation (to pick up the influence of foreign debt) in Table VI, in the household savings decision. Hence, households save more to maintain their future disposable income.

$$\frac{\partial(\ \ )}{\partial\phi(GOV)} < 0$$

If, in addition, Government debt creates inflation, this stimulates even more saving, since households want to preserve their real balances.

5.3 Government and Central Bank

In the MOSES economy the Government figures as (1) a user and a redistributor of resources (financed through the tax system[21]) and as (2) a macro policy maker. The first function is modeled very crudely. There is only one aggregate Government production activity. Government employment is exogenously determined (a policy variable). Other resources are used in accordance with the Government input-output coefficients. The Government offers the average wage change determined endogenously in the manufacturing sector the quarter before. It enters the labor market next quarter - before the firms - and as long as there are unemployed people[22] in the market, it gets what it needs at the wage offered. Hence both Government employment and Government pay are in a sense endogenously determined.

With a given set of tax rates the economy yields an endogenous tax income. A net Government surplus or deficit follows and is deposited or financed in the Commercial Bank at the market rate, whatever its level[23].

The policy agenda is more varied. The Government or the Central Bank can:

(1) vary tax and transfer parameters that affect the size of the surplus (deficit)

(2) borrow abroad (GFOR)

(3) impose a liquidity (LIQ) constraint on the Commercial Bank

(4) Impose a trade margin (ξ) on the Commercial Bank

(5) impose an interest rate for Commercial Bank refinancing in the Central Bank (RP, see next section)

(6) impose interest rate controls (a ceiling on the domestic interest rate)

(7) vary the exchange rate (Ω).

In this context all these options are important because they affect the supply of and demand for funds in the market.

In a more general context we could of course ask ourselves why the Government cares to vary these parameters. We share the traditional view, that the Government should be concerned with inflation, employment and output growth and strive to obtain a mix compatible with what it perceives to be optimum national welfare. An alternative "welfare conception" of the Government would be to look at the national net asset position in Table V as a goal variable signifying the combined value of all resources accumulated in the economy.

6. Interest Determination - First Approximation

This section describes the simple credit system currently in the operating version of the model. Look at the balance sheet of the "Simple Commercial Bank" below.

Table IX The Simple Commercial Bank

Assets	Debt
BW(B)	DEP(B)
BW(G)	DEP(H)
FASS	DEP(G)
BLIQ (non-interest bearing)	FD
	CBANK Borrowing(CBB)
	Net Worth of Bank (NW(BANK))

BW(B),DEP(B),DEP(H) are sensitive to the domestic interest rate.

FASS, FD are fictitious items in the Commercial Bank balance sheet. In reality they are moved by the firms that have generated them in response to the foreign-domestic interest differential. Hence, they are outside the control of the Bank, and the simple Bank makes decisions for the next period as if the past period's (FASS, FD) combination will hold.

The amount of Government borrowing (or depositing) is entirely interest inelastic. It comes straight out of the Government deficit (or surplus). Open market operations do, however, affect Government interest payments, and hence its deficit (surplus).

The Bank requires ex ante that its net worth increases at least in pace with its own lending rate. This means that the Bank's profitability requirement is:

$$RRN(BANK) = \frac{\Pi(BANK)}{NW(BANK)} > RI \qquad (IV:28)$$

or more specifically; Commercial Bank credit supply decisions in the credit market should be:

Step I

Calculate RRN(BANK) =

$$= \frac{RI \cdot BW(B+G) + RIF \cdot (FASS-FD) - RI \cdot (1-\xi) \cdot \big(DEP(B+H+G)\big) - RP \cdot CBB}{NW(BANK)}$$

If RRN < RI, raise the domestic interest rate (RI) and Bank margin (ξ) by equal amounts until equality. ξ is the margin between the bank lending and deposit rates. RP is the interest rate for commercial bank refinancing (CBB) in the Central Bank.

Step II

If the required (RI,ξ) steps are larger than 1 percentage point, make it 1 percentage point and wait until next quarter. Keep doing this until

- The bank RRN requirement is satisfied

- if RP>RI(1-ξ), reduce Central Bank debt in steps of up to 10 percent of initial amount of debt per period until CBB=0 (see below).

Step III (Alternative Mode=credit rationing)

The Government may have imposed a ceiling on the market interest rate RI.

- Then restrict parameter change to margin (ξ).

- Ration credit by some exogenously applied rule.

(The general case should be that for all firms for which CHBW>0, the same percentage reduction (10 percent each period) applies as long as the Commercial Bank cannot meet its RRN(BANK) standard.)

The interest rate charged to a firm (RIS_i) is local and accelerated with the leverage ($d/d\Phi > 0$, $d^2/d\Phi^2 > 0$). The bank is keen on earning a high return RIS_i on its lending to firm i, but it is also averse to risks associated (it is believed) with a high Φ. A firm with a bad profit performance and/or a high interest will gradually increase its Φ, either through a drain on NW (if Φ=BW/SH) or through a bad market valuation of NW (=q·NW=SH) because of the higher risk that further raises in RIS_i will cause, and so on. Hence in a perfect market setting credit rationing should take care of itself.

If there is a regulatory effect, meaning smaller total credit volume available and/or a lower interest rate in the market (that we preset) the bank could do one of two things:

(1) If "allowed", or possible, it can change its local mark-up for "Φ uncertainty" by applying (IV:28), inserting the controlled interest rate ($\overline{RIS}$) and distribute credit as before.

(2) If only the controlled interest rate $\overline{RIS}$ can be charged, the bank applies risk minimization and provides borrowers as much as they want out of its gross cash flow available, beginning with the firm with the lowest Φ_i and continuing until it doesn't want to lend any more, or until the assigned, regulated credit supply is exhausted. The latter case would have consequences for the allocation of investments.

Step IV (next period initialization)
Borrowers and depositors adjust their balances in accordance with the new interest rates or rules.

Step V
FASS and FD adjust as described earlier.

Step VI
Calculate in- and outgoing cash flows. Add or subtract from non-interest bearing bank liquidity (BLIQ).

Step VII
Check BLIQ against the bank's own liquidity requirement BLIQ*. If deviation, regulate now by changing the spread ξ a 1/2 percentage point in desired direction.

Step VIII
If BLIQ turns negative or falls below Central Bank minimum liquidity requirement (= policy variable),

refund in Central Bank at going (exogenous) offering rate RP (also = policy variable).

Step IX

Recompute all accounts.

Step X

Start afresh from **Step I**.

7. Long-Term Interest Rate

Four nominal interest rates have appeared in our previous discourse; a long- (RIL) and a short-term (RIS) rate and of each there is a foreign and a domestic rate. The two foreign rates are exogenous. Together with the foreign market price assumption DPFOR, they can be redefined as Fisher (1907, 1930) type real interest rates.[24]

The foreign short-term rate enters the MOSES economy through the short-term foreign asset and debt positions. These positions respond to foreign-domestic interest differentials as described above.

To determine the long-term domestic interest rate adjustment in response to foreign long-term interest movements we introduce a modified, simple purchasing power and interest parity mechanism. In passing, this allows us to introduce the exchange rate as a "policy" or a "pressure relief" parameter.

Why do we need a long-term interest rate in the model? The main reason is to introduce stability and symmetry in the long-term investment-financing decision in Chapter III. The best thing would of course have been to have an elaborate credit model, with a multitude of credit institutions and a spectrum of interest rates pertaining to various time horizons and risk levels. Barring that the second best is to work with three "credit dimensions", the long and the short term, and the equity market.

The dual character of the nominal part of the credit system exercises a particular influence on the business sector. Whenever

RIS > RIL

expanding firms, planning to invest and grow (in Chapter III) on the basis of external finance, start gobbling up inexpensive long-term, external finance, to obtain balance sheets nicely structured for growth. What is not needed currently, is temporarily deposited short term in banks.[25] This credit market activity, if it goes on, will of course eventually drive down the short-term interest rate as described in the previous section.

The long-term interest rate is a policy parameter that can be directly influenced by the Central Bank. In a financially closed economy this could be said to be <u>almost</u> true. Open market operations would do the trick, and regulation of access to long-term external finance - a typical Swedish policy feature up to the early 60s (E 1969) - can be fairly effectively enacted.

The real problem arises when the economy cannot be assumed to be a financially closed one. This fact has been gradually accepted by Swedish policy authorities, since the late 60s.

The tricky modeling problem has to do with capturing a financial system that is partially - but to a diminishing extent - regulated, and which is, at the same time, integrated with the world financial markets. We use the distinction between the long and the short term to accomplish that integration in the model with the help of the simple purchasing parity and interest parity theories.

The simple purchasing power and interest parity theories presume a more or less instantaneous and simultaneous real interest arbitrage across the world through speedy capital flows.

The purchasing power parity formulation reads:

$$DCPI = DPFOR + \theta \qquad (IV:29)$$

θ is the rate of change in the spot exchange rate (DSPOTR). The interest parity formulation reads:

$$RIL = RIL^{WORLD} - FP \qquad (IV:30)$$

where FP is the forward interest premium. In the pure versions of the two "theories", the forward interest premium equals the expected spot rate change. Then:

$$\theta = -FP \qquad (IV:31)$$

Domestic and foreign real rates of interest are then assumed to be equal to each other. Hence:

$$RIL^{WORLD} - DPFOR = RIL - DCPI \qquad (IV:32)$$

To achieve such an equilibrium state, for one thing, a world with free and fast international capital flows has to be assumed and the market has to have correct expectations as to spot rate changes. These are necessary but not sufficient conditions.

While there is some empirical support for fast interest arbitrage, there is little support for the purchasing power parity theory in the instantaneous format commonly formulated and market expectations do not predict future spot changes well[26] (Oxelheim 1981, 1984). And this is exactly the way we want it to be in the micro-to-macro model. Foreign-domestic price transmission is a time consuming process that involves more or less the entire market adjustment machinery of the model (E 1978a, p. 105 ff.). There is empirical support for the kind of price transmission lag structure that operates within the MOSES economy (Genberg 1974, 1983). Hence (IV:29) should be rewritten:

$$\text{Ø} = DCPI - DPFOR + LAG \qquad \text{(IV:29B)}$$

and (IV:31) can then be rewritten as:

$$DCPI - DPFOR + LAG = -FP \qquad \text{(IV:33)}$$

Combining (IV:29) and (IV:33) we obtain:

$$(RIL^{WORLD}-RIL) = DPFOR-DCPI-LAG = (-1 \cdot \text{Ø}) \qquad \text{(IV:34)}$$

or

$$LAG = RIL-DCPI-(RIL^{WORLD}-DPFOR)$$

LAG approximates the difference between the domestic real ("Fisher") and the foreign real interest rate.

LAG is determined endogenously in the model and essentially involves the entire MOSES, real economic machinery. Ø, or DSPOTR, is a policy variable[27].

LAG in (IV:29B) so to speak measures the exchange rate adjustment needed each period for purchasing power parity to hold each period. If, however, the

MOSES currency continues to be over- or undervalued by that standard, endogenous mechanisms in the model economy keep working or adjusting LAG (rather than Ω) "from within". Eventually this shows up in DCPI in (IV:29B). The correction process may, however, be socially very painful. Unemployment may rise. Hence, policy authorities often opt for adjusting the exchange rate Ω instead.

If we can assume (IV:31), then (IV:34) will also serve as an explanation of long-term interest rate movements in the MOSES economy. They will differ from world long-term interest rates by the expected rate of change in the spot rate Ω, which is assumed incorrectly to equal the actual change. From this assumption follows the perhaps not so realistic conclusion that short-term interest rates may adjust much more slowly to foreign interest rate developments than the long-term rate.

Necessary and sufficient conditions for the pure purchasing and interest parity combination to hold each period are that capital flows respond immediately to interest rate differentials to eliminate the LAG. If expectations as to inflation, exchange rates or policies are wrong as they were after 1973 and after 1979 then LAG$\neq$0. If adjustment times in capital markets and foreign domestic price transmission speeds differ, we also have a LAG$\neq$0.

Whenever the foreign price level moves away from its earlier relationship with the domestic price level, this movement sets into motion a series of (time consuming) responses in the MOSES economy that gradually affect the supply and demand conditions throughout the system. In the longer term this process is self-regulating and a new relationship between domestic and foreign prices is established. During that process the trade balance (or current balance) is affected and supply and demand for MOSES currency in the world markets are affected. So if MOSES inflation is higher than world inflation and if this is not immediately countered by domestic real responses a LAG≠0 emerges and a deteriorating, or improving, current balance puts pressure on the spot rate, $\otimes$, such that it eventually has to be changed through external policy action.

The complexity of the dynamics of the economic machinery suggests that LAG varies considerably in size over time. LAG can also be affected by domestic policies. RIL is often regarded as a policy parameter, as is the exchange rate. If one can assume that all capital flows in and out of Sweden - except trade credit flows - are effectively controlled, and that the Government is the only long-term borrower abroad, one can make the long-term domestic interest rate exogenous. A quick glance at (IV:29B and 34) however tells us, that this is not possible if the spot rate is not continuously adjusted. We will have to abandon (IV:31) if we believe that the long-term domestic interest rate can be effectively controlled.

Suppose firms have a free choice to borrow long term both at home and abroad. Then differences (RIL^{WORLD}-RIL) will cause immediate adjustments in new, long-term financing. If (RIL^{WORLD},RIL) is fixed and if DSPOTR=0 (by assumption) the model system cannot ensure that LAG adjusts to make (IV:34) hold if $\otimes$ = -FP. Something will have to give.

With all these considerations in mind a natural way to handle the domestic long-term interest rate would be either to assume a freely floating exchange rate, adjusting for LAG≠0 and hence assuming (IV:34), LAG≠0 to hold, or breaking up (IV:31) by introducing an <u>expected exchange rate change</u>, dependent upon LAG to achieve an effect similar to moving $RIL^{DOMESTIC}$ together with RIL^{WORLD} or to assume that $RIL^{DOMESTIC}$ cannot be controlled, or allowing for all three possibilities.

Our <u>standard procedure</u> will be to assume (IV:34) in effect making RIL equal to RIL^{WORLD}, except for spot rate adjustments. This assumption is simple and wrong and forces unreasonably strong quantity adjustments on the MOSES economy. An alternative ad hoc procedure, that is technically similar to introducing an expected interest rate, would be to let the foreign domestic interest differential vary in a pattern that lags the corresponding price differential (see previous footnote).

This discussion introduces an interesting property of an economic system that integrates theories of quantity adjustment and price adjustment, as the MOSES economy can do. We have learned by now that adjustment speeds are different in the four "markets". Quantities are the slowest to adjust, then come prices, including wages, then interest rates and finally exchange rates, if allowed to float freely. The slower all other variables adjust, the more of erratic behavior in the fast moving exchange market which has to absorb all inconsistencies in macroeconomic behavior. If exchange rates are fixed, the adjustments show up very much in interest rates. If interest rates are "controlled" through monetary policies, adjustments take place in monetary flows as they did before the Bretton

Wood system broke down in 1970. This again illustrates why it is so important for economics to understand why speeds of market processes differ if the nature of the macroeconomic growth cycle is ever to be understood.

NOTES to Chapter IV

[1] Waiting for a micro household database, micro household modeling should be a relatively low priority in this context, considering the excellent micro firm database organized on the format of the MOSES system. However, if sufficient funding can be provided, a large scale household database, nicely structured for MOSES use will soon be available. See Eliasson-Klevmarken (1981), E (1982a) and Klevmarken (1984).

[2] See E (1969, Chapter X).

[3] Only sketched in this chapter, but not in Code on program.

[4] It should be mentioned that we still have several database consistency problems to solve before the money part of MOSES is adequately operational.

[5] For instance, MOSES firms do not hold assets or acquire debt in foreign currencies but immediately transform any foreign currency account into Swedish kronor, thereby transferring the foreign currency entries to the bank as FASS or FD. This has been done for practical, simplifying reasons. For the time being individual firm capital losses and gains on foreign account all show up in the accounts of the Bank and cannot be studied as part of firm behavior. The addition of such a feature to the firm model requires that firms are also modeled to respond to changes in currency values vis-à-vis the Swedish krona. For the time being we do not plan any such extension of the firm model.

[6] See E (1980a).

[7] Since the system is nominal, total income Y includes an inflationary component.

[8] In our current macro version of the household sector, it appears only as a net supplier of funds.

[9] In a company with only one activity, the manufacturing of one product, this is no problem. There are only two prices to compare; the rate of return on that activity and the going interest rate. If there are many divisions that manufacture many products, the problem is roughly analogous, as shown already in Chapter III (Supplement I). The portfolio problem appears, when there are many competing outside investment opportunities.

[10] This can also be written

$$i = \theta \cdot RNW \cdot \frac{NW}{N} + (1-\theta) \cdot RNW$$

revealing immediately that i=RNW when the market value of the firm equals its "replacement value", "substance" or "reproduction value".

The proof of this formula runs as follows:

Make the value of the company (as seen by a stockholder that plans to keep his shares forever) equal to the discounted sum of all dividends ever.

$$SH_t = \int_t^{\infty} \theta \cdot R^{NW} \cdot NW \cdot e^{-i\xi} d\xi$$

i = discount factor.

Define $NW_t = NW_0 e^{R^{NW}(1-\Theta)t}$.

R^{NW} is assumed to be a time constant.

Then: $SH_t = \int_t^{\infty} \Theta \cdot R^{NW} \cdot NW \cdot e^{R^{NW}(1-\Theta)\xi - i\xi} d\xi = \dfrac{\Theta \cdot R^{NW} \cdot NW_t}{i-(1-\Theta) \cdot R^{NW}}$

But $\Theta \cdot R^{NW} \cdot NW_t = DIV_t$

Hence $D(DIV) = \dfrac{dDIV/dt}{DIV} = R^{NW} \cdot (1-\Theta)$ and $SH_t = \dfrac{DIV}{i-D(DIV)}$.

Q.E.D.

[11] When q=1 we can keep the simple borrowing investment function in the early versions of the M-M model. The rate of change in borrowing (DBW) now is:

$$DNW = a + b(RRN_i - RI - \alpha\Phi_i)$$

Only the last term is new. See E (1978a, p.66) and Eliasson-Lindberg (1981, p.399).

Note also that:

$$RRI_i = RRI \cdot e^{\Phi_i}$$

yields no solution.

[12] Proof:

$$SH = \frac{\Theta \cdot RNW_0 \cdot e^{RNW \cdot (1-\Theta)t}}{i - (1-\Theta) \cdot RNW}$$

Make $\frac{dSH}{d\Theta} = 0$ and:

$$RNW = i\left[\frac{\partial RNW}{\partial \Theta} \cdot \frac{\Theta}{RNW} + 1\right] - \Theta \frac{\partial i}{\partial \Theta}$$

Assuming RNW to be a time constant one obtains:

$$RNW = i - \Theta \frac{\partial i}{\partial \Theta}$$

Q.E.D.

[13] In capital market equilibrium then $q=1$ and $\varepsilon=0$ (see V:2B in next chapter) for marginal investments.

[14] See Grassman (1970).

[15] Estimated to be 2 months on the average in the 60s by Grassman (1970).

[16] In the current version of the model only investments in production assets including working capital and in bank deposits actually take place. However, returns to the other investments enter the targeting formula and prevent the firm from investing in lower grade production activities. If cash flows are high surplus cash is nevertheless deposited in the bank at the rate $RI(1-\xi)$.

[17] K* is seen as including inventories. We exclude (here and in what follows) the possibility to buy inventories in advance in expectation of future price increases.

[18] In our earlier notation this would be K1+K2+K3+K4. Note, however, that bank deposits K2 have now been entered as a separate item in the portfolio.

[19] Such data were not available by 1985 and the work effort needed for the rest of the model was sufficient to keep us busy at the time. Access to micro household data of the kind needed will, however, be possible for the first time in Sweden because of the large household survey project initiated by IUI and professor Klevmarken at the University of Gothenburg. See Eliasson-Klevmarken (1980), Eliasson (1982a) and Klevmarken (1983).

[20] See for instance the quite amusing example of this discovered in a series of taxation experiments on the model (E 1980a, p.64, footnote).

[21] In the current version of the model there is no bond market. Hence we do not discuss Government financing through the floating of bonds here. The tax system is presented in E (1980a).

[22] The pool of unemployed plus new entrants.

[23] In earlier versions of the model the Commercial Bank accepted unlimited deposits without regard for its own rate of return development, which was disastrous for the bank in some runs. This is one of the reasons why we have had the monetary sector disconnected in most runs. (In current versions the Commercial Bank receives deposits and lends only at rates that guarantee a long-run rate of return on its net worth compatible with the going market interest rate. See next section.)

[24] Note that we use the aggregate of DPFOR as a measure of the current price level change in the world. This is OK for the time being.

[25] or invested in other firms, property etc. (Not yet in program, but sketched. See above.)

[26] Hence $FP + Q \neq 0$ due to mistaken market expectations.

[27] By estimating:

$$Y = \alpha_1 (DCPI\text{-}DPFOR) + \alpha_2 Y_{t-1},$$

where $Y = RIL - RIL^{WORLD}$ one would obtain some information on speed of price and interest transmission in the economy, that is captured by LAG in model simulations.

PART III

THE ENDOGENOUS GROWTH CYCLE

V The Endogenous Growth Cycle – Mathematical Summary of Theory with Special Emphasis on the Wicksellian Capital Market Disequilibrium

Economic theory lacks a comprehensive theory of dynamic markets. The three following chapters make up a philosophical argument for the necessity of dynamic micro-to-macro modeling to capture the nature of a capitalist market economy. The discussion is carried on as an indirect critique of the exact opposite economic theory, static competitive equilibrium theory, which lacks essential elements of a market economy. We first attempt the rudiments of a mathematical summary of MOSES. We then go on to decompose the elements of macroeconomic growth when technical change occurs simultaneously with a continuous market adjustment of both prices and quantities. Finally (Chapter VII), we ask the question what equilibrium and stability mean in a theoretical context like this. Journal economic theorizing has become extremely mechanical in exercising the standard equilibrium model backwards and forwards without questioning its basic foundations. The practically oriented reader may go on directly to part IV on the microeconometrics of MOSES.

1. The Market Game

The micro-to-macro model, MOSES, can in principle be summarized as a sequence of sets of market games. The players are the firms and the households, both defined as financial decision entities, and the rules are set by what we call the market regime.

The top management of each firm (CHQ for Corporate Headquarters) confronts its shareowners, other firms and the bank in the financial market, other firms and labor in the labor market, and households and some other firms in the product markets. The outcome of those games determines the long-term rate of return requirement (TARGL(G)), interest rates (RI, ...), wages (W) and prices (P).*

The labor and product market games are non-cooperative. Contracting takes place out of equilibrium. The markets are characterized by temporary monopolists and monopsonists confronting each other, non-clearing, and price dispersion (no single price). In the financial market individual firms confront suppliers of funds to determine the interest rate and differential rents in the system.

Within each firm two consecutive games take place; one <u>long-term</u>, determining the internal allocation of investment resources, where division managers have to demonstrate good profitability prospects (implying high potential profit performance), and one <u>short-term</u>, determining current performance, where CHQ attempts to force reluctant division managers to enact a higher productivity performance over a given set of capital installations.

Firms continue to exist by demonstrating superior profitability performance in their capital market environment. This superior performance is embedded

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* Note list of symbols at end of chapter.

in the parameter set characterizing their technical state and rules of operation. If firm performance deteriorates, and/or if market competition improves, the firm finds it difficult to acquire, or to keep, resources to maintain its current relative size and value growth rate.

Firms behave rationally in the sense that they consistently aim at upgrading their value, given their endowment of information. There is a rational explanation for price setting and quantity adjustment. Firms adjust prices and offer wages on the basis of perceived market conditions and long-term profitability standards. Firms adjust quantities on the basis of perceived and offered prices (wages) and imposed profit standards. Realized prices and quantities depend on "continuous" contracting by all agents in the market. They normally depart significantly from the corresponding perceived, offered or planned figures.

2. Market Processes and Dynamic Competition

The agents (players) in the market and the rule system define the market process in MOSES. There are three market processes at work in the MOSES economy

- the labor market
- the product market
- the credit market

The firms are both price setters (P_i, w_i, RI_i) and quantity setters (Q, L, BW) in each market.

The labor market process is an elaborate search activity where firms announce wage offers in the market. Those who pick up the signals compare with their reservation wage. Each firm can be in the market several times each quarter and contracting takes place all the time. Recontracting can be seen as a negotiation process and each time an agreement is reached, a mutual adjustment of the wage levels and the reservation wages of the firms takes place, and people move. (Remember that even though labor is homogeneous, the productivity of individuals depends on where they work).

Employment and wage distributions over firms are set in the process.

In the product market firms operate on the basis of individually conceived future prices. Each period, when all quantities have been adjusted, the domestic market clears at one average price, with each firm adjusting its inventories to fit that price level. Since domestic and foreign prices as well as export ratios of firms differ, price differences between firms are, nevertheless, generated endogenously.

The credit market in principle should consist of two parts, a regular credit market and an equity market that feed back rate of return requirements to the business sector through the additive targeting equation (in 6.1.a below).

The credit market process is based on a portfolio (asset-debt) adjustment à la Tobin (1969, etc.) with the interest rate endogenously determined, given an exogenously specified band. (This monetary system for the time being, is, however, not yet in "empirical working order", so in our experiments the upper and lower levels of the interest band have been made identical. All monetary accounts are, nevertheless, printed out, and monetary imbalances can be monitored and corrected manually (see E 1983b).

3. Principal Exogenous Inputs

(a) Choice of Market Regime which Specifies Competition;

(1) from abroad (openness of economy),
(2) between firms (product, labor and credit markets),
(3) within a firm.

It includes parameterization of the following activities:

- exogenous growth in PFOR (foreign competition),
- market arbitrage speeds, (domestic labor and product market competition),
- internal cost and profit control (targeting)
- Entry (not yet ready; see E 1978a, pp.52 ff, Granstrand 1985, Hanson 1985).
- exit (bankruptcy).

The foreign product market environment is assumed to be in long-term ("permanent") equilibrium in a sense to be explained in Chapter VII.

(b) Initial Conditions for Prices and Quantities

(Database)

(c) Exogenous Variables

(1) PFOR - foreign prices, one for each of the four markets
(2) RI - interest rate (foreign and domestic)
(3) MTEC - labor productivity in new investment vintages (micro)
(4) INVEFF - investment requirements for capacity expansion on the margin (micro)
(5) Labor force
(6) Choice of fiscal and monetary policy parameters
(7) Choice of market regime (adjustment speed parameters etc.).

4. Non-Manufacturing (Macro) Environment

In the MOSES model now operational the micro-based manufacturing sector has been placed in the midst of an 11 sector macro Keynesian demand - Leontief input-output model (see Chapter II and Bergholm 1983a, where the input-output model is described). In an earlier model version (documented in E 1978a and in Eliasson-Heiman-Olavi 1978) firms interact solely with households. The households are represented by a macro, non-linear, Stone type expenditure system where households save to maintain a real wealth balance as cyclical insurance, and occasionally oversave or undersave if the real interest rate is high or low enough to make it economical to delay or advance durable goods purchases. Households, hence, represent a delayed, domestic demand feedback and a supply of savings in the MOSES economy.

5. Decisions at the Firm Level

Firms in the four manufacturing sectors are represented by explicit micro decision models. We distinguish between five integrated, but different parts of the firm model.

(I) Choice of Objectives (Targets)

- Additive Targeting Theorem
- Long term
- Short term

(II) Financing

- Local interest rate
- Borrowing decision
- Dividend decision
- Investment budget

Ultimate monetary discipline and inflation control are administered through the monetary system by way of shareowners (profit target) and lenders (interest rate).

The interest rate links today with the future through investment and savings decisions.

The public authority can affect macroeconomic behavior through varying public sector resource use and financing (fiscal policies) through affecting money supply (monetary policies) and the exchange rate.

If the set of public policy parameters is fixed in advance - irrespective of macroeconomic behavior - the model macro economy is essentially self-coordinating.

(III) The Choice of Production Frontiers (Investment Decision)

This (INV-FIN) decision concerns long-term investment and profit targeting in the firm - the dynamic allocation side - through the decisions to

- borrow
- invest, and to
- scrap (exit).

(IV) The Entering of New Technology (Innovation Decision)

This decision concerns the upgrading of Production Frontiers through new investment of a higher (productivity) quality, by way of:

a) innovative entry through new investment in existing firms (DMTEC, INVEFF enter exogenously in new vintages)

b) entry of new establishments (the whole establishment is of new vintage quality)

c) exit of non-competitive establishments (endogenous).

The new quality of investment is exogenous, but enters firms at the rate new investment takes place, and hence endogenously.

We can think of R&D spending as a high-risk investment activity which makes firms more efficient at exploiting (imitating) exogenous new technology, and which also feeds into the pool of exogenously available new technology.

(V) Capacity Utilization (Production Decision)

The production decision (short-term) guides cyclical behavior. The labor market process exercises a dominant influence.

6. Firm Model

We can now bring all the elements of the firm model together in a mathematical summary.

1 The Choice of Objectives (Targets)

(Symbols are explained at the end of chapter.)

Rate of return requirements [TARGL(G)]
(Both labor, capital and other factor productivities considered.)

a) Additive targeting theorem (Equation III:1)
(Derived in E 1978a, pp.80-81)

Rate of Return (Equation III:1)

$$G \equiv DNW + \Theta = \underbrace{M \cdot \alpha - \rho \cdot \beta + DP(DUR) \cdot \beta}_{A(=RRN)} + \underbrace{(RRN - RI) \cdot \phi}_{B(=\varepsilon \cdot \phi)}$$

Price-Cost Margin (Equation III:9)

$$M = 1 - \frac{W}{P} \cdot \frac{1}{Q/L}$$

A = Operational,
B = Investment/financing,
ε = The rent over and above the loan rate RI that the firm can earn.

b) Long-term R-targets (Equation III:11 or 12)

$TARGL(G) = F[LAG(G), MAX\psi]$

Note: In the current version of the model we have approximated TARGL(G) by a weighted average of LAG(G) and RIS. See (III:11).

2 Set of Investment Opportunities (Equation IV:12)

3 Financing

a) Local interest rate (Equation IV:14)

$$RIS_i = F(RIS, \Phi_i), \qquad \frac{\partial RIS_i}{\partial \Phi_i} > 0$$

b) Borrowing (Equation IV:26)

$$DBW_i = F[MAX(\psi_i) - RIS_i]$$

where

$$\psi_i = [RIS, RIS_i, MAX(R_{ij}), RIL, T, \tau]$$

j = lists divisions

Note: ϕ is Φ as it appears in the books, which is BW/NW.

c) Dividend Decision (Equation IV:19)

$$\Theta = F[MAX(\psi_i)-RIS_i, EXP(DS)]$$

$F_1' > 0, \quad F_2' < 0$

Φ in 6.3a is Φ as valued in the market, which is BW/SH, where SH is the market valuation of NW.

ϕ/Φ = NW/SH = Tobin's (q).

d) Investment budgets (net of mandatory (technically fixed) allocation, cf. Eqs. (III:20) and (IV:27))

$$INVF_i = EXP[\Pi] - \frac{(1-\beta)CHS(PLAN)}{\alpha} + DBW + RAM \cdot BW - (RIS+RAM)BW - DIV - TAX - CHLIQB$$

or,

$$INVF_i = EXP[\Pi] - CH[\text{NET WORKING CAPITAL}] - DIV - TAX - RIS_i \cdot BW - CHBW$$

4 Investment Volume Determination

a) Investment needed to sustain planned growth path (each division)

Define:

$$\alpha = \frac{S}{A}$$

$$\beta = \frac{K1}{A} \quad \text{and}$$

$$p \cdot S = p \cdot Q \cdot \xi$$

$$\therefore K1 = \frac{\beta \cdot S}{\alpha}$$

$$\text{or: } \bar{K}\bar{1}/Q = \frac{\beta}{\alpha} \cdot \xi \cdot \frac{\bar{P}}{P(DUR)}$$

Define:

$$INVEFF = \frac{CHQTOP}{INV/P(DUR)}$$

Hence:

$$INVEFF = MARGINAL\left(\frac{\alpha \cdot P(DUR)}{\bar{P} \cdot \alpha \cdot \beta \cdot \xi}\right)$$

If relative prices are unchanged, and (α, β, ξ) are constants then INVEFF is also a constant at the firm level.

Whatever one assumes; the definition of

$INV \equiv CHK1 - K1 \cdot DP(DUR) + \rho \cdot K1$

gives:

$$INV = \frac{\beta}{\alpha} \cdot [CHS - S \cdot DP(DUR) + \rho \cdot S]$$

or - on the margin:

$$INV = \frac{P(DUR) \cdot [CHS - S \cdot DP(DUR) + \rho \cdot S]}{\bar{P} \cdot \xi \cdot INVEFF}$$

This INV can be defined for any number of years of the long-term plan. The firm may be technically prepared to realize X percent of that INV next year.

b) Planned, next period INV

Recompute INV on a next period (quarterly) basis.

c) Realized next period INV

$INV = MIN[INVF, INV, REDINV]$

REDINV reduces next period INV calculated under a) above for the long term, if capacity is currently underutilized ("Accelerator correction").

5 Entering New Technology

5.1 Through New Investment in Existing Firms

a) Frontier

$QFR(L) = QTOP[1-e(-\gamma L)]$

$\frac{d}{dL} > 0, \frac{d^2}{dL^2} < 0.$

b) Best technology vintage in existing establishment (last to go, first to be used)

Each new vintage of investment is characterized by a vector (INVEFF,MTEC) signifying capital and labor productivity, respectively.

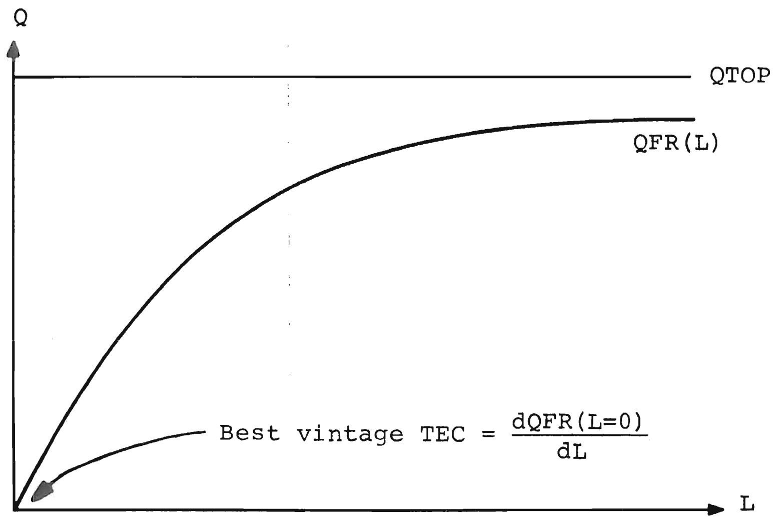
(INVEFF,MTEC) are set exogenously.

b1) Upgrading labor productivity of new investment

$$\frac{dQFR(L=0)}{dL} = TEC$$

Define: $TEC := \gamma \cdot QTOP$

Figure V:1 Upgrading of Production System



New vintage investment:
$MTEC = NEW(\gamma) \cdot CHQTOP$ associated with new, marginal production frontier:

$$NEW(QFR(L)) = CHQTOP \cdot [1-e(-NEW(\gamma) \cdot L)].$$

Merge a) and b1):

$$\frac{NEWQTOP}{NEWTEC} = \frac{QTOP+CHQTOP}{NEWTEC} = \frac{QTOP}{TEC} + \frac{CHQTOP}{MTEC} = \gamma + NEW(\gamma)$$

or:

$$TEC := NEWTEC = \frac{QTOP+CHQTOP}{\frac{QTOP}{TEC}+\frac{CHQTOP}{MTEC}} = \frac{NEWQTOP}{\gamma+NEW(\gamma)}$$

b2. Upgrading capital productivity of new investment

Define: $INVEFF = \frac{CHQTOP \cdot P(DUR)}{INV}$

as an approximate measure of the "marginal productivity of capital", a concept that we do not recognize in our model.

Note: $\alpha = \frac{P \cdot Q}{A}$, $\beta = \frac{K1}{A}$

$\therefore \frac{\beta}{\alpha} = \frac{K1}{P \cdot Q}$

This holds for the existing capital installation; the plant or the firm.

For the new investment vintage we have:

$$\frac{NEW(\beta)}{NEW(\alpha)} = \frac{INV}{CHQTOP \cdot P} = \frac{INV}{CHQTOP \cdot P(DUR)} \cdot \frac{P(DUR)}{P} = \frac{P(DUR)}{P} \cdot \frac{I}{INVEFF}$$

5.2 Through New Entry

INVEFF corresponds to β/α for new investment vintages corrected for relative price change. MTEC corresponds to Q/L for new investment vintages.

New technologies are acquired by firms through new investment. New investment generates a new, marginal QFR(L) frontier that merges with the existing production frontier as described above.

The new, marginal QFR(L) can also establish itself as a new firm entity. It then hires people at the average market wage up to a point where it can operate at full capacity (see E 1978a, pp. 52-55). The entry function is currently being modified and elaborated (see Granstrand 1985, Hanson 1985).

The control function (III:1) in Chapter III for a new entrant, hence, is:

$$G = M \cdot \frac{\beta}{INVEFF} - \rho \cdot \beta + DP(DUR) \cdot \beta + \varepsilon \cdot \phi$$

$$M = 1 - \frac{W}{P} \cdot \frac{1}{MTEC}$$

6 Capacity Utilization

This section summarizes the short-term (quarterly) production decision in the firm presented in some detail in Chapter II. Corporate Headquarter demands improved performance from its interior agents (divisions) under much less than full information on "How to do things". CHQ knows about (profit) performance in the past and uses this information to enforce improved performance (MIP-targeting). CHQ also knows something about performance rates in other firms in the market.

MIP-targeting (see E 1976a, pp. 236 ff.) recognizes that efficient targets, to be taken seriously, can be only slightly above what is feasible. They should not be set below what is feasible, since then performance will equal the target.

Profit Margin Targeting dominates this decision. It aims at short-term "static" efficiency given the production frontier, and hence disregards capital efficiency.

Low performing divisions are pushed to do their best and the MIP-targeting technique allows CHQ to gradually learn the extent of the feasibility region. The performance of the firm is monitored in the capital market. Further expansion is checked through limited access to external finance, leaking of resources (through DBW < 0 or increased dividends, see E 1983b), and eventually exit.

6.1 Profit Targeting

a) MIP-Criterion

a1) Apply external opportunity measure (say an interest rate in the capital market to G in 5.2 above and derive external M target called TARGX(M) (Additive Targeting Theorem).

b) Introduce (see equation (II:4b) in Chapter II):

$$TARG(M) := (1-R)\cdot MHIST\cdot(1+\hat{\varepsilon}) + R\cdot TARGX(M)$$

Define:

$$MHIST := \lambda\cdot MHIST + (1-\lambda)\cdot M$$

$(R,\lambda) \subset (0,1)$, $\hat{\varepsilon} > 0$ is small.

(Note: M is determined endogenously in the model.)

c) MIP-Targeting Criterion (see Equation II:6b):

Apply:

TARG(M) := MAX[TARGX(M), MHIST$\cdot(1+\hat{\varepsilon})$]
conditioned by:
CH[EXP(P)$\cdot$Q - EXP(W)$\cdot$L] $\geq$ 0.

Note: If TARG( ) and EXP( ) come true, as targeted and expected, and stay fixed over time, then MIP-targeting is a profit hill-climbing (gradient) search activity that should eventually lead to a global optimum, if it exists. "Existence" is indirectly conditioned by the dynamics of the market processes. "Dynamics of markets" as a rule will prevent targets from being realized and expectations from coming true.

EXP( ) and TARG( ) are updated completely between periods, and partially within periods on the basis of signals being emitted from the ongoing market process. Any attempt to fix them exogenously is contrary to the MOSES idea, and disrupts the model economy.

Hence, the optimizing domain is not only a multifaceted Arizona canyon landscape. The landscape also changes as a consequence of the market process.

6.2 Production Search

This is a negotiation set up between CHQ (the principal) and divisions (agents). Division managers have a rough idea of their QFR(L) and their operational status (Q,L). CHQ knows neither, and generally presumes that

$$QFR(L) - Q = \hat{\varepsilon} > 0$$

$\hat{\varepsilon}$ is fairly small.

Division managers are reluctant to divulge in formation to CHQ of the size of $\hat{\varepsilon}$.

Targeting is the CHQ strategy to make divisions reveal their potential performance indirectly, through agreeing to perform in the neighborhood of TARG(M).

Division management has to exhibit high, prospective returns to capital (RRN in (6.1.a) above) to receive investment money. The higher RRN, the higher the future expected M that is revealed, that is compared with $MHIST(1+\hat{\varepsilon})$ and that forces division (plant) management to look for an improved rate of return situation.

Division management now applies PRODSEARCH to satisfy TARG(M). PRODSEARCH is a set of algorithms that monitors search from actual (Q,L) positions underneath QFR(L) in Figure V:1 to a satisfactory (Q,L) or labor productivity combination. CHQ does not have to know <u>how</u>, as long as TARG(M) is met. The choice of PRODSEARCH is altogether an empirical question. The choice sequence currently used is described in E 1978, (p.68 ff.).

7. Markets for Products

The firm as a financial decision unit faces three markets (for labor, credits and products). The labor market has been described in a fair amount of detail in Chapter II and I have not found a way to condense it further to the format of this mathematical chapter. The product market needs, however, further explication.

In the short period firms evaluate their internal capacities and profitability to produce and to deliver on the basis of price signals from the market. These price signals relate to the neighborhood of the current volume absorption of the market. Firms could regard themselves to be price takers in that neighborhood and believe that the market can absorb anything each of them can offer without significant price effects. This they do in foreign markets. Domestically or at home firms could perhaps be expected to exercise more deliberation, and reason in terms of a downward sloping demand curve. The question is, should they do that, as they do in MOSES domestic markets by period to period trial and error, and within the period <u>after</u> the production decision has been taken, through the decision to accumulate final goods inventories, <u>or</u> should they make a deliberate choice each quarter to perhaps move out of the current operations domain by drastically changing the price? When capacity utilization is low, perhaps. I prefer, however, not to introduce such behavior in a short period context. For firms that exercise some control of their markets, price is not the prime policy parameter (Eliasson-Bergholm-Horwitz-Jagrén 1985), and if price is deliberately changed, the change is invariably related to a long-term price policy, and to the investment decision. Basic industries and/or producers of staple commodities, on the other hand, may sometimes realistically be regarded as price takers. A measure of sophistication in respect of pricing is nevertheless implicit in the short-term production decision as it is currently modeled.

In reality, the production frontier QFR(L) is not well defined for decision makers in a MOSES firm. The firm always operates more or less beneath it because of a temporary, and quite common, misjudgement of the cyclical development of demand, or because management does not know where the frontier is. In the former case lowering of the price temporarily to catch a larger market share is suboptimal strategy if the expectation is that demand will soon swing back. It will be difficult to increase price again even though it is possible to increase deliveries rapidly out of inventories. The main point of the argument is, however, that to exploit large unused labor capacity through price decreases is a longer term decision than the next period production decision. If it is too costly on the margin to increase output well beyond the current operating level on short notice (next quarter), or if to achieve a larger volume through price cutting means too large longer term losses in terms of lower prices when operating at full capacity, both circumstances should be regarded as a situation with steep adjustment costs today, that effectively prohibit such action.

We have simply designed the production search paths, or rules guiding production search, so that large expansions of sales and output are avoided (see Section 7 in Chapter II). This set of rules could, however, be more conventionally formulated as an assumed zero sales price supply elasticity.

The supply elasticity is then defined in relation to the shortest period used in model simulations, currently a quarter. In domestic markets (currently not in foreign markets) demand is endogenously generated. Hence, through repeated simulations, enough data could be generated to plot a momentary demand curve exactly, and to estimate the demand schedule for that quarter for one firm.

8. Symbols Used

:=	= make equal to (in Algol)
CHX	= ΔX (absolute change)
DX	= $\Delta X/X$ (relative change)
EXP( )	= expectations operator. Generates expectations on ( ) on the basis of past observations of ( ), and external inputs
TARG( )	= ditto targeting operator
A	= total assets (K1+K2=NW+BW)
α	= $P \cdot Q/A$
β	= K1/A
BW	= debt
DIV	= dividends
G	= firm profitability targets (see I.1.a)
INV	= investments
INVEFF	= inverse of marginal (gross) capital output ratio in new investment vintages.
T	= discount rate (occasionally in Chapter IV)
L	= labor input
M	= gross (operating) profit margin (operating profits/value added)
MTEC	= labor productivity in new investment vintages
NW	= net worth
K1	= production (depreciable) assets to which ρ applies
K2	= all other assets
$\bar{P}$	= value added price
P	= product price
P(DUR)	= price of investment goods
Q	= production volume
$\bar{P} \cdot Q$	= value added
QFR(L)	= production frontier, a function of L
ρ	= economic depreciation rate
SH	= market value of NW or the firm
ϕ	= BW/NW
Φ	= SH/NW
ψ	= opportunity vector (see I.1.b)

π = p•Q - L•w = gross operating profits
Ψ = investment budget (see I.2.c)
Θ = DIV/NW (dividend payout ratio)
REDINV = factor that corrects INV for unused capacity. See (III:21).
R_{ij} = real rate of return in division j in firm i
RI = market interest rate
RIS = nominal, short-term market interest
RIS_i = nominal rate, short-term local (i) interest rate
RIL = nominal, long-term interest rate
RNW = real return on net worth
RRN = nominal rate of return
r = market interest rate (in Chapter IV)
τ = expected rate of return on property investments
T = expected rate of return on investment in stock.
ε = individual division "rent" = $RRN_{ij} - RI_i$ (see pp.141 and 277).
$\hat{\varepsilon}$ = individual firm target pressure factor ($\hat{\varepsilon} > 0$ but small. See pp. 55 and 258).
$\hat{\hat{\varepsilon}}$ = individual division "slack factor" = QFR(L) - Q ($\hat{\hat{\varepsilon}} > 0$ but small, as perceived by CHQ management; see for instance p.260).
RAM = Rate of amortization of BW
S = sales value
SH = market valuation of NW
ξ = sales/value added ratio ($S/\bar{p}Q$). Hence (ξ-1) is the ratio between external purchases of goods and services and value added
TAX = tax payments
RU = rate of unemployment

9. Summary Listing of Agents, Rules and Other External Conditions in the MOSES Economy

(Numbers in brackets indicate pages where concepts are introduced and discussed.)

A <u>MARKET GAME</u>

<u>Players</u>: FIRMS (Households) as financial institutions
<u>Rules</u>: Market Regime

B MARKET PROCESSES AND COMPETITION

- Labor Market (w, L); see pp.67 ff)
- Product Market (p, q)
- Credit Market (RI, BW; see Chapter IV)

Firms are both price and quantity setters in each market.

C EXOGENOUS INPUTS (p.41)

- Market Regime
- Initial State (also p.350 ff)
- Exogenous Variables

Rules of Market Regime define degree of competition:

- from abroad (PFOR)
- in domestic markets (arbitrage speeds)
- within firms (targeting)
- eventually forcing exit (bankruptcy) of some players (132 ff.)

D DECISIONS AT FIRM LEVEL

- Objectives (Targets)
- Finance
- Choice of production frontier (Long term, INV)
- Entering of new technology (investment decision)
- Capacity utilization (production decision)

These decisions can be further elaborated into:

E THE FIRM MODEL

(1) Choice of Objectives (Targets)

- Distributional equation (139 ff)
- Additive Targeting Theorem (109 ff)
- The Mip principle (48 ff, 116 ff)
- Allocation Menu (143 ff)
- Long-Term R-Target (Credit Market; see pp. 122 ff)

(2) Financing

- Local Interest Rate (199)
- Dividend Decision (127, 202 f)
- Borrowing Decision (127 f, 213)
- Investment Budget (130 f)

(3) Choice of Production Frontier (55 ff)

(INV volume determination)

- Long-term plan (profit check, liquidity check)
- Next period INV (planned)
- Ditto, realized

(4) Enter New Technology

- Shift in PROD frontier
- DMTEC (Q/L in M)
- INVEFF (α, β in RRN)
- New ENTRY

(5) Capacity Utilization
(PROD decision)

(a) MIP on M
(b) PROD SEARCH (57 ff)

VI Growth in the Moses Economy – The Real Side

1. Introduction

The following two chapters represent two ambitions. The growth (Chapter VI) and stability (Chapter VII) properties of the entire economic system are analyzed. Earlier publications on the M-M model (E 1976b, 1978a) have focused on the short-term side of labor and product market processes. In this volume the long-term finance-investment decision at the micro level comes together with the determination of rates of return to capital in firms, the interest rate (a macro phenomenon) and productivity change. Productivity change in MOSES is endogenous down to the new vintage of capital invested in one individual establishment. At that level we distinguish between labor productivity (Q/L in Eq. (III:9)) and capital productivity (INVEFF which is part of α in Eq. (III:1)) as it enters via new investment vintages. In Chapter III we found a very simple relationship between labor productivity and the profit margin (see Theorem 2). This chapter investigates the relationship between total factor productivity growth and the real rate of return on capital.

We have frequently referred to the MOSES economy as a formalized, Schumpeterian type economy which blends with the Wicksellian notion of a disequilibrium cumulative process, this time at the micro level, which in turn feeds on a difference between the return to investment in firms and the market interest rate (E 1984c). This difference - a spread of temporary micro rents - defines the "disequilibrium conditions" in the capital market. The rent of the individual firm is endogenously determined from quarter to quarter (see next chapter) and the distribution of rents across the firm population is the key characteristic of the state of the growth cycle, in which both growth trends and business cycles are explained. Institutions act in the markets. Their response times to price signals ("inertia") affect the dynamic properties of the entire model economy. Hence, the following two chapters also attempt to relate MOSES thinking to more traditional theory, including the classical - but static - Walrasian general equilibrium model. I want to emphasize again that the economic principles at work in MOSES are the classical ones, with the difference that we deal with a "tâtonnement" micro process in time in the French meaning of the term,[1] and concentrate on the dynamic process per se, not its final destination.

The consequence of the two chapters appears to be that Walras fades away and Schumpeter comes to life to make a long-term, dynamic micro interpretations of the Wicksellian cumulative process and the Smithian invisible hand (1776) possible. Even though Wicksell (1898) was concerned with the inflationary consequences of a positive gap between the nominal return to capital (his real rate of interest) and the money interest rate, this difference is just as naturally entered ex ante (as in Wicksell) in the investment function of one firm, and you have a growth model. Long-term capacity growth is open-ended, except for the exogenous technical constraint associated with new investment vintages. As capacity growth evolves as a result of the investment process at the micro level, the current rate of capacity utilization is determined in the short-term labor, product and credit market processes. The explanation of the Business Cycle and Economic Growth is merged within one formalized framework.

This chapter begins by bringing out the logic behind the economic growth explanation in MOSES. It continues to detail a micro-to-macro growth accounting system that is compatible with the fundamental profit targeting equation. Then follows a discussion about how spending on R&D account and technical change should be incorporated in this accounting framework. The main argument that concludes the chapter is that explaining economic growth within this micro-to-macro accounting system means making structural change between the observation units (through a reweighting of the aggregate quantity index) an explicit part of macro output growth. Relative prices are the weights and this opens the bridge to the next chapter by casting doubt on the relevance of macroeconomic production relationships, when relative prices are subject to shifts. The market price allocation mechanism is highlighted as the important vehicle behind total factor productivity growth. We find that it is necessary to understand dynamic disequilibrium market adjustment processes - which we call "tâtonnement" processes - if one is to have any understanding of economic growth. This is the Schumpeter connection with the next chapter.

2. The Growth Machinery of a MOSES Firm

Economic growth in the micro-to-macro economy is endogenized and bounded from above by an exogenous technology constraint associated with new investment in the individual firm. Technology associated with new investment vintages is exogenous. The investment and production decisions are endogenous. Differently structured market regimes allow for a wide variety of resource allocations and associated macroeconomic growth rates for each set of technical constraints. To understand this we should review the labor and product market processes, the investment financing decision in a firm and the credit market process simultaneously with a view to understanding the output growth process.

Think of the credit market as an arbitrage in rate of return requirements in firms. There is no Walrasian auctioneer and contracting occurs all the time irrespective of whether the economy is in equilibrium or not. Markets never clear and a dispersion of interest rates - and prices as well - prevail at each point in time.

1. Hence, the first market function in the growth process is the determination of the interest rate (RI), which is strongly influenced by (exogenous) interest rates abroad (see Chapter IV).

2. The second function in the growth machinery refers to the firm's market, cost and productivity performance, or the endogenous determination of labor productivity, wages and domestic prices as described in Chapter II. This process is by quarter and assumes a given capacity. The production frontier (QFR(L)) is fixed for the quarter. Only labor (L) and output (Q) can be varied during the quarter. This short-term process is directly guided by the profit margin target of the budgeting process and hence "weakly" guided indirectly, by the rate of return requirement imposed by the

credit market - because the profit margin target derives from a rate of return target (see Theorem 2 in Chapter III, expression (III:9)).

Foreign competition affects domestic market prices as described in Chapter II.

The reader may wonder why inventories do not play a more central role in the production decision and the short-term supply process. Besides the fact that firm managements, in their quarterly output decisions, try to adjust finished goods inventories to "optimal" levels, it is production that is varied, not stocks. In an industry offering specialized products in customer markets this seems to be the empirically realistic formulation.

3. The <u>choice of production frontier</u> (in Chapter III) is more intricate. Expected rates of return, interest rates and productivity performance play the crucial roles. However, expectations have to be formed on the basis of facts and perceptions of the future. Hence, the translators of the past into the future are very simple-minded. Uncertainty about the future and other complications like differences in talent, foresight and entrepreneurial competence at the micro level are introduced as a stochastic element.[2]

Theorems 1 and 2 in Chapter III now explain how the performance rates of one firm are translated into

(a) a rate of return variable and
(b) an internal cash flow variable.

4. The rate of return variable, when compared with the individual firm borrowing rate, in the borrowing functions, determines how much external finance to take on.

5. External and internal cash inflows determine how much investment can be financed. The firm picks its new marginal production frontier as elaborated in Chapter III. This process is "strongly" guided by the rate of return requirement imposed in the credit market through the borrowing decision.

6. This much or less is invested in production capital, while production capacity exits through depreciation and bankruptcy. How much investment that falls below the financial frame depends upon current capacity utilization (endogenous) and alternative investment opportunities.

7. Technical change. The investment decision in Chapter III signifies the choice of a new production frontier. New investment vintages are characterized by particular capital (INVEFF) and labor (MTEC) input-output characteristics.

8. Investment and technical change shift the allocation field of production frontiers that bounds feasible output from above.

This sequence at the firm level is reformulated simply in mathematical terms. (Symbols have been listed at the end of the previous Chapter V).

I. The additive targeting formula[3]

$$G = DNW + \Theta = M\cdot\alpha - \rho\cdot\beta + DP(DUR)\cdot\beta + (RRN-RI)\cdot\phi$$

yields a minimum rate of return requirement through the application of some MIP-technique ((III:1) in Chapter III).

II. The set of investment opportunities available to the firm i (the "allocation menu") is described by the rate of return vector:

$$[RIS,\ RIS_i,\ MAX(\quad)]$$

For an explanation of MAX( ), see IV:9A and Section IV:5.1.c in Chapter IV.

III. The interest rate local to firm i is ((IV:14) in Chapter IV):

$$RIS_i = F[RIS,\ \phi_i]; \qquad \frac{\partial RIS_i}{\partial \phi_i} > 0$$

IV. The current and potential profit, or price cost margin is described by ((III:9) in Chapter III):

$$M = 1 - \frac{w}{p} \cdot \frac{1}{Q/L}$$

V. Desired long-term investment INV on the basis of targeted long-term G in the additive targeting formula (I) above is "proposed" from the production level (bottom up):

$$INV = F[TARGL(G)]$$

to Corporate Headquarter people for approval.

Technical knowhow enters through Q/L which can take on any size within the feasibility production frontier:

$$Q/L < \frac{QFR(L)}{L}$$

Short-term (within quarter) market adjustments determine the position of Q/L underneath QFR(L)/L as well as labor recruitment, wages etc. The functional form of QFR(L) is defined below under §(VIII).

QFR(L) is moved from quarter to quarter through investment. ΔQFR is determined at the corporate level in three sequential steps §(VI) borrowing, §(VII) investment and §(VIII) QFR updating.

VI. The ex ante <u>borrowing</u> function (see (III:17) and (IV:26))

$DBW_i = F[MAX(\ \ )_i - RIS_i]$

controls the cash flow available for investment.

A preliminary investment budget proposal (INVF) is obtained:

$INVF_i = F(RRN_i, RI_i, RI, DS_i, S_i)$

VII. Actual INV is calculated after correction for desired INV (in §(IV) above) and the current state of capacity utilization:

$INV_i < MIN(INVF, INV, CAPINV)$

$CAPINV = f(\text{capacity utilization})$

Residual finance $INVF_i - INV_i > 0$ is deposited in bank.

VIII. Assume:

INVEFF	exogenous[4]
MTEC	exogenous

for the new capital vintage (INV). Calculate new QTOP by inserting QTOP and INV in:

$$INVEFF = \frac{CHQTOP \cdot P(DUR)}{INV}$$

Calculate γ by inserting QTOP and MTEC in:

$$TEC = \gamma \cdot QTOP$$

and a new, updated production frontier [see (II:5)] is obtained:[5]

$$QFR(L) = QTOP[1-e(-\gamma L)]$$

The rest of this chapter and the next chapter are concerned with the importance for macroeconomic growth of how INV is determined, distributed over, and used at individual establishments.

3. The Growth Accounting System

So much for one firm. Let us look at the entire economy through the following accounting identity:

$$\sum^{i} p^{*} \cdot Q \equiv \sum^{i} p^{X} \cdot X \qquad \text{(VI:1)}$$

(VI:1) states that the sum value of total factors expended as inputs equals the sum value of total output. Summation is over production units (i) or rather divisions, the firm being organized on a product (market) taxonomy. One aggregation scheme hence yields a set of firms, or financial decision units (see Chapter III). Aggregation one step further yields the entire industry.

p^{*} is the price on value added (Q), and p^{X} and X are the price and volume of factor inputs, respectively. More precisely, (VI:1) can be spelled out as:

$$\underset{(1A)}{\Sigma p\bar{S}} \equiv \Sigma[\underset{(2)}{wL} + \underset{(3)}{(RR+Dp^{I}+\rho)K} + \underset{(1B)}{p^{X}X}] \qquad \text{(VI:2A)}$$

p is the product price associated with the gross value ($S = p\bar{S}$) produced by each firm. w is the level of wages (or rather wages and taxes on wages) paid for each unit of labor input (=L). RR is the real rate of return on capital inputs (K) and DP^I the capital gains component associated with K. ρ is an appropriately chosen depreciation factor. (p^X, X) represents a vector of other factor prices and input volumes. Some of them also appear as outputs in some firms.

(VI:1) or (VI:2A) is a mere accounting framework on the format of the macro mapping of the model in Figure II:1 in Chapter II. Beyond providing a consistent classification scheme for micro-to-macro accounting - like Figure II:1 - this identity tells nothing about economic behavior. However, (VI:2A) contains the important, endogenous micro variables in MOSES and gives an organizational breakdown of the accounts for a discussion of the dynamics of the growth machinery, both in the model and in the real life economy.

Components 1A and 1B in (VI:2A) represent the final results of output decisions in firms each period (price and quantity). Component (2) is the labor market and (3) represents the financial markets, although in a way that requires explanation.

The accounting breakdown (VI:2A) of the MOSES economy corresponds to the accounting breakdown of a firm in Chapter III (The Separable Additive Targeting Theorem and Theorem 2). Combining the two, one obtains a systematic aggregation formula from "in plant" productivity, via profitability to - as we shall see in this chapter - macroeconomic growth. For instance, the value of K is not explicit in the MOSES firm, and is not traded directly in the financial markets. The critical thing is how RR_i, the real rate of return in production unit i, relates to the interest rate (RI) in the credit market. The determination of RR

- ex post - was explained in Chapter II (the production model). The determination of RI in the credit market was explained in Chapter IV. The firm decided on its production frontier (the investment decision) on expectations as to RR and RI in Chapter III. Here these three steps combine to yield economic growth at the macroeconomic level.

$(RR+DP^I+\rho)$ is the standard definition of the cost of capital from the neoclassical theory of investment. In the MOSES economy it figures as the cost of capital only in a trivial accounting sense. The interesting question is how rate of return targets are set in a firm and how these targets affect investment spending through the cost of capital.

To see this, replace $(RR+DP^I)$ by some external cost component like the nominal market interest rate from Chapter IV (call it the discount factor) and rewrite (VI:2A) as:

$$\Sigma p\bar{S} \equiv \Sigma[wL + (RI+\rho)K + p^x X] + \Sigma\varepsilon K \qquad \text{(VI:2B)}$$

$$\varepsilon_i = RR_i + DP_i^I - RI.$$

In neoclassical theory standard conditions for producer equilibrium adjust (L,K) to a given (exogenous) set of prices so that $\Sigma\varepsilon K$ is maximized for the individual firm, or a group of firms. When this holds at any level of aggregation the groups of firms are operating on their production function and total factor productivity growth can be measured as a shift in that production function. If prices on outputs and inputs are properly measured, Jorgenson-Griliches (1967, p. 249) argue that "the observed growth in total factor productivity is negligible". They recognize that there is a severe aggregation problem, that increasing returns to scale and externalities cause problems, and that disequilibrium producer conditions blur the distinction between shifts in and movements along the production function. Brown & Greenberg (1983) argue outright that the users of traditional Divisia indexes of total factor productivity - claimed to be relatively free of aggregation errors - ignore the general equilibrium effects when prices and quantities are mutually interdependent, as they are in the MOSES economy. This is, of course, exactly our case of dynamic disequilibrium in which structural adjustment between quantities and prices in the market allocation is the source of economic expansion. We illustrate this by a formal exercise below.

We also ask the question (in the next chapter) what to mean by equilibrium. Non-zero $\varepsilon_i \neq 0$ at the micro level are perfectly compatible with the existence of producer equilibrium conditions. It appears that the Jorgenson-Griliches claim that the properly measured input and output prices that make total factor productivity change negligible, also make aggregate $\Sigma\varepsilon_i$ into a negligible magnitude (see below). What does this imply for the nature and existence of a capital market equilibrium?

Make the interest rate equal to the marginal product of capital at all points. Then $RI=RRN_i$ is enforced on the margin everywhere. Excess or deficit profits are eliminated on the margin everywhere. Hence:

Marginal $\varepsilon_i \equiv 0$. $i=1,\ldots,n$.

This is of course what happens in perfect equity market arbitrage (Section 6 in Chapter IV) where K is market evaluated and ρ consistently adjusted.

By this criterion,

$$\overset{i}{\Sigma}\,\varepsilon K$$

(using our reproduction cost valuation of K) could be said to represent a measure of the extent of "disequilibrium" or "diversity" in the economy (cf. Figure 1a,b in E 1984c). We can also talk about Schumpeterian, entrepreneurial or temporary (monopoly) rents. In the MOSES economy there will always be a distribution of quasi rents ε (positive or negative) across firms. The nature of "technical change" in the model is to create new $\varepsilon > 0$. Differentially distributed information and uncertainty are other reasons for the existence of ε. Monopolistic competition in all markets allows quasi monopoly rents to exhibit themselves as ε, as does of course a general "disequilibrium" in the capital market, if savers are not sufficiently interest sensitive. The nature of firm behavior in MOSES is to exploit such profit potentials. The nature of market processes in the model is to compete them away.

The nature of the actual distribution of ε across establishments is important for macroeconomic behavior of the entire economic system. This distribution can be calculated at the micro level at each point in time in a MOSES simulation.

The credit market may be afflicted by imperfections. The RI_i represents a spread of interest rates over firms. A question that naturally comes to mind is what it means to assume that $RR_i = RI_i$ or $\varepsilon=0$ at all points in time. What should be meant by a general capital market equilibrium? We will return to this question in the next chapter on equilibrium and stability in MOSES.

Formalizing slightly, the central problem for the rest of this chapter concerns the properties of the equation system:

$$F(q,p,\varepsilon) = 0$$

$$q = (\bar{S}_i, L_i, K_i, X_i)$$

$$p = (p_i, w_i, r_i, p_i^x)$$

$$\varepsilon = (\varepsilon_i)$$

Here the differences between the Walrasian system and the MOSES economy show up. The quasi rents ε_i link markets and agents over time. As long as $\varepsilon_i \neq 0$, or better, as long as there is no solution $F(q,p,\varepsilon_i=0)=0$ sequences of temporary equilibria do not exist.[6]

4. R&D Investment and Technical Change

What is being discussed in this section is currently not in MOSES Code. It amounts to making DMTEC and INVEFF endogenous (currently they are exogenous for each vintage of investment) by making individual firm investments in marketing and in R&D partly endogenous, and applying a stochastic payoff in terms of faster or slower DMTEC and INVEFF rates. Negative effects on DMTEC and INVEFF would then signify "failures".

A growing share of spending on capital account in sophisticated manufacturing firms is not booked on capital account, but charged to current account (see Eliasson-Bergholm-Horwitz-Jagrén 1985). Quantified knowledge of spending on R&D and marketing investment is scarce, or missing. Nevertheless, these investment categories shift the production frontier QFR(L) outwards, either by reducing factor inputs per unit of output, or by increasing the end value of products for a given set of inputs. Several real firms in the MOSES economy spend more on R&D and marketing investments than on equipment purchases and constructions. This alone is a good reason not to make hardware capital explicit in the production function while - at the same time - ignoring other forms of capital.

Entering R&D investment into a MOSES firm has to recognize the scant information existing for the investigator as well as for firm decision makers. We also recognize that much software investment really is of a routine nature (Eliasson-Granstrand 1982). Much of R&D spending concerns learning about, initiating or adopting technical change that takes place in competing firms or in research institutions. Consequences of routine R&D spending on product specifications are fairly predictable. The bulk of R&D spending in manufacturing seems to be aimed at product quality improvements (E 1982b). Hence, uncertainty associated with R&D investment lies to a large extent on the marketing (investment) side.

In principle we could treat software investments as any other investment category, adding an uncertainty factor to each category. This would generate distributions of business success that would be compatible with observed distributions, but it would deepen our understanding of macroeconomic behavior only if the stochastic hypothesis is a good representation of success and failure in business life. We are willing to consider such a simple explanation, but it does not seem to be compatible with the more well rounded theory of economic growth that we are attempting to piece together. And, we are not prepared to impose the stochastic explanation as a prior in our analysis, even if it happens to generate well fitting time series and cross-sectional distributions.

The above, more general concept of the generation of technical change is what we have in mind (but not yet in the program) for application when data become available.[7]

R&D spending affects technological development in the MOSES economy in two ways.

(1) Industrial R&D - directly in firms or elsewhere - raises potential INVEFF and MTEC improvements embodied in new investment.

(2) The extent of R&D spending in one firm raises the MTEC and INVEFF levels of that firm compared to its previous level and the potential level as determined in (1) above. I would expect the effect to be non-linear in the sense that the closer the firm is to the potential frontier, the more additional R&D investment is needed to push one step ahead.

(1) and (2) differentiate DMTEC and INVEFF development between firms.

In the MOSES economy designed so far business risks consist only of profit consequences of mistaken market price expectations. We now propose to introduce a new type of business risk, namely:

(3) Technological risks associated with failed R&D programs.

Technological risks could be handled by a stochastic return factor associated with R&D spending in the individual firm. This would further differentiate (MTEC, INVEFF) development between firms. Mathematically such a device would be very similar to the stochastic creation of temporary innovative rents that Futia (1980) argues should be the cornerstone of what he calls Schumpeterian competition.

This respecification of the firm model would introduce a desired increase in macro diversity into the economy that can be further increased through relating similar characteristics to new entrants.

There is, however, one problem. By introducing such a crude technical change generator the possibility of "predicting" individual firm behavior has to be abandoned altogether. Only macro behavior and consequences for distributional characteristics can be meaningfully analyzed. Individual firm predictions are not interesting per se as long as we are concerned with understanding macroeconomic behavior. However, shifts in the frequences of particular behavioral characteristics of individual firms are central to explaining macro behavior under the micro-to-macro hypothesis of economic change. Individual firm characteristics of behavior generally mean something for macro behavior under a monopolistic competitive setting. Pure stochastic explanations to individual firm behavior, like the generation of innovative rents refute the idea of meningful micro-to-macro disequilibrium theory. It is not difficult to understand that the analytical tools for equilibrium or macro analysis can be kept in continued use if disequilibrium conditions can be assumed to be purely random.

The database used for MOSES will soon make it possible to derive individual firm estimates of R&D, INVEFF and DMTEC. Hence, the average effect of extra R&D spending on the shifting and the shape of the production frontier intermediated through the investment decision can eventually be estimated.

How is the extent of R&D spending determined? We will have to enter this specification very simple-mindedly. Moving into high-tech, R&D intensive industries is a slow process, so the extent of R&D investment will be heavily dependent upon past R&D investments. It should also depend on rate of return performance. For the moment it would be fairly easy to generate R&D adaptation of a firm in the sense that past experience of R&D profitability (achieved MTEC and INVEFF shifting) affects the size of future R&D spending.

(In principle, the same performance raising function should be attached to marketing investment.)

By treating R&D spending and marketing investments as just another, but somewhat different form of capital spending, we need to recognize truly innovative technical change. We can do that very simply, through <u>new entry</u>. New firms enter in the upper end of MTEC and do not have to mix with old technologies and old mixes of factors. We can assume that new firms enter according to a frequency distribution around MTEC and in "volumes" that correspond to the opportunities in the market, measured by upper end ε, and perhaps other, exogenous social factors.

5. Total Factor Productivity Growth and the Representation of Production and Technical Change in MOSES

5.1 Market Aggregation

Throughout the micro-to-macro modeling work we have represented information handling and decision making within the business organization according to the same principles as those upon which the measurement (accounting) systems of firms are organized. The rationale for this procedure of course is that we are modeling firm decisions, and that we are using actual data processed within real firms and used in their own planning and decision making. These data are generally of a much higher quality than data gathered according to some other imposed format of thinking. In particular, we are much closer to the source, and we know the nature of errors that creep in. We think these two reasons are sufficient to warrant a few departures from received procedure. This rules of behavior approach to modeling recognizes two things; First that rules applied in the decision process have to rely on insufficient information (there is extensive fumbling in the darkness). Second, in choosing what information to use, well defined and accurately measured variables are to be preferred. This becomes a very obvious choice when one thinks of rate of return requirements. Vague concepts in agreements simply cannot be enforced. Capital, for instance, does not appear explicitly in the internal accounts of a business organization as a quantified measure of a factor input (a "stock") in the production system. It cannot be measured properly. Rather, firms work in terms of estimates of potential output and rates of utilization of installed factors.

The closest one gets to the concept of a production function is the standard costing procedure and the use of standard cost functions, but these do not pretend to represent the physical side of capital use in production (E 1976a, p. 296 ff.).

We have approximated the same procedure by applying two productivity measures, one for labor (MTEC) and one for "capital" (INVEFF). They both refer to new vintages of investment. Hence, the concept of capital of course sneaks in through the back door. A production function can so to speak be derived from the accounts of the model. The point is that one first has to define the concept of capital one needs for estimating the production function by specifying a method of measurement. Then we can use the model to calculate a time series of capital stocks to our liking. The MOSES firm, however, does not depend upon any particular such method to make a decision, except the procedure to measure INVEFF.

Were it not for two things we could simply leave the problem at that. The two things that force us into a digression on capital theory are (1) curiosity and (2) the fact that we have argued strongly that some 50 percent, or more, of total factor productivity (TFP) growth in the Swedish economy between 1955 and 1975, as measured by traditional macro production function techniques, may in fact be accounted for by structural adjustments between plants and firms (E 1979 and 1980b, and Carlsson 1981). In terms of the MOSES model this adjustment should have been caused by market price competition, endogenized by the behavior of all firms. The all industry total factor productivity (TFP) measure necessarily rests on an aggregate production function estimate. A stable aggregate production function normally does not exist if the ε_i vary significantly over time. They always do in our model economy, and in any real life economy.

Introduce the concept of <u>total factor productivity</u> as:

$$TFP = \frac{Q}{X} \qquad (VI:4A)$$

or as the ratio between the quantity of aggregate output and the quantity of aggregate input. Hence, relative change in TFP;

$$DTFP = DQ - DX = \Sigma wDQ - \Sigma vDX \qquad (VI:4B)$$

where

$$w_i = P_i Q_i / \Sigma P_i Q_i$$

$$v_i = P_i^x X_i / \Sigma p_i^I X_i$$

are the appropriate (price) weights in the quantity index.

Impose the identity (VI:1) and DTFP=DQ-DX. Growth in total factor productivity can then be expressed by its dual

$$DQ-DX = DP-DP^x = \Sigma vDP-\Sigma wDX \qquad (VI:5)$$

Imposing (VI:1) means making $\varepsilon_i=0$ everywhere, and all RRN_i and RI_i equal throughout the economy.

Under (VI:1) $[p^*, p^x]$ are exogenous price vectors that clear all markets for products and factors. Equilibrium conditions prevail in all markets, including also the capital market (since all $\varepsilon_i=0$). Aggregation is permissible. In such circumstances only, total factor productivity growth equals the difference in aggregate relative change in the output and input price indexes. <u>Any</u> consistent macro model with the actual return to investment properly measured would <u>have to</u> satisfy (VI:5) ex post.

In MOSES $\varepsilon_i \neq 0$ almost everywhere and always. ε_i moves investment in firm i. The analytical problem addressed in this chapter is how this dynamic "property" affects macroeconomic growth in the model. It will be demonstrated that the existence of a "variable" distribution of quasi-monopoly rents, ε_i, that are temporary for the individual firm, such that $\Sigma\varepsilon K>0$ most of the time is a necessary, but not a sufficient condition for TFP growth in the MOSES economy.

The next chapter addresses the question: What will happen to the macro economy when we try to establish a capital market equilibrium, i.e., to move all $\varepsilon_i \to 0$?

One could also say that the dynamics of the various market processes in the MOSES economy are described by the time movements of weights:

$\{w_i\} = \frac{PQ}{\Sigma PQ}$; determined in the <u>product</u> market

$\{v_{Ii}\} = \frac{wL}{\Sigma wL}$; determined in the <u>labor</u> market

$\{v_{IIi}\} = \frac{(RI+\rho)K}{\Sigma(RI+\rho)K}$; determined in the <u>credit</u> market

$\{v_{IIIi}\} = \frac{\varepsilon_i K_i}{\Sigma_i \varepsilon_i K}$; determined in the <u>equity</u> market

This formulation takes us right into the fascination and mystique of capital theory and the explanation of the rate of interest. Let us try it with a modest degree of ambition.

Using a Divisia (1928) quantity index we can express:

$$DTFP = DQ - DX = \Sigma w_{ij} DQ_{ij} - \Sigma v_{ij} DX_{ij} \quad \text{(VI:6)}$$

where

$$w_{ij} = P_{ij}Q_{ij}/\Sigma P_{ij}Q_{ij}$$

$$v_{ij} = P^{x}_{ij}X_{ij}/\Sigma P^{x}_{ij}X_{ij}$$

D( ) as before are relative change operators. Summation is across profit centers in firms (j) and across firms (i). From now on we discard indices whenever it is obvious from the context what the symbols represent. We want to demonstrate two things:

1) How structural adjustment enacted through the price system affects aggregate TFP in the MOSES economy.

2) How the production system of the MOSES firm relates to a traditional production function representation.

The first answer follows directly from (VI:6). Aggregate quantities of outputs and inputs (Q and X) depend on the relative price vectors (P, P^{x}) used in the price deflators. These price vectors are all endogenously determined through the factor and product markets. Prices determine the corresponding allocation of quantities (Q,X) and so on.

DTFP as measured at industry levels through aggregate production function analysis has accounted for some 75 percent of aggregate output growth during the post-war period (Carlsson et al. 1979). Given the MOSES parameter specification that best explains long-term industrial growth during the post-war period (see Chapter VII), more than half of that particular aggregate productivity growth can be technically accounted for by "reweighting" of the firm and plant composition (the w_{ij}) through the market allocation process. Change the market allocation parameters in some appropriate fashion and DTFP can be made to disappear almost altogether (in MOSES). To this we return with the long-run simulation experiments reported in Chapter VIII.

This proposition leaves us with the task of explaining what change in aggregate TFP really means; A bias in the measurement technique,[8] a statistical error, or something real?

A question like this does not make sense if you accept the standard assumptions of macro production function analysis, notably that of exogenous prices which eliminates the distinction between ex ante and ex post prices. That is out of the question for the MOSES economy, so the gist of the argument that follows has to do with the measurement system and the priors you are willing to impose upon your theory. The conclusion will be that the standard assumptions of macro production function analysis are not even acceptable approximations for the meaningful use of a macro production function to analyze economic growth.

To demonstrate this we have to make the relationship between DTFP and the rate of return explicit, or to establish the links between the production system and the profit targeting formula (III:1) in Chapter III.

Introduce (VI:2B) and the assumption that $\varepsilon_i \neq 0$ for all i, implying that RI is used as the appropriate accounting rate of interest. Define again:

$$\Xi X = w \cdot L + (RI+\rho)K \qquad \text{(VI:7)}$$

Note that RI is the nominal interest rate and Ξ the implicit price deflator for X. Assume - for simplicity - that all other X=0 and reweigh:

$$DTFP = DQ - [\xi_1 DL + \xi_2 D\bar{K} -] \qquad (VI:8)$$

where $\sum^{2} \xi_i = 1$

and $\xi_1 = \frac{w \cdot L}{\Xi X}$

$\xi_2 = \frac{(RI+\rho)K}{\Xi X}$

Aggregate output change can now be expressed as:

$$DQ = \Theta_1 DL + \Theta_2 DK + \Theta_3 D\varepsilon \qquad (VI:9)$$

where $\sum^{3} \Theta_i = 1$

$\Theta_1 = \frac{wL}{pQ}$

$\Theta_2 = \frac{(RI+\rho)K}{pQ}$

$\Theta_3 = \frac{\varepsilon}{pQ}$

(ξ_i) and (Θ_i) are the weights in the implicit deflators (Ξ,P) with which we deflate total costs and value added, respectively. It follows immediately that:

$\Theta_1 = \xi_1 \cdot \frac{\Xi X}{pQ}$

$\Theta_2 = \xi_2 \cdot \frac{\Xi X}{pQ}$

and

$$DTFP = DQ - DX = [1 - \frac{pQ}{\Xi X}] \cdot DQ + \Theta_3 \cdot \frac{pQ}{\Xi X} \cdot D\varepsilon \qquad (VI:10)$$

or[9]

$$DTFP = [1 - \frac{pQ}{\Xi X}] DQ + \frac{CH\varepsilon}{\Xi X}$$

The first term is negative if $DQ>0$ and $\varepsilon>0$, since then $pQ>\Xi X$, but rather small. The second term can be positive or negative depending on the sign of $CH\varepsilon$. There is no guarantee that DTFP>0.

In fact:

a) For $\varepsilon \neq 0$

If $CH\varepsilon \rightarrow 0$

then $DTFP \rightarrow \frac{-\varepsilon}{\Xi X} \cdot DQ$

since $p \cdot Q - \Xi X = \varepsilon$.

Hence $DTFP \rightarrow 0$ if, and only if $DQ = 0$.

b) For $\varepsilon = 0$

$DTFP = 0$

if, and only if $CH\varepsilon = 0$

c) For $\varepsilon = 0$, $CH\varepsilon \neq 0$

also

$DTFP = \frac{CH\varepsilon}{\Xi X} \neq 0$

For all ε_i this represents a disturbed Walrasian capital market equilibrium, for instance by innovating $DTFP_i$ that generate innovative rents $CH\varepsilon_i$.

Once the Walrasian capital market equilibrium has been disturbed and a Wicksellian capital disequilibrium has been created it appears as if Walrasian capital equilibrium can only be restorded if <u>all</u> $[\varepsilon_i, CH\varepsilon_i, DTFP_i, DQ_i]$ simultaneously hit = 0. This makes steady state equilibrium growth, except zero growth, infeasible. The question raised in the next chapter is whether a dynamic process exists that takes the MOSES economy to a Walrasian equilibrium, and if not, what happens if we reorganize the market regime such that competition pushes all $\varepsilon_i \rightarrow 0$.

All the above has been derived in continuous time. When you measure total factor productivity change it takes place between two discrete points in time. So you can "manufacture" more or less of total factor productivity growth through appropriate changes of weights in the price deflators. This is synonymous with the choice of production function into which to fit your measurements. To define production function specifications that produce TFP changes that are invariant to changes in structure between the two points of measurement seems close to impossible (Brown-Greenberg 1983, Caves-Christensen-Diewert 1982). Strictly speaking, by saying that X percent of total factor productivity change depends on structural change, hence, means to say X percent of something that may not exist. What we have done elsewhere (see E 1979, Carlsson 1981) is only to demonstrate that by entering a DMTEC of on the average 2.5 percent per annum 1955/75 (differing between sectors) and a D(INVEFF) = 0 we have been able to generate an expansion path of Q, INV and L in manufacturing that tracks actual historic data well (and a number of other historic (Q, INV, L) paths as well if we change market parameters), and that records a macro Q/L development close to 7 percent per annum. Average labor productivity change at the micro level, hence, is less than half of macroeconomic Q/L change the same period. The rest has to do with reshuffling of (L, INV) between plants and firms in the economy to obtain a more efficient allocation of factors. This can only be achieved with a continuous turnover of $\varepsilon_i \neq 0$ over time.

It is obvious from this discussion that total factor productivity change depends on the nature of the design of aggregate output (Q) and input (X) volume indexes, i.e., how the corresponding deflators have been designed. The shift in the aggregate production function really is a phenomenon related to relative price change, where the price of capital services (the interest, depreciation rates and the rate of return) plays the crucial rôle. In saying so, the nature of capital market disequilibrium enters as the vehicle for total factor productivity change. DTFP≠0 does not occur when $\varepsilon_i=0$ everywhere. This is what we wanted to demonstrate in the first round.

We will now pass on three questions to the next chapter;

Question one:

Does the MOSES economy have an equilibrium in the sense that the whole economy stays at the state all $\varepsilon_i = 0$, once it has been placed there? The second question is very different, even though it may appear on the surface to be the same.

Question two:

If you increase capital market competition to the extent that you compete all ε_i away at any point in time, will the above, possible equilibrium state be approached?

Question three:

If an equilibrium state with all $\varepsilon_i = 0$ exists, is this also a stationary state, with no growth in output?

5.2 Total Factor Productivity Change in Single Production Unit

In this final section we demonstrate how the individual production unit of the MOSES production system relates to the traditional production function. More specifically, we demonstrate how the parameters MTEC and INVEFF link backwards to the profit target control equation and forward to the coefficients in a production function.

Discard all outputs in (VI:2B) but one (i=1). We have one firm that produces one homogeneous output by applying labor (p_1=w;X_1=L) and capital (p_2=(RI+ρ);X_2=$\bar{K}$). As before, RI is a suitable discount factor (interest rate) nominally denominated and determined outside the firm, perhaps in the credit market. ρ is the rate of economic depreciation of assets K. Hence, (VI:5) for this firm reads:

$$DTFP = DQ - \underbrace{\frac{(RI+\rho)K}{(RI+\rho)K+w\cdot L}\cdot D\bar{K}}_{a} - \underbrace{\frac{w\cdot L}{(RI+\rho)K+w\cdot L}\cdot DL}_{b} \qquad (VI:11)$$

Three matters now have to be considered.

First this expression has no meaning in an economic context until we have related the symbols to a well defined measurement instrument, that generates data on all variables. This is especially important for the tricky triad (RI,ρ,K).

Second, if RI is replaced by a properly defined nominal rate of return on K (meaning ε=0) for this particular firm, the whole expression collapses into an identity where DTFP$\equiv$0. For proof see above.

Third, under certain conditions (V:11) can be integrated into an aggregate (for the firm) relationship:

$$Q = F(L,K,t) \qquad (VI:12)$$

or a production function, that is stable, and perhaps is not an identity.

The first problem is to bring MTEC and INVEFF into (VI:11). Let us begin by establishing a partial relationship (Q,t) in (VI:7) to this firm that is the same for any RI.

As pointed out already by Wicksell (1901) a set of power production functions,

$$Q = AK^{a}L^{b} \qquad (VI:13)$$

can be derived from (VI:11) if

$$a = \frac{(RI+\rho K)}{(RI+\rho)K+wL} \quad \text{and}$$

$$b = \frac{wL}{(RI+\rho)K+wL}$$

can be assumed to be time constants. A is an integration constant. In equilibrium, where all RRN_i equal the discount rate RI, a and b are constants, but then the whole expression is an identity since

$$(RI+\rho)K + wL \equiv Q\cdot p$$

Then also $a=\xi_2$ and $b=\xi_1$ in (VI:9).

We can of course assume that RI and ρ are constants and define K such that RRN=RI.[10] You then make an identity of (VI:11), but there is, nevertheless, no guarantee that a and b in (VI:11) are time constants, which they have to be for (VI:11) to be integrated to a simple power type production function that is stable over time.

The rationale for a stable, aggregate production function of a simple power function type hence rests on approximate time stability of a and b in (VI:6), and an aggregate $\Sigma\varepsilon\neq 0$, if there is to be any total factor productivity change.

If there is, shifts occur in the aggregate production function and all benefits from these shifts accrue to the capital owners,[11] since they are the recipients of all profits accruing from $\varepsilon > 0$.

This would traditionally be taken to signify a capital market disequilibrium situation (monopolistic conditions), generated through superior innovative behavior during an intermediary period, before being competed away by new innovators or imitators. In the meantime all $\varepsilon > 0$ have been reinvested somewhere and formed the basis for continued economic growth, the rate of which in turn depends on the rate of return on the new investments and so on.

In so far as this rent (ε) generating capacity is stable over time we might be able to describe the data generated by the growth process by estimating a reduced form of the growth model, namely the production function of the firm. The production function then is a summary statistic of the firm's data. By simply changing the parameters of the growth process we would - even for a single firm - obtain different estimates of such a function. Hence, they will be very difficult to interpret as a summary description of the production system of the firm.

At higher levels of aggregation irregular micro motion in ε_i may aggregate into a stable aggregate monopoly rent that may be proportional to DTFP. But what explains economic growth is the process that generates the ε_i and then translates them into new allocations of investment.

It finally remains to relate (INVEFF, MTEC) to the parameters in a production function of the above type and to the fundamental profit targeting equation (III:1) in Chapter III.

We know from Section 5.1(b2) in Chapter V (p.256) that (on continuous form):

$$\frac{\partial QTOP}{\partial \bar{K}1} = INVEFF.$$

We can hence rewrite (II:5) in Chapter II (p.57) as:

$$Q = QTOP(\bar{K}1)\cdot(1-\exp(-\gamma\cdot L))$$

Hence:

$$\frac{\partial Q}{\partial L} = QTOP\cdot\gamma\cdot\exp(-\gamma\cdot L)$$

and $\frac{\partial Q}{\partial L} \rightarrow QTOP\cdot\gamma$
$L \rightarrow 0$

We afforded the marginally best piece of equipment (the last to exit when L = 0) the highest labor productivity (see Section 5.1 (b.1 in Chapter V, p.255 f.).

$$TEC = QTOP\cdot\gamma$$

Hence, differentiating the "production function" above totally we obtain:

$$dQ = \frac{\partial Q}{\partial \bar{K}1}\cdot d\bar{K}1 + \frac{\partial Q}{\partial L}\cdot dL = (1-\exp(-\gamma L))\cdot INVEFF\cdot d\bar{K}1 + $$
$$+ TEC\cdot\exp(-\gamma L)\cdot dL \qquad (VI:14)$$

After some straightforward algebra and integration, we obtain the following power type production function:

$$Q = C \cdot \bar{K}1^{a} \cdot L^{b}$$

where C is an integration constant and

$$a = INVEFF \cdot \bar{K}1/QTOP$$

$$b = \frac{\exp(-\gamma L) \cdot TEC}{Q/L}$$

have been assumed to be time constants. TEC and Q/L should move roughly parallel over time. In industries where capital productivity does not change on the margin (INVEFF) and where (QTOP/$\bar{K}$1) and labor input (L) follow a horizontal trend, this assumption may be approximately correct, and hence explains the stability of Cobb-Douglas type macro production function estimates often obtained.

Now, finally, recall from the fundamental, profit targeting equation (III:1) in Chapter III;

$$\alpha = \frac{pQ}{A}$$

$$\beta = \frac{K1}{A}$$

$$\frac{\alpha}{\beta} = \frac{pQ}{p(DUR) \cdot \bar{K}1}$$

Hence: INVEFF on the margin $= \frac{\alpha}{\beta} \cdot \frac{P(DUR)}{P}$

TEC is labor productivity of the marginally best equipment installed, which is the equipment installed last. MTEC was the Q/L associated with <u>new investment</u> or the new entrant firm. Now look at (II:3) in Chapter II (p.53). For that last piece of investment,

$$M = 1 - \frac{w}{p \cdot Q/L} = 1 - \frac{w}{p \cdot MTEC}$$

Hence, for the marginal piece of investment, or the new entrant in the market, the fundamental profit targeting equation (III:1) looks like:

$$G = \left[1 - \frac{w}{p \cdot MTEC}\right] \cdot \frac{INVEFF \cdot p \cdot \beta}{p(DUR)} - \rho \cdot \beta + Dp(DUR) \cdot \beta + \varepsilon \cdot \phi$$

If we have data, or ideas, on the technical properties associated with new investment goods (plants) i.e., on (MTEC, INVEFF) we can plug them directly into the targeting function (III:1) together with expected prices and financing variables to evaluate profitability performance of a new project. This is done in two ways within firms. First, Corporate Headquarter people in firms have some access to such reference data from similar activities within the firm or in competing firms. Second, and more important, in a market economy, firms are continually subjected to such data through price competition from the marginally best producers.

NOTES to Chapter VI

1 For some peculiar reason the useful term "tâtonnement in Anglo-Saxon competitive equilibrium literature has been reserved for centralized pricing through "the auctioneer". The MOSES individual firm price setting through period-to-period trial and error should hence be called non-tâtonnement. The original French meaning of the word is much more appropriate as used here. Even a layman not versed in general equilibrium theory will capture the idea with satisfactory precision.

2 See E (1976a, Chapter XI, Section 4). We have chosen to keep such exogenous, random elements shut off in all experiments of the model reported so far.

3 Same as (III:1) in Chapter III. Note for easy recollection that in the <u>no</u> external finance, <u>no</u> dividend, <u>no</u> inflation case this formula collapses into:

$G=DA=M\bullet\alpha-\rho\bullet\beta=RNN=RR.$

Growth in total assets (A) equals the real (and nominal) rate of return.

4 Note that INVEFF is the α, in (III:1), of the marginally added output capacity (=CHQTOP) through INV.

5 The procedure is somewhat more complicated than this. Capital depreciation has to be entered, etc. See (III:13) in Chapter III.

6 This appears to be the point made by Brown-Greenberg (1983), namely that a divisia index of total factor productivity growth is a line integral. Its value depends on the path of integration which in turn depends on the interaction of prices and quantities across firms and over time in our dynamic setting. B&G show that path independence only prevails when RIS = 0.

7 A survey on investments in R&D, production and marketing to the same group of firms as the planning survey sample used in MOSES simulations is currently being collected by IUI. Preliminary results are reported in Lindberg-Pousette (1985).

8 Cf. Brown-Greenberg (1983) again. The problem of what to mean by productivity growth measured as the time derivative of the production function (Solow 1957) is neither trivial nor academic.

Caves-Christensen-Diewert (1982) devote considerable effort to trying to find such general structures of production that arbitrariness in the productivity change measure is removed when the structures of production have been allowed to differ between the two points of measurement.

[9] Or:

$$DTFP = DQ - TFP \cdot \frac{P}{\Xi} \cdot \left[\frac{CH\varepsilon}{\Xi X} - DQ \right].$$

[10] or proportional. This is what Åberg (1969) and Berndt-Fuss (1982) more or less do.

[11] Note that this conclusion depends on the separability assumption associated with the shift.

VII Equilibrium, Coordination and Stability in the Moses Economy – The Invisible Hand in Dynamic Markets

1. The Need for a Dynamic Equilibrium Concept

The markets in the MOSES economy carry out three tasks:

(1) Coordination of exchange (short term)
(2) Coordination of allocation processes (investment, long term)
(3) Imposition of values

Without a set of assumptions expressing societal values about acceptable profits for firms and consumption standards for individuals the two coordination functions become openended. Hence, it has become customary to impose value structures on the economic mechanisms that guarantee some kind of predictability of the system. Profit and utility maximization are examples. Predictability is naturally related to boundedness of outcomes. The concept of equilibrium is an extreme version of boundedness.

Boundedness is achieved through prior restrictions ("simplifications") on the model. The exclusion of dynamic factors is customary. In a pure exchange economy with no information costs and/or certainty it was proven long ago that it did not matter who performed the static coordination task under (1), the institutions in the market or the central planning agency operating as a Walrasian auctioneer. By our standards there is no market in such an economy. Markets coordinate economic activities (1) in time, (2) with limited foresight and (3) at a cost.

The notion of equilibrium is still important. As we just observed, without any "equilibrium properties", the economic system is open-ended and yields no or weak predictive powers. We are, of course, carrying out this modeling exercise to tell something about a dynamic economy at work, hence a maximum measure of predictability is what we aim for. In mathematical terms both predictability and equilibrium imply the existence of a solution.

We have done the following. We have studied behavior at the micro level. We have attempted to formulate this behavior as generally as possible in terms of profit motivated information gathering and decision rules. As far as the MOSES economy presented in the previous chapters goes we believe its specification to be general enough to capture micro behavior of firms over at least the entire postwar period, and perhaps offer a useful representation of longer term industrialization processes as well. Quantification might differ somewhat, but the principles at work should be the same. Given this presumption, analyzing the macro system at work amounts to asking the question, what is the <u>nature of equilibrium</u> in a dynamic economy like this.

As we will try to demonstrate below, the whole idea of the correspondence principle, voiced by Samuelson (1947) must be misconceived. The properties of a dynamic system do not generally converge on those of a static system as you remove the time dimension (i.e. $t \to 0$).

The steady state concept of an equilibrium is also out of question, since it presumes complete coordination at each point in time around an exogenously moving "fix trend". Steady state models are static.

A more meaningful dynamic equilibrium concept is convergence into a bounded domain, a tunnel or a corridor (E 1983a). This is a generalized version of the questions that should be asked in competitive equilibrium theory [see Hahn's (1973, p.8,ff.) angry reply to Kaldor's (1972) question, and Kornai (1971)]. By asking this question we immediately focus on the problems of how, and how fast, market processes make the economy converge into a bounded region where it is somehow desirable to be. The latter is the welfare aspect of dynamic analysis.

This is why we entered the third function of the market at the beginning of this section, the imposition of values. Equilibrium can only be defined in terms of a value system of the agents of the economy. It is a social concept. If the economy behaves badly, unpredictably, erratically or chaotically, this value system will be changed or be brought to bear on the parameters that regulate the market process (the market regime). If values change it is part of the market process. However, one can envision a collectivist political process that changes the market regime (government).

An economic system free of value restrictions would be unbounded and nobody would be interested in knowing what happens to it. If the system collapses, for instance through abrupt and large drops in output, some will be concerned and try to do something about it. This is how welfare economics becomes part of economics. This is how Keynesian demand management developed etc.

Let us repeat. In the standard Arrow-Debreu model the equilibrium, if it exists, is not thought of as the end point of a dynamic market process. It rather describes under what conditions the system will remain in place (in equilibrium) once it has been placed there. The key question is why somebody want it to be there, and there is a large literature on that issue. How to get there is an entirely different matter. In MOSES related discussions we must think of equilibria as end points of dynamic processes. We have to be concerned about both why and how. We can, however, think of two properties of a MOSES equilibrium:

1 Can one or more (p,q) combinations be found at which the system will stay, once it has been placed there?

2 Can we design an adjustment process that takes the system from any initial (p,q) state to all, or some of these (p,q) combinations or any other (p,q) combination, such that the system stays there?

If 1 but not 2 can be demonstrated, or if neither 1 nor 2 can be demonstrated, do we have a problem? Should we redesign the model or should we redefine the concept of an equilibrium?

The first analytical problem corresponds to proving the existence of an Arrow-Debreu type equilibrium or an extended von Neuman growth equilibrium. Such an equilibrium, or a sequence of such equilibria, may exist in the MOSES system. One would probably have to invent a fairly large number of identical (homogeneous) firms and experiment with a large number of price combinations until a stable (p,q) vector can be found. This may not be the only one, and it may be highly unstable in the sense that a small external disturbance may tip the whole economy. In fact, this seems to be the case. Hence, from a welfare point of view, it is probably not a desirable state to reside in.

How do we set up an initial state from which the system converges onto one such equilibrium? One could perhaps start from the neighborhood of an equilibrium ascertained as under 1 and specify an adjustment process that is so slow that no internal disturbances in the system (e.g. exits) do occur. Is this possible?

Suppose any such experiment, however close to the type 1 equilibrium point, will always generate internal dynamics such that the economy at least for a while moves even further away from that same point. What happens now if many type 1 equilibria exist, perhaps a continuum? Does each combination of initial state and adjustment regime correspond to one unique final end point, or many? If more than one end point to each combination of initial state and market regime the end point of the market adjustment process will be undetermined.

One could then conceive of a very different concept of equilibrium, namely a set of type 1 equilibria. We can say that the model has an equilibrium if it moves into a bounded such set. If the ongoing market process then stays in that operating domain forever, or returns when disturbed, we may talk about a dynamic equilibrium.

If it is desirable that the economy possess such an equilibrium, we must ask what and who make it stay there, and who determines what is desirable? How is the economy controlled?

2. Controllability - the Policy Problem

Does the MOSES economy, or the model need a (central) pilot to fly, to avoid crashing, or to stay within bounds? Is it a ship that goes to the wrong destination if not centrally guided, or is the economy self-coordinating by one, or many, invisible hands that do better in terms of output than other guidance systems? What can a Government do to MOSES to improve economic performance over an indefinite time horizon, to pose a traditional question in economics?

For instance, are cyclical variations of varying amplitude a normal quality of a properly represented macroeconomic growth process? Does government policy interference reduce long-term economic growth as it goes about diminishing these fluctuations and/or does it simply build up a latent potential for an even larger swing at some later stage, as I have suggested elsewhere (E 1983a)? What sort of "equilibrium" are we thinking of if maximum sustainable economic growth requires a major economic depression now and then to remove tension in the system and to clear up mismatched structures? Should a dynamic model have the property that the system eventually converges onto the same growth path irrespective of starting point (initial conditions)? What social utility function - or rather, what kind of market regime - is best suited for an economy which is never in equilibrium and in general not predictable? What kind of role is left for government?

It is easy to lose control of a dynamic market economy. The M-M model we are discussing is populated by institutionally well defined firms that grow internally through an endogenized (within the firm) investment process. Decisions related to the future are taken on expectations generated through "intelligence" functions based on past price and quantity signals. Hence, the firms set both prices and quantities individually.

Endogenous investment, interpreting of noisy price and quantity signals and individual price and quantity setting introduce new properties in our macro economy.

Endogenous capacity augmentation effectively removes the situation of a pure exchange economy, an assumption which has been necessary for stable, static equilibrium through a non-tâtonnement process, without (Smale 1976a,b) or with explicit (Friedman 1979, Clower-Friedman 1985) transaction costs, or intermediate trade specialists.

Endogenous capacity augmentation removes convergence to static or steady state equilibria. When coupled with endogenous expectations formation based on past price and quantity signals in markets, interrupted or 'noisy' "communication of signals occur when the system departs too far from its 'equilibrium' motion" (Clower 1975). Once in disorder I see difficulties of knowing which restrictions (policies) to impose to take the system back to order, or equilibrium, over time (E 1983a). I prefer to reserve the term "dynamic" to economic models with such latent instability properties. Here equilibrium and stability conceptually merge and it becomes more interesting to talk about boundedness. Leijonhufvud (1973) discusses this as "corridor" phenomena.

As Clower (1975) notes the set of possible conjectures on this theme is effectively unbounded. We have a policy problem; how should the market regime be organized to keep the economy within a "corridor" defined by some welfare criteria (E 1983a)?

If general unpredictability is a natural state of the economy it becomes natural for market agents to develop elaborate information gathering systems. The expectations function in a MOSES firm represents these tasks. There is no explicit cost associated with information gathering in a MOSES firm, except that information gathering and interpretation take time and - in a disorderly economic state - generate more or less false signals (forecasts). It is only to regret that we did not fully recognize the importance of information gathering at an early stage of MOSES model work.

In a parallel study at IUI (E 1984a) we observe that large business firms spend perhaps more than half of their resources on gathering information about their interior life - which is recognized in Chapters II and III - and about their external markets. Marketing efforts are of course the main activity in this respect, occupying some 25 percent of total costs in the 20 largest Swedish corporations.[1]

This observation has two strong implications. First, the economic mechanisms usually associated with the market also become more or less a natural element of the informal information system of the firm, making the institution called a firm as such endogenous as to size and content of activities and demarcation lines vis-à-vis the market (see E 1984a).

The only way of keeping the traditional distinction between the firm and the market well defined is to introduce specialized traders in information, the actions of which we call the market. But this is not a good way, since most firms also carry on the functions that we would like to associate with the traders, as part of their internal production activities. The market, its institutions and the firms mix in a changing flux (see E 1985a,d).

Second, the ambition to monopolize or to control a market becomes natural to the firm, not necessarily in order to expropriate static monopoly gains, but to achieve some predictive order vis-à-vis the market (cf. Arrow 1959). This is a function we often want to associate with Government. The welfare implications now become very different from those derived from static theory.

While the MOSES firm strives to achieve predictability for its external market environment through elaborate information gathering and analyzing mechanisms[2] the main competitive instrument of the MOSES firm is to create technological quasi rents (the positive ε in Chapters V and VI) that carry improved market control, and that lower market control for competitors. Hence, information gathering and use is not only a dominant interior firm activity it is also the dominant generator of "technical" improvements in the firm, being perhaps much more important than what we generally mean when with "technical change" (see E 1984c).

In introducing technical change Joseph Schumpeter began his discussion by assuming a Walrasian equilibrium as the initial state. This equilibrium was then disturbed by the entrepreneur, who created a temporary monopoly for himself by his innovations and thus started a growth process (see previous chapter). We have to accept that it may not be possible to establish a Walrasian type of equilibrium (or a steady state) at all in the MOSES economy to start from.

Kirzner (1973), on the other hand, introduces the entrepreneur as a vehicle for stabilizing the economy, that moves it toward "equilibrium" by exploiting the opportunities that reside in the business environment.

For a theoretical debate of that kind to be meaningful we first have to define what we mean by "an equilibrium". And once we have introduced the concept it forces us to reason as if an equilibrium of the standard, static type exists. That is not a satisfactory intellectual situation. Let us instead return to the idea of a bounded region that we want to reach, and concentrate on the dynamic process that may or may not take us there. For that purpose the capital market process becomes central. We introduced the capital market rent ε as the temporary profit consequence of the successful innovative activities that move the economy.

3. The Market Game Situation

In the MOSES economy agents are differently endowed with information about their environment and about themselves.

More information can be gathered, but gathering is time consuming and costly, and when some information has been acquired the market game situation has normally changed, since the new information changes every agent's behavior. Hence, information gathering to improve the information base for a decision is not the typical decision procedure, but rather search according to a set of rules that are currently updated, and a rapid realization of mistakes through scrapping.

Essential information is always missing in a typical business decision and for reasons to be given below, the situation can be described as one of pure uncertainty. It is inconsistent with the logic of the model design to restore a transitive choice situation of outcomes by equipping agents with the faculty of calculating subjective probabilities or certainty equivalents that come true on the average in the longer term. This may, or may not, be feasible depending upon the state of the market. Rational expectations will hence be a misleading abstraction.

Mistaken decisions due to lack of, or false, information generate a continued state of nonclearing market situations at the micro level, or a dispersion of partial or special monopolies. This in itself defines a state of "disequilibrium", and in such a state there is no reason to expect a single market price (Reder 1947, pp.126-51, Diamond 1984, Axell 1977, 1985), which is exactly the result exhibited in the labor market (with homogeneous labor) in MOSES simulations.

The individual decision maker in MOSES all the time has to act before marginal adjustments (ex ante) have been completed, even if it appears as if a better positioning can be reached. Ex post this early action may lead to superior outcomes as frequently than late and more (ex ante) informed action. As decision makers learn about that relationship between ex ante information and ex post outcome through mistakes, it will be added to their rules of behavior. The long-run equilibrium characteristics of the economy will take time, if not forever, to learn about, so there will always be a trade-off between decision rules that lead to fast action, and to rules that aim for what appears ex ante to be exactly the right action.

In such an economic setting rationality is something much broader than optimal choice. Given what information the agent, or the decision maker, happens to have, he behaves rationally if he strives to improve his utility position through continuous learning, and if he never takes steps that deliberately lower his ex ante perceived utility. All MOSES agents behave rationally in this sense of applying a gradient search rule with relatively weak information requirements of the kind that meets realistic decision settings.

However, search, experimentation and learning are costly activities. They draw a significant resource volume within the business organization, and mistakes are, as a rule, very costly experiences. To model a firm one, hence, should also model improvements in information gathering and processing systems. There are many examples of how new competitive market circumstances, and mistakes have made firms modify their decision rules. High real interest rates in the 70s, for instance, has made many firms modify their profit margin targeting systems to include capital productivity considerations also in the short-term decision, not only in the investment decision (see E 1984a).

Rationality hence requires that decision rules are changed or adjusted when they consistently lead to mistaken action. One can then - in a MOSES dynamic market setting - experience the paradoxical situation that optimal decision rules derived from received theory consistently lead to a deteriorating utility position and are changed for better rules.

If agents are very differently endowed with information and if the workings of the economy is of such an order of complexity that even a very large number of experiments on the economy (or searches) does not make it possible for individual agents to learn and form rational expectations, then we have the typical market situation of a non-cooperative game. The equilibrium - if it exists - is a set of solutions, perhaps a very large set, rather than one point (see Johansen 1982).

4. Risk and Uncertainty in MOSES

The concepts of risk and uncertainty carry a convincing power of insight. At closer scrutiny one, however, fails to pin down an empirically based distinction. The distinction cannot be made outside the context of an explicit model of the economy and, as it appears to me, uncertainty does not exist as distinct for calculable risks[3] in a model with equilibrium properties. And business organizations are certainly aware of this in setting their decision rules.

Let me develop my argument from this point and relate the concept of risk to predictability as it affects firms in the MOSES economy. Predictability requires that you can ascertain ("estimate") certain reasonably stable relationships representing an economy that you can assume will prevail over some future period, that will then allow you to forecast with some confidence. The same requirements are needed to allow the calculation of risks.

However, predictability can only be obtained on the basis of a model structure that is the same for the estimation and the forecast period, excepting instabilities that can be treated as random noise. (Optimum modeling for forecasting purposes is the technique of simplifying model structures up to the level where this condition ceases to be appropriate.) The random noise abstraction of errors of forecast - or fit - can only be achieved within equilibrium models which tend to converge onto an equilibrium path whenever disturbed. Convergence also has to be imposed in some way for the forecast or calculation period, for random noise characteristics to hold for the same period.

If equilibrium does not obtain for the forecast period, an erratic element (unpredictability) enters. This element could also carry the label "uncertainty" in the sense that there is no way of forecasting it or insuring yourself for it.

Let me illustrate from the MOSES system. We have demonstrated (see below) that certain market regimes tend to generate dramatic collapses of the macro economy that exclude the random noise assumption for at least one particular forecasting period.

You can learn about the collapse by running the full MOSES system. Suppose MOSES is the real economy, and that you only have a more simple model representation of it. As long as the simple representation contains the collapse characteristics, you have predictability. If the state of theory and modeling precludes that - or rather make you believe that it should be precluded - a certain element of uncertainty or unpredictability prevails. Insurance companies tend to exclude wars and major disasters from their liabilities. The forecaster does the same for major economic collapses that do not belong to his domain of experience.

If "the crisis" obliterates the world during the forecast period and if no available model representation of the world could predict it, then it would have been warranted to talk about uncertainty. Similarly, if this final apocalypse would have been caused by some (by definition) unpredictable exogenous disturbance, the same conclusion holds.

However, the world may recover again, but perhaps beyond the forecast period. For an insurance company working under an infinite time horizon on the assumption that no final collapse will ever occur one could perhaps say that the world would eventually generate data to allow the estimation of a forecasting model that generates major collapses now and then. Perhaps this is sufficient to guarantee insurability?! What kind of equilibrium properties of the model system does insurability, predictability and the absence of uncertainty require? The minimum requirement to my mind would be that the model economy in the absence of outside (unpredictable) disturbances eventually convergences "to within the interval" irrespective of initial conditions prevailing when experience began to be accumulated. This property of our system can only be ascertained by analytical methods. There is no empirical way to know, and we should impose the property if we believe in it. If you do, then your theory should be capable of predicting, for instance, major economic collapses and all risks should in principle be calculable. If not, uncertainty in the sense of uncalculable risks is present.

When the time horizon is shortened because of lack of knowledge or unability to analyze complex information, if your theory is bad etc., uncertainty enters as a practical concern. This is well illustrated again by simulation experiments (see Figure VIII:1). I know of no econometric model (real or potential) that, on the basis of the 80 quarters or so of micro and macro data preceding the collapse in the year 20 would have been able to forecast its occurrence, and even less its timing and extent.

From this viewpoint the bounded rationality that characterizes decision makers in the micro-to-macro model economy creates uncertainty. If all decision makers understand that their model of the world is a simplification of the entire world, if they all the time keep learning from their mistakes by updating their model, if the learning experience of all is a converging process in the sense that all errors over all time in retrospect can be treated as random noise, then you have an equilibrium model in the sense above and expectations can be said to be rational. Even so the time dimension of the learning process is undefined. Unless you want to treat major economic catastrophs as normal learning experiences that will eventually tell you how to avoid future such catastrophs, no welfare or policy recommendations are possible.

5. Equilibrium or Stability?

Time requirements are critical. This lends very special qualities to any equilibrium one desires to define.

Each period a set of equilibrium prices can be computed that clears all markets and leaves all agents with desired inventories. In general, however, this set of prices is not compatible with

(1) efficient next period production (output), or

(2) the preservation - through investment - of existing capital installations. Neither is it compatible with

(3) the same production set the next period.

Hence, the next period supply of quantities in the market will generate a new set of clearing prices and so on, that moves production plans and investment plans ahead at different rates etc. The interacting of prices and quantities (p,q) over time is the concern of this chapter. Can the market perceive and peg a set of prices ($\bar{p}$) which makes quantities converge upon some stable set of growth trajectories ($\bar{q}$), such that we can talk about a "stable equilibrium quantity vector"? Or is there a dominant player (trader or policy maker) with enough resources to trade at those prices until the whole economy caves in onto his set of prices?

The former is the traditional question and it is normally addressed as a mathematical optimization problem. If there is a solution, the "auctioneer" will certainly find it if enough time and market struggle is allowed for.

However, if there is no global optimum what kind of dynamics will we have? What will such an economy do to us if allowed to "move freely"? Is the solution set narrow enough to allow us to talk about "the equilibrium" as a bounded n-dimensional oscillation?

Are the bounds in the n-dimensional corridor path independent, or will the location of the corridor depend on where you begin or how the system "steps along"?

Should we even consider dramatic changes of corridor locations (collapses) now and then? Perhaps there is no corridor system at all, and no resemblance of an equilibrium situation, or "chaos", as it has also been called.[4]

If the real economy has got no stable, static equilibrium - which is perfectly possible - then equilibrium theory may give very misleading predictions and especially when predictions are transferred to a real economy in a disorderly state. This means that we cannot accept, as a working hypothesis that statics is a limiting case of dynamics and that "properties of a (comparative) statical system" give information of the dynamic system (Samuelson 1947, p. 284 on the correspondence principle).[5]

Suppose there is an equilibrium where the economy will stay <u>if</u> it finds its way there. But suppose dynamic processes (search rules, the institutional specification) never, or rarely, take the model there. The first question - conditions of equilibrium or rest - is the fundamental existence and stability problem of static, competitive analysis.

How to get there is our problem. It is usually avoided in literature.

Why are we at all interested in equilibrium and stability? Of course, because quantities that move erratically within widely defined boundaries are socially undesirable (E 1983a) and defy our sense of social economic order. If the free national economy is inherently unstable or unbounded, then we want to impose restrictions (regimes) and policies that narrow down the boundaries to what is socially acceptable. To many this is enough to ask for a Government to step in to guarantee "order" or "equilibrium". Once this general problem has been opened up we have to accept, however, the possibility

that a market economic system is inherently unstable, and can be disturbed by policies;

that there are limits to the stability (boundedness) that policy makers can impose;

that a distinction has to be made between stability at different levels of aggregation.

This is again the question of controllability of an economic system. Any systems theory of an economy, like a Keynesian model or a general equilibrium model is characterized by the degree to which the system is self-coordinating, or needs policy guidance to move within a predetermined, bounded domain. Controllability has to be addressed if we think we need a dynamic model like MOSES to understand the real world. Endogenous and interactive price and quantity adjustment at the micro level is exactly the specification that gives rise to all this trouble.

In a dynamic model we can leave the world of the Walrasian auctioneer and ask the question; what happens if a dominant player - a monopolist like the Government, a large trade union or a large firm - simply keeps trading at a predetermined set of prices, which would not be an equilibrium set of prices, and which could never be, if we are confronted with a non-cooperative game? This is the general notion of "price regulation". It is exercised in planned economies. It was exercised partially through the Bretton Woods fixed parity system in international trade. It is the rationale for the existence of monetary policy as something different from fiscal policy (see Section 4 in Chapter IV, p.186), and so on. Now suppose that "price regulation" so defined can be effectively imposed and/or that it cannot be countered through the creation of black, gray or unobserved markets (which, of course, is an unrealistic, theoretical assumption). If the dominant player through financial resources, exhortation and/or political stamina can impose that price vector indefinitely the structure (quantities) of a dynamic, microbased economy, like the MOSES model, will eventually adjust to the imposed price vector.

It may, however, not be possible to impose any price vector, because a large set of price vectors may generate quantity oscillations that are socially unacceptable, but nevertheless, there <u>may</u> exist a set of price vectors that, if imposed, gives the entire economy a satisfactory quantity performance.

This must be the policy problem of a national economy. In the MOSES economy there exist some truly exogenous prices (foreign prices) that can be manipulated at the border through the exchange rate. Fiscal parameters can inflict "wedges" on the domestic price system. The domestic interest rate can (in principle incorrectly) be made endogenous. What are the options of controlling such an economy through policy manipulation in the sense of doing better than leaving the economy on its own, with a fixed regime specification? And what do we mean by doing better? This is a question about the relative performance of the invisible and the visible hands.

6. Welfare in the Long Run and in the Short Run

If individuals would accept a wide margin of variability in an economy then the problem of equilibrium and stability would go away. Equilibrium and stability require a welfare context to carry an economic meaning.

To make the welfare point let us discuss what happens to firms in the MOSES economy as if they were individuals. Can we use the traditional welfare criteria in the dynamic setting of the MOSES economy? Hahn (1982) does that in the dynamic setting of the real U.K. economy in discussing Mrs. Thatcher's policies, using pareto optimality as a welfare criterion (see below). We attach two meanings to a pareto optimum. The first relates to the static concept as traditionally defined. What happens when it is extended in time to cover more than one generation? We begin with that. The second is a more common-sense notion. If the economy is not in pareto optimum, meaning that some can gain without hurting anyone else, then the economy is not in long-run equilibrium. There will be economic forces at work to move the economy toward pareto standard. If the first (dynamic) notion is ignored, as in Hahn (1982), an entirely different conclusion is reached. This discussion is important to determine what the government can, and should, do. In the process, however:

(a) the economy may move through several depressions clearly making some individuals better off for some time at the expense of others,

(b) many, or all, of the initial population may die. Future bliss, if it at all exists will benefit future generations.

Even without the generational problem, to apply the pareto criterion one has to make the absurd assumption that each individual's time preference is known so that a "pareto optimal" time path up to bliss can be chosen (cf. Varian 1980).

With sequences of qenerations a pareto optimum must mean that a Government should only pursue policies that leave each individual in the next generation at least as well off as each of his predecessors. Besides being nonsensical, such policies may not be at all feasible in a dynamic economy. The normal situation in a dynamic economy probably is that some gain and some lose all the time for the economic process to stay alive at all. So, in a dynamic setting the whole set of traditional, static, ground rules associated with standard economic welfare criteria cease to be of much interest.

If attainment of pareto equilibrium conditions in the future can only be reached by breaking the same conditions over an indefinite time span, then forget about the whole idea. The complication of dynamics is elegantly sidetracked in Hahn's (1982) beautiful discussion of the pros and cons of the invisible hand as represented by Mrs. Thatcher's ideas, based on a strictly imposed pareto criterion and a zero time dimension.[6] To begin with it is wrong to talk about an invisible hand in the static Arrow-Debreu model where no markets exist. The central planner (the auctioneer) in the Arrow-Debreu model, on the other hand, cannot guide agents that do not form both price and quantity decisions (as pointed out by Arrow, 1959), only hold them in place when in equilibrium. Will the removal of the "political pareto obstacle" give more leverage to the market or the government intervention argument? This is a highly practical question, that can be illuminated in the MOSES context.

As far as can be learned from a large number of simulation experiments on the model, continued economic growth at the macro level requires a constant transformation of micro structures. The origin of this Brownian motion at the micro level in turn can be traced to the prime mover of the economic system, namely constant innovative (or technical) change at the micro level. Innovative change is, however, only a necessary but not a sufficient condition. The institutional setting (we have called it "the market regime") has to be the right one. The market regime has to support change at the optimal rate. Too rapid change can disrupt the system; too slow change means low, or no, economic growth at the macro level. The MOSES economy always takes a long time in exploiting the technological frontiers introduced by the innovators (E 1979). However, as far as can be seen, the maximum, sustainable macroeconomic growth path for a given innovative input has to be supported by a sequence of overlapping long and short-run cycles.

Macroeconomic growth can "temporarily" - for several decades - be speeded up by countercyclical policies that remove recessions and/or by a more rapid reallocation of resources - only to be followed by a "collapse-like" development (E 1983a).

The collapse can be avoided by constraining the allocation process at the cost of slower macroeconomic growth and a permanently larger exposure to exogenous shocks - in an open economy - from foreign competitors that upgrade the competitiveness of domestic producers. But none of this can be achieved without constantly displacing achieved welfare positions at the micro level in both directions.

7. The Preservation of Structural Diversity

The preservation of structural diversity appears to be an important feature of a stable macro growth process (E 1983b). The capital market is the prime vehicle for controlling the system in that respect. Even with homogeneous labor the productivity of labor depends on its allocation. If there is enough variation among firms there will normally be enough variation in wage paying capacity to generate wage dispersion. If wages are "regulated" and not much variation is allowed (E 1983b), the low performing firms are forced out of business and the high performers earn a hefty profit. For such an economy to preserve diversity there has to be a steady input of high performing activities, to allow the average level of wages to increase continuously, all the time killing off a tail of low performers.

If this entry and exit process is not vital enough, either wages have to spread again, or the distribution of ε (see previous chapter) flattens. This is a sign of latent instability (E 1983b) that we also saw develop in the Swedish economy in the mid-70s. A small upward shift in the interest rate can suddenly make the "bulk" of industry ε negative (a "cost crisis") causing contractions in production, investment and employment that eventually restore diversity through an adjustment of the overall price structure. During the adjustment process the macro economy suffers a collapse, a depression or a recession depending on its extent (E 1984c). Apparently flexibility of prices plays a role in avoiding severe quantity adjustments. However, it does not follow generally that the faster the price adjustment the better (E 1983a) because price adjustment can easily get disorderly, decreasing market price predictability. Downward rigidity of nominal wages means that firms opt for curtailing production when profitability standards are not met. However, the key notion in the adjustment process ultimately is the rate of return standard imposed on the economy. In an open economy, like the Swedish one, where both product prices and the interest rate are imposed more or less from the outside, the economy and wages have to stay in line as was elaborated already in Chapter II.

In a closed economy in the traditional sense we only have to ask what capital owners can do alternatively with their resources. It is difficult to imagine a market economy in which the foreign interest rate or interest rates in other countries do not play a crucial role in setting a lower limit to rates of return. A rigid rate of return target - a "floor" - in a badly performing economy either forces improved performance through productivity improvements and/or domestic price adjustments and/or a quantity collapse, as we have demonstrated. The ownership function is only symbolically present in a MOSES firm. We, nevertheless, discussed it at some length in Chapter IV, because, contrary to the anonymous capital market the owner is a "trader" in the sense of Clower-Friedman (1985) between the business and the capital market. The ownership function operates directly on the "productivity solution" supplying finance to profitable producers and removing it from bad performers.

Suppose there is no owner and a closed economy. We have not yet set up such an experiment, but we can approximate it by making imports and exports exogenous and by removing financial transactions across the border. The latter can technically be done by closing off the monetary sector and imposing a firm profit target of the pure feed-back type without any external inputs. Even this economy would not be safe from collapse prone developments, since there is always domestic competition for resources, notably labor. Firms with superior productivity performance bid labor away from bad domestic performers. Only when domestic competition is closed down, by removing incentives or possibilities for labor to move and by allocating intermediate goods by some other means will market generated quantity collapses disappear. Then - using the MOSES targeting system - firms will use their individual targets. No reallocation gains will occur and economic growth will presumably dwindle away, or turn negative (cf. E 1985a).

Since there will normally be some competitive processes at work, even in a planned economy, economic growth will be associated with a cycle that reflects both sides of the allocation process, entry and expansion of new processes and exit. At the micro level this allocation process constantly changes the work environments of individuals. Individuals will lose their jobs. They may find better paying jobs, but once in the market they may have to accept a lower pay than before. The ability of the economy to avoid macroeconomic collapses may decrease if the downward rigidity of nominal wages of people employed is removed,[7] and so on. Taken together this means that the growth process will constantly violate the pareto criterion. A successful macro economy will require a population of gamblers or a very efficient compensation or insurance scheme.

Full insurability requires that all uncertainty can be handled as calculable risks (see above). This in turn requires that the market somehow can enumerate all possible outcomes over the indefinite future, apply an interest rate and compute and choose the best paths. If all the possible combinations of paths can be surveyed and players can form the necessary coalitions for everybody to be in a position that he will not be inclined to leave, we have by definition a Nash equilibrium.

How about that in MOSES? Take the first step the wrong way, and only a second best solution is open, and so on. The fact that action is taken before available knowledge has been analyzed fully by the agent and by the system is enough to guarantee that errors will be made frequently. Hence, all possibilities cannot be surveyed to reach a global optimum.

We can now return to the four different allocation effects introduced in Chapter I. They were:

1)	Static efficiency	- Reallocation of given quantities or given prices (competitive equilibrium theory)
2)	Static, neoclassical efficiency	- Investment growth on given price signals (steady state economics)
3)	Dynamic efficiency	- Disequilibrium capital market coordination generates macroeconomic growth cycle
4)	Schumpeterian efficiency	- Entry, exit and institutional recombinations

8. The Capital Market Process Summarized

We now make some simplifications to achieve a measure of transparency in explaining (a) interest determination and (b) the valuation of the firm, to understand the disequilibrium engine of the growth cycle in the next section. In doing so we draw directly on the summary,formal presentation in Chapter V.

Imagine that product and labor markets are in equilibrium. Firms are operating on their production frontiers and sales, price and wage expectations always come true. This assumes away the Wicksellian capital market disequilibrium, but it allows us to concentrate on the exogenous Schumpeterian innovative rent creating process represented by the ε_i factor, or the rent.[8]

8.1 Household Saving

The next simplification involves assuming away all economic actors but households and firms. All income derives from employment in firms or dividends from firms.

Since labor is homogeneous and the labor market is in assumed equilibrium wages are the same, and we can aggregate all savings functions. This implies that dividend income is equal across the labor population. Hence, <u>the aggregate household savings function</u> looks like (E 1978a, Section 4.8):

$$SAVH = F_1[DI, RI] \qquad \text{(VII:1)}$$

$$DI = W \cdot L + DIV \qquad \text{(VII:2)}$$

8.2 Firm Investment and Finance

All debt in the system is taken on by firms and the only source is the household sector. Firm investment given, we assume a simple "production technology";

$$PQ = \xi K \qquad \text{(VII:3A)}$$

There are no other assets than production assets and:

$$CH(PQ) = \xi \Delta K \qquad \text{(VII:3B)}$$

Investment in one firm i (INV_i) is according to the cash flow accounting identity:

$$INV_i = P_i Q_i - W_i L_i - RI_i BW_i - \Theta_i NW_i \qquad \text{(VII:4)}$$

which simplifies to:

$$INV_i = (RNW_i - \Theta_i)NW_i$$

If;

$$\Theta_i = F_2(\varepsilon_i) = \alpha_{2i}\varepsilon_i \qquad \text{(VII:5)}$$

$$\varepsilon_i = RRN_i - RI_i$$

then:

$$INV_i = [RRN_i + \varepsilon_i(\Phi_i - \alpha_{2i})]NW_i$$

Now assume:

$$RI_i = F_3(RI, \Phi_i) \qquad \text{(VII:6)}$$

or more specifically:

$$RI_i = \alpha_3 RI + \beta_3 \Phi_i$$

After a fair amount of algebraic manipulation we now obtain:

$$INV_i = RRN_i[1+(\Phi_i-\alpha_{2i})]NW_i - \beta_3\Phi_i(\Phi_i-\alpha_{2i})NW_i - RI\cdot\alpha_3(\Phi_i-\alpha_{2i})NW_i \qquad \text{(VII:7)}$$

8.3 Capital Market Macro Equilibrium

Capital market equilibrium requires that:

$$SAVH = \Sigma INV_i \qquad (VII:8)$$

We want to solve for the interest rate, RI. We have entered all sorts of simplifications to make that possible but it cannot be done unless we assume something like:

$$SAVH = F_1(DI;RI) \qquad (VII:9)$$

or more specifically

$$SAVH = \alpha_1 \cdot RI \cdot DI.$$

Then the equilibrium condition above gives:

$$RI = \frac{\Sigma[\qquad\qquad]}{\alpha_1 \cdot DI - \Sigma\alpha_3(\Phi_i - \alpha_{2i})NW_i} \qquad (VII:10)$$

We do not need more than that. Even when the short-term labor and product market dynamics of the economy have been assumed away, supply and demand in the capital market will be in a flux and the general equilibrium interest will follow a path that depends on a spectrum of rent distributional characteristics in the firm sector.

There is no guarantee that RI will equal the RRN's of the marginally best performers in the market. It can be above or below, creating large swings in investment, which is dependent upon the individual firm ε_i. We will ask below whether there is a solution with $RI = Max(\varepsilon_i) + RRN_i$ or $\varepsilon_i = 0$ for all i among the feasibility set of (RI, RRN_i) distributions that satisfy the macro equilibrium condition above.[9]

8.4 Valuation of the Firm

The rent affects the market valuation of the firm and its ability to borrow. The extent of borrowing affects the credit market's valuation of firm risk exposure and the local interest charge, and hence indirectly the rent. An important local interest-and rent-determining factor hence is the leverage factor Φ_i, which measures local firm risk exposure. It is defined (see expressions (IV:14,15, pp.199 ff.) in Chapter IV):

$$\Phi_i = \frac{BW_i}{SH_i} \qquad \text{(VII:11)}$$

where

$$SH_i = q_i NW_i \qquad \text{(VII:12)}$$

q_i is Tobin's q.

SH is the market valuation of the reproduction value of Net Worth (NW_i). It is the market assessment of the leverage that enters in the local interest determination. Since the local interest rate affects ε_i and investment, the conventional valuation formula for the firm, assuming myopic expectations on the part of the market (see Section 5.1c in Chapter IV), is:

$$SH_i = \frac{\Phi_i \cdot RNW_i \cdot NW_i}{RI - (1-\Theta_i)RNW_i} \qquad \text{(VII:13)}$$

We use the market interest rate (RI) as discount rate. This expression immediately gives

$$q_i = \frac{SH_i}{NW_i} = \frac{\Theta_i \cdot RNW_i}{RI - (1-\Theta_i)RNW_i} \qquad \text{(VII:14)}$$

and

$$\Phi_i = \frac{BW_i}{SH_i} = \frac{1}{q_i} \cdot \frac{RI - (1-\Theta_i)RNW_i}{\Theta_i \cdot RNW_i} \qquad \text{(VII:15)}$$

8.5 A Few Propositions

With the real side of the economy exogenously given and in an assumed equilibrium, we can argue a few tentative propositions about the capital market process.

First, if the local interest rate (RI_i) and hence costs for the financing of investment, depends on financial exposure as measured by Φ_i, and this is the way suppliers of credit see it, then the allocation of credit on firms, and hence on investment, should be affected by the risk exposure of the firm as well as of future expected profitability. If risk exposure is inversely related to future profitability prospects, this may not matter. But if there is a tendency among the new prospective investors and innovators (cf. argument of old and large versus new, innovative and small firms) to have a bad financial risk exposure (low Φ_i's) as seen by the market, then negative real macro allocation effects should be expected. Here we have a first rationale for particular equity arrangements to compensate for a deficient relative risk exposure.

Second, it is interesting to ask what would happen to the market interest rate RI - with the real economy in assumed equilibrium - when the financial or capital market approaches micro equilibrium. The question is: What happens to RI when all $\varepsilon_i \to 0$ everywhere from below? Market competition for funds should push RI upwards toward the high end of the R_N distribution, while the low or negative ε_i firms are competed out of the market (exit). We have from (VII:2) and the macro equilibrium condition (VII:8) that SAVH equals total investment:

$$\alpha_1 \cdot RI \cdot DI = \Sigma[RRN_i + \varepsilon_i(\Phi_i - \alpha_{2i})]NW_i \qquad \text{(VII:16)}$$

Reshuffling terms a bit we obtain:

$$RI = \frac{\Sigma \frac{RRN_i \cdot NW_i}{NW}}{\alpha_1 \cdot \frac{DI}{NW}} + L \qquad \text{(VII:17)}$$

$$L = \Sigma\varepsilon_i(\Phi_i - \alpha_{2i})NW_i \to 0$$

when all $\varepsilon_i \to 0$

Hence with all $\varepsilon_i = 0$ we have

$$RI = \frac{RRN}{\alpha_1(\frac{W \cdot L}{NW} + \frac{DIV}{NW})}$$

or

$$RI = \frac{NW/A}{\alpha_i(\frac{W \cdot L}{\pi} + \frac{DIV}{\pi})}$$

where $\pi = P \cdot Q - W \cdot L$.

I am somewhat unclear what this means. The nominal market interest rate RI equals RRN (the average nominal rate of return on total assets in industry) divided by the product of the macro savings rate out of disposable income (α_1) and the sum of the fraction of profits (π) paid in dividends and the ratio of wages to profits. Even though the last ratio is clearly above unity, the savings rate is much below unity. Hence, as a rule RI > RRN and the average $\bar{\varepsilon} < 0$.

9. The Growth Cycle Verbally Summarized

In the artificial setting of the M-M model the growth cycle is generated through the multiple forces of

(a) exogenous Schumpeterian innovations, creating superior business performers in terms of $\varepsilon_i > 0$,

(b) the inability of the capital market under such conditions to establish anything resembling equilibrium conditions and

(c) an historically determined financial risk exposure of the individual firm, that

(d) together determines a macro distribution of temporary "rents" ε_i that moves investments of individual firms.

Remove the assumption of equilibrium in product and labor markets and even more diversity and micro instability enters the determination of ε_i.

The essence of the macroeconomic growth process can now be summarized by the following factors:

(1) The human capital productivity potential resulting from the combinatorial activities of "the entrepreneur" is extremely high. The distribution of this combinatorial competence is unknown and/or the outcome of such combinatorial activities is highly unpredictable.

(2) The socially and culturally defined market regime determines the extent and intensity of entrepreneurial search for new combinations (innovations) and hence the average outcome. The regime includes individual and political preferences, risk aversion, incentive systems and educational achievement levels of the economy etc. Hence, it is almost impossible to parameterize.

(1) and (2) to some extent incorporate noneconomic factors that supply a continuous, exogenous "feed in", or supply of entrepreneurship that contributes towards the maintenance of diversity. Innovations upgrade the quality of new investment exogenously. The investment decision of the individual firm is, however, endogenous.

(3) Rents (called ε) from successful innovative behavior arise temporarily in the economy. They first accrue to the "contract holder" of the innovation and benefit the rest of society indirectly through a higher and more efficient production, with the delays needed to develop (invest in) the roundabout process. The contract holder in our simulations is the owner of the net worth of an individual firm.[10]

(4) Competition in all markets limits the extent of temporary rents, forces inferior units to exit (creative destruction) and releases factors of production (notably labor) for more productive employment elsewhere.

(5) The investment decision in the firm is moved by the rent ε, and the firm decision makers are only partially aware of the origin of the rent.

(6) Price decisions in firms are taken on the basis of perceived prices as offered and charged by all other agents in the market, as computed by the firm under a profitability constraint. The complexity of the market game makes it impossible for each firm management to foresee the consequences of all possible activities of all other firms in the market.

Hence, this game appears to be of the non-cooperative type and the distribution of rents is dependent upon how, and how fast, all participants in the game jostle into position in each market (competition).

(7) The market process generally pushes the economy towards increased static efficiency, conditional upon the future relative prices as viewed (expected) by agents in markets at each point in time.

(8) The adjustment of quantities towards static efficiency, can be too fast and generate gyrations in the price system of the economy that lower predictability and take the economy down below the growth trajectory on which it would have traveled without these gyrations. This

new trajectory embarked upon each period changes all future trajectories open to the economy if, and when, the price system is stabilized. The new price system will in general be different from the one that would have persisted, were it not for the disturbance that initially sent the price system into gyrations. The long-term reason for this is the fact that the new trajectory implies a changed relative cost structure in the economy due to structural adjustment and a different allocation of investment.

The adjustment process can also be erroneously conceived. Expectations can be wrong or prices can be fixed temporarily in positions not supported in the longer term by the market process, by a dominant player like a price leader or a price controlling agency.

Attempts to fix prices in relative positions that are not supported in the longer term by the market process disrupt both quantities and prices after some time. Disruptions generally take a long time to correct and tend to lower price predictability in markets throughout the adjustment period. Disrupted relative prices are symptoms of increased uncertainty (lowered predictability) and are at first interpreted by agents with the old rules of thumb. Mistakes are made and agents scramble to relearn and adjust interpretation rules. In the process, caution prevails. Growth rates are down.

(9) The supreme arbitrator of the M-M economy is the rate of return requirement imposed through the Fundamental Equation (III:1) in Chapter III on each firm. It can be viewed as both

internally generated (from past performance) and externally imposed by the capital market.

(10) The capital market is decisive for long-run economic systems performance in the M-M economy. Very large and widespread rents (= $\varepsilon_i > 0$) tend to generate waste (misallocation) in the investment process. Too small rents tend to shorten the gestation period - to use an old Austrian term.

There is a tradeoff between short-term allocative efficiency and the ability of the economy to maintain investment activities that take a very long time to generate profits. The optimal balance (the "interest problem") is a problem that has to be settled empirically. The short-term allocation aspect is the traditional, neoclassical, micro interpretation of the Wicksellian hypothesis. The other alternative has been emphasized in Dahmén (1984). For instance, if rents are kept high in a low performing industrial economy through low interest rate policies or generous tax policies, the result is different from the case in which rents are high because of a superior commercial performance relative to, say, an international market interest rate (cf. Chen 1979).

One consequence of allowing the endogenously determined rents ε to affect individual firm investment is that cyclical behavior unavoidably enters as a natural factor in the growth process. Two factors can start the cycle; (1) an exogenous, unexpected change in market conditions for firms; or (2) a failure of the market system to establish a transparent, predictable price system and to adjust quantities to it, barring exogenous changes in the price system. The reason for the cycle is that it takes longer to create the new superior capacity to produce than it takes to scrap installed, inferior capacity. There is always an intermediate solution that is superior in stabilizing the price system and the economy on the fastest sustainable growth path.

10. Managing the Growth Cycle

The conclusion appears to be that economic growth is a genuine disequilibrium process. Without the two types of dynamic market allocation mechanisms described above there will be no macroeconomic growth. The state of disequilibrium is reflected in the extent and dispersion of rents ε, or entrepreneurial remuneration, in the economic system. These rents cannot be removed without disturbing the economy and eliminating macroeconomic growth.

An economic system with no rents or approximately so, meaning equally looking and equally performing firms, will be extremely unstable and fragile (E 1984c). We have not been able to derive the properties of the MOSES economy analytically with all ε_i competed away ($\varepsilon_i = 0$), but I venture the hypothesis that it will collapse rather than approach a zero growth situation as all $\varepsilon_i \rightarrow 0$. This proposition suggests that if micro diversity is narrowed down today, the domain through which the economy may have to travel in the future gets wider (increased instability). Excess demand policies over a long period could have such long-term effects, especially if the supply of innovators and entrepreneurs, through new entry, is inadequate (cf. E 1983a).

Intense price competition and rapid quantity adjustments can also generate such results (E 1984c). A dominant player like the government can generate similar results through manipulations with the market regime that in turn regulate competition. Obviously, all this has to do with the nature of the turnover of micro rents ε_i in the markets.

Dominant player control can be engineered in two ways. The dominant player can (1) attempt to impose his or her price system on all other players. Our proposition is that in the end - if he or she persists and if the actions are not countered by new organizational market solutions (institutional dynamics) the price system of the economy will be destabilized and the economy will collapse. The alternative for the dominant player is (2) to play with the markets. Among other things, experience with the MOSES model economy has told us two things; that there is an optimal market (speed) regime for each set of exogenous circumstances, and that the more of continued diversity the economy can engineer through innovative entry and high D(MTEC) and D(INVEFF), the faster the markets can work without getting disorderly. Viable entry and exit functions are the main diversity creating functions, market competition is the main diversity eliminating function.

NOTES to Chapter VII

1 See E 1984b, Table 9B, p. 42.

2 Note that even though I write so, the corresponding model representation today only fractionally matches the real activity going on.

3 This is the distinction made by Lindahl already in (1939, pp.348-49) and in Hart (1942).

4 Note that chaos is perfectly consistent with the existence of an equilibrium point, but the economy is never there and does not even approach it. See Day (1982a,b).

5 Competitive equilibrium theory, for instance, is only concerned with the existence and stability of equilibria, and not at all about how they are to be reached. Approach has to be guaranteed for the correspondence principle to apply.

6 Of course, the verdict comes out against Mrs Thatcher, which was probably the idea from the beginning.

7 Downward rigidity of nominal wages of people holding a job is currently a feature of the model.

8 The rent can depend on an erroneous evaluation of the firm itself, by the market as expressed in RI_i and Φ_i (a possibility that we assume away here) or a general capital market disequilibrium, meaning here that the general market interest rate "the bank" or the market charges an individual risk premium related to Φ_i.

9 The individual firm rent $\varepsilon_i = RRN_i = RI_i$ can be decomposed into a pure Wicksellian micro rent

$$RRN_i - RI$$

and a corrective factor

$$RI_i - RI$$

that depends on the local firm financial risk exposure.

10 There is a fundamentel difference between this type of rent, and the rent arising out of a raw material resource. This rent arises out of new, created knowledge. By exploiting this knowledge in other industries - through imitation - the rent may eventually be competed away, but the new knowledge has permanently raised the level of productivity.

PART IV

THE MICROECONOMETRICS OF MOSES

''With both feet firmly
on the ground, you are
standing still''.

Unknown Norwegian
Philosopher

VIII Estimation, Databases, Tracking Performance and the Empirical Application of Moses

1. Introduction

There are four kinds of empirical issues related to the MOSES econometric model. The first issue has to do with modeling objectives. It can be dealt with clearly and immediately. M-M modeling aims at improving the information content of data and facts. Theory is a set of a priori assumptions and guesses needed to bring data together into a coherent systems form. We obtain a "working hypothesis", that should be subjected to further testing. However if we believe in our theory, a "working hypothesis" can serve as a guide in policy making.

The second issue relates to the first, and concerns the problems of estimating the behavioral relationships of the model, in short, bringing in the facts. Facts are not independent of theory.

Thirdly, since most economists are unfamiliar with these kinds of models, a comparison between the nature and quality of information carried in the MOSES system and a more familiar macro model is warranted. Some simulation results on the current empirical version of the model should be presented. It turns out that this to a large extent means accounting for the micro database upon which the model is run, and only secondarily has to do with statistical fits at the macro level.

Finally, an empirical chapter should also report on the empirical analyses for which MOSES has so far been used.

2. Micro Estimation

The ideal econometric procedure would be to estimate every single relationship at the micro level under the constraint of a time series of real macro data that also the model can generate. This has of course not been possible. We have applied an approximate procedure. We have estimated or guessed at individual micro relationships. We have then attempted to modify them so that they fit the chosen set of macro time series. The results of a series of such calibrations - as we call them - are pictured in Tables VIII:1A,B,C. A set of parameters as they have been manipulated in various experiments are displayed in Table VIII:1D.

Before we get into the practicalities of this calibration let us go through the logics of the ideal estimation procedure, highlight the errors we have deliberately made and discuss the risks of erroneous inference that are associated with such a procedure.

Let us therefore assume that we have a very simple micro econometric model consisting of n identical, but numerically different, linear equations. Each micro agent possesses k different dependent variables (Y_{ij}) and there are n independent explanatory variables (X_{ij}).

All variables add up exactly to their corresponding macro (national accounts) variables

$$Y_j = \sum_i Y_{ij}$$

$$X_j = \sum_i X_{ij} \qquad \text{(VIII:1)}$$

The straightforward procedure would be to apply multiple regression techniques to a time series for each individual ij relation, or a simultaneous technique to a block of relations, explaining agent behavior under the constraint that, except for an error term, the model tracks the macro variables (Y_j, X_j).

The other extreme would be to assume that all conditions for ordinary least squares on each individual relation are fulfilled. Bad statistical fits at the macro level would be explained away by bad macro statistics - a good point in general, but not here.

Neither extreme approach is satisfactory. Since our main argument for the micro approach is the treasure of high quality micro information that we have, micro estimates should be given a fair chance. A general (Bayesian) approach to estimating the M-M model would be to weigh the sum of squared deviations at the micro and macro levels together, assign a relative weight to the macro deviation that signifies its relative importance in statistical quality, and then minimize the weighted sum of squared deviations.

Another approach could be to assume that each macro aggregate is associated with a stochastic error of measurement and assume that the errors average to zero in the sample for all Y_j. Given these conventional, stochastic a priori assumptions all micro parameter estimates can be given traditional stochastic interpretations. This is all right for the very simple model that we used as an example. Such estimation procedures have also been developed for simple models.

However, difficulties show up when we take the first steps in the direction of MOSES realism.

Three problems in particular should be mentioned in the context of estimating micro-based macro models.

(1) Aggregation is dynamic and explicit. A comparison of problems of estimating conventional macro models has to include a comparison of prior aggregation assumptions in the macro model, with behavioral specifications (priors) in the micro model. If these behavioral assumptions are well researched by micro inquiries such a comparison ought to come out in favor of the micro approach.

(2) Specification is complex and, hence, presumably more realistic than in conventional models. Non-linearities are normal and many specifications involve qualitative choices like exits from and entries to markets, etc. (see Brownstone 1983).

(3) While exogenous variables are decisive for predictive performance of macro models, this is not the situation in a dynamic micro-to-macro model. Initial conditions dominate macro behavior rather than the relatively few exogenous variables. Hence, the quality of initial database measurement becomes crucial. A related, and interesting problem is whether the MOSES model has, and/or should have long-run convergence properties in the sense that it eventually converges into a bounded domain - and stays there - that is independent of the initial state. Imposing convergence in that sense

means entering a prior dynamic equilibrium property in the model as a theoretical requirement. Like the corresponding property of static models, dynamic equilibrium in the sense of long-term convergence is an untestable proposition. I have not made up my mind whether I want such an assumption in a dynamic model. Contrary to the case in static theory this assumption does not simplify the mathematics of our analysis. Neither does it narrow down the set of possible predictions within a future time span that is of interest for economic analysis.

These considerations have led me to conclude that good and well researched behavioral specifications entered as priors, and high quality data are far more important to consider than the traditional estimation problems.

3. The Information Content of MOSES

The information content of the MOSES econometric model system is another issue. Information is carried very differently in the MOSES model, compared to what one is used to from conventional macro models.

For one thing the model is dynamic. Agents are not resting in equilibrium positions at the end of each period and this is part of their behavioral specifications. Hence, it is theoretically incorrect to estimate parameters on single cross sections of data. Panel data on agent behavior are needed, and then initial conditions become important.

In a macro model the bulk of information about the economic structure is stored in the estimated coefficients. Since macro model specification is often of the linear, or slightly nonlinear, type the information in the linear specification is restricted to an enumeration of the variables.[1]

Using a linear format would distort information if linearity does not in fact hold.

In the MOSES process model the information embedded in the coefficients of the macro model resides in (1) the initial structural specification (the state variables), in (2) the hierarchial (causal) ordering of the market processes that regulate the interrelationships between all decision units of the system, in (3) the estimated, and in (4) the postulated coefficients of the behavioral relationship, and in (5) the analytical categories (the taxonomy) chosen to represent the micro units.

3.1 **Initial Conditions** (database)

Problems associated with measurement errors and internal consistency in initial database specifications are as a rule neglected in the context of macro modeling. We cannot do the same in the MOSES model, a circumstance that makes it appropriate to discuss the quality of the initial database here.

The predetermined variables in all models are exogenous variables and lagged endogenous variables. The importance for macro model forecasts of "correct" specification of ("forecasts of") the exogenous variables has been discussed at length in the literature. There is, however, very little discussion on the importance of correct specification of initial values of lagged endogenous variables.

The lagged endogenous variables correspond to our initial database. Can this be taken as indirect evidence that errors in measurement and consistency problems associated with the initial database "do not matter" in macro modeling, while exogenous, predetermined variables do?

We have exactly the opposite experience from the analysis of the MOSES micro-to-macro model. Exogenous predetermined variables (they are quite few) mean relatively little, while initial database misspecification can generate a very different forecast compared to one where known errors have been removed (see further below).

The bulk of the empirical information on the Swedish economy vested in a micro-to-macro model of the MOSES type resides in the measured, initial state variables (initial conditions). They are continuously (quarterly) updated by the model as the simulation experiment runs on, and we know from experience with the model that the nature and the quality (overall statistical consistency) of initial conditions very much determine the properties of the simulation. The estimation problem here is good statistical measurement (the database technique). Therefore, we have invested considerable effort in obtaining a consistent micro-to-macro database to start simulations from (see Albrecht-Lindberg 1982). In macro models, on the other hand, systematic errors of measurement are picked up by the estimated coefficients and given economic interpretations.

In some sense this dependence on initial conditions is a handicap. The dynamic properties of the MOSES economy are not very robust vis-à-vis the initial state description. There are two types of variations in the initial state description that we have to consider; (1) actual variations in the "real" state that we measure and (2) errors of measurement including internal database inconsistencies.

Concerning the first problem, it could be argued that models should be designed a priori so that long-run properties do not depend upon initial conditions. I disagree. In my opinion, no dynamic model should be so designed. If the responses of a policy parameter change are very different depending upon whether policies are enacted at the bottom of, in the middle of or at the peak of the business cycle, the quality of initial specifications will be important (see E 1977).

How to handle this problem is an empirical question related to the quality of measurement. As mentioned, most of the project effort is currently going into database work. We want the model to be sensitive to systematic errors and inconsistencies in the database. To remove the problem of sensitivity we improve the quality of the database. However, errors of measurement cannot be eliminated completely and the robustness of the model to stochastic errors of measurement should be good. Robustness in this particular sense could be tested by designing an experiment in which the initial state description is polluted by random noise (Brownstone 1983). This analysis has yet to be carried out.

In macro model building very few initial conditions are normally needed. Much of the information residing in the initial database is ironed out through the imposed aggregation assumptions, meaning, as a rule, that all agents are almost identical and that they all rest in, or close to, equilibrium each period.

While the micro-to-macro approach uses good quality measurement of initial conditions, macro model builders enter a priori, ad hoc assumptions, that would rarely pass even a generous statistical test (see Klevmarken 1983 and Brownstone 1983). Micro-to-macro modeling is clearly a superior analytical method.

3.2 **Specification** (causal ordering)

The causal ordering of the interaction between decision units, to be specified here, corresponds to specifying the functional forms of the equation system estimated in macro modeling. The MOSES empirical background studies (notably E 1976a) have been used to investigate certain "facts" about the ways decisions etc. are taken within firms. Moreover, the MOSES measurement domain is close to the direct (human) observation level. When we don't know from direct case studies etc., we have used intuition, casual observation and scattered empirical studies to modify micro-macro specifications provisionally. This has been the method as model work has progressed. More systematic empirical work is gradually replacing assumptions and ad hoc observations.

All prior research notwithstanding, such specifications always enter as priors in the results that we infer from model analysis. The prior assumptions - they are all explicit - that enter the MOSES model are more numerous than the explicit prior assumptions that enter standard macro models. One way to compare the importance of a priori assumptions in micro-to-macro models, and in macro models would be (Brownstone 1983) to adopt a Bayesian view, seeing these assumptions as part of the prior distributions. The contribution of the prior distribution to the posterior distribution generated on the data by the model then measures their effect. In this new perspective all macro models rest on a vast number of implicit assumptions - at least as many as in the micro-based model - that are necessary, e.g., to obtain structurally stable relationships. And they are often simply wrong. The improved specification of microbased macro models where aggregation is explicit hence means improved intellectual control of the analysis, which is a clear scientific advantage.

3.3 Estimation

Macro models have a clear advantage on the parameter estimation side through simple specification. There are no intricate causal orderings and only rudimentary initial state descriptions. The information embedded in the initial database, the structural micro specification and the estimated and assumed micro parameters (see below) appear explicitly in MOSES, while they are packed into the parameter estimates in a macro model through aggregation assumptions. Simple estimation techniques on macro time series data now become feasible.

The richness in specification in MOSES, on the other hand, with many non-linearities, dynamic feedbacks and frequent switching of behavior takes us far beyond the capacity of current simultaneous estimation techniques. Furthermore, much of the empirical knowledge that enters the model, as mentioned, resides in its specification, and in the initial state (database) description. This is a matter of priors that enter the analysis. These priors, database measurement ("facts") and model specification are, however, generally introduced into MOSES in a form that can be subjected to empirical testing. But the fact that small variations in specification can mean a very different long-run macro behavior of the model makes this perhaps a more important matter to consider than the traditional estimation problems. The reason for this sensitivity is the dynamic specifications. This is a property that is also desired in well designed models. For instance, a bias in market price signalling caused by a tax wedge may make no difference for macro output for many years, only to begin, after a decade, to generate major negative growth effects, because of a decade of misallocated investment (see e.g. Eliasson-Lindberg 1981).

The micro unit decision models (the firms) are principally tractable for conventional estimation on micro time series. A simplified, and not very realistic version of the firm model could be represented by a nonlinear, simultaneous equation system. In principle, each firm model could then be estimated individually and be plugged into the market process as a block.

If this were possible, if the initial state variables were measured with great precision, if the same could be said of the exogenous variables and (finally) if the causal ordering of the market processes were right by belief and entered uncritically as a maintained hypothesis, there would be no more to say. The simulations would be the best representation of reality. If aggregate national account statistics were not compatible with simulations, the statistics, not the model, should be changed.

Estimation problems are not that simple. The MOSES firm model cannot be estimated directly, partly due to lack of data, partly due to specification problems. A realistic specification of the decision process inside the firm breaks the firm down into a sequential process. Parts (like the production frontiers and the investment functions) can be estimated. Beyond that a causal ordering like that between the firms also regulates the interior firm decision process. This, however, has been formulated on the basis of evidence from a large number of interviews on the budgetary, planning and decision organization of firms.[2] Hence, the micro parameters of the MOSES system are either estimated, based on variously assembled evidence, or simply assumed. In practice this will always have to be the case, although the number of estimated and researched specifications is gradually increasing. As a consequence, part of the estimation has had to be carried out in the form of trial and error experimentation with parameters to make the model fit national accounts aggregates for an historic period, and to generate micro firm performance scatters of actual firms (see below).

3.4 Taxonomy and Compatibility between Internal Firm and National Statistical Systems

The statistical taxonomies used in MOSES and in standard macro modeling differ significantly. The statistical grid of the macro model has to be based on a number of more or less artificial classification schemes (sectors, types of markets etc.) used by public statistical offices. The MOSES statistical system is specifically designed for MOSES theory. It goes right down to the decision unit, a firm, or rather a division, and at some later stage in the development of the model perhaps also to individuals or households (see E 1985b). In particular, firm behavior is modeled on the format of actual information and decision systems used for decision-making support in firms. Data are taken directly from the accounts of firms on their own format. This gives a measurement (statistical) quality, that macro economists will never obtain. The advantage for the micro-to-macro modeler, is that he models a behavior that he, in fact, can observe himself by visiting a firm or a household. Macro modelers have to observe the world through statistical intermediaries, which is like using consultants. They keep much of the information to themselves.

However, a serious problem of verification follows from this procedure. The national accounts data are always based on manipulated micro data. Data are modified or reclassified to suit particular macroanalytical needs. This poses two kinds of problems for us. First, consolidated firm data will not be entirely compatible with macro data, when the two data sets are merged (see below). Second, the errors that enter from these inconsistencies cause deviant behavior at the macro level. This problem has been particularly difficult to handle during the first quarters of a simulation, and made calibration of cyclical behavior frustrating (see below how this problem has been handled in the recent application of MOSES for policy experiments over the period 1984-1990).

3.5 Instabilities in Institutional Definitions

The ideal taxonomy should, of course, be composed of basic categories with stable physical and measurable characteristics. The division, or the single product firm - our "elementary particle" - should take us as far as we can hope to go in this respect in social sciences.

A division, or a firm also operates on a well defined, financially oriented measurement system, and as a rule, is guided by a fairly monolithic decision structure concerned singularly with long-term profitability. This is more or less right in principle and would be fine in practice if economic behavior were organized in such a way that exterior (surface) behavior of an economic unit could be explained for our purposes, without disaggregating further into the interior processes of the decision unit. This may be possible in some respects, but not when it comes to explaining growth in size of the decision unit (see E 1980b). Growth in size of a firm, as we have carefully noted, is primarily explained by the ability of the firm to earn a return on invested assets (a typical internal competence problem) and secondarily how it divides these earnings, or cash flows, into one stream that is reinvested in the company, and another that goes elsewhere. The second, less difficult part can be captured by our financially designed division, or firm, by modeling how it "leaks" or "attracts" resources.

Even so, a division defined by its business or "product" is not a stable institution. The life histories of divisions and firms entered in 1976 in a MOSES simulation (see listing in Albrecht-Lindberg 1982) can now be followed from 1974 to

1984 as financially defined institutions. Their "definitions" have often changed significantly during that period. The firms may have reorganized themselves on a different, organizational taxonomy (new divisions). The product definition, or the production technology may have changed through acquisitions and divestments, rather than through internal reorganization. This means that establishment growth (change) in the MOSES database is not one hundred percent internal and regulated by the rate of return and the cash flow, as the model presumes. This we have to accept and it won't help to disaggregate further down along production activities because then "institutional change" begins to increase again. A production line is normally very unstable in terms of structural or institutional definitions.

This means that our chosen observation unit probably maximizes institutional or structural stability. The micro units, as a rule, have been defined as organizational units by firm owners or managers on the same grounds. But firm managers do not need time series data to estimate models of their units to run them; they have access to interior information directly. The reader may have noticed that our modeling design to the extent possible uses the same technique, using similar sets of information as firm managers, mimicking their decision procedures and surveying their institutions once a year to update the database, thereby reducing the needs for direct estimation of the firm model.

3.6 Desired Properties

Dynamic analysis means comparing different economic processes. If the model is too complex for formal analysis, this means comparing the outcome of carefully designed model experiments. Testing the model could mean either finding out whether the model generates behavior of the kind that actually has occurred during some "sample" period, or behavior that is desired on a priori grounds. An "equilibrium" of some sort should perhaps exist? It should perhaps be stable etc.?

If one entertains very strong prior views, one may want to reject the model out of hand, or the estimates, if some desired properties can be theoretically proven to be missing. It has become conventional in economics to require the existence of a stable equilibrium for a model to be acceptable, and to discard models that do not exhibit such properties, with words that make it appear as if an empirical test had in fact been made. One example of this is that dynamic models that do not converge onto steady state growth paths are not regarded as empirically sound. I have long been disturbed by such practices, and am happy to note that theorists who have earlier been concerned about ascertaining these traditional properties have recently begun to relax their views on the same matters - in the wake of the experiences of the 70s, I presume. Personally, I would dismiss static competitive equilibrium theory out of hand from practically all empirical contexts. A sound practice would be to regard static reasoning in empirical contexts as misleading on prior grounds, until the opposite has been demonstrated. Empirical tests of static theory is bad method in general since the priors are normally wrong. There may be other reasons for indulging in static economic theory, but I have great difficulties - after many years of work on this model - to buy the argument of von Neuman-Morgenstern (1944) that "there is ample evidence that it is futile to try to build one (read: a dynamic theory) as long as the static side is not thoroughly understood". Samuelson (1947) pushed the same idea under the name of "the correspondence principle". I think it is simply wrong. For instance, I hope that the analysis of Chapters VI and VII has made it clear that growth models should not be constrained a priori by a steady state equilibrium growth path onto which the economy is forced, whatever treatment it receives from its environment, or itself.

The MOSES system probably belongs to the class of models that Samuelson (1947) calls "state dependent". It is possible that the self-regulatory market mechanisms of the model give it a dynamic equilibrium in the sense that it eventually converges on to the same growth path, or into the same "activity corridor", irrespective of initial state. Such a property can only be demonstrated analytically, and I have not been able to do that (see Chapter VII).

Fortunately, however, the MOSES simulation model offers some unique possibilities to extend the testing domain in the dynamic dimension. Growth is endogenized in a realistic fashion and historic experiments (50 years or more) can be carried out without making the macro growth trajectories a priori determined by trend assumptions. Comparison can then be made with historical statistics gathered from different countries. It is comforting to know that MOSES generates various combinations of cycles and growth rates where market regimes, rather than trends, determine long-run growth rates, that vary as much as they have done during the last 100 years between the industrialized countries. A real depression appears to be something normal, that perhaps should be expected to occur now and then in that time perspective (E 1983a and b).

3.7 Symbolic vs. Numerical Analysis

The mathematical or analytical economist by practice and tradition draws more esteem from his colleagues than his fellow number-cruncher econometrician. This higher esteem can only be achieved through simplification of problem formulation to achieve mathematical tractability. However, there is no law of nature that guarantees that the important problems that we choose to study can all be handled analytically by the mathematical languages that we happen to have, and to muster. The esteem market in which economists operate as a consequence is afflicted by a bias towards bad problem formulation. In this project we have to deal with a very particular instance of this problem. We may want to impose some long-run stability characteristics on the model a priori, or rather, we may want to know the asymptotic properties of the model. Such properties can be analyzed through numerical experimentation. Methods, especially graphics, are rapidly being developed to facilitate such analysis. The next section will include some illustrations. Numerical analysis is necessarily discrete. In practice, one cannot map and investigate all dimensions of the model. In this area, however, the computer is coming to help.

Symbolic analysis on the computer has been around since many years, and general solutions to fairly complex analytical optimization problems can already be achieved through computer analysis. Eventually this will put mathematical economics of today to rest as special cases of vastly more relevant problems. Thinking in economics will change dramatically as these new methods develop. Simplicity and transparency will no longer be the virtues, but rather process understanding. For instance, it is normally not very interesting to understand how a car is driven along a road in a normal operating mode. The problem "how a car is driven" cannot even be defined. But if the car breaks down, or begins to swerve, understanding of the unexpected, abnormal operating mode is suddenly very important. To identify and evaluate the situation under which new, unexpected, difficult operating modes will occur in an economy, or a model of the economy, is an analytical problem that is conventionally handled by trial and error, and occasionally through numerical simulation, e.g., in monitoring systems for nuclear power plants (cf. the discussion of the collapse of the North East power grid in E 1983a). General, analytical descriptions of the circumstances under which undesired events will occur in complex models will probably be an interesting domain for theoretical economics in the future.

4. MOSES Calibration in Practice

The actual estimation procedure of the MOSES model is more rough-hewn than the ideal ways discussed earlier. Three different aspects of what we have done have to be covered: (1) database work, (2) micro parameter estimation and (3) historic tracking performance.

4.1 MOSES Micro Database

To put the model project on an empirical footing a substantial database work has been required at the micro level. The annual planning survey of the Federation of Swedish Industries was originally designed (in 1975) on the format of this model to be used in model analysis. The model is currently loaded with 1976 data on divisions from the 40 largest Swedish companies and several medium-sized firms, altogether some 150 real life decision units (divisions). The idea has been to design a measurement system around these decision units, and to use the high quality data at the firm level to improve understanding of macroeconomic behavior through the model. Such data are seldom used efficiently in support of macro analysis. This is one raison d'être of the model project. Direct observation of the units of measurement allows the use of simple and efficient estimation techniques at the micro level. Some of this econometric work has been completed already, and some is under way, but much more data work has yet to be undertaken before the model has been satisfactorily tested.

Part of the database work consists in building a consistent micro(firm)-to-macro (national accounts) database that can be currently updated and improved upon by adding new real firms (see Bergholm 1983a and Albrecht-Lindberg 1982). The national accounts statistics are taken as the best available statistical macro picture of the Swedish economy.

Micro firm data from our own sources are ready and final once our checking is done. Macro national accounts data, on the other hand, are systematically manipulated to achieve macro consistency and tend to be revised substantially every now and then. We do not want to be dependent upon such revisions in the sense of being forced to reestimate the earlier model whenever a revised database is ready.

Hence, we have designed the following procedure. Micro firm models are estimated independently on our own micro data (see next section). The core micro database is unaffected by revisions in macro national accounts statistics. To make accounts match at the macro level the model "initialization" procedure consolidates all real firms in the database, computes an aggregate entity and takes the difference up to the currently available macro sector accounts. The residual (the difference) is treated as one firm, or synthetically split into several firms. They operate as the real firms in model simulations. The problem is that most statistical errors of measurement tend to appear in this residual. It is also heavily affected by each revision of national accounts data. When this occurs we simply reinitialize the model on the new macro database, if we wish to do so, leaving the core model machinery as before. Some problems of internal micro-macro database consistency nevertheless remain, and they show up in simulations during the first quarters or years, as jerky movements in some variables, as the demand and supply structures of the model adjust dynamically in response to these inconsistencies. This has been a real problem, when we attempted this year (1985, see below) - perhaps unwisely - to use the MOSES system in a forecasting context. The problem is that if macro national accounts statistics are manipulated to enforce consistency between a number of synthetically defined accounts compared to the databases from which they are collected, e.g. internal accounts of firms, corresponding adjustments in principle have to be made on the micro data that we use "uncorrected" in MOSES. We don't want to do that in MOSES work, because it is against the idea of running the model on the same information and decision rules as those firms use.

However, with such principles the national accounts data are not proper representatives of the Swedish economy. They should be corrected. In order not to turn the MOSES project into a Bureau of Statistics, for the time being we will be very restrictive in using the model for purposes that even resembles forecasting.

The Swedish national accounts (NA) statistics were not, and are not yet ready on a consistent format in real (production) input-output, nominal and financial dimensions, with a consistent price deflator system. This is unfortunately a requirement of the MOSES model even in a non-forecasting context, and for the same reason as before. Model behavior is very sensitive to inconsistent initial database specification. Hence, a provisional statistical "integration" of national accounts data has been attempted within the modeling project, and internal, structural inconsistencies have to some extent been cleaned out of the Swedish national accounts statistics (see Ahlström 1978, 1983 and Bergholm 1983b).

For instance, when a model simulation begins on a spectrum of initial supply and demand conditions that are partially inconsistent at higher levels of aggregation, the first few quarters of the model simulation involve sudden relative price responses that force excessively strong adjustments in the supply and demand structures. Most of these undesired properties disappeared when the new real firm database of 1976 was ready in 1980 (see E 1983a), but they reappeared again when a new, provisional database was put together for 1982 (see below).

The statistical dimensions integrated in our scheme are inter alia income statistics, production statistics, demand statistics, financial stock and flow statistics (the latter still not in good shape), delivery statistics in the form of a complete 11 sector input-output table, foreign trade statistics and a large number of price indices. The 11 sector input-output table is the most problematic macro source of statistics, since it is placed in the midst of the individual firm delivery system (see Bergholm 1983b).

Despite these deficiencies and inconsistencies among sources we have taken the NA levels as recorded in 1976 (current initialization year used in experiments) as a given "bench mark" for the size of the Swedish economy.

The micro data have been obtained directly from the accounts of the firm. They are internally consistent, but not 100 percent complete. Some cost items have been missing which make profit margins somewhat too large. We have obtained data on these missing items, and have used these data to approximate the same items for other years. After these corrections remaining errors do not seem to be large, but there appears to be a bias. The aggregate errors from the micro data together with errors in the NA statistics give a strong bias in the data for the residual firms in the direction of being low performers compared to average industry. The residual firms also exhibit unlikely internal combinations of data. In fact, synthetic firms are so bad that they are always the first to close down (exit) in simulation experiments.

4.2 Actual and Planned MOSES Micro Database

Besides aggregate statistics the MOSES micro database currently consists of two integrated sets of data;

- (1) the planning survey carried out annually and jointly with the Federation of Swedish Industries since 1975, was specially designed for the model. It covers more than 200 divisions or one-division firms and concentrates on the short-term operating characteristics (capacity utilization, output, employment, profit margins, etc.). Data begin in 1974. The entire survey covers some 70 percent of value added in Swedish manufacturing and about two thirds of the firms (together 110) have been used for model simulations beginning 1976. In a provisional update of the entire MOSES database for 1982, more than 200 firms are being used.

- (2) a firm financial database of balance sheets, profit and loss statements and cash-flow balances since 1965 on some 40 large corporate groups of one or several division units under (1) above.

The planning survey (1) provides data for the production system, especially for estimating and updating (through investment) of QFR(L) in Figure II:3 in Chapter II.

These micro databases have been made ready in steps. The first, all synthetic firm database engineered from micro statistics was ready in 1976. Financial group data, with half synthetic data on the production system were gradually introduced between 1978 and 1980. The current, integrated database from 1976 was (finally) ready in the late fall 1980. The provisionally updated database for

1982 has been used in the IUI 1985 long-term survey (see below).

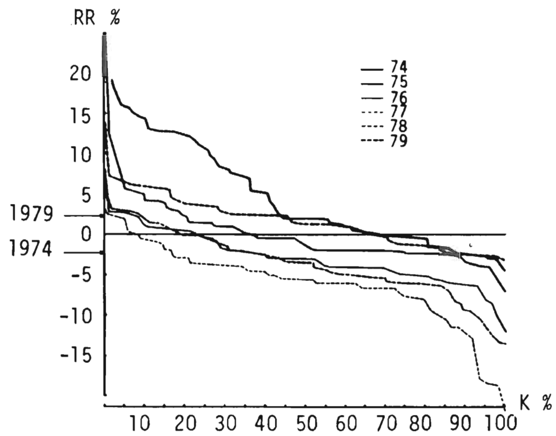
Figures VIII:1A,B give a summary illustration of part of the "initial states" as described for the years 1974 through 1984 in the planning survey (1) and the firm financial database. The profitability distributions in Figure VIII:1A exhibit the formation of "thresholds" during the crisis years of the 70s, studied in simulation experiments in E (1984c). The productivity distributions in Figure VIII:1B show that these thresholds only to a small extent developed because of unused labor capacity. Both actual and potential productivity, however, were almost standing still on the average for most of the period. Hence, the troublesome profitability development could be attributed to price development; cost overshooting in the middle 70s, and an unusually large part of total resources being locked up in firms, that continued to operate in the "wrong markets" (see below under policy studies).

The data sources above still only cover the domestic parts of Swedish companies, which is clearly a descriptive deficiency for an industry with some 30 percent of employment in foreign countries. The two micro databases have recently been integrated with

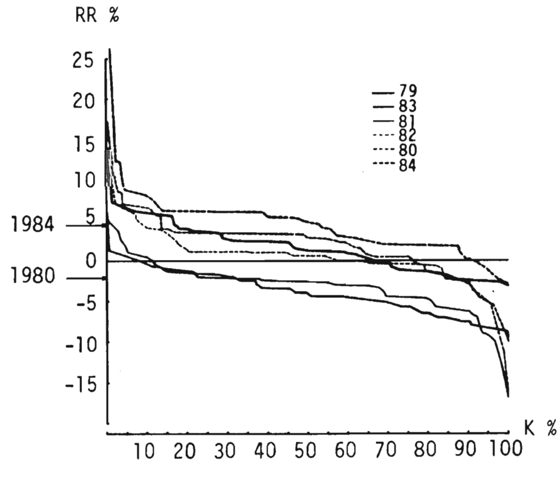
- (3) three sets of data covering every single foreign operating establishment owned by a Swedish company, for the years 1965, 1970, 1974 and 1978. Data on foreign activities have been collected by IUI during the last 10 years. These data cover internal and external trade flows (see Swedenborg 1973, 1979, 1982, Bergholm 1983b). The three sets of data allow us to assign data on foreign produc-

Figure VIII:1A The Distribution of Real Rates of Return (RR) over Installed Capital (K) 1974-1984

(1) Years 1974-1979



(2) Years 1979-1984

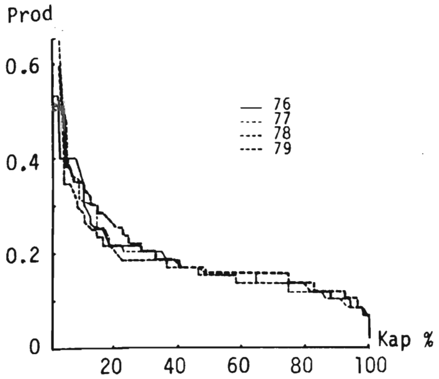


Note: The real rate of return defined as RR in Chapter III.2.4.

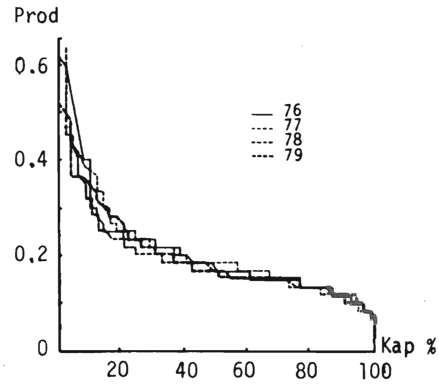
Figure VIII:1B **The Distribution of Potential and Actual Labor Productivity over Installed Production Capacity (Kap), 1976–1983**

(1) Years 1976–1979

Potential productivity

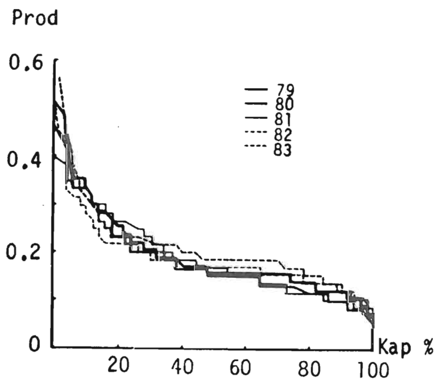


Actual productivity

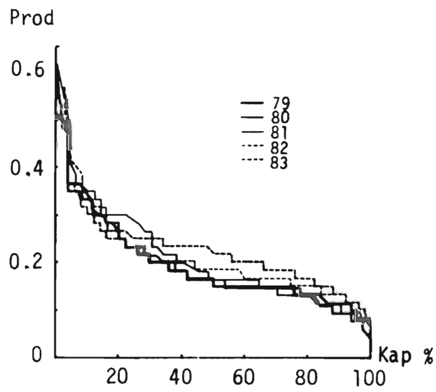


(2) Years 1979–1983

Potential productivity



Actual productivity



Note: Actual labor productivity = Q/L
Potential labor productivity = Q*/L
Q measures output in point A in Figure II:3 on p.60.
Q* measures potential output in point B, corrected for "idle labor".
Both Q and Q* are measured in Million 1976 SEK, and L is number of full-time employees.

tion and marketing establishments to each division or firm in the MOSES system, as well as to estimate certain parameters that regulate foreign-domestic investment, and trade relations.[3] In addition to this:

- (4) a separate survey to all establishments in the planning survey was carried out during 1983 with the purpose of obtaining data on interior resource disbursements on various activities, the main categories being (a) marketing and distributing, (b) materials processing and (c) R&D activities. (See Fries 1983b and Lindberg-Pousette 1985). Furthermore:

- (5) a separate survey to all establishments in the planning survey took place in 1985. This time questions were asked on medium-term plans on relevant MOSES firm variables, and also on various employment categories. The data have been used for special "forecasting type" experiments in the context of the IUI 1985 long-term survey (see below). They will later be useful in estimating individual firm behavioral relationships, since one can expect that the ex ante plan data have been "generated" from an information - decision - planning model of the type that we have in the model.

In addition to this, ongoing research at IUI allows us to add to the MOSES database frequently. One instance of this was a joint IUI research project with the Swedish Academy of Engineering Sciences (IVA) in 1979 which added data on DMTEC in industry (see Chapter V.3 and Chapter 6 in Carlsson et al. 1979, and Carlsson 1981).

Similarly, the planning survey is normally extended with questions for special studies. In this way we have obtained depreciation rate estimates, purchase/value added ratios, short-term export price elasticity estimates, etc. for individual divisions.

4.3 Micro and Macro Parameter Estimation

Estimation of the model has seven dimensions;

1. Traditional econometric techniques are applied to behavioral relationships at the micro level and of course also to the macro relationships in the model.[4]

2. For a restricted number of large firms, real firm-model interfaces (interviews, model simulation meetings, etc.) to establish quantitative relationships have been, and will be carried out.

3. Direct measurement. Some planning surveys, notably a special planning survey carried out in the spring of 1985, include short-term and long-term plan data from the firms. These data reveal relationships from the calculation models, or procedures, that the firm uses itself in deriving its plan data (see §5 in the previous section).

4. Partial calibration. Isolated model parts are calibrated separately, with the rest of the model economy shut off.

5. Particular dynamic properties (time profiles) are simulated on the model on real exogenous

data inputs and are compared with independent econometric results for the same period on Swedish data. (See for instance Genberg 1983.)

6. Tracking performance of the entire model system against historic data (macro aggregates and individual firm data) has been studied.

7. Simulation experiments to establish the existence of certain properties (long-run stability, etc.) of the system have been carried out.

The M-M approach has one particular advantage in estimation. It is possible to achieve an explicit representation of the causal ordering of interior model processes. The estimation of distributed lags between macro variables is replaced by quarter to quarter interaction between decision units and market processes. This requires proper classification of decision units and proper periodization of their decisions - an old idea from the Stockholm school economists that has been empirically implemented.[5]

What is required is a periodization of data that corresponds to the major internal decisions, notably the production decision (roughly a quarter) and a micro unit that is a reasonably autonomous decision unit (a division and a financial decision unit).

Distributed lags do appear to some extent within the micro units, but here they have a well defined, operational meaning. For instance, the investment decision matures into an increase in operational capacity with a delay that differs between firms of different categories. The time profile depends on the type of production. The important "time bridge", however, is that past activities are always updated in the form of new, initial stocks the next period.

All seven techniques of calibration have been applied to some extent simultaneously during project work. On the parameter estimation side simple micro estimation, individual firm interaction, and estimation of macro parameters have been carried out.

On the <u>micro parameter</u> estimation side most work has been done on the production system (see Albrecht 1978b and Albrecht-Lindberg 1983), on technical change at the new investment level (see Carlsson-Olavi 1978), and to some extent on the firm financing and investment model (see Eliasson-Lindberg 1981 and Carlsson-Bergholm-Lindberg 1981). As for other micro relationships simple ratio-estimation techniques have been applied; the same technique as that used in estimating input-output coefficients from flow observations for two periods.

So far, only one direct model-to-firm interface has been attempted, but more are planned. This method may eventually make possible estimation of behavioral response patterns on relations for which statistical observations do not exist.

A second micro estimation problem has to do with certain micro parameters that enter as time dependent exogenous variables. These are the two technical change parameters associated with new investment which are then integrated in the firm production structure. On these variables considerable prior research has been carried out to the extent that a new research area at IUI has been opened up.

Within a joint research project with the Swedish Academy of Engineering Sciences (IVA) a large group of engineers that for many years had been associated with high level, technically oriented investment decisions in Swedish industry were questioned on their experience with productivity development (or more precisely DMTEC) in new, best practice installations for a wide range of industrial activities over the period 1955-75. The results - reported on in Carlsson et al. (1979) and Carlsson (1981) - have been directly incorporated into the MOSES system.

The recent completion of panel data in three, of the above five, integrated databases will soon make much more microeconometric work on MOSES possible. Current estimation work goes on within several IUI projects and includes estimating industrial firm borrowing, dividend, interest and export functions.

On the macro side the main concern has been to estimate parameters in the non-linear consumption expenditure system and the input-output coefficients.

The private consumption sector draws heavily on results from Dahlman-Klevmarken (1971), and for macro income tax parameters on Jakobsson-Normann (1974). Since the consumption classification scheme is different from that in MOSES, the Dahlman-Klevmarken estimated price and income elasticities have been weighted together to the four consumption categories used in MOSES. A non-linear feature, and a savings elasticity (see E 1978a, p.79) have been added more or less by "informed" assumption.

Major statistical reclassification and adjustment work have been required on the input-output side, first for the 1968 database, then for the 1976 initial year (Ahlström 1978 and 1983) and currently for the updating of the initial year to 1982 (Lindberg-Eliasson 1985).

Partial calibration of parameters would appear to be a recommended procedure. For instance, we should attempt to ascertain the micro parameters by entering real data on individual firm exports and/or investments exogenously. Exports each period relate recursively to the firm and the economy. If we believe at all in the dynamic properties of the MOSES economy, however, this procedure is not acceptable from a scientific point of view. The quarterly adjustment of export supplies of individual firms in response to price developments in foreign markets (exogenously) and in domestic markets (endogenously) is the prime transmitter of foreign prices to the Swedish economy through domestic wage and quantity responses in all markets. Similarly, individual firm investment behavior is regulated by individual firm profitability development and interest rate development which relate back dynamically to practically all variables in the economy. Partial calibration with exports and/or with investments at the firm level should result in different parameter estimates throughout the economy, that in turn should differ[6] from the parameter estimates obtained through simultaneous dynamic calibration of the kind to be reported on in the next section. Partial estimation is a not recommended procedure on a dynamic model with interdependent markets of the MOSES kind.

5. Historical Tracking Performance of MOSES Model

Observations are simply missing on a number of important model micro variables, most notably expectations variables. These variables enter behavioral relationships that require parameterization to be operational. Here we have provisionally assumed response patterns to be identical across firms, experimented with the model and compared historical tracking performance of the model at the macro level. This method, which we call dynamic calibration is described in Eliasson-Olavi (1978). The test periods for macro data have been 1950-74, 1968-75 and recently 1982-1985. The statistical fits of the entire model system at various stages of completion will be described below. The problem here is that several parameter constellations can often explain the same macro time series equally well. This identification problem can only be sorted out through microeconometric analysis.

The model has been built in different stages of increasing complexity. The earlier stage has usually been a subset of the new stage, or model vintage. The model has been calibrated against macro time series data at each stage. Considerable care has been taken to organize model work so that new model features would not radically alter total systems properties. But one could never be sure, and considerable risk taking has been involved in the sense that the results of calibration work at earlier stages would have to be thrown out. The various model vintages have, however, exhibited considerable robustness in this respect.

Direct, isolated block estimation has also been tried by imposing exogenous investments and exports at the firm level, for instance in Carlsson-Olavi (1978) and Carlsson (1981) to estimate technical change, and in Carlsson-Bergholm-Lindberg (1981) to obtain a realistic cyclical model behavior during the period 1976-80.

A more sophisticated indirect calibration method has been to estimate and analyze partial macro models to establish the existence of certain phenomena in real life that have been generated in model experiments. Certain price overshooting phenomena observed on the model in Eliasson (1978a) have been tested in Genberg (1983). His results confirm the overshooting hypothesis and in principle also the existence of asymmetric price transmission patterns, depending upon the size and sign of the initial price shock. However, the extent of asymmetries observed in model observations was not confirmed. Indeed, on new and more realistic model versions, and improved initial databases exhibiting more structural diversity, the strong instability properties generated by price overshooting and asymmetric response patterns experienced on earlier model versions seem to have disappeared (Eliasson-Hanson 1985).

Considerable recalibration of the official input-output system turned out to be necessary to get the entire model micro-to-macro database initially consistent in 1976.

The 1976 version of the model also features individual firm input-output coefficients. They have been obtained by using purchase/value added ratios from the 1976 planning survey and then distributing purchases, so calculated, for each firm according to the macro input-output table (see Bergholm 1983b). This means that the macro input-output coefficient table constantly changes in simulation experiments, because firms grow at different rates; the input-output structure is so to speak endogenized.

So far, most model experimental work has been performed with the monetary module, or rather with the endogenous interest determination, turned off. The reason has been problems with the monetary sector specifications and the database. All data needed to fill in the accounts in the money Chapter IV have been put together for 1976. No estimation of financial macro parameters are yet ready. The final check of model capability will come when the monetary model is empirically ready and integrated.

A pragmatic note may be appropriate here. Large model systems will never be completely debugged of peculiar fringe properties. This is a defect that model builders in this field will have to live with. Many of the odd properties discovered in model simulations may even turn out to be quite realistic features of real life, when we know better at some later stage. We have had several of these experiences in the model all along. They have mostly appeared in the financial and monetary dimensions which are openended in current experiments, as long as the interest feedback is shut off.

Very few models of an entire economic system have a complete monetary sector integrated with the real part of the economy as we have it organized within the MOSES system. Hence, monetary inconsistences will never be revealed or exhibited in most models. In MOSES work they show on the printout from every simulation. This is of course a great, but disturbing, advantage.

On the "macro tracking" record we can say the following. Long-term growth performance requires a long time series database for checking. We have not been able to initialize the model in the early 50s, even on a synthetic database. There simply were not enough data. However, on the presumption that the Korean shock in 1950/51 did similar things to the Swedish economy as the oil price shock in 1973, we initialized the model economy on all synthetic micro data in 1973 and compared 20 year forward simulations with development from 1950 to 1970. Exogenous DMTEC data for 1955/75 estimated in Carlsson-Olavi (1978) and Carlsson (1981) were used in these tracking experiments. This time we were mostly concerned with the transmission paths of inflation.

Similarly, we initialized a partially real firm, but incomplete database in 1968 and carried out a broad spectrum of 8 year simulations through 1976 on several model versions.

Cyclical fine tuning of the model was attempted but not successfull on the 1976 database. Considerable extra work on the new 1982 database, however, produced a desirable cyclical pattern. Comparing micro-distributional performance with the same real development in the database or with ex ante plan data in the same firms has just begun. This means that the long, the medium, the short term and the micro properties of the model for the time being have to be evaluated on somewhat different model versions and different data sets. Until more historical data are obtained, i.e., until the end of this decade, we cannot do much to improve this situation.

On the track record we can say that:

- (1) price transmission patterns have been properly generated at the macro level from the beginning. Figure VIII:2 illustrates this. It shows the wage and consumer price transmission paths generated by the 1950/51 "Korean" and 1973/74 oil price generated export price shocks. Model simulations are compared with real wage and consumer price developments. On the synthetic micro database, the model generated too strong price and wage overshooting. More important is, however, that overshooting tended to generate quantity instabilities in the economy when the model was run on synthetic, or incomplete real data, because of too little across firm diversity (see discussion in Chapters II and VII).

- (2) medium and long-term growth tracking improved as we moved up the model vintages and databases. Except for the shift from an industry model to a full economy model with a complete input-output system no major parameter revisions have been needed. Tables VIII:1 illustrate macro tracking performance for a sequence of model vintages.

These nicely behaved results should not, however, detract attention from the fact that certain sections of the model may have generated odd results.

The model simulates a complete and consistent national accounts statistical system by quarter in practically all dimensions, and in fine detail. It would be surprising if a careful look did not reveal odd behavior here and there. It is possible to order the model to print out practically all intermediate or partial results that one wants. This is extremely useful for the analyst, but quite often disquieting. Tools of analysis, however, do not improve by aggregation that conceal such deficiencies. In MOSES work we are forced to do something if we discover these deficiencies and if we consider them to be important.

- (3) Cyclical behavior has been a problem so far in calibration work. The parameter settings that generate well behaved macro results under (1) and (2) tend to produce initially jerky behavior and too long cycles when begun on the 1976 micro-macro database. The first one or two years of a simulation generally produce too high rates of output growth, and a heavy exiting of firms. The reason is that firms exploit the slack that exists in the database in excess of what real firms appear to do. And the cyclical situation in 1976 was abnormal indeed. So far, it has not been possible to generate a first one to two year macro cycle that corresponds to the real business cycle. However, after two years, when the model was started on the 1982 micro-macro database, initial and extreme inconsistencies had been eliminated, and from 1984 quite nice cyclical behavior emerged. This cyclical behavior is illustrated in Figures VIII:3A-F (see separate exhibit with comments and tables). The simulation experiments in Figures VIII:3 are from the use of the MOSES system as a projection model in the IUI 1985 long-term survey (Att rätt värdera 90-talet (Evaluating the 90s), IUI, 1985, Chapter VI).

- (4) Micro calibration has only recently begun, and no results can be reported.

Extensive simulation work has been devoted to attempts to establish long-term steady state properties of the model. We finally realized that this was the wrong idea to pursue. A dynamic micro-to-macro model of the MOSES type with a continuing Wicksellian capital market disequilibrium should not necessarily have steady state properties. We rather found that if the model was pushed closer to a capital market equilibrium situation of the kind discussed in Chapter VII, it lost in diversity of structure and eventually collapsed or went into a long-winding depression, that restored diversity (E 1983a, 1984c). A set of such historic simulation experiments are exhibited in Figure VIII:4A. Note that with a high speed market arbitrage (everything else the same) a seemingly stable steady, and fast expansion path was interrupted, after 30 years, by a severe recession. We observed that diversity in performance characteristics of firms had diminished significantly prior to the "collapse", and then widened again (see Figure VIII:4B and E 1984c). We concluded that this must be an empirically relevant property of a dynamic market economy, that should not be removed by convenient assumption. We also observed (same references) that steady state equilibrium properties appeared not to prevail in the sense that the model converged onto the same growth trajectory, or into the same "growth domain" irrespective of initial state. Research is currently in progress investigating whether a dynamic new entry feature will enhance diversity of economic structures and remove the output collapse (Hanson 1985). Simulation experiments, of course, can never provide proof for the absence, or existence of eventual steady state, or weak "equilibrium" properties. It can only be proven analytically. Neither have we decided whether it is desirable that a dynamic model possesses such properties.

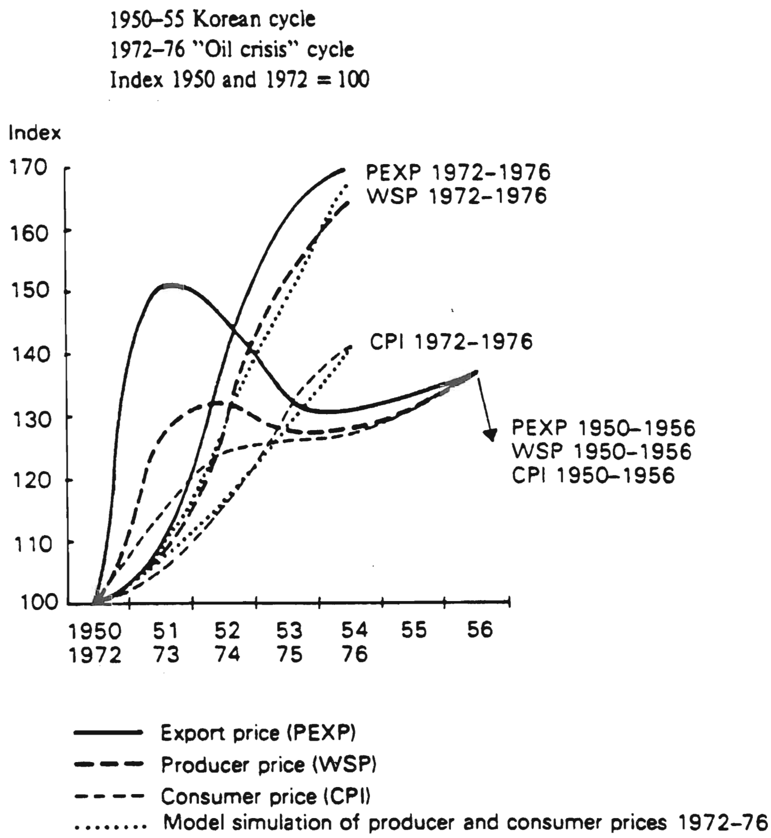
Levels of private consumption, exports and imports in Table VIII:2B are still off by almost 15 percent in 1984 (cf. Table VIII:1C which exhibits similar errors for 1968).

Table VIII:2C finally gives the macro financial balances 1984 and 1990 for the REF simulation. Considering all the numbers coming together in the simulation the fit for 1984 appears satisfactory.

The interior items are rather close and the income and GNP break downs as well. Since interest payments on foreign debt is not explicit in the model, items (3) and (7) are wrong in the REF. Also an overestimation of firm income and an underestimation of public income generate a much too large business surplus. Nevertheless, both the REF and the real data for 1984 tell the story we know about a too large deficit on public account, too small savings in the household sector, and significant savings in the business sector, making up the balance. During 1984 the business cycle peaked (see Figure VIII:3C). The foreign account was in net surplus, after many deficit years.

The REF run has been geared up to cautious growth for the rest of the decade. This means slowly increasing business savings, and a growing foreign surplus, while the excess consumption of the public sector is only moderately tempered. To engineer this scenario, rates of return on a real, non-financial basis has to stay at least where they are, and grow slowly (see Figure VIII:3G). It should be noted, however, that this higher real return to capital during the 1984 business upswing is still only on par with the level of the early and middle 60s or on par with the trend for 1952-72. Both returns to capital, the foreign balance and the public deficit deteriorate strongly in the expansionary Keynesian policy alternative in Figure VIII:6.

Figure VIII:2 Domestic Price Transmission, 1950-1956 and 1972-1976



Source: Measurement and Economic Theory, IUI Yearbook 1978/1979, Stockholm 1979, p.72.

Table VIII:1A Long-term (20 year) Trend Comparisons Manufacturing

Average annual change in percent

	1950-74 (24 years)	RUN 67	RUN 88	RUN 96
1) Production (Q)	4.6	2.7	3.5	5.0
2) Hours of labor input (L)	-0.9	-3.9	-2.3	-2.4
3) Productivity (PROD)	6.1	6.8	5.3	6.7
4) Value productivity (PROD•P)	10.0	-	-	11.7
5) Product price (P)	4.7	5.4	3.3	4.7
6) Wage level (W)	9.7	13.6	9.4	11.9
7) Investments, current prices (INV)	9.5	7.7	5.4	8.3
8) Ditto, constant prices (INV/PDUR)	4.3	1.1	2.7	3.8
9) Rate of unemployment (RU)	1.8	17.6	11.9	10.0
10) Sales (S)	8.8	8.2	6.0	9.8
	-	(R=0.4)	(R=0.4)	(R=0.8)

Constraints

Profit margins (M)	Horizontal trend
Capacity utilization rate (SUM)	Horizontal trend

Note:

(1) For explanation of symbols, see p.391.

(2) In the bottom row of table the simulated rates of change have been correlated with the real ones for the period 1950-74. The simulations in this table were run in 1976 and 1977 on an early version of the model. The numbering of runs have the following meaning (see E 1978a, p.57). For runs numbered below 100 the model is basically micro and industrial, including manufacturing specified more or less as in all later model vintages. A crude, macrospecified sector for service production for final consumption operates together with the manufacturing firms. Later versions numbered from 350 (see next table) include a complete input-output sector (10 sectors), integrated with the model. From run 500 a crude Government sector has been added. Run 1 000 for the first time includes the first version of the Monetary sector and an endogenous domestic interest rate determination.

Source: E 1978a, p.42.

		REF*	Slow	Fast	Very slow	Semi-fast										
DQ	6.4	5.0	4.5	7.1	3.7	3.1	3.8	3.8	4.4	3.8	3.7	3.7	4.7	4.3	5.9	5.6
DL	-1.3	0.8	-0.5	-10.3	-0.2	1.8	0.3	-0.1	0.4	1.3	-0.2	0.4	0.4	0.3	0.8	-0.2
DPROD		4.8	5.5	11.0	4.4	3.0	4.1	4.5	4.6	2.8	4.4	3.8	4.8	4.6	5.9	5.8
DPDOM	6.1	7.0	7.0	9.1	5.8	8.5	5.8	5.8	5.8	7.6	5.8	5.8	6.6	5.8	7.0	7.7
DW	12.7	13.0	16.7	28.1	2.8	13.7	4.4	4.9	6.3	4.3	2.8	3.2	8.8	4.4	14.0	15.7
$\bar{M}$	31.5	40.9	37.9	29.5	47.4	43.5	46.6	46.6	43.9	49.1	47.4	46.8	46.0	46.8	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		6.3			8.9	6.7									5.9	3.3
DPFOR																
Priv.con.	2.7	-0.2														6.0
DGNP	3.1	3.7			2.2	-1.5									4.6	5.7
DCPI	6.4	6.7			6.0	3.2									6.5	7.2
DDI	11.1	6.9			4.4	7.7									7.2	13.1
SAVHR	3.0	3.3			2.0	6.5									5.0	8.3
RI															2.6	6.3
X	31.6	33.3													33.4	29.0
IMP(1+2)	28.6	24.5													25.0	27.4
INV(cur)	8750	7660			6029										11519	
DBW	13.5	14.4			11.2	13.8									19.1	17.7
DNW					5.9	8.6										5.4
DX(vol)					7.5	7.5									10.1	8.8
DM(vol)					2.6	2.0									6.8	9.8
DQ by subindustry																
(1) RAW	6.5	6.4			5.4		5.9				6.5				7.3	7.1
(2) IMED	3.2	5.5			4.7		4.6				5.4				6.6	4.8
(3) INV	6.8	4.1			3.0		2.8				4.3				5.1	4.9
(4) CON	2.5	4.6			2.9		4.7				4.6				5.5	5.7

* For historic experiments in E (1983a) and Figure VIII:4A.

Table VIII:1C GNP Break Down 1968-75 (8 years)

Demand side

	Real		RUN 1035		Volumes in current prices	
	1968/75	Volumes 1968 1968 prices	Volumes 1968	Rate of change 1968/75	Real 1975	RUN 1035 1975
Private C	3.0	79	75	4.6	150	166
Public C	4.2	30	37	6.2	72	119
INV Total	2.4	33	29	5.4	60	58
Inventory changes	-	-	-	-	9	2
EXPORTS	5.4	31	28	6.6	83	77
IMPORTS	5.6	-31	-28	8.2	-86	-87
GNP (purchase prices)	3.5	142	141	4.8	288	335

Supply side

	Real		RUN 1035		Volumes in current prices	
	1968/75 (fixed prices)	Volumes 1968 1968 prices	Volumes 1968 (fixed prices)	Rate of change 1968/75	Real 1975	RUN 1035 1975
RAW	6.5	5	4	4.6	11	13
IMED	3.2	7	6	3.6	16	13
INV/DUR	6.8	11	11	3.6	30	25
NDUR	2.8	10	11	4.6	18	32
Total Mnf	6.4	32*	32	4.2	74**	82
A/F/F**	0.6	6	7	4.4	14	15
ORE**	3.6	1	1	5.0	3	2
EL**	6.8	3	3	4.3	6	5
Government**	4.8	20	25	3.6	53	82
Other and indirect taxes	-	80	73	-	137	149
GNP (market price)	3.2	142	14	4.8	288	335

Notes:

* 35.7 billion in N1976:7.4
** From N1976:7.4 (Swedish National Accounts publications).
*** 83.1 in N1976:7.4
**** Exponential interpolation between end values.

	800	821	822	832	831	823	824	825	826	827	828	829	830	1000	1035	REF*	FAST**
NITER	9	9	18	12										9	9	3	9
KSI	0.15	0.15	0.5	0.3	0.1		0.1							0.15	0.25	0.15	0.25
IOTA	0.5	0.5	0.9	0.6	0.3			0.6						0.5	0.5	0.5	0.5
SKREPA	50	50	50	50	50	50	50	50	50	50	50	50	50	50	5C	75	50
MAXD	0.06	0.06	0.18	0.18	0.03				0.18					0.06	0.06	0.06	0.06
MARKETITER	3	3	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	0.3	0.01
THETA	0.1	0.1	0.5	0.3	0.005						0.03			0.01	0.01	0.01	0.01
TMX	5	5	1	3	7					3		0.01	0.01			7	3
TMIMP	5	5	1	3	7								3	5	3	7	3

* REF is Reference case in Figure VIII:3.
** FAST is faster labor market policy experiment in Figures VIII:6B.

Note: Parameters are explained in symbol listing to follow.

Source: E 1983a, p.307. Note that these are parameter settings in the stability experiments in Figure VIII:4, also listed in Table VIII:1B.

Symbols Used in Tables

Endogenous variables

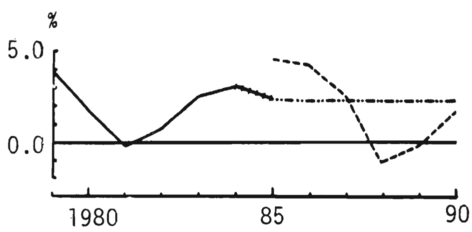
Q	= value added, constant prices
L	= labor input (effective labor time)
PROD	= labor productivity
PDOM	= domestic price, industrial goods and services
W	= wage cost level
M	= profit margin
$\bar{M}$	= average profit margin
A21, A22	= capacity utilization measurement, A-B and C-D, respectively (see Figure II:3). Actual development of these variables in planning survey is shown in Figure VIII:2C.
RU	= open unemployment in percent of labor force
PFOR	= foreign price of industrial goods and services (exogenous for four sectors)
Priv.Cons.	= private consumption
DI	= household disposable income (current prices)
SAVHR	= household saving in percent of DI
RI	= interest rate (nominal)
X	= exports in percent of value added
IMP	= ditto for imports
INV(cur)	= manufacturing investment in current prices
BW	= borrowing in manufacturing
NW	= net worth in manufacturing
X (vol)	= export volume
M (vol)	= import volume

Parameters

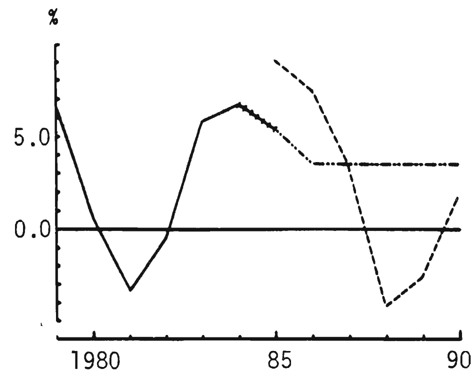
NITER	= number of searches each firm is allowed in labor market
KSI	= propensity of a firm in search of labor to upgrade its own level (part of wage difference observed) when confronted with another firm with higher wage level
IOTA	= fraction of next year's expected wage increase offered first quarter
SKREPA	= probability (percent) of labor market search leading to pool of unemployed
MAXD	= maximum product price deviation from expected price allowed during year
MARKETITER	= number of adjustments (iterations) in domestic product market
GAMMA	= reservation wage of worker is (100+GAMMA) percent of current wage
THETA	= proportion of a firm's labor force allowed to quit in response to "one search"
TMX	= export supply price elasticity. 1/TMX is fraction of domestic-foreign price gap planned to be closed first year
TMIMP	= Ditto, imports

Figures VIII:3 Cyclical Behavior of MOSES Economy 1984-1990

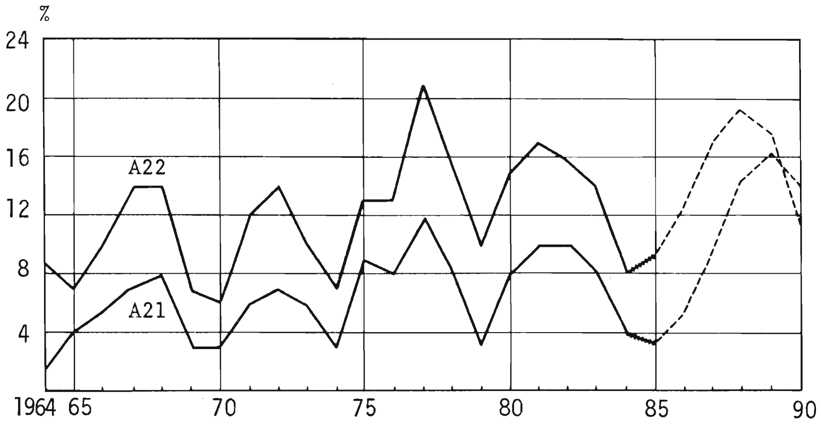
A. GNP
percentage change



B. Manufacturing output
percentage change



C. Machine capacity (A22) and Labor capacity utilization (A21) 1964-1990



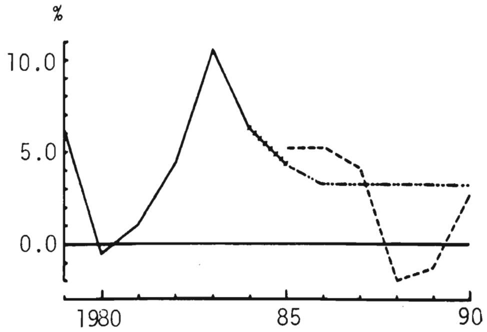
Note: ---- show the reference case (REF) used in IUI 1985 long-term survey (see Eliasson-Björklund-Pousette et al. 1985, Chapter VI) as a reference for policy experiments (see Figures VIII:6).

Historic data from national account (——). Data for 1984 (preliminary) and forecast for 1985 (++++) from Treasury forecast (Reviderad finansplan 1985). The line (-··-··), if drawn, is projection according to Government long-term survey (LU84).

Source: 1975-1985 planning survey, MOSES database. For the years 1964-1975 these data were "chained" with qualitative business indicator data. (See Eliasson-Björklund-Lindberg-Pousette et al. 1985, and Att välja 80-tal (Choosing the Eighties), IUI 1979, Section 10.6).

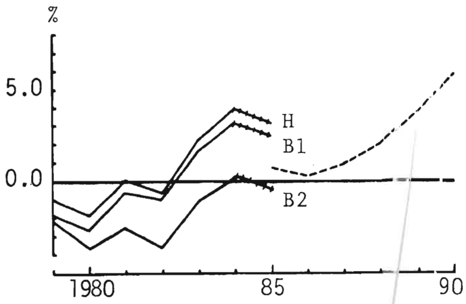
D. Exports

Percentage change, volume



E. Exports minus imports

Current prices; Percent of GNP

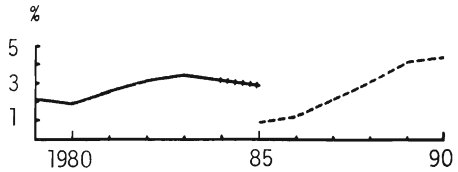


H = trade balance

B1 = current balance before interest

B2 = current balance after interest

F. Unemployment



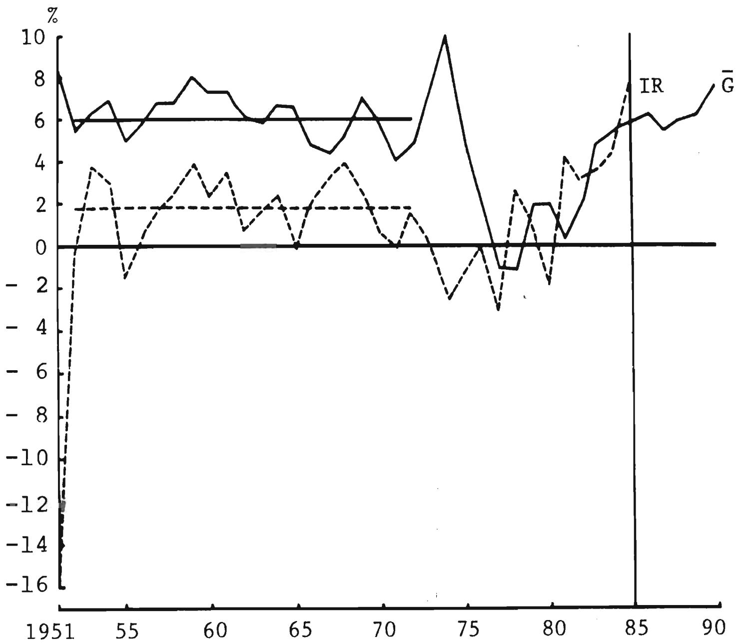
Note: Unemployment has been defined as in labor force survey. For technical reason the levels are not the same in historic data and in REF.

For parameter settings of REF see Table VIII:1D. REF is based on "modified" exogenous export price expectations for 1985-1990 collected from firms in a special planning survey in 1985 (see below). REF has been calibrated to exhibit acceptable fits for the initial year 1984 (see Diagrams, and Tables VIII:2B,C). Developments between 1983 (first simulated year) and 1985 is jerky in many macro variables, even though the averages for 1983/84 are acceptable. As mentioned this depends on inconsistencies in initial end of 1982 databases. Work is currently under way to even out these errors, by manipulating the micro databases to achieve acceptable cyclical developments from 1982 through 1985. As discussed in the text we have been somewhat hesitant on theoretical grounds to do just that.

A few comments on the calibration of REF are appropriate. If the actual export price expectation delivered by firms were used (Alt. II in Table VIII:2A below) too many firms went bankrupt and exited. When the SEK was devalued 4 percent in 1986 REF was obtained. Fewer firms exited. The exiting firms

G. Real rates of return on equity in manufacturing ($\bar{G}$) and the nominal interest on industrial bonds, deflated by the consumer index (IR) 1951-1990

Projection 1985-1990 is according to REF; percent



Note: Horizontal lines are averages for 1952-72. Note that $\bar{G}$ has been corrected for temporary capital gains because of inflation as in equations (III:10A) and (III:4). Also see description of method in Södersten (1985).

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or divisions were firms that we knew had had profitability problems for some time. The left-hand column in the table below gives raw plan data for the MOSES sample of firms for 1984-1990. When we enter individual firm export plans and export prices 1984-1990, but devalue by 4 percent in 1986 (as in REF) Alt. I is obtained. Even with the devaluation, forcing firms with profit problems to carry out export volume plans as planned turned out overoptimistic, forcing excessive exit of firms, reducing aggregate output and export growth to zero. Exiting firms were predominantly basic industries with high export ratios. The reason for the higher firm exit rate when plans are realized as plans, are micro-macro inconsistencies arising out of mistaken expectations about other firms' behavior in the labor market in particular. In the separate planning survey firms, on average, expected wage costs to increase by 9.7 percent per year. The distribution of expected wage costs was quite skewed. The inflationary firms with high profitability offered higher wages in the labor market driving out low performing firms. Tables VIII:2B and C give additional calibration tests for REF.

Table VIII:2A **Tests against planning survey data 1984–1990**

Annual percentage changes

	Data from planning survey	REF	Alt. I	Alt. II
Manufacturing output	4.6	1.6	0.1	0.0
Hours worked	0.5	-0.9	-3.6	-3.3
Labor productivity	4.5	1.6	3.2	2.4
Export volume	6.1	2.3	0.1	0.6
Export price	4.1	5.4	3.0	2.8
Production price	4.3	5.0	1.7	3.0
Wage cost per hour	9.7	6.8	4.3	6.5
Profit margin	(+)	(-)	(+)	(-)

Note: For explanation, see text.

Table VIII:2B **Balances of Resources 1982, 1984, 1990**

Billion SEK, 1982 prices

	National accounts 1982	Preliminary 1984	REF 1989	REF 1990
Private consumption	330	324	281	325
Public consumption	183	189	196	210
Gross investment	117	121	122	128
- Manufacturing	16	-	18	12
- Public sector	24	-	25	27
- Home building	27	-	33	34
- Other	50	-	47	55
Inventory change	-7	-6	3	-11
Exports	203	282	238	273
Imports	208	254	219	230
GNP	621	784	620	695

Table VIII:2C **Financial Balance of REF**
Billion current SEK

	Public sector	House-holds	Firms	Foreign	Sum
A. REF 1984					
(1) Factor income	0	463	197	0	660[1]
(2) Tax income (gross)	314	-240	-12	0	62
(3) Interest net and transfers	-128	142	-12	-2	0
(4) **DISPOSIBLE** (1)+(2)+(3)	186	364	174	-2	722[2]
(5) Consumption	239	347	-	-	586
(6) Investment	25	0	99	-	125
(7) Other	0	0	7	5	11
(8) Net financing saving (4)-(5)-(6)-(7)	-79	17	68	-6[3]	0
B. 1984 according to preliminary National Accounts data					
(1) Factor income	15	568	115	0	699[1]
(2) Tax income (gross)	362	-259	-14	0	88
(3) Interest net and transfers	-147	113	7	27	0
(4) **DISPOSIBLE** (1)+(2)+(3)	230	422	108	27	787[2]
(5) Consumption	222	398	-	-	619
(6) Investment	27	21	97	-	145
(7) Other	-1	2	-9	30[4]	23
(8) Net financing saving (4)-(5)-(6)-(7)	-18	2	20	-3	0
C. REF 1990					
(1) Factor income	0	725	300	0	1025[1]
(2) Tax income (gross)	499	-380	-23	0	95
(3) Interest net and transfers	-257	237	4	17	0
(4) **DISPOSIBLE** (1)+(2)+(3)	241	582	280	17	1122
(5) Consumption	372	537	-	-	909
(6) Investment	33	0	126	-	159
(7) Other	0	0	-13	65	52
(8) Net financing saving (4)-(5)-(6)-(7)	-164	45	167	-49	0

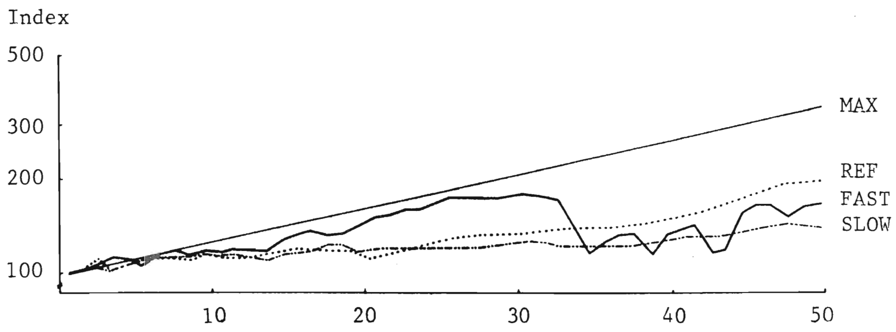
1 GNP at factor prices
2 GNP at market prices
3 minus current balance
4 including trade balance surplus of 30 Billion SEK.

Source: Special calculations for MOSES database by Tomas Nordström.

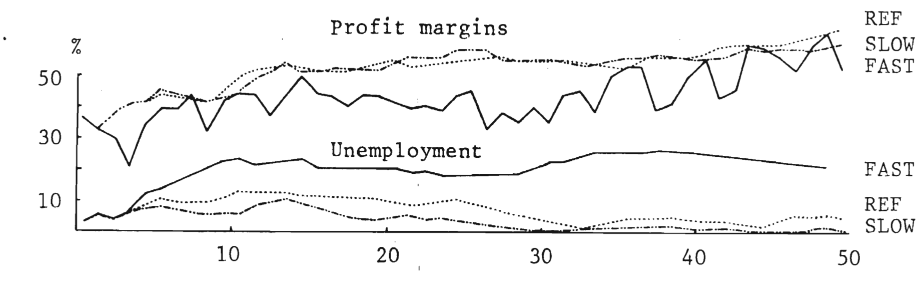
Figure VIII:4A Long-Term Stability Properties of the MOSES Economy

Historic experiments 1977-2027 (50 years)

A. Industrial output
Index 1976=100



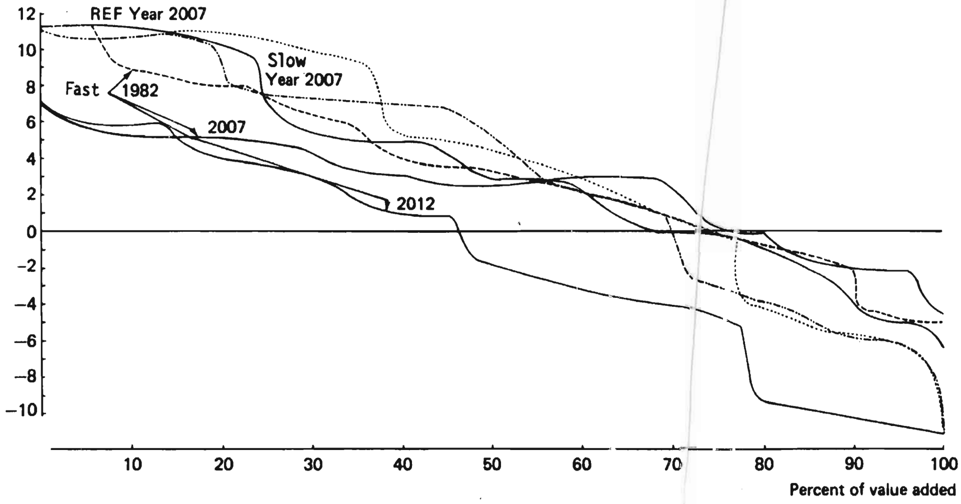
B. Profit margins (percent of value added, upper part) and unemployment (percent, lower part)



Note: FAST = 822 in Table VIII:1B
SLOW = 821 in Table VIII:1B

Source: E (1983a, p.317).

Figure VIII:4B Distribution of Growth Rates of Entire Firm Populations at Various Points in Time in REF; FAST and SLOW Simulations in Figure VIII:4A

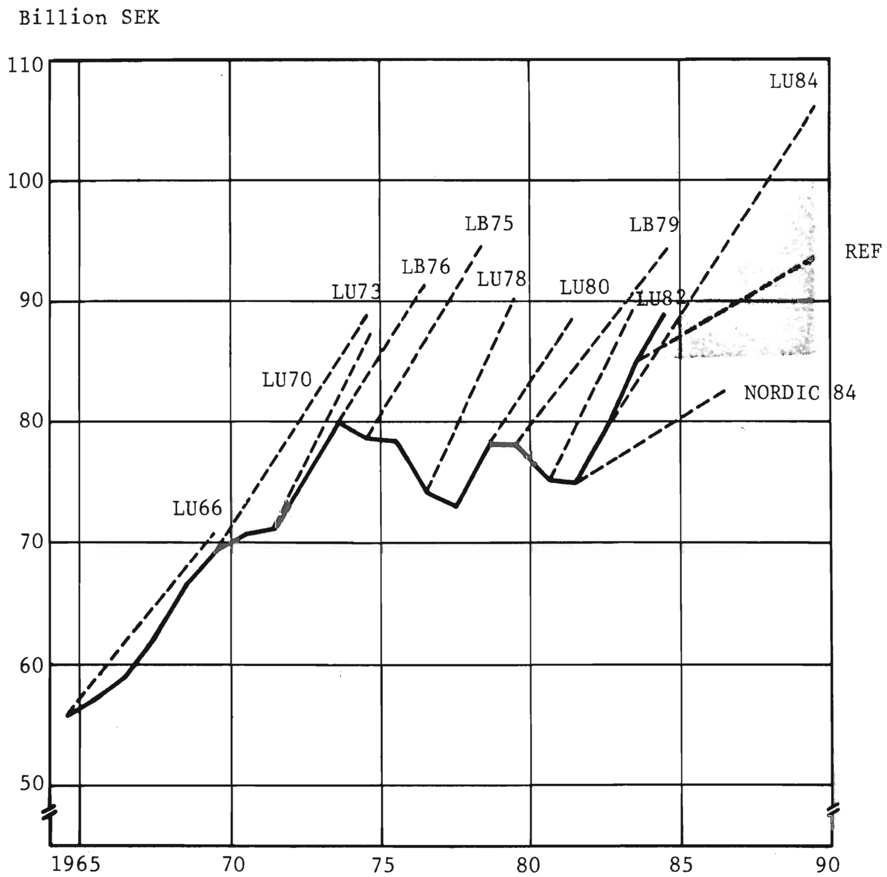


Note: FAST 2007 is just before output collapse, FAST 2012 just after.
The vertical scale measures cumulative, 5 year moving averages, in percentage growth in output. Capacity to produce measured by potential value added has been used as weights.

FAST = 822 in Table VIII:1B
SLOW = 821 in Table VII:1B

Source: E 1984c, Figure 2. Cf. Figure VIII:1A.

Figure VIII:5 The Swedish "Porcupine" since 1965



Note: The figure exhibits manufacturing output since 1965 and various forecasts and projections between 1965 and 1985. LU66 stands for Government Long-Term Survey ("Långtidsutredningen") of 1966. LB79 is the IUI Long-Term Survey of 1979. NORDIC is the corresponding IUI projection of 1984 in Economic Growth in a Nordic Perspective, IUI et al. 1984. The shaded area encloses all policy experiments in Figures VIII:6.

Source: Eliasson-Björklund-Pousette-Deiaco-Lindberg et al. (1985).

	Manufacturing output	Wages	Unemployment	Inflation
	Index REF=100	Index REF=100 from REF	Percentage difference from REF	Percentage difference
	(1)	(2)	(3)	(4)

(A) Keynesian policy

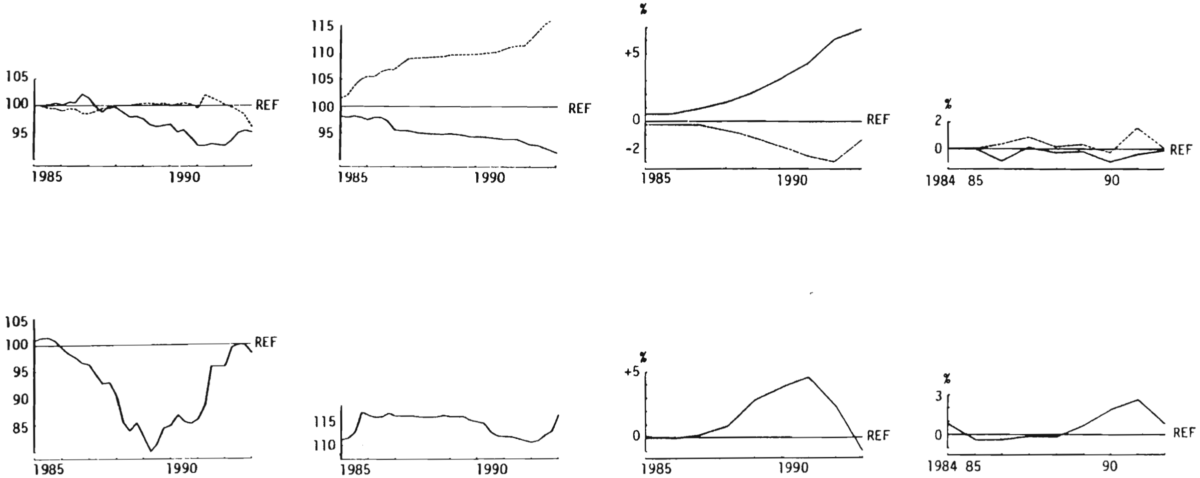
Public employment

..... +1.2% per year

—— -1.2% per year

(B) Classical policy

—— Faster[1] labor market price responses

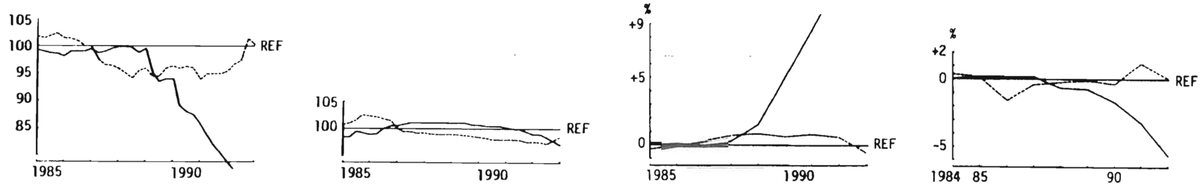


1 For parameter setting see FAST in Table VIII:1D

(1) (2) (3) (4)

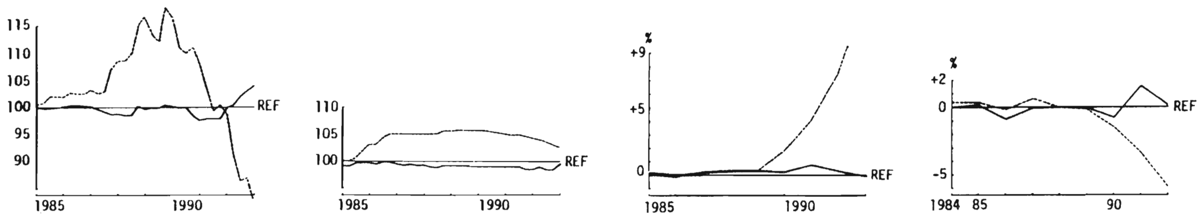
(C) Neoclassical policy

Interest
...... -3%
—— +3%



(D) Schumpeterian policy

...... DMTEC + 2 percentages points, capacity restriction on new investment spending removed
—— DMTEC + 2 percentage points



Note: All comparisons are with REF in Figure VIII:3.

6. Policy Analysis

Good theory means good empirical specification. There has been enough of the Swedish economy in the MOSES model from the beginning to make it interesting to ask "what if" questions to the model on the presumption that it would respond as the Swedish economy - and more so the more model specification and databases improved.

Hence, the MOSES system has been used as an experimental tool in several studies at IUI.

We have studied the macroeconomic consequences of exchange rate variations (E 1977), of different expectational modes (Albrecht 1978a), of a change of tax system (E 1980a), of absolute price shocks (E 1978a), of relative price and technical shocks (E 1978b), of technical change (E 1979), etc.

As the current version of the model was prepared, and especially when the new 1976 database had been entered, the empirical ambition grew. In Eliasson-Lindberg (1981) we demonstrated the existence of negative allocation effects from price wedges introduced by corporate taxes. It was possible to demonstrate, in particular, that tax induced expansion in inefficient industries, or industries operating in the wrong markets, reduced long-term output growth in efficient firms operating in expanding markets. The reason for this was, not surprisingly, that expansion in the wrong firms inflated factor prices compared to the case when such expansion was not stimulated by the tax system.

The ambition to quantify increased when we evaluated the macroeconomic effects of the Swedish industrial subsidy program (see Carlsson-Bergholm-

Lindberg 1981, Carlsson 1982, 1983). In the subsidy study the actual money value of industrial subsidies disbursed after 1976 was redistributed in four different ways, in experiments where the public deficit was controlled and equal in all four experiments. The subsidies were distributed (1) as in real life to the worst performers, the crisis firms, (2) to the best performers, the most profitable firms, (3) to the firms with the best export growth records, and (4) to all firms in proportion to their size in the form of a proportional reduction in the payroll tax. The largest, positive long-term output effects occurred in experiment (2). The second best outcome was observed in experiment (4). In all experiments except the first (real life case) the experiment began with a few years of dramatic adjustment and high unemployment when the crisis firms (being unsubsidized in these experiments) went bankrupt, and exited from the model economy. In the actual subsidy experiments the bad effects showed up in the form of long-term stagnation of output. The model has also been used for quantifying the pull effects on the Swedish economy of Swedish foreign investments (E 1984b, Bergholm 1984).

The database has recently been updated to a 1982 base year, to be used for policy analysis in the IUI 1985 long-term survey and in IUI research for the next Nordic medium-term survey. Figures VIII:5 and 6 are from the 1985 survey and illustrate different sets of policy measures to set the Swedish economy on a long-term balanced growth path for the 90s. Particular emphasis has been placed on the potential risk of initiating a cost crisis, or a worsening of the slump that normally follows after a few years of faster production growth, generated by expansionary policies. These policy experiments nicely summarize many properties of the model presented in several publications. Keynesian demand policies can pull the economy out of a recession if it is only cyclically out of balance. With a badly matched supply and demand structure, and large initial public and external deficits, the price structure is distorted. If demand is further stimulated, inflation follows and deficits increase. Classical policies aimed at speeding up the labor market process, as expected improved output growth to begin with, then initiated wage overshooting and a slump. Neoclassical interest rate policies and Schumpeterian policies aimed at stimulating the faster dissemination of improved technology through the investment process, again, as has been the case in earlier experiments, had the expected effects after a very long delay into the late 80s.

The MOSES system was never intended to be used for forecasting purposes. We thought, nevertheless, that feeding it with the real export plans and export price expectations of individual firms collected in a separate survey would produce something like a conditional forecast, to be used in the long-term analysis. The model did not respond with "normal" behavior to "forced feeding" with real firm plans. This is exactly what should be expected from our discussion of partial calibration in Section 4.3 above. Either the model runs on the wrong parameters, or the data delivered to us from the firms are inconsistent with the macro environment determined from the combined action of all firms (M-M inconsistency). When firms were forced to realize their export plans on the basis of their price expectations and the same behavior of all other firms, factor prices developed in such a fashion that a large number of establishments had to shut down, practically all of them either being known to be in trouble, or belonging to the group of synthetic firms. When exports were endogenized exit frequencies returned to normal and macro behavior as well. We obtained the reference case in Figures VIII:3.

In all earlier studies the Swedish model economy has been positioned on an initial state described by the 1976 micro database. Results from varying certain parameters are, hence, dependent on that state, as they should be in a dynamic economy. One might argue that the initial state should rather be an equilibrium state and that comparisons should be made between that state and the equilibrium state on which the model economy eventually settles after the parameter change of the experiment. As mentioned, any such equilibrium state is an imaginary state in a dynamic model. It does not correspond to a real situation (see discussion in E 1983a). Comparisons of such states using static models (comparative static analysis) are conceptually wrong, at least in our context.

The MOSES model economy should probably not be used as a forecasting or projection model until a large amount of additional estimation work has been completed. The basic feature of a forecast, however, is that it starts from a true disequilibrium state - somewhere on a business cycle - and then follows a disequilibrium trajectory.

7. The Growth Cycle

The main problem of all medium-term projections is how to deal with the business cycle and the trend simultaneously (the growth cycle). The common solution has been to use an equilibrium model and to correct all data for cyclical characteristics (unused capacity, unemployment etc.). Our argument has been that this is principally wrong. The initial state is imperative in determining the long-term path the economy will follow, and the path is more interesting than the final destination.

The MOSES model offers a solution to this problem. Today, the quality of parameter estimation does not allow us to simply start the model on its initial database description. However, the initial database description is of high quality compared to all ad hoc adjustments that have been, and can be carried out in order to use conventional macro or sector equilibrium models. These models, furthermore, have to be run on some exogenous inputs, notably labor productivity trends, that more or less impose, by assumption, the growth trends to be forecast. The MOSES model offers a more sophisticated alternative. In principle we can exogenize individual firm exports and/or investments, by assumption or by using the "plans" of the real firms. We can enter these individual firm plans into the dynamically calibrated model and start it from the high quality database description of any initial year that we choose. If we exogenize both exports and investments it would roughly correspond to the degree of exogenization traditionally applied in macroeconomic forecasting. But the forecast would be founded on the wealth of structural information residing in the initial micro database and the macro economy would be propelled into the future by the expectations and plans of individual decision units and by the (model) micro dynamics of a Schumpeterian type growth cycle. If expectations and plans are internally and externally (micro-macro) inconsistent, we would expect macro behavior to respond to such inconsistencies - as it did in the policy experiments just discussed.

Notes

[1] Of course, a macro model may use lagged variables, which are part of the state variables in MOSES. A simultaneous estimation procedure also requires technical constraints that may be said to "impose" structural information.

[2] See Eliasson (1976a).

One example is direct model interfaces with real firms represented in the model. A group of people from a model firm has been asked to specify their own parameters and play around with their firm until they were satisfied with its behavior. To date only one such experiment has been carried out.

[3] See Eliasson (1984b) and Eliasson-Bergholm-Horwitz-Jagrén (1985).

[4] For instance, the household consumption and savings system.

[5] See for instance Lindahl (1939).

[6] The difference between dynamic and partial calibration is illustrated in Bergholm (1983a).

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