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MOSES CODE

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THE INDUSTRIAL INSTITUTE FOR
ECONOMIC AND SOCIAL RESEARCH

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FOREWORD

This book is the technical part of the elaborate documentation of the MOSES micro-to-macro model of the Swedish economy. It consists of a set of internal documents that have been used for understanding and operating the model for many years, now revised and made available in compact form for a wider circle of readers.

Stockholm in April 1989

Gunnar Eliasson

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CHAPTER I

Modeling the Experimentally Organized Economy
– Overview of the MOSES Model

by
Gunnar Eliasson

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1 Introduction [1]

The MOSES[2] modeling project was initiated in 1974 by IBM Sweden and work began in 1975 at my department at the Federation of Swedish Industries.[3] The modeling project was first designed as a special study on the dynamics of pricing behavior, the transmission of inflationary impulses through markets and the allocative efficiency of capital markets.

The project gradually took a more ambitious path attempting to model the dynamics of growth of the capitalist market economy. Micro specification of firm behavior in dynamic markets then was necessary.

This chapter gives an overview of the MOSES micro-to-macro model of an experimentally organized economy. It introduces the complete model code in Chapter IV. First, however, a few brief remarks on the idea of the model, then a presentation of its modular design. Finally, the basic economic specifications will be introduced. There will be frequent, exact references to the technical code of Chapter IV.

The MOSES Model is a dynamically coordinated <u>computable disequilibrium adjustment model of economic growth</u>. Agents in markets (firms and labor) make quantity decisions on the basis of perceived profit or wage opportunities, but adjust prices, price expectations, and quantities as they learn about actual opportunities from participation in the ongoing market process.

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

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[1] This chapter is a slightly edited version of a paper read at the 15th Earie-conference in Rotterdam in August 1988.

[2] for **Mo**del of the **S**wedish **E**conomic **S**ystem.

[3] See Eliasson (1976b, 1978, 1985a).

Three assumptions of the classical equilibrium model have been modified to obtain the experimental model:

(1) State space has been assumed to be very large and intractable, rather than small and altogether transparent at negligible or exactly known costs.

(2) Behavior is boundedly rational and knowledge is importantly tacit (non-tradeable).

(3) Access to market opportunities is free, except for natural obstacles and ownership entitlements.

The firm intelligence system is accordingly organized to cope with bounded rationality and tacit knowledge. It is designed for competition in an extremely large, and for all practical purposes unknown state space, or as we prefer to call it, business opportunity set. Profit opportunities are seen as perceived, unexploited commercial and technological combinations in that opportunity set. Firms are characterized by rent (profit) seeking on a hill climbing (not optimization) mode. The landscape of rent opportunities is, however, constantly changing as a consequence of all agent behavior.

Failure of agent plans shows up in unused capacity and undesired stocks.

Ex ante plans, hence, normally fail to match the constraints imposed by the plans of all other actors and the characteristics of the opportunity set. Individual mistakes are frequent and unpredictability at the micro level the normal situation.

Firms, as a consequence, conceive of themselves as experimentators in a positive sum game, where mistakes are common and firms are specialists in fast identification and effective correction of errors.

The source of dynamics in the MOSES economy is exactly this constant failure of ex ante plans to match at the micro level, causing a constant ex ante – ex post dichotomy. An explicit plan realization function exists.

Out of equilibrium there is no way to tell how prices and quantities will move if you only have an equilibrium model. You need a process representation of economic activity in which learning behavior and expectations forming, decision making and the realization processes are explicit in time.

The nature of the plan realization process determines the state of information in the economy, the potential for learning reliably about its fundamentals and the feasibility of a state of full information (equilibrium).

The competitive position of each firm is that of a temporary monopoly established through technological (process) superiority.

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

However, demand feedback is complicated by price feedbacks making firms price makers in the Arrow (1959) sense.

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

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

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

The overall outcome is a micro(organization)-based economic process model driven by profit seeking firms, characterized by some institutional change (entry, exit), but with other major-technology-determining reorganizations within firms exogenous.

The experimental organization of the economy so presented can be said to thrive on different forms of information processing, growth being restricted from above by technological change (in information processing) in a broad sense.

Personally I would say that MOSES puts life into the General Equilibrium Model. Looked at from the perspective of economic doctrines it combines (exogenous) entrepreneurial activities à la the young Schumpeter (1912), or the Austrian tradition with Smithian (1776) dynamic coordination in markets, notably the capital market, characterized by a permanent state of Wicksellian (1898) disequilibrium. It allows economies of scale through innovative activities. Concentration is checked by technological competition among all agents in the market. Salter curves are so to speak truncated at one end by Schumpeterian "creative destruction" (exit) and updated at the other end through innovative activity, including competitive entry. Thus a situation of general monopolistic competition among the few is endogenously carried on. In this sense the MOSES model is a step in the direction of designing a core framework for a theory of industrial economics. Economic competence in a MOSES firm is exhibited in three principal ways:

(1) through learning in the markets by ready price and quantity signals in order to coordinate and adjust;

(2) through the endogenous investment decisions that brings new (exogenous) technology into the firm; and

(3) through competitive selection. Only the most competitive firms survive.

Since MOSES economic development is characterized by endogenous market induced reorganization of micro structures, the evolving micro state is a "tacit" memory of competence, that determines the ability of the firm to exploit the opportunity set and at each time bounds the feasibility of future states (path dependence). Unexploited business opportunities are abundantly available to firms willing to engage in risk taking through trial and error (experimentation). Hence, price and profit expectations are enough to move the MOSES economy. By exogenously changing the market regime characteristics, very different growth paths can be generated from the same initial states. Furthermore, the model structure is very non-linear and stimulations exhibit typical phases of unpredictable ("chaotic") behavior. This occurs, for instance, when I attempt to force the economic system close to a situation of capital market equilibrium (Eliasson 1985a, pp. 294 and 306 f.).

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

However, the current state of the art does not allow a methodological break out of mainstream theory without giving up analytical clearness for numerical methods.

I do not like the accepted practice of current theoretical modeling of incorporating assumptions, which makes certain well-known analytical procedures manageable, but creates biased theoretical representations of the economic world around us. The seriousness of this prior bias cannot be assessed, neither as to direction or size, except by placing the theoretical model in a wider modeling framework. Once you have done that you might as well use the more general model. This is all so obvious and well-known that it does not require further explanation.

The MOSES modeling project attempts to break away from that practice. Rather than aiming for simplification it accepts this wider theoretical framework to allow the dynamics of market behavior to affect the macroeconomic growth process.

The theory on which the model is based is fully specified and explicit. The method chosen guarantees consistency. It would have been even more relevant, had we thought of certain relevant aspects from the beginning. However, even with the most advanced mathematical expertise, the model is currently beyond analytical methods. But we work on it. Until then we substitute numerical for "analytical" methods in economic analysis. The same procedure is adopted in the estimation of model parameters. Full scale econometric estimation of all parameters under the constraint of some exogenous macro variables will be beyond current techniques for decades (Brownstone 1983). By using partial estimation techniques (Eliasson 1985a, Chapter VII) we can at least face up to the biases explicitly.

2 Macro Overview of the Micro-to-Macro Model Economy

When seen "from above" the macro mapping of the Swedish micro-to-macro model is a Keynesian–Leontief eleven sector model with a non-linear, Stone type consumption system, wealth creation being treated as a separate "future" consumption category ("saving"), with complete feedback through demand and investment capacity growth (Figure I.1). Underneath the macro level, exogenous Schumpeterian innovative activity upgrades the characteristics of new investment of individual firms, à la the "young" Schumpeter (1912). New technology is brought into firms through their individual investment decisions determined by a Wicksellian (1898) micro disequilibrium in the capital market. This capital market disequilibrium is defined as the expected return of the firm over the market loan rate. Hence, rate of return criteria imposed through the capital market dominate long–term dynamics in the model. A Smithian invisible hand coordinates the whole economy dynamically through monopolistic competition in the product, labor, and capital markets. Foreign prices, the foreign interest rate, and the labor force are exogenous. Together these mechanisms determine the dynamics of resource allocation. Keynesian demand feedback is needed to keep the economy growing. It enters in three ways: through endogenous income formation and demand feedback (the system is complete), through exogenous government, fiscal and monetary policies, and through foreign trade.

The M-M economy is regulated by the interaction of domestic (endogenous) and foreign (exogenous) prices in the four markets for manufacturing goods. Hence, Marxian demand deficiency (or excess demand) situations of varying length occur all the time in the model through failure of local demand plans to meet local supply plans. Markets do not clear and stocks and later prices adjust. Disequilibria then feed back into next period decisions. The source of dynamics of the macroeconomy originates in this failure of ex ante plans to match through the realization functions of markets (Modigliani–Cohen 1958, 1961; Eliasson 1967, 1968). This notion can be traced to Wicksell and Myrdal (1927, 1939), the Swedish School of Economics (also see Palander 1941) but for some reason was lost to economics in the postwar era, heavily influenced as it has been by the classical static model.

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

One should also note that M-M theory as represented by the MOSES model can be regarded as an extended positive sum game of infinite duration with a variable number of players, learning, and forming and enacting decisions on the basis of "intermediated information" from the markets. In retrospect the latter is particularly interesting but crudely represented in the model. Since each firm cannot be in touch with all other firms individually, it interprets various items of aggregate information ("indices") generated by the market process, provided with a delay by traders, intermediators, and institutions that with a few exceptions are not explicit in the model. The nature and efficiency of this learning process depend on how the economy is organized into markets and hierarchies, but learning also affects this organization and hence the future efficiency of economic learning, and so on, creating a path dependent evolutionary process, that cannot be predicted due to the complexity of the combinatorial organizational possibilities facing the agents of the economy. On this point, an interesting theoretical development should be possible considering the two facts that this intermediation is the dominant resource-using activity in an economy and that practically nothing seems to have been done in this area of research.

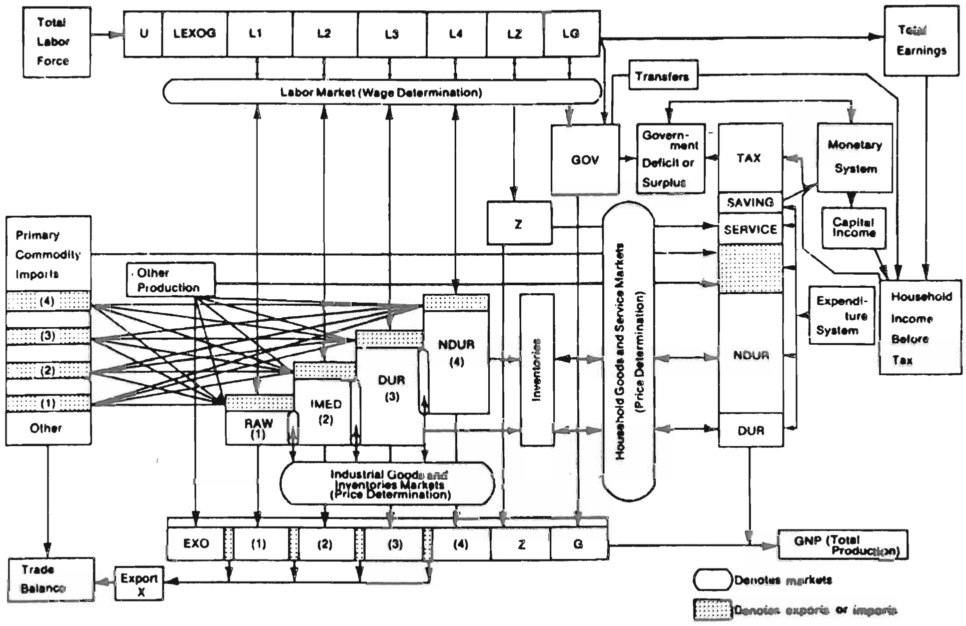
The M-M model is oriented mainly toward analyzing industrial growth. Therefore, the manufacturing sector is the most detailed in the model. Manufacturing is divided into four industries (raw material processing, semi–manufactures, durable goods manufacturing, and the manufacture of consumer nondurables). Each industry consists of a number of firms, some of which are real (with data supplied mainly through an annual survey) and some of which are synthetic. Together, the synthetic firms in each industry make up the differences between the real firms and the industry totals in the national accounts. 225 firms inhabit the manufacturing sector, 154 of which are real firms, or divisions. The real firms cover 70-75 percent of industrial employment and production in the base year, currently 1982. The model is based on a quarterly time specification.

3 The Micro-Macro Economies of Information

First the Swedish micro-macro model is introduced from the point of view of its use of information. Second the code specifying some of the process activities in markets and in hierarchies is presented.

The first task is to define the minimal unit of measurement for the model, a unit that enjoys reasonable decision autonomy in the market, notably the capital market (see Figure I.2), and that is fairly stable as to its content of activities over time (see the listing on p. 93, Ch. II).

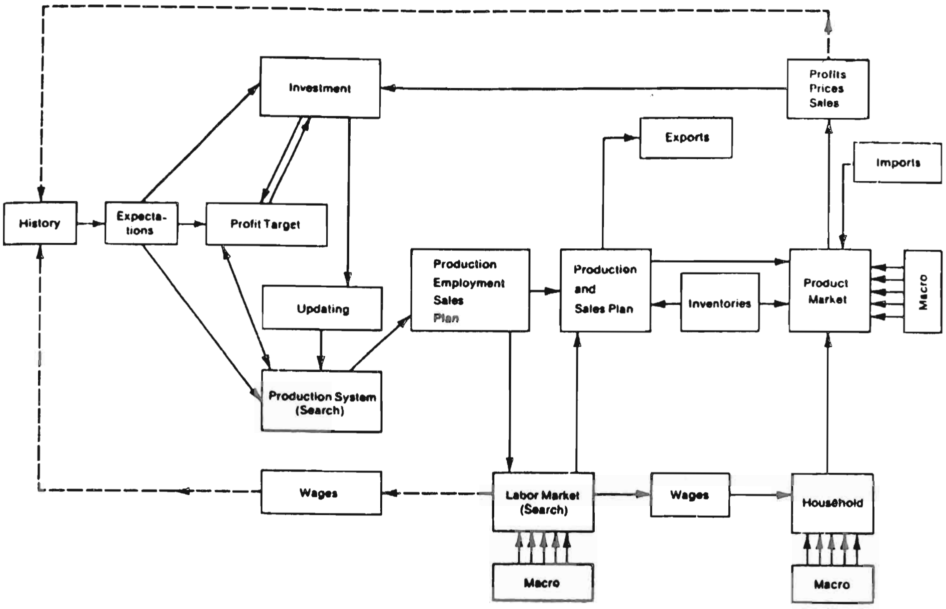
Figure I.1 Macro delivery and income determination (market) structure of micro-macro model



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).

Source: Eliasson (1985a), p. 46.

Figure I.2 Business decision system (one firm)



Source: Eliasson (1985a), p. 47.

3.1 The Unit of Measurement

The firm of economic theory is a factory that produces a well defined output quantity in response to given prices. The firm we are modeling is distinctively different and much more difficult to capture with our measuring instruments. The factory, or production establishment, is clearly the wrong measurement unit in economic modeling. It is an integrated, and often unstable entity within the centrally administered hierarchy called a firm. It enjoys little autonomy to take market decisions. The rational unit with maximum autonomy will be the firm defined as a financial entity by its financial accounts. This entity is normally monolithically controlled by its chief executive director (CEO), by its board of directors, by dominant owners and/or by the capital market. This financial decision system is also well defined by its own internal statistical information system, which reasonably well matches its external accounting system. Data from both systems can be collected, and their internal use for decision making modeled. The autonomy of this unit can be restricted by being more or less owned by another decision body (subsidiary relationship). We might also consider the possibility of modeling a smaller entity within the firm, the division, that is controlled indirectly by the capital market and the board of directors through the corporate headquarter investment bank function. This is the decision body we will choose. The main drawback of all possible choices is that they are internally unstable. The names of the firms may stay the same for hundreds of centuries, and the financial, statistical accounts may be continuously maintained from year to year, but the content of their activities and their outer limits are structurally unstable. This is illustrated for a couple of firms in Jagrén (1988) and Johansson (1989). Take, for example, the firms in Table I.1. ASEA Corporation merged in 1987 with Brown Bovery Corporation of Switzerland making it a 180 thousand group. Electrolux Corporation has acquired 300 and sold off 100 subsidiaries, or parts of subsidiaries since 1968. Recent large acquisitions are Zanussi, Italy 1984, and White Incorporated, USA 1986, making it the world's largest manufacturer of whiteware goods and vacuum cleaners, employing currently some 140 thousand people globally. Stora Kopparberg celebrated its 700 anniversary in 1988 by acquiring Swedish Match (also on the list). And so on. None of these changes, that are truly Schumpeterian and innovative in nature, can really be predicted ex ante

Table I.1 **The largest Swedish (manufacturing) exporters 1965, 1978, 1981 and 1985**

Name of firm; rank by size of exports 1985	Exports (percent of total Swedish goods exported)				Type of activity	Production first started
	1985	1981	1978	1965		
Volvo	11.5	10.6	9.2	5.0	Automobiles, trucks, etc	1926
Saab–Scania	5.4	4.2	3.8	1.6	Trucks, automobiles, aircraft	1937/1891
Asea	4.1	5.2	3.4	2.6	Heavy electrical, robots	1883
Electrolux	3.0	3.6	2.3	0.8	White goods, etc.	1910
Ericsson	3.0	2.5	4.0	2.3	Telecommunications, computers, etc.	1876
Stora Kopparberg	2.5	1.5	1.5	1.7	Copper mining, steel	13th century
SSAB	2.2	1.5	1.5	–	Steel	(1978)
Sandvik	1.9	2.6	2.6	2.1	Tungsten carbide, tools	1862
SCA	1.8	2.3	2.1	3.0	Paper and pulp	1929
Boliden	1.5	1.8	1.2	1.4	Metal and mining	1925
Nobel Industrier	1.5	1.2	1.3	1.0	Weapons, steel, electronics	–
Papyrus	1.4	1.1	0.9	0.3	Paper	1895
SKF	1.3	1.6	1.5	2.5	Ball bearings, etc.	1907
MoDo	1.1	1.3	1.3	2.4	Pulp and paper	1873
Statens Skogsindustrier	1.1	–	–	–	Pulp and paper	1941
Holmens Bruk	1.1	1.2	1.2	1.0	Paper	1609
LKAB	1.1	1.5	1.8	4.6	Iron ore	1890
Alfa Laval	1.0	1.5	1.6	1.1	Dairy systems, centrifugal equipment	1878
Södra Skogsägarna	1.0	1.5	1.5	0.6	Pulp and paper	1943
Swedish Match	0.8	–	–	–	Wood products, matches, chemical products, etc.	1917

Note: In 1984 Electrolux acquired Zanussi, Italy, in 1986 White Inc., USA.
In 1987 ASEA merged with Brown Bovery, Switzerland.
In 1988 Stora Kopparberg acquired Swedish Match.

through theory, only, possibly the frequencies of their occurrence in a large sample of firms. This is really a macro problem. The realization of individual outcomes, on the other hand, are largely organized as an experimental learning process the exact outcome of which can only be ascertained ex post. They have to be handled exogenously, very much as the firms handle such changes themselves in their internal accounting and information systems.

3.2 The External, Exogenous Environment

Technically each firm has two external environments. The first is the collective action of all other firms. Since M-M theory deals with competition among the few, each firm affects the collective environment of all other firms in proportion to its market position. This offers scope for strategic behavior (see below). Since there is a limit to how much of the world can be modeled we have technically (and arbitrarily) made the national borders (of Sweden) the limit of M-M feedback. Outside Sweden a steady state equilibrium – which is technically incompatible with the dynamics of the M-M model – has been assumed. Domestic firms are price takers in foreign markets. The nature of that steady state equilibrium can be exactly described when the firm model has been specified.

3.3 The Firm – Four Kinds of Boundedly Rational Behavior

I The creation of knowledge (innovation and reorganization)

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

The dominant, measured intelligence gathering and interpretation activities of a manufacturing firm concern technical information processing creating new knowledge, mostly associated with product development. [This activity is driven by investment in R&D and shifts the technical specifications of the firm's production system, through its investment (see section 10 and sections 4.0 and 4.1 of Technical Code in Chapter IV).] If this activity is not somehow explicitly accounted for, the firm is grossly misrepresented and – I claim – aggregate dynamics misspecified. Lack of data on (and lack of academic insight into) the nature of information use in business organizations thus far means that we have had to be crude in modeling the creation of knowledge.

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

Self-coordination in markets is achieved through intelligence gathering and learning behavior. Firms interpret price signals (prices, wages, interests and profits) and transform them into expectations. These transformations include correction learning from past mistakes and attitudes toward risk (see section 1 of Technical Code). The self-coordinating properties of the entire economy depend significantly on the specification of these intelligence gathering and expectations functions.

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

III Competitive selection (the filter)

The Salter (1966) curves of each market are constantly upgraded endogenously through competitive exit ("creative destruction") and entry. Only those firms which have acquired superior performance characteristics through innovative creation of new knowledge (item I above), through learning in market (item II) and through interior process efficiency (item IV below) survive in the long run (see Chapter VI and section 6 in this chapter).

IV Learning about interior firm capacity

No firm management is fully informed about its own capacity to produce (see Eliasson 1976). A boundedly rational search procedure that I call MIP targeting (MIP = Maintain or Improve Profits) is applied from top management to force upward improvements in interior firm performance (see sections 2 and 4.3 of Technical Code).

MIP-targeting assumes that top management knows that the firm always operates somewhere below the feasible level of capacity. Past experience determines the level from which top management knows that an upward improvement in its profit rate can be achieved. The psychology of targeting is that top management knows that some improvements can be achieved. However, knowing that excessive, impossible targets are never taken seriously even if slack is quite large, it is wrong to impose grossly infeasible targets. Hence, targeting is organized only to push for gradual improvements. Targeting, then, becomes a form of learning, or transferring knowledge of potential capacities within the firm organization. Top corporate management is probing for the limits of capacity, information that lower level management wants to conceal. If new technology is not being created, targeting will eventually push activity on to the feasibility (production) frontier (see QFR(L) in Figure I.4).

3.4 Household Behavior

As was indicated in the overview, both the demand system and the price system of the model are closed. Most importantly, income generated in the production system (see sections 5.4.1 and 5.4.2 of Technical Code) is fed back as demand through the household system, or via taxes as public demand (see sections, 7.3.3, 7.4 and 11.20 of Technical Code).

Private household demand is determined through a nonlinear Stone type consumption system, with saving entering as a separate consumption category – in principle for each individual household, in current modeling practice as a macro expenditure system (see sections 7.4 and 7.10.3 of Technical Code).

I will not go through the details of the household sector here (for detail see Eliasson 1978, pp. 76-79, 201-210), but focus on the savings decision, which is the novel part.

The observation unit in the household sector is the extended family including a group bound together by common interests, values and culture, extending over several generations and together providing a synergistic production, income-generation and insurance team. We won't discuss the interior member behavior of the extended family further and how it is affected by external market and policy behavior (see further Eliasson 1982). The main task here is to model family financial behavior that determines savings and consumption, regulated by a utility function of the following kind.

Utility function

$$U = U(C_I, CF_{FUTURE}, C_{FAMILY})$$

Savings function

$$SAVH = F(\frac{WH}{DI}, RI - DCPI, RU)$$

The family derives utility today from saving for future consumption for itself and its current and future members: saving is a separate artificial "consumption" category that competes for income with immediate consumption desires.

We expect the family to substitute future consumption for the family for current consumption to achieve a stable family wealth/disposable income relationship. This trade-off depends on the real (after tax) return to savings. In this sense we have formulated an extended family life cycle hypothesis, meaning that current family savings are targeted to pass on – to future generations – the currently achieved family wealth/disposable income ratio. This long-term savings target is modified by a short-term "insurance" modifier, related to labor market conditions and unemployment risks.

Since the household sector is currently modeled in macro (see sections 7.10 and 7.11 of Technical Code) we won't elaborate the microeconomics of households implied further here.

3.5 Policy Making

Policy making in the MOSES experimentally organized economy is exogenous (for detail see Eliasson 1980).

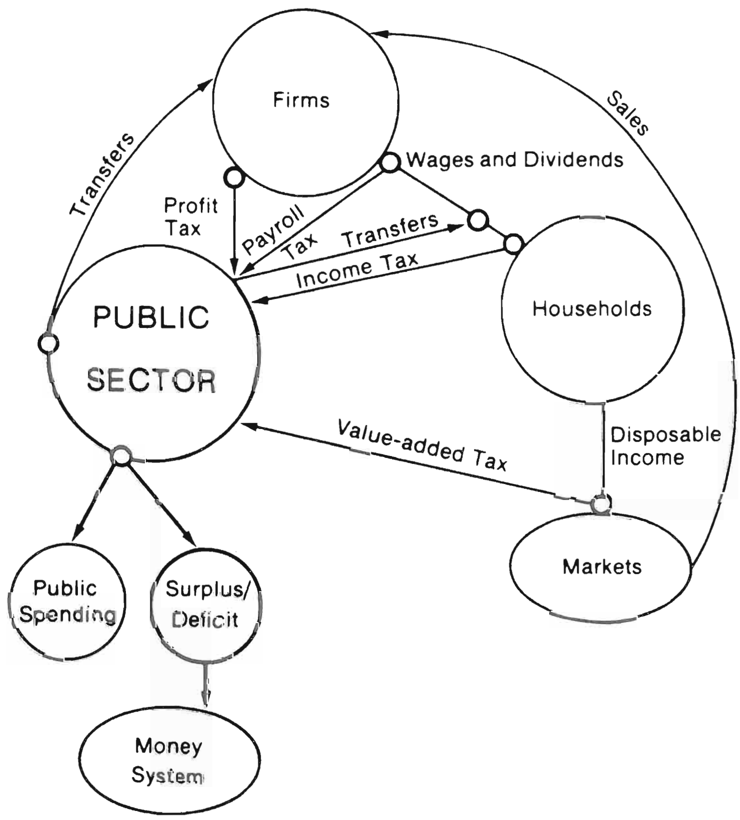
Through taxation and public sector expansion the government can influence demand in a traditional Keynesian fashion. In the model personal income (see section 7.2.6 of Technical Code), corporate income (section 10.6 of Technical Code), payroll (section 7.2.4 of Technical Code) and value added (section 7.11 of Technical Code) taxes are applied on income flows as defined in legislation. Public sector expansion is regulated exogenously through the public sector recruitment decision (see section 5.3 of Technical Code) and through the transfer payment decision (see section 11 of Technical Code). The structure of the tax system of the model is shown in Figure I.3.

Since taxes enter as a cost of both capital and labor and affect the net outcome of personal savings, both the supply of, and the demand for labor and capital are affected.

The policy makers can also affect the exchange rate (exogenously) and set the mode, or regime, of the various markets by affecting some of the parameters that determine the extent of interaction between agents and markets and the speed of agent response to price signals in the market (see section 7.3.1 of Technical Code and section 9.3 in this chapter).

In all these capacities the policy maker affects the organization of markets and, hence, their capacity to transmit and interpret information and to allocate resources.

Figure I.3 The tax system



Source: Eliasson (1980, p. 63)

3.6 Market Behavior

a) Experimental selection

Selection or filtering occurs in all markets in which the outcome is the result of a tacit, experimental selection process. The investment budget of firms is determined by the expected rate of return over the interest rate (see investment function, section 10.10 of Technical Code). New firms enter or exit through a profit opportunity and bankruptcy filter respectively (see Eliasson 1978, pp. 52-55 and 1985, pp. 163 ff., Chapter VI in this volume and also sections 4.3.10 and 12.3.8 of Technical Code).

Finally, people are filtered among producers (firms); in the labor market through elaborate information signaling and wage adjustment mechanisms (see section 5.4.1 of Technical Code).

Labor is classically homogeneous in MOSES, in the sense that any unit of labor input performs identically at each job location. The productivity of one unit of labor input is completely specified by the job location. Hence, for the time being, no learning to accumulate individual human capital occurs in the model, except learning about more productive and better paid jobs.

b) Coordination – the invisible hand

Altogether the model distinguishes between the four information processing activities of section 3 above, (1) the creation of new knowledge (innovation), (2) coordination, (3) filtering and (4) the transmission of knowledge, even though the latter is poorly specified.

Innovative activities occur within firms. They are exogenous, and can be made more or less unpredictable to market agents, thus affecting the "fundamentals" of the model economy about which agents strive to learn.

Similarly, filtering affects the organizational design of the entire economy, the allocation of people and capital, and the size, number and allocation of producers (firms).

Learning behavior occurs at different levels. Learning, in the classical sense of knowledge transmission, is currently restricted to the outcome of the competitive process in the form of an irreversible path of organizational change that sets the initial conditions (the memory) for the next competitive round.

Learning, however, also occurs in the form of information gathering for decision makers. Firms have to learn about their internal capacities to produce. We have the targeting process above.

In the evolving micro-based economic structure, ex ante decisions regarding production, investment, consumption etc. have to be coordinated through market price and quantity adjustments in order to generate ex post behavior. Together this process is a true[4] "non-tâtonnement" process of the invisible hand, as it operates in the markets of the micro-to-macro model.

The efficiency of this economy-wide coordination function depends both on the organizational structure of the economy and on how informed each agent is about the same structure at any given point in time. Firms constantly strive to learn about the structural fundamentals through their reflections in prices (see sections 1, 2 and 3 of Technical Code). In equilibrium prices map one-to-one onto the corresponding quantity structure. Out of equilibrium we don't know the relationships. Since the organizational structure facing each agent is immensely complex and constantly evolving as a consequence of the ongoing coordination and filtering process involving all agents, agents are constantly grossly misinformed about their market environment. They are, even though we do not invoke strategic behavior. The state of full information is not a feasible one.

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[4] For some mysterious reason literature has distorted the meaning of the French word "tâtonnement". The French meaning is ours, namely the actual adjustment process. No such adjustment occurs in the static general equilibrium model which only specifies conditions for equilibrium, but nevertheless gives "it" the dynamic name tâtonnement.

3.7 Technical Change in Information Processing Determines the Performance Characteristics of the Economy

The ultimate problem associated with introducing information processing explicitly in economic modeling – and hence in economics – now becomes a matter of how technical change in economic information processing and communication affects the macroeconomy. Since innovation, coordination, filtering and learning permeate the entire micro-macro fabric of the economy, the leverage effects on macroeconomic performance of even small shifts in information technology may become enormous, feeding back on the environment of micro agents in a highly unpredictable fashion and causing fundamental changes in the application of mainstream economic theory. The main changes in coordination technology are matters of organizational change within firms and markets. On the market side we have frequently used the model to study the macro effects of different market regimes.

Coordination technology determines how fast and how reliably market and hierarchical price signals of underlying quantity structures are transmitted through the economy and how efficiently they are interpreted by actors. The speed and completeness of transmission depend entirely on the organization of the economy; the interior organization of actors and the organization of relationships between actors. Some of these organization changes are endogenous effects of the ongoing market process itself (filtering of people, exit and entry, investment; see sections 5.4.1 and 10 of Technical Code and Chapter VI). Other aspects of the organization of the economy have to be changed exogenously, e.g. parameters of the labor market filter that regulates price signaling and search order (see section 5.4.1 of Technical Code), speed of price adjustment (see section 7.6 of Technical Code) etc.

One could also say that Government policy making belongs to the organizational design of the economy.

4 The Firm Model

4.1 Deriving the Control Function of the Firm

To outline the capital market dynamics of the M-M economy we derive the profit targeting and profit monitoring formulae used for both production and investment decisions. These guide the firm in its gradient search for a rate of return in excess of the market loan rate.

a) Defining the rate of return

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

$$TC = wL + p^I \cdot I + \left[r + \rho - \frac{\Delta p^k}{p^k} \right] p^k \cdot \bar{K} \tag{I.1}$$

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

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

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

$$\varepsilon = p^* \cdot \bar{S} - TC \tag{I.2}$$

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

$$\bar{\varepsilon} = \frac{\varepsilon}{K} = R^N - r \tag{I.3}$$

$$R^N = \frac{\varepsilon + r\bar{K}}{K} \tag{I.3B}$$

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

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

b) <u>The control function of the firm</u>

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

$$R^{EN} = M \cdot \alpha - \rho + \frac{\Delta p^k}{p^k} + \varepsilon \cdot \phi = R^N + \varepsilon \cdot \phi \tag{I.4}$$

$$M = 1 - \frac{w}{p^*} \cdot \frac{1}{\beta} \tag{I.5}$$

where:

M = the gross profit margin, i.e., value added less wage costs in percent of S
R^{EN} = $(p^*\bar{S}-TC)/E$ the nominal return to net worth (E = K–debt)
ρ = rate of economic depreciation (RHO in section 10.3 of Technical Code)
α = $\bar{S}/\bar{K}$
β = $\bar{S}/L$
ϕ = Debt/E = (K–E)/E
ε = $(R^N-r)K$

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

$\varepsilon \cdot \phi$ defines the contribution to overall firm profit performance from the financing department.

At any given set of expectations on (w, p*) in (I.4) determined through individual firm adaptive error learning functions [see (I.7) below], a target on M means a labor productivity target on $\bar{S}/L$. Thus, the profit margin can be viewed as a price-weighted and "inverted" labor productivity measure.

c) <u>Long–term objective function</u> (investment selection)

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

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

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

$$r_i = F(r, \phi) \qquad \frac{\partial F}{\partial \phi} > 0 \qquad (I.6)$$

The ε of an individual firm is generated through innovative technical improvements at the firm level (Schumpeterian innovative rents) that constitute Wicksellian type capital market disequilibria defined at the micro level. The ε drives the rate of investment spending of the individual firm. The standard notion of a Wicksellian capital market equilibrium is that of "average" $\varepsilon = 0$ across the market[5]. As a rule this state is not achieved. Unused capacity may prevent the firm from expanding capacity even though investment long term is expected to yield $\varepsilon > 0$. More important, however, is the fact that realized investment comes much later than the current quarter and that firms continue to make mistakes.

4.2 *Learning Functions (outward bounded rationality)*

Firms read off market signals and convert them into expectations through applying learning functions. They do this for product prices (P), market wages (W) and their own sales (S). Long-term and short-term expectations differ. Expectations (P,S,W) enter in the first investment and production decisions each quarter. During the quarter firms keep revising their expectations as decisions are realized and as they learn through encounters in the market what other firms are doing.

The general expectations function (see section 1 of Technical Code) includes a projection, an error correction from the previous quarter, and a caution (risk aversion) factor based on the experienced variability of the variable. The general expectations or learning function for P has the following form:

$$EXP(P) = HIST(P) + \alpha\, HIST(DEV) + \beta \sqrt{HIST(DEV2)} \qquad (I.7)$$

The projection, or smoothing component:

$$HIST_t(P) = \lambda_1 \cdot HIST_{t-1}(P) + (1 - \lambda_1) \cdot P$$

[5] Note distinction $E(\Sigma\varepsilon) \neq 0$.

The error correction component:

$$\text{HIST}_t(\text{DEV}) = \lambda_2 \cdot \text{HIST}_{t-1}\ \text{DEV}) + (1 - \lambda_2) \cdot \text{DEV}$$
$$\text{DEV} = \text{P} - \text{EXP(P)}$$

The "caution" component:

$$\text{HIST}_t(\text{DEV2}) = \lambda_3 \cdot \text{HIST}_{t-1}(\text{DEV2}) + (1 - \lambda_3) \cdot \text{DEV2}$$
$$\text{DEV2} = [\text{y} - \text{EXP(y)}]^2$$

$$0 \leq \lambda_i \leq 1 \qquad i = 1, 2, 3$$

4.3 The Creation of New Technology

A new investment vintage can be regarded as a "new firm" with exogenous capital productivity ($\alpha = \bar{S}/\bar{K}$) and labor productivity ($\beta = \bar{S}/L$) characteristics. A new investment can be seen as a new vintage of capital with these particular technology (α, β, ρ) characteristics in the profit control function (I.4) that mix with capital installations in existing firms (see section 4.1 of Technical Code). Technology is exogenous and embodied in new investment vintages. Hence, the <u>international opportunity set</u> introduced earlier is represented by current (α, β, ρ) specifications of new investment vintages, while <u>local competence</u> is defined by the local investment process (and – of course – the short-term production decision) that upgrades the technical specifications (the "frontier") of the firm, under which quarterly production decisions are taken.

The productivity upgrading process can now be seen to take place in four steps (See Eliasson 1985a, pp. 329 f). Call current operating productivity of one unit of measurement, one firm (α, β), when operating on the QFR(L) frontier (α^*, β^*) and productivity associated with new investment (α^{**}, β^{**}). We have $(\alpha^{**}, \beta^{**}) > (\alpha^*, \beta^*) > (\alpha, \beta)$.

(1) Actual, operating labor and capital productivities (α, β) are pushed by competition towards potential productivity (α^*, β^*) on the frontiers. Static operating efficiency of the economy improves.

(2) Potential productivity (α^*, β^*) of existing units is increased through more investment of higher productivity (INV of quality (α^{**}, β^{**}) > (α^*, β^*) raises → ($\Delta\alpha^*$, $\Delta\beta^*$) of existing units). Neoclassical efficiency improves.

(3) Reorganizations between existing firms raise the aggregate (α^*, β^*) of the economy. Labor is reallocated towards the more efficient plants. Allocational efficiency improves.

(3B) Allow all three above changes to occur simultaneously. Dynamic allocational efficiency improves.

(4) Innovations create new type ($\Delta\alpha^{**}$, $\Delta\beta^{**}$) of productivity characteristics. Schumpeterian efficiency is achieved as these new investments enter the economy then the intermediation of entrepreneurs and competing old technologies out of business (creative destruction) thus upgrading the Salter structures of the economy.

It is somewhat difficult to distinguish between efficiency categories (2), (3) and (4) in principle, since the categorization depends on the definition of the unit of measurement. In practice and in modeling they sort themselves out nicely since we have defined the unit of measurement.

Fix investment, and increase competition in the MOSES model. Firms tend to operate closer to the QFR(L) frontier and type (1) efficiency improves.

Stop exogenous ($\Delta\alpha^{**}$, $\Delta\beta^{**}$) = (0,0) upgrading of new investment, hold the market competitive regime constant, and allow investment, and type (2) efficiency will improve.

Change both competitive regime and (α^{**}, β^{**}) characteristics of new investment and reorganizations between existing units (relative size, exit) and type (3) allocational efficiency will improve. [Internal reorganizational improvements within a unit of measurement by definition come under type (4)]. If no investment is allowed (all capital installations being given) and if no initial slack of type (1) is allowed, type (3) allocational efficiency will be identical to comparing two statically efficient allocations within a general equilibrium model, each corresponding to a different given set of relative prices.

All four types of efficiency improvements occur simultaneously in the MOSES model. The classical model can only account for type (1) and (possibly) type (2) productivity improvements. Sector models with investment endogenized [e.g. the Cambridge Growth Model, and the IUI ISAC model (Ysander 1986)] allow for aggregate improvements in neoclassical productivity. To sort out the relative importance of different productivity improvements requires a very careful design of model experiments. One difficult problem relates to the endogeneity of prices in the MOSES model, which the classical model has no problem with. Except for the interest rate, wages and product prices cannot be "fixed" during a simulation.

However, type (1) productivity improvements could be measured by simply taking the aggregate difference at one point in time between Q on QFL, vertically above existing L, and actual aggregate Q (see Figure I.4). Hold total labor input in each firm and technical change constant and study the consequences of a proportional increase in investment. Type (2) improvements in productivity occur. Stop investment and technical change and set the model going. Type (3) allocational efficiency improves.

With all factors at work simultaneously type (3B) or <u>dynamic</u> allocational efficiency occurs.

The interesting things, however, occur when competitive regime is changed, when exit and entry are allowed, and when improved technology enters through the investment decision. Then type (4) Schumpeter efficiency improves.

The difficulties arise when one tries to explain the creation of new (α^{**}, β^{**}) at the level of the unit of measurement. This requires that we model the creation of new technology through entrepreneurial search in the opportunity set.

The simplest way of doing this is to model R&D investment and define stochastic pay-offs, possibly from a differentiated risk approach (imitative or innovative technological regimes. See Winter 1984).

Alternatively, and much more ambitiously, one can introduce priors about the content of the opportunity set and model search (information) technology in approaching the set, very much as some industrial policy authorities and R&D managers in large firms believe it can be done.

Personally I am very sceptical about the potential of such technology management. My prior view would be that current knowledge capital of the nation and of the firms will then bias search (and hence R&D) in a conservative direction. Since we know that such R&D management goes on, it is nevertheless an empirical fact to be incorporated. In dealing with it in the model I would do exactly as suggested above, namely confine search orientation to existing technology specifications of the firm.

The problem is that the MOSES model does not recognize firm technology characteristics, except by broad product and market identification. So at this level we are back in practice to the Nelson–Winter (1982) and Winter (1984) R&D modeling specification.

4.4 The Investment Decision

We have presented the short-term quarterly production planning sequence of the micro-to-macro economy as it occurs within a given production feasibility frontier. The investment decision deals with the choice of future production frontiers. Technology enters in the long-term capacity augmentation phase (shifting of the production frontier).

New techniques are embodied in new investments and affect the MOSES economy in five ways:

(1) through the exogenous technical performance characteristics of a unit of new investment (called MTEC). MTEC measures labor productivity (β) (see section 4.1.1 of Technical Code),
(2) through the amount invested (endogenous),
(3) through the allocation of new investment over firms,
(4) through the rate of utilization of installed investment (UTREF endogenous; see section 10.10 of Technical Code), and finally
(5) through price competition from abroad (DPFOR), which is exogenous (see section 6 of Technical Code).

The investment function is driven by the ex ante $\bar{\varepsilon}$ factor of the individual firm, i.e. the rate of return expected to be earned over the going interest rate (see section 10.10 of Technical Code).

$$INV = F(EXP(\bar{\varepsilon}), UTREF) \tag{I.8}$$

This specification simplifies the investment decision considerably. The firm aims for a certain INV, conditioned by expected $\bar{\varepsilon}$ and the rate of capacity utilization. It gears up the capital budget accordingly. Actual investment, however, is also determined by the actual ex post cash flow, and the actual $\bar{\varepsilon}$.

5 Strategic Behavior

There are two principally different types of micro-macro models. In the first kind agents form expectations about all other agents as a group, or attempt to see through all intricate interactions of the micro-macro machinery to aim for a perceived (rational expectations) equilibrium. The MOSES system is mostly of this kind.

The second kind of model involves strategic behavior, each agent attempting to foresee and counter the strategies of competing firms. Strategic behavior involves withholding information, becoming a free rider, or showing moral hazard behavior. If agents learn that strategic behavior is occurring and that it cannot be conceived of as random noise, they take defensive strategic action against the strategic action of others, and thus behavior of this kind may be self-defeating and non-optimal.

Strategic behavior of firms generally destabilizes markets. The probability of mistakes increases, and new inconsistencies arise in individual plans.

Strategic behavior enters through profits targeting and expectations forming, and the model allows deviations from the standard procedure of reading market price and wage signals, and projecting aggregate local market growth to set targets on one's own performance. The EXPXDP etc. factors in sections 1.1.5, 1.2.5, 1.3.5 and the TARG XM factor in section 2.3 can be tagged on to perceptions of competitor action and be weighted into expectations and targets through the R factor in sections 1.1.6, 1.2.6, 1.3.6 and in 2.3 of Technical Code.

The firm can in fact tag its targets or expectations on any set of signals coming out of the MOSES economy. Thus, for instance, profit targets can be set as profit performance of the best competitor, and wage and price expectations can be derived from information from the highest paying firm, and the lowest price recorded in the market.

It is an empirical question how (and how much of) such strategic behavior may be allowed to enter.

6 The Entry and Exit Filter

Firms close down when they are persistently unable to meet rate of return targets and/or when net worth is exhausted (see sections 4.3.10 and 12.3.8 of Technical Code).

New firms enter the market in response to the best opportunities in the market represented by some measure of $F(\bar{\varepsilon})$. $F(\bar{\varepsilon})$ determines the number of new entrants per quarter. The size and performance characteristics of each new entrant is a drawing from a distribution of these characteristics. In general (Granstrand 1986), the average new entrant is not better, only smaller, than the average incumbent firm (see Chapter VI).

6.1 Initiating a Firm with Known Performance Characteristics

Technically the entry of a new firm requires the specification of some performance characteristics and its mode of entry (initialization). This is done in programing terms in Chapter VI. I spell it out briefly in economic terms.

We begin with equations (I.4) and (I.5) in section 4.1 that characterize the "state" performance characteristics of the firm completely, once a scale (size) factor has been added.

The entering firm is assumed to be 100 percent equity financed, i.e. $\phi = 0$ in (4). All prices (P^k, P^*, w, r) are given in the market from the moment of entry. We assume that the firm obtains all the people it needs from the pool of unemployed in the first quarter at the average wage in the market. The owners of the entering firm may have misconceived the price situation, but they will learn immediately.

Hence, the vector of performance characteristics:

$(\text{size}, \alpha^*, \beta^*, \gamma, \rho)$

is sufficient to define the firm and its control function can be written:

$$G = M \cdot \alpha^* - \rho + \frac{\Delta p^k}{p^k} + \varepsilon \cdot \phi$$

$$M = 1 - \frac{w}{P} \cdot \frac{1}{\beta^*}$$

Thus, the rate of entry in the market depends on the market

$$\bar{\varepsilon} = R^N - r$$

and its control function is [cf. (I.4) and (I.5)]:

$$G = M \cdot \alpha^* - \rho$$

$$M = 1 - \frac{w}{P} \cdot \frac{1}{\beta^*}$$

The entering firm has no debt and expects no inflation ($\Delta P^K / P^K = 0$).

Since G now becomes

$$G = R^N$$

the assumption for entry is that

Expected $(R^N - r) \geq 0$

or sufficiently positive to warrant entry.

Technically again, entry can be seen as an investment vintage of each firm (defining its size) that is allowed to operate freely in the market, rather than mix with existing capital installations of another firm. To get the firm initialized and production started, this entering investment vintage has only to employ people. We assume that the firm hires people the initial quarter from the pool of unemployed such that all are effectively employed in production (no labor hoarding. A21 = 0; see Chapter VI). From there on the firm operates as any other firm.

α^* defines potential capital productivity in value terms[6] of entering firm, operating with employed labor on the frontier [$\bar{S}/K$, see (I.4)].

β^* defines potential labor productivity of entering firm [$\bar{S}/L$; see (I.5)]

γ measures the slope of QFR(L) for a firm of size QTOP (see Figure I.4).

$$\partial QFR(L)/\partial L = QTOP \cdot \gamma \cdot \exp(-\gamma \cdot L) \rightarrow QTOP \cdot \gamma; \quad \text{when } L \rightarrow 0$$

ρ measures the rate of depreciation of K.

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6 Note the terminological inconsistency. α in (I.4) is really $= P \cdot \bar{S}/P^* \cdot \bar{K}$ while β in (I.5) is $\bar{S}/L$.

For entry to function, and for all other state variables of the firm to be consistently initialized (see Chapter VI) we have to make the size specification consistent with the performance vector.

$\frac{\partial QFR(L)}{\partial L}$ measures the labor productivity of a new, marginal addition of capital, or the labor productivity of a new vintage of capital = β^*.

Hence $\beta^* = QTOP \cdot \gamma$

$$\gamma = \frac{\beta^*}{QTOP}$$

β^* is exogenously specified for each vintage of new investment. QTOP is one of the needed size variables (see Figure I.4). The other size variable is the size of the labor force (= L) that the firm wants to employ.

Within (β^*, QTOP) of the entering firm, given QFR(L), can be estimated.

With L given, entry Q can be estimated.

With (β^*, ρ) the parameters of the control function are given.

Hence, the (minimum) specification (QTOP, L, α^*, β^*, ρ) is sufficient to identify a new, entering firm and set it in motion in the MOSES economy.

6.2 Sampling the Performance Characteristics of the Entering Firm

While the investing firm decides on the size of investment and buys the best-practice equipment in the market (see Chapter VI) the performance characteristics of the entering firm have to conform with the average of what we (we think) know about entering firms. These averages are the constraining facts of the situation and are entered as prior (assumed) distributions of performance characteristics:

(QTOP, L, α^*, β^*, ρ).

We know the first moments (averages) of these distributions, except for size which is completely specified.

In choosing the other parameters, the owners/entrepreneurs of the entering firm exercise business judgment and selective competence. The choice may be more or less risky, a circumstance entered a priori through selecting the second moment of the distribution. On this score we correctly assume (as does Winter 1984) new entrants to be highly risk-willing, selecting from distributions of (α, β) with a low likelihood of an extreme outcome. This is in contrast to the investment decisions in firms which exhibit a high likelihood of picking the average outcome (currently they always pick the average (α, β) characteristics).

The reader should note that the entry specification of the technical code is not yet tested. The entry experiments have so far (Eliasson 1978, pp. 52 ff. and Hanson 1986) been carried out in a much more rough and ready fashion, by simply adding prepared firms by hand. Allowing firms to enter according to a general entry function similar to the ones specified above in fact very soon overloaded the existing computer workspace. For the time being main frame computers do not seem to allow the large number of firms needed for full scale entry experiments on a normal research budget.

Each new entrant so determined immediately establishes himself or herself as a competitor employing people from the pool of unemployed at the going wage rate up to A21 = 0 (i.e. at point B, on the frontier in Figure I.4).

From that point on, each new entrant behaves as a normal firm.

6.3 Exit

Firms exit when they constantly fail to meet profit targets, declaring their assets to be of nil value and laying off all labor. Laid-off labor is then available for work through the pool of unemployed (see section 4.3.10 of Technical Code). Firms also close down when net worth is exhausted (see section 12.3.8 of Technical Code).

7 Market Organization

The notion of competition among the few is the appropriate conceptualization of the market organization of the micro-macro model.

In its most updated form with an endogenous entry and exit feature (see Chapter VI and section 4.3 of Technical Code) the micro-macro model can be seen as a dynamic game among a variable number of players, each aiming for an increased market share as long as rate of return targets are not violated.

Competition is technologically based in the same sense as in modern trade theory (see Krugman 1984). Technological upgrading affects process performance only, and the relative state representation of each firm describes its relative technological capacity ("knowledge") to outperform other firms.

Competition is for a share of total production value, i.e. what foreign and domestic producers are willing to pay.

Each new technology upgrading, and each reallocation of resources towards relatively better producers (technologies) generate improved economies of scale and more capacity for growth in the sense that (all else being equal), by adding new best-practice capacity and hiring new labor at higher wages, the best performer will eventually be able to force all other firms to exit. The control factor is time. This selection or filtering mechanism upgrades the "Salter (1966) structure" of the MOSES economy.

However, each new technological improvement also means less value to relatively bad producers, reducing the value of their capital. New best-practice technology can be invested in any firm taking on an investment program, and superior technology can enter from the outside. Furthermore the highest profit performers do not necessarily pay the highest wages. A superior productivity performer setting out on an investment growth and recruiting program, may suddenly destroy a favorable factor price situation for a higher profit firm. Finally consumer preferences and foreign markets may change the relative price situation.

Since concentration altogether depends on relative long-term profit performance, unlimited concentration through economies of scale through technological performance is checked by new competing technologies and changing market circumstances, factors that drive down the market value of assets of incumbent producers.

New competing technologies through new investments or new entrants drive down market price and push wages and interest upwards, thus lowering rates of return and $\bar{\varepsilon}$ on incumbent, slower producers. This rate of technological competition is intensified by the rate of entry and rate of investment, which in turn depend on $\bar{\varepsilon}$ observed in the market and how current $\bar{\varepsilon}$ performance is translated into expectations and investment.

The check on concentration tendencies from new competitive entry is clearly demonstrated in the model when we vary the intensity and character of competitive entry.

Depending upon the rate and character of technological change and the mood and speed of the market the "optimal" growth regimes differ.

8 The Quarterly Production Decision – Short-term Market Behavior of the Firm

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

8.1 MIP Targeting – Interior Information Search (inward, bounded rationality)

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

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

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

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

The production decision is typically boundedly rational in the sense of Simon (1955) and Eliasson (1976a). Top level management does not know enough to impose the flow structure that maximizes ε in (I.2) through the components of M in (I.4), given capital installations. It resorts to MIP targeting (see section 2 of Technical Code). Expected (p, w) are applied to historic data on M, and suggested to lower level management, thus initiating an internal negotiation, called production search, eventually resulting in a preliminary agreement (a plan). The negotiation process continues as long as management believes M will stay above targets without resulting in a lowering of ex ante profits (see section 4.3 of Technical Code). Convexity is thus preserved, and decisions correspond to a gradient search for maximum ex ante profits, a position that will be reached if other environmental conditions remain ceteris paribus. The latter is, however, normally not possible to impose on a dynamic micro-based model of this kind.

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

Mathematically, the interior trial and error process of a MOSES firm makes use of a graded search algorithm for 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 is, however, given a time dimension which means that hill-tops are rarely reached by micro agents. The hill-tops move (endogenously) from quarter to quarter as a consequence of the interaction of all agents in the markets.

8.2 Short Term – Production Planning

Expected percent changes in sales, product prices, wages and targeted profits are used in the three micro specified market contacts of the firm in the model – investment (the interest rate), production planning and the labor market (wages) and the product market (prices). Each firm's expectations on prices and its profit target produce a final (quarterly) output. The reader should note that we have simplified our exposition by excluding purchases even though a set of individual firm input-output coefficients applies to each firm (see section 7.5 of Technical Code). This means that in our exposition, value added and sales volume differ only by variations in finished goods inventories.

a) Sales plan

The first step involves making a sales plan based on past market experience, using the simple error-learning correction projections described in section 4.2 (section 1.3 of Technical Code). If inventories from the earlier (quarterly) market adjustment are above desired levels, this plan is reduced. If inventories have been depleted, the sales plan is increased over the sales projection. Hence, inventories are the triggering device that determines a turn-around, when sales (and subsequently sales projections) have been slow for some time.

b) Production search

Production planning is carried out individually by each firm. Within this block each firm chooses a preliminary, planned output and labor combination (Q, L). The algorithm by which a (Q, L) plan is chosen is intricate. Figures I.4 and I.5 illustrate the principles.

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

$$QFR = QTOP*[1-\exp(-\gamma \cdot L)] \quad (I.9)$$

This feasible set shown by the curve in both Figures I.4 and I.5 is determined by the firm's past investments as they are embodied in QTOP and γ. Investment between quarters pushes this set outward. To the set of feasible (Q, L) combinations of the firm

$\leq$ QFR or

$\leq$ QFR/L

corresponds a set of satisfactory (Q, L) combinations

$$\geq \frac{EXP(W)}{EXP(P)} \cdot \frac{1}{1-TARGM}$$

A quarterly profit margin target (TARGM) defines the satisfying criterion. This target is calculated as defined above. The shaded area in Figure I.5 defines the feasible and satisfactory production set.

The basic targeting is done on a yearly basis with quarterly adjustments, and profit margin targets adapting gradually as experience on what is possible to achieve is accumulated.

As shown above [see (I.5)] a profit margin target (TARGM) can be derived from the rate of return target. Bad profit experience can make the firm lower its target in the short term. This will normally affect long-term development negatively; immediately through smaller cash flows 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 forms of slack within the company, in a way that can be called learning or search for better solutions (see below and Eliasson 1978, pp. 68-73).

Expectations are of an adaptive error correction – learning type based on the smoothing formula (I.7). Risk considerations ("aversion") in expectations forming enter through a standardized variance measure in the expectations variable. If variance increases in product prices, 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 Eliasson (1978a, section 4.2).

c) <u>Purchasing</u>

The MOSES economy features an 11 sector (market) input/output system. Four of these sectors/markets (basic products, intermediate products, investment goods, and non-durable consumption goods) making up all manufacturing, are micro specified. The input/output coefficients are endogenously determined in the following way (see section 7.5 of Technical Code. Also see Bergholm 1989.) Each firm can buy in all 11 markets, including services from the public sector. Each firm has a given purchase ratio of sales estimated in the yearly planning survey. Total purchases so determined are distributed each period according to the I/O coefficients of the sector/market in which the firm operates. Since individual firms grow at different rates, the macro sector I/O coefficients change endogenously.

d) <u>Inventories</u>

Inventories exist as buffers on the input and the output sides of each firm. There are no strategic inventories built on price speculation. Each firm aims for a desired level of inventories, but always comes out ex post with too much or too little (see section 8.1 of Technical Code) depending on how production plans come true.

Each production planning round – as mentioned – aims for restoring desired inventory levels.

Since firms dimension their production plans from sales plans, which are themselves trend projections out of the past, it may be worth observing how a turn-around in production from decline to growth occurs through inventory adjustments. A sequence of declining sales years would be followed by a sales projection continuing that trend. However, a market turn-around of course means that finished goods inventories will soon be depleted. The firm then adds – to each projected sales plan – what is needed to restore inventories. If the market improvement continues, the situation repeats itself until the opposite situation occurs.

e) Selecting the production plan

The firm now chooses a point within the shaded area of Figure I.5 that is both feasible and satisfactory. This is done by specifying an initial set of (Q, L) points and the rules to adjust these points if they do not fall within the feasible and satisfactory lens area. Note that it is labor productivity that is adjusted.

This search for improved productivity is a learning process that is activated and intensified by difficulties of meeting profit targets. This is a well recognized phenomenon in the business world. Firms do not know their feasibility sets well even in the short term. Learning goes on all the time in a piecemeal fashion. This learning is speeded up when the profitability situation deteriorates. Under such circumstances internal resistance to change yields, and improvements often do not have to be associated with more than minor, additional expenditures (Eliasson 1976a).

Search is guided by a comparison of the productivity ratio to an equally scaled expected price ratio. 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 in Figure I.5 may, however, lead onto B, and down along it, to a premature collapse of operations. This may 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 supplementary rule 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 in Figure I.5 and/or (2) feasible but not satisfactory (Region B), or (3) neither feasible nor satisfactory (Region C).

Slack in the form of labor hoarding and unused machine capacity exists by way of the measurement technique we use to estimate QFR(L). It is a normal cyclical phenomenon. It occurs because ex ante plans can only rarely be made to match ex post realizations. Furthermore, even though technically the model firm competes with process efficiency, the firm we have in mind is a temporary monopoly based on product knowhow. Through the investment decision in the long run QFR(L) tends to be located where long-run profitability targets are satisfied. Hence, long-run targets are satisfied when the firm operates on its QFR(L). In markets for technological product competition where we see MOSES firms operate one furthermore does not lower the price to achieve a short-term increase in volume. Customers do not change producers and product technology at short notice and producers do not compete with price, but rather by adding more quality, information or marketing to the product. So, prices are quite sticky in the short term, and price wars do not occur.

In addition, on the assumption of bounded rationality, firm management is aware only of the existence of slack, not the exact location of the boundary. It operates on the assumption that it is closely above the actual operating domain. As a consequence QFR(L) will function as a stopping rule in the production planning process. Work on improving productivity goes on all the time. It is, however, time consuming and rarely completed within a period. Target non-satisfaction may force it to speed up a bit, but improvements normally stop when production plans hit QFR(L). Where exactly to stop is, however, endogenized within each period depending upon which way search goes and over time when QFR(L) shifts because of investment (see sections 4.1 and 4.3 of Technical Code). There are even ways of breaking through this maximum frontier capacity under exceptional (crisis) circumstances (see the factor RES; section 4.1.6 of Technical Code).

The state of slack across firms – the vertical distance to QFR in Figure I.4 – can be measured every year in the Planning Survey of the Federation of Swedish Industries on which the model is based. Each year some firms are operating at full capacity, but most are not. We also know roughly from empirical studies (see for instance Eliasson 1976a) how firms adjust their output plans in a stepwise fashion. Production search has been tailored to mimic such procedures within firms. When a model run is set up, the state of slack is assessed for the initial year in the initialization process (see Chapter II by Albrecht–Lindberg). The state of slack is then monitored through the MIP-targeting and production planning procedure every quarter by every firm as the simulation goes on.

When a feasible and satisfactory (Q, L) point in Figure I.5 is reached, the firm's preliminary plan is set at the minimum Q such that SAT(Q, L) holds. If SAT(Q, L) does not hold, and if the point is in region A, the firm adjusts by planning to lay off labor. If this does not help, the firm's preliminary plan is to set the minimum feasible Q and L.

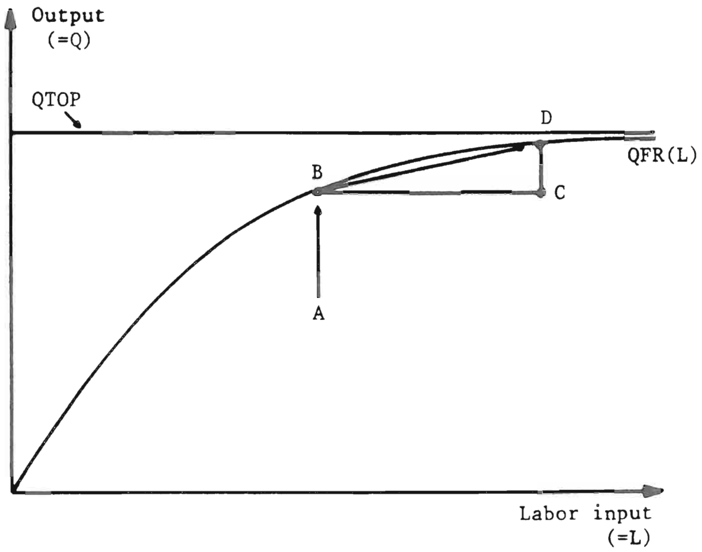
Each firm now has a planned employment and output level. At the aggregate level, however, these plans may not be feasible. Firms must confront one another in the labor and product markets to sort out remaining inconsistencies (see section 5.4. of Technical Code).

9 Multimarket Interaction (Interdependence and Dynamic Coordination)

The ex ante ex post realization processes are modeled as a sequence of market confrontations that sort out ex ante and ex post inconsistencies and lead to the determination of price and quantity distributions.

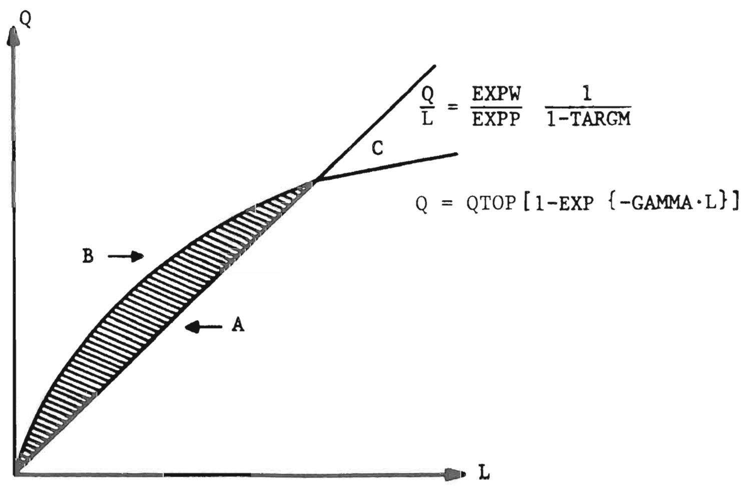
The production volume is distributed to export and domestic markets according to an export share, which is dependent on that from the previous quarter, but which also depends on the difference during the previous quarter between the export price and the domestic price. If this export price (which is exogenous) was higher than the domestic price, the firms try to increase their export share during the current quarter. However, the adjustment takes place over several quarters, not instantly. If the export price is lower than the domestic price, firms do not try to lower their export share but rather maintain it at a constant level. In spite of this asymmetry concerning

Figure I.4 Production system (one firm)



The function describing the production system of one firm at one point in time is $QFR = QTOP \cdot (1-e^{-\gamma L})$ (see section 4.0.1 of Technical Code). How this function is estimated and how it shifts in time in response to investment is described in Eliasson (1976b, Ch. 4) and in Albrecht (1978).

Figure I.5 MIP-principle and profit targeting (one firm)



the effect of positive or negative price differences between exports and the domestic markets, it turns out that the export shares in the various markets can both increase and decrease. This depends on whether firms with high export shares fare better or worse than other firms in the market. The import share in the four markets is also determined by the difference between the export and domestic prices with a certain time delay. High domestic prices relative to foreign prices lead to increasing import shares.

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

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

9.1 The Capital Market

The capital market dominates real economic behavior in the MOSES model through the interest rate. In the current operating version of the model presented here the interest rate is exogenously[7] determined abroad, an assumption that appears to be an empirically valid approximation (Oxelheim 1988).

The current operating version of MOSES thus makes firms interest takers and impose the Fisher (1907, 1930) separability theorem.

The markets for finance hence function as exogenous goal setters (setting rate of return targets) and as allocation mechanisms for "tacit" entrepreneurial competence. The former function is in turn influenced through the savings decision, savers' determining de facto, the time horizon under which the

[7] There exists a more sophisticated version, with explicit interest arbitrage (Eliasson 1985a). This version, however, is not yet empirically implemented.

entire economy operates. The interest rate and the ex ante competence of firms determine investment and capacity growth in the economy. It can also cool down price setting in other markets, for instance the labor market, since the ultimate objective variable of the firm is the rate of return (Eliasson 1974, Eliasson – Lindberg 1986).

9.2 The Labor Market Search

Let us first return to the outcome of the internal firm quarterly production plan of the firm (section 8.2e above), a planned output, employment level and anticipated price and wage levels, satisfying the rate of return target of the firm.

Each firm now enters the labor market with a planned change CHL in its labor force (see section 5.4 of Technical Code).

If CHL $\leq$ 0, the firm begins to lay off workers with the notification delays that are required by Swedish laws. (The AMAN vector, section 5.4.1 and 5.4.2 of Technical Code).

If CHL $\geq$ 0, these firms will start looking for additional labor in the pool of unemployed, or, as happens more frequently, try to bid labor away from other firms.

Ideally labor market 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 empirically far more convincing for Sweden to make the firm rather than the worker the active search agent. Choosing labor as the sole search agent would mean uncritically applying theoretical specifications developed for the U.S. labor market to Sweden.

The number of searchers per period (=NITER) is a preset parameter calibrated by trying to fit macroeconomic model behavior to macro data.

Raiding of another firm for labor can be successfully carried out if the wage offer of the raiding firm sufficiently exceeds that of the raided firm (see section 5.4.1.8 of Technical Code). 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 partly hold back its expectations during the first quarter of search as it learns about wages in other firms. This search process eventually finalizes quarterly wage levels and employments for each firm.

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 facilitate understanding.[8] Let W be the wage paid by a firm in the preceding quarter.

Then its wage offer is computed as

$$WW = W + ö1 \cdot (EXPW - W).$$

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

Firms are now ranked according to their relative demand for additional labor, i.e., 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 (see section 5.4.1.6 of Technical Code). 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 the raiding firm (see Eliasson 1984). An upward probability bias can be (and normally is) applied to the pool of

[8] A full description can be found in Eliasson (1978, pp. 137-148 and 218-227).

unemployed. Raiding can be global across all firms, or be selective and restricted to a particular kind of firms, say in one sector.[9]

Let i index the raider and let j index the target. An attack is successful in $WW > (1 + ö2) \cdot WW_j$, and labor in the amount of $MIN>(ö3 \cdot L_j, CHL_i)$ 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 $MIN(ö3 \cdot LU, CHL_i)$ workers become employed in firm i. When an attack succeeds, (CHL_i, CHL_j, L_i, L_j) are adjusted and the firm losing labor increases its wage offer by

$$CHWW_j = ö4 \cdot (WW_i - WW_j).$$

If the attack is not successful (see section 5.4.1.8 of Technical Code), then the attacking firm increases its wage by setting

$$CHWW_i = ö5 \cdot [WW_j \cdot (1 + ö2) - WW_i].$$

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

We have learned from repeated numerical analyses of the entire 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.

9.3 Foreign Market Competition, Foreign Trade and the Exchange Rate

The world market of the M-M economy is assumed to be in steady state competitive equilibrium. Model firms are price takers in foreign markets, that are characterized by exogenous (PFOR, RIFOR, MTEC, INVEFF) trajectories. PFOR and RIFOR are foreign product prices and interest rates, respectively. MTEC and INVEFF define – for each period – best-practice technology

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[9] 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 225 firms we currently use in a simulation. For the time being, both access to firm data and prohibitive computer costs prevent such simulations.

embodied in new investment (also called α, β in the performance vector in section 6 of this chapter). We are of course free to study any development of the above vector, and we have done so, but the idea has been (Eliasson 1983) to specify an internally consistent exogenous steady state environment where world market prices are set such that best practice producers entering the market earn a return on their total (marginally invested) capital equal to RIFOR, i.e. assuming $\bar{\varepsilon} = 0$.

Since $\beta^* = \text{MTEC} = \bar{S}/L$
$\alpha^* = \text{INVEFF} = \bar{S}/\bar{K}$

of the marginal investment we can use formula (I.4) to derive (for $\varepsilon = 0$);

The Fisher Real Interest Rate $= \text{RIFOR} - \frac{\Delta \text{PFOR}}{\text{PFOR}} = M \cdot \alpha^* - \rho =$
$(1 - \frac{w}{p}\frac{1}{\beta^*})\alpha^* - \rho.$

In the exogenous, foreign market steady state equilibrium, the real (Fisher) interest rate and technology in new, best-practice, and internationally available investments exactly determine the real wage level such that $\varepsilon \equiv 0$.

Thus, the ability of the micro-macro economy to control the level and distribution of wages and to upgrade productivity determines the competitive situation of domestic firms in domestic and foreign markets.

Export and import functions of the model are supply based (see sections 6 and 7.3.1 of Technical Code).

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

$$\text{CHX} = F \left| \frac{\mu \cdot \text{PFOR} - \text{PDOM}}{\mu \cdot \text{PFOR}} \right|$$

where $F' > 0$ and μ is the exchange rate.

There is no other explanatory variable, and it is important to understand that, with the quarterly specification, we should not have any additional explanatory variables. This formulation can be demonstrated to mean (roughly) that the ratio of deliveries to foreign markets and the domestic market slowly changes toward relatively more exports as long as a positive difference persists between profit margins on export and domestic sales for the producing firm (see Eliasson 1978).

Two additional things should be noted here.

First, the main factor that keeps export ratios from generally converging towards 1 or 0 is that domestic prices respond (through quantity adjustments within the entire model economy) to the diversion (or vice versa) of supplies to foreign markets and this diminishes the (PFOR–PDOM) difference. This process (and the corresponding mechanism on the import side) is the main transmitter of 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 the sense that 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.

9.4 Domestic Product Market Competition

The final quarterly, domestic market confrontation is between firms as suppliers on the one hand, and households and firms as demanders on the other (see section 7.3 of Technical Code). This process 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 just 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 the product markets within the quarter, and supplies are predetermined 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 the final product market outcomes only through the initial prices and quantities offered. Firms also indirectly affect the operation of the product markets through the wages they offer and the total amount of income that consumers thereby have available for expenditure.

A few clarifications of the product market process are needed at this stage. Firms have differing price levels on their products. The reason is differing export and domestic sales mixes and the fact that the foreign domestic price difference of each market and each firm's export ratio are endogenously determined in the model. Also, the same domestic price is charged by all firms. The reason for this simplification is the practical unavailability of price data for individual firms. It does not make sense to model differing product price levels if there is no way of implementing this part of the model empirically. This particular specification means that firms compete as a group with prices against foreign producers, but against each other in terms of achieved rates of return, or cost performance. Even though wage levels for homogeneous labor differ across firms in practice this means competition with production efficiency. Full price arbitrage is assumed within each product market each quarter. In model terms, this 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.

9.5 Closing Note on Price Feedback

The micro-macro model briefly introduced above exhibits endogenous price and quantity setting at the micro level and complete price and demand feedback through markets and income determination. Being an empirically implemented model of the Swedish economy, it has been placed in an international market environment. Domestic Swedish performance control is exercised through the international capital market (the international interest rate), international product competition through foreign trade, and economic policy. Labor movement in the model is within Swedish borders only.

From an analytical point of view this makes the model more complex than it has to be in order to highlight the problems of this essay. Closing the entire model would mean either making the domestic interest rate an exogenous policy parameter, which is easy as the model stands now[10], or completely determined through micro intermediated demand and supply processes in the markets for finance. We have not yet been successful in integrating this feature in the empirical model.

In principle, however, the Swedish micro-macro model is assumed to be interacting with an equilibrium steady state world model. This is traditional. In practice it gives rise to complications, since an environmental steady state situation is very demanding on consistent specification (see section 9.3 above).

[10] Such experiments have already been carried out. See Eliasson (1984).

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CHAPTER II

The Micro Initialization of MOSES

by
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This paper documents our micro-initialization work on MOSES through 1982. Since then databases have been updated, and improvements in the initialization procedure have been put into place. These changes refer to the actual running of the MOSES model, while this chapter presents the basic ideas underlying the micro initialization procedure as we described them in the paper of 1982. These principles are still valid. Updated instructions for initializing and operating the model have been included in Bergholm, F., MOSES Handbook, 1989, IUI, Stockholm.

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1 Introduction and Overview

1.1 Introduction

This paper is part of the description and documentation of IUI's MOSES model. In particular, it describes how the model is "initialized" using two micro-datasets, one a collection of "firms-level" data taken primarily from annual reports and other public sources and the other a "division- or establishments-level" dataset drawn from an annual Planning Survey conducted jointly by IUI and the Federation of Swedish Industries.

The emphasis in this paper is on issues of micro-initialization. However, enough information is given about the operation of the model, about the overall initialization procedure and about the underlying datasets to make the paper self-contained.

The paper consists of three parts. The first section gives a general description of the model with an emphasis on those blocks using micro-data, an overview of the complete initialization procedure and a brief description of the data. In this section we briefly identify each of the variables needing micro-initialization. The second section explains the mechanical aspects of the micro-initialization procedure and constitutes the "documentation" part of the paper. The full details of the procedure are, however, relegated to the appendix where the programming code that is central to procedure is listed with extensive comments. In the third and final section we offer an assessment and some suggestions about how the initialization procedure might be improved.

1.2 Overview of the Model

In this section we give a very abbreviated introduction to the model. For a complete description of the model one can refer to a series of papers by Eliasson (1976, 1978, 1983).

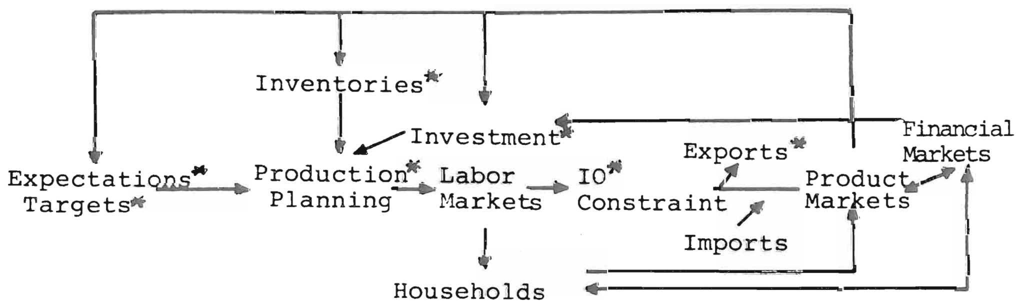
MOSES (for MOdel for Simulating the Economy of Sweden) is a "micro-to-macro simulation of the Swedish economy." It is a micro model in the sense that the behavior of individual production units (establishments) in the manufacturing sectors is explicitly modelled, and it is a micro-to-macro model both in the sense that these individual units operate within the framework of a national economy and in the sense that the behaviors of these individual units aggregate to form a significant part of that national economy. It is a simulation model in that most of the specifications in the model are not estimated in the conventional econometric sense, and it is a model of the Swedish economy both in the sense of being initialized with Swedish data and in the sense of having the ultimate ambition to be a useful numerical representation of the Swedish economy.

The model is constructed as a sequence of recursive blocks, or modules, and the completion of one sequence of these modules is taken to represent the passage of one quarter of calendar time. A first set of blocks models the behaviors of the individual production units that are the "micro units" of the model, and a second set of blocks models the macroeconomic framework within which these individual units operate.

In each period each establishment (micro unit) is described by a vector of data (on production levels, employment, etc) and parameters (e.g. response coefficients). The micro-initialization of the model refers to the provision of initial start-up values for these data and parameters.[1] Likewise the macro-initialization of the model refers to the provision of initial start-up data and parameters for the macroeconomic blocks.

To understand the operation of the model it is useful to refer to Figure 1 which presents a simplified (in the sense of de-emphasizing the macroeconomic framework) schematic representation of the MOSES economy from the viewpoint of a single establishment. Initialization takes place prior to the operation of the model (i.e, prior to the repeated execution of the modules pictured in Figure 1). The starred modules represent those components of the model requiring external micro-data as initial inputs.

Figure 1 Modular Representation of the MOSES Economy



Starting from the left-hand side of the diagram, in each quarter each establishment begins by forming price, wage and sales expectations and a profit margin target. These expectations and targets are then used as inputs into the production planning module in which each establishment sets a preliminary production/employment plan. There are three basic inputs to this planning procedure. The first is a specification of each establishment's initial position (level of employment, stock of inventories, etc). The second is a specification of the technical possibilities open to the establishment, i.e., the set of feasible production/employment combinations, as determined by past investments. Finally, expectations and targets are used to construct the third basic input to the production planning module, namely, the set of satisfactory production/employment combinations. For a given initial position, the intersection of the sets of feasible and satisfactory production/employment combinations is then used to determine the preliminary plan.

Neither the employment nor the production plans of all the model's establishments need be mutually consistent. There may, for example, be plans to hire more workers than are available at the wage levels establishments intend to offer. Or, the aggregate of planned productions may require more of certain inputs than is available in the short run. Therefore, adjustment mechanisms are introduced to impose ex post consistency.

Ex post employment consistency is achieved via a stylized labor market, the outputs of which are a final employment and a (possibly) revised production plan for each establishment and an aggregate wage income for the household sector. After the operation of the labor market module, ex post production consistency is imposed via an input/output constraint.

Once the I/O constraint is exercised, the final quarterly production of each establishment is determined. An establishment's production goes to three destinations -- sales on the export market, sales on the domestic market and additions to the stock of product inventories. (In addition, exports and domestic market sales can be realized by drawing down the existing inventory stock.) The split is achieved as follows. First, planned sales are determined as production plus the desired change in the inventory stock. Next, a fraction of planned sales is diverted to exports, with the (establishment-specific) export fractions determined by the previous period's export fractions and the establishments' offering price relative to the exogenous world market price. This leaves a quantity to be supplied to the domestic market.

Actual domestic market sales (at the establishment-specific level) and domestic prices (at the market level -- i.e., all establishments in any one market sell at the same price) are then determined by the "interaction between supply and demand" in the product markets module. Demand comes from three sources -- households, establishments and the other sectors of the economy (including government) that are modelled at the macro level.

The completion of the product markets module thus generates quarterly sales volume, price and the change in the stock of product inventory for each establishment. Combining these data with the vectors of establishment wage bills (determined in the labor market module), input goods purchases (determined in the I/O constraint module) and changes in input goods inventories (also determined in the I/O constraint module) gives short run operating profits for each establishment. These quarterly profits are then used to update the establishments' financial positions, and these updated financial positions are in turn used as inputs to the investment block.

The investment finance module as currently implemented in the model is basically a "capital budgeting" model with borrowing determined by a rate of return criterion. In addition, there exists a more complicated (but as yet non-operational) "sophisticated investment finance" module which explicitly models a long-run planning process. In our micro-initialization work we have provided for most of the input requirements of the sophisticated version. Whichever investment finance option is used, the ultimate outcome is an updating of the technical possibilities open to each establishment. The operation of the investment finance module completes one quarter's running of the model.

To summarize, the model begins by computing production/employment plans for each establishment. These plans are then modified (made consistent) in the labor market and I/O constraint modules. Next, "supplies are confronted with demands" in the product markets module. The outcome of this module is then used to update the establishments' financial positions which in turn becomes an input to the investment module. Finally, investments are used to update each establishment's production possibilities, and the model is ready to run for another quarter.

From a micro-initialization point of view it is now useful to present more detail in two general areas. The first of these is short-run operations (expectations and targets, production planning and revision of production plans) which initializes using the Planning Survey data (establishments-level data) as direct input. Second, we give a more detailed presentation of the investment module. The micro units in MOSES are intended to represent establishments; however, in reality investment decisions are made at the firm level. Accordingly, the variables in this module are initialized using data from the firms-level database.

1.3 Short-Run Operations Modules[2]

Expectations/Targets

The expectations module generates expectations about percentage changes in sales (S), prices (P) and wages (W) for each establishment. These expectations are generated on an annual basis with quarterly modifications and serve as inputs to the production planning module.

All annual expectations are generated in percentage rates of change according to

$$EXP(V) = R \cdot EXPI(V) + (1-R) \cdot EXPX(V); \qquad 0 \leq R \leq 1,$$

where EXPI and EXPX stand for "internally" and "externally" generated expectations and V is the variable about which expectations are being generated. The externally generated expectations, EXPX, and the weighting factor, R, are treated as free parameters to be set exogenously; that is, the data problem pertains to the internally generated expectations, EXPI. These are in turn set as

EXPI(V): = HIST(V) + (E1·HISTDEV(V)) + $(E2 \cdot HISTDEV2(V))^{1/2}$,
where

HIST(V): = (SM(V)·HIST(V)) + (1-SM(V)) · V,
HISTDEV(V): = (SM(V) · HISTDEV(V)) + (1-SM(V)) · (V-EXP(V)),
HISTDEV2(V): = (SM(V) · HISTDEV2(V)) + (1-SM(V)) · $(V-EXP(V))^2$

and E1, E2 and SM(V) (i.e., SMP, SMW and SMS) are parameters. The notation ":=" should be read as "is set equal to". Thus, for example, HISTDW is set equal to SMW times the previous period's HISTDW plus (1-SMW) times the previous period's DW.

Thus, the data requirements for the initialization of the expectations module are

(1) DP, EXPDP, HISTDP, HISTDPDEV and HISTDPDEV2,
(2) DS, EXPDS, HISTDS, HISTDSDEV and HISTDSDEV2 and
(3) DW, EXPDW, HISTDW, HISTDWDEV and HISTDWDEV2.

Data for each of these 15 variables are required for each of the model's establishments.

The operation of the targets module is quite similar. A profit margin target (TARGM) is generated on an annual basis for each establishment with quarterly modifications according to

TARGM: = MHIST·(1+EPS),
MHIST: = SMT·MHIST + (1-SMT)·M,

where EPS and SMT ($0 \leq SMT \leq 1$) are parameters and MHIST and M are the "profit margin history" and the actual realized (previous period) profit margin, respectively. Thus, the data requirements for the initialization of the target module are MHIST and M for each establishment.

Production Planning

The specification of the production planning module is complicated; however, the data requirements of the module and its basic operation can be explained without great difficulty. As indicated in our overview of the model, there are three basic data inputs involved -- (i) a specification of the set of satisfactory output/employment combinations, (ii) a specification of the set of technically feasible output/employment combinations and (iii) a specification of a set of trial output/employment combinations which in turn depends upon the establishment's initial position.

These concepts can be explained by reference to Figure 2. The QQ on the vertical axis refers to the quarterly output of a single establishment, and the L on the horizontal axis refers to the corresponding establishment employment.[3] The straight line from the origin labelled "TARGET" divides the set of all (QQ,L) combinations into "satisfactory" and "unsatisfactory" subsets, where "satisfactory" is defined by the inequality

$$QTARGM \leq 1 - (QEXPW \cdot L)/(QEXPP \cdot QQ),$$

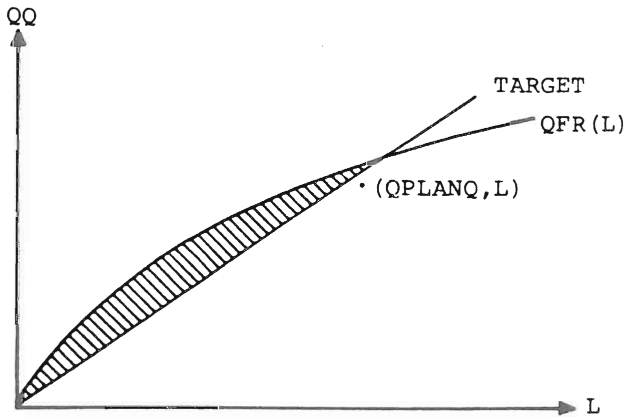
i.e, by the set of (QQ,L) that satisfy the quarterly profit margin criterion.

Next, the set of feasible (QQ,L) combinations is given by those pairs lying below the "short-run production frontier" labelled QFR(L) in the figure. This latter is specified as

$$QFR(L) = (1\text{-}RES) \cdot QTOP \cdot (1 - \exp(-\frac{TEC}{QTOP} \cdot L))$$

The set of simultaneously satisfactory and feasible (QQ,L) combinations is then given by the shaded area. The establishment's problem is to find a production/employment plan somewhere within this lens.

Figure 2 The Production Planning Module



Finally, suppose the firm has a given initial employment and expects to be able to sell an amount QEXPS/QEXPP, i.e., quarterly expected sales deflated by the quarter's expected price level. Adjusting this expectation of sales in volume terms by the desired change in the stock of product inventory gives a quarterly output plan, QPLANQ. Then the point (QPLANQ,L) becomes the trial output/employment combination.

If (QPLANQ,L) is simultaneously feasible and satisfactory, i.e., lies within the lens, then that point is adopted as the production/ employment plan. If on the other hand (QPLANQ,L) does not lie within the lens (as is the case in Figure 2), then adjustment mechanisms are called into play. It is the specification of these adjustment mechanisms that makes the production planning module complicated; however, from a data requirements point of view these mechanisms are essentially irrelevant.[4]

We now have enough context to go through the data requirements for the production planning module. First, there are the data required for the specification of the set of satisfactory (QQ,L) combinations. But these are just QTARGM, QEXPW and QEXPP which are previously generated in the expectations and targeting modules.

The specification of QFR(L), i.e., of the short-run production possibilities frontier, is somewhat more complicated. There are three parameters involved -- RES, QTOP and TEC --, the first of which is set exogenously within the range 0 RES 1. (RES is interpreted as a "residual slack fraction" and is inherently unobservable.) This leaves QTOP and TEC to be set on an establishment-by-establishment basis using microdata.

To do this first note that the quantity QTOP·(1-RES) corresponds to a standard notion of capacity, i.e., the maximum potential output from existing facilities. Thus, given an observation on output, the standard capacity utilization measure identifies QTOP·(1-RES) and therefore QTOP (given an assumed value for RES). To calculate the remaining parameter, viz, TEC, another capacity utilization measure is required. Given an observation on output and employment, potential output conditional on that employment provides a value QFR(L) at some particular L; thus providing enough information to calculate TEC from

$$QFR(L) = QTOP\cdot(1-RES)(1-\exp(-\frac{TEC}{QTOP}\cdot L))$$

The data which are actually employed for these computations are called A21 and A22 in the MOSES terminology. For a given output, QQ, and employment, L, these are defined by

QFR(L) = QQ(1+A21)

QTOP·(1-RES) = QQ(1+A21+A22);

thus A21 and A22 in effect decompose the standard capacity utilization measure into two separate components. (See Albrecht (1979) for a discussion.) Together with observations on output and employment, the two capacity utilization measures A21 and A22 thus constitute the data requirements for the specification of QFR(L).

Finally, there is the question of data requirements for the specification of the trial (QPLANQ,L) combination. As discussed above, QPLANQ equals quarterly expected sales in volume terms (calculated using inputs from the expectations module) plus the desired change in the stock of product inventory. More precisely, QPLANQ is computed as

$$QPLANQ = \max\left(0,\ \frac{QEXPS}{QEXPP} + \frac{OPTSTO-STO}{4 \times TMSTO}\right),$$

where STO is the existing stock of product inventory

OPTSTO: = MINSTO + BETA·(MAXSTO-MINSTO)

MINSTO: = SMALL·4·(QS/QP)

MAXSTO: = BIG·4·(QS/QP)

and TMSTO is an exogenous "time adjustment parameter." In the determination of OPTSTO, MINSTO and MAXSTO, BETA is an exogenous parameter set equal for all establishments, QS and QP refer to the previous quarter's sales and price level, and SMALL and BIG are establishment-specific variables determined from the micro-data. Of course, SMALL is interpreted as the minimum inventory stock/annual sales volume ratio, and BIG is likewise interpreted as the maximum such ratio. These two variables (BIG and SMALL), together with STO, QS and QP, thus constitute the data required for the specification of the initial trial (QPLANQ,L) combination.

I/O Constraint

Establishments' production and employment plans are revised in two stages, first by the operation of a "labor market" and second by an input/output constraint. The labor market module requires as inputs the establishments' wage offers and desired changes in employment. Both of these are generated as a result of operations in blocks preceding this module; therefore no independently generated data are required from the micro-initialization.

However, the operation of the input/output constraint does require micro-initialized data. The I/O constraint operates by comparing the input requirements of each establishment with the inputs available to each establishment. Input requirements are computed by multiplying the QPLANQ for each establishment by a vector of establishment-specific coefficients called SHARE. Taken across all establishments, SHARE is of dimension (number of establishments) times 10, where 10 is the number of markets in the MOSES system. It is interesting to note that the specification of establishment-specific I/O coefficients together with shifts in production across establishments over time implies variable I/O coefficients at the macro level; that is, the SHARE-specification in effect "endogenizes" the macro I/O matrix.[5]

The inputs available to an establishment equal lagged input purchases, i.e., purchases made in the previous quarter, plus the maximum allowable decrease in input goods inventories. Lagged input goods purchases are denoted by QIMQ; thus, taken across all establishments, QIMQ is also of dimension (number of establishments) times 10. The maximum allowable decrease in input goods inventories is computed as IMSTO - MINIMSTO, where IMSTO is the pre-existing stock of input goods inventories for each establishment and MINIMSTO is the minimum acceptable stock of input goods inventories for each establishment. In fact, the input goods inventory system is analogous to the product inventory system (except that product inventory is a scalar and input goods inventory is a 10-tuple), i.e., four inventory concepts are involved -- the actual level of inventories (IMSTO), the desired (optimal) level of inventories (OPTIMSTO), and the maximum and minimum allowable levels of inventories (MAXIMSTO and MINIMSTO). MAXIMSTO and MINIMSTO are determined by multiplying QIMQ by the establishment-specific coefficients IMBIG and IMSMALL, respectively.

The output of the module in which the I/O constraint is activated is a reduction in QPLANQ if the amount required of any input exceeds the amount available; otherwise QPLANQ becomes the establishment's quarterly production. In addition to this final adjustment of QPLANQ, establishments' input goods purchases are set, i.e., next period's QIMQ is determined, and adjustments to input goods inventories are made. The data required from the micro-initialization for the operation of the I/O constraint are thus the matrices SHARE, QIMQ and IMSTO and the vectors IMBIG and IMSMALL.

Summing Up

The above identifies the variables that need to be initialized to run the model's short-run operations modules. The data required are all establishment-level data and are fetched from the Planning Survey. This is in contrast to the data needed to micro-initialize the investment finance module which are taken from a firms-level data source.

Before turning to the firm-level data requirements, we summarize the variables requiring establishment-level initialization in Table 1.

Table 1 Variables to be Micro-Initialized in SR Operations Modules

Variables	Modules
DP EXPDP HISTDP HISTDPDEV HISTDPDEV2	EXPECTATIONS
DS EXPDS HISTDS HISTDSDEV HISTDSDEV2	"
DW EXPDW HISTDW HISTDWDEV HISTDWDEV2	"
M MHIST	TARGETING
AMAN L	PRODUCTION PLANNING
A21 A22	"
STO BIG SMALL	"
QS QP	"
SHARE QIMQ IMSTO IMBIG IMSMALL	I/O CONSTRAINT
X[a]	EXPORTS
QW[a]	LABOR MARKET

[a] Not discussed in the text. X is the establishment-specific export share used in the export module. QW is used in the labor market module in determining each establishment's wage offer.

1.4 Investment Finance

The major outputs of the current investment finance module (INV-FIN) are the amount of production equipment (QINV) to be installed in each establishment in the following quarter and the efficiency parameter associated with that investment (INVEFF).[6] These new investments are used as input to the production planning block to upgrade technical possibilities and production capacity. In other words, they change the level and curvature of the establishment-specific production possibility frontiers (QFR(L)).

In the current version of MOSES no distinction is made between establishments and firms, rather the micro entities of the model are regarded as both establishment and firm simultaneously.[7] It is in this context that we apply firm-level financial concepts to the MOSES "establishment" while at the same time referring to these micro-entities as "firms" (which in this section is the relevant data concept). However, it should be stressed that in reality there exists a very clear distinction between the two concepts. Production, stock-piling and other real activities take place at the plant or establishment level, more or less separate from the activities in other plants within the group or at the higher division level in the company hierarchy. Financial and growth decisions, on the other hand, are made in the corporate headquarters which allocates existing resources between the various branches of the organization.

The investment "function" determining QINV is of the "capital budgeting" type. Firms first calculate their desired investments using a rate of return criterion, reducing those desired investments (and concomitant borrowing) later only if too much slack capacity exists. Firms then interact with each other and the rest of the economy in the credit market module and the quarter's actual borrowings (and therefore investments) are determined as a result. The final step is to recognize the lag between investment expenditures and the realization of those expenditures. This is done using a delay function which makes realized QINV depend upon past periods' investments (QINVLAG).

An array of firm-level financial variables is required to go through the process generating the subsequent real outputs. To specify the data actually required, it is useful to have a simplified balance sheet (Table 2) as a reference. The entries in this table, and some of their sub-components are required as micro-input for the INVFIN module.[8]

Table 2 Simplified Balance Sheet

K1 Fixed Assets	BW Borrowing (Debt)
K2 Liquid and Other Assets	Net Worth (A-BW)
K3 Inventories	
A Total Assets	A

The first step is to compute a preliminary estimate of the funds available for investment for each firm as the quarter's cash flow (QCASH) plus the desired change in debt (i.e., borrowing -- QDESCHBW) less the desired change in liquid assets (QDESCHK2). QCASH consists of five components -- (1) operating profits from the current quarter (determined prior to the INVFIN module), (2) receipt of interest payments on liquid assets (RIK2·K2), (3) interest payments on outstanding debt (RIF·BW), (4) dividend payments (QDIV) and (5) the quarter's tax payments (QTAX). The two interest rates, RIK2 and RIF, are linked to an endogenously determined (in the credit market module) "base rate." QTAX is paid out of net taxable profits taking depreciation allowances into account and QDIV is paid out as a fraction of QTAX. The specification of QTAX requires the book value of fixed assets

(K1BOOK) as input. "Book depreciation" is then determined by applying the statutory rate RHOBOOK to K1BOOK.

Next QDESCHBW needs to be calculated. The specification used in the model is that QDESCHBW is proportional to existing debt with the factor of proportionality dependent on the "internal-external interest margin." More precisely,

$$QDESCHBW: = BW \cdot (ALFABW + BETABW \cdot (QDPK + \frac{QRR-RI}{4}))$$

where

ALFABW and BETABW are exogenous parameters, QDPK is the percentage change in the capital goods price index (which has been previously determined in the product market module) and QRR is the current quarter's rate of return on total assets. This (i.e., QRR) is in turn computed as

$$QRR: = 4 \cdot \frac{(QCASH + QDIV + QTAX - QDEPR)}{K1 + K2 + K3}$$

i.e., an "annualization" of the quarter's revenues less depreciation relative to total assets. Depreciation (QDEPR) is computed by applying an "economically motivated" (as opposed to statutorily determined) rate RHO to fixed assets valued at current replacement cost (K1). Finally, the desired change in the firm's liquid assets (QDESCHK2) is set. These assets are kept as a buffer against temporary fluctuations in sales and hence are directly related to the turnover, i.e.

$$QDESCHK2: = (4 \cdot RW \cdot QS) - K2,$$

where RW is an exogenous constant.

The above determines the firm's preliminary investment budget. These planned expenditures (and borrowings) are reduced if the degree of capacity utilization (computed using data from the production planning module) is lower than an exogenous reference level, leaving each firm with a "demand for funds", QDESCHBW. These demands are then confronted with the "supply of funds" from the rest of the economy in the (macro-level) credit market module, and actual borrowing (QCHBW) is determined for each firm as a result.

The quarter's investment expenditures are then set as

QINVLAG: = max(0, QCASH + QCHBW - QDESCHK2).

Should QCASH + QCHBW - QDESCHK2 be negative, liquid assets bear the adjustment, i.e.,

QCHK2: = QCASH + QCHBW - QINVLAG.

The final setting of QINV is achieved by taking into account the time lag between investment expenditures and the actual mounting of the assets on the shop floor. This specification requires the three previous quarter's expenditures (i.e., QINVLAG) and the exogenous parameters of the delay function (TMINV) as input. The calculation of the investment efficiency parameter (assumed equal to the capacity/capital ratio) concludes the INVFIN block, i.e.,

INVEFF: = (QTOP·QP)/K1,

where K1 has been updated according to

K1: = QINV + (1-RHO)·(K1·(1+QDPK)).

The INVFIN module is further described in Eliasson-Lindberg (1981) where also some experiments in quantification are given.

To summarize, the data requirements of the INVFIN module are the basic balance sheet items (K1, K2, K3, BW and NW), the figure needed for tax computation purposes (K1BOOK) and previous periods' investment expenditures (QINVLAG).

1.5 The Initialization Procedure

The initialization procedure has as inputs the two micro-databases and a macro-dataset and produces as output the variables needed to run the model. In this section we discuss this procedure somewhat generally with the aim of clarifying the basic problems involved. A more technical description of the initialization process is given in Bergholm (1982).

Production in the MOSES model is carried out in ten sectors, four of which are modelled at the micro level. These micro sectors are (1) Raw Materials Processing, (2) Intermediate Goods, (3) Durables, (i.e., Investment Goods and Consumer Durables) and (4) Non-Durables. Each of the micro-sectors is composed of a number of establishments. The number of establishments in any micro-sector can be varied, but aggregation across establishments must be consistent with the sectoral totals derived from the macro-data. For example, the model can be initialized with 10, 20, 50 or 100 establishments in the Raw Materials Processing sector, but the sum of (say) production across whatever number of establishments we choose must equal total Raw Materials Processing sectoral production as indicated by the macro-data. There is a difficult micro-to-macro consistency problem involved here that is aggravated by the fact that the MOSES sectoral classification and the sectoral classifications of the micro- and macro-databases are all different.

Within each micro sector some of the establishments are "real" and some are "synthetic". To say that an establishment is real simply means that it is initialized directly from the micro-data. In particular, each real establishment in the model has a counterpart in the Planning Survey data. Thus, if we have data on a particular Volvo plant (establishment) in the Planning Survey, we can use those data directly to initialize a corresponding MOSES establishment. Alas, the Planning Survey data are purely establishment-level data whereas the corresponding MOSES entity is regarded simultaneously as firm and establishment. That is, for example, the MOSES entities representing the Planning Survey Volvo establishments need to be fleshed out with firm-level (financial) data from the Volvo group. This is done by integrating the firm-level and establishment-level micro-databases as described in section 2.2 and 2.3.

There are not enough real establishments in any sector to generate the aggregate sector totals; therefore additional "synthetic" establishments need to be introduced. These synthetic establishments are created in such a way that the sum of any synthetic establishment variable plus the corresponding real establishment sum equals the sectoral aggregate derived from the macro-database. Of course, this leaves considerable choice as to how the individual synthetic establishments should be initialized, and we have devised a procedure which reproduces among synthetic establishments the pattern of covariation between variables observed in the real establishment subject to the "adding up constraint." Again, the details are to be found in section 2.3.

This procedure of creating real and synthetic establishments is the basis of the micro-initialization process and represents a new approach relative to earlier documentation of the model. Prior to the summer of 1980, when we completed the first working version of the new micro-initialization programming, the Planning Survey data were not used in the initialization procedure. In our opinion, the use of establishments-level micro-data has significantly improved the initialization process by incorporating available information about variation within sectors at the micro level into MOSES.

1.6 The Databases

Planning Survey Data

Since 1975 the Federation of Swedish Industries has conducted an annual Planning Survey under the direction of Ola Virin (later together with Kerstin Wallmark). Some of the questions in this survey were specifically designed with the data requirements of the MOSES project in mind, and in this section we briefly describe the Planning Survey from that point of view. A more general description and analysis is given in Albrecht (1982).

The Planning Survey is sent out in February of each year to the establishments comprising the largest firms in Swedish manufacturing. A strict definition of the respondents is not easy to give since they may be either pure production units, lines of production units including overhead functions like marketing and distribution, i.e. what is commonly referred to as divisions, or they may even be the entire firm itself. The latter is usually the case when the firm is not divisionalized and/or when it is localized to only one place. This labelling is however not so important and we have chosen "establishments" throughout this paper. What really matters is that the Planning Survey, in all cases, observes decision units.

In each year the potential number of respondent establishments is approximately 250, and a response rate of 70-80 % has been achieved in each year. This represents a substantial fraction of Swedish industry. For example, in the survey covering 1980 the degree of coverage in terms of number of employees was 51 % for the sectors covered by the Planning Survey.[9] It should be noted that the sectoral classification of the Planning Survey; namely (1) Raw Materials Processing, (2) Intermediate Goods, (3) Investment Goods, (4) Consumption Goods (i.e., both Durables and Non-Durables) and (5) Building Materials, differs slightly from the one used in MOSES.[10]

Information is available over all survey years (1975-81), with some omissions in 1975, in eight basic areas:

(1) employment and wages
(2) sales (broken down into domestic sales and exports)
(3) raw materials and input goods purchases
(4) investment (broken down into structures and equipment)
(5) annual percentage change in production volume
(6) capacity utilization
(7) orders
(8) inventories (both product and raw materials/input goods).

Information on the first five categories is available for the year of the survey, retrospectively for the preceding year and as a forecast for one year in advance for most survey years. In addition to these eight basic areas, different supplementary questions were asked in each year.

The capacity utilization questions are of particular interest in these surveys. The answers to these questions can be used to perform the decomposition of the capacity utilization gap into the components A21 and A22 as described in the overview of the production planning module given above. So far as we know this decomposition is unique to these data.

The Planning Survey data can in principle be used as a pooled cross-section of time series. That is, we have observations on many of the same establishments repeated year after year. There is, however, a difficulty with this in that definitions of production units (establishments) may be changed by firms between years. It is possible to check on this by retrospectively linking data between surveys, but this involves a good deal of detective work.

In any event, only the 1976 Planning Survey, i.e., the survey sent out in February 1977, is used in the current micro-initialization procedure. That is, the procedure described in this paper produces a model initialized to run beginning with the first quarter of 1977. The reason that 1977 (and only 1977) has been chosen as the start-up year has primarily to do with the problem of macro consistency. Although merging firm data with establishments data involves tedious work matching "by hand," it poses no problem in principle. The real problem is the difficulty involved in updating the I/O system in a consistent way. The benefit of being able to have start-up years other than 1977 does not currently seem worth the large cost in terms of the effort involved in "imposing consistency" on the macro-database for later years. Rather, if the Planning Survey data from years after 1976 are to be used in the model project, effort for the time being is better directed towards using them for calibration purposes.

Firms Data

Financial data on Swedish corporations have been collected for many years at the IUI. These data have been used in different ways in various projects and have not previously been systematically organized. The MOSES-model has provided an incentive to combine several of these datasets into a consistent database. Standards for collecting, arranging and storing have been established, and the analysis and processing of these data have, therefore, been facilitated. A description of the complete financial database is given in Lindberg (1982).

The subset of data relevant to the model consists of slightly compressed Profit and Loss Statements and Balance Sheets for between 30 and 50 major Swedish manufacturing corporations. All model inputs originate from annual reports and other publicly available sources, although considerable processing of these data has been required. The enlarged database also includes more confidential data, for example, survey answers and information from direct contacts with firms.

One appealing feature of this dataset is that it contains time-series of considerable length on investments, initially gathered by

Rolf Rundfelt and Bo Lindörn - both formerly at the Institute - for the purpose of profitability measurement and flow of funds analysis. This enables us, for instance, to calculate capital stocks (valued at replacement cost) and deferred tax liabilities through very simple cumulation processes.

As already mentioned, the financial firm data are used to attach a financial framework to the real activities at the establishment level. How this matching technically is carried out is described in detail below in section 2.2. The most frequently used sample of company groups and corresponding Planning Survey establishments is presented in Table 3.

Thirty-one firms, accounting for 54 per cent of sales and 69 per cent of employment in manufacturing are included in the database. These firms comprise 98 out of the approximately 200 Planning Survey respondents. The selection of real establishments used to micro-initialize the model has been guided by the available set of firm data. The implication of this approach is twofold. First, it does not ensure the maximum number of establishments given the contents of the two databases, nor does it ensure the most complete picturing of each chosen firm. We see, for example, in table 3 that Astra and Bahco are only represented by one establishment each. These establishments cover only 53 and 17 per cent of the respective company-groups total sales in 1976.

Second, the distribution of real establishments on the four MOSES industrial sectors is presently rather unequal. The fact that only five establishments represent the real part of the Non-Durable Consumption goods industry (NDUR) is a consequence of the relative smallness of firms operating in that sector in combination with the thus far adopted criterion for firm data collection ("major manufacturing companies"). This latter point is important since we know from experience that the model performs

Table 3 Matching of Firms and Establishments

Markets / Firms	1. RAW	2. IMED	3. DUR	4. NDUR
AGA	0	1	3	0
Alfa Laval	0	0	3	0
ASEA	0	1	3	0
Astra	0	0	0	1
Atlas Copco	0	0	2	0
Bahco	0	0	1	0
Bofors	0	2	2	0
Boliden	1	2	0	0
Bulten Kanthal	0	4	0	0
Electrolux	0	0	5	0
ESAB	0	0	1	0
Euroc	0	5	0	0
Fagersta	1	1	0	0
Fläktfabriken	0	0	2	0
Gränges	3	3	0	0
Holmens	0	1	0	0
Iggesund	3	2	0	0
Kema Nobel	0	3	0	0
Ericsson	0	0	3	0
MoDo	2	0	0	0
PLM	0	2	0	0
SAAB	0	0	8	0
Sandvik	1	0	1	0
SKF	2	1	0	0
Swedish Match	0	2	1	1
Stora Kopparberg	1	1	0	0
Volvo	0	2	4	0
Cardo	0	0	0	1
Esselte	0	1	1	2
Kockums	0	0	2	0
Korsnäs	2	1	0	0
No. of establishments	16	35	42	5
Per cent of sub-industry sales	35	27	42	3

poorly when synthetic establishments comprise too large a share of any market.

The large companies included in the firm database are, with a few exceptions, vertically integrated conglomerates operating simultaneously in several subindustries. This is clearly illustrated in table 3, where almost every other firm is shown to have establishments in more than one market. At an earlier stage in the model work, before the Planning Survey was incorporated and hence only firms data were used at the micro level, this data problem was quite evident. To which market should, for example, Swedish Match - presently operating in three markets - be classified? This is no longer such a problem since activity at the establishment level is rather homogenous and therefore easy to classify along the "user-oriented" definitions of markets.

There is, however, still a problem with the presently used method of matching firms and establishments. We attribute the financial characteristics of the firms to the corresponding establishments, making them more or less miniature copies of the former. What we instead eventually want to model is financial management behavior at the corporate headquarter (CHQ) level. In such a model establishment-level activities could be confined to those directly connected with production. We could possibly model in a CHQ-function some of the following:

- Overall corporate tax planning
- Financial planning (eg. external fund raising)
- Allocation of financial resources among subsidiaries (incl. retained earnings reallocation)
- Transfer pricing (input deliveries between subsidiaries)
- Interest/exchange rate arbitrage between foreign and domestic parts
- Merging and scrapping of production units

This would solve our current data problems, but additional data collection from firms would be necessary.

As is the case with the number of firms, the number of variables included in the firm dataset (labelled FTGS for the Swedish abbreviation of "företags" - firms) is only a fraction of all variables in the complete database.

In table 4 a subset of the variables in the firm database is listed, with stars indicating those actually used in the micro-initialization of the model. Time-series, starting in 1965, exist for variables 1 through 25.[11] To provide for a more sophisticated specification, e.g., corporate tax behavior in the investment-finance module and/or a CHQ-module, the dataset also includes a decomposition of fixed assets at book value (equal to the tax assessment or historic cost value). Capital stocks thus defined are increased through gross investment and appreciation (e.g., in connection with bonus share issues) but decreased by fiscal depreciation, depreciation against investment funds and sales of real assets. Since all of the components of fixed assets are traced back to 1950, we can construct replacement-valued capital stocks by cumulating investments and inflating with a suitable index of capital goods prices. If we assume an average economic life-length of capital of, say, 15-20 years and geometric depreciation, this would produce a rather trustworthy capital stock for the period 1970-present.[12] This is the way we have constructed the micro capital stock model-inputs (K1) appearing as the last item in table 4.

Macro Data

The macro data description given in this section only refers to the micro-initialization process. Naturally, macro inputs are used in many other places in the model. Unfortunately, no complete documentation of the overall macro-database is currently available.[13]

In earlier versions of the model the macro data were used extensively in the micro-initialization. This is not so much the case anymore since these data requirements are in most cases now met by the Planning Survey data. In fact, only four macro variables are necessary for the micro-initialization of the model. They are

Table 4 Variables in workspace FTGS

Balance Sheet:

*	1.	Cash and bank balances
*	2.	Other current assets
*	3.	Inventories, real value incl. reserve
*	4.	Other long-term assets
*	5.	Structures and equipment
*	6.	Forest and land
	7.	Reserves in fixed assets (cf. 14 below)
*	8.	Current liabilities
*	9.	Provisions for pensions
*	10.	Other long-term liabilities
	11.	Shareholders' equity (taxed)
	12.	Untaxed reserves in investment funds
	13.	Untaxed reserves in inventories
	14.	Untaxed reserves in fixed assets ("hidden")

Income Statement and miscellaneous

*	15.	Sales
	16.	Operating income before depreciation
	17.	Financial income (interest and dividends)
	18.	Financial expenses
	19.	Taxes paid
*	20.	Dividends to shareholders
	21.	Minority interest in net income
	22.	New share issues
	23.	Number of employees
	24.	Wages and salaries
	25.	Social security contributions
*	26.	Capital stock at replacement cost

LON	The wage sum in manufacturing
SALES76	Sales in manufacturing
TIM	Number of working hours
IO76	Input/output flow matrix (and the corresponding coefficient matrix)

These data all come from the National Central Bureau of Statistics (SCB) which unfortunately uses the "ordinary" classification of economic activity according to production processes (SNA/ISIC). As a consequence, we have to convert their division of total manufacturing (12 subindustries) into the MOSES format of four user-oriented subindustries (which in turn corresponds rather well to the OECD "end-use" classification system). This transformation is achieved via a weighting matrix constructed from heavily disaggregated (5-digit level) subindustry data on value added (by Ola Virin at the Federation of Swedish Industries) and applied to all four macro variables.[14] The thus derived market totals of wages, sales and number of full-time employees (TIM divided by an average number of hours per worker per year) are compared later in the macro-initialization with the real establishment totals and the residuals are distributed on the so-called "synthetic" establishments (explained in section 2.3).

The input-output matrix with its four industrial sectors (out of a total of 14 rows and 21 columns) is used to allocate total input goods purchases across the ten delivering sectors on an establishment-by-establishment basis. This allocation is also carried out for the corresponding input goods inventories. The I/O-matrix is further used to ensure that certain micro variables (e.g., export ratios) sum at the sector level. Finally, since the I/O-matrix is vital to the functioning of the micro-specified industrial sector it is also used - together with the other macro variables - for consistency checks at the end of the initialization.[15]

2 Detailed Documentation of Micro-Initialization

2.1 Initialization Programs

The initialization of MOSES, as well as the running of the model, is carried out using the programming language APL. In the documentation that follows some minimal familiarity with APL has to be assumed (e.g., the concepts of workspaces, functions and variables), but in no sense is a working knowledge of the language required.

MOSES is initialized via a sequence of APL functions and involves a number of APL workspaces. The master (top-level) function is called START and is contained together with many of the initialization functions in the workspace INIT. START takes as an argument a scalar "xx". Invoking START xx causes the execution of another function, ISTARTxx.[16] The ISTARTxx functions are used to invoke "initialization variants", i.e., execution of a function ISTARTxx brings about the modification of certain aspects of the initialization procedure.

Once these ISTARTxx modifications are carried out, the master function START invokes another sub-funtion, SI∆INIT. The first thing this function does is to copy the workspace MACRO into INIT. MACRO contains the macro-data in a sufficiently processed form to be used in the initialization. The unprocessed (more accurately, less processed) macro-data are stored in the workspace DT8000. After copying MACRO, the essence of the initialization is carried out by a sequence of (second-level) subfunctions executed under the control of SI∆INIT. These are:

(1) TAX∆PARAMETERS, (2) PUBLIC∆SECTOR, (3) MONETARY, (4) MARKETS, (5) HOUSEHOLDS, (6) ESTABLISHMENTS, (7) DISPOSE∆VAR∆INPUT, (8) MARKETS∆DATA, (9) SECONDARY∆DATA, (10) PUBLIC∆DATA, (11) MONETARY∆DATA, (12) HOUSEHOLDS∆-DATA, and (13) OUTPUT∆OPERATIONS.

The first five functions in this reasonably mnemonic sequence have to do purely with macro-initialization. It is the sixth function, ESTABLISHMENTS, that carries out the micro-initialization. This function first copies data from the workspace SI76 and then uses those data to initialize the model's establishments. The workspace SI76 is analogous to the workspace MACRO insofar as it contains "processed" micro-data. The raw establishments-level data are stored in the workspaces PD75, PD76, ..., PD81, i.e., one workspace for each year of Planning Survey data; and the (relatively) unprocessed firms-level data is stored in the workspace FTGS. The workspace SI76 is a processed merging of PD76 and FTGS (cf. § 2.2).

The functions following ESTABLISHMENTS perform neither strictly micro-initialization nor macro-initialization. Rather, they combine establishment aggregates with the macro-data to initialize certain market-level variables. In addition a variety of "housecleaning" tasks are performed. The final outcome of this process is a workspace Rxx which contains an initialized version of the model ready to run.

A detailed documentation of the micro-initialization of MOSES must thus consist of two components. First, we need to explain the creation and contents of the workspace SI76. Second, we need to explain how the data in SI76 are used in the function ESTABLISHMENTS to micro-initialize the model. These two tasks comprise the remainder of this section. The full details of ESTABLISHMENTS are, however, relegated to the appendix.

2.2 The Workspace SI76

When establishments-level data were incorporated into the micro-initialization procedure in 1980, the starting year for the simulations was changed to 1977. The previously used year for initialization (1968) therefore was replaced with 1976. The reason for this choice was that complete Planning Survey data are not available for years prior to 1976 combined with the fact that the essential input-output "raw-data" (from SCB) did not exist for a later date than 1975. This I/O-matrix was, however, updated with considerable effort to 1976 (see Ahlström, 1981).

Remonstrances could be raised against this choice for several reasons. For example, picking the first survey year precludes the possibility of using the Planning Survey data as a time series, i.e., exploiting establishment-specific life histories, in the micro-initialization.[17] Further, 1976 was in certain respects not a representative year; in particular, inventory levels in most companies were extremely high due to an "inventory build-up subsidization policy" invoked by the government to bridge-over the recession. However, 1976 was not so abnormal a year, and in any event it is the year for which all required data are available.

The workspace SI76, which is a processed merging of workspaces PD76 and FTGS, provides the model with the required micro-data inputs for this particular year.[18]

SI76 contains two important data matrices, one with establishment data, labelled X, and one with firms data, FΔDATA. The latter is of dimension (number of firms) times (number of variables), cf. table 4 above.

The Planning Survey data (X) is of the dimension (number of establishments) times (1 + number of variables), the first column showing the establishment-ID.[19] Corresponding to this column are two separate vectores used for the further identification in the merging process with firms. These link each establishment with (1) a parent-firm (via the vector FIRMID, a consecutive number, presently 1-31), and (2) an industrial market (via the vector RΔMARKET, equalling 1, 2, 3 or 4). These four arrays constitute, together with the vector LIST - a variable subset of the establishment ID's actually to be used in any simulation - the output of the SI76-workspace. These are copied into workspace INIT at the request of the function ESTABLISHMENTS.

2.3 The Function ESTABLISHMENTS

The function ESTABLISHMENTS is the heart of the micro-initialization procedure. The function itself consists of several hundred lines of APL-code (many of which of course are comments); therefore in this section we restrict ourselves to an exposition of the organization and basic ideas of the function. For the details one must refer to the function itself which is listed as an appendix.

The first line in the function (after the comment-lines) copies the variables X̲, F∆DATA, FIRMID, R∆MARKET and LIST from the workspace SI76 (cf § 2.2). These data are then further prepared ("processed") for use in the micro-initialization procedure; in particular, the establishments-level data (X̲) and firms-level data (F∆DATA) are merged and "reduced" according to a "flagging" procedure.

Before this matching actually starts X̲ is reduced to eliminate the establishments not included in the simulation as defined by the vector LIST. For each remaining establishment a "scale factor" is then calculated, indicating that establishment's share in the total sales of the corresponding firm. Summing these shares over the observed constituent parts of a firm usually gives a result of less than unity since the Planning Survey's coverage is not complete. However, the two sets of sales figures are not entirely consistent since they are gathered at different points in time during the year and possibly are defined slightly differently and it happens occasionally that the sum of the establishment sales exceeds firm sales. In this case the establishment with the lowest sales figure is "flagged" and omitted (thereby further reducing X̲) in a repeated procedure until the required condition is satisfied. The real establishment financial variables are then produced by distributing the firm data (capital stocks, current assets, debt and so forth) across the establishments using the above-mentioned sales-based "scale-factor".

Once the processing of the real data is completed, some machinery for the creation of the synthetic establishments is set up. Required as inputs in this stage are the variable SYNTH∆FIRMS (set in the function ISTARTxx) and the sub-funtion SCALE. SYNTH∆FIRMS is a 4-element vector giving the number of synthetic establishments in each of the 4 micro-sectors, and SCALE sets the "relative scale" of each of the synthetic establishments.

SCALE is a dyadic (2-argument) function taking as its left-hand argument the number of synthetic establishments on a given market and as its right-hand argument a fraction setting the scale of the smallest to the largest synthetic establishment on that market. It returns as output a vector of positive logarithmically declining fractions summing to one, giving the scale of each of the synthetic establishments on the market. (Example: The command 8 SCALE 0.1 returns the vector 0.3021, 0.2174, 0.1564, 0.1126, 0.0810, 0.0583, 0.0420, 0.0302. See the appendix for a listing.)[20]

SCALE is put to use in the setting of sales (which we use as a "base variable") for the synthetic establishments. The procedure goes as follows. First we set a help variable called REAL∆SALES equal to the vector of sales for the Planning Survey establishments we are using. Then we sum REAL∆SALES on a market-by-market basis (using the function REAL∆SUM1, see the appendix) to produce a 4-element vector with components equal to the total sales accounted for by Planning Survey establishments on each of the markets 1-4. Comparing this 4-element vector with total sales on each of the markets as given by the macro-data (SALES76) gives a 4-element vector of sales to be accounted for by the synthetic establishments on each of the markets (RES∆SALES). To create a vector of sales for the synthetic establishments on the first market we then multiply the scale vector for that market (previously created by executing SCALE with left-hand argument equal to the first element of SYNTH∆FIRMS and right-hand argument equal to a preset scale factor) by the first element of RES∆SALES. The procedure is the same for markets 2, 3 and 4. Finally, we create the sales vector (the variable S) by concatenating ("stringing together") the vector of sales from the real establishments (i.e., the data taken directly from X) with the vectors of sales from the synthetic establishments.

The next variable created is employment (L). We could, of course, proceed in the same fashion, taking REAL∆LABOR from the Planning Survey data, applying REAL∆SUM1 to the resulting vector, comparing the result with the corresponding 4-element vector from the macro-data to create RES∆LABOR and then using SCALE to create a vector of employment for the synthetic establishments on each market. However, this would have the disadvantage of implying the same sales/employment ratio within any given market for all synthetic establishments. Therefore we have employed another method based on the function RANDOMIZE.

RANDOMIZE is another dyadic function taking as left-hand argument a vector of real establishment data on a first variable and as right-hand argument a vector concatenating real establishment data with synthetic data on a second variable. It returns as output a vector of synthetic establishment data on the first variable which reproduces (1) the market-by-market dispersions in the synthetic data that we observed in the corresponding real data and (2) the market-by-market correlations between the two variables in the synthetic data that are observed in the real data. Thus, e.g., REAL∆LABOR RANDOMIZE S produces a vector of employments for synthetic establishments such that (1) market-by-market variance of synthetic employments equals that or real employments and (2) the correlation between sales and employment on each market for synthetic establishments is the same as that observed among the real establishments.

In practice we apply the randomization procedure to ratio variables. Thus, for example, we create a vector of synthetic employment by randomizing the real employment/sales ratio on sales and then multiplying the resulting output by the synthetic sales vector. In addition we need to "normalize" the synthetic employment vector produced by the randomization procedure; that is, we need to apply market-by-market scale factors to the synthetic data so that the sums of real and synthetic employments equal the macro totals.

Following the creation of the variable L, all other variables are created in essentially the same fashion; i.e., by randomizing on a previously created variable. The order of variable creation and which variables are used as a "base" in the randomization can be found in the comments to ESTABLISHMENTS as listed in the appendix.[21]

3 Conclusion

Assessment

We conclude by offering an assessment of the micro-initialization work to date and suggestions about how to approach the many problems that remain to be solved.

Prior to the micro-initialization procedure described above, the model developed through several generations. In its earliest version the model was run on a completely "all-synthetic" basis; i.e., no micro-data were used in the initialization and the model's "establishments/firms" were created by "chopping up" the sectoral aggregates given by the macro-data. Of course, initializing a "micro-to-macro" model without any micro-data had serious drawbacks.

One important reason to use micro-data is that such data provide information about variation between establishments. Using macro-data one can, for example, set an average value for labor productivity among establishments in a particular sector, but the deviation around this average must be set by assumption. This is precisely what was done in the earlier versions, and our impression after the fact is that in general too little variability was assumed.

Likewise, micro-data provide information about the covariation between variables across establishments. It might be the case, for example, that in a particular sector establishments with export ratios above the sectoral average also tend to have above-average labor productivities. Such information could be essential in an analysis of the effects of foreign price shocks. The all-synthetic initialization lacked the data to incorporate such information; in fact, that procedure implicitly assumed zero covariation between ratio variables across establishments.

The next generation of model initializations incorporated some of the real firm data from the FTGS database described in § 1.6. This represented an obvious improvement over the all-synthetic version, but equally obvious problems remained unsolved. The most important of these was the incompleteness of the firms data relative to what is required in MOSES. The lack of establishment-level data to specify the production planning module (A21, A22, etc) seemed particularly crucial. A second problem had to do with the creation of the synthetic units -- at that time no device existed to impose any systematic correlation among the synthetic establishment variables.[22]

Finally, the fact that the large manufacturing firms represented in the FTGS database typically operate in more than one market implied a micro-to-macro consistency problem since in many cases data were assigned to the wrong markets at the micro level.

The micro-initialization procedure based on the function ESTABLISHMENTS thus seems to us to be an important improvement relative to its predecessors. It utilizes a much richer set of data in a more reasonable way, and one might have hoped that these extra data should have "solved" the initialization problem. Alas, such is clearly not the case, and significant problems remain. Problems have been experienced with the synthetic establishments in that unreasonable initial positions have been produced. Furthermore, although no systematic calibration of the model has been carried out at the micro level, it is clear that MOSES does not produce an empirically "good fit" at that level. This may of course imply something about the specification of the model, but it must also imply problems with the initial position of the model, i.e. with the internal consistency of all data bases put together.

One is therefore lead to ask how the current initialization procedure might be improved or where the problems lie. One obvious task is that the mechanical programming aspects of ESTABLISH-

MENTS and its sub-function RANDOMIZE should be more thoroughly checked than they have been. Another obvious task is to come up with a better way to merge the establishment-level and firm-level datasets. There would seem to be three possible approaches to dealing with these two levels of data, one of which would be to aggregate the establishments data to the firm level. This would not be satisfactory, however, in a model which is so oriented towards establishment-level decisions in its micro-specification. The second alternative, which is the one actually used in MOSES, is to disaggregate the firms data to the establishments level. The final possible approach, and by far the most ambitious one, would be to work with a model containing both firms and establishments. As in reality, firms would exist as a collection of establishments with operations (production, etc) decisions made at the establishment level and financial management decisions made at the firm level. This would require the writing of a "headquarters function", i.e., a model of the process by which firms allocate funds to their constituent establishments (cf. § 1.6), and preferably data on financial flows within firms, neither of which are available now. In any event, were the requisite data on intra-firm financial flows to materialize, much of the problem of how to disaggregate firm data to the establishment-level would disappear. The creation of a "headquarters function" would then have more to do with changing the model's operating specification than with the micro-initialization procedure.

Suggestions for Improvement

In our opinion there are two likely sources of significant improvement in the micro-initialization procedure, one of which, perhaps surprisingly, has to do with the macro-database. That database was created by transforming sectoral data according to the classification used by the Central Bureau of Statistics (many sectors) to sectoral data according to the MOSES classification (4 sectors). If this transformation is significantly incorrect for any variable, then the "residual data" for that variable, i.e., the difference between the macro sector total and the real establishment total, will also be significantly incorrect. But, it is precisely from these residual data that the synthetic establishment data are generated, and it is precisely the synthetic establishment data that are most suspect in the initialization process.

Misspecification of the transformation between sectoral classifications is sufficient to cause important errors in the synthetic microdata, and there is reason to suspect such misspecification. Only one transformation matrix (applied to a vector of SCB sector totals and producing a vector of MOSES sector totals) is used, namely, the matrix used to convert SCB sectoral value added to the MOSES sectoral value added totals. This particular transformation matrix seems well based on micro-data for value added, but there is no reason to expect the same matrix to apply equally well to the transformation of SCB sectoral totals for, say, employment, to the corresponding MOSES totals.

This problem could possibly be corrected by constructing a transformation matrix for each macro variable "by hand", but that would be a tedious and unnecessary task. Instead, a better strategy would be to attempt to "automate" such a procedure. The idea can be illustrated using employment as an example.

Data are available in the raw (unprocessed) macro-database for sectoral employment totals according to the SCB classification. Independent of the SCB data, one can generate a vector of synthetic employment totals in the MOSES sectors by the randomization procedure, absent any normalization or consistency control. The real consistency constraint in the system is that total employment in the manufacturing sector as indicated by the macro-data be equal to total employment in manufacturing as indicated by MOSES. As in the current micro-initialization program, the synthetic establishment employments can be normalized to produce consistent totals, but there is really no need to undertake the normalization on a sector-by-sector basis.

The above procedure would in effect construct a new macro-database. The MOSES sectoral employment totals would, for example, equal the sum of real establishment employments plus the sum of synthetic establishment employments for each sector with synthetic establishment employments subject only to an economy-wide constraint rather than an individual sector constraint. This would have the effect of creating a separate transformation matrix for employment, converting SCB employment totals to MOSES totals. Application of the above method to each of the variables currently subject to a normalization or consistency check could conceivably bring about a significant improvement in the micro-initialization procedure.

The second possible source of substantial improvement in the micro-initialization procedure would simply be to use more of the establishment-level data. We currently restrict ourselves to using data from the Planning Survey respondents that can be linked with a firm in the FTGS dataset. This restriction is probably not important in the initialization on 3 of the 4 MOSES micro-sectors, but it must introduce significant error in the initialization of the Non-Durables sector. The reason is that relatively few large firms operate in that sector, and firm size was a selection criterion in constructing the firms dataset. Thus, from Table 3 one can see that the initialization of the Non-Durable sector is based on at most 5 real establishments. These 5 establishments exercise an inordinate influence in the specification of that sector. If there are errors in the data, or if one of the establishments is atypical, those errors and unusual characteristics are replicated throughout the sector's synthetic establishments.

The obvious way to solve this "small-sample" problem would be to collect more data on firms operating in the Non-Durables sector, i.e., to expand the FTGS dataset. Perhaps less obviously, the Non-Durables establishment data from the Planning Survey could be used without collecting any new firm data. This would involve dealing with three types of micro-entities in the model initialization -- (1) entities with real establishment and real firm components, (2) entities with real establishment but synthetic firm components and (3) entities with synthetic establishment and synthetic firm components. This would require some re-programming of the initialization procedure, but the potential improvement would be substantial.

Both of our recommendations in effect require greater reliance on data at the most micro-level available. Of course, what should seem more natural in a "micro-based" model?

FOOTNOTES

[1] Some of these parameters are set without any direct reference to the micro-data and therefore are not treated as a part of the micro-initialization procedure.

[2] Some notational prefixes used throughout the documentation are:

D: indicates annual percentage rate of change
Q: indicates quarterly
EXP: indicates expected.

Thus, for example, EXPDW should be read as the expected annual percentage rate of change in the wage rate and QDS should be read as the quarterly percentage rate of change in sales.

[3] Recall the notational convention that Q preceding any variable denote "quarterly". Employment is treated as a "stock variable" so there is no need to distinguish between L and "QL".

[4] There is one exception. An establishment's ability to immediately lay off workers is limited in Sweden according to the "job security" or Åman laws. This institutional factor is represented in the model by the variable AMAN, a matrix of dimension (number of establishments) times 3. For each establishment the AMAN 3-tuple represents the number of workers who can be laid off 1, 2 and 3 quarters hence.

[5] The micro-initialization of individualized I/O coefficients was added to our programs by Fredrik Bergholm in late 1980.

[6] The current version of INVFIN will eventually be replaced with a more elaborated and sophisticated module (cf. Eliasson (1983) Ch. 3). The most important difference is that long range planning is incorporated in the more sophisticated version, i.e., the time horizon for growth decisions is extended to several future periods. This module has been programmed but has not yet been "made compatible" with the rest of the model.

[7] That is, the micro entities of the model are regarded as one-establishment firms or, with a slightly different and perhaps more accustomed terminology, independent divisions within a group.

[8] Some new notational conventions are introduced in the formulae below:

CH = change over a period, usually a quarter
DESCH = desired change.

[9] According to SI Konjunkturen, Konjunkturrapport från Sveriges Industriförbund, No. 2, May 13, 1981, p. 18.

[10] Durable consumption goods are in sector 3 according to the MOSES classification. In addition, a few of the Planning Survey Building Materials respondents can be re-allocated to the MOSES sector 2, i.e., Intermediate Goods.

11 Technically the FTGS dataset is stored in the computer as an APL-workspace. Two major groups of functions exist in this workspace, one for updating the firm-specific data-matrices and one for arranging the variables in accordance with the other MOSES workspace.

Each firm is represented by two data-matrices, with names given by the first four letters in their respective "English-spelled" names, e.g., FLAK1 and FLAK2 for Fläktfabriken. The first matrix contains the variables 1-25 in table 4 above for the years 1965-81 and the second book-values of fixed assets, including their components of change, 1950-81.

12 The implications of these assumptions could be checked against the 1979 Planning Survey data. In that questionnaire respondents were asked for the replacement value of their capital stocks. Further, information about the expected life length of capital was collected in the 1977 Planning Survey.

13 Partial documentation is available in Ahlström (1978, 1981) and in Bergholm (1982).

14 This is essentially correct but not strictly accurate as regards IO76. See Ahlström (1981) for a discussion of how this matrix was constructed.

15 See Bergholm (1982) for a discussion of the consistency checks.

16 The scalar "xx" has no significance other than to call the appropriate ISTARTxx function.

17 On the other hand, use of the 1976 data for initialization leaves open the possibility of using the later data for "micro-calibration".

18 Were it not for the lack of reliable annual I/O-tables, workspaces SI77, SI78, ... could be constructed along the lines of SI76 from the micro datasets.

19 For example: ID = 2.09, where 2 stands for the second market - intermediate goods - and 9 for the serial number used by the Federation of Swedish Industries (SI) in their records.

20 The function SCALE is understruck to distinguish it from SCALE, its right-hand argument.

21 In reading through ESTABLISHMENTS one does not "see" the function RANDOMIZE. This is because RANDOMIZE is hidden in, i.e., is a sub-function of, another function called USING. USING performs the concatenation of real data to the synthetic data created by RANDOMIZE.

22 This was a problem with the initialization procedure per se, as opposed to a database problem.

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Appendix:

Listing of ESTABLISHMENTS and Help-Functions

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      ∇ESTABLISHMENTS[⎕]∇

    ∇  ESTABLISHMENTS;R;F;ALPHA;SCALE;RATIO;RATIO1;RATIO2;HELP;FLAG;
      DUMMY
[1]   ⍝ THIS COMMENTED VERSION OF THE FUNCTION ESTABLISHMENTS IS
[2]   ⍝ TO BE USED IN CONJUNCTION WITH THE DOCUMENTATTION PAPER
[3]   ⍝ ALBRECHT/LINDBERG, 'MICRO-INITIALIZATTION OF MOSES'
[4]   ⍝ DATED AUGUST 1982
[5]   ⍝ PAGE CITATIONS IN THESE COMMENTS REFER TO THAT PAPER
[6]   ⍝
[7]   ⍝
[8]    ⍎')COPY SI76 X FΔDATA FIRMID   LIST RΔMARKET'
[9]   ⍝
[10]  ⍝ INPUT DATA FROM WORKSPACE SI76
[11]  ⍝ X IS ESTABLISHMENTS DATA (PROCESSED FROM WS PD76)
[12]  ⍝ FΔDATA IS FIRMS DATA (PROCESSED FROM WS FTGS)
[13]  ⍝ FIRMID IS KEY LINKING ESTABLISHMENT ID TO FIRM ID
[14]  ⍝ RΔMARKET GIVES MARKET ID FOR EACH ESTABLISHMENT
[15]  ⍝ LIST GIVES LIST OF ESTABLISHMENTS TO BE USED IN INITIALIZATION
[16]  ⍝
[17]  ⍝ IN ADDITION THERE ARE 2 VARIABLES THAT ARE GLOBAL TO THIS FUNCTI
      ON:
[18]  ⍝.....IO (INPUT/OUTPUT MATRIX--SET IN FUNCTION MARKETS)
[19]  ⍝.....SYNTHΔFIRMS (NMBR OF SYNTH ESTABLISHMENTS PER MARKET--SET IN
       ISTARTXX)
[20]  ⍝
[21]  ⍝ OUTPUT FROM THIS FUNCTION
[22]  ⍝MARKET,P,QP,DP,W,QW,DW,S,QS,DS,Q,QQ,DQ,
[23]  ⍝L,EXPDP,EXPDS,EXPDW,HISTDP,HISTDS,HISTDW,
[24]  ⍝HISTDPDEV2,HISTDWDEV2,HISTDSDEV2,MHIST,CHM
[25]  ⍝VA,QIMQ,QVA,DVA,M,AMAN,STO,IMSTO,
[26]  ⍝QTOP,TEC,QINV,QINVLAG,DELAYΔINV,K1,K1BOOK,K2,BW,
[27]  ⍝QTDIV,RSUBSΔCASH,RSUBSΔEXTRA,RES,INVEFF,RESMAX,BETA,
[28]  ⍝IMBETA,TMINV,BIG,SMALL,IMBIG,IMSMALL,FΔINKOP,BRINKOP,
[29]  ⍝SHARE,X,ORIGMARKET,LEFT
[30]  ⍝
[31]  ⍝ THE NEXT SET OF LINES MERGES FIRMS DATA WITH ESTABLISHMENTS DATA
[32]  ⍝ IN ADDITION A ~REDUCTION~ ON LIST IS CARRIED OUT
[33]  ⍝    IE DATA NOT PERTAINING TO INCLUDED ESTABLISHMENTS ARE DROPPED
[34]  ⍝ THE FLAGGING PROCEDURE CHECKS THAT THE SUM OF ESTABLISHMENT
```

```
⍝  SALES DO NOT EXCEED PARENT FIRM SALES.
⍝  IN CASE THEY DO THEN WE DROP ESTABLISHMENTS ONE-BY-ONE
⍝  UNTIL THE CONSTRAINT IS MET.
⍝  THIS IS DONE BY DROPPING THE SMALLEST ESTABLISHMENT
⍝  FIRST, THEN THE SECOND SMALLEST, ETC.
⍝  OTHER PATTERNS MIGHT BE PREFERABLE.
L0:F←FIRMID[(X[;1]∊LIST)/⍳ρX[;1]]
 NAMNΔMARKET←RΔMARKET[(X[;1]∊LIST)/⍳ρX[;1]]
 ALPHA←(+/X[(X[;1]∊LIST)/⍳ρX[;1]; 7 12])÷FΔDATA[F;15]
⍝ CHECK ON ALPHA
⍝..ALPHA=ESTABLISHMENT SALES ÷ PARENT FIRM SALES
 →(0=ρFLAG←(1<ALPHA+.×F∘.=⍳⌈/F)/⍳⌈/F)/L2
 HELP←⍳0
L1:HELP←HELP,ALPHA⍳⌊/ALPHA[((1↑FLAG)=F)/⍳ρF]
 →(0<ρFLAG←1↓FLAG)/L1
 'DROPPING ',(5 2 ⍕LIST[HELP]),' FROM LIST.'
 LIST←(~(⍳ρLIST)∊HELP)/LIST
 →L0
L2:X←X[(X[;1]∊LIST)/⍳ρX[;1];]
⍝
⍝ THE FOLLOWING VARIABLES ARE GLOBAL FOR HELP FUNCTIONS USED BELOW
⍝ R=NUMBER OF REAL ESTABLISHMENTS
⍝ MARKET=VECTOR WITH MARKET NUMBERS FOR EACH ESTABLISHMENT
⍝...(FOR EXAMPLE:  1 1 1 2 1 3 1 4 1 4 ...ETC.)
⍝ NAMNΔMARKET=VECTOR WITH MARKET NUMBER FOR REAL ESTABLISHMENTS
⍝...(NAMNΔMARKET COMES FROM ~LIST-REDUCTION~ ON RΔMARKET)
⍝ SΔMARKET=VECTOR WITH MARKET-NUMBERS FOR SYNTHETIC ESTABLISHMENTS
⍝
 SΔMARKET←SYNTHΔFIRMS DUP⍳4
 MARKET←NAMNΔMARKET,SΔMARKET
 R←1↑ρX
⍝
 'SIZE-UTSKRIFT 2'
 ⍎')SIZE'
⍝
⍝ SETTING SCALE FOR SYNTHETIC ESTABLISHMENTS (CF PP.XX)
 SCALE←⍳0
 SCALE←SCALE,SYNTHΔFIRMS[1]SCALE 0.02
 SCALE←SCALE,SYNTHΔFIRMS[2]SCALE 0.001
 SCALE←SCALE,SYNTHΔFIRMS[3]SCALE 0.02
```

```
[75]   SCALE←SCALE,SYNTH∆FIRMS[4]SCALE 0.0001
[76]  ⍝
[77]  ⍝ ENS (AND SISTER FUNCTION ALWAYS) ARE INTENDED TO ~ENSURE~ THAT
[78]  ⍝   THE STIPULATED CONDITION IS TRUE. IF NOT, THEN ~ERROR~ IS RETU
      RNED
[79]  ⍝
[80]   ENS 1=SYNTH∆SUM1 SCALE
[81]  ⍝
[82]  ⍝ THE HELP FUNCTIONS SUM1, REAL∆SUM1 AND SYNTH∆SUM1 ARE USED
[83]  ⍝ EXTENSIVELY IN THE SEQUEL
[84]  ⍝ THESE FUNCTIONS SUM ESTABLISHMENT VARIABLES TO MARKET TOTALS
[85]  ⍝ SUM1 OPERATES ON REAL AND SYNTHETIC DATA
[86]  ⍝...REAL∆SUM1 ON REAL DATA ONLY
[87]  ⍝...SYNTH∆SUM1 ON SYNTHETIC DATA ONLY
[88]  ⍝
[89]  ⍝ SALES IS THE FIRST VARIABLE CREATED. NOTE THE USE OF SCALE
[90]  ⍝     IN THE SETTING OF SYNTH∆SALES
[91]   REAL∆SALES←(+/X[; 7 12]×1000000)
[92]   RES∆SALES←SALES76-REAL∆SUM1(REAL∆SALES)
[93]   SYNTH∆SALES←SCALE×RES∆SALES[S∆MARKET]
[94]   S←REAL∆SALES,SYNTH∆SALES
[95]  ⍝
[96]   ⎕RL←123476
[97]  ⍝
[98]  ⍝ ⎕RL SETS THE SEED FOR THE RANDOM-NUMBER GENERATOR
[99]  ⍝RANDOMIZATION IS USED IN SETTING ALL VARIABLES AFTER SALES (THE ~
      BASE~ VARIABLE)
[100] ⍝THE RANDOMIZATION FUNCTION IS CALLED USING
[101] ⍝THIS FUNCTION IS OF THE FORM A USING B, WHERE
[102] ⍝    A IS A VECTOR OF REAL-ESTABLISHMENTS DATA (1ST VARIABLE)
[103] ⍝    B IS A VECTOR OF REAL- AND SYNTHETIC-ESTABLISHMENTS DATA (2ND
      VARIABLE)
[104] ⍝ USING ~EXTENDS~ A TO BE A REAL- AND SYNTHETIC-ESTABLISHMENTS DAT
      A VECTOR
[105] ⍝(CF PP.XX...SEE ALSO THE FUNCTIONS USING AND RANDOMIZE)
[106] ⍝
[107] ⍝ THE FIRST VARIABLE TO BE CREATED USING RANDOMIZATION IS LABOR
[108] ⍝NOTE THE NORMALIZATION ON MACRO-SECTOR TOTALS USED IN SETTING SYN
      TH∆LABOUR
[109]  REAL∆LABOUR←X[;3]
```

```
RES∆LABOUR←(TIM÷HOURS∆PER∆YEAR)-REAL∆SUM1(REAL∆LABOUR)
SYNTH∆LABOUR←R↓S×RATIO←(REAL∆LABOUR÷REAL∆SALES)USING S
SYNTH∆LABOUR←SYNTH∆LABOUR×(RES∆LABOUR÷(SYNTH∆SUM1 SYNTH∆LABOUR))[
S∆MARKET]
L←REAL∆LABOUR,SYNTH∆LABOUR
⍝
⍝ NOW ALL OTHER VARIABLES ARE SET IN ESSENTIALLY THE SAME WAY AS L
⍝
⍝EXPORT FRACTIONS   (EXPORTS÷SALES)  :
⍝ PRODUCTION USED TO APPROXIMATE SALES
⍝ XM=EXPORTS (MKTS 1,2,3,4) ÷ PRODUCTION (MKTS 1,2,3,4)
XM←IO76[⍳4;18]÷IO76[14;⍳4]
REAL∆RATIO←(X[;7]÷(+/X[; 7 12]))
SYNTH∆RATIO←REAL∆RATIO RANDOMIZE S
RES∆EXPORT←(XM×(SUM1 S))-REAL∆SUM1(REAL∆RATIO×REAL∆SALES)
SYNTH∆RATIO←SYNTH∆RATIO×(RES∆EXPORT÷(SYNTH∆SUM1(SYNTH∆RATIO×
SYNTH∆SALES)))[S∆MARKET]
X←REAL∆RATIO,SYNTH∆RATIO
'TEST PA EXPORTANDEL:X>0.95  '
(X<0)∨(X>0.95)
X←0⌈0.95⌊X
⍝
⍝PRICES
P←(⍴MARKET)⍴100
⍝
⍝ PRODUCT INVENTORIES
⍝RATIO=ACTUAL STOCK-RATIO=STOCK÷SALES
⍝ RATIO1=~NORMAL~ LEVEL OF STOCK÷SALES
RATIO←(X[;48]÷100)USING S
STO←(S÷P)×RATIO
RATIO1←(X[;50]÷100)USING RATIO⌈0.01
⍝
⍝ NOTE WE ARE SETTING BIG AND SMALL FOR EACH ESTABLISHMENT
⍝
BIG←RATIO⌈(1+∆←0.5)×RATIO1
SMALL←RATIO⌊(1-∆)×RATIO1
BIG[HELP/⍳⍴BIG]←(HELP←(RATIO<(1-∆)×RATIO1))/(2×RATIO1)-RATIO
BIG←0⌈0.5⌊BIG
SMALL[HELP/⍳⍴BIG]←(HELP←(RATIO>(1+∆)×RATIO1))/(2×RATIO1)-RATIO
SMALL←0⌈SMALL
```

```
ΔK3ΔFINISH←S×RATIO-RATIO1
⍝
⍝ INPUT GOODS INVENTORIES
⍝INPUTRATIO=(PURCHASES OF RAW MATERIALS)÷SALES
⍝ RATIO1=ACTUAL RATIO OF STOCKS/INPUT PURCHASES
⍝ RATIO2=~NORMAL~ RATIO STOCKS/INPUT PURCHASES
 INPUTRATIO←(X[;17]÷+/X[; 7 12])USING S
 RATIO1←(X[;44]÷100)USING INPUTRATIO
 RATIO2←(X[;46]÷100)USING RATIO1⌈0.01
 K3ΔIMED←S×INPUTRATIO×RATIO1
 IMBIG←RATIO1⌈(1+Δ)×RATIO2
 IMSMALL←RATIO1⌊(1-Δ)×RATIO2
 IMBIG[HELP/⍳⍴IMBIG]←(HELP←(RATIO1<(1-Δ)×RATIO2))/(2×RATIO2)-
RATIO1
 IMBIG←0⌈0.5⌊IMBIG
 IMSMALL[HELP/⍳⍴IMBIG]←(HELP←(RATIO1>(1+Δ)×RATIO2))/(2×RATIO2)-
RATIO1
 IMSMALL←0⌈IMSMALL
 BETA←IMBETA←0.5
 ΔK3ΔIMED←S×INPUTRATIO×RATIO1-RATIO2
⍝
⍝ IMSTO
⍝ IMSTO IS OF DIMENSION (NUMBER OF ESTABS)×10
⍝ IMSTO CREATED BY SPREADING ΔK3ΔIMED ACROSS SECTORS USING I/O MAT
RIX
⍝ THIS IS DONE USING HELP FUNCTION MULT7
⍝ MULT7 MULTIPLIES A MATRIX WITH A COLUMN VECTOR
⍝ IE, M MULT7 V; M=MATRIX M(I,J), V=VECTOR V(I)
⍝ RESULT: A MATRIX WITH ELEMENTS M(I,J)×V(I)
⍝
 IMSTO←((((⍉IO)DIV7+/⍉IO)[MARKET;])MULT7 K3ΔIMED)÷100
⍝
⍝ NOTE: WE HAVE DIVIDED BY 100 ASSUMING BASE YEAR=START YEAR.
⍝IMSTO SHOULD BE IN FIXED PRICES,THUS DIVISION BY 100
⍝,WHICH IS THE PRICEINDEX FOR 1976
⍝ THE IDEA BEHIND THAT COMPUTATION WAS AS FOLLOWS:
⍝   (⍉IO)[1;] LOOKS LIKE A[1,1],.....,A[1,10], WHERE
⍝   A[1,J]=FRACTION OF GROSS PRODUCTION IN SECTOR 1 ACCTD FOR BY
⍝     INPUTS FROM SECTOR J.
⍝   THEN A[1,J]÷SUM ON J OF A[1,J]  =  FRACTION OF INPUT GOODS
```

```
[185] ⍝      COMING FROM SECTOR J
[186] ⍝
[187] ⍝ INPUT GOODS PURCHASES (PRELIMINARY TO QIMQ)
[188] ⍝ HELP=TOTAL INPUT GOODS PURCHASES BY SYNTH ESTABS.
[189] ⍝ INP=INPUT GOODS PURCHASES FOR EACH ESTABLISHMENT
[190] ⍝     SUMMED OVER SECTORS
[191] ⍝
[192]  REALΔINP←X[;17]×1000000
[193]  QCURR←S+ΔK̄3ΔFINISH
[194]  HELP←(+/(⎕IO)[⍳4;]MULT7 SUM1 QCURR)-(REALΔSUM1(REALΔINP-R↑
      ΔK3ΔIMED))
[195]  HELP←HELP+SYNTHΔSUM1(R↓ΔK3ΔIMED)
[196]  INP←REALΔINP,(R↓S×INPUTRATIO)×(HELP÷(SYNTHΔSUM1 R↓S×INPUTRATIO))[
      S̲ΔMARKET]
[197] ⍝
[198] ⍝ QIMQ
[199] ⍝ QIMQ=INP SPREAD ACROSS THE 10 SECTORS, JUST LIKE IMSTO ABOVE.
[200]  QIMQ←((((⎕IO)DIV7+/⎕IO)[MARKET;])MULT7 INP)÷100
[201]  QIMQ←QIMQ÷4
[202] ⍝ SAME COMMENT AS APPLIES TO THE DEFLATION OF IMSTO
[203] ⍝
[204] ⍝ VALUE ADDED
[205]  VA←QCURR+ΔK3ΔIMED-INP
[206] ⍝
[207] ⍝ THE NEXT FUNCTION PERFORMS SOME ~HOUSE-CLEANING~
[208] ⍝ IE, SOME UNNEEDED VARIABLES ARE EXPUNGED
[209]  DISPOSE1ΔFIRMS
[210] ⍝
[211] ⍝ SOME VARIABLES USED IN FUNCTION CONTROLS
[212] ⍝
[213]  RESΔFORVF←SYNTHΔSUM1(R↓VA)
[214]  FORVF←SUM1(VA)
[215]  REALΔFORVF←R↑VA
[216]  SYNTHΔFORVF←R↓VA
[217] ⍝
[218] ⍝ WAGES
[219]  REALΔKRΔLON←X̲[;5]×1000000
[220]  REALΔW←REALΔK̄RΔLON÷(R↑L)
[221]  SYNTHΔW←R↓S×(RATIO←(REALΔKRΔLON÷REALΔSALES)USING L)÷L
[222]  RESΔKRΔLON←LON-REALΔSUM1(REALΔW×(R↑L))
```

```
[223]  SYNTHΔW←SYNTHΔW×(RESΔKRΔLON÷(SYNTHΔSUM1(R↓L)×SYNTHΔW))[SΔMARKET]
[224]  W←REALΔW,SYNTHΔW
[225]  SYNTHΔKRΔLON←SYNTHΔW×(R↓L)
[226]  DW←(¯1+(×/X[; 2 5])÷×/X[; 3 4])USING W
[227]  QDW←DW÷4
[228]  QW←((⍉((2,(ρW))ρ(W,W+DW)))+.×(0.625,0.375))
[229] ⍝
[230] ⍝ SOME PCT CHANGE AND QUARTERLY VARIABLES
[231]  DVA←DS←(¯1+(+/X[; 7 12])÷+/X[; 6 11])USING DW
[232]  QS←((⍉((2,(ρS))ρ(S,S+DS)))+.×(0.625,0.375))÷4
[233]  QVA←VA×(1+DVA÷4)÷4
[234] ⍝
[235] ⍝ MARGINS
[236] ⍝ MHIST=PROFIT MARGIN FOR 1975
[237]  M←1-W×L÷VA
[238]  M75←1-(X[;4]÷+/X[; 6 11])×R↑S÷VA
[239]  HELP←(R↑M)-M75
[240]  MHIST←0.5×(2×M)-CHM←HELP USING DS
[241] ⍝
[242] ⍝
[243]  OVERSKOTT←SUM1(M×VA)
[244]  SYNTHΔOVERSKOTT←R↓(M×VA)
[245]  REALΔOVERSKOTT←R↑(M×VA)
[246] ⍝
[247]  DP←((R↑DS)-X[;26]÷100)USING DS
[248]  QP←((⍉((2,(ρP))ρ(P,P+DP)))+.×(0.625,0.375))
[249] ⍝ QUANTITIES
[250]  Q←(S+ΔK3ΔFINISH)÷P
[251]  QQ←(QS+ΔK3ΔFINISH÷4)÷QP
[252]  DQ←DS-DP
[253] ⍝
[254] ⍝ SOME VARIABLES ADDED 27 OCT 1980...
[255] ⍝ FΔINKOP=AGGREGATE INPUT PURCHASE/OUTPUT FOR EACH ESTAB
[256] ⍝ BRΔINKOP=AGGREGATE INPUT PURCHASE/OUTPUT (SECTORAL AVERAGES)
[257] ⍝ SHARE INDIVIDUALIZES ESTABLISHMENT I/O COEFFICIENTS
[258]  FΔINKOP←(INP-ΔK3ΔIMED)÷(100×Q)
[259]  BRINKOP←4↑(+/[1]IO)
[260]  SHARE←FΔINKOP÷BRINKOP[MARKET]
[261] ⍝
[262] ⍝ A21 AND A22
```

```
A22←(-/X[; 30 32]÷100)USING A21←(-/X[; 32 26]÷100)USING M
A21←0⌈0.5⌊A21
A22←0.025⌈0.5⌊A22
⍝ MUST ENSURE A22>0 SO TEC CAN BE COMPUTED..
⍝ AMAN--BASED ON APPROXIMATION GIVEN IN INDUSTRIKONJUNKTUREN PAPER
AMAN←⍉(3,⍴L)⍴(L×A21÷1+A21)÷3
⍝
⍝ EXPECTATIONS
HISTDS←EXPDS←(¯1+(+/X[; 8 13])÷+/X[; 7 12])USING DS
HISTDSDEV2←(HISTDSDEV←-0.02 BETWEEN(⍴HISTDS)⍴0.02)*2
HISTDP←EXPDP←((R↑EXPDS)-X[;28]÷100)USING EXPDS
HISTDPDEV2←(HISTDPDEV←-0.02 BETWEEN(⍴HISTDP)⍴0.02)*2
HISTDW←EXPDW←EXPDS-EXPDP
HISTDWDEV2←(HISTDWDEV←-0.02 BETWEEN(⍴HISTDW)⍴0.02)*2
⍝
⍝ PRODUCTION FUNCTION PARAMETERS.
QTOP←(QQ×1+A21+A22)÷1-RES←(⍴QQ)⍴0.5×RESMAX←0.2
TEC←¯1×(⍟A22÷1+A21+A22)×QTOP÷L
ENS(QQ-QFR1 L)<0.5
⍝
⍝ FINANCIAL VARIABLES
K1BOOK←S×((÷/FΔDATA[F; 5 15])USING S)
K1←S×((÷/FΔDATA[F; 26 15])USING K1BOOK)
K2←K1BOOK×(((+/FΔDATA[F; 1 2 4 6])÷FΔDATA[F;5])USING K1)
A←K1+K2+K1BOOK×((÷/FΔDATA[F; 3 5])USING S)
BW←K1BOOK×(((+/FΔDATA[F; 8 9 10])÷FΔDATA[F;5])USING K1)
BAD←(⍴BW)⍴0
⍝ QTDIV IS A MARKET-VARIABLE (⍴QTDIV=4)
QTDIV←SUM2 ¯0.25×K1BOOK×((÷/FΔDATA[F; 20 5])USING M)
INVEFF←QTOP×QP÷K1
QINV←S×(((+/X[; 21 24])÷+/X[; 7 12])USING S)÷4
QINVLAG←QINV×1+(VA AVG1 DP DDIV 4)[DUR←3]
TMINV← 2 1 1 0.5
DELAYΔINV←⍉(3,⍴QINV)⍴QINV MULT1(4×TMINV)÷3
RSUBSΔCASH←RSUBSΔEXTRA←L×0
⍝
⍝ CONSISTENCY CONTROL FUNCTION
⍝
CONTROLS
⍝
```

```
[303] ⍝ I/O MATRIX IN FLOWS WRITTEN OUT (IF REQUESTED)
[304] ⍝
[305]  IO∆MATRIX
[306] ⍝
[307] ⍝ MORE ~HOUSE-CLEANING~
[308]  DISPOSE2∆FIRMS
[309] ⍝
[310] ⍝ SOME VARIABLES NEEDED FOR NULLIFY AND SHRINK
[311]  LEFT←MARKET=ORIGMARKET←MARKET
[312]  'SIZEUTSKRIFT 3'
[313]  ⍎')SIZE'
[314] ⍝
    ∇
```

```
      ∇AVG1[⎕]∇

    ∇  A←W AVG1 D
[1]    ⍝
[2]    ⍝ TO GET MARKET AVERAGES FROM FIRM DATA:
[3]    ⍝ 'D' IS THE FIRM (VECTOR) DATA TO BE AVERAGED.
[4]    ⍝ 'W' IS A WEIGHTING VECTOR.
[5]    ⍝ GLOBAL VECTOR 'MARKET' TELLS MARKET NUMBER OF EACH FIRM.
[6]    ⍝ GLOBAL 'NMARKETS' TELLS NUMBER OF MARKETS.
[7]    ⍝ 'A' IS THE (VECTOR) AVERAGE.
[8]    ⍝
[9]     A←((W×D)+.×MARKET∘.=⍳NMARKETS)÷(W+.×MARKET∘.=⍳NMARKETS)
    ∇
```

```
      ∇BETWEEN[⎕]∇

    ∇   R←A BETWEEN B
[1]     R←A+(B-A)×0.01×¯1+?101×B=B
    ∇
```

```
      ∇CONTROLS[⎕]∇

    ∇  CONTROLS;DIFF
[1]    ⍝
[2]     ENS(LON+OVERSKOTT)=FORVF
[3]     ENS LON=(REALΔSUM1 REALΔKRΔLON)+(SYNTHΔSUM1 SYNTHΔKRΔLON)
[4]     ENS OVERSKOTT=(REALΔSUM1 REALΔOVERSKOTT)+(SYNTHΔSUM1
       SYNTHΔOVERSKOTT)
[5]     ENS FORVF=(REALΔSUM1 REALΔFORVF)+(SYNTHΔSUM1 SYNTHΔFORVF)
[6]     DIFF←SALES76-(SUM1 S)
[7]     ENS DIFF<1.000000000E¯6 ×(SUM1 S)
[8]     ENS(TIM÷HOURSΔPERΔYEAR)=(REALΔSUM1 REALΔLABOUR)+SYNTHΔSUM1
       SYNTHΔLABOUR
[9]     ENS(REALΔFORVF-(REALΔKRΔLON+REALΔOVERSKOTT))<1.000000000E¯7
[10]    ENS(SYNTHΔFORVF-(SYNTHΔKRΔLON+SYNTHΔOVERSKOTT))<1.000000000E¯7
[11]    ENS(SYNTHΔSUM1(SYNTHΔW×SYNTHΔLABOUR))=SYNTHΔSUM1(SYNTHΔKRΔLON)
[12]    ENS(REALΔSUM1(REALΔW×REALΔLABOUR))=REALΔSUM1(REALΔKRΔLON)
[13]    ENS(SYNTHΔSUM1((R↓M)×SYNTHΔFORVF))=SYNTHΔSUM1(SYNTHΔOVERSKOTT)
[14]    ENS(REALΔSUM1((R↑M)×REALΔFORVF))=REALΔSUM1(REALΔOVERSKOTT)
[15]    ENS X≥0
[16]    ENS X≤1
[17]    ENS((SUM1 VA)÷(SUM1 QCURR))=(1-BRINKOP[⍳4])
[18]    ENS((SUM1(INP-ΔK3ΔIMED))÷(SUM1 QCURR))=(BRINKOP[⍳4])
[19]    DIFF←(XM×SUM1 S)-(SUM1 X×S)
[20]    ENS DIFF<(0.01×SUM1 S)
    ∇
```

```
      ∇DDIV[⎕]∇

    ∇  Z←A DDIV B
[1]    ⍝
[2]    ⍝ TO 'DIVIDE' A TREND PERCENTAGE.
[3]    ⍝ 'Z' IS COMPUTED AS THE SOLUTION TO: (1+A)=(1+Z)*B
[4]    ⍝
[5]     Z←¯1+*(⍟1+A)÷B
    ∇
```

```
∇DEV[⎕]∇

    ∇  A←DEV X
        A←X-+/X÷⍴X
    ∇


    ∇DISPOSE1ΔFIRMS[⎕]∇

    ∇  DISPOSE1ΔFIRMS
        →(TESTUTSKRIFT=0)/START
        'REALΔRATIO'
        REALΔRATIO
        'SYNTHΔRATIO'
        SYNTHΔRATIO
        'INPUTRATIO'
        INPUTRATIO
        'REALΔSALES'
        REALΔSALES
        'SYNTHΔSALES'
        SYNTHΔSALES
        'SLUT PA TESTUTSKRIFT I DISPOSE1ΔFIRMS  '
       START:
       ⍝
        KILL 'SCALE MAKEQUARTERS'
        KILL 'RAMARKET FIRMID RESΔLABOUR SYNTHΔSALES RESΔSALES RATIO1 RAT
       IO2 INPUTRATIO'
        KILL 'REALΔRATIO SYNTHΔRATIO RESΔEXPORT REALΔINP LIST K3ΔIMED '
       ⍝THIS FUNCTION DELETES VARIABLES AND FUNCTIONS OF NO FURTHER USE.
    ∇


    ∇DISPOSE2ΔFIRMS[⎕]∇

    ∇  DISPOSE2ΔFIRMS
        →(TESTUTSKRIFT=0)/START
        'SΔMARKET'
        SΔMARKET
        'A21'
        A21
        'A22'
        A22
        'INP'
```

```
[9]     INP
[10]    'QCURR'
[11]    QCURR
[12]    'M75'
[13]    M75
[14]    'ΔK3ΔIMED'
[15]    ΔK3ΔIMED
[16]    'ΔK3ΔFINISH'
[17]    ΔK3ΔFINISH
[18]    'REALΔFORVF'
[19]    REALΔFORVF
[20]    'SYNTHΔFORVF'
[21]    SYNTHΔFORVF
[22]    'FORVF'
[23]    FORVF
[24]    'REALΔLABOUR'
[25]    REALΔLABOUR
[26]    'SYNTHΔLABOUR'
[27]    SYNTHΔLABOUR
[28]    'REALΔW'
[29]    REALΔW
[30]    'SYNTHΔW'
[31]    SYNTHΔW
[32]    'REALΔOVERSKOTT'
[33]    REALΔOVERSKOTT
[34]    'SYNTHΔOVERSKOTT'
[35]    SYNTHΔOVERSKOTT
[36]    'OVERSKOTT'
[37]    OVERSKOTT
[38]    'REALΔKRΔLON'
[39]    REALΔKRΔLON
[40]    'SYNTHΔKRΔLON'
[41]    SYNTHΔKRΔLON
[42]    'LON'
[43]    LON
[44]    'SLUT PA TEST'
[45]   START:
[46]    KILL 'X̲ FΔDATA S̲ΔMARKET NAMNΔMARKET A21 A22 INP QCURR M75'
[47]    KILL 'Δ̄K3ΔIMED Δ̄K3ΔFINISH REALΔSALES REALΔFORVF SYNTHΔFORVF FORVF
        REALΔLABOUR SYNTHΔLABOUR '
[48]    KILL 'REALΔW SYNTHΔW REALΔOVERSKOTT SYNTHΔOVERSKOTT OVERSKOTT'
[49]    KILL 'REALΔKRΔLON SYNTHΔKRΔLON LON SCALE HELP'
[50]    KILL 'IOΔMATRIX CONTROLS REALΔSUM1 SYNTHΔSUM1 DISPOSE1ΔFIRMS RAND
       OMIZE USING QFR1 HISTORY BETWEEN'
[51]   ⍝
[52]   ⍝THIS FUNCTION DELETES FUNCTIONS AND VARIABLES OF NO FURTHER USE..
     ∇
```

```
      ∇DIV7[⎕]∇

    ∇  Z←M DIV7 V
[1]     ENS(⍴V)=(⍴M)[1]
[2]    ⍝
[3]    ⍝ TO DIVIDE A MATRIX WITH A VECTOR:
[4]    ⍝ EACH ELEMENT 'M[I;J]' IS DIVIDED BY 'V[I]'.
[5]    ⍝ THUS, 'M' MUST HAVE AS MANY ROWS AS 'V' HAS ELEMENTS.
[6]    ⍝
[7]     Z←M÷⍉(⌽⍴M)⍴V
    ∇


      ∇DUP[⎕]∇

    ∇  Z←NUM DUP EL
[1]    ⍝ Z←(NUM[1]⍴EL[1]),(NUM[2]⍴EL[2]),  ...  ,(NUM[N]⍴EL[N])
[2]     ENS(1≥⍴⍴NUM),(1≥⍴⍴EL)
[3]     ENS(1≤⍴,NUM),(2≤⍴,EL)
[4]     ENS(1=⍴,NUM)∨((⍴,NUM)=(⍴,EL))
[5]     NUM←(⍴EL)⍴NUM
[6]     Z←EL[(0≠Z)/Z←,⍉(((⌈/NUM),⍴NUM)⍴⍳⍴NUM)×(⍳⌈/NUM)∘.≤NUM]
    ∇


      ∇ENS[⎕]∇
    ∇  ENS STRING
[1]     →(∨/STRING=1)/0
[2]     'ERROR:'
[3]     ⍎')SI'
    ∇
```

```
      ∇KILL[⎕]∇

    ∇  KILL NAMES;POS;DUMMY
[1]    L:→(0=⍴NAMES)/0
[2]    POS←NAMES⍳' '
[3]    DUMMY←⎕EX(POS-1)↑NAMES
[4]    NAMES←POS↓NAMES
[5]    →L
    ∇
```

```
      ∇MULT1[⎕]∇

    ∇  Z←F MULT1 M
[1]    ⍝
[2]    ⍝  TO MULTIPLY FIRMS' DATA WITH A MARKET VECTOR:
[3]    ⍝ 'F' IS THE FIRMS' DATA VECTOR.
[4]    ⍝ 'M' IS THE MARKET VECTOR.
[5]    ⍝ GLOBAL VECTOR 'MARKET' CONTAINS MARKET NUMBER OF EACH FIRM.
[6]    ⍝ 'Z' IS THE RESULTING (FIRM VECTOR) DATA.
[7]    ⍝
[8]     Z←F×M[MARKET]
    ∇
```

```
      ∇MULT7[⎕]∇

    ∇  Z←M MULT7 V
[1]     ENS((⍴V)=(⍴M)[1])
[2]    ⍝ TO MULTIPLY A MATRIX WITH A VECTOR:
[3]    ⍝ EACH ELEMENT 'M[I;J]' IS MULTIPLIED WITH 'V[I]'.
[4]    ⍝ THUS, 'M' MUST HAVE AS MANY ROWS AS 'V' HAS ELEMENTS.
[5]    ⍝
[6]     Z←M×⍉(⌽⍴M)⍴V
    ∇
```

```
∇RANDOMIZE[⎕]∇

    ∇  C←A RANDOMIZE B;D;E;AID
[1]     C←((REALΔSUM1 A)÷+/NAMNΔMARKET∘.=⍳4)[SΔMARKET]
[2]    ⍝ EACH ELEMENT OF C EQUALS CORRESPONDING REAL MARKET  AVERAGE
[3]     →((0=B)∧1=⍴B)/END
[4]    ⍝ IF B=0, SKIP CORRELATION ASPECT
[5]     D←(⍴NAMNΔMARKET)↑B
[6]     E←(⍴D)↓B
[7]    ⍝ HELP VBLES: D=REAL PART OF B, E=SYNTHETIC PART OF B
[8]     AID←E-((E+.×SΔMARKET∘.=⍳4)÷+/SΔMARKET∘.=⍳4)[SΔMARKET]
[9]    ⍝ AID=DEVIATION OF ELEMENTS OF E FROM THEIR MKT AVERAGES
[10]    C←C+AID×((+/(DEV D)×DEV A)÷+/(DEV E)*2)×(⍴E)÷⍴D
[11]   ⍝ THAT USED THE APPROXIMATION COV(C,E)=COV(A,D)
[12]   END:AID←A-((A+.×NAMNΔMARKET∘.=⍳4)÷+/NAMNΔMARKET∘.=⍳4)[NAMNΔMARKET]
[13]   ⍝ AID=DEVIATION OF ELEMENTS OF A FROM THEIR MKT AVERAGES
[14]    C←C+((¯50+(⍴C)?100)÷50)×(((REALΔSUM1 AID*2)÷+/NAMNΔMARKET∘.=⍳4)*
       0.5)[SΔMARKET]
[15]   ⍝ C[I,J]=C[I]×(1+EPS[I,J])×SD(A[I])
[16]   ⍝ WHERE: C[I]=C FOR MARKET I AS COMPUTED ABOVE
[17]   ⍝        EPS[I,J] IS UNIFORM OVER [¯0.5, 0.5]
[18]   ⍝        SD(:)=STANDARD DEVIATION OF A ON THE ITH MARKET
[19]    G
    ∇


∇REALΔSUM1[⎕]∇

    ∇  A←REALΔSUM1 V
[1]    ⍝
[2]    ⍝ TO SUM FROM FIRMS TO MARKETS:
[3]    ⍝ 'V' IS THE FIRM DATA TO BE AGGREGATED, IF IT HAS MORE THAN
[4]    ⍝ ONE AXIS, FIRST DIMENSION MUST INDICATE FIRM NUMBER.
[5]    ⍝ GLOBAL VECTOR 'NAMNΔMARKET' TELLS MARKET NUMBER OF EACH FIRM.
[6]    ⍝ GLOBAL 'NMARKETS' TELLS NUMBER OF MARKETS.
[7]    ⍝ 'A' IS THE AGGREGATE.
[8]    ⍝
[9]     A←((⍳NMARKETS)∘.=NAMNΔMARKET)+.×V
    ∇
```

```
      ∇SCALE[⎕]∇
    ∇  S←N SCALE PAR
[1]    ENS(0<PAR),(1≤⍴PAR),(PAR≤S←1,¯1↓PAR)
[2]   ⍝ TO GET N SCALED NUMBERS IN DESCENDING ORDER.

[3]   ⍝ (¯1↓PAR) ARE SIZES OF NUMBERS 2,3,... RELATIVE TO FIRST NUMBER.

[4]   ⍝ AFTER THAT, MORE NUMBERS ARE GENERATED IN A LOGARITHMICALLY DECL
      INING FASHION DOWN TO (¯1↑PAR).
[5]   ⍝ NUMBERS ARE NORMALIZED TO HAVE SUM=1.

[6]    →(N=⍴S←(N⌊⍴S)↑S)/L
[7]    S←S,⌽(¯1↑PAR)×((÷/¯2↑1,PAR)*÷N-⍴S)*¯1+⍳N-⍴S
[8]   L:S←S÷+/S
    ∇
```

```
      ∇SUM1[⎕]∇

    ∇  A←SUM1 V
[1]   ⍝
[2]   ⍝ TO SUM FROM FIRMS TO MARKETS:
[3]   ⍝ 'V' IS THE FIRM DATA TO BE AGGREGATED. IF IT HAS MORE THAN
[4]   ⍝ ONE AXIS, FIRST DIMENSION MUST INDICATE FIRM NUMBER.
[5]   ⍝ GLOBAL VECTOR 'MARKET' TELLS MARKET NUMBER OF EACH FIRM.
[6]   ⍝ GLOBAL 'NMARKETS' TELLS NUMBER OF MARKETS.
[7]   ⍝ 'A' IS THE AGGREGATE.
[8]   ⍝
[9]    A←((⍳NMARKETS)∘.=MARKET)+.×V
    ∇
```

```
      ∇SUM2[⎕]∇
    ∇  A←SUM2 V
[1]   ⍝
[2]   ⍝ TO SUM FROM FIRMS TO A COUNTRY TOTAL:
[3]   ⍝ 'V' IS THE FIRM DATA TO BE AGGREGATED. IF IT HAS MORE THAN
[4]   ⍝ ONE AXIS, FIRST DIMENSION MUST INDICATE FIRM NUMBER.
[5]   ⍝ 'A' IS THE AGGREGATE.
[6]   ⍝
[7]    A←+⌿V
    ∇
```

```
      ∇SYNTHΔSUM1[⎕]∇

    ∇  A←SYNTHΔSUM1 V
[1]    A←((⍳NMARKETS)∘.=S̲ΔMARKET)+.×V
    ∇


      ∇USING[⎕]∇

    ∇  OUT←REAL USING V
[1]    OUT←REAL,(REAL RANDOMIZE V)
    ∇
```

CHAPTER III

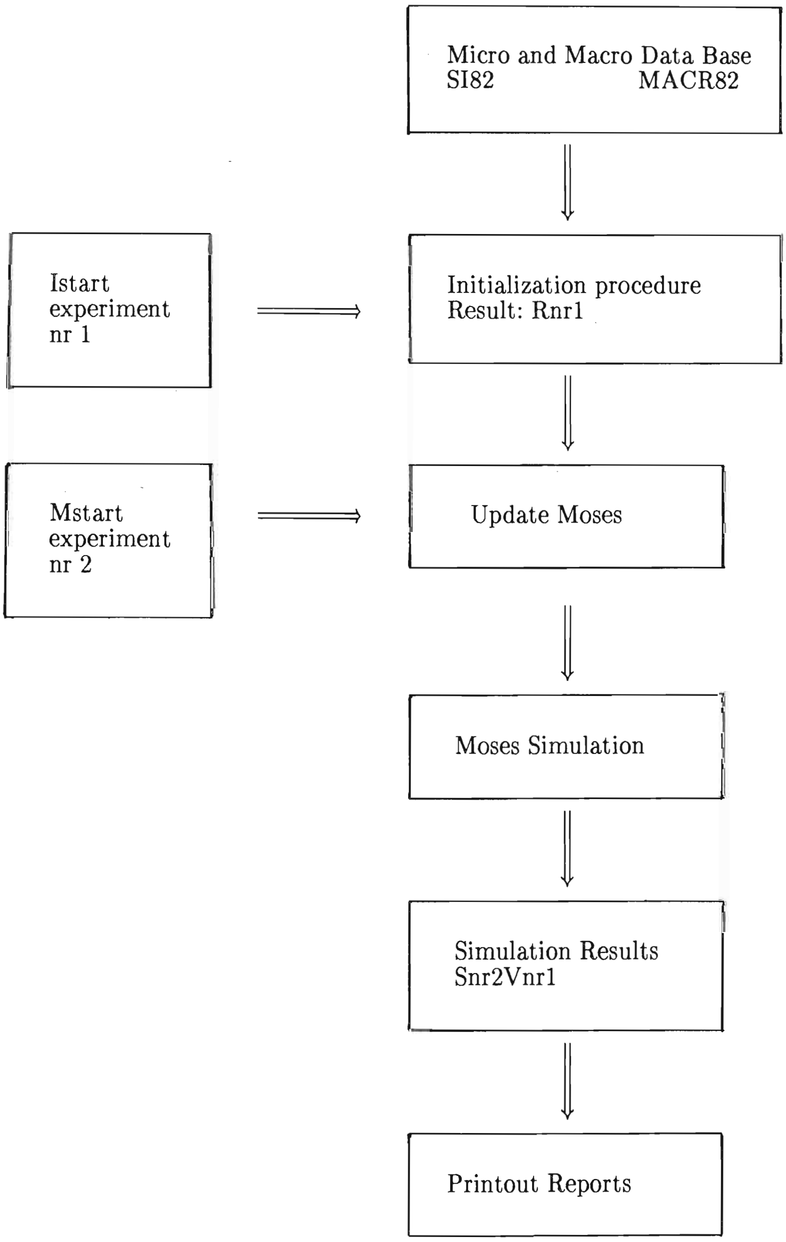
Flow Presentation of MOSES Initialization and Simulation

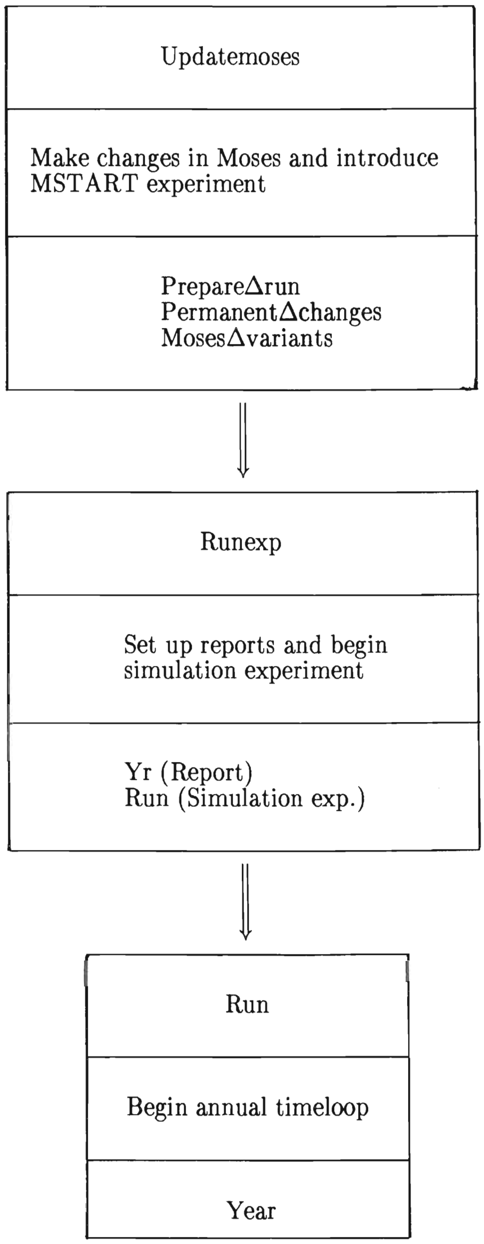
by
Kenneth A. Hanson

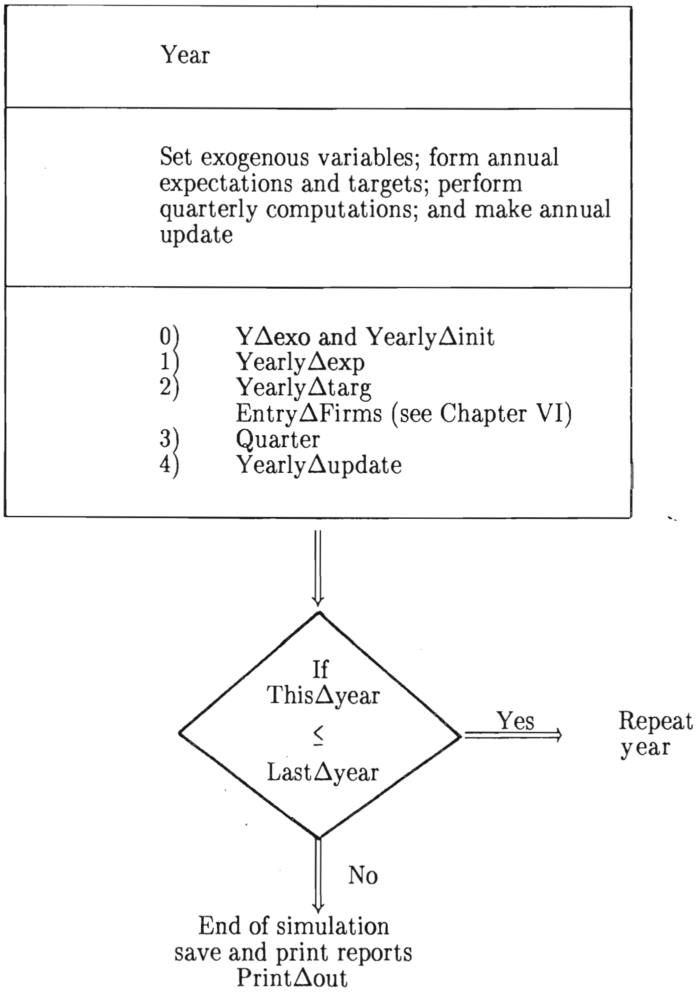
A MOSES simulation involves a recursive sequence of operations as traced through with the flow chart. Computations are made on a quarterly basis and accumulated into annual results. The model is initialized using micro and macro data, which are brought into consistency through the initialization procedure. The simulation model combines agent behavior and market processes in deriving a sequence of quarterly activities. Experiments can be conducted with both initialization and simulation by changes made to the Istart and Mstart functions.

This flow chart can serve as an introduction to the more detailed technical specification and listing of model variables. References indicate the number of the appropriate section in Technical specifications Code in Chapter IV.

MOSES Initialization and Simulation




Updatemoses
Make changes in Moses and introduce MSTART experiment
PrepareΔrun
PermanentΔchanges
MosesΔvariants
Runexp
Set up reports and begin simulation experiment
Yr (Report)
Run (Simulation exp.)
Run
Begin annual timeloop
Year


Year
Set exogenous variables; form annual expectations and targets; perform quarterly computations; and make annual update
0) YΔexo and YearlyΔinit
1) YearlyΔexp
2) YearlyΔtarg
EntryΔFirms (see Chapter VI)
3) Quarter
4) YearlyΔupdate
If ThisΔyear ≤ LastΔyear
Yes
Repeat year
No
End of simulation save and print reports PrintΔout

Y∆exo Yearly∆init Yearly∆exp Yearly∆targ
Variables with exogenous rates of change are specified. Expectations and profit margin targets based on history are determined.

Entry∆Firms (see Chapter VI)
New Firms enter according to profitability conditions, with size and productivity conditions specified relative to existing firms.

3) Quarter
Agent behavior and market transactions occur on a quarterly basis in a sequential order as given in this function.
3.0) Q∆exo 3.1) Quarterly∆exp 3.2) Quarterly∆targ 4) Prodplan 5) Labour∆market 6) Export∆markets 7) Domestic∆market 8) Stosystem 9) Quarterly∆result 10) Invfin 11) Government∆accounting 12) Monetary∆sector 13) National∆accounting

1) 2) 3)	QΔexo QuarterlyΔexp QuarterlyΔtarg
	In these three functions annual values for exogenous variables, expectations, and profit margin target are converted to quarterly values.
	Key variables
1)	ExoΔri, Ribwfor, Ridepfor, Qdpfor, Odpin Txvai(2), Qdwg, Qrealchig, Qinvin, Qinvbld, Qinvg
2)	Qexpdp, Qexpdw, Qexpds, Qexpp, Qexpw, Qexps, Qexpplm
3)	Qtargm

4)	Prodplan
	Firm production plans are derived through a profit seeking behavioral search; given capital, expectations and profit margin target.
4.0) 4.1) 4.2) 4.3)	Luupdate Prodfront Initprodplan TargΔsearch
	Key variables
0) 1) 2) 3)	L, Lu, Aman Mtec, Qtop, Res, Tec Qexpsu, Qplanq Qplanq, Qplanl, Aman

5) Labour∆market

Computation of firm and government employment and wage.

5.1) Zlabour (service labour not active)
5.2) Glabour
5.3) Indlabour

↓

5.3) Indlabour

Interaction among firms, employed, and unemployed, determining firm employment and wage. Firms may also revise production plans due to labour market outcome.

5.3.1) Labour∆search
5.3.2) Labour∆update
5.3.3) Planqrevise

Key variables

2) Qwg, Lg
3.2) L, Qw, Qdw, Ru, Aman
3.3) Qplan Q, Qq, Qimq, Imsto, Qoptsu

↓

5.3.1) Labour∆search

Labour∆search∆input
Confront
Labour∆search∆output

6)	ExportΔmarkets
	Fraction of desired sales designated for export market is determined.
	Key variables X, Qpfor, Qsufor

7)	DomesticΔmarket
	Firm and household interaction on product markets. Price, sales, and import shares are computed.
7.1) 7.2) 7.3) 7.7) 7.8) 7.9) 7.10) 7.11)	MarketΔentrance HouseholdΔinit MarketΔconfront ComputeΔimports DomesticΔresult ExternalΔsectors HouseholdΔupdate IndirectΔtaxes
Key variables	
3) 7) 8) 9) 10) 11)	Qtbuy, Imp, Qbuy, Pt Qtbuydom, Qtbuyfor Qpdom, Qdpdom QimpurchΔin Qc, Qsouh, Qcpi Qvatax

⇓

7.3)	MarketΔconfront
	Iterative process by which price and sales are determined.
7.4) 7.5) 7.6)	ComputeΔspending ComputeΔbuying AdjustΔprices

8)	Stosystem
	Industry inventories are distributed over firms and firm domestic sales computed.
8.1)	Firmsto
	Key variables Sto, Qsudom, Qsdom

9)	QuarterlyΔresult
	Compute quarterly price, sales, value added and profit margin. Accumulate over quarters for annual value.
9.1) 9.2)	Finalqpqsqm QuarterlyΔcum
	Key variables Qsu, Qds, Qs Qdp, Qp, Qva, Qm cum (inv, Q, VA, S, SU, Snet, L)

10)	Invfin
	Compute firm cash flow, source-use of funds, value of assets, rate of return. Formulate firm capital investment and Borrowing plan.
	Key variables Qrev, Qdpk, Ki, Kibook Qtax, Qdiv, Qrr, Rwc Qdeschbw, Qinv Inveff

11) Government∆accounting

Government Revenues and expenditures are computed.

12) Monetary∆sector

Supply of credit and money, and determination of interest rate. Feedback effect on firm investment. Foreign flow of cash in bank accounts.

12.1) Bank∆transactions
12.2) Credit∆market
12.3) Invfin∆adjustments
12.4) Bank∆update

Key variables

12.1) Fd
12.2) Qchbw, Qchri
12.3) Bw, Qinvlog, K2, Nw
12.4) Liqb, Nwb

13) National∆accounting

Quarterly results are accumulated into national account reports, at fixed and current prices.

Reports

Runexp

Setting up reports files begins
in the Function

Yr
Y∆r∆firm

⇓

YR

Y∆R∆Prices
Y∆R∆Industry∆Total
Y∆R∆Foreign∆Trade
Y∆R∆Country∆Total
Y∆R∆Market
Y∆R∆Households
Y∆R∆Government
Y∆R∆Bank∆Transactions
Y∆R∆Bank∆Position
Y∆R∆Finance
Y∆R∆GNP
Y∆R∆Rate∆of∆Return
Y∆R∆Distribution

YΔRΔ"Reportname"

In these functions the report header is setup and the file name for storage of data is defined usually as: YearlyΔReportname. Finally a function by the name YΔ"Reportname" is called for defining and storing the data.

⇓

YΔ"Reportname"

The variables going into a report are defined and entered into the report file: YearlyΔReportname.

⇓

YearlyΔ "Reportname"

A character string which contains the report. Individual reports may be printed out by: Print"YearlyΔReportname"; or all reports by PrintΔout.

CHAPTER IV

The MOSES Technical Specification Code

by
Fredrik Bergholm, Gunnar Eliasson,
Christina Hartler and Gösta Olavi

0 Yearly Initialization
(YEARLY INIT)

At the beginning of each year, the following firmrelated variables are set to zero:

CUMQ, CUMM, CUMSU, CUMS, CUMWS, CUML, CUMINV, CUMVA, CUMSNET

They are all updated each quarter in the block 9.2 "Quarterly Cumulation".

The following government-related variables are set to zero:

CUMWTAX, CUMITAX, CUMVATAX, CUMCTAX, CUMWSG, CUMLG, CUMINVG, CUMPURCHG, CUMTRANS, CUMSUBS, CUMMPRINT, CUMINTG

Finally the following variables are set to zero:

CUMGNPCUR, CUMGNPFIX, CUMEXPORT, CUMIMPORT

1 Yearly Expectations
(YEARLY EXP)

Exponential smoothing is used as a special case of weighted time averages in chapter II. The smoothing factors SMP, SMW, SMS, the constants E1, E2 and the "extroversion" coefficient R do not vary between firms. DP, DW, DS were computed last year in block 14 "Yearly update".

1.1 Prices

1.1.1 $HISTDP := SMP \times HISTDP + (1-SMP) \times DP$

1.1.2 $HISTDPDEV := SMP \times HISTDPDEV + (1-SMP) \times (DP-EXPDP)$

1.1.3 $HISTDEPDEV2 := SMP \times HISTDPDEV2 + (1-SMP) \times (DP-EXPDP)^2$

1.1.4 EXPIDP:= HISTDP+E1×HISTDPDEV –
$-E2\times\sqrt{HISTDPDEV2}$

1.1.5 EXPXDP:= EXOGENOUS

1.1.6 EXPDP:= (1–R)×EXPIDP+R×EXPXDP

1.2 Wages

1.2.1 HISTDW:= SMW×HISTDW+(1–SMW)×DW

1.2.2 HISTDWDEV:= SMW×HISTDWDEV+(1–SMW)×(DW–EXPDW)

1.2.3 HISTDWDEV2:= SMW×HISTDWDEV2 +
$+(1-SMW)\times(DW-EXPDW)^2$

1.2.4 EXPIDW:= HISTDW+E1×HISTDWDEV+E2×$\sqrt{HISTDWDEV2}$

1.2.5 EXPXDW:= EXOGENOUS

1.2.6 EXPDW:= (1–R)×EXPIDW+R×EXPXDW

1.3 Sales

1.3.1 HISTDS:= SMS×HISTDS+(1–SMS)×DS

1.3.2 HISTDSDEV:= SMS×HISTDSDEV+(1–SMS)×(DS–EXPDS)

1.3.3 HISTDSDEV2:= SMS×HISTDSDEV2+(1–SMS)×$(DS-EXPDS)^2$

1.3.4 EXPIDS:= HISTDS+E1×HISTDSDEV–E2×$\sqrt{HISTDSDEV2}$

1.3.5 EXPXDS:= EXOGENOUS

1.3.6 EXPDS:= (1–R)×EXPIDS+R×EXPXDS

2 Yearly Targeting
(YEARLY TARG)

The targeting function is a special case of the smoothing device in block 1, with R = E1 = E2 = 0. The feed-back value of margin M is computed in block 14 "Yearly update". The fraction EPS increases target pressure (if it is not zero).

2.1 MHIST:= SMT × MHIST + (1–SMT) × M

2.2 TARGM:= MHIST × (1+EPS)

We will also make experiments with the following formula, where TARGXM is exogenous or e.g. the actual profit margin for a market leader:

2.3 $TARGM := MAX\{MHIST \times (1+EPS), (1-R) \times MHIST \times (1+EPS) + R \times TARGXM\}$

3.1 Quarterly Expectations
(QUARTERLY EXP)

Long-term expectations are transformed to a quarterly basis. In all quarters except the first one, a trade-off takes place with respect to immediate experience. Prices that firms expect to pay for input materials are computed.

3.1.1 $QEXPDP := \frac{EXPDP}{4}$

$QEXPDW := \frac{EXPDW}{4}$

$QEXPDS := \frac{EXPDS}{4}$

3.1.2 (Not in the first quarter each year)
$QEXPDP := QEXPDP + FIP \times (QDP-QEXPDP)$
$QEXPDW := QEXPDW + FIW \times (QDW-QEXPDW)$
$QEXPDS := QEXPDS + FIS \times (QDS-QEXPDS)$

3.1.3 $QEXPP := QP \times (1+QEXPDP)$
$QEXPW := QW \times (1+QEXPDW)$
$QEXPS := QS \times (1+QEXPDS)$

3.1.4 Expected purchasing price for input materials; from explicit and external sectors:

$QEXPDPIM(MKT) := \frac{SUM(QQ \times QEXPDP)}{SUM(QQ)}$

$QEXPDPIM(IN) := QDPIN - QCHTXVA2$

$QEXPPIM := (1-TXVA2) \times QPDOM \times (1+QEXPDPIM)$

3.2 Quarterly Targeting
(QUARTERLY TARG)

3.2.1 QTARGM:= TARGM

4 Production System and Production Planning
(PRODPLAN)

4.LU Updating of Unemployment
(LUUPDATE)

Retirements are computed, and new entries to the labour force are added to the pool of unemployed.

4.LU.1 LF:= LU + LG + SUM(L)
4.LU.2 L:= L × (1–RET)
4.LU.3 AMAN1,2,3:= AMAN1,2,3 × (1–RET)
4.LU.4 LU:= LU × (1–RET)
4.LU.5 LU:= LU + ENTRY × LF

4.0 Production Possibility Frontier

In block 4, the following function describes the relationship between labour input and maximum production for a firm under normal profitability conditions:

4.0.1 $$QFR(L) = WTIX \times (1-RES) \times QTOP \times \left[1 - e^{-\frac{TEK}{QTOP} \times L}\right]$$

The inverse of this function will also be used:

4.0.2 $$RFQ(Q) = \frac{QTOP}{TEC} \times \ln \frac{WTIX \times (1-RES) \times QTOP}{WTIX \times (1-RES) \times QTOP-Q}$$

4.1 Determining Change in Production Frontier (PRODFRONT)

Productivity of modern equipment is updated. Depreciation is accounted for. A fraction of total investment (LOSS) does not influence production capacity directly but is directed to the "residual slack", and can be used in future expansions only if current slack is low. Productivity has to be updated since old and new equipment differ in quality.

4.1.1 $MTEC := MTEC \times (1+QDMTEC)$
(QDMTEC is entered exogenously)

4.1.2 $QTOP := QTOP \times (1-RHO)$

4.1.3 $QCHQTOP1 := (1-LOSS) \times \frac{QINV \times INVEFF}{QP}$

(QINV and INVEFF from block 10, Investment–Financing)

4.1.4 $$QCHQTOP2 := MIN\left[LOSS \times \frac{QINV \times INVEFF}{QP} \times \times \frac{RESMAX-RES}{RESMAX}, \frac{RESMAX-RES}{1-RESMAX} \times (QTOP+QCHQTOP1)\right]$$

(The slack RES cannot exceed RESMAX)

4.1.5 $QCHQTOP := QCHQTOP1+QCHQTOP2$

4.1.6 $$RES := \frac{RES \times (QTOP+QCHQTOP1) + QCHQTOP2}{QTOP+QCHQTOP}$$

4.1.7 $$TEC := \frac{QTOP+QCHQTOP}{\frac{QTOP}{TEC} + \frac{QCHQTOP}{MTEC}}$$

4.1.8 $QTOP := QTOP + QCHQTOP$

4.2 Initial Quarterly Production Plan
(INITPRODPLAN)

This initial plan is based on the sales forecast, plus the desire to keep the stock at its "optimal" level.

4.2.1 $QEXPSU := \frac{QEXPS}{QEXPP}$

4.2.2 $QPLANQ := MAX \left\{0, QEXPSU + \frac{OPTSTO - STO}{4 \times TMSTO}\right\}$

4.3 Search for Target Satisfaction
(TARGET SEARCH)

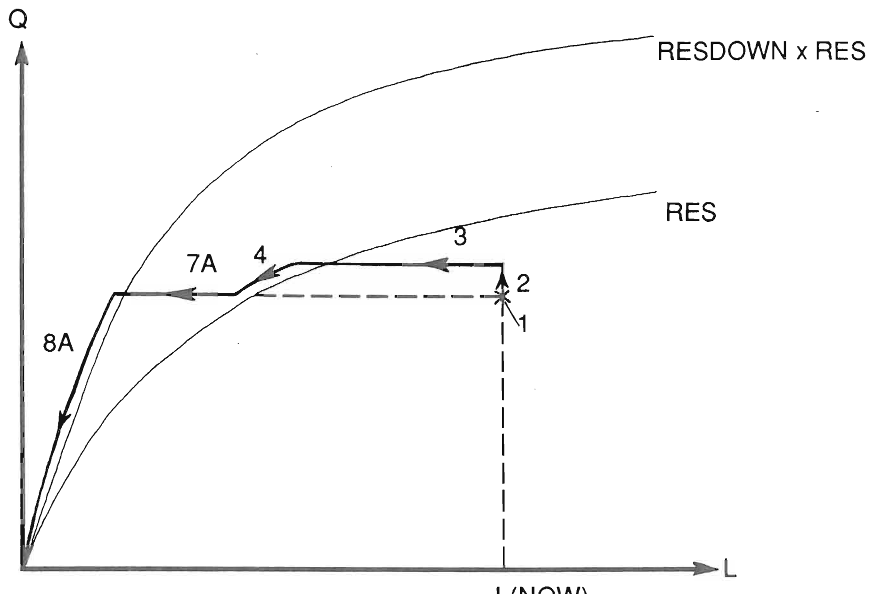
This block describes how a firm varies its combination of labour input and production level to satisfy its profit margin requirement (QTARGM). When the target is reached, search is terminated; this means that each section within 4.3 is entered only if the firm has not yet found a satisfactory plan.

The diagrams and search paths on the next page explain how this search process has been modelled. Note that search will probably terminate within one of the paths, and not at a corner. Two cases can be distinguished, depending on whether the initial plan implies recruitment or not.

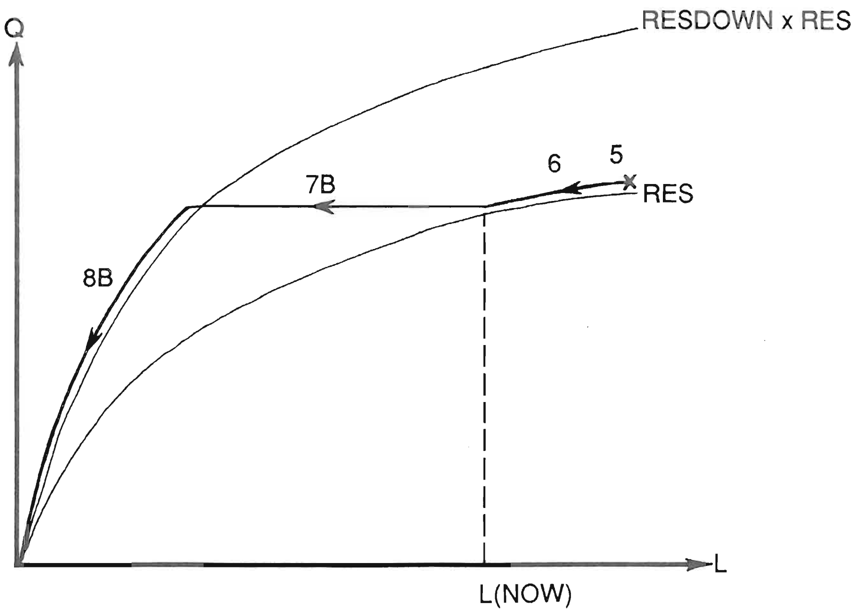
Two devices called "SAT" and "SOLVE" are referred to throughout the block; they are described in 4.3.12 and 4.3.14.

The specification in 4.3 holds for each firm, one at a time.

The name QEXPPNET will be used to denote a "net" sales price: QEXPP – SUM(IO × QEXPPIM)



Search path, case A: QPLANQ < QFR(L)



Search path, case B: QPLANQ > QFR(L)

4.3.0 QEXPPNET:= QEXPP – SHARE × [SUM(IO × QEXPPIM)]

4.3.1 Is the initial plan feasible, and does it imply recruitment?

```
IF QPLANQ ≥ QTOP × (1–RES) × WTIX
   THEN GOTO 4.3.7
   ELSE IF QPLANQ > QFR(L)
      THEN GOTO 4.3.6
      ELSE CONTINUE
```

4.3.2 Does the initial plan give satisfaction at "1" in the diagram?:

```
IF SAT (QPLANQ, L)
   THEN QPLANL:=L
      GOTO 4.3.11
```

4.3.3 Increase production with same labour force. Raise until production frontier or stock limit is reached (path 2).

```
Q2:= MIN[QFR(L),QEXPSU + MAXSTO – STO]
IF SAT(Q2,L)
   THEN QPLANQ:= L × (QEXPW/4) / [(1–QTARGM) × QEXPPNET]
        QPLANL:=L
        GOTO 4.3.11
   ELSE IF Q2:=QFR(L)
      THEN GOTO 4.3.5
      ELSE CONTINUE
```

Note: This step of the search has proven not to conform with practice in most firms. Thus, in most simulations we bypass this step. Computationally this is done by setting Q2 equal to MIN[QPLANQ, QFR(L)] in the first equation in this step.

4.3.4 Cut down labour force, still producing up to the level Q2 (path 3).

```
IF SAT [Q2, RFQ(Q2)]
   THEN QPLANQ:=Q2
        QPLANL:= (1–QTARGM) × Q2×QEXPPNET / (QEXPW/4)
        GOTO 4.3.11
```

4.3.5 Reduce production down to QPLANQ, with corresponding decrease in labour force (path 4).

IF SAT [QPLANQ, RFQ(QPLANQ)]
THEN QPLANQ, QPLANL:=SOLVE
GOTO 4.3.11
ELSE Q7:= QPLANQ
GOTO 4.3.8

4.3.6 With an initial plan implying recruitment, will the profit target be reached?

IF SAT [QPLANQ, RFQ(QPLANQ)]
THEN QPLANL:= RFQ(QPLANQ)
GOTO 4.3.11

4.3.7 First step in search when initial plan implies recruitment (path 6).

IF SAT[QFR(L), L]
THEN QPLANQ, QPLANL:= SOLVE
GOTO 4.3.11
ELSE Q7:= QFR(L)

4.3.8 Keep production at the level Q7 (as it resulted from 4.3.5 or 4.3.7), but reduce the slack RES and thereby the labour force. RESDOWN is a model parameter (path 7), telling how much slack can be reduced during a single quarter.

IF SAT $\left[Q7, RFQ\left(\frac{1-RES}{1-RESDOWN \times RES} \times Q7\right)\right]$
THEN QPLANL:= Q7
QPLANL:= $\frac{(1-QTARGM) \times Q7 \times QEXPPNET}{QEXPW/4}$
RES:= $1-\frac{Q7 \times (1-RES)}{QFR(QPLANL)}$
GOTO 4.3.11
ELSE RES:= RESDOWN×RES

4.3.9 With the new, lower, slack from 4.3.8, try to reach target by reducing production and labour force (path 8).

<u>IF</u> SAT(0,0)
  <u>THEN</u> QPLANQ, QPLANL:= SOLVE
    GOTO 4.3.11

4.3.10 No plan could be found that satisfies profit target. The firm is eliminated from the model, and the labour force is added to the pool of unemployed.
LU:= LU + L
NULLIFY this firm.

4.3.11 QPLANQ and QPLANL have now been decided. The AMAN vector, describing the 2-quarter lag of firings, is updated. (AMAN1 can be fired this quarter).

LAYOFF:= MAX(L–QPLANL, 0)
AMAN1:= MIN(LAYOFF, AMAN2)
AMAN2:= MIN(LAYOFF–AMAN1, AMAN3)
AMAN3:= LAYOFF–AMAN1–AMAN2

4.3.12 "SAT": This device is used to find out if a certain combination Q/L of planned production and labour force will satisfy profit targets.

<u>IF</u> L > 0
  <u>THEN</u> MARGIN:= $1 - \frac{L \times (QEXPW/4)}{Q \times QEXPPNET}$
  <u>ELSE</u> (L=0)MARGIN:=
    $1 - \frac{QEXPW/4}{WTIX \times (1-RES) \times TEC \times QEXPPNET}$

(The case L=0 is used in 4.3.9)

<u>IF</u> MARGIN ≥ QTARGM
  <u>THEN</u> SAT:= TRUE
  <u>ELSE</u> SAT:= FALSE

4.3.13 "SOLVE MONEY": This device ascertains that no step in SEARCH leads to less expected profits in money terms than in position before. If decrease step back to earlier position and EXIT with plan.[1]

4.3.14 "SOLVE": This device solves the equation:

$$1 - \frac{QPLANL \times (QEXPW/4)}{QFR(QPLANL) \times QEXPPNET} = QTARGM$$

for QPLANL, with an error less than 0.1%. Once QPLANL is found, QPLANQ is also calculated as

QPLANQ:= QFR(QPLANL)

The equation is

$$1 - \frac{QPLANL \times (QEXPW/4)}{WTIX \times (1-RES) \times QTOP \times \left\{1-e^{-\frac{TEC}{QTOP} \times QPLANL}\right\} \times QEXPPNET} =$$

$$= QTARGM$$

Substitute $y = \frac{TEC}{QTOP} \times QPLANL$

$$1 - \frac{\frac{QTOP}{TEC} \times y \times QEXPW/4)}{WTIX \times (1-RES) \times QTOP\,(1-e^{-y}) \times QEXPPNET} = QTARGM$$

$$1-e^{-y} = \frac{QEXPW}{(1-QTARGM) \times WTIX \times (1-RES) \times TEC \times QEXPPNET \times 4} \times y$$

With a substitution this gives

$$1-e^{-y} = b \times y$$

or $f(y) = b \times y + e^{-y} - 1 = 0$

with $f'(y) = b - e^{-y}$

($b > 0$ must hold when we enter SOLVE, else no solution can be found).

---

[1] This block is not being used for the moment.

We use Newton–Raphson's formula

$$y := y - \frac{f(y)}{f'(y)}$$

with the starting value $y_0 := 1/b$, which is surely greater than the exact root, and gives convergence with all f/f' positive.

For $b \geq 1$, the algorithm gives the correct result $y = 0$. The possiblity of $b \leq 0$ must be checked, however.

4.4 Intermediate Products

The main part of this block has been moved to 5.4.3.2. Now QPLANQ is saved before it is changed in the labour market block.

4.4.1 QPLANQSAVE:= QPLANQ

5 Labour Market

5.1 (This block does no longer exist)

5.2 (This block does no longer exist)

5.3 Government Sector Labour Market (GLABOUR)

Government sector takes the labour it wants from the pool of unemployed. Wage increase is equal to average wage increase in industry last quarter.

5.3.1 QCHLG:= MIN(LU,LG×RET+QREALCHLG)
(QREALCHLG is entered exogenously)

5.3.2 LG:= LG+QCHLG–RET×LG

5.3.3 LU:= LU–QCHLG

Notice that if QCHLG < 0, this means that people are fired from government sector.

5.3.4 QDWG:= QDWIND

5.3.5 QWG:= QWG×(1+QDWG)

5.4 Industry Sector Labour Market
(INDLABOUR)

This block consists of three parts:

– Labour search
– Labour update
– Revision of production plans

They are all further specified below.

5.4.1 Labour Search
(LABOUR SEARCH INPUT; CONFRONT; LABOUR SEARCH OUTPUT)

Describes the sequence of actions that determine the labour force in every firm for the next quarter.

In LABOUR SEARCH INPUT (5.4.1.0) some help variables are introduced.

In CONFRONT (5.4.1.1 – 5.4.1.11) the actual interaction for new labour takes place.

Firms are ranked in order of the planned relative change in recruitment. Each firm is allowed to "attack" another firm, chosen at random. The desired change in new employment (CHL) is continuously changed. Firms strive to make CHL equal to zero. Firms that achieve this objective refrain from further raiding of other firms. This procedure is repeated NITER times (NITER is a model parameter).

In LABOUR SEARCH OUTPUT (5.4.1.12 – 5.4.1.13), results are summarized and layoff lags accommodated.

5.4.1.0 Desired change in labour force, and initial wage offering:

IF CHM > 0
    THEN CHL:= QPLANL – L
    ELSE CHL:= RFQ(QPLANQ) – L

WW:= QW + IOTA × (QEXPW – QW)
LL:= L concatenated to LU (The pool of unemployed will take part in the interactions)

5.4.1.1 Rank firms in decreasing order after CHL/L.

5.4.1.2 Repeat 5.4.1.3 – 5.4.1.11 NITER times (one time representing one attack from each firm).

5.4.1.3 Repeat 5.4.1.4 – 5.4.1.10 for each firm.

5.4.1.4 Select the firm that is to perform the next attack (from the ordering in 5.4.1.1). Denote it by I.

5.4.1.5 IF CHL(I) ≤ 0 THEN GOTO 5.4.1.10 (in this case the firm does not want any more labour).

5.4.1.6 Choose a firm to attack. Denote the firm being attacked by II. The selection is done at random by a function called HIT. The probability for a certain firm to be chosen is the size of its labour force, divided by the sum of the labour forces in all firms plus the number of unemployed. The relative probability to hit the pool of unemployed is increased by a factor SKREPA.

5.4.1.7 We now check whether the attacked object really was a firm (II ≤ NTOT), or whether it was the pool of unemployed (II = NTOT + 1) (cf. comment to 5.4.1.0).

IF II ≤ NTOT
    THEN GOTO 5.4.1.8
    ELSE GOTO 5.4.1.9

5.4.1.8 We now check whether the attack was a success (i.e. whether the wage of the attacking firm was high enough) or not.

IF WW(I) > WW(II) × (1+GAMMA)
    THEN GOTO 5.4.1.9
    ELSE WW(I):=WW(I)+KSI×{WW(II)×(1+GAMMA)–
            – WW(I)}
        GOTO 5.4.1.10.

5.4.1.9 If we come to this statement, the attack was a success, and labour is moved from firm II to firm I. If the "attacked firm" was the unemployed, (i.e. II = NTOT+1) the attack is always a success.

NOW:= MIN{THETA×LL(II), CHL(I)}
LL(I):= LL(I)+NOW
CHL(I):= CHL(I)–NOW
LL(II):= LL(II)–NOW
IF II ≤ NTOT
    THEN CHL(II):= CHL(II)+NOW

5.4.1.10 One attack is completed, GOTO 5.4.1.3

5.4.1.11 All firms have had the opportunity to attack once, GOTO 5.4.1.2

(Labour market interactions are now completed).

5.4.1.12 Summarize results; abandon help variables:

LU:= Last component in LL
QCHL:= LL – L
QCHW:= WW – QW

5.4.1.13 People who leave one firm for another are subtracted from the layoff-lagging vector AMAN in their first firm.

EXIT:= MAX(0, –QCHL)
IF EXIT > AMAN1 + AMAN2
    THEN AMAN3:= AMAN3 – (EXIT–AMAN1–AMAN2)
    (but AMAN3 ≥ 0 must hold)
IF EXIT > AMAN1
    THEN AMAN2:= AMAN2 – (EXIT – AMAN1)
    (but AMAN2 ≥ 0 must hold)
IF EXIT > 0
    THEN AMAN1:= AMAN1 – EXIT
    (But AMAN1 ≥ 0 must hold)

5.4.2 Labour Update

Layoff is accommodated. Wage increase in the industry is computed. Labour force and wage is updated for each firm, as determined in the previous block.

5.4.2.1 Layoffs; AMAN1 is a limit on how many people a firm can fire this quarter.

SACK:= MIN{AMAN1, MAX(0,L + QCHL – QPLANL)}
QCHL:= QCHL – SACK
AMAN1:= AMAN1 – SACK
LU:= LU + SUM(SACK)

5.4.2.2 Wage average and trend:

$$\text{OLDQW} := \frac{\text{SUM}(\text{L} \times \text{QW})}{\text{SUM}(\text{L})}$$

$$\text{NEWQW} := \frac{\text{SUM}\{(\text{L}+\text{QCHL}) \times (\text{QW}+\text{QCHW})\}}{\text{SUM}\{\text{L}+\text{QCHL}\}}$$

$$\text{QDWIND} := \frac{\text{NEWQW}}{\text{OLDQW}} - 1$$

5.4.2.3 Update labour force and wage:

$$L := L + QCHL$$

$$QDW := \frac{QCHW}{QW}$$

$$QW := QW + QCHW$$

5.4.2.4 Unemployment:

$$QCHRU := \frac{LU}{LU + LG + SUM(L)} - RU$$

$$RU := RU + QCHRU$$

5.4.3 <u>Revision of Production Plans</u>
(PLANQREVISE)

If a firm has lost too much of its labour force, or could not meet recruitment plans, its production plan must be reduced. The same holds if the firm has too low levels in its input-goods inventories. The new level of production assigned to the variable QQ is determined in this block. Input-goods inventories are updated. Optimum sales volume is computed.

5.4.3.1 $QPLANQ := MIN\left[QPLANQ, QFR(L)\right]$
(QFR is the production frontier as described in block 4.0)

5.4.3.2 Each firm computes its desired purchasing for each kind of input material used in its production. This is based on current production plan, plus an inventory-correction component. For the time being, no speculative behaviour is assumed. Later on, this will be done via the definition of OPTIMSTO (see 8.2.6) taking into account current and expected future prices.

$$QIMQ := SHARE \times IO \times QPLANQSAVE + \frac{OPTIMSTO - IMSTO}{4 \times TMIMSTO}$$

5.4.3.3 $QDQ := \frac{QPLANQ}{QQ} - 1$

5.4.3.4 $QQ := QQ \times (1 + QDQ)$

5.4.3.5 $IMSTO := MIN(MAXIMSTO, IMSTO + QIMQ - SHARE \times IO \times QQ)$

5.4.3.6 $$QOPTSU := MAX\left[0, QEXPSU \times \frac{QQ}{QEXPSU + \frac{OPTSTO - STO}{4 \times TMIMSTO}}\right]$$

6 Export Markets

Export share and supply, price and sales in foreign markets are determined. Export component of industry subsidies is computed.

6.1.1 IF $QPDOM \times (1 - TXVA2) > QPFOR$

THEN $X := X - X \times \frac{1}{4 \times TMX} \times \frac{QPDOM \times (1 - TXVA2) - QPFOR}{QPFOR}$

ELSE $X := X + (1 - X) \times \frac{1}{4 \times TMX} \times$

$$\frac{QPFOR - QPDOM \times (1 - TXVA2)}{QPDOM \times (1 - TXVA2)}$$

This formula can make $X > 1$ or $X < 0$. If this happens, X is put equal to one (or to zero).

6.1.2 $QSUFOR := X \times QOPTSU$

6.1.3 $QPFOR := (1 + QDPFOR) \times QPFOR$
(QDPFOR is entered exogenously.)
(This equation holds both for explicit and external model sectors.)

6.1.4 $QSFOR := QSUFOR \times QPFOR \times (1 + RSUBS)$

6.1.5 $QSUBSFOR := SUM\ (QSUFOR \times QPFOR \times RSUBS)$

6.1.6 $QEXPORT := SUM \left\{\frac{QSFOR}{1 + RSUBS}\right\}$

7 Domestic Product Market
(DOMESTIC MARKET)

This block encompasses the behaviour of firms and households within a complete input-output system for the economy. The supply side includes also imports and external sectors. Demand comes from households, government (consumption and investments), firms and external sectors (input materials and investments, with residential construction as a separate component).

1. Market Entrance
2. Household Initialisation
3. Market confrontation
4. Computation of Household Expenditures
5. Computation of Total Buyings
6. Price Adjustments
7. Compute Imports
8. Domestic Result
9. External Sectors
10. Updating of Households' Data
11. Indirect Taxes

Computationally, blocks 4, 5, 6 are sub-blocks to "Market Confrontation".

Functionally, blocks 1, 6, 8 describe the behaviour of firms. Blocks 2, 4, 10 form an integrated model of household behaviour and can be studied separately. Blocks 3, 5, 7, 9, 11 link the pieces of the full input-output system.

The producing sectors in the model (exclusive of government) can be grouped as:

MKT – Explicitly producing sectors
IN – External model sectors

Household expenditure categories include all MKT and IN sectors, plus savings. The following grouping of the categories is more relevant for the households:

NDUR – Services and non-durable goods
DUR – Durable goods
SAV – Saving

7.1 Market Entrance

Each firm computes its optimum sales volume. When determining an initial offering price, firms plan as if prices in domestic and foreign markets will develop similarly. Any changes in indirect taxes are assumed, by firms, to be carried by buyers.

7.1.1 $QOPTSUDOM := (1-X) \times QOPTSU$

7.1.2 $QPRELPDOM := QPDOM \times (1+QCHTXVA2) \times$

$$\times \frac{SUM\left\{QOPTSUDOM \times \frac{QEXPP}{QP}\right\}}{SUM(QOPTSUDOM)}$$

(The average is from firms to markets, giving one preliminary price for each market.)

7.2 Household Initialisation

(HOUSEHOLD INIT)

Households' total income consists of wages less payroll tax, interests, government transfer payments (where an unemployment compensation is singled out), dividends from firms (previous quarter), and previous quarter's surplus from external model sectors (these sectors have no labour force; the quantity QINPAY includes both wages and capital income). From total income the income tax is deducted, and the remaining disposable income is distributed among households. Last, each household's share of required saving (from the previous quarter) is computed.

7.2.1 $QTRANS := (RTRANS \times QTTAX) + LU \times RLU \times$

$$\times \frac{SUM[L \times QW \times (1-TXW)]}{4 \times SUM(L)}$$

7.2.2 $QINTH := SUM\left\{\frac{RIH \times WH}{4}\right\}$

7.2.3 $QTWS := \frac{LG \times QWG}{4} + QINPAY + SUM\left\{\frac{L \times QW}{4}\right\}$

7.2.4 $QWTAX := \frac{LG \times QWG}{4} \times \frac{TXWG}{1+TXWG} + \left\{ QINPAY + SUM\{\frac{L \times QW}{4}\} \right\} \times \frac{TXW}{1+TXW}$

7.2.5 QTI:= (QTWS–QWTAX)+QINTH+QTRANS+QTDIV

7.2.6 QITAX:= QTI × TXI1

7.2.7 $QDI := \frac{QTI - QITAX}{NH}$

7.2.8 $QSPSAVREQ := \frac{QSAVHREQ}{NH}$

7.3 Market Confrontation
(MARKET CONFRONT)

Adjust import shares IMP for explicitly producing sectors. Form the vector PT of trial prices. Let supply and demand interact a prespecified number of times.

7.3.1 IF QPDOM > QPFOR

THEN $IMP := IMP + \frac{1 - IMP}{4 \times TMIMP} \times \frac{QPDOM \times (1 - TXVA2) - QPFOR}{QPFOR}$

ELSE $IMP := IMP - \frac{IMP}{4 \times TMIMP} \times \frac{QPFOR - QPDOM \times (1 - TXVA2)}{QPDOM \times (1 - TXVA2)}$

This formula can make X > 1 or X < 0. If this happens, X is put equal to one (or to zero).

7.3.2 PT(MKT):= (1–IMP)×QPRELPDOM+IMP×QPFOR/(1–TXVA2)
PT(IN):= QPDOM(IN) × QDPIN

7.3.3 Government consumption in each category:
QPURCHG:= GKOFF × LG × WGΔREF/4×PT

7.3.4 Perform 7.3.5 – 7.3.7 MARKETITER times:

7.3.5 Compute household expenditures (see 7.4).

7.3.6 Compute total buyings (see 7.5).

7.3.7 (Not in the last iteration)
Adjust prices (see 7.6).

7.4 Computation of Household Expenditures
(COMPUTE EXPENDITURES)

This block describes how households react to a set of trial offering prices in the expenditure categories. It will interact with firms several times in an iterative manner. The expenditure categories correspond to the producing model sectors and to savings.

Prices are called PT (trial) and QPH (last quarter's final prices). QDI comes from block 7.2.

All variables have an order of magnitude referring to one household, not to the aggregate.

7.4.1 Preliminary Consumer Price Index (CPI), based on new prices in all expenditure categories:

$$QPRELCPI := \frac{SUM\left[QC(I)\right]}{SUM\left\{\frac{QC(I)}{PT(I)}\right\}}$$ [2]

$$QCHDCPI := \frac{QPRELCPI}{QCPI} - 1 - QDCPI$$

7.4.2 Essential nondurables consumption (goods and services).

$$QSPE(NDUR) := CVA(NDUR) \times PT(NDUR)$$

---

[2] Experiments will also be made with the following formula:

$$QPRELCPI := \frac{SUM\ CVA(I) \times PT(I)}{SUM\{CVA(I)\}}$$

7.4.3 Essential consumption of durable goods:

$$SWAP:= ALFA3 \times (\frac{QCHRI}{4} - QCHDCPI) + ALFA4 \times QCHRU$$

$$QSPE(DUR):= \frac{PT(DUR) \times CVA(DUR)}{RHODUR} -$$

$$- \frac{PT(DUR)}{QPH(DUR)} \times STODUR{-}QDI \times SWAP$$

7.4.4 Essential level of saving:

$$QSPE(SAV):= (WHRA \times QDI - WH) + QDI \times SWAP$$

(WHRA is updated in 7.10.4)

7.4.5 Adjustment to income constraint
("I" denotes NDUR,DUR,SAV)

$$QSP(I):= BETA1(I) \times QSPE(I) +$$

$$+ \left\{BETA2(I) + \frac{BETA3(I) \times QPRELCPI}{QDI - QSPSAVREQ}\right\} \times$$

$$\times \left\{QDI{-}QSPSAVREQ{-}SUM[BETA1(I) \times QSPE(I)]\right\}$$

Where all $BETA1 \geq 0$
$SUM(BETA2) = 1$
$SUM(BETA3) = 0$

7.4.6 $QSP(SAV):= QSP(SAV) + QSPSAVREQ$

7.4.7 For all non-saving categories $QSP \geq 0$ is enforced. Thus, at this stage $SUM(QSP) > QDI$ might hold. This is accomodated in the block 7.10 "Household Update", where savings are recomputed as a residual.

7.5 Computation of Total Buyings
(COMPUTE BUYING)

This block constructs a full demand matrix for the economy in volume terms. The matrix QBUY will have rows corresponding to each MKT and IN producing sector, and columns for input materials, also MKT and IN, plus final demand from G, HH, INV. All equations below result in one component for each producing sector, with the exception of 7.5.6, where the external sectors' input-output matrix is inverted to generate production for these sectors only.

7.5.1 $QBUY(MKT) := SUM(QIMQ)$

7.5.2 $QBUY(G) := \frac{QPURCHG}{PT}$

7.5.3 $QBUY(HH) := \frac{SUM(QSP)}{PT}$

7.5.4 $QINVTOT := OMEGAG \times QINVG + OMEGABLD \times QINVBLD + {} + OMEGAIN \times QINVIN + OMEGA \times SUM(QINVLAG)$

7.5.5 $QBUY(INV) := \frac{QINVTOT}{PT \times (1-TXVA2) / (1-TXVA1)}$

7.5.6 $QQIN := SUM \left\{ \left(1 - \frac{1-IMP(IN)}{1-XIN} \times I03\right)^{-1} \times \right.$

$\left. \times SUM(QBUY[MKT,G,HH,INV]) \times \frac{1-IMP(IN)}{1-XIN} \right\}$

This sum over QBUY computed <u>other</u> sectors' demand on goods (input-materials, government, households, investments) from the external sectors.

7.5.7 $QBUY(IN) := (I02 \text{ and } I03) \times QQIN$

7.5.8 $QTBUY := SUM(QBUY)$
This gives total purchasing from each sector.

7.6 <u>Price Adjustments</u>
(PRICE ADJUST)

This block describes how firms (in each iteration) adjust their prices, once the market has responded to a set of prices with provisional expenditures.

The common goals of the firms in a market is to keep prices (sales sum) up and the stock at OPSTO.

7.6.1 MAXDP2:= (1–IMP) × MAXDP

7.6.2 <u>IF</u> QTBUY × (1–IMP) < SUM(QOPTSUDOM)

$$\underline{\text{THEN}}\ \text{PT:= PT} - \frac{\text{MAXDP2} \times \text{PT}}{4 \times (\text{MARKETITER}-1)}$$

$$\underline{\text{ELSE}}\ \text{PT:= PT} + \frac{\text{MAXDP2} \times \text{PT}}{4 \times (\text{MARKETITER}-1)}$$

where the fraction MAXDP is a model parameter.

7.7 <u>Compute Imports</u>

Import fractions are used to compute normal import volumes for each market, inclusive of external markets. Market interactions may result in a demand that would lower stocks below minimum levels. In that case, "extra" imports are used to satisfy this demand (explicit markets only).

7.7.1 QTBUYFOR1:= IMP × QTBUY

7.7.2 QTBUYDOM:= QTBUY – QTBUYFOR1

7.7.3 Explicit sectors only:

QMAXTSUDOM:=MAX{0,SUM[QQ+(STO–MINSTO)–QSUFOR]}

QTBUYDOM:= MIN{QTBUYDOM,QMAXTSUDOM}

7.7.4 "Extra" imports:

QTBUYFOR2:= QTBUY–(QTBUYDOM+QTBUYFOR1)

7.7.5 QTBUYFOR:= QTBUYFOR1 + QTBUYFOR2

7.7.6 QIMPORT:= SUM{QTBUYFOR × QPFOR}

7.8 Domestic Result

Domestic price is updated in each market (cf. QPH in 7.10.5). Total domestic sales volume is computed for each market.

7.8.1 $QDPDOM_i := [(PT_i - IMP_i \times QPFOR_i)/(1 - IMP_i) \times QPRELPDOM_i)] \times$
$\times\ [QPRELPDOM_i / QPDOM_i] - 1,$ =1,2,3,4

7.8.2 $QDPDOM_i := \dfrac{PT_i}{QPDOM_i} - 1$ i=5,6,7,8,9,10

7.8.3 $QPDOM := (1 + QDPDOM) \times QPDOM$

7.8.4 QTSUDOM:= QTBUYDOM

7.9 External Sectors

Compute foreign and domestic sales for external sectors. Correction for purchases of input materials gives value added. The net cash-flow, being payed to households as wage and capital income next quarter, is computed by subtracting payments for investments from external sectors (residential construction and "other"; both being exogenously specified).

7.9.1 $QEXPORTIN := SUM[QPFOR(IN) \times XIN \times QQIN]$

7.9.2 $QEXPORT := QEXPORT + SUM\{QEXPORTIN\}$

7.9.3 $QSDOMIN := QTBUYDOM \times QPDOM \times (1 - TXVA2)$

7.9.4 $QIMPURCHIN := QBUY(IN) \times QPDOM \times (1 - TXVA2)$

7.9.5 $QVAIN := QSDOMIN + QEXPORTIN - QIMPURCHIN$

7.9.6 $QINPAY := SUM\{QVAIN\} - \{QINVBLD + QINVIN\}$

7.10 Updating of Households' Data
(HOUSEHOLD UPDATE)

This block adjusts household variables after firm-households interactions, resulting in a set of prices and a final household expenditure pattern. Trial prices (PT) are then made final (QPH).

7.10.1 Nondurables consumption

QC(NDUR):= QSP(NDUR)

7.10.2 Durables consumption and update

$$STODUR := \frac{PT(DUR)}{QPH(DUR)} \times STODUR + QSP(DUR)$$

QC(DUR):= RHODUR × STODUR

STODUR:= (1–RHODUR) × STODUR

7.10.3 Saving
QSP(SAV):= QSAVH:= QDI – SUM{QSP(NDUR,DUR)}
WH:= WH + QSAVH

7.10.4 Addicted levels
(I denotes NDUR and DUR)

$$CVA(I) := SMOOTH(I) \times CVA(I) + [1 - SMOOTH(I)] \times \frac{QC(I)}{PT(I)}$$
$$WHRA := SMOOTH(SAV) \times WHRA + [1 - SMOOTH(SAV)] \times \frac{WH}{QDI}$$

7.10.5 Prices

QPH:= PT
OLDQCPI:= QCPI

$$QCPI:=\frac{SU[QC(I)]}{SU\left\{\frac{QC(I)}{QPH(I)}\right\}}$$ [3]

QDCPI:= (QCPI OLDQCPI)/OLDQCPI

7.11 Indirect Taxes

Value added tax is calculated for purchases from households and government. If TXVA1 > 0, value added tax is charged also for investments. Last, the share of value added tax that is related to imports is computed. This will be needed later for GNP accounting.

7.11.1 $QVATAX:= TXVA2 \times \{QPURCHG + SUM(QSP)\}$

(One component for each explicit and external sector.)

7.11.2 (Only when TXVAI < 0)

$$MORE:= \frac{QPDOM \times (1-TXVA2)}{1-TXVA1} \times QBUY(INV)$$

$QVATAX:= QVATAX + TXVA1 \times MORE$

7.11.3 $QVATAXIMP:= SUM\left\{\frac{QTBUYFOR}{QTBUY} \times QVATAX\right\}$

8 Inventory System
(STOSYSTEM)

8.1 Distributing Change in Inventories over Firms
(FIRMSTO)

Change in inventories industry by industry is distributed over individual firms. Thereafter domestic sales are calculated for each firm.

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[3] See note to 7.4.1.

8.1.1 For each firm, compute the maximum inventory it could end up with – if domestic sales are zero:

LIMSTO:= STO + QQ – QFSUFOR

8.1.2 For each firm, compute upper and lower limits to the result of the distribution process below:

UPPER:= MIN(LIMSTO,MAXSTO)

LOWER:= MIN(LIMSTO,MINSTO)

8.1.3 For each industry, compute total change in inventories to be distributed between firms:

TOTCHSTO:= MIN{[SUM(QQ–QSUFOR)]–QTSUDOM,
SUM(UPPER–STO)}

(The second alternative in the MIN corresponds to waste due to limited inventory capacities.)

8.1.4 TOTCHSTO will be reduced below; record the quarterly change for each industry:

QCHTSTO:= TOTCHSTO

8.1.5 Record the waste for each industry:

QWASTE:= SUM(QQ–QSUFOR)–QTSUDOM–TOTCHSTO

8.1.6 Some firms might end up with inventories outside the prespecified limits. We adjust for that:

```
IF STO > UPPER
   THEN  TOTCHSTO:= TOTCHSTO+STO–MAXSTO
         STO:= UPPER
   ELSE IF STO < LOWER
      THEN TOTCHSTO:=TOTCHSTO+STO–MINSTO
         STO:= LOWER
```

8.1.7 The rest of TOTCHSTO is distributed over the firms.

IF TOTCHSTO > 0

$$\text{THEN STO:=STO} + \frac{\text{UPPER–STO}}{\text{SUM(UPPER–STO)}} \times \text{TOTCHSTO}$$

$$\text{ELSE STO:=STO} + \frac{\text{LOWER–STO}}{\text{SUM(LOWER–STO)}} \times \text{TOTCHSTO}$$

8.1.8 Domestic sales are calculated in volume terms:

QSUDOM:= QQ–QSUFOR–QCHSTO

(where QCHSTO for each firm is the sum of the changes in inventories made in 8.1.6 and 8.1.7).

8.1.9 And domestic sales in money terms, where account is taken for industry subsidies and value added tax:

QSDOM:= QSUDOM × (1+RSUBS) × QPDOM × (1–TXVA2)

8.1.10 Industry subsidies are computed as a fraction of domestic sales. (Note that subsidies were also payed relating to foreign sales; see block 6: Export Markets.)

QSUBSDOM:= SUM{QSUDOM×RSUBS×QPDOM×(1–TXVA2)}

8.2 Reference Inventory Levels

Minimum, maximum and optimum levels are computed for finished-goods and input-goods inventories. The levels are a fraction of "current" sales in volume terms:

8.2.0 Estimate "current" sales and price, compatible with longer-term trends.

$$\text{CURS:=}4 \times \frac{S\times(1+\text{EXPIDS}/4)^{J+1.5} + \text{CUMS} \times (1+\text{HISTDS}/4)^{(J-1)/2}}{4 + J}$$

$$\text{CURP:=} \frac{4\times P\times(1+\text{EXPIDP}/4)^{J+1.5} + J\times\text{CUMP}\times(1+\text{HISTDP}/4)^{(J-1)/2}}{4 + J}$$

(J is the number of quarters that are recorded in the CUM variables).

8.2.1 $MINSTO := SMALL \times \frac{CURS}{CURP}$

8.2.2 $MAXSTO := BIG \times \frac{CURS}{CURP}$

8.2.3 $OPTSTO := MINSTO + BETA \times (MAXSTO - MINSTO)$

8.2.4 $MINIMSTO := IPSMALL \times IO \times SHARE \times \frac{CURS}{CURP}$

8.2.5 $MAXIMSTO := IMBIG \times IO \times SHARE \times \frac{CURS}{CURP}$

8.2.6 $OPTIMSTO := MINIMSTO + IMBETA \times (MAXIMSTO - MINIMSTO)$

9.1 <u>Calculating Final Prices, Sales and Profits</u>
(FINALQPQSQM)

We have the values of prices and sales in foreign and domestic markets, and calculate total sales, average prices, value added, and net sales. This enables us to determine this quarter's profits.

9.1.1 $QSU := QSUFOR + QSUDOM$

9.1.2 $QDS := \frac{QSFOR + QSDOM}{QS} - 1$

9.1.3 $QS := QSFOR + QSDOM$

9.1.4 $QDP := \frac{QS / QSU}{QP} - 1$

9.1.5 $QP := QS/QSU$

9.1.6 $QDVA := \frac{QQ \times \{QP - SHAREX[SUM(IO \times (QPDOM \times (1 - TXVA2)))]\}}{QVA}$

9.1.7 $QVA := QVA \times (1 + QDVA)$

9.1.8 $QSNET := QS - SUM[QIMO \times QPDOM \times (1 - TXVA2)]$

9.1.9 $QM := 1 - \frac{L \times (QW/4)}{QSNET}$

9.2 <u>Quarterly Cumulation</u>
(QUARTERLY CUM)

Investments, production, value added, sales, wage sum, and labour force are cumulated. Up-till-now margin, price, and wage level are computed. (J is the number of the quarter within the year).

9.2.1 $CUMINV := CUMINV + QINVLAG$

9.2.2 $CUMQ := CUMQ + QQ$

9.2.3 $CUMVA := CUMVA + QVA$

9.2.4 $CUMS := CUMS + QS$

9.2.5 $CUMSU := CUMSU + QSU$

9.2.6 $CUMSNET := CUMSNET + QSNET$

9.2.7 $CUMWS := CUMWS + L \times \frac{QW}{4}$

9.2.8 $CUML := \frac{(J-1) \times CUML + L}{J}$

9.2.9 $CUMM := 1 - \frac{CUMWS}{CUMSNET}$

9.2.10 $CUMP := \frac{CUMS}{CUMSU}$

9.2.11 $CUMW := \frac{4 \times CUMWS}{J \times CUML}$

10 Investment Financing
(INVFIN)

Compute gross cash inflow; sales minus wages and purchases of input materials, plus and minus interests. Update value of production equipment – two depreciations schemes are followed by the firm, one for its own, internal considerations and one for taxation purposes. Update inventory components of balance sheet. Compute corporate taxes, and postulate for dividends that they relate in a certain way to taxes. Now, net cash inflow can be computed, including those subsidies which are considered by firms to be temporary.

Current rate of return gives desired new borrowing; the latter being adjusted for the degree of capacity utilization in the firm. Desired change in the holdings K2 of liquid assets is computed, based on sales level.

Next quarter's installment of production equipment is computed, and the corresponding "investment efficiency" (capital-output ratio) is derived.

Last, certain macro-level variables are aggregated for later use.

10.1 $QREV := QM \times QSNET + \frac{K2 \times RIK2}{4} - \frac{BW \times RIF}{4}$

10.2 Short-hand variable for inflation of capital equipment:

$QDPK := UM\{OMEGA \times (QDPDOM + QCHTXVA1 - QCHTXVA2)\}$

10.3 $K1 := QINV + K1 \times (1+QDPK)$
$QDEPR := RHO \times K1$
$K1 := K1 - QDEPR$

10.4 $K1BOOK := QINV + K1BOOK$
$QDEPRBOOK := MAX\{0, MIN(QREV, RHOBOOK \times K1BOOK)\}$
$K1BOOK := K1BOOK - QDEPRBOOK$

10.5 K3IMED:= SUM{IMSTO × QPDOM × (1–TXVA2)}
K3FINISH:= STO × QP
K3:= K3IMED + K3FINISH

10.6 QTAX:= TXC × MAX{0,QREV–QDEPRBOOK}

10.7 QDIV:= RTD × QTAX

10.8 QCASH:= QREV – (QTAX+QDIV) + QS × RSUBSCASH

10.9 $QRR := 4 \times \frac{QREV-QDEPR}{K1+K2+K3}$

10.10 $QDESCHBW := BW \times \{ALFABW+BETABW \times (\frac{QRR}{4} + QDPK - \frac{RIF}{4})$

IF QDESCHBW > REDCHBW × BW, THEN

10.10.1 QDESCHBW:= REDCHBW × BW
A:= K1 + (K2+QDESCHK2) + K3
$QDESCHBW := QDESCHBW \times MAX\left\{0,1 - ELINV \times \left[UTREF - \frac{QQ}{QTOP \times (1-RES)}\right]\right\}$
QDESBW:= Q

10.11 QDESCHK2:= (RW × CURS) – K2
(CURS as in 8.2.0)

10.11.1 $QDESCHBW := BW \Delta CHECK \left\{\frac{A - (BW+QDESCHBW)}{A}\right\}$

10.12 QINV:= DELAY(QINVLAG,TMINV)

(A third-order exponential delay function, with average delay time equal to TMINV).

10.13 $INVEFF := \frac{QTOP \times QP}{K1}$

(Now follow macro-level monetary aggregates.)

10.14 QCTAX:= SUM(QTAX)

10.15 QINTF:= SUM(BW × RIF/4)

10.16 QTDIV:= SUM(QDIV)

10.17 QINTK2:= SUM(K2 × RIK2/4)

10.18 QSUBSCASH:= SUM{QS × RSUBSCASH}

11 Government Accounting

Incomes are taxes on wages, income, value added, and corporate profits. Expenditures are for wages, investments, purchases, transfers and business subsidies. This is corrected for interest payments, and quarterly government surplus (or deficit) is computed. The surplus/deficit is accommodated via a combination of domestic and foreign borrowing, and via changes in the stock of money. – After that, all variables are cumulated over the year.

11.1 QTTAX:= QWTAX + QITAX + QVATAX + QCTAX

11.2 QWSG:= LG × QWG/4

11.3 QSUBS:= QSUBSFOR + QSUBSDOM + QSUBSCASH

11.4 QSPG:= QWSG + QSUBS + QTRANS + SUM(QPURCHG)

11.5 QINTG:= (DEPG × RIDEPG/4) – (BWG × RIBWG/4)

11.6 QINTGFOR:=(DEPGFOR × RIDEPGFOR/4) –
– (BWGFOR×RIBWGFOR/4)

11.7 QSURPLUSG:= QTTAX+QINTG+QINTGFOR–QSPG–QINVG

11.8 QMPRINT:= (POLICY OPTION)

11.9 QCHPOSGFOR:= (POLICY OPTION)
POSGFOR:= POSGFOR + QCHPOSGFOR
DEPGFOR:= MAX(0,POSG)
BWGFOR:= MAX(0,–POSGFOR)

11.10 QCHPOSG:= QSURPLUSG + QMPRINT – QCHPOSGFOR
POSG:= POSG + QCHPOSG
DEPG:= MAX(0,POSG)
BWG:= MAX(0,–POSG)

(Now follow cumulations.)

11.11 CUMWTAX:= CUMWTAX + QWTAX

11.12 CUMITAX:= CUMITAX + QITAX

11.13 CUMVATAX:= CUMVATAX + QVATAX

11.14 CUMCTAX:= CUMCTAX + QCTAX

11.15 CUMWSG:= CUMWSG + QWSG

11.16 $$\text{CUMLG} := \frac{\text{LG} + \text{CUMLG} \times (\text{J}-1)}{\text{J}}$$

(J is the number of the quarter within the year.)

11.17 CUMSUBS:= CUMSUBS + QSUBS

11.18 CUMTRANS:= CUMTRANS + QTRANS

11.19 CUMPURCHG:= CUMPURCHG + QPURCHG

11.20 CUMINVG:= CUMINVG + QINVG

11.21 CUMINTG:= CUMINTG + QINTG + INTGFOR

11.22 CUMMPRINT:= CUMMPRINT + QMPRINT

(Exit here if not the last quarter within the year.)

11.23 WTAX:= CUMWTAX

11.24 ITAX:= CUMITAX

11.25 VATAX:= CUMVATAX

11.26 CTAX:= CUMCTAX

11.27 $DWSG := \frac{CUMWSG}{WSG} - 1$

$WSG := WSG \times (1+DWSG)$

11.28 $DWG := \frac{CUMWSG}{CUMLG \times WSG} - 1$

$WG := WG \times (1+DWG)$

11.29 SUBS:= CUMSUBS

11.30 TRANS:= CUMTRANS

11.31 PURCHG:= CUMPURCHG

11.32 SPG:= WSG + SUBS + TRANS + SUM(PURCHG)

11.33 INVG:= CUMINVG

11.34 INTG:= CUMINTG

11.35 SURPLUSG:= WTAX + ITAX + VATAX + CTAX +
+ INTG – SPG – INVG

11.36 MPRINT:= CUMMPRINT

12 Monetary Sector

12.1 Bank Transactions

This block performs monetary accounting to make possible the determination of money supply in block 12.2: The stock of claims on foreign importers is added to via exports, and is depreciated from at a certain rate. A corresponding scheme holds for the stock of debts to foreign exporters, which is updated via imports and maturation. (Note that individual items entering either of these stocks are pooled and lose their identity.) The bank's holding of foreign liquidity can now be updated, and its holdings of domestic liquidity is updated to a temporary status – this will later on be recomputed (block 12.4) when firms' new deposits and borrowings are known.

12.1.1 Monetary time reaction parameters are affected by the foreign/domestic rate-of-interest differential:

$$RFPAY := \frac{LAMDA2 \times (RI - RIBWFOR)}{MAXRIDIFF}$$

(But enforced within interval ± LAMDA2)

12.1.2 $$QFASSPAY := \frac{FASS + QEXPORT}{1 + 4 \times TMFASS \times (1 - RFPAY)}$$

12.1.3 QCHFASS:= QEXPORT – QFASSPAY

12.1.4 FASS:= FASS + QCHFASS

12.1.5 $$QFDPAY := \frac{FD + QIMPORT}{1 + 4 \times TMFD \times (1 + RFPAY)}$$

12.1.6 QCHFD:= QIMPORT – QFDPAY

12.1.7 FD:= FD + QCHFD

12.1.8 QCHLIQBFOR:= QFASSPAY+QINTGFOR–QFDPAY–
–QCHPOSGFOR

12.1.9 LIQBFOR:= LIQBFOR + QCHLIQBFOR

12.1.10 QCHLIQB:= QINTF+QSAVH+QCHPOSG+QIMPORT+
+QCHPOSGFOR–QINTK2–QINTH–QINTG–
–QINTGFOR–QEXPORT

12.2 Credit Market

Demand for and supply of funds is computed. In case of excess demand, households are forced to an extra net savings component (up to a ceiling). After that, firms have to reduce their claims on new borrowing, to a certain extent. The other major borrower, the Government, never has to reduce its desired new borrowing. Instead, the bank is left with unsatisfied monetary restrictions. – Last, the effect on the rate of interest is computed.

12.2.1 QDEMFUND:= MAX(0,–QCHPOSG) +
+ SUM{MAX(0,QDESCHBW)}

12.2.2 After this quarter's credit market operations, the bank's liquidity must not fall below a certain fraction of total borrowing. This gives one limit to the availability of new loans:

QSUPFUND1:=

$$\frac{LIQB+QCHLIQB+SUM(QDESCHK2)-RFUND1\times\{SUM(BW)+BWG\}}{1+RFUND1}$$

12.2.3 Another limit to the availability of loans comes from the stipulation that, after the quarter, the bank's liquidity must not be below a certain fraction of total deposits:

QSUPFUND2:= LIQB + QCHLIQB + SUM(QDESCHK2) –
– FUND2 × {SUM(K2+QDESCHK2) + DEPG + SUM(WH)}

12.2.4 QSUPFUND:= MAX{0,MIN(QSUPFUND1,QSUPFUND2)}

(It is also possible to specify that supply always equals demand.)

12.2.5 QSAVHREQ:= MIN{KAPPA1×MAX[0,SUM(QDI)],
MAX(0,QDEMFUND–QSUPFUND)}

12.2.6 QREDTBW:= MIN{KAPPA2×SUM[MAX(0,QDESCHBW)],
MAX(0,QDEMFUND–QSUPFUND–QSAVHREQ)}

12.2.7 QCHBW:= QDESCHBW–QREDTBW ×

$$\times \frac{MAX(0,QDESCHBW)}{SUM\{MAX(0,QDESCHBW)\}}$$

(This last equation holds for each firm, not for the aggregate. It distributes the forced reductions in firms' borrowing in a simple, proportional fashion.)

12.2.8 $$QCHRI := LAMDA1 \times \frac{QDEMFUND - QSUPFUND}{QSUPFUND}$$

(But enforced within interval ± MAXQCHRI)

12.2.9 RI:= RI + QCHRI

(But enforced within interval MINRI – MAXRI)

12.2.10 Domestic rates of interest move in parallel with the "nominal" rate RI, with a certain difference between borrowing and lending rates:

RIBWG:= RI
RIDEPG:= RI – MB
RIF:= RI
RIH:= RI – MB
RIK2:= RI – MB

12.2.11 Foreign rates of interest are exogenous:

RIBWGFOR:= RIBWFOR
RIDEPGFOR:= RIDEPFOR

12.3 Investment Financing Adjustments
(INVFIN ADJUSTMENTS)

This block completes the account of financial flows within each firm: New borrowing was determined in 12.2.7, and via the desired change in the holdings K2 of liquid assets, investments are computed as a cash-flow residual. The firm's net worth is then computed. – Last, some macro entities are aggregated.

12.3.1 OLDINV:= SUM(QINVLAG)

12.3.2 BW:= BW + QCHBW

12.3.3 QINVLAG:= MAX(0, QCHCASH + QCHBW – QDESCHK2)

(Negative investments are not possible; in that case K2 will act as the residual so that desired and actual K2 differ.)

12.3.4 QCHK2:= QCHCASH + QCHBW – QINVLAG

12.3.5 K2:= K2 + QCHK2

12.3.6 NW:= K1 + K2 + K3 – BW

12.3.7 If NW < 0, then BAD:= BAD + 1 (BAD = 0 initially)

12.3.8 If BAD = 6, then nullify

(Now follow macro–level monetary aggregates.)

12.3.9 QTCHBW:= SUM(QCHBW)

12.3.10 QTCHINV:= {SUM(QINVLAG)} – OLDINV

12.3.11 QTCHK2:= SUM(QCHK2)

12.4 Bank Update

Now that credit market operations are cleared, the bank's balance sheet can be completed, and the stock of money computed:

12.4.1 QCHLIQB:= QCHLIQB + QTCHK2 – QTCHBW

12.4.2 LIQB:= LIQB + QCHLIQB

12.4.3 NWB:= (Assets) – (Debts) =
= {SUM(BW)+BWG+FASS+LIQBFOR+LIQB}–
– {SUM(K2)+DEPG+SUM(WH)+FD}

12.4.4 MONEY:= SUM(K2) + DEPG + SUM(WH)

13 National Accounting

Gross National Product is computed from supply and demand sides, and at current and fixed prices. – Last, quarterly data is cumulated over the year.

13.1 Current prices; components 13.1.1 – 13.1.5 give GNP from the supply side and 13.1.5 – 13.1.14 give it from the demand side. (The two sides are always equal in the model.)

13.1.0 Help entities to accomodate changes in inventories:

QCHTSTOCURF:= SUM(K3FINISH) – TSTOCURF
TSTOCURF:= TSTOCURF + QCHTSTOCURF
QCHTSTOCURM:= SUM(QPDOM×STO) – TSTOCURM
TSTOCURM:= TSTOCURM + QCHTSTO

13.1.1 Production in explicit model sectors:

SUM(QSNET) + QCHTSTOCURF

13.1.2 Production in external sectors: QVAIN

13.1.3 Indirect Taxes:
SUM(QVATAX) + SUM(QCHTSTOCURM) –
SUM(QCHTSTOCURF) – QVATAXIMP

13.1.4 Subsidies:= (QSUBS–QSUBSCASH)

13.1.5 Government wages (entering on both sides of the GNP accounting): QWSG

13.1.6 Government purchases: SUM(QPURCHG)

13.1.7 Private consumption: SUM(QSP) – QSAVH

13.1.8 Investments made by explicit model sectors:
SUM(QINVLAG) – QTCHINV

13.1.9 Investments made by external sectors, exclusive of housing: QINVIN

13.1.10 Investments for residential construction: QINVBLD

13.1.11 Government investments: QINVG

13.1.12 Inventory changes: SUM(QCHTSTOCURM)

13.1.13 Exports: QEXPORT

13.1.14 Imports: – (QIMPORT–QVATAXIMP)

13.2 Fixed prices, deflated to a reference year; components 13.2.1 – 13.2.5 give GNP from the supply side and 13.2.5 – 13.2.14 it from the demand side. (The two sides are always equal in the model).

13.2.1 Production in explicit model sectors:
P(REF) × {SUM(QQ) – QWASTE}

13.2.2 Production in external sectors: PREF × QQIN

(13.2.3–4 Not relevant when measuring in fixed prices).

13.2.5 Government wages, deflated to the government wage level of the reference year (and thus assuming no increase of productivity in the Government sector); entering on both sides of the GNP accounting:

LG × WGREF/4

13.2.6 Governments purchases: $SUM\left\{\frac{PREF \times QPURCHG}{QPDOM}\right\}$

13.2.7 Private consumption; sum over non-saving categories:

$$SUM\left\{\frac{PREF \times QSP}{QPDOM}\right\}$$

13.2.8 Investments made by explicit model sectors:

$$SUM\left\{\frac{PREF \times OMEGA \times [SUM(QINLAG) - QTCHINV)}{QPDOM \times (1-TXVA2)/(1-TXVA1)}\right\}$$

13.2.9 Investments made by external sectors, exclusive of housing:

$$SUM\left\{\frac{PREF \times OMEGAIN \times QINVIN}{QPDOM \times (1-TXVA2)/(1-TXVA1)}\right\}$$

13.2.10 Investments for residential construction:

$$SUM\left\{\frac{PREF \times OMEGABLD \times QINVBLD}{QPDOM \times (1-TXVA2)/(1-TXVA1)}\right\}$$

13.2.11 Government investments:

$$SUM\left\{\frac{PREF \times OMEGAG \times QINVG}{QPDOM \times (1-TXVA2)/(1-TXVA1)}\right\}$$

13.2.12 Inventory changes: SUM(PREF × QCHTSTO)

13.2.13 Exports: SUM(PREF×QSUFOR) + SUM(PREF×XIN×QQIN)

13.2.14 Imports: –SUM(PREF×QTBUYFOR)

13.3 Cumulations

13.3.1 CUMGNPCUR:= CUMGNPCUR + QGNPCUR

13.3.2 CUMGNPFIX:= CUMGNPFIX + QGNPFIX

13.3.3 CUMEXPORT:= CUMEXPORT + QEXPORT

13.3.4 CUMIMPORT:= CUMIMPORT + QIMPORT

(Exit here if not last quarter in the year.)

13.4.1 GNPFIX:= CUMGNPFIX

13.4.2 GNPCUR:= CUMGNPCUR

13.4.3 EXPORT:= CUMEXPORT

13.4.4 IMPORT:= CUMIMPORT

14 Yearly Update

Yearly production, price, wage, sales, margin, value added, and net sales are computed, based on cumulation in block "Quarterly Cum".

14.1 $DQ := \frac{CUMQ}{Q} - 1$

$Q := Q \times (1 + DQ)$

14.2 $DP := \frac{CUMS/CUMSU}{P} - 1$

$P := P \times (1+DP)$

14.3 $DW := \frac{CUMWS\ /\ CUML}{W} - 1$

$W := W \times (1+DW)$

14.4 $DS := \frac{CUMS}{S} - 1$

$S := S \times (1+DS)$

$DL := \frac{CUML}{L} - 1$

14.5 $CMH := CUMM - M$

$M := M + CHM$

14.6 $DVA := \frac{CUMVA}{VA} - 1$

$VA := VA \times (1+DVA)$

14.7 $SNET := CUMSNET$

Exogenous Variables

The following variables are entered on a year-to-year basis:

Tax parameters: TXC, TXW, TXWG, TXI2, TXI3
Industry subsidies: RSUBS

The following variables are entered quarterly:

Tax parameters: QCHTXVA1, QCHTXVA2
(updating TXVA1, TXVA2)
Prices: QDPFOR, QDPIN
Public sector: QREALCHLG, QINVG
Interest rates abroad: RIBWFOR, RIDEPFOR
External sectors investments: QINVIN, QINVBLD

The following variables are kept constant:

Technological progress: QDMTEC
Expectations: EXPXDP, EXPXDS, EXPXDW
Labour force: ENTRY, RET
Transfer Payments: RTRANS

The following variables are Government "Policy Options":

Changes in the monetary base: QMPRINT
Government borrowing abroad: QCHPOSGFOR

ALFABW – Constant used in INVFIN to determine firms' desired change in borrowing.

ALFA3 – Constant used in COMPUTE EXPENDITURES to determine the short-term swap between savings and expenditures on durables.

ALFA4 – Constant used in COMPUTE EXPENDITURES to determine the short-term swap between savings and expenditures on durables.

AMAN – For each firm, a three-component vector accomodating the two-quarter lag of layoffs. The first component holds the number of people that can be fired <u>this</u> quarter, etc.

BAD – Counts number of quarters during which NW<0.

BETA – Constants used to compute optimum finished-goods inventory levels in relation to MINSTO and MAXSTO. Same for all firms within a market.

BETABW – Constant used in INVFIN to determine firms' desired change in borrowing.

BETA1 – Constants used in COMPUTE EXPENDITURES to adjust household expenditures in different categories to the income constraint. All BETA1≥0.

BETA2 – Constants used in COMPUTE EXPENDITURES to adjust household expenditures in different categories to the income constraint. SUM (BETA2)=1.

BETA3 – Constants used in COMPUTE EXPENDITURES to adjust household expenditures in different categories to the income constraint. SUM(BETA3)=0.

BIG – For each firm, the fraction of current yearly sales that firms consider as maximum for their finished-goods inventories.

BWAΔHECK – Subroutine checking each firm's (net worth)/total assets.

BW – A firm's total borrowing. Updated in INVFIN ADJUSTMENTS.

BWG – Current level of the Government's domestic borrowing. Updated in GOVERNMENT ACCOUNTING

BWGFOR – Current level of the Government's borrowing abroad. Updated in GOVERNMENT ACCOUNTING.

CHL – Each firm's desired change in labour force. A help variable used within LABOUR SEARCH to accommodate market interactions.

CHM – For each firm, its change in profit margin from one year to another (a difference between fractions). Computed in YEARLY UPDATE.

CTAX – Aggregate corporate taxes during one year. Computed in GOVERNMENT ACCOUNTING.

CUMCTAX – Aggregate corporate taxes, cumulated over the year in GOVERNMENT ACCOUNTING.

CUMEXPORT – Aggregate export value, cumulated over the year in NATIONAL ACCOUNTING.

CUMGNPCUR – The components of the gross national product in current prices, cumulated over the year in NATIONAL ACCOUNTING.

CUMGNPFIX – The components of the gross national product in fixed prices, cumulated over the year in NATIONAL ACCOUNTING.

CUMIMPORT – Aggregate import value, cumulated over the year in NATIONAL ACCOUNTING.

CUMINTG – Government net receipts of interest, cumulated over the year in GOVERNMENT ACCOUNTING.

CUMINV – For each firm, a cumulation over the year of its investments. Updated in QUARTERLY CUM.

CUMINVG – Government investments, cumulated over the year in GOVERNMENT ACCOUNTING.

CUMITAX – Aggregate income taxes, cumulated over the year in GOVERNMENT ACCOUNTING.

CUML – For each firm, a cumulation over the year of the number of employed. Updated in QUARTERLY CUM.

CUMLG – For the government, a cumulation over the year of the number of employed. Updated in GOVERNMENT ACCOUNTING.

CUMM – For each firm, a cumulation over the year of its profit margin. Updated in QUARTERLY CUM.

CUMMPRINT – Changes in the monetary base, cumulated over the year in GOVERNMENT ACCOUNTING.

CUMP – For each firm, its cumulated sales price within a year. Computed in QUARTERLY CUM.

CUMPURCHG – The government's purchases of goods and services (less investments), cumulated over the year in GOVERNMENT ACCOUNTING.

CUMQ – For each firm, a cumulation over the year of its production volume. Updated in QUARTERLY CUM.

CUMS – For each firm, a cumulation over the year of its sales value. Updated in QUARTERLY CUM.

CUMSNET – For each firm, a cumulation over the year of its net sales, less purchases of input materials. Updated in QUARTERLY CUM.

CUMSU – For each firm, a cumulation over the year of its sales volume. Updated in QUARTERLY CUM.

CUMSUBS – The government's subsidies of the industry, cumulated over the year in GOVERNMENT ACCOUNTING.

CUMTRANS – Aggregate government transfer payments to households, cumulated over the year in GOVERNMENT ACCOUNTING.

CUMVA – For each firm, a cumulation over the year of its value added. Updated in QUARTERLY CUM.

CUMVATAX – Aggregate value added tax, cumulated over the year in GOVERNMENT ACCOUNTING.

CUMW – For each firm, its cumulated wage level within a year. Computed in QUARTERLY CUM.

CUMWS – For each firm, a cumulation over the year of its wage sum. Updated in QUARTERLY CUM.

CUMWSG – Government wage sum, cumulated over the year in GOVERNMENT ACCOUNTING.

CUMWTAX – Aggregate payroll taxes, cumulated over the year in GOVERNMENT ACCOUNTING.

CURS – Each firm's estimate of its current sales per year, compatible with longer-term trends. Computation is described in STOSYSTEM.

CURP – Each firm's estimate of its current sales price, compatible with longer-term trends. Computation is described in STOSYSTEM.

CVA – A household's "addicted" consumption volume in each expenditure category (units per quarter). Updated in HOUSEHOLD UPDATE.

DEPG – Current level of the Government's domestic bank deposits. Updated in GOVERNMENT ACCOUNTING.

DEPGFOR – Current level of the Government's foreign bank deposits. Updated in GOVERNMENT ACCOUNTING.

DISTR	–	A help variable used in FIRMSTO to distribute inventory adjustments among firms.
DP	–	For each firm, its yearly change in sales price (a fraction). Computed in YEARLY UPDATE.
DQ	–	For each firm, its yearly change in production volume (a fraction). Computed in YEARLY UPDATE.
DS	–	For each firm, its yearly change in sales value (a fraction). Computed in YEARLY UPDATE.
DUR	–	A vector index, giving "Consumer durables"/"Industrial investment goods" data from a vector or a matrix.
DVA	–	For each firm, its yearly change in value added (a fraction). Computed in YEARLY UPDATE.
DW	–	For each firm, its yearly wage change (a fraction). Computed in YEARLY UPDATE.
DWG	–	Yearly rate of change in the government wage level. Computed in GOVERNMENT ACCOUNTING.
DWSG	–	Yearly rate of change in the Government wage sum. Computed in GOVERNMENT ACCOUNTING.
ELINV	–	An elasticity, reducing firms' desired new borrowing (and hence investments) whenever capacity utilization is low. Used in INVFIN.
ENTRY	–	A parameter regulating the inflow of new persons to the labour market (quarterly fraction of the total labour force). Exogenous and constant.
EPS	–	A constant forcing firms to sharpen their profit-margin targets as compared with historical data.
EXIT	–	For each firm, discrepancy between actual and planned labour force (after market interactions). Help variable used in LABOUR SEARCH to accomodate AMAN layoff lag.
EXPDP	–	Each firm's expected change in sales price for a year (a fraction). Computed in YEARLY EXP.
EXPDS	–	Each firm's expected change in sales for a year (a fraction).Computed in YEARLY EXP.
EXPDW	–	Each firm's expected wage change for a year (a fraction). Computed in YEARLY EXP.
EXIDP	–	Each firm's "internally" expected change in sales price for a year (a fraction). Updated in YEARLY EXP.

EXPIDS	–	Each firm's "internally" expected change in sales for a year (a fraction). Updated in YEARLY EXP.
EXPIDW	–	Each firm's "internally" expected change in wage for a year (a fraction). Updated in YEARLY EXP.
EXPORT	–	Aggregate export value during one year. Computed in NATIONAL ACCOUNTING.
EXPXDP	–	In each market, the "externally" expected change in sales price for a year (a fraction). Entered exogenously.
EXPXDS	–	In each market, the "externally" expected change in sales for a year (a fraction). Entered exogenously.
EXPXDW	–	In each market, the "externally" expected change in wage for a year (a fraction). Entered exogenously.
E1	–	A constant used in YEARLY EXP to form "internal" expectations on prices, sales, and wages.
E2	–	A constant used in YEARLY EXP to form "internal" expectations on prices, sales, and wages.
FASS	–	The Bank's holding of foreign trade credits (claims on foreign importers). Updated in BANK TRANSACTIONS.
FD	–	The sum of the Bank's debts to foreign suppliers of Swedish imports. Updated in BANK TRANSACTIONS.
FIP	–	A constant describing how firms trade off only just experienced price change against longer-term expectations. Used in QUARTERLY EXP.
FIS	–	A constant describing how firms trade off only just experienced sales value change against longer-term expectations. Used in QUARTERLY EXP.
FIW	–	A constant describing how firms trade off only just experienced wage change against longer-term expectations. Used in QUARTERLY EXP.
G	–	Indexing variable, extracting data that relate to Government.
GAMMA	–	A constant telling how big wage increase is needed for a person that he should leave this job for a new one. Used in LABOUR SEARCH.
GKOFF	–	Government purchasing (less investments) in each sector, as a fraction of Government wage sum.
GNPCUR	–	Gross national product during one year (current prices), with components as indicated in NATIONAL ACCOUNTING.

GNPFIX – Gross national product during one year (fixed prices), with components as indicated in NATIONAL ACCOUNTING.

HH – Indexing variable, extracting from vectors and matrices data that relate to households.

HISTDP – For each firm, a time-smoothed average of its experienced yearly price increase. Updated in YEARLY EXP.

HISTDPDEV – For each firm, a time-smoothed average of the difference between actual and expected yearly price increase. Updated in YEARLY EXP.

HISTDPDEV2 – For each firm, a time-smoothed average of the square of the difference between actual and expected yearly price increase. Updated in YEARLY EXP.

HISTDS – For each firm, a time-smoothed average of its experienced yearly sales increase. Updated in YEARLY EXP.

HISTDSDEV – For each firm, a time-smoothed average of the difference between actual and expected yearly sales increase. Updated in YEARLY EXP.

HISTDSDEV2 – For each firm, a time-smoothed average of the square of the difference between actual and expected yearly sales increase. Updated in YEARLY EXP.

HISTDW – For each firm, a time-smoothed average of its experienced yearly increase in wage level. Updated in YEARLY EXP.

HISTDWDEV – For each firm, a time-smoothed average of the difference between actual and expected increase in wage level. Updated in YEARLY EXP.

HISTDWDEV2 – For each firm, a time-smoothed average of the square of the difference between actual and expected increase in wage level. Updated in YEARLY EXP.

IMBETA – Constant used to compute optimum input-goods inventory level in relation to MINIMSTO and MAXIMSTO. Same for all firms.

IMBIG – That fraction of one year's use of a certain input good, which a firm considers as the maximum inventory level for that good. Individual for each firm.

IMP – Import share for each explicit and external sector. Updated in MARKET CONFRONT (explicit sectors only).

IMPORT – Aggregate import value during one year. Computed in NATIONAL ACCOUNTING.

IMSMALL – That fraction of one year's use of a certain input good, which a firm considers as the minimum inventory level for that good. Individual for all firms.

IMSTO – For each firm, the inventory level for each kind of input good. Updated in PLANQREVISE.

IN – Indexing variable, extracting external-sectors data from any vector or matrix.

INTG – Net interest receipts by the Government during one year. Updated in GOVERNMENT ACCOUNTING.

INV – Indexing variable, extracting from vectors and matrices data that relate to investments.

INVEFF – For each firm, its investment effeciency (increase in quarterly production value, divided by investment). Computed in INVFIN.

INVG – Government investments during one year, updated in GOVERNMENT ACCOUNTING.

IO – $\sum_{I=1}^{11} IO_{IJ} = \sum_{I=1}^{10} IO_{IJ} + \text{VALUE ADDED} = 1$

Market-input-output-coefficients. The amount of each kind of input material that a firm needs for its production. Same for all firms in a market; expressed as volume fractions of production. Assumed to be constant.

IO2 – The amount of each kind of input material from explicit model sectors that is needed for production in each of the external sectors. Expressed as volume fractions of production, and assumed constant.

IO3 – The amount of each kind of input material from external sectors that is needed for production in each of the external sectors.

IOTA – A constant used by firms to form their initial wage offer in LABOUR SEARCH.

ITAX – Aggregate income taxes during one year, updated in GOVERNMENT ACCOUNTING.

J – Counts the quarters within the year.

KAPPA1 – A constant giving the maximum fraction of household's disposable income that can be stipulated as a reduction in household borrowing (increased net savings) in case of excess demand on the credit market.

KAPPA2 – A constant giving the maximum fractional reduction of firms' desired new borrowing in case of excess demand on the credit market.

KSI – A constant, used in LABOUR SEARCH, which tells by how much a firm raises its own wage level after it has performed an unsuccessful attack.

K1 – For each firm, the replacement value of its production equipment. Updated in INVFIN.

K1BOOK – For each firm, the book value (for taxation purposes) of its production equipment. Updated in INVFIN.

K2 – For each firm, its current assets. Updated in INVFIN ADJUSTMENTS.

K3 – For each firm, the value of its total inventory: The sum of K3IMED och K3FINISH.

K3IMED – For each firm, the value of its input-goods inventory. Computed in INVFIN.

K3FINISH – For each firm, the value of its finished-goods inventory. Computed in INVFIN.

L – For each firm, its labour force. Updated in LUUPDATE (retirements) and in LABOUR UPDATE (other changes).

LAMDA1 – A constant used to compute the change in the rate of interest effected by supply-demand conditions in CREDIT MARKET.

LAMDA2 – A constant that indicates how the foreign/domestic differential in the rate of interest impacts on average payment times for foreign trade credits. Used in BANK TRANSACTIONS.

LAYOFF – For each firm, discrepancy between actual and planned labour force (before market interactions). Help variable used in TARGET SEARCH to accomodate AMAN layoff lag.

LF – Total labour force in the economy. Updated in LUUPDATE.

LG – Government labour force. Updated in GLABOUR.

LIMSTO – For each firm, the inventory level that it would end up with at zero domestic sales. A help variable used within STOSYSTEM.

LIQB – The bank's holdings of "liquidity", of an unspecified nature. Updated in BANK UPDATE.

LIQBFOR – The bank's current holdings of foreign "liquidity", of an unspecified nature. Updated in BANK TRANSACTIONS.

LL – Each firm's labour force. A help variable used within LABOUR SEARCH to accomodate the market interactions.

LOSS – A constant, telling how much of firms' investments that are directed to the structural slack.

LOWER – For each firm, the minimum inventory level it could ever end up with. A help variable used within STOSYSTEM.

LU – Number of people unemployed. Updated in LUUPDATE and at various places within block LABOUR MARKET.

M – For each firm, its yearly profit margin (a fraction). Computed in YEARLY UPDATE.

MARKETITER– Number of iterations on domestic product market. Used in MARKET CONFRONT.

MAXDP – A fraction which determines maximum yearly deviation in domestic prices from what firms expect. Used in ADJUST PRICES to accomodate supply-demand interactions.

MAXIMSTO – For each firm, its "maximum" level for inventories of each kind of input good (volume terms). Computation is described within block STOSYSTEM.

MAXQCHRI – A limit on the rate of change for the rate of interest; used in CREDIT MARKET.

MAXRI – A ceiling on the rate-of-interest movements, used in CREDIT MARKET.

MAXRIDIFF – The maximum difference between foreign and domestic rate of interest, which is allowed to have an impact on the rate of payment of foreign trade credits. Used in BANK TRANSACTIONS.

MAXSTO – For each firm, its "maximum" inventory level (volume terms). Computation is described within block STOSYSTEM.

MB – The prescribed differential between domestic borrowing and lending rates of interest.

MHIST – For each firm, an average of past profit margins (a fraction). Updated in YEARLY TARG.

MINIMSTO – For each firm, its "minimum" level for inventories of each kind of input good (volume terms). Computation is described within block STOSYSTEM

MINRI – A floor for the rate-of-interest movements, used in CREDIT MARKET.

MINSTO – For each firm, its "minimum" inventory level (volume terms). Computation is described within block STOSYSTEM.

MKT – Index variable, extracting data that apply to explicit markets.

MONEY – The stock of money in the economy, defined as total deposits in the bank. Computed in BANK UPDATE.

MPRINT – One year's change in the monetary base (absolute value). Computed in GOVERNMENT ACCOUNTING.

MTEC – On each market, technology factor of modern equipment (potentially produced units per person and quarter). Updated in PROFRODFRONT.

NDUR – Index variable, extracting from household "expenditure category" vectors data that apply to non-durable consumption categories.

NH – number of households – a constant.

NITER – Number of iterations on the labour market each quarter. Used in LABOUR SEARCH.

NOW – Number of people hired in one successful attack on the labour market. A help variable used within CONFRONT.

NTOT – The current number of firms in the simulation.

NW – For each firm, its net value as the residual between total assets and borrowing. Computed in INVFIN ADJUSTMENTS.

NWB – The net value of the bank, as the residual between assets and liabilities. Computed in BANK UPDATE.

OMEGA – A distribution vector indicating how firms' outlays for investments are allocated on purchases from different model sectors. Assumed to be equal for all firms.

OMEGABLD – A distribution vector indicating how investments in residential construction result in purchases from different model sectors.

OMEGAG – A distribution vector indicating how government investments result in purchasing from different model sectors.

OMEGAIN – A distribution vector indicating how investments from external sectors (less residential construction) result in purchases from different model sectors.

OPTIMSTO – For each firm, its optimum inventory level for each kind of input good (volume terms). Computed in STOSYSTEM.

OPTSTO – For each firm, the "optimum" level for its finished-goods inventory (volume terms). Computation is described within block STOSYSTEM.

ORD – Vector, telling in which sequence firms are allowed to make attacks on the labour market (big relative recruitment plan goes first).

P – For each firm, its yearly average sales price. Computed in YEARLY UPDATE. This price includes any sales-based subsidies but not value added tax.

POSG – The government's net position in the bank. Updated in GOVERNMENT ACCOUNTING.

POSGFOR – The government's net foreign deposit/borrowing position. Updated in GOVERNMENT ACCOUNTING.

PREF – Domestic prices for each model sector from a reference year. Used in NATIONAL ACCOUNTING.

PRIMCHSTO – A help variable used in FIRMSTO to distribute inventory adjustments among firms.

PROPCHSTO – A help variable used in FIRMSTO to distribute inventory adjustments among firms.

PT – On each market, the offering price in one iteration. First computed in MARKET CONFRONT; later updated in ADJUST PRICES.

PURCHG – For each model sector, the government's purchases of goods and services (less investments) during one year. Computed in GOVERNMENT ACCOUNTING.

Q – For each firm, its total production for a year (volume). Updated in YEARLY UPDATE.

QBUY – A matrix giving total quarterly purchasing in volume terms by each sector from each sector (both explicit and external sectors). Computed in COMPUTE BUYING for each iteration on the domestic product market.

QC – A household's consumption in each of the non-savings expenditure categories (value per quarter). Computed in HOUSEHOLD UPDATE.

QCASH – For each variable, the net cash inflow during one quarter, before new borrowing and payments of investments. Computed in INVFIN.

QCHBW – For each firm, its quarterly change in borrowing, computed in CREDIT MARKET.

QCHDCPI – Attempted rise in consumer price index between quarters (a fraction). Computed in COMPUTE EXPENDITURES each time households meet an offering price vector PT.

QCHFASS – The quarterly change in the aggregate stock of trade credits to foreigners. Computed in BANK TRANSACTIONS.

QCHFD – The quarterly change in the aggregate stock of trade debts to foreigners. Computed in BANK TRANSACTIONS.

QCHK2 – For each firm, its quarterly change in current assets. Computed in INVFIN ADJUSTMENTS.

QCHL – For each firm, its quarterly labour force change due to labour market interactions (retirements are not included). Computed in LABOUR SEARCH; updated in LABOUR UPDATE if layoffs occur.

QCHLG – Number of new persons in government sector labour force each quarter (including replacements for retirements).

QCHLIQB – The quarterly change in the bank's liquidity. Preliminarily computed in BANK TRANSACTIONS, and finally established in BANK UPDATE.

QCHLIQBFOR – The quarterly change in the bank's foreign liquidity. Computed in BANK TRANSACTIONS.

QCHPOSG – The quarterly change in the government's net position in the bank. Computed in GOVERNMENT ACCOUNTING.

QCHPOSGFOR – The quarterly change in the government's net foreign deposit/borrowing position. Entered in GOVERNMENT ACCOUNTING as a policy option.

QCHQTOP – For each firm, quarterly change in production capacity QTOP due to investments. Computed in PRODFRONT.

QCHQTOP1 – Production capacity increase that can be used regardless of slack considerations. Computed in PRODFRONT.

QCHQTOP2 – That part of a production capacity increase which goes into the firm's slack. Computed in PRODFRONT.

QCHRI – Quarterly change in the base rate of interest. Computed in CREDIT MARKET.

QCHRU – Quarterly change in rate of unemployment (a difference between fractions). Computed in LABOUR UPDATE.

QCHTSTO – On each market, total quarterly change in inventory to be distributed between firms. Computed in FIRMSTO.

QCHTSTOCURF – Quarterly change in aggregate (sector-level) inventories, value at factor prices. Help variable used in NATIONAL ACCOUNTING.

QCHTSTOCURM – Quarterly change in aggregate (sector-level) inventories, valued at factor prices. Help variable used in NATIONAL ACCOUNTING.

QCHTXVA1 – Quarterly change in value-added tax rate for investment goods. Entered exogenously.

QCHTXVA2 – Quarterly change in value-added tax rate for non-investment goods. Entered exogenously.

QCHW – For each firm, its quarterly wage change in absolute terms. Computed in LABOUR SEARCH.

QCPI – Consumer price index, updated in HOUSEHOLD UPDATE.

QCTAX – Aggregate corporate taxes during one quarter. Computed in INVFIN.

QDCPI – Quarterly change in consumer price index (a fraction). Computed in HOUSEHOLD UPDATE.

QDEMFUND – Total demand on funds for new borrowing during one quarter, from firms and the government. Computed in CREDIT MARKET.

QDEPR – For each firm, the quarterly depreciation of its production equipment at replacement value. Help variable in INVFIN.

QDEPRBOOK – For each firm, the quarterly depreciation of its production equipment at book value (for taxation purposes). Help variable in INVFIN.

QDESCHBW – For each firm, its desired new borrowing for one quarter. Computed in INVFIN based on current real rate of return and on the capacity utilization within the firm.

QDESCHK2 – For each firm, its desired change in current assets, to make these a certain proportion of sales. Computed in INVFIN.

QDI – A household's disposable income for one quarter. Computed in HOUSEHOLD INIT.

QDIV – For each firm, its quarterly payments of dividends to the household aggregate. Computed in INVFIN.

QDMTEC – On each market, the rate of technology upgrade for production equipment (a fraction on quarterly basis). Entered exogenously.

QDP – For each firm, its quarterly increase in sales price (a fraction). Computed in FINALQPQSQM.

QDPDOM – On each market, the quarterly increase in domestic price (a fraction). Computed in DOMESTIC RESULT.

QDPFOR – On each market, the quarterly increase in foreign price (a fraction). Exogenously entered in EXPORT MARKETS.

QDPIN – For each external sector, the quarterly increase in domestic price including value added tax (a fraction). Entered exogenously.

QDPK – One quarter's relative price increase for investment goods. A help variable computed in INVFIN, equal for all firms.

QDQ – For each firm, its quarterly increase in production volume (a fraction). Computed in PLANQREVISE.

QDS – For each firm, its quarterly increase in sales value (a fraction). Computed in FINALQPQSQM.

QDVA – For each firm, its quarterly increase in value added in current prices (a fraction). Computed in FINALQPQSQM.

QDW – For each firm, its quarterly wage increase (a fraction). Computed in LABOUR UPDATE.

QDWG – The quarterly increase (a fraction) in government wage level. Computed in GLABOUR.

QDWIND – Average wage increase in the industry during one quarter (a fraction). Computed in LABOUR UPDATE.

QEXPDP – For each firm, its expectation on price increase for the next quarter (a fraction). Help variable used in QUARTERLY EXP.

QEXPDS – For each firm, its expectation on sales value increase for the next quarter (a fraction). Help variable used in QUARTERLY EXP.

QEXPDW – For each firm, its expectation on wage increase for the next quarter (a fraction). Help variable used in QUARTERLY EXP.

QEXPORT – Aggregate export value during one quarter. First computed in EXPORT MARKETS, and then added to in EXTERNAL SECTORS.

QEXPORTIN – For each external sector, the export value during one quarter. Computed in EXTERNAL SECTORS.

QEXPP – For each firm, its expected sales price for the next quarter. Computed in QUARTERLY EXP.

QEXPPIM – For each kind of input good, the expected purchase price for a quarter. Computed in QUARTERLY EXP; assumed to be same for all firms.

QEXPPNET – For each firm, an expected "net" sales price for the next quarter, with reductions for purchases of input goods. Help variable in TARGET SEARCH.

QEXPS – For each firm, its expected sales value for the next quarter. Computed in QUARTERLY EXP.

QEXPSU – For each firm, its expected sales volume for the next quarter. Computed in INITPRODPLAN.

QEXPW – For each firm, its expected wage level for the next quarter (expressed on a yearly basis). Computed in QUARTERLY EXP.

QFASSPAY – One quarter's payment of trade credits, reducing the stock FASS of claims on foreigners. Computed in BANK TRANSACTIONS.

QFDPAY – One quarter's payments of trade debts, reducing the stock FD of debt to foreigners. Computed in BANK TRANSACTIONS.

QFR – For each firm, its production possibility frontier (volume per quarter) as a function of its labour force. Computation is described within block PRODPLAN.

QGNPCUR – Gross national product during one quarter (current prices), with components as indicated in NATIONAL ACCOUNTING.

QGNPFIX – Gross national product during one quarter (fixed prices), with components as indicated in NATIONAL ACCOUNTING.

QIMPORT – Aggregate import value during one quarter. Computed in COMPUTE IMPORTS.

QIMPURCHIN – For each external model sector, the value of input–good purchases by the sector during one quarter. Computed in EXTERNAL SECTORS.

QIMQ – For each firm and each kind of input good, the quantity (volume terms) that the firm buys of that good during one quarter. Computed in INTERMEDIATE PRODUCTS.

QINPAY – Households' aggregate wage and capital income from the external sectors during one quarter. Computed in EXTERNAL SECTORS.

QINTF – Aggregate interest payments from firms to the bank during one quarter. Computed in INVFIN.

QINTG – Net domestic interest receipts by the government during one quarter. Computed in GOVERNMENT ACCOUNTING.

QINTGFOR – Net foreign interest receipts by the government during one quarter. Computed in GOVERNMENT ACCOUNTING.

QINTH – Aggregate interest receipts by households during one quarter. Computed in HOUSEHOLD INIT.

QINTK2 – Aggregate interest receipts by firms during one quarter. Computed in INVFIN.

QINV – For each firm, its quarterly installed investments (value terms). Computed in INVFIN.

QINVBLD – Aggregate investments in residential construction during one quarter. Entered exogenously, and payed for by one external model sector.

QINVG – Government investments during one quarter, exogenously entered.

QINVIN – Aggregate investments by external sectors during one quarter (less residential construction). Entered exogenously.

QINVLAG – For each firm, the money allocated for investments during one quarter, entering as demand on the product market next quarter. Computed in INVFIN ADJUSTMENTS.

QINVTOT – Aggregate investments in the economy (money terms) during one quarter. One component for each sector delivering goods for investments; a help variable used in COMPUTE BUYING.

QITAX – Aggregate income taxes during one quarter. Computed in HOUSEHOLD INIT.

QM – For each firm, its profit margin during a quarter (a fraction). Calculated in FINALQPQSQM.

QMAXTSUDOM – For each explicit market, maximum sales volume for a quarter due to MINSTO considerations. Help variable used within COMPUTE IMPORTS.

QMPRINT – One quarter's change in the monetary base (absolute value). Entered in GOVERNMENT ACCOUNTING as a policy option.

QOPTSU – For each firm, its optimum sold volume during a quarter. Computed in PLANQREVISE.

QOPTSUDOM – Optimum sold volume on the domestic market (units per quarter). Computed for each firm in MARKET ENTRANCE.

QP – For each firm, its sales price during a quarter (an average between foreign and domestic price). Updated in FINALQPQSQM. This price includes any sales-based subsidies, but not value added tax.

QPDOM – On each market, the domestic price during one quarter. Updated in DOMESTIC RESULT. This price includes value added tax.

QPFOR – On each market, the foreign price during one quarter. Updated in EXPORT MARKETS. This price does not include value added tax.

QPFORIN – For each external sector, the foreign price during one quarter, not including value added tax. Updated in EXTERNAL SECTORS.

QPH – Domestic price in each expenditure category as households see them. Updated in HOUSEHOLD UPDATE.

QPLANL – For each firm, its planned labour force for a quarter. Computed in TARGET SEARCH.

QPLANQ – For each firm, its planned production volume during a quarter. Computed in INITPRODPLAN; revised in TARGET SEARCH and in PLANQREVISE.

QPRELCPI – Preliminary consumer price index. Computed in COMPUTE EXPENDITURES each time households meet an offering price vector PT.

QPRELPDOM – On each explicit market, the firms' initial offering price. Computed in MARKET ENTRANCE.

QPURCHG – For each model sector, the government's purchases (money terms) of goods and services (less investments) during one quarter. Computed in MARKET CONFRONT.

QQ – Production for a firm (units per quarter). Computed in PLANQREVISE.

QQIN – For each external sector, its aggregate production volume during one quarter. Updated in EXTERNAL SECTORS.

QREALCHLG – Quarterly net change in government employment (number of persons). Entered exogenously in GLABOUR.

QRED – For each firm, the forced reduction (if any) in one quarter's production volume due to insufficient inventories of input-materials. Help variable in PLANQREVISE.

QREDTBW – The total quarterly amount by which firms have to lower their desired new borrowing, in the case of excess demand for funds. Help varible in CREDIT MARKET.

QREV – For each firm, its quarterly gross revenue: Sales less wages and purchases of input materials, plus and minus interests. Help variable in INVFIN.

QRR – For each firm, its rate of return before taxes (a fraction on a yearly basis). Computed in INVFIN each quarter.

QS – For each firm, its sales value during one quarter. Computed in FINALQPQSQM.

QSAVH – Aggregate household savings (per quarter). Computed in HOUSEHOLD UPDATE.

QSAVHREQ – One quarter's reduction in aggregate household borrowing (forced increase in net savings), in the case of excess demand for funds. Computed in CREDIT MARKET.

QSDOM – For each firm, its domestic sales value during one quarter. Computed in FIRMSTO.

QSDOMIN – For each external sector, its aggregate sales value during one quarter. Computed in EXTERNAL SECTORS.

QSFOR – For each firm, its foreign sales value during one quarter. Computed in EXPORT MARKETS.

QSNET – For each firm, its net sales value (less purchases of input goods) during one quarter. Computed in FINALQPQSQM.

QSP – Household expenditure in each category (value per quarter and household). Computed in COMPUTE EXPENDITURES in each iteration on the domestic market.

QSPE – "Essential" household expenditures in each category (value per quarter and household). Help variable used within COMPUTE EXPENDITURES.

QSPG – Total government expenditures (less investments and interest payments) during one quarter. Updated in GOVERNMENT ACCOUNTING.

QSPSAVREQ – For each household, one quarter's reduction in new borrowing (forced increase in new savings) in the case of excess demand for funds. Computed in HOUSEHOLD INIT.

QSU – For each firm, its sales volume during one quarter. Computed in FINALQPQSQM.

QSUBS – One quarter's total subsidy payments to firms from the government. Computed in GOVERNMENT ACCOUNTING as the sum over three components.

QSUBSDOM – One quarter's subsidy payments, related to domestic sales, to firms from the government. Computed in FIRMSTO.

QSUBSFOR – One quarter's subsidy payments, related to exports, to firms from the government. Computed in EXPORT MARKETS.

QSUBSCASH – One quarter's temporary subsidy payments ("liquidity injections") to firms from the government. Computed in INVFIN.

QSUDOM – For each firm, its domestic sales volume during one quarter. Computed in FIRMSTO.

QSUFOR – For each firm, its foreign sales volume during one quarter. Computed in EXPORT MARKETS.

QSUPFUND – Availability of funds for new borrowing during one quarter, in concordance with prevailing monetary restrictions. Computed in CREDIT MARKET.

QSUPFUND1 – Ceiling on the availability of funds for new borrowing during one quarter, related to the bank's necessity to have a liquidity in proportion to its total lending. Help variable in CREDIT MARKET.

QSUPFUND2 – Ceiling on the availability of funds for new borrowing during one quarter, related to the bank's necessity to have a liquidity in proportion to total deposits in the bank. Help variable in CREDIT MARKET.

QSURPLUSG – The government's surplus during one quarter. Computed in GOVERNMENT ACCOUNTING.

QTARGM – For each firm, its profit-margin target for a quarter (a fraction). Computed in QUARTERLY TARG.

QTAX – For each firm, the corporate tax that it pays during one quarter. Help variable in INVFIN.

QTBUY – Aggregate purchasing (including imports) from each model sector during one quarter. Computed in COMPUTE BUYING (volume terms).

QTBUYDOM – Aggregate purchasing (exclusive of imports) from each model sector during one quarter. Computed in COMPUTE IMPORTS (VOLUME TERMS).

QTBUYFOR1 – One quarter's aggregate "normal" (related to an import fraction) imports within each model sector. Computed in COMPUTE IMPORTS (VOLUME TERMS).

QTBUYFOR2 – One quarter's aggregate "extra" (in cases of large excess demand) imports within each explicit model sector. Computed in COMPUTE IMPORTS (VOLUME TERMS).

QTCHBW – One quarter's total new borrowing for all firms. Computed in INVFIN ADJUSTMENTS.

QTDIV – One quarter's aggregate payments of dividends from firms to households. Updated in INVFIN.

QTI – Total household incomes (before taxes) during one quarter. Computed in HOUSEHOLD INIT.

QTOP – Potential output for a firm (units per quarter) at zero slack and infinite labour force. Updated in PRODFRONT.

QTRANS – One quarter's transfer payments from government to the household aggregate. Computed in HOUSEHOLD INIT.

QTSUDOM – For each explicit model sector, the quarterly sold volume on the domestic product market (exclusive of imports). Computed in DOMESTIC RESULT.

QTTAX – Total tax receipts by the government during one quarter. Updated in GOVERNMENT ACCOUNTING.

QTWS – Total wage sum in the economy (before payroll taxes) during one quarter. Help variable in HOUSEHOLD INIT.

QVA – For each firm, its value added during one quarter. Computed in FINALQPQSQM.

QVAIN – For external sector, its value added during one quarter. Computed in EXTERNAL SECTORS.

QVATAX – For each model sector, the value added tax generated during one quarter. Computed in INDIRECT TAXES.

QVATAXIMP – That part of total value added taxes, generated during one quarter, which is related to imports.

QW – For each firm, its wage level (expressed on a yearly basis) during one quarter. Updated in LABOUR UPDATE. The wage includes any payroll taxes.

QWASTE – For each explicit sector, the waste that occurs (during one quarter) in case of insufficient finished-goods inventory capacities. Computed in FIRMSTO.

QWG – Government wage level (expressed on a yearly basis) during one quarter. Updated in GLABOUR. The wage includes any payroll taxes.

QWSG – The government's wage sum during one quarter, including any payroll taxes. Computed in GOVERNMENT ACCOUNTING.

QWTAX – Aggregate payroll taxes during one year. Updated in GOVERNMENT ACCOUNTING.

Q2 – For each firm, maximum production for a quarter regarding sales plan and inventory maximum. Help variable used within TARGET SEARCH.

Q3 – For each firm, maximum production for a quarter regarding actual labour force and slack limitations. Help variable used in TARGET SEARCH.

Q7 – For each firm, a quarterly production level, below which structural slack is activated. Help variable used within TARGET SEARCH.

R – A constant implying how much firms rely on external information when they form expectations (in YEARLY EXP).

REDCHBW[4] – Maximum allowed change in borrowing (fraction of BW).

RES – Structural slack for a firm (fraction). Updated in PRODFRONT and (under target pressure only) in TARGET SEARCH.

RESDOWN – A constant telling by how much firms can reduce their slack during one quarter.

RESMAX – A constant telling maximum slack any firm can possibly have.

RET – Retirement rate on the labour market (a fraction on quarterly basis).

RFPAY – A variable, accounting for the effect of foreign/domestic rate-of-interest differentials on payment periods for foreign trade credits and debts. Help variable in BANK TRANSACTIONS.

RFQ – For each firm, the minimum labour force needed as a function of desired production (volume per quarter). The computation is described within block PRODPLAN; this is the inverse function to QFR(L).

RFUND1 – A fraction indicating the liquidity restriction on the bank as regards total lending. Used in CREDIT MARKET.

RFUND2 – A fraction indicating the liquidity restriction on the bank as regards total deposits. Used in CREDIT MARKET.

RHO – Physical depreciation rate of production equipment (a fraction on quarterly basis).

RHOBOOK – Maximum allowed depreciation rate of production equipment, for taxation purposes. A fraction on quarterly basis.

RHODUR – Depreciation rate of consumer durable goods (a fraction on quarterly basis).

RI – The base rate of interest, in parallel with which all other domestic rates move. Updated in CREDIT MARKET.

RIBWFOR – The exogenous foreign lending rate of interest.

RIBWG – The rate of interest on the government's domestic borrowing. Updated in CREDIT MARKET.

RIBWGFOR – The rate of interest on the government's foreign borrowing. Updated in CREDIT MARKET.

RIDEPFOR – The exogenous foreign deposit rate of interest.

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[4] REDCHBW = 0.15 for the present.

RIDEPG – The rate of interest on the government's domestic deposits. Updated in CREDIT MARKET.

RIDEPGFOR – The rate of interest on the government's foreign deposits. Updated in CREDIT MARKET.

RIF – The rate of interest on firms' borrowing from the bank. Updated in CREDIT MARKET.

RIH – The rate of interest on household savings. Updated in CREDIT MARKET.

RIK2 – The rate of interest on firms' deposits in the bank. Updated in CREDIT MARKET.

RLU – Fraction used in HOUSEHOLD INIT to compute unemployment compensation in proportion to average wage level in the industry.

RSUBS – Fraction used in EXPORT MARKETS and FIRMSTO to compute government subsidies to firms in relation to their sales value. Same for all firms in a market.

RSUBSCASH – Fraction used in INVFIN to compute temporary government subsidies to firms ("liquidity injections"), in relation to sales value.

RTD – Ratio between firms' dividend payments and corporate taxes; used in INVFIN. Assumed constant, and assumed equal for all firms.

RTRANS – Ratio between total transfer payments to households (less unemployment compensation) and total taxes. Used in HOUSEHOLD INIT; Assumed constant.

RU – Rate of unemployment (a fraction). Computed in LABOUR UPDATE.

RW – A constant giving firms' desired amount of working capital (K2) as a fraction of current yearly sales.

S – For each firm, its sales value during one year. Updated in YEARLY UPDATE.

SACK – For each firm, the number of people fired during a quarter. Help variable within LABOUR UPDATE.

SAV – Indexing variable, giving savings component of household expenditure vectors.

SHARE – $share_i\ IO_{j_m}$ = purchasing share (fraction of prod.) of product j for firm i where firm i belongs to product market.

i = firm-index (1,...10)
j = product-index (1,...10)
m = " " (1,...10)

SHORTAGE – For each firm and each kind of input good, the discrepancy between the quantity of the good, needed to fulfill production plans a certain quarter, and the available quantity (zero if supplies are enough). Help variable in PLANQREVISE.

SKREPA – A constant factor by which the probability for the pool of unemployed to be selected at a labour market attack is upgraded, as compared with the probability for any firm to be selected. Used in CONFRONT.

SMALL – For each firm, the fraction of current yearly sales that firms consider as minimum for their finished-goods inventories.

SMOOTH – Constant used by households to (each quarter) time-smooth their addicted consumption levels and savings ratio.

SMP – Constant used by firms to (each year) time-smooth their price experiences.

SMS – Constant used by firms to (each year) time-smooth their sales experiences.

SMT – Constant used by firms to (each year) time-smooth their profit-margin experiences.

SMW – Constant used by firms to (each year) time-smooth their wage experiences.

SNET – For each firm, its net sales value (less purchases of input goods) during one year. Computed in YEARLY UPDATE.

SPG – Total government expenditures (less investments and interest payments) during one year. Computed in GOVERNMENT ACCOUNTING.

STO – For each firm, its current inventory level (volume terms). Updated in FIRMSTO.

STODUR – Each household's stock of durable goods (value terms). Updated in HOUSEHOLD UPDATE.

SUBS – One year's total subsidy payments to firms from the governmnent. Updated in GOVERNMENT ACCOUNTING.

SURPLUSG – The government's surplus during one year. Computed in GOVERNMENT ACCOUNTING.

SWAP – A factor determining the short-term trade-off between savings and expenditures on consumer durables. Computed in COMPUTE EXPENDITURES.

TARGM – For each firm, its profit-margin target for one year (a fraction). Computed in YEARLY TARG.

TEC – Technology factor for a firm (units per person and quarter). Updated in PRODFRONT.

THETA – Maximum fraction of a firm's labour force that it can lose in one labour market attack. Used in LABOUR SEARCH.

TMFASS – Average payment period for foreign trade credits; used in BANK TRANSACTIONS.

TMFD – Average payment period for foreign trade debts; used in BANK TRANSACTIONS.

TMIMP – For each market, the time constant to adjust import share in MARKET CONFRONT.

TMIMSTO -- Time constant for firms when adjusting finished-goods inventories. Used in INTERMEDIATE PRODUCTS. Assumed to be equal for all firms.

TMINV – Average delay time to install investments in new production equipment. Used in INVFIN; assumed to be equal for all firms in a market.

TMSTO – Time constant for firms when adjusting finished-goods inventory discrepancy (years). Used in INITPRODPLAN and in PLANQREVISE.

TMX – Time constant for firms when they adjust export share in EXPORT MARKETS (years; common to all firms on a market).

TOTCHSTO – For each explicit market, the total change in finished-goods inventories that remains to be distributed between firms. Help variable in FIRMSTO.

TRANS – One year's transfer payments from the government to the household aggregate. Computed in GOVERNMENT ACCOUNTING.

TSTOCURF – For each explicit sector, the aggregate finished-goods inventories at current factor prices. Updated in NATIONAL ACCOUNTING.

TSTOCURM – For each explicit sector, the aggregate finished-goods inventories at current market prices.

TXC – The exogenous corporate-tax rate.

TXI2 – An exogenous income-tax parameter.

TXI3 – An exogenous income-tax parameter.

TXVA1 – The exogenous value-added-tax rate (investment goods only).

TXVA2 – The exogenous value-added-tax rate (non-investment goods).

TXW	–	The exogenous payroll-tax rate for the non-government sectors.
TXWG	–	The exogenous payroll-tax rate for government sectors.
UPPER	–	For each firm, the maximum inventory level it could ever end up with. A help variable in STOSYSTEM.
UTREF	–	A "reference" level of capacity utilization. Used in INVFIN when firms form their desired new borrowing and correct it for their current degree of utilization. Assumed equal for all firms.
VA	–	For each firm, its value added during one year. Computed in YEARLY UPDATE.
VATAX	–	Total value added tax during one year. Computed in GOVERNMENT ACCOUNTING.
W	–	For each firm, its average wage during one year. Computed in YEARLY UPDATE. The wage includes any payroll taxes.
WG	–	Average government wage level during one year, including any payroll taxes. Updated in GOVERNMENT ACCOUNTING.
WGREF	–	Government wage level (WG) for a reference year. Used in NATIONAL ACCOUNTING to deflate the public-services component of GNP.
WH	–	Each household's wealth (current value of its bank deposits). Updated in HOUSEHOLD UPDATE.
WHRA	–	Each household's addicted wealth ratio (quotient between bank deposits and quarterly disposable income). Updated in HOUSEHOLD UPDATE.
WSG	–	Total government wage sum during one year. Updated in GOVERNMENT ACCOUNTING.
WTAX	–	Total payroll taxes during one year. Updated in GOVERNMENT ACCOUNTING.
WTIX	–	Working time index in the explicit sectors; assumed equal for all firms. Enters into each firm's individual production function QFR.
WW	–	Each firm's wage. A help variable used within LABOUR SEARCH to accomodate market interactions.
X	–	For each firm, its export share (fraction of sold volume). Updated in EXPORT MARKETS.
XIN	–	Export fraction for each external model sector. Assumed to be constant over time.

CHAPTER V

Semi–Technical Specification of Pricing in MOSES

by
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Functions are computed in a sequential process. This technical note outlines the ones pertinent to pricing in MOSES.

One final price is determined for each market and quarter in the MOSES model. However, before the final quarterly market price is determined, a number of individual firm ex ante price and quantity adjustments have been made (see Eliasson 1978, p. 78 f. and Eliasson–Heiman–Olavi 1978, pp. 203 ff.).

At the market level prices are computed for the four endogenous (firm specified) sectors. For the other six sectors, prices change exogenously.

Given firm production, exports and imports are computed and the supply available for domestic markets is derived. An initial offer price for each market is specified, from which final demand is derived. Inter industry flows necessary to match final demand are also computed. If domestic demand does not equal supply, the domestic market price is adjusted and final demand recomputed. After a prespecified number of adjustments the outcome is taken as final. Any excess demand is met by extra imports, whereas excess supplies are accumulated as inventories of individual firms, as they find appropriate, given the market price.[1]

I Quarterly Expectations

$$QEXPP = QP \cdot (1 + QEXPDP)$$
$$QEXPW = QW \cdot (1 + QEXPDW)$$
$$QEXPS = QS \cdot (1 + QEXPDS)$$
$$QTARGM = MHIST \cdot (1 + ERS)$$

where

QP, QW, and QS are the previous quarters' average values. Note QP accounts for both foreign and domestic prices.

The quarterly expected change in P, W, and S is a smoothed trend of past changes

$$QEXPDP = QEXPDP + FIPA(QDP - QEXPDP)$$

[1] For explanation of symbols see Chapter IV, pp. 196 ff.

II Prodplan

Given expectations the production plan is derived.

The initial production plan proposal is:

QPLANQ = max(0, QEXPSU + OPTSTP – STO),

where quarterly expected sales volume is

QEXPSU = QEXPS/QEXPP

This initial production plan is adjusted according to target profit margin (QTARGM), the production frontier [QFR(L)], quarterly expected wage (QEXPW) and quarterly expected net sales price (QEXPPNET). The last is defined as:

QEXPPNET = QEXPP – sum(IO · QEXPPIM)

where

$$QEXPPIM = QPDOM_{t-1} \cdot (1 + QEXPDPIM)$$
$$QEXPDPIM\ (IN) = QDPIN$$
$$QEXPDPIM(MKT) = \frac{Sum(QQ \cdot QEXPDP)}{Sum(QQ)}$$

The adjustment of the production plan is a rather complicated process in the function TARG Δ SEARCH, and results in QPLANQ (see flowchart of targ search, Chapter III, p. 139). This production plan may require additional revision due to the outcome of labor market interactions which results in firms learning about the labor supply and wage situation having hired more or less labor (=L) then originally planned. This is done in the function PLANQREVISE, resulting in:

QPLANQ = min[(PLANQ, QFR(L)].

III PlanQrevise

Actual production (QQ) and target sales (QOPTSU) are computed, given the inventory disequilibrium (OPTSTO – STO), planned production (QPLANQ) and expected sales (QEXPSU).

$$QOPTSU = \max\left[Q,\ QEXPSU \cdot \frac{QQ \cdot (1+QDQ)}{QEXPSU + (OPTSTO-STO)}\right]$$

where

$$QDQ = [QPLANQ/QQ(t-1)] - 1$$
$$QQ = QQ(t-1) \cdot (1+QDQ)$$

IV Foreign Market

Adjustments over time of exports and imports depend on relative domestic to foreign prices.

A Exports

The fraction of target sales for the foreign market, X, is:

If [QPDOM(t–1) > QPFORT(t–1)]
then $X = X(t-1) \cdot f(QPDOM, QPFOR)$
else $X = X(t-1) + X(t-1) \cdot f(QPDOM, QPFOR)$

The foreign price is adjusted exogenously.

$$QPFORT(t) = (1+QDPFOR) \cdot QPFOR(t)$$

Consequently targeted domestic sales are:

$$QOPTSUDOM = (1-X) \cdot QOPTSU$$

B Imports

The import share, IMP, is computed analogously to the export share. For each market, price computations are as follows:

$$IMP(t) = IMP(t-1) \pm f[QPDOM(t-1), QPFOR(t-1)].$$

V Domestic Product Market (domestic Δ market)

In this function there is a sequence of sub-functions with the primary purpose of computing domestic product demand and domestic price for the four endogenous market sectors.

A Market Δ entrance

Given the target domestic sales (QOPTSUDOM) the initial price offer is derived in the function: Market Δ entrance.

$$QPRELPDOM = QPDOM(t-1) \cdot \left[\frac{Sum(QOPTSUDOM \cdot \frac{QXPP}{QP})}{Sum(QOPTSUDOM)}\right]$$

B Household Δ initialization

Here quarterly disposable income for households is computed and a minimum savings requirement is subtracted.

C Market Δ confront

This function involves the iterative solution of three subfunctions for the adjustment of price and final demand towards a temporary market equilibrium.

The initial price offer is specified as:

PT(MKT) = QPRELPDOM
PT(IN) = QPDOM(IN) · QDPIN

Government purchases are given and the import share is specified.

An iterative solution of the following three functions follows:

i) Computed Δ spending

Household final demand is derived given a trial price, disposable income, and consumption-savings behavior. A Stone type expenditure system is used for aggregate household demand.

ii) Compute Δ buying

Volume demand for the economy is computed, accounting for inter industry activities, the result is QTBUY.

iii) Adjust Δ price

The adjustment of trial price is in response to the discrepancy between total demand (QTBUY) minus import share (IMP) with quarterly targeted domestic sales.

If [QTBUY · (1–IMP) < Sum(QOPTSUDOM)], then
PT = PT – PT · [MAXDP · (QTBUY · (1–IMP) – sumQOPTSUDOM)]
PT = PT + PT · [MAXDP · (QTBUY · (1–IMP) – sumQOPTSUDOM)].

Upon completion of this iterative solution process, imports are computed, inventories are adjusted of individual firms, production of individual firms is determined, and total supply in domestic markets determined:

QPDOM = PT
QTSUDOM = QTBUYDOM.

This completes the specification of market price for the four endogenous sectors.

During the autumn of 1986 the domestic price mechanism in MOSES was reprogrammed to appropriately account for the price and size of imports (cf. Technical Specification, Eliasson–Heiman–Olavi 1978).

VI The Basic Modifications are:

7.3.2 (in MARKETΔCONFRONT)
Before: PT(MKT): = QPRELPDOM
Now: PT(MKT): = (1–IMP) · QPRELPDOM + IMP · QPFOR/(1–TXVA2)

Other equation modifications needed for consistency with the basic change are:

7.6.1 (in PRICEΔADJUST)

Before:

```
IF QTBUY · (1–IMP) < SUM(QOPTSUDOM)
THEN PT(MKT): = PT(MKT) –
    MAXDP · PT(MKT)/[4 · (MARKETITER – 1)]
ELSE PT(MKT): = PT(MKT) +
    MAXDP · PT(MKT)/[4 · (MARKETITER – 1)]
```

Now:

```
MAXDP2: = (1–IMP) · MAXDP
IF QTBUY · (1–IMP) < SUM(QOPTSUDOM)
THEN PT(MKT): = PT(MKT) –
    MAXDP2 · PT(MKT)/[4 · (MARKETITER – 1)]
ELSE PT(MKT): = PT(MKT) +
    MAXDP2 · PT(MKT)/[4 · (MARKETITER – 1)]
```

7.7.6 (in COMPUTEΔIMPORT)
Before: QIMPORT: = SUM[QTBUYFOR · PT(1–TXVA2)]
Now: QIMPORT: = SUM(QTBUYFOR · QPFOR)

7.8.1	(in DOMESTIC∆RESULT)
Before:	QDPDOM: = PT/PTDOM – 1
Now:	QDPDOM: = [(PT – IMP · QPFOR)/[(1–IMP) · QPRELPDOM)] · (QPRELPDOM/QPDOM) – 1

7.8.2	(in DOMESTIC∆RESULT)
Before:	QPDOM: = PT
Now:	QPDOM: = (1+QDPDOM) · QPDOM

All the appropriate functions in which these lines exist have been copied and renamed to 'the original name ∆NEWP'. In these new functions the current changes have been introduced.

Upon using MOSES with these modifications MSTART79 is used today (December 1988) by the preprogrammed function 'modsubst'.

VII Explanations

The first modification (line 7.3.2) is the main change and the following changes are related to that one. This line was originally misspecified, because imports are bought at foreign prices, i.e. QPFOR. Actually the calculations run in 2 steps:

PH: = the price of domestic use in producer's price
PH: = (1–IMP) · QPRELPDOM · (1–TXVA2) + IMP · QPFOR
PT: = PH · 1/(1–TXVA2)

TXVA2 is VAT including trade margins. VAT and trade margins are both included in the import and the nonimport. Consequently they are divided by (1–TXVA2). Customs can be included in TXVA2 but are not. Consequently the QPFOR(1–TXVA2) is somewhat on the low side and QPDOM somewhat too high. Currently MOSES does not include customs duties explicitly. A reason for including customs duties in TXVA2 is to get central government income consistent with the public budget (see Nordström 1988). If customs duties are included they should only be added to imports. PT (IN) and the line below will stay unchanged (exogenous prices).

According to the old (1978) specifications of the model QPDOM increases only because of the difference between supply and demand on the domestic market (see line 7.6.1). This line has now been changed and PT has a new meaning, a weighted average of QPDOM and QPFOR. For example, if PT rises by 1 percent then QPDOM rises with 2 percent for an import share of 50 percent.

From a general point of view the following is approximately valid:

$$GG = (1-IMP) \cdot KK + IMP \cdot 1.0$$

where GG = the rate of increase in PT
KK = the rate of increase in QPDOM
IMP = import share
and the rate of increase in QPFOR = 0

ex: $1.01 = (1-1/2) \cdot 1.02 + 1/2 \cdot 1.0$

The change in PT, as exemplified, requires an adjustment to MAXDP in equation 7.6.1. It now becomes a function of the import-share and is redefined as MAXDP2.

If IMP2 is greater than zero, i.e. if there is some extra import, then line 7.7.6 will be affected by the PT change. The extra import share has the price QPFOR and not PT.

Line 7.8.1 must also change in keeping with the new PT meaning still QPDOM increases only as a result of the mechanism on line 7.6.1. The outcome of the new iteration, expressed in equation 7.8.7 is based on the following derivation:

$$PT(new) = (1-IMP) \cdot QPRELPDOM \cdot factor + IMP \cdot QPFOR$$
$$factor = [PT(new) - IMP \cdot QPFOR]/[(1-IMP) \cdot QPRELPDOM]$$

Line 7.8.1 implies that factor $\neq 1$. The old equation took only PT(new) as new QPFOR on line 7.8.1 and line 7.8.2.

Actually the changes on line 7.8.1 are split up into two lines:

(i) for the industrial sectors
$QDPDOM_i := [(PT_i - IMP_i \cdot QPFOR_i)/(1-IMP_i) \cdot QPRELPDOM_i] \cdot (QPRELPDOM_i/QPDOM_i) - 1$,
where i = 1, 2, 3, 4

(ii) for the exogenous sectors
$QDPDOM := (PT_i/QPDOM_i) - 1$,
where i = 5, 6, 7, 8, 9, 10

The prices in the exogenous sectors should partly (or wholly) include foreign prices. QPFOR is only derived for i = 1, 2, 3, 4.

CHAPTER VI

Firm Entry in MOSES: A User Manual

by
Kenneth A. Hanson

How to activate new firm entry in a MOSES simulation is described. Since a number of options exist for introducing new firms it is necessary to provide a user manual. Some familiarity with the model is assumed, particularly, how to set up and execute a MOSES simulation as described in IUI Working Paper No. 75 by Fredrik Bergholm (1982).

A set of functions in the 'MOSES' workspace is activated in an 'MSTART'. These functions specify the timing, number, sector, and characteristics of the new firms. The key parameters controlled by the modeler for an experiment are specified in the 'MSTART'. The discussion here provides a knowledge on how the functions currently operate and on what the key entry parameters are.

A comment on firms in MOSES using the 1982 database. A total of 154 'real' firms and 71 'synthetic' firms are specified with micro data and distributed among four out of ten industrial sectors of the modeled economy. Sector one starts with 37 firms, sector two with 70 firms, sector three with 81 firms and sector four with 37. Each micro specified new firm must have about 150 variables and parameters initialized. How to specify these variables is one part of the programming problem. Another part of the programming problem is specifying how many new firms enter each sector in each period of a simulation experiment. A third programming problem is providing printout reports on the initial characteristics of new firms and on the historical development of the new firms. Each of these programming problems will be discussed below.

A MOSES simulation experiment is carried out by submitting a Tops20 job control file. For entry experiments I have been using such files as 'Entry30.CTL'. The key difference between a file for entry experiments and a file for normal experiments is the line 'Runentry YNR' rather than 'Runexp YNR'. The 'Runentry' functions allow for optional reports not available in 'Runexp'. Otherwise they are identical.

A MOSES simulation begins with an initialization, Rxx. For the 1976 database R5 is used and for the 1982 database, R89 is used. The command 'updateMOSES xx' introduces 'mstartxx' to begin the simulation. The design of experiments is made in the 'mstartxx' function. Firm entry experiments have been carried out using mstartxx, xx = 31, 32 ..., 38. A set of Firm entry parameters are specified in the mstart and then a sequence of entry functions are set into operation.

The key entry parameters will be defined below in the discussion of the entry function they correspond to. They are:

Firm Entry Parameters in MSTARTxx

START∆ENT3 : ∆TEC ← 0.5
START∆ENT3 : ∆RES ← 0.5
START∆ENT3 : Resize ← 0.5
START∆ENT1 : mm∆ENTRY ← 0 1 2 3 4
START∆ENT1 : xx ← 85 + ι 30

The sequence of functions is invoked through the function 'START∆ENT1'. If it desired to have no entry while the firm entry setup then place a comment symbol in front of the mstart line which invokes this function. The sequence of functions invoked for entry simulation experiments are:

START∆ENT1
START∆ENT∆MOD
START∆ENTRY
START∆ENT2
START∆ENT3
FIRMENTRY2

The purpose and content of these functions will now be described.

I START∆ENT1

The purpose of the function is to initialize entry reports and control the timing and sector of new firm entry. The sector of new firm entry is specified in the 'mstart' as mm∆entry. This line in the mstart actually supersedes, by substitution for line [8] in 'START∆ENT1'. The sectors are specified as 1, 2, 3, 4 or any combination. The zero is for vector dimension and should remain.

New firms enter at the beginning of a year. Lines [9] and [10] control the entry. The mstart line 'xx ← 85 ← ι 30' supersedes line [9] for specifying the year of entry. The first year of entry is given as 85 and for each of the next 30 years new firms may enter. Either or both 85 and 30 may be changed for an entry experiment in the MSTART. The command 'performΔyear', in line [10], will insert in year 'xx' the function 'startΔentry' between the functions 'yearlyΔTARG' and 'Quarter', both of which are invoked from the function 'Year'.

Three types of entry reports are initialized in this function. The first report, initialized in line [1], pertains to the initial characteristics of all new firms. The report is maintained as the character string 'Firmcharc'. The variables contained in the report are specified in the last line of the function 'Firmentry2'. The report does not include headings telling the variable names, currently they are:

100m	L	VA	QQ	QP	DS
K1	QTOP	TEC	100inveff	100RES	100A22

The printout of the report is done manually within the workspace of a simulation experiment. The first and second line of variables is obtained by typing:

Firmcharc[;ι 90]
Firmcharc[;90 + ι 90]

The second type of reports are initialized in lines [4–6]. The content of these reports are given in the 'runentry' function. Essentially the reports are an abbreviated version of the standard reports contained in the character string 'Allreports' which is printed out with the command PrintΔout. The abbreviated entry reports are contained in the character string 'Entryreports' and are printed out with the command PrintΔentry. To conserve storage space during computer operation only one or the other of these alternative standard reports should be activated. To choose make the appropriate change in the 'Runentry' function. Note, the character string 'EdΔParms' contains the simulation experiment parameter values and the character string 'EdΔNullified' contains the timing of the firms which exit. Also note, the abbreviated entry reports contain some variables new to the model. These variables are specified in the function 'Start∆ENT∆MOS'.

The third set of reports contain a time series of selected firm variables for some selected new firms. These reports are initialized in line [11], using the command Perform∆run. For these reports to occur it is necessary to specify the year of entry, xx, and the sector-firm number, such as 3.61. Doing this will require some presimulation conceptualization of what firms will enter when. The function 'New∆Firm∆REPS' sets up the variables which are contained in the reports.

II START∆ENT∆MOD

Several new variables are created for entry simulations, all in this function. All but one is for entry reports. One variable is created, 'entry∆epsilon'. This variable serves as the basis for specifying the number of new firms to enter a sector at the beginning of a year. The variable is a sector rate of return or profit measure.

III START∆ENTRY

The number of new firms to enter each sector and the exogenously specified characteristics of the new firm are determined in this function. In the first line the indicator used as the basis for determining the number of new firms to enter a sector is specified as the entry∆epsilon. This vector is four dimensions, one for each sector, and the value changes from year to year. 'Entry∆epsilon' is specified in the function 'start∆ent∆mod'.

The new firms are introduced one sector at a time, consequently the remaining lines in the function occur and reoccur as a loop, iterated over the sectors which entry occurs. The counter for the loop is I and the control over which sectors is given by mm∆entry which is specified in the mstart. In line [5] the first element of the vector 'entry∆MKTNR' is assigned the sector number (1, 2, 3, 4). In line [6] the second element of 'entry∆MKTNR' is specified as the number of new firms to enter the sector. The number of firms is determined in the function 'StartΔent2' as will be discussed below. If the number of new firms is zero then line [7] determines this and stops further entry functions for the particular sector. In line [8] the exogenously specified parameters of the new firms are determined using the function 'StartΔent3'. Finally in line [9] the function 'Firmentry2' is invoked for characterizing the new firms.

IV STARTΔENT2

The purpose of this function is to specify the number of new firms to enter a sector in the particular year of the simulation. A sector average of the entry indicator, which is specified in the function 'startΔentry', is computed and used as the basis for determining the number of new firms. As currently formulated the number of firms is a linear function of the entry indicator. The outcome is then constrained by a maximum and minimum value imposed by the modeler. Finally it is necessary to ensure the outcome is integer valued.

V STARTΔENT3

Three characteristics of new firms have been chosen for exogenous specification. The purpose of this function is to assign values to the appropriate variables. As the function is currently written the assignment of values is redundant with the specification in the MSTART and each firm gets the same value. More general formulations may eventually be designed, in which case this function will be pertinent.

Two of the three parameters pertain to the productivity of the new firms. The third parameter pertains to the size of the new firm. All three parameters are expressed relative to a sector average firm. Specification of the sector average firm is a bit complicated and will be described below in context of the function 'AvgΔTop'.

The first productivity parameter is labor productivity of the new firms production technology. A positive value gives the percentage improvement from the labor productivity of the sector average firm. The second productivity parameter pertains to slack in the efficient use of the production technology. A positive value gives the percentage reduction in slack. The relative size parameter specifies the magnitude of stocks to the new firm as a percentage of the sector average firm's stocks.

VI AvgΔTop

New firms are characterized relative to existing firms in the sector. A hypothetical sector average firm is formulated using the function 'AvgΔTop'. Since new firms are considered innovative they are expected to be most similar to the best existing firms rather than the average in the sector. For this reason the function 'AvgΔTop' first selects the top twenty five percent of real firms, ranked according to the existing firms' rate of return on capital, that is 'entryΔepsilon'. Then an average firm is formulated on the basis of these best real firms.

The reason for selecting the top real firms rather than top existing firms is that the initial synthetic firms sometimes take on some exceptionally good characteristics and are bad in other characteristics. The reason for the inconsistency is that in formulating these initial synthetic firms they are forced to account for residual values of aggregate accounting measures. This is a difficult task carried out in the initialization of a MOSES simulation.

During the course of a simulation all real firms in a sector may exit. In this case the sector average firm is based on all existing firms at the point in time during the simulation. The function 'AVg5' does the sector average computation.

There are some misgivings for using a hypothetical sector average firm and for using the formulation given in 'AvgΔTop'. Currently, it seems a formidable task to specify new firms independently of existing firms in the model and expect the new firms compete. Empirical data on actual new firms suggest that they are small and most either fail or merge with existing firms after a short time. Rather than introducing a large number of small new firms, I have chosen to introduce a few firms which are larger and more mature than actual entrants.

VII FIRMENTRY2

Each time a new firm in a sector enters the model the vector (and matrix) dimension of the variables must be expanded and assigned an appropriate value. The function 'Firmentry2' accomplished the task of specifying the variables of the new firms, one sector at a time. This function is a modification of the function 'Firmentry' originally designed by Gösta Olavi.

The variables of the new firm can be classified according to how they are characterized. There are: stocks, averaged flows, zeroed flows, function flows, matrix flows, and a few Auxiliary variables. Each group of variables are treated differently. For the stocks of the new firm the stock value derived for the hypothetical firm is multiplied by the 'relsize' parameter for the new firm.

The averaged flows are assigned values from the 'aveΔtop' function. A number of flow variables can be given zero values but the dimension of the vectors must be expanded for the number of new firms entering the sector. The matrix flows are given values with the 'avgΔtop' function.

The function flows involve variables that are interrelated through equations specifying the structure and behavior of the firm. To maintain internal consistency these equations are used to relate the value of variables. These equations are either accounting equations or relate to the production technology of the firm. The two exogenously specified parameters relating to production technology influence the new firm through these equations. The order in which equations are solved and the choice of exogenous variables can be changed, to experiment with different new firm specifications. It may also be desired to constrain some variables within ranges that are felt reasonable but which are not restricted mathematically by the equations.

APPENDIX I Firm Entry 2 Variables

I) Stocks: x ← x, x̲ Relsize * (x A̲v̲g̲Δ̲T̲o̲p̲ x)
K1, K1Book, K2, BW, QIMV, QINVlag
VA, QVA

II) Averaged flows: x ← x, (ρ Relsize)ρS A̲v̲g̲Δ̲T̲o̲p̲ x
RW, A22, X, P, QP, DP, W, DW, QDW, QW
DVA, Share
expdp, expds, expdw, Histdp, Histds, Histdw
Histdpdev, Histdpdev2, Histdsdev, Histdsdev2
Histdwdev, Histdwdev2
Big, Small, Imbig, Imsmall

III) Zeroed flows: x ← x, (ρ Relsize) 0
A21
cuminv, cumL, DL, DNW, cumm, cumQ
cums, cumsnet, cumsu, cumVA, cumws
cumintpayf, cumdepr, cumtexf, cumdiv
cumsubsf, cumchbwf, cumchkzf, snet
Qdp, QdQ, Qds, QDVA, Qm, Qoptsu
Qsdom, Qsfor, QSNET, QSU, QSUdom
Qsufor, STD
Bad, reallybad
EntryΔepsilon
LLastyr, NWLastYr ρ(1)
RsubSΔcash ← RsubSΔcash, O * Relsize
RsubSΔextra ← RsubSΔextra, O * Relsize

IV) Function flows: in order of specification

Q ← Q, Q̲ ← VA ÷ P̲ – S̲h̲a̲r̲e̲ *
[(Qpdom * 1 – TXVA2) +, IO] (mm)

QQ ← QQ, <u>QQ</u> ← <u>QVA</u> ÷ <u>QP</u> – <u>Share</u> *
[(Qpdom * 1 – TXVA2) +, IO] (mm)

DQ ← DQ, <u>DQ</u> ← <u>DVA</u> – <u>DP</u>

S ← S, <u>S</u> ← <u>Q</u> * <u>P</u>

DS ← DS, <u>DS</u> ← (Q * <u>DP</u> + <u>DQ</u> * <u>P</u>) ÷ <u>S</u>

QS ← QS, <u>QQ</u> * <u>QP</u>

Res ← Res, <u>Res</u> ← (ρ Relsize) ρ (1–ΔRes) *

(VA <u>AvgΔTop</u> Res)

QTop ← QTop, <u>QTOP</u> ← <u>QQ</u> ÷ 1 – A21 + A22 + <u>RES</u>

Tec ← Tec, <u>Tec</u> ← (ρ relsize) ρ (1+ΔTec) *
(Tec <u>AvgΔTop</u> Tec)

Inveff ← inveff, <u>Inveff</u> ← <u>QTop</u> * <u>QP</u> ÷ <u>K1</u>

L ← L, <u>L</u> ← (<u>QTop</u> ÷ <u>Tec</u>) * (+) (1–<u>RES</u>) ÷ A22

LU ← LU – + /, <u>L</u>

m ← m, <u>m</u> ← 1 – <u>W</u> * <u>L</u> ÷ <u>VA</u>

mHist ← mHist, <u>m</u>

V) Matrix flows:

Aman ← [(ρ Aman) + (ρ Relsize), 0] ↑ aman

Imsto ← imsto, [1] [Φ(10, ρ Relsize) ρ Relsize] *
{[(ρ Relsize), 10] ρ (IO +, x [(+/Imst <u>AvgΔTop</u> (+/QIMQ)])}

VI) Auxiliary

Market ← Market, (ρ relsize) ρ mm
origmarket ← origmarket, (ρ relsize) ρ mm
Left ← left, Relsize = Relsize

VII) Exogenous: mmm Firmentry2 Parms

mm ← mmm [1]

num ← mm [2]

ΔTec ← num ↑ Parms

ΔRes ← num ↑ ΔRes ← num ↓ Parms

Relsize ← (–num) ↑ Parms

CHAPTER VII

The MOSES APL Program Code

by
Fredrik Bergholm, Christina Hartler, Mats Heiman,
Thomas Lindberg, Gösta Olavi,

CONTENTS

Part 1 The Initialization Code

```
     ∇  START N
[1]     ⍎')MAXCORE 352 '
[2]    ⍝ NEEDED SPACE IN COMPUTER...
[3]     WORKSPACENAME←'R',⍕N
[4]    ⍝THE RESULT FROM THE INITIALIZATION WILL BE STORED IN A WORKSPACE
[5]    ⍝CALLED RXX,WHERE XX IS THE NUMBER N GIVEN IN THE CALL START N
[6]      ' RESULT FROM INITIALIZATION IS STORED IN WORKSPACE ',⍕
       WORKSPACENAME
[7]    ⍝
[8]    ⍝WORKSPACENAME IS USED IN FUNCTION OUTPUTΔOPERATIONS...
[9]    ⍝
[10]    NYR←30
[11]   ⍝NUMBER OF YEARS TO INITIALIZE VARIABLES.
[12]   ⍝CAN BE CHANGED IN FUNCTION ISTARTXX.
[13]   ⍝
[14]    ⍎')COPY FUNCTI MODADD MODDEL MODSUBST SCANMAT PACK ENS EQUALS ABO
       VE'
[15]    NAME←'ISTART',⍕N
[16]    ⍎')COPY ISTART'
[17]   ⍝START-FUNCTIONS SHOULD LIE IN WORKSPACE ISTART
[18]    ⍎NAME
[19]   ⍝THE LINE ABOVE MEANS THAT THE FUNCTION ISTARTXX WILL BE EXECUTED.
[20]   ⍝XX IS THE NUMBER OF THE INITIALIZATION.(XX=N)
[21]   ⍝ISTARTXX IS SPECIFIC FOR A CERTAIN EXPERIMENT.
[22]   ⍝IN ISTARTXX ONE CAN CHANGE LINES BELOW WITH 3 SPECIAL
[23]   ⍝FUNCTIONS MODADD,MODSUBST,MODDEL.
[24]   ⍝THUS ISTARTXX CAN CHANGE THE PROGRAM BELOW DURING EXECUTION.
[25]   ⍝
[26]   ⍝
[27]    SIΔINIT NYR
[28]    'INITIALIZATION COMPLETED'
[29]    ⍎')CLEAR'
[30]    ⍎')WS CLEAR'
[31]    G
     ∇
```

Part 1 The Initialization Code

```
    ∇ SI∆INIT NYR;DUMMY
[1]   ⍝ DUMMY←∊')COPY SI76 F∆DATA X FIRMID'
[2]   ⍝LINE ABOVE EXECUTED IN FUNCTION EST. (LINE [25] BELOW)
[3]    DUMMY←∊')COPY MACRO'
[4]    DUMMY←∊')COPY FUNCTIONS'
[5]   ⍝
[6]   ⍝FIRMDATA FROM WORKSPACE SI76
[7]   ⍝MACRODATA FROM WORKSPACE MACRO
[8]   ⍝HELPFUNCTIONS FROM WORKSPACE FUNCTIONS
[9]   ⍝
[10]  ⍝
[11]   TESTUTSKRIFT←0
[12]  ⍝NYR=NUMBER OF YEARS TO RUN THE SIMULATION.
[13]  ⍝
[14]  ⍝
[15]   NQR←4×NYR
[16]  ⍝NQR=NUMBER OF QUARTERS
[17]   NMARKETS←4
[18]  ⍝
[19]  ⍝
[20]   TAX∆PARAMETERS
[21]   PUBLIC∆SECTOR
[22]   MONETARY
[23]   MARKETS
[24]   HOUSEHOLDS
[25]   ESTABLISHMENTS
[26]  ⍝FUNCTION DISPOSE∆VAR∆INPUT DELETES VARIABLES FROM WORKSPACE MACRO
      ...
[27]  ⍝XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
[28]  ⍝  SECOND PART OF INITIALIZATION
[29]  ⍝XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
[30]  ⍝THE FOLLOWING VARIABLES ARE NEEDED IN THE SECOND PART
[31]  ⍝OF THE INITIALIZATION.COPIES ARE TAKEN BECAUSE IT SEEMS LOGICAL
[32]  ⍝TO FORBID READING FROM INPUTFILES IN SECOND PART OF
[33]  ⍝INITIALIZATION...
[34]   GROWTH←INIT∆GROWTH
[35]   TXVA2COPY←TXVA2
[36]   RU∆COPY←RU
[37]   TXWCOPY←TXW
[38]   TXWGCOPY←TXWG
[39]   QINPAYCOPY←QINPAY
[40]   RI∆COPY←RI
[41]   TXI1COPY←TXI1
[42]  ⍝FROM NOW ON NO MORE READING FROM INPUT-WORKSPACES
[43]  ⍝(MACRO AND SI76).THERE WILL BE,ONLY,FURTHER WORK WITH
[44]  ⍝VARIABLES AND PARAMETER-SETTING.
[45]   DISPOSE∆VAR∆INPUT
[46]   MARKETS∆DATA
[47]   SECONDARY∆DATA
[48]   PUBLIC∆DATA
[49]   MONETARY∆DATA
[50]   HOUSEHOLDS∆DATA
[51]  ⍝
[52]  ⍝
[53]   OUTPUT∆OPERATIONS
[54]  ⍝THIS FUNCTION HANDLES OUTPUT.(UNNECESSARY VARIABLES ARE DELETED).
[55]   'TESTUTSKRIFT2'
    ∇
```

Part 1 The Initialization Code

```
    ∇  TAX∆PARAMETERS
   ⍝VARIABLES IN WORKSPACE MACRO WHICH IS FINAL OUTPUT FROM INITIALIZ
   ATION:
   ⍝ TXVA1,TXVA2
   ⍝
   ⍝ OTHER VARIABLES IN TAX∆PARAMETERS WHICH WILL BE FINAL
   ⍝ OUTPUT FROM INITIALIZATION:
   ⍝ ALL EXO-VARIABLES TO THE LEFT OF '←' BELOW AND TXI3
   ⍝
    EXO∆QCHTXVA1←NQR↑DIFF EXO∆QTXVA1
    EXO∆QCHTXVA2←NQR↑DIFF EXO∆QTXVA2
    EXO∆TXC←NYR CONTINUE1 EXO∆TXC
    EXO∆TXI1←NYR CONTINUE1 EXO∆TXI1
    EXO∆TXW←NYR CONTINUE1 EXO∆TXW
    EXO∆TXWG←NYR CONTINUE1 EXO∆TXWG
    TXI3←1.6
    ∇
```

```
    ∇  PUBLIC∆SECTOR;ALG;QLG;WAGES;RATE1;RATE2;QCHLG
   ⍝
   ⍝  VARIABLES IN PUBLIC∆SECTOR WHICH WILL BECOME
   ⍝ FINAL OUTPUT FROM ININTIALIZATION:
   ⍝ OMEGAG,QINVG,EXO∆QDINVG,EXO∆RSUBS,QWG,WG,LG,WG∆REF
   ⍝GKOFF,EXO∆REALCHLG
   ⍝
   ⍝
    OMEGAG←10↑IOCOEFF76[;13]
    INVG←IO76[14;13]
    RATE1←G∆RATE1
    RATE2←G∆RATE2
   ⍝ RATE1=YEARLY PERCENTAGE CHANGE IN INVG,RATE2=TREND CHANGE
    ALG←TIM∆OFF÷HOURS∆PER∆YEAR
   ⍝
    WAGES←2⍴0
    WAGES[1]←LON∆OFF[1]÷ALG[1]
    WAGES[2]←LON∆OFF[2]÷ALG[2]
   ⍝
    QLG←(4×(⍴ALG))⍴0
    QLG←MAKEQUARTERS ALG
   ⍝RESULT FROM MAKEQUARTERS:QLG=
   ⍝AVERAGE LABOUR FORCE IN EACH QUARTER.QLG(1)=
   ⍝QUARTER 1 BASE YEAR AND SO ON...
    QCHLG←DIFF QLG
    LG←QLG[4]
    EXO∆REALCHLG←NQR CONTINUE1(3↓QCHLG),LGTRENDCH
    EXO∆REALCHLG←EXO∆REALCHLG×0.4
   ⍝ATTEMPT TO MODIFY GOVERNMENT DEMAND FOR LABOUR DUE TO
```

Part 1 The Initialization Code

```
⍝FICTIOUS LABOUR-FORCE IN THE MODEL...
⍝(GOVERNMENT LABOUR+INDUSTRY LABOUR)÷(TOTAL LABOUR FORCE)=1.7÷4.1
MILLION PEOPLE
⍝THAT IS: FICTIOUS LABOURFORCE=1.7 MILL. PEOPLE IS
⍝APPROXIMATELY 0.4×TOTAL LABOUR FORCE.
⍝THAT'S WHY DEMAND IS MULTIPLIED WITH 0.4...
⍝FREDRIK B
⍝
 QWG←WAGES[1]+0.375×(WAGES[2]-WAGES[1])
 WG←WAGES[1]
⍝
 QINVG←(0.25×INVG×1000000)×RATE1*(1.5÷4)
⍝QUARTER1: RATE1*(-2.5÷4)
⍝QUARTER2: RATE1*(-1.5÷4)
⍝QUARTER3: RATE1*(0.5÷4)
⍝QUARTER4: RATE1* 1.5÷4)
⍝SUM = (APPROX.) 4  ,WHICH MEANS THAT SUM(QINVG)=INVG
 EXO∆QDINVG←(NQR⍴(RATE2*(1÷4)))-1
 EXO∆RSUBS←NYR CONTINUE2 RSUBS
 GKOFF←(10*6)×(10↑I076[;1])÷(WG×LG)
⍝
 WG∆REF←WG
∇
```

```
∇ MONETARY
 ⍝ VARIABLES FROM WORKSPACE MACRO   WHICH WILL REMAIN
 ⍝ UNCHANGED  AND WHICH WILL BECOME FINAL OUTPUT FROM
 ⍝INITIALIZATION: RI,LIQB,POSG,LIQBFOR
 ⍝ OTHER VARIABLES WHICH WILL
 ⍝ BECOME FINAL OUTPUT FROM INITIALIZATION: ALL EXO-VARIABLES HERE
 ⍝
  EXO∆RI←NQR CONTINUE1 EXO∆RI
  EXO∆RIBWFOR←NQR CONTINUE1 EXO∆RIBWFOR
  EXO∆RIDEPFOR←NQR CONTINUE1 EXO∆RIDEPFOR
∇
```

Part 1 The Initialization Code

```
    ∇  MARKETS;PDOM;MΔPRICE
 ⍝FINAL OUTPUT FROM THIS FUNCTION:
 ⍝XIN,IO,IO2,IO3,OMEGA,OMEGABLD,OMEGAIN,IMP,
 ⍝QINVBLD,QINVIN,EXOΔQDINVIN,EXOΔQDINVBLD,
 ⍝QPDOM,QDPDOM,EXOΔQDPIN,PΔREF,QPFOR,EXOΔQDPFOR
 ⍝
 ⍝OUTPUT TO FUNCTION HOUSEHOLDSΔDATA:
 ⍝QDPIN,QDPFOR
 ⍝
 ⍝
 ⍝
 ⍝
 ⍝
  IMP←10⍴0
  XIN←6⍴0
  XIN[3]←0
  XIN[1,2,4,5,6]←IO76[5,6,8,9,10;18]÷IO76[14;5,6,8,9,10]
 ⍝XIN=EXPORT SHARES IN SECTORS OUTSIDE OUR 4 MARKETS
  SWEDISHΔDEMAND←IO76[⍳10;21]-(IO76[⍳10;20]+IO76[⍳10;19]+IO76[⍳10;18])
 ⍝SWEDISHΔDEMAND←PRODUCTION(INCL. IMPORTS)-(DIFF+IMPORTS+EXPORTS).
 ⍝NOTE THAT IMPORTS IS STORED WITH NEGATIVE SIGN IN IO76...
 ⍝
  IMP←(|IO76[⍳10;19])÷SWEDISHΔDEMAND
 ⍝IMP= IMPORT-SHARE OF_SWEDISH_CONSUMER'S DEMAND ...
 ⍝ IMP=IMPORTS VECTOR FOR MARKETS 1,2..10
 ⍝
 ⍝
 ⍝
  IO←IOCOEFF76[⍳10;⍳10]
  IO2←IOCOEFF76[⍳4;4+⍳6]
  IO3←IOCOEFF76[4+⍳6;4+⍳6]
  OMEGA←10↑IOCOEFF76[;16]
  OMEGABLD←10↑IOCOEFF76[;14]
  OMEGAIN←10↑IOCOEFF76[;15]
 ⍝
 ⍝
 ⍝
 ⍝
  INVBLD←IO76[14;14]
  INVIN←IO76[14;15]
  QINVBLD←(0.25×INVBLD×1000000)×BLDΔRATE1*(1.5÷4)
  QINVIN←(0.25×INVIN×1000000)×INΔRATE1*(1.5÷4)
  EXOΔQDINVIN←¯1+(NQR⍴(INΔRATE2*(1÷4)))
  EXOΔQDINVBLD←¯1+(NQR⍴(BLDΔRATE2*(1÷4)))
 ⍝
 ⍝
 ⍝
 ⍝ HISTΔTXVA2[YEARS;QUARTERS] YEAR=1,2,3,4   YEAR 1=1974
```

Part 1 The Initialization Code

```
⍝ P[MARKETS;YEARS]YEAR=1,2,3,4
 P←IMPLΔPRIS,[1]IMPLΔPRISΔIN
 PDOM←P DIV8 1-0.25×+/HISTΔTXVA2[⍳4;]
 ENS P[;3]=100
⍝QPFOR ESTIMATED FROM VARIABLE EXPORTΔPRIS IN
⍝OLD INITIALIZATION (BEFORE JULY 1980)...
 QPFOR← 101.4 100.8 102.1 101
 QDPFOR←(TLΔEXPΔPRISΔ76 NYR)[;1]
 EXOΔQDPFOR← 0 1 ↓TLΔEXPΔPRISΔ76 NYR
⍝
⍝THOMAS LINDBERG  HAS MADE THE FUNCTION TLΔEXPΔPRISΔ76
⍝WHICH YIELDS QUARTERLY EXPORTPRICE-CHANGES...
⍝
⍝
 QPDOM←PDOM[;3,4]+.× 0.625 0.375
 QDPDOM←¯1+(PDOM[;4]÷PDOM[;3])*(1÷4)
 QDPIN←¯1+((IMPLΔPRISΔIN[;4]÷IMPLΔPRISΔIN[;3])*(1÷4))+(HISTΔTXVA2[
3;4]-HISTΔTXVA2[3;3])
 MΔPRICE←(6,4×(⍴IMPLΔPRISΔIN)[2])⍴0
 J←1
ST:→(J=7)/SL
 MΔPRICE[J;]←MAKEQUARTERS IMPLΔPRISΔIN[J;]
 J←J+1
 →ST
SL:
 MΔPRICE←(0,11)↓MΔPRICE
 EXOΔQDPIN←NQR CONTINUE2((RELDIFF MΔPRICE),TRENDM)
 PΔREF←PDOM[;3]
∇
```

```
∇ HOUSEHOLDS
 ⍝OUTPUT FROM INITIALIZATION: SEE HOUSEHOLDSΔDATA INSTEAD
 ⍝WHSUM AND HH76 WILL  BE USED IN HOUSEHOLDSΔDATA IN
 ⍝THE SECOND PART OF INITIALIZATION...
  HH76←IOCOEFF76[⍳10;12]
  WHSUM←HUSHALLSDEP
∇
```

Part 1 The Initialization Code

```
∇ ESTABLISHMENTS;R;F;ALPHA;SCALE;RATIO;RATIO1;RATIO2;HELP;FLAG;
  DUMMY
   ⍎')COPY SI76 X FΔDATA FIRMID   LIST RΔMARKET'
  ⍝FIRM-VARIABLES FROM WORKSPACE SI76.
  ⍝
  ⍝
  ⍝INPUT FROM FUNCTION MARKETS:IO (INPUT-OUTPUT-MATRIX)
  ⍝INPUT FROM ISTARTXX-FUNCTION: SYNTHΔFIRMS
  ⍝
  ⍝
  ⍝OUTPUT FROM THIS FUNCTION:
  ⍝MARKET,P,QP,DP,W,QW,DW,S,QS,DS,Q,QQ,DQ,
  ⍝L,EXPDP,EXPDS,EXPDW,HISTDP,HISTDS,HISTDW,
  ⍝HISTDPDEV2,HISTDWDEV2,HISTDSDEV2,MHIST,CHM
  ⍝VA,QIMQ,QVA,DVA,M,AMAN,STO,IMSTO,
  ⍝QTOP,TEC,QINV,QINVLAG,DELAYΔINV,K1,K1BOOK,K2,BW,
  ⍝QTDIV,RSUBSΔCASH,RSUBSΔEXTRA,RES,INVEFF,RESMAX,BETA,
  ⍝IMBETA,TMINV,BIG,SMALL,IMBIG,IMSMALL,FΔINKOP,BRINKOP,
  ⍝SHARE,X,ORIGMARKET,LEFT
  ⍝
  ⍝
  ⍝
  ⍝INFORMATION ABOUT INDATA:
  ⍝X IS FIRM-DATA.
  ⍝FΔDATA IS INDATA ABOUT FIRM-GROUPS.
  ⍝X IS A MATRIX WITH FIRST COMPONENT= FIRM
  ⍝AND SECOND COMPONENT= VARIABLE (SALES,LABOUR,ETC..).
  ⍝X CONSISTS MAINLY OF DATA FOR THE YEAR 1976.
  ⍝
  ⍝
  ⍝ REDUCTION ON LIST
  ⍝FIRMS WITH INCONSISTENT VARIABLES ARE OMITTED .
  L0:F←FIRMID[(X[;1]∊LIST)/⍳⍴X[;1]]
   NAMNΔMARKET←RΔMARKET[(X[;1]∊LIST)/⍳⍴X[;1]]
   ALPHA←(+/X[(X[;1]∊LIST)/⍳⍴X[;1]; 7 12])÷FΔDATA[F;15]
  ⍝ CHECK ON ALPHA
   →(0=⍴FLAG←(1<ALPHA+.×F∘.=⍳⌈/F)/⍳⌈/F)/L2
   HELP←⍳0
  ⍝ OLD: L1:HELP←HELP,F⍳1↑FLAG
  L1:HELP←HELP,ALPHA⍳⌊/ALPHA[((1↑FLAG)=F)/⍳⍴F]
```

Part 1 The Initialization Code

```
 →(0<ρFLAG←1↓FLAG)/L1
 'DROPPING ',(5 2 ⍕LIST[HELP]),' FROM LIST.'
 LIST←(~(⍳ρLIST)∊HELP)/LIST
 →L0
L2:X←X[(X[;1]∊LIST)/⍳ρX[;1];]
⍝
⍝
⍝
⍝ R=NUMBER OF REAL FIRMS.
⍝MARKET=VECTOR WITH MARKET NUMBERS FOR EACH FIRM,
⍝FOR EXAMPLE:  1 1 1 2 1 3 1 4 1 4 ...ETC.
⍝SΔMARKET=VECTOR WITH MARKET-NUMBERS FOR SYNTHETIC FIRMS.
⍝
 SΔMARKET←SYNTHΔFIRMS DUP⍳4
 MARKET←NAMNΔMARKET,SΔMARKET
 R←1↑ρX
⍝
 'SIZE-UTSKRIFT 2'
 ⍎')SIZE'
⍝
⍝
⍝
⍝ SETTING SCALE FOR SYNTHETIC FIRMS:
 SCALE←⍳0
 SCALE←SCALE,SYNTHΔFIRMS[1]SCALE 0.02
 SCALE←SCALE,SYNTHΔFIRMS[2]SCALE 0.001
 SCALE←SCALE,SYNTHΔFIRMS[3]SCALE 0.02
 SCALE←SCALE,SYNTHΔFIRMS[4]SCALE 0.0001
 ENS 1=SYNTHΔSUM1 SCALE
⍝
 ⎕RL←123476
⍝⎕RL YIELDS START-VALUE FOR PSEUDO-RANDOM-NUMBERS:
⍝THIS MEANS THAT THE SAME 'RANDOM-NUMBERS' WILL BE
⍝GENERATED IN DIFFERENT EXECUTIONS ,AS LONG AS ONE
⍝DOESN'T CHANGE ⎕RL.
⍝RANDOMNUMBERS OCCUR IN THE FUNCTIONS 'USING' AND 'RANDOMIZE'.
⍝
⍝
⍝
⍝
⍝
⍝SALES:
```

Part 1 The Initialization Code

```
[81]   ⍝SUM1,REAL∆SUM1,SYNTH∆SUM1 ETC. SUM FIRMVARIABLES TO
[82]   ⍝MARKET-VARIABLES.A FIRM-VECTOR IS SUMMED UP TO A
[83]   ⍝MARKET-VECTOR OF LENGTH 4.
[84]    REAL∆SALES←(+/X[; 7 12]×1000000)
[85]    RES∆SALES←SALES76-REAL∆SUM1(REAL∆SALES)
[86]    SYNTH∆SALES←SCALE×RES∆SALES[S∆MARKET]
[87]    S←REAL∆SALES,SYNTH∆SALES
[88]   ⍝
[89]   ⍝
[90]   ⍝
[91]   ⍝LABOUR:
[92]    REAL∆LABOUR←X[;3]
[93]    RES∆LABOUR←(TIM÷HOURS∆PER∆YEAR)-REAL∆SUM1(REAL∆LABOUR)
[94]    SYNTH∆LABOUR←R↓S×RATIO←(REAL∆LABOUR÷REAL∆SALES)USING S
[95]   ⍝
[96]   ⍝FUNCTION 'USING' HAS THE FORM 'A USING B'
[97]   ⍝FUNCTION 'USING' DOES:
[98]   ⍝(1) EXTENDS VARIABLE A WITH RANDOMIZED VALUES FOR
[99]   ⍝    SYNTHETIC FIRMS.
[100]  ⍝ (2)THE RANDOMIZED VALUES OF A COVARIES WITH B.
[101]  ⍝    THE VARIABLES A AND B ARE FIRM-VECTORS...
[102]  ⍝
[103]   SYNTH∆LABOUR←SYNTH∆LABOUR×(RES∆LABOUR÷(SYNTH∆SUM1 SYNTH∆LABOUR))[
       S∆MARKET]
[104]   L←REAL∆LABOUR,SYNTH∆LABOUR
[105]  ⍝
[106]  ⍝
[107]  ⍝
[108]  ⍝EXPORT FRACTIONS   (EXPORTS÷SALES)   :
[109]  ⍝XM=  EXPORT-SHARE (MARKET-AVERAGE). FROM
[110]  ⍝IO-MATRIX. XM IS A VECTOR OF LENGTH=4 .
[111]  ⍝SALES IS APPROXIMATED WITH PRODUCTION.
[112]   XM←4⍴0
[113]   XM←IO76[⍳4;18]÷IO76[14;⍳4]
[114]  ⍝XM←EXPORTS (MARKETS 1,2,3,4) ÷ PRODUCTION (MARKETS 1,2,3,4)
[115]   REAL∆RATIO←(X[;7]÷(+/X[; 7 12]))
[116]   SYNTH∆RATIO←REAL∆RATIO RANDOMIZE S
[117]   RES∆EXPORT←(XM×(SUM1 S))-REAL∆SUM1(REAL∆RATIO×REAL∆SALES)
[118]   SYNTH∆RATIO←SYNTH∆RATIO×(RES∆EXPORT÷(SYNTH∆SUM1(SYNTH∆RATIO×
       SYNTH∆SALES)))[S∆MARKET]
[119]   X←REAL∆RATIO,SYNTH∆RATIO
[120]   'TEST PA EXPORTANDEL:X>0.95   '
```

Part 1 The Initialization Code

```
 (X<0)∨(X>0.95)
 X←0⌈0.95⌊X
⍝
⍝
⍝
⍝
⍝PRICES
 P←(⍴MARKET)⍴100
⍝
⍝
⍝INVENTORIES
⍝RATIO=ACTUAL STOCK-RATIO=STOCK÷SALES
 RATIO←(X[;48]÷100)USING S
 STO←(S÷P̄)×RATIO
⍝RATIO1=NORMAL  LEVEL OF STOCK-RATIO
 RATIO1←(X[;50]÷100)USING RATIO⌈0.01
⍝ NOTE WE ARE SETTING BIG, SMALL, ETC FOR EACH FIRM
 BIG←RATIO⌈(1+Δ←0.5)×RATIO1
 SMALL←RATIO⌊(1-Δ)×RATIO1
 BIG[HELP/⍳⍴BIG]←(HELP←(RATIO<(1-Δ)×RATIO1))/(2×RATIO1)-RATIO
 BIG←0⌈0.5⌊BIG
 SMALL[HELP/⍳⍴BIG]←(HELP←(RATIO>(1+Δ)×RATIO1))/(2×RATIO1)-RATIO
 SMALL←0⌈SMALL
 ΔK3ΔFINISH←S×RATIO-RATIO1
⍝ THAT WAS PRODUCT INVENTORIES..NEXT IS INPUT GOODS INVENTORIES.
⍝
⍝INPUTRATIO=(PURCHASES OF RAW MATERIALS)÷SALES
 INPUTRATIO←(X[;17]÷+/X[; 7 12])USING S
⍝
 RATIO1←(X[;44]÷100)USING INPUTRATIO
⍝ RATIO1=ACTUAL STOCK-RATIO.
 RATIO2←(X[;46]÷100)USING RATIO1⌈0.01
⍝RATIO2= NORMAL STOCK LEVEL.
 K3ΔIMED←S×INPUTRATIO×RATIO1
 IMBIG←RATIO1⌈(1+Δ)×RATIO2
 IMSMALL←RATIO1⌊(1-Δ)×RATIO2
 IMBIG[HELP/⍳⍴IMBIG]←(HELP←(RATIO1<(1-Δ)×RATIO2))/(2×RATIO2)-
RATIO1
 IMBIG←0⌈0.5⌊IMBIG
 IMSMALL[HELP/⍳⍴IMBIG]←(HELP←(RATIO1>(1+Δ)×RATIO2))/(2×RATIO2)-
RATIO1
 IMSMALL←0⌈IMSMALL
```

```
 BETA←IMBETA←0.5
 ΔK3ΔIMED←S×INPUTRATIO×RATIO1-RATIO2
⍝IMSTO  IS A FIRM×PRODUCT-MATRIX (=FIRM×10-MATRIX)
⍝MULT7 MULTIPLIES A MATRIX WITH A COLUMN-VECTOR.
⍝
⍝M  MULT7  V ,M=MATRIX M(I,J)  V=VECTOR V(I)
⍝RESULT: A  MATRIX WITH ELEMENTS  M(I,J)×V(I)
⍝
⍝ NEXT: SPREAD K3ΔIMED ACROSS SECTORS USING IO-MATRIX
 IMSTO←((((⍉IO)DIV7+/⍉IO)[MARKET;])MULT7 K3ΔIMED)÷100
⍝ NOTE: WE HAVE DIVIDED BY 100 ASSUMING BASE YEAR=START YEAR.
⍝IMSTO SHOULD BE IN FIXED PRICES,THUS DIVISION BY 100
⍝,WHICH IS THE PRICEINDEX FOR 1976
⍝ THE IDEA BEHIND THAT COMPUTATION WAS AS FOLLOWS:
⍝   (⍉IO)[1;] LOOKS LIKE A[1,1],......,A[1,10], WHERE
⍝   A[1,J]=FRACTION OF GROSS PRODUCTION IN SECTOR 1 ACCTD FOR BY
⍝     INPUTS FROM SECTOR J.
⍝   THEN A[1,J]÷SUM ON J OF A[1,J]  =  FRACTION OF INPUT GOODS
⍝     COMING FROM SECTOR J
⍝
⍝
⍝
⍝
⍝ COMPUTATION OF INPUT GOODS PURCHASES
 REALΔINP←X[;17]×1000000
 QCURR←S+ΔK3ΔFINISH
⍝
⍝QCURR=PRODUCTION IN CURRENT PRICES:SALES+CH. IN STOCK
⍝HELP (BELOW) IS TOTAL INPUT CONSUMPTION BY THE
⍝SYNTHETIC FIRM UNITS PER SECTOR (1,2,3,4).
⍝
 HELP←(+/(⍉IO)[⍳4;]MULT7 SUM1 QCURR)-(REALΔSUM1(REALΔINP-R↑
ΔK3ΔIMED))
 HELP←HELP+SYNTHΔSUM1(R↓ΔK3ΔIMED)
⍝ HELP=TOTAL INPUT GOODS PURCHASES BY THE SYNTHETIC UNITS (⍴HELP=4
)
⍝     IN EACH SECTOR
⍝ INP=INPUT GOOD PURCHASES FOR EACH PRODUCTION UNIT, SUMMED OVER S
ECTORS
⍝ ⍴INP = ⍴MARKETS
 INP←REALΔINP,(R↓S×INPUTRATIO)×(HELP÷(SYNTHΔSUM1 R↓S×INPUTRATIO))[
SΔMARKET]
```

Part 1 The Initialization Code

```
⍝
⍝ QIMQ=INP SPREAD ACROSS THE 10 SECTORS. JUST LIKE IMSTO ABOVE.
 QIMQ←((((⍉IO)DIV7+/⍉IO)[MARKET;])MULT7 INP)÷100
 QIMQ←QIMQ÷4
⍝ SAME COMMENT AS APPLIES TO THE DEFLATION OF IMSTO
⍝ VALUE ADDED
 VA←QCURR+ΔK3ΔIMED-INP
 DISPOSE1ΔFIRMS
⍝
⍝CONSUMPTION=INP-ΔK3ΔIMED=PURCHASES-CHANGE IN STOCK
⍝ VALUE ADDED=PRODUCTION-CONSUMPTION
⍝
 RESΔFORVF←SYNTHΔSUM1(R↓VA)
 FORVF←SUM1(VA)
 REALΔFORVF←R↑VA
 SYNTHΔFORVF←R↓VA
⍝FORVF,REALΔFORVF ETC. ARE USED  IN FUNCTION CONTROLS BELOW...
⍝
⍝
⍝
⍝
⍝
⍝ WAGES
 REALΔKRΔLON←X̲[;5]×1000000
 REALΔW←REALΔKRΔLON÷(R↑L)
 SYNTHΔW←R↓S×(RATIO←(REALΔKRΔLON÷REALΔSALES)USING L)÷L
 RESΔKRΔLON←LON-REALΔSUM1(REALΔW×(R↑L))
 SYNTHΔW←SYNTHΔW×(RESΔKRΔLON÷(SYNTHΔSUM1(R↓L)×SYNTHΔW))[S̲ΔMARKET]
 W←REALΔW,SYNTHΔW
 SYNTHΔKRΔLON←SYNTHΔW×(R↓L)
 DW←(¯1+(×/X̲[; 2 5])÷×/X̲[; 3 4])USING W
 QDW←DW÷4
 QW←((⍉((2,(⍴W))⍴(W,W+DW)))+.×(0.625,0.375))
 DVA←DS←(¯1+(+/X̲[; 7 12])÷+/X̲[; 6 11])USING DW
 QS←((⍉((2,(⍴S))⍴(S,S+DS)))+.×(0.625,0.375))÷4
 QVA←VA×(1+DVA÷4)÷4
⍝
⍝
⍝
⍝
⍝ MARGINS
 M←1-W×L÷VA
```

Part 1 The Initialization Code

```
[241]  M75←1-(X̲[;4]÷+/X̲[; 6 11])×R↑S÷VA
[242] ⍝ M75=PROFIT MARGIN 1975.
[243]  HELP←(R↑M)-M75
[244]  MHIST←0.5×(2×M)-CHM←HELP USING DS
[245] ⍝VARIABLES FOR FUNCTION CONTROL BELOW
[246] ⍝
[247]  OVERSKOTT←SUM1(M×VA)
[248]  SYNTH∆OVERSKOTT←R↓(M×VA)
[249]  REAL∆OVERSKOTT←R↑(M×VA)
[250]  DP←((R↑DS)-X̲[;26]÷100)USING DS
[251]  QP←((⍉((2,(ρP))ρ(P,P+DP)))+.×(0.625,0.375))
[252] ⍝ QUANTITIES
[253]  Q←(S+∆K3∆FINISH)÷P
[254]  QQ←(QS+∆K3∆FINISH÷4)÷QP
[255]  DQ←DS-DP
[256] ⍝ SOME VARIABLES ADDED 27 OCT 1980...
[257]  F∆INKOP←(INP-∆K3∆IMED)÷(100×Q)
[258] ⍝PURCHASING-SHARE PER FIRM =F∆INKOP
[259]  BRINKOP←4↑(+/[1]IO)
[260] ⍝PURCHASING SHARE PER MARKET =BRINKOP
[261]  SHARE←F∆INKOP÷BRINKOP[MARKET]
[262] ⍝SHARE IS USED IN THE MODEL IN THIS WAY:
[263] ⍝SHARE×(MARKET AVERAGE INPUT SHARE)=
[264] ⍝THE INDIVIDUAL INPUT SHARE FOR EACH FIRM.
[265] ⍝MARKET AVERAGE INPUT SHARE=BRINKOP[1]..BRINKOP[4]
[266] ⍝
[267] ⍝
[268] ⍝
[269] ⍝
[270] ⍝
[271] ⍝ A21 AND A22
[272]  A22←(-/X̲[; 30 32]÷100)USING A21←(-/X̲[; 32 26]÷100)USING M
[273]  A21←0⌈0.5⌊A21
[274]  A22←0.025⌈0.5⌊A22
[275] ⍝ MUST ENSURE A22>0 SO TEC CAN BE COMPUTED..
[276] ⍝ AMAN--BASED ON APPROXIMATION GIVEN IN INDUSTRIKONJUNKTUREN PAPER
[277]  AMAN←⍉(3,ρL)ρ(L×A21÷1+A21)÷3
[278] ⍝ EXPECTATIONS...NOTE THAT EXPDW SHOULD BE FIXED
[279]  HISTDS←EXPDS←(¯1+(+/X̲[; 8 13])÷+/X̲[; 7 12])USING DS
[280]  HISTDSDEV2←(HISTDSDEV←-0.02 BETWEEN(ρHISTDS)ρ0.02)*2
[281]  HISTDP←EXPDP←((R↑EXPDS)-X̲[;28]÷100)USING EXPDS
[282]  HISTDPDEV2←(HISTDPDEV←-0.02 BETWEEN(ρHISTDP)ρ0.02)*2
```

Part 1 The Initialization Code

```
 HISTDW←EXPDW←EXPDS-EXPDP
 HISTDWDEV2←(HISTDWDEV←-0.02 BETWEEN(ρHISTDW)ρ0.02)*2
⍝ PRODUCTION FUNCTION PARAMETERS.
 QTOP←(QQ×1+A21+A22)÷1-RES←(ρQQ)ρ0.5×RESMAX←0.2
 TEC←¯1×(⊛A22÷1+A21+A22)×QTOP÷L
 ENS(QQ-QFR1 L)<0.5
⍝ FINANCIAL VARIABLES
 K1BOOK←S×((÷/FΔDATA[F; 5 15])USING S)
 K1←S×((÷/FΔDATA[F; 26 15])USING K1BOOK)
 K2←K1BOOK×(((+/FΔDATA[F; 1 2 4 6])÷FΔDATA[F;5])USING K1)
 A←K1+K2+K1BOOK×((÷/FΔDATA[F; 3 5])USING S)
 BW←K1BOOK×(((+/FΔDATA[F; 8 9 10])÷FΔDATA[F;5])USING K1)
 BAD←(ρBW)ρ0
 QTDIV←SUM2 ¯0.25×K1BOOK×((÷/FΔDATA[F; 20 5])USING M)
 INVEFF←QTOP×QP÷K1
 QINV←S×(((+/X̲[; 21 24])÷+/X̲[; 7 12])USING S)÷4
 QINVLAG←QINV×̄1+(VA AVG1 DP¯DDIV 4)[DUR←3]
 TMINV← 2 1 1 0.5
 DELAYΔINV←⍉(3,ρQINV)ρQINV MULT1(4×TMINV)÷3
 RSUBSΔCASH←RSUBSΔEXTRA←L×0
⍝
⍝
 CONTROLS
⍝
⍝
⍝ CONSISTENCY-CONTROLS ARE MADE IN FUNCTION CONTROLS
⍝
 IOΔMATRIX
⍝IO-MATRIX IN F̲L̲O̲W̲S̲  IS WRITTEN OUT
⍝
 DISPOSE2ΔFIRMS
⍝THIS FUNCTION DELETES VARIABLES OF NO FURTHER USE
⍝
⍝ SOME VARIABLES NEEDED FOR NULLIFY AND SHRINK
 LEFT←MARKET=ORIGMARKET←MARKET
 'SIZEUTSKRIFT 3'
 ⍎')SIZE'
⍝
∇
```

Part 1 The Initialization Code

```
∇ ESTABLISHMENTSΔ91;R;F;ALPHA;SCALE;RATIO;RATIO1;RATIO2;HELP;FLAG;
  DUMMY;HELPΔINP
   ⍎')COPY SI82 X FΔDATA FIRMID   LIST RΔMARKET'
  ⍝FIRM-VARIABLES FROM WORKSPACE SI82.
  ⍝
  ⍝
  ⍝INPUT FROM FUNCTION MARKETS:IO (INPUT-OUTPUT-MATRIX)
  ⍝INPUT FROM ISTARTXX-FUNCTION: SYNTHΔFIRMS
  ⍝
  ⍝
  ⍝OUTPUT FROM THIS FUNCTION:
  ⍝MARKET,P,QP,DP,W,QW,DW,S,QS,DS,Q,QQ,DQ,
  ⍝L,EXPDP,EXPDS,EXPDW,HISTDP,HISTDS,HISTDW,
  ⍝HISTDPDEV2,HISTDWDEV2,HISTDSDEV2,MHIST,CHM
  ⍝VA,QIMQ,QVA,DVA,M,AMAN,STO,IMSTO,
  ⍝QTOP,TEC,QINV,QINVLAG,DELAYΔINV,K1,K1BOOK,K2,BW,
  ⍝QTDIV,RSUBSΔCASH,RSUBSΔEXTRA,RES,INVEFF,RESMAX,BETA,
  ⍝IMBETA,TMINV,BIG,SMALL,IMBIG,IMSMALL,FΔINKOP,BRINKOP,
  ⍝SHARE,X,ORIGMARKET,LEFT
  ⍝
  ⍝
  ⍝
  ⍝INFORMATION ABOUT INDATA:
  ⍝X IS FIRM-DATA.
  ⍝FΔDATA IS INDATA ABOUT FIRM-GROUPS.
  ⍝X IS A MATRIX WITH FIRST COMPONENT= FIRM
  ⍝AND SECOND COMPONENT= VARIABLE (SALES,LABOUR,ETC..).
  ⍝X CONSISTS MAINLY OF DATA FOR THE YEAR 1982.
  ⍝ 50 FIRST COLS. FROM SI-PLANNING SURVEY
  ⍝ 6 (ADDITIONAL) LAST FROM SERVICE SURVEY
  ⍝
  ⍝ REDUCTION ON LIST
  ⍝FIRMS WITH INCONSISTENT VARIABLES ARE OMITTED .
  L0:F←FIRMID[(X[;1]∊LIST)/⍳⍴X[;1]]
   NAMNΔMARKET←RΔMARKET[(X[;1]∊LIST)/⍳⍴X[;1]]
   ALPHA←(+/X[(X[;1]∊LIST)/⍳⍴X[;1]; 7 12])÷FΔDATA[F;31]
  ⍝ CHECK ON ALPHA
   →(0=⍴FLAG←(1<ALPHA+.×F∘.=⍳⌈/F)/⍳⌈/F)/L2
   HELP←⍳0
  ⍝ OLD: L1:HELP←HELP,F⍳1↑FLAG
```

Comment: **ESTABLISHMENTSΔ91** is used after dec. 1986 instead of **ESTABLISHMENTS**

Part 1 The Initialization Code

```
L1:HELP←HELP,ALPHA⍳⌊/ALPHA[((1↑FLAG)=F)/⍳⍴F]
 →(0<⍴FLAG←1↓FLAG)/L1
 'DROPPING ',(5 2 ⍕LIST[HELP]),' FROM LIST.'
 LIST←(~(⍳⍴LIST)∊HELP)/LIST
 →L0
L2:X←X[(X[;1]∊LIST)/⍳⍴X[;1];]
⍝
⍝
⍝
⍝ R=NUMBER OF REAL FIRMS.
⍝MARKET=VECTOR WITH MARKET NUMBERS FOR EACH FIRM,
⍝FOR EXAMPLE:  1 1 1 2 1 3 1 4 1 4 ...ETC.
⍝SΔMARKET=VECTOR WITH MARKET-NUMBERS FOR SYNTHETIC FIRMS.
⍝
 SΔMARKET←SYNTHΔFIRMS DUP⍳4
 MARKET←NAMNΔMARKET,SΔMARKET
 R←1↑⍴X
⍝
 'SIZE-UTSKRIFT 2'
 ⍎')SIZE'
⍝
⍝
⍝
⍝ SETTING SCALE FOR SYNTHETIC FIRMS:
 SCALE←⍳0
 SCALE←SCALE,SYNTHΔFIRMS[1]SCALE 0.05
 SCALE←SCALE,SYNTHΔFIRMS[2]SCALE 0.05
 SCALE←SCALE,SYNTHΔFIRMS[3]SCALE 0.05
 SCALE←SCALE,SYNTHΔFIRMS[4]SCALE 0.05
 ENS 1=SYNTHΔSUM1 SCALE
⍝
 ⎕RL←123476
⍝⎕RL YIELDS START-VALUE FOR PSEUDO-RANDOM-NUMBERS:
⍝THIS MEANS THAT THE SAME 'RANDOM-NUMBERS' WILL BE
⍝GENERATED IN DIFFERENT EXECUTIONS ,AS LONG AS ONE
⍝DOESN'T CHANGE ⎕RL.
⍝RANDOMNUMBERS OCCUR IN THE FUNCTIONS 'USING' AND 'RANDOMIZE'.
⍝
⍝
⍝
⍝
⍝
```

Part 1 The Initialization Code

```
⍝SALES:
⍝SUM1,REALΔSUM1,SYNTHΔSUM1 ETC. SUM FIRMVARIABLES TO
⍝MARKET-VARIABLES.A FIRM-VECTOR IS SUMMED UP TO A
⍝MARKET-VECTOR OF LENGTH 4.
 REALΔSALES←(+/X[; 7 12]×1000000)
 RESΔSALES←SALES̄82-REALΔSUM1(REALΔSALES)
 SYNTHΔSALES←SCALE×RESΔSALES[S̲ΔMARKET]
 S←REALΔSALES,SYNTHΔSALES
⍝
⍝
⍝
⍝LABOUR:
 REALΔLABOUR←X[;3]
 RESΔLABOUR←(T̄IM÷HOURSΔPERΔYEAR)-REALΔSUM1(REALΔLABOUR)
 SYNTHΔLABOUR←R↓S×RATIO←(REALΔLABOUR÷REALΔSALES)USING S
⍝
⍝FUNCTION 'USING' HAS THE FORM 'A USING B'
⍝FUNCTION 'USING' DOES:
⍝(1) EXTENDS VARIABLE A WITH RANDOMIZED VALUES FOR
⍝     SYNTHETIC FIRMS.
⍝ (2)THE RANDOMIZED VALUES OF A COVARIES WITH B.
⍝     THE VARIABLES A AND B ARE FIRM-VECTORS...
⍝
 SYNTHΔLABOUR←SYNTHΔLABOUR×(RESΔLABOUR÷(SYNTHΔSUM1 SYNTHΔLABOUR))[
SΔMARKET]
 L←REALΔLABOUR,SYNTHΔLABOUR
⍝
⍝
⍝
⍝EXPORT FRACTIONS   (EXPORTS÷SALES)  :
⍝XM=  EXPORT-SHARE (MARKET-AVERAGE). FROM
⍝IO-MATRIX. XM IS A VECTOR OF LENGTH=4 .
⍝SALES IS APPROXIMATED WITH PRODUCTION.
 XM←4⍴0
 XM←IO76[⍳4;18]÷IO76[14;⍳4]
⍝XM←EXPORTS (MARKETS 1,2,3,4) ÷ PRODUCTION (MARKETS 1,2,3,4)
 REALΔRATIO←(X[;7]÷(+/X[; 7 12]))
 SYNTHΔRATIO←R̄EALΔRATIŌ RANDOMIZE S
 RESΔEXPORT←(XM×(SUM1 S))-REALΔSUM1(REALΔRATIO×REALΔSALES)
 SYNTHΔRATIO←SYNTHΔRATIO×(RESΔEXPORT÷(SYNTHΔSUM1(SYNTHΔRATIO×
SYNTHΔSALES)))[S̲ΔMARKET]
 X←REALΔRATIO,S̄YNTHΔRATIO
```

Part 1 The Initialization Code

```
 'TEST PA EXPORTANDEL:X>0.95
 (X<0)∨(X>0.95)
 X←0⌈0.95⌊X
⍝
⍝
⍝
⍝
⍝PRICES
 P←(⍴MARKET)⍴100
⍝
⍝
⍝INVENTORIES
⍝RATIO=ACTUAL STOCK-RATIO=STOCK÷SALES
 RATIO←(X[;48]÷100)USING S
 STO←(S÷P)×RATIO
⍝RATIO1=NORMAL  LEVEL OF STOCK-RATIO
 RATIO1←(X[;50]÷100)USING RATIO⌈0.01
⍝ NOTE WE ARE SETTING BIG, SMALL, ETC FOR EACH FIRM
 BIG←RATIO⌈(1+Δ←0.5)×RATIO1
 SMALL←RATIO⌊(1-Δ)×RATIO1
 BIG[HELP/⍳⍴BIG]←(HELP←(RATIO<(1-Δ)×RATIO1))/(2×RATIO1)-RATIO
 BIG←0⌈0.5⌊BIG
 SMALL[HELP/⍳⍴BIG]←(HELP←(RATIO>(1+Δ)×RATIO1))/(2×RATIO1)-RATIO
 SMALL←0⌈SMALL
 ΔK3ΔFINISH←S×RATIO-RATIO1
⍝ THAT WAS PRODUCT INVENTORIES..NEXT IS INPUT GOODS INVENTORIES.
⍝
⍝INPUTRATIO=(PURCHASES OF RAW MATERIALS)÷SALES
 INPUTRATIO←(X[;17]÷+/X[; 7 12])USING S
⍝
 RATIO1←(X[;44]÷100)USING INPUTRATIO
⍝ RATIO1=ACTUAL STOCK-RATIO.
 RATIO2←(X[;46]÷100)USING RATIO1⌈0.01
⍝RATIO2= NORMAL STOCK LEVEL.
 K3ΔIMED←S×INPUTRATIO×RATIO1
 IMBIG←RATIO1⌈(1+Δ)×RATIO2
 IMSMALL←RATIO1⌊(1-Δ)×RATIO2
 IMBIG[HELP/⍳⍴IMBIG]←(HELP←(RATIO1<(1-Δ)×RATIO2))/(2×RATIO2)-
RATIO1
 IMBIG←0⌈0.5⌊IMBIG
 IMSMALL[HELP/⍳⍴IMBIG]←(HELP←(RATIO1>(1+Δ)×RATIO2))/(2×RATIO2)-
RATIO1
```

Part 1 The Initialization Code

```
[161]  IMSMALL←0⌈IMSMALL
[162]  BETA←IMBETA←0.5
[163]  ΔK3ΔIMED←S×INPUTRATIO×RATIO1-RATIO2
[164] ⍝IMSTO  IS A FIRM×PRODUCT-MATRIX (=FIRM×10-MATRIX)
[165] ⍝MULT7 MULTIPLIES A MATRIX WITH A COLUMN-VECTOR.
[166] ⍝
[167] ⍝M  MULT7  V .M=MATRIX M(I,J)  V=VECTOR V(I)
[168] ⍝RESULT: A  MATRIX WITH ELEMENTS  M(I,J)×V(I)
[169] ⍝
[170] ⍝ NEXT: SPREAD K3ΔIMED ACROSS SECTORS USING IO-MATRIX
[171]  IMSTO←((((⍉IO)DIV7+/⍉IO)[MARKET;])MULT7 K3ΔIMED)÷100
[172] ⍝ NOTE: WE HAVE DIVIDED BY 100 ASSUMING BASE YEAR=START YEAR.
[173] ⍝IMSTO SHOULD BE IN FIXED PRICES,THUS DIVISION BY 100
[174] ⍝,WHICH IS THE PRICEINDEX FOR 1976
[175] ⍝ THE IDEA BEHIND THAT COMPUTATION WAS AS FOLLOWS:
[176] ⍝   (⍉IO)[1;] LOOKS LIKE A[1,1],.....,A[1,10], WHERE
[177] ⍝   A[1,J]=FRACTION OF GROSS PRODUCTION IN SECTOR 1 ACCTD FOR BY
[178] ⍝     INPUTS FROM SECTOR J.
[179] ⍝   THEN A[1,J]÷SUM ON J OF A[1,J]  =  FRACTION OF INPUT GOODS
[180] ⍝     COMING FROM SECTOR J
[181] ⍝
[182] ⍝
[183] ⍝
[184] ⍝
[185] ⍝ COMPUTATION OF INPUT GOODS PURCHASES
[186]  REALΔINP←X[;17]×1000000
[187]  QCURR←S+ΔK3ΔFINISH
[188] ⍝QCURR=PRODUCTION IN CURRENT PRICES:SALES+CH. IN STOCK
[189] ⍝HELP (BELOW) IS TOTAL INPUT CONSUMPTION BY THE
[190] ⍝SYNTHETIC FIRM UNITS PER SECTOR (1,2,3,4).
[191] ⍝
[192] ⍝ HELPΔINP←(+/(⍉IO)[⍳4;]MULT7 SUM1 QCURR)-(REALΔSUM1(REALΔINP-R↑ΔK
      3ΔIMED))
[193] ⍝ HELPΔINP←HELPΔINP+SYNTHΔSUM1(R↓ΔK3ΔIMED)
[194] ⍝ HELP=TOTAL INPUT GOODS PURCHASES BY THE SYNTHETIC UNITS (⍴HELP=4
      )
[195] ⍝     IN EACH SECTOR
[196] ⍝ INP=INPUT GOOD PURCHASES FOR EACH PRODUCTION UNIT, SUMMED OVER S
      ECTORS
[197] ⍝ ⍴INP = ⍴MARKETS
[198] ⍝ INPΔOLD←REALΔINP,(R↓S×INPUTRATIO)×(HELPΔINP÷(SYNTHΔSUM1 R↓S×INPU
      TRATIO))[SΔMARKET]
```

Part 1   The Initialization Code

```
⍝ INP←INP∆OLD
⍝
⍝ INP←(REAL∆INP×1.1),(SYNTH∆INP←(R↓S×INPUTRATIO)×1.5)
 SCB∆INP←(+/(⍉IO)[⍳4;]MULT7 SUM1 QCURR)
⍝ HELP∆INP←SCB∆INP-SUM1(INP-∆K3∆IMED)
 INPMA←SCB∆INP÷SUM1 QCURR
⍝ XID←((100×(INPMA[MARKET]-INP÷QCURR))>0)×⍳⍴MARKET
⍝ MARKET1←(XID≠0)/MARKET
⍝ POSQCURR←(XID≠0)/QCURR
⍝ MSPQCURR←SUM11 POSQCURR
⍝ POSINP←(XID≠0)/INP
⍝ XINP←SUM11(INPMA[MARKET1]-POSINP÷POSQCURR)
⍝ XINP∆FRAC←0⌈(INPMA[MARKET]-INP÷QCURR)÷XINP[MARKET]
⍝ E∆INP←XINP∆FRAC×QCURR
⍝ EXTRA∆INP←E∆INP×(HELP∆INP÷SUM1 E∆INP)[MARKET]
⍝ INP←INP+EXTRA∆INP
⍝
 REAL∆INP←REAL∆INP×1.2
 INPMA∆1←(¯0.05 0 0 0)+INPMA
 HELP∆INP←INPMA∆1[NAMN∆MARKET]×((R↑QCURR)÷(REAL∆INP-R↑∆K3∆IMED))
 REAL∆INP←REAL∆INP×HELP∆INP
 RES∆INP←SCB∆INP-REAL∆SUM1(REAL∆INP-R↑∆K3∆IMED)
 RES∆INP←RES∆INP+SYNTH∆SUM1(R↓∆K3∆IMED)
 SYNTH∆INP←SCALE×RES∆INP[S̲∆MARKET]
 INP←REAL∆INP,SYNTH∆INP
 REAL∆INPMA←(REAL∆SUM1 REAL∆INP)÷(REAL∆SUM1 R↑QCURR)
 RES∆INPMA←RES∆INP÷SYNTH∆SUM1 R↓QCURR
 ⎕ ←'   INPMA      REAL∆INPMA    RES∆INPMA'
 ⎕ ←'F8.4'$(INPMA;REAL∆INPMA;RES∆INPMA)
⍝ INPUT∆ANDEL←(REAL∆INP÷(R↑S))USING(1⍴0)
⍝ INP←INPUT∆ANDEL×S
⍝
⍝ QIMQ=INP SPREAD ACROSS THE 10 SECTORS. JUST LIKE IMSTO ABOVE.
 QIMQ←((((⍉IO)DIV7+/⍉IO)[MARKET;])MULT7 INP)÷100
 QIMQ←QIMQ÷4
⍝ SAME COMMENT AS APPLIES TO THE DEFLATION OF IMSTO
⍝ VALUE ADDED
⍝ INP←INP⌊(0.9×QCURR)
 VA←QCURR+∆K3∆IMED-INP
 SCB∆VA←IO82[12;⍳4]
 HELP∆VA←SCB∆VA-SUM1 VA
 ⎕ ←'SCB∆VA,RES∆VA'
```

Part 1 The Initialization Code

```
 ⎕ ←SCBΔVA,HELPΔVA
⍝ VA←QCURR+ΔK3ΔIMED−(INPL(0.9×QCURR))
⍝ VA←QCURR+ΔK3ΔIMED−(INP+(OTHΔPURCH×INP))
⍝ DISPOSE1ΔFIRMS
⍝
⍝CONSUMPTION=INP−ΔK3ΔIMED=PURCHASES−CHANGE IN STOCK
⍝ VALUE ADDED=PRODUCTION−CONSUMPTION
⍝
 RESΔFORVF←SYNTHΔSUM1(R↓VA)
 FORVF←SUM1(VA)
 REALΔFORVF←R↑VA
 SYNTHΔFORVF←R↓VA
⍝FORVF,REALΔFORVF ETC. ARE USED  IN FUNCTION CONTROLS BELOW...
⍝
⍝
⍝
⍝
⍝
⍝ WAGES
 REALΔKRΔLON←X[;5]×1000000
 REALΔW←REALΔKRΔLON÷(R↑L)
 SYNTHΔW←R↓(REALΔW USING(1⍴0))
 RESΔKRΔLON←LON−REALΔSUM1(REALΔW×(R↑L))
⍝
 SYNTHΔW←SYNTHΔW×(RESΔKRΔLON÷(SYNTHΔSUM1(R↓L)×SYNTHΔW))[SΔMARKET]
 W←REALΔW,SYNTHΔW
 SYNTHΔKRΔLON←SYNTHΔW×(R↓L)
 DW←(¯1+(×/X[; 2 5])÷×/X[; 3 4])USING W
 QDW←DW÷4
 QW←((⍉((2,(⍴W))⍴(W,W+DW)))+.×(0.625,0.375))
 DVA←DS←(¯1+(+/X[; 7 12])÷+/X[; 6 11])USING DW
 QS←((⍉((2,(⍴S))⍴(S,S+DS)))+.×(0.625,0.375))÷4
 QVA←VA×(1+DVA÷4)÷4
⍝
⍝
⍝
⍝ MARGINS
 M←1−W×L÷VA
 M75←1−(X[;4]÷+/X[; 6 11])×R↑S÷VA
⍝ M75=PROFIT MARGIN 1975.
 HELP←(R↑M)−M75
 MHIST←0.5×(2×M)−CHM←HELP USING DS
```

Part 1 The Initialization Code

```
⍝VARIABLES FOR FUNCTION CONTROL BELOW
⍝
 OVERSKOTT←SUM1(M×VA)
 SYNTH∆OVERSKOTT←R↓(M×VA)
 REAL∆OVERSKOTT←R↑(M×VA)
 DP←((R↑DS)-X[;26]÷100)USING DS
 QP←((⍉((2,(⍴P))⍴(P,P+DP)))+.×(0.625,0.375))
⍝ QUANTITIES
 Q←(S+∆K3∆FINISH)÷P
 QQ←(QS+∆K3∆FINISH÷4)÷QP
 DQ←DS-DP
⍝ SOME VARIABLES ADDED 27 OCT 1980...
 F∆INKOP←(INP-∆K3∆IMED)÷(100×Q)
⍝PURCHASING-SHARE PER FIRM =F∆INKOP
 BRINKOP←4↑(+/[1]IO)
 ⎕ ←'BRINKOP'
 ⎕ ←BRINKOP
⍝PURCHASING SHARE PER MARKET =BRINKOP
 SHARE←F∆INKOP÷BRINKOP[MARKET]
⍝SHARE IS USED IN THE MODEL IN THIS WAY:
⍝SHARE×(MARKET AVERAGE INPUT SHARE)=
⍝THE INDIVIDUAL INPUT SHARE FOR EACH FIRM.
⍝MARKET AVERAGE INPUT SHARE=BRINKOP[1]..BRINKOP[4]
⍝
⍝
⍝
⍝
⍝
⍝ A21 AND A22
 A22←(-/X[; 30 32]÷100)USING A21←(-/X[; 32 26]÷100)USING M
 A21←0⌈0.5⌊A21
 A22←0.025⌈0.5⌊A22
⍝ MUST ENSURE A22>0 SO TEC CAN BE COMPUTED..
⍝ AMAN--BASED ON APPROXIMATION GIVEN IN INDUSTRIKONJUNKTUREN PAPER
 AMAN←⍉(3,⍴L)⍴(L×A21÷1+A21)÷3
⍝ EXPECTATIONS...NOTE THAT EXPDW SHOULD BE FIXED
 HISTDS←EXPDS←(¯1+(+/X[; 8 13])÷+/X[; 7 12])USING DS
 HISTDSDEV2←(HISTDSDEV←-0.02 BETWEEN(⍴HISTDS)⍴0.02)*2
 HISTDP←EXPDP←((R↑EXPDS)-X[;28]÷100)USING EXPDS
 HISTDPDEV2←(HISTDPDEV←-0.02 BETWEEN(⍴HISTDP)⍴0.02)*2
 HISTDW←EXPDW←EXPDS-EXPDP
 HISTDWDEV2←(HISTDWDEV←-0.02 BETWEEN(⍴HISTDW)⍴0.02)*2
```

Part 1 The Initialization Code

```
⍝ PRODUCTION FUNCTION PARAMETERS.
 QTOP←(QQ×1+A21+A22)÷1−RES←(⍴QQ)⍴0.5×RESMAX←0.2
 TEC←¯1×(⍟A22÷1+A21+A22)×QTOP÷L
 ENS(QQ−QFR1 L)<0.5
⍝ FINANCIAL VARIABLES
 K1BOOK←S×((÷/FΔDATA[F; 22 31])USING S)
 K1←S×((÷/FΔDATA[F; 11 31])USING K1BOOK)
 K2←K1BOOK×(((+/FΔDATA[F; 3 4 6 8 9 10])÷FΔDATA[F;22])USING K1)
 A←K1+K2+K1BOOK×((÷/FΔDATA[F; 5 22])USING S)
 BW←K1BOOK×(((+/FΔDATA[F; 16 17])÷FΔDATA[F;22])USING K1)
 BAD←(⍴BW)⍴0
 QTDIV←SUM2 ¯0.25×K1BOOK×((÷/FΔDATA[F; 47 22])USING M)
 INVEFF←QTOP×QP÷K1
 QINV←S×(((+/X̲[; 21 24])÷+/X̲[; 7 12])USING S)÷4
⍝ FOR MACRO CŌNSISTENT MICRŌ INVESTMENT
 RESΔQINV←SCB82ΔQINV−SUM1 QINV
 EXTRAΔQINV←RESΔQINV[MARKET]×QINV÷((SUM1 QINV)[MARKET])
 QINV←QINV+EXTRAΔQINV
⍝
 QINVLAG←QINV×1+(VA AVG1 DP DDIV 4)[DUR←3]
 TMINV← 2 1 1 0.5
 DELAYΔINV←⍉(3,⍴QINV)⍴QINV MULT1(4×TMINV)÷3
 RSUBSΔCASH←RSUBSΔEXTRA←L×0
⍝ STANNA
⍝
 CONTROLS
⍝
⍝
⍝ CONSISTENCY-CONTROLS ARE MADE IN FUNCTION CONTROLS
⍝
 IOΔMATRIX
⍝IO-MATRIX IN F̲L̲O̲W̲S̲  IS WRITTEN OUT
⍝
⍝ DISPOSE2ΔFIRMS
 STOP
⍝ SOME VARIABLES NEEDED FOR NULLIFY AND SHRINK
 LEFT←MARKET=ORIGMARKET←MARKET
 'SIZEUTSKRIFT 3'
 ⍎')SIZE'
⍝
    ∇
```

Part 1 The Initialization Code

```
    ∇  OUT←REAL USING V
[1]    OUT←REAL,(REAL RANDOMIZE V)
    ∇


    ∇  C←A RANDOMIZE B;D;E;AID
[1]    C←((REALΔSUM1 A)÷+/NAMNΔMARKET∘.=⍳4)[SΔMARKET]
[2]   ⍝ EACH ELEMENT OF C EQUALS CORRESPONDING REAL MARKET  AVERAGE
[3]    →((0=B)∧1=⍴B)/END
[4]   ⍝ IF B=0, SKIP CORRELATION ASPECT
[5]    D←(⍴NAMNΔMARKET)↑B
[6]    E←(⍴D)↓B
[7]   ⍝ HELP VBLES: D=REAL PART OF B, E=SYNTHETIC PART OF B
[8]    AID←E-((E+.×SΔMARKET∘.=⍳4)÷+/SΔMARKET∘.=⍳4)[SΔMARKET]
[9]   ⍝ AID=DEVIATION OF ELEMENTS OF E FROM THEIR MKT AVERAGES
[10]   C←C+AID×((+/(DEV D)×DEV A)÷+/(DEV E)*2)×(⍴E)÷⍴D
[11]  ⍝ THAT USED THE APPROXIMATION COV(C,E)=COV(A,D)
[12]  END:AID←A-((A+.×NAMNΔMARKET∘.=⍳4)÷+/NAMNΔMARKET∘.=⍳4)[NAMNΔMARKET]
[13]  ⍝ AID=DEVIATION OF ELEMENTS OF A FROM THEIR MKT AVERAGES
[14]   C←C+((¯50+(⍴C)?100)÷50)×(((REALΔSUM1 AID*2)÷+/NAMNΔMARKET∘.=⍳4)*
      0.5)[SΔMARKET]
[15]  ⍝ C[I;J]=C[I]×(1+EPS[I,J])×SD(A[I])
[16]  ⍝ WHERE: C[I]=C FOR MARKET I AS COMPUTED ABOVE
[17]  ⍝        EPS[I,J] IS UNIFORM OVER [¯0.5, 0.5]
[18]  ⍝        SD(:)=STANDARD DEVIATION OF A ON THE ITH MARKET
    ∇
```

Part 1 The Initialization Code

```
    ∇  CONTROLS;DIFF
     ⍝
      ENS(LON+OVERSKOTT)=FORVF
      ENS LON=(REALΔSUM1 REALΔKRΔLON)+(SYNTHΔSUM1 SYNTHΔKRΔLON)
      ENS OVERSKOTT=(REALΔSUM1 REALΔOVERSKOTT)+(SYNTHΔSUM1
     SYNTHΔOVERSKOTT)
      ENS FORVF=(REALΔSUM1 REALΔFORVF)+(SYNTHΔSUM1 SYNTHΔFORVF)
      DIFF←SALES76-(SUM1 S)
      ENS DIFF≤1.000000000E¯6 ×(SUM1 S)
      ENS(TIM÷HOURSΔPERΔYEAR)=(REALΔSUM1 REALΔLABOUR)+SYNTHΔSUM1
     SYNTHΔLABOUR
      ENS(REALΔFORVF-(REALΔKRΔLON+REALΔOVERSKOTT))≤1.000000000E¯7
      ENS(SYNTHΔFORVF-(SYNTHΔKRΔLON+SYNTHΔOVERSKOTT))≤1.000000000E¯7
      ENS(SYNTHΔSUM1(SYNTHΔW×SYNTHΔLABOUR))=SYNTHΔSUM1(SYNTHΔKRΔLON)
      ENS(REALΔSUM1(REALΔW×REALΔLABOUR))=REALΔSUM1(REALΔKRΔLON)
      ENS(SYNTHΔSUM1((R↓M)×SYNTHΔFORVF))=SYNTHΔSUM1(SYNTHΔOVERSKOTT)
      ENS(REALΔSUM1((R↑M)×REALΔFORVF))=REALΔSUM1(REALΔOVERSKOTT)
      ENS X≥0
      ENS X≤1
      ENS((SUM1 VA)÷(SUM1 QCURR))=(1-BRINKOP[⍳4])
      ENS((SUM1(INP-ΔK3ΔIMED))÷(SUM1 QCURR))=(BRINKOP[⍳4])
      DIFF←(XM×SUM1 S)-(SUM1 X×S)
      ENS DIFF≤(0.01×SUM1 S)
    ∇
```

Part 1 The Initialization Code

```
∇ IO∆MATRIX;MA;PROD;CHAR;RESIDUAL;SWEDISH∆DEMAND
⍝THIS FUNCTION DOES:
⍝(1)    AN INPUT-OUTPUT MATRIX FOR THE SWEDISH
⍝       ECONOMY IN FLOWS IS PRINTED OUT.
⍝       THE INITIALIZED VARIABLES ARE USED.
⍝(2)    VERTICAL SUM SHOULD BY DEFINITION BE
⍝       EQUAL TO HORIZONTAL SUM.THE UNEXPLAINED
⍝       RESIDUAL IS PRINTED OUT.
⍝
⍝
⍝
 'DO YOU WANT THE INPUT-OUTPUT-MATRIX PRINTED OUT?'
 'YES OR NO :    '
 CHAR←⍞
 →(∧/(CHAR[1 2]='NO'))/0
⍝
 MA←IO76
 PROD←SUM1(Q×100)
 MA[;⍳4]←(IOCOEFF76[;⍳4],[1]1)MULT8(PROD÷10*6)
⍝ THE FIRST 4 COLUMNS IN MA ARE REPLACED WITH FLOWS
⍝ COMING FROM INITIALIZATION.
⍝ COLUMN 5..10 UNCHANGED.
 MA[⍳13;11]←(GKOFF×WG×LG÷10*6),(0,0,0)
 MA[14;11]←+/[1]MA[⍳13;11]
 MA[⍳13;12]←(HH76×4×QDI∆INIT2÷10*6),(0,0,0)
⍝ QDI∆INIT2 YIELDS THE HOUSEHOLD'S DISPOSABLE INCOME
 MA[14;12]←+/[1]MA[⍳13;12]
 MA[;13]←(OMEGAG×QINVG×4÷10*6),(0,0,0,4×QINVG÷10*6)
 MA[;14]←(OMEGABLD×QINVBLD×4÷10*6),(0,0,0,QINVBLD×4÷10*6)
 MA[;15]←(OMEGAIN×QINVIN×4÷10*6),(0,0,0,4×QINVIN÷10*6)
 MA[;16]←(OMEGA×(+/QINV)×4÷10*6),(0,0,0,4×(+/QINV)÷10*6)
⍝
 MA[⍳13;17]←(+/(∆K3∆IMED+∆K3∆FINISH)÷10*6)×IOCOEFF76[⍳13;17]
 MA[14;17]←+/[1]MA[⍳13;17]
⍝
 MA[1 2 3 4 ;18]←(SUM1(X×S))÷10*6
 MA[14;18]←+/[1]MA[⍳13;18]
⍝
 SWEDISH∆DEMAND←+/MA[⍳10;⍳17]
 MA[⍳13;19]←(IMP×SWEDISH∆DEMAND),(0,0,0)
```

Part 1 The Initialization Code

```
 MA[14;19]←+/[1]MA[⍳13;19]
 MA[;19]←(¯1)×MA[;19]
⍝
 MA[⍳13;21]←MA[14;⍳10],(0,0,0)
 MA[14;21]←+/[1]MA[⍳13;21]
⍝
 RESIDUAL←MA[;21]-((+/MA[⍳10;⍳20]),(0,0,0),(+/MA[14;⍳20]))
⍝
⍝*********O*******************
⍝
 ⎕PW←110
⍝PAGE WIDTH
 'INPUT-OUTPUT MATRIX FROM INITIALIZATION: '
 80ρ' '
 '       1         2          3         4          5          6         7
8        9         10'
 80ρ' '
 (8,0)⍕MA[;⍳10]
 80ρ' '
 '        11        12        13        14        15        16        17        18
       19        20        21'
 80ρ' '
 (8,0)⍕MA[;10+⍳11]
 'ROW 1: RAW MATERIAL SECTOR '
 'ROW 2: INTERMEDIATE GOODS  '
 'ROW 3: INVESTMENT GOODS AND CONSUMER DURABLE GOODS'
 'ROW 4: CONSUMPTION GOODS '
 'ROW 5: AGRICULTURE,FORESTRY,FISHING '
 'ROW 6: MINING AND QUARRYING '
 'ROW 7:   OIL  '
 'ROW 8 : CONSTRUCTION  '
 'ROW 9 : ELECTRICITY '
 'ROW 10: OTHER SERVICIES '
 'ROW 11: COMMODITY BASED INDIRECT TAXES '
 'ROW 12: VALUE ADDED  IN PRODUCER''S PRICES '
 'ROW 13: CORRECTIONS'
 'ROW 14: SUM =PRODUCTION '
 'COLUMN 1,2 THROUGH 10 = CORRESPONDING ROWS '
 'COLUMN 11: GOVERNMENT''S CONSUMPTION '
 'COLUMN 12: HOUSEHOLDS''S CONSUMPTION '
 'COLUMN 13: GOVERNMENT''S INVESTMENTS '
 'COLUMN 14: INVESTMENTS,BUILDINGS '
```

Part 1 The Initialization Code

```
[80]   'COLUMN 15: INVESTMENTS IN SECTOR 6..10 '
[81]   'COLUMN 16: OTHER INVESTMENTS '
[82]   'COLUMN 17: CHANGE IN STOCK '
[83]   'COLUMN 18: EXPORTS '
[84]   'COLUMN 19: IMPORTS '
[85]   'COLUMN 20: MOMS ETC. '
[86]   'COLUMN 21: HORIZONTAL SUM=PRODUCTION '
[87]   80⍴' '
[88]   'RESIDUAL '
[89]   RESIDUAL
[90]  ⍝
[91]  ⍝MADE BY FREDRIK BERGHOLM DEC 1981.....
    ∇
```

```
    ∇  MARKETSΔDATA;TMEXP;TMTARG
[1]   ⍝

[2]    NPER←4
[3]    DUR←3
[4]    MKT←⍳4
[5]    IN←4+⍳6
[6]   ⍝

[7]    RET←¯1+1.035*(1÷4)
[8]    ENTRY←RET+0.0068÷NPER
[9]    EXPXDP←0.03
[10]   EXPXDW←0.07
[11]   EXPXDS←0.07
[12]   R←0.5
[13]   E1←0.1
[14]   E2←0
[15]   SMP←SMW←SMS←1-2÷1+TMEXP←3
[16]   FIP←FIW←FIS←(1-R)×2÷1+NPER×TMEXP
[17]   SMT←1-2÷1+TMTARG←3
[18]  ⍝

[19]   GAMMA←0.1
[20]   THETA←0.01
[21]   KSI←0.25
[22]   SKREPA←50
[23]   IOTA←0.5
[24]   NITER←9
[25]  ⍝

[26]   TMSTO←1
[27]  ⍝

[28]   TMIMSTO←1
[29]  ⍝

[30]   RHO←¯1+(1+1÷35)*(1÷4)
[31]   RHOBOOK←¯1+(1.15)*(1÷4)
[32]   QDMTEC←¯1+(1.056 1.03 1.026 1.004)*(1÷4)
[33]  ⍝ RESMAX←0.2 IS SET IN ESTABLISHMENTS...
```

Part 1 The Initialization Code

```
 LOSS←0.1
 RESDOWN←0.9
 WTIX←1
⍝

 RW←K2÷S
 ALFABW←0.075÷NPER
 BETABW←1
 UTREF←0.85
 ELINV←3
 RTD←1
⍝TMINV IS SET IN ESTABLISHMENTS
⍝

 EPS←0
 TMX← 3 3 3 3
 TMIMP← 3 3 3 3
⍝

 RLU←0.6
 MAXDP←0.06
∇
```

```
∇ SECONDARYΔDATA;MTECΔPERΔFIRM
⍝VARIABLES WHICH WILL BE OUTPUT FROM INITIALIZATION:
⍝MTEC,LU,QDWIND
⍝RUΔCOPY IS A COPY OF RU WHICH COMES FROM INPUTFILE.
⍝L,QW,QDW,QDMTEC,TEC COMES FROM ESTABLISHMENTS
⍝GROWTH COMES FROM INPUTFILE (INITΔGROWTH=GROWTH)
⍝LG COMES FROM FUNCTION PUBLICΔSECTOR
 LU←(LG+SUM2(L))×RUΔCOPY÷(1-RUΔCOPY)
⍝LG+SUM2 L=WORKING LABOUR FORCE=TOTAL LABOUR FORCE-UNEMPLOYED
⍝UNEMPLOYED=R×'WORKING LABOUR FORCE'
⍝WHERE R SHOULD BE UNEMPLOYED÷WORKING LABOUR FORCE
⍝SINCE RU IS DEFINED AS UNEMPLOYED÷TOTAL LABOUR FORCE R=   RU÷(1-R
U)...
 QDWIND←¯1+(L AVG2 QW×(1+QDW))÷(L AVG2 QW)
 MTECΔPERΔFIRM←TEC DIV1(1-QDMTEC÷((RHO+GROWTH)*(1÷4)))
 MTEC←L AVG1 MTECΔPERΔFIRM
⍝AVG1 YIELDS MARKET-AVERAGES FROM FIRMS-DATA (MTECΔPERΔFIRM) WEIGH
TED BY LABOUR-SHARES (L÷SUM L)
 ENS 0<MTEC
∇
```

Part 1 The Initialization Code

```
    ∇  PUBLICAΔDATA
[1]    ⍝ VARIABLES WHICH WILL BE OUTPUT FROM INITIALIZATION: WSG RTRANS,T
      STOCURF,TSTOCURM
[2]     WSG←WG×LG
[3]     RTRANS←0.5
[4]    ⍝TSTOCURF IS A MARKET-VECTOR (4 MARKETS).FUNCTION SUM1 TRANSFORMS
      FIRMS-DATA TO MARKET-DATA...
[5]     TSTOCURF←SUM1(STO×QP)
[6]     TSTOCURM←QPDOM[⍳4]×(SUM1 STO)
    ∇
```

```
    ∇  MONETARYΔDATA
[1]    ⍝ALL VARIABLES BELOW WILL BE OUTPUT FROM INITIALIZATION
[2]     POSGFOR←0
[3]     TMFASS←3÷12
[4]     TMFD←2÷12
[5]     FD←FASS←(SUM2 X×S)×TMFASS
[6]     KAPPA1←0.02
[7]     KAPPA2←0.3
[8]     RFUND1←0.5
[9]     RFUND2←0.25
[10]    LAMDA1←0.6
[11]    LAMDA2←0.8
[12]    MAXQCHRI←0.01
[13]    MB←0.015
[14]    MAXRIDIFF←0.05
[15]    RIΔISΔEXOGENOUS←1
[16]    MINRI←MB
[17]    MAXRI←0.25
[18]    FUNDSΔAREΔENOUGH←0
[19]    REDCHBW←0.15
    ∇
```

Part 1 The Initialization Code

```
    ∇ HOUSEHOLDS∆DATA;PRICECHANGES;DUR
      ⍝INPUT TO THIS FUNCTION:
      ⍝GKOFF,LG,WG,L,QW,QTDIV,LU,QDWIND FROM FUNCTION PUBLIC∆SECTOR,ESTA
      BLISHMENT,SECONDARY∆DATA
      ⍝QPDOM,QDPFOR,QDPIN FROM FUNCTION ESTABLISHMENTS
      ⍝RTRANS,RLU,RHO  FROM FUNCTION MARKETS∆DATA
      ⍝TXI1,TXW,TXWG,QINPAY,RI (INDIRECTLY) FROM WORKSPACE MACRO
      ⍝HH76,WHSUM  FROM HOUSEHOLDS...
      ⍝xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
      ⍝OUTPUT FROM THIS FUNCTION,WHICH WILL BE FINAL OUTPUT FROM INITIAL
      IZATION:
      ⍝Z,SAV,NDUR,NDUR∆DUR,NH,WH,WHRA,QPH,QC,CVA,QDCPI,QCPI,QDI
      ⍝QSAVHREQ,RHODUR,STODUR,ALFA AND BETA-COEFFICIENTS,SMOOTH  ,MARKET
      ∆ITER...
      ⍝
       DUR←3
       NDUR∆DUR←⍳11
       Z←11
       SAV←12
       NDUR←(DUR≠⍳11)/⍳11
      ⍝NDUR,Z,SAV ARE INDEX-VARIABLES...
       NH←LG+(SUM2 L)+LU
       WH←WHSUM÷NH
       QDI∆INIT
      ⍝FUNCTION QDI∆INIT IS CALLED TO GIVE A VALUE TO QDI,AND THIS IS TH
      E ONLY PURPOSE OF THIS FUNCTION.QDI=DISPOSABLE INCOME
       WHRA←WH÷QDI
       QPH←QPDOM,0
      ⍝QPH USED TO BE A VECTOR OF LENGTH 11.QPH(11) WAS THE PRICE IN THE
       SERVICE SECTOR.THERE IS NO LONGER AN ELEVENTH SERVICE- SECTOR,SO
      QPH=QPDOM.FOR TECHNICAL REASONS WE SEE TO THAT QPH
      ⍝HAS THE LENGTH 11 DESPITE THIS,FOR THE TIME BEING,WHERE WE WILL H
      AVE A REDUNDANT 0 AT THE END...
       QC←(HH76×QDI),0
       QC←(1,⍴QC)⍴QC
       QC←⍉QC
      ⍝QC AND CVA MUST BE COLUMN-VECTORS FOR TECHNICAL REASONS...
      ⍝SEE MOSES-FUNCTION CPI1...
       CVA←QC DIV7 QPH
       QCPI←CPI1(QPH)
```

Part 1 The Initialization Code

```
[33]  PRICECHANGES←QDPFOR,QDPIN,0
[34]  QDCPI←(PRICECHANGES+.×,QC)÷(+/,QC)
[35]  QSAVHREQ←0
[36] ⍝
[37]  RHODUR←RHO
[38]  STODUR←QPH[DUR]×CVA[DUR;1]÷RHODUR
[39] ⍝
[40]  ALFA3←0.3
[41]  ALFA4←0.5
[42]  BETA1← 1 1 0.7 0.75 0.9 1 1 0.9 1 0.75 1 0.5
[43]  BETA2← 0 0.02 0.1 0.22 0.01 0 0 0.08 0 0.36 0 0.21
[44]  BETA3←0×BETA2
[45]  SMOOTH←(11⍴0.9),1
[46] ⍝
[47]  MARKETΔITER←3
[48] ⍝MARKETΔITER TELLS HOW MANY ITERATIONS WILL BE DONE IN THE  MARKET
      PROCESS DURING SIMULATION...
[49]  NH←1⍴NH
    ∇
```

```
    ∇ DISPOSE1ΔFIRMS
[1]   →(TESTUTSKRIFT=0)/START
[2]   'REALΔRATIO'
[3]   REALΔRATIO
[4]   'SYNTHΔRATIO'
[5]   SYNTHΔRATIO
[6]   'INPUTRATIO'
[7]   INPUTRATIO
[8]   'REALΔSALES'
[9]   REALΔSALES
[10]  'SYNTHΔSALES'
[11]  SYNTHΔSALES
[12]  'SLUT PA TESTUTSKRIFT I DISPOSE1ΔFIRMS
[13] START:
[14] ⍝
[15]  KILL 'SCALE MAKEQUARTERS'
[16]  KILL 'RAMARKET FIRMID RESΔLABOUR SYNTHΔSALES RESΔSALES RATIO1 RAT
      IO2 INPUTRATIO'
[17]  KILL 'REALΔRATIO SYNTHΔRATIO RESΔEXPORT REALΔINP LIST K3ΔIMED '
[18] ⍝THIS FUNCTION DELETES VARIABLES AND FUNCTIONS OF NO FURTHER USE.
    ∇
```

Part 1 The Initialization Code

```
      ∇ DISPOSE2ΔFIRMS
[1]     →(TESTUTSKRIFT=0)/START
[2]     'SΔMARKET'
[3]     SΔMARKET
[4]     'A21'
[5]     A21
[6]     'A22'
[7]     A22
[8]     'INP'
[9]     INP
[10]    'QCURR'
[11]    QCURR
[12]    'M75'
[13]    M75
[14]    'ΔK3ΔIMED'
[15]    ΔK3ΔIMED
[16]    'ΔK3ΔFINISH'
[17]    ΔK3ΔFINISH
[18]    'REALΔFORVF'
[19]    REALΔFORVF
[20]    'SYNTHΔFORVF'
[21]    SYNTHΔFORVF
[22]    'FORVF'
[23]    FORVF
[24]    'REALΔLABOUR'
[25]    REALΔLABOUR
[26]    'SYNTHΔLABOUR'
[27]    SYNTHΔLABOUR
[28]    'REALΔW'
[29]    REALΔW
[30]    'SYNTHΔW'
[31]    SYNTHΔW
[32]    'REALΔOVERSKOTT'
[33]    REALΔOVERSKOTT
[34]    'SYNTHΔOVERSKOTT'
[35]    SYNTHΔOVERSKOTT
[36]    'OVERSKOTT'
[37]    OVERSKOTT
[38]    'REALΔKRΔLON'
[39]    REALΔKRΔLON
```

Part 1 The Initialization Code

```
[40]   'SYNTH∆KR∆LON'
[41]   SYNTH∆KR∆LON
[42]   'LON'
[43]   LON
[44]   'SLUT PA TEST'
[45]  START:
[46]   KILL 'X̲ F∆DATA S̲∆MARKET NAMN∆MARKET A21 A22 INP QCURR M75'
[47]   KILL 'Ā K3∆IMED Ā K3∆FINISH REAL∆SALES REAL∆FORVF SYNTH∆FORVF FORVF
       REAL∆LABOUR SYNTH∆LABOUR '
[48]   KILL 'REAL∆W SYNTH∆W REAL∆OVERSKOTT SYNTH∆OVERSKOTT OVERSKOTT'
[49]   KILL 'REAL∆KR∆LON SYNTH∆KR∆LON LON SCALE HELP'
[50]   KILL 'IO∆MATRIX CONTROLS REAL∆SUM1 SYNTH∆SUM1 DISPOSE1∆FIRMS RAND
      OMIZE USING QFR1 HISTORY BETWEEN'
[51]  ⍝
[52]  ⍝THIS FUNCTION DELETES FUNCTIONS AND VARIABLES OF NO FURTHER USE..
      .
    ∇
```

```
    ∇ DISPOSE∆VAR∆INPUT;COP∆RI;COP∆TXW;COP∆TXWG;COP∆RIDEPFOR;
      COP∆RIBWFOR;COP∆TXC;COP∆TXI1
[1]   ⍝THIS FUNCTION GETS RID OF INPUTVARIABLES FROM
[2]   ⍝FIRST PART OF INITIALIZATION
[3]   ⍝
[4]    COP∆RIDEPFOR←EXO∆RIDEPFOR
[5]    COP∆RIBWFOR←EXO∆RIBWFOR
[6]    COP∆RI←EXO∆RI
[7]    COP∆TXW←EXO∆TXW
[8]    COP∆TXWG←EXO∆TXWG
[9]    COP∆TXC←EXO∆TXC
[10]   COP∆TXI1←EXO∆TXI1
[11]  ⍝
[12]  ⍝MACROLIST CONTAINS VARIABLENAMES FOR INPUT-VARIABLES
[13]   KILL MACROLIST
[14]   EXO∆RIDEPFOR←COP∆RIDEPFOR
[15]   EXO∆RIBWFOR←COP∆RIBWFOR
[16]   EXO∆RI←COP∆RI
[17]   EXO∆TXW←COP∆TXW
[18]   EXO∆TXWG←COP∆TXWG
[19]   EXO∆TXC←COP∆TXC
[20]   EXO∆TXI1←COP∆TXI1
[21]  ⍝VARIABLES FROM WORKSPACE MACRO HAS SOMETIMES THE SAME
[22]  ⍝ NAME AS AN OUTPUT-VARIABLE.SUCH VARIABLES MUST NOT
[23]  ⍝BE DELETED BY THE CALL ''KILL MACROLIST''   .
[24]  ⍝
    ∇
```

Part 1 The Initialization Code

```
     ∇  QDIΔINIT;QTWS;QTI;QWTAX;QINTH;QTRANS;QITAX;TXI1
[1]    ⍝INPUT TO THIS FUNCTION:
[2]    ⍝GKOFF,LG,WG,L,QTDIV,QW,LU FROM PUBLICΔSECTOR,ESTABLISHMENTS,SECON
       DARYΔDATA..÷
[3]    ⍝RTRANS,RLU  FROM MARKETSΔDATA
[4]    ⍝TXI1,TXW,TXWG,QINPAY,RI COME (INDIRECTLY) FROM INPUTFILE  MACRO..
       .
[5]    ⍝LOCAL COPIES OF TXW,TXWG...ARE USED...
[6]    ⍝NH,WH  FROM HOUSEHOLDSΔDATA
[7]    ⍝
[8]     QTRANS←(RTRANS×(LG×QWG÷4)×1++/GKOFF)+RLU×0.25×LU×L AVG2 QW×1-
       TXWCOPY
[9]     QINTH←NH×(RIΔCOPY-MB)×WH÷4
[10]    QTWS←(LG×QWG÷4),SUM2 L×QW÷4
[11]    QTWS←QTWS+(0,QINPAYCOPY)
[12]    QWTAX←QTWS+.×(TXWGCOPY,TXWCOPY)÷1+(TXWGCOPY,TXWCOPY)
[13]    QTI←QTDIV+QINTH+QTRANS+((+/QTWS)-QWTAX)
[14]    TXI1←TXI1COPY
[15]    QITAX←0.25×AGGRITAX 4×QTI
[16]    QDI←(QTI-QITAX)÷NH
     ∇
```

```
     ∇  ZZ←QDIΔINIT2;QTWS;QTI;QWTAX;QINTH;QTRANS;QITAX;LU;NH;MB;RTRANS;
       RLU
[1]    ⍝INPUT TO THIS FUNCTION:
[2]    ⍝GKOFF,LG,WG,L,QTDIV,QW,LU FROM PUBLICΔSECTOR,ESTABLISHMENTS,SECON
       DARYΔDATA..÷
[3]     RTRANS←0.5
[4]     RLU←0.6
[5]     MB←0.015
[6]    ⍝TXI1,TXW,TXWG,QINPAY,RI COME (INDIRECTLY) FROM INPUTFILE  MACRO..
       .
[7]     LU←(LG+SUM2(L))×RU÷(1-RU)
[8]     NH←LG+SUM2(L)+LU
[9]     WH←WHSUM÷NH
[10]   ⍝
[11]    QTRANS←(RTRANS×(LG×QWG÷4)×1++/GKOFF)+RLU×0.25×LU×L AVG2 QW×1-TXW
[12]    QINTH←NH×(RI-MB)×WH÷4
[13]    QTWS←(LG×QWG÷4),SUM2 L×QW÷4
[14]    QTWS←QTWS+(0,QINPAY)
[15]    QWTAX←QTWS+.×(TXWG,TXW)÷1+(TXWG,TXW)
[16]    QTI←QTDIV+QINTH+QTRANS+((+/QTWS)-QWTAX)
[17]    QITAX←0.25×AGGRITAX 4×QTI
[18]    ZZ←(QTI-QITAX)
     ∇
```

Part 1 The Initialization Code

```
    ∇ OUTPUTΔOPERATIONS;LIST;TOTLIST
  ⍝OUTPUT FROM INITIALIZATION IS BEING GROUPED:
  ⍝VARIABELGRUPP1,VARIABELGRUPP2...COME FROM WORKSPACE VLISTS,
  ⍝AND ARE TEXT-VECTORS .THIS WORKSPACE ALSO CONTAINS SOME
  ⍝ EXTRA VARIABLES AND FUNCTIONS...
   ⍎')WSID TEMPORARY'
   ⍎')SAVE'
   LIST←⎕NL 2,3
   LIST←,LIST
   ⍎')COPY VLISTS'
   MN←WORKSPACENAME
   KILL LIST
   ⎕RL←123467
   ⍎'⍎'')COPY MACRO  '',GRUPP1,'''''
   TOTLIST←VARIABELGRUPP1,' ',VARIABELGRUPP2,' ',VARIABELGRUPP3
   TOTLIST←TOTLIST,' ',VARIABELGRUPP4,' ',VARIABELGRUPP5
   ⍎')ERASE VARIABELGRUPP1 VARIABELGRUPP2 VARIABELGRUPP3'
   ⍎')ERASE VARIABELGRUPP4 VARIABELGRUPP5 GRUPP1 LIST'
   ⍎')ERASE DOKUMENTATION   '
  ⍝
  ⍝
   MN COPYSAVE TOTLIST
  ⍝OUTPUT FROM INITIALIZATION,AND NOTHING ELSE,IS SAVED
  ⍝IN WORKSPACE(WHOSE NAME IS STORED IN WORKSPACENAME).
  ⍝
  ⍝
   ⍎')DROP TEMPORARY'
    ∇
```

```
    ∇ Y COPYSAVE X
  ⍝THIS FUNCTION TAKES VARIABLES FROM WORKSPACE TEMPORARY
  ⍝,TAKING ONLY THOSE SPECIFIED IN LIST X,AND SAVES THEM IN A WORKSP
  ACE  WITH NAME Y...
   ⍎'⍎'')COPY TEMPORARY '',X,'''''
   ⍎'⍎'')WSID '',Y,'''''
   ⍎')SAVE'
    ∇
```

Part 2 Updating the Model

UPDATEMOSES is the function doing changes in the model itself. The function is documented below, with the APL-code. It should be noted that this documents all permanent changes in the model-program since 1986.

In **UPDATEMOSES** four functions are called.

1	**PREPAREΔRUN**	(fixes headlines etc for printing out simulation results)
2	**PERMANENTΔCHANGES**	(permanent changes in the model-program since 1986)
3	**MOSESΔVARIANTS**	(larger permanent changes in the model-program since 1986)
4	**MSTARTXX**	(the experiment version function)

The changes in **PERMANENTΔCHANGES** are maybe more permanent than **MOSESΔVARIANTS**, that is why they are separate.

The mode-program is updated in this fashion, so as to make it possible to repeat old experiments from 1986 and onwards. Another reason for this updating procedure is that the changes are clearly defined, and could be checked by anyone wishing to convince himself that the changes have been properly done.

Part 2 Updating the Model

```
    ∇ UPDATEMOSES NUM
  ⍝THIS FUNCTION DOES:
  ⍝(1): PREPARES HEADLINES ETC. FOR PRINT-OUT FROM MOSES-RUN
  ⍝(2): MAKES CHANGES IN THE MOSES PROGRAM FROM 1978
  ⍝
   PREPARE∆RUN
   PERMANENT∆CHANGES
   MOSES∆VARIANTS
  ⍝EXPERIMENT-MODULES IN WORKSPACE MSTART.
  ⍝THEY ARE CALLED MSTARTXX WHERE XX IS THE NUMBER IN
  ⍝THE CALL 'UPDATEMOSES XX'
  ⍝
   'GIVE THE NAME OF THE WORKSPACE WITH START-'
   'VALUES FROM INITIALIZATION (FOR EXAMPLE R1 ETC.) :'
   INITWORKSPACE←⍞
   ⍎')COPY ',INITWORKSPACE
  ⍝THIS LINE FETCHES INDATA FROM INITIALIZATION...
   PREPARE2
   ⍎')COPY MSTART  MSTART',⍕NUM
   ⍎'MSTART',⍕NUM
  ⍝LINE ABOVE MEANS THAT MSTARTXX IS EXECUTED.
  ⍝
  ⍝ IF YOU WANT MARKET TIME-SERIES RESULTS TO BE PRINTED OUT
  ⍝ DURING SIMULATION REMOVE COMMENT ON NEXT LINE...
  ⍝ TRACE1
  ⍝TRACE1 PRINTS OUT TIME-SERIES RESULTS...
  ⍝TRACE2
  ⍝
    ∇
```

```
    ∇ PREPARE∆RUN
   LOEPNR←NUM
   DATUM
   DSCR←'**** EXPERIMENT ',⍕NUM
   ⎕PW←120
   ⍎')MAXCORE 352'
  ⍝MAXIMUM CORE IN COMPUTER-MEMORY...
    ∇
```

```
    ∇ DATUM;TS
   TS←⎕TS
   TIMESTAMP←(TWO TS[1]),'-',(TWO TS[2]),'-',(TWO TS[3]),' ',(TWO TS
  [4]),':',(TWO TS[5])
    ∇
```

Part 2 Updating the Model

```
    ∇  PERMANENT∆CHANGES
     ⍝ 'PERMANENT' CHANGES IN MOSES:
     ⍝
      'MARKET∆CONFRONT' MODADD 'PT⍵QPURCHG←QPURCHG×PT[⍳10]×(1÷(QWG÷WG∆R
     EF))÷100'
     ⍝CORRECTION OF DEFLATOR FOR QOVERNMENT'S PURCHASES
     ⍝
      'INVFIN' MODSUBST 'K1BOOK←K1BOOK⍵K1BOOK←K1BOOK-QDEPRBOOK←0⌈QREVLR
     HOBOOK×K1BOOK←QINV+K1BOOK'
     ⍝ BOOK-VALUE SHOULD NOT BE UPDATED WITH INFLATION
     ⍝
     ⍝ CHANGES TO VECTOR-FORMAT ON MAX/MIN/OPT-STO MADE PERM.
     ⍝ CORRESPONDING FOR MAX/MIN/OPT-IMSTO IN FN.'IND∆PURCH∆SHARES'
     ⍝
     ⍝
      'PLANQREVISE' MODSUBST 'QIMQ←0⌈⍵⍝ QIMQ-LINE MOVED ABOVE IMSTO'
      'PLANQREVISE' MODADD 'QQ←QQ⍵QIMQ←0⌈((⍉IO)[MARKET;]MULT7 QPLANQSAV
     E)+(OPTIMSTO-IMSTO)÷4×TMIMSTO'
     ⍝
      EXO∆QDWG←''
     ⍝THE Z-SECTOR IS OBSOLETE AND ISN'T ANY LONGER USED.
     ⍝THE FOLLOWING LINES DELETE OR CHANGE LINES SO THAT
     ⍝THIS SECTOR IS IGNORED.
      'LABOUR∆MARKET' MODDEL 'ZLABOUR'
      'MARKET∆CONFRONT' MODSUBST 'PT←Q⍵PT←QPRELPDOM,(QPDOM[IN]×1+QDPIN)
     ,1'
      'HOUSEHOLD∆INIT' MODSUBST 'INMONEY⍵INMONEYHH←QTRANS+QINPAY+QTDIV+
     (SUM2 L×QW÷4)+(LG×QWG÷4)+(QINTH←NH+.×RIH×WH÷4)'
      'HOUSEHOLD∆INIT' MODSUBST 'QTWS←(LG⍵QTWS←(LG×QWG÷4),SUM2 L×QW÷4'
      'HOUSEHOLD∆INIT' MODSUBST 'QTI←QTDI⍵QTI←QTDIV+QTRANS+((+/QTWS)-QW
     TAX)+QINTH'
      'LUUPDATE' MODSUBST 'LF←⍵LF←LU+LG+SUM2 L'
      'Q∆EXO' MODDEL 'TXVAZ←'
      'LABOUR∆UPDATE' MODSUBST 'RU←RU+Q⍵RU←RU+QCHRU←(LU÷LU+LG+SUM2 L)-R
     U'
      'DOMESTIC∆RESULT' MODDEL 'QPZ←'
      'FINALQPQSQM' MODDEL 'QMZ←'
      'FINALQPQSQM' MODDEL 'QCHKZ←'
      'FINALQPQSQM' MODDEL 'QDIVZ←'
      'INVFIN' MODSUBST 'QCTAX←(SU⍵QCTAX←(SUM2 QTAX)'
      'Y∆COUNTRY∆TOTAL' MODDEL 'CT∆CHKZ←'
      'DOMESTIC∆RESULT' MODDEL 'QSZ←'
      'INDIRECT∆TAXES' MODSUBST 'QVATAX←⍵QVATAX←(TXVA2×QPURCHG+QSP[MKT,
     IN;]+.×NH),0'
      'Y∆INDUSTRY∆TOTAL' MODSUBST 'LTOT←⍵LTOT←LG+SUM2 L'
      'Y∆INDUSTRY∆Q' MODSUBST 'LTOT←⍵LTOT←LG+SUM2 L'
     ⍝
      VARIANTS←VARIANTS,' PERMANENT CHANGES 1980-81 '
    ∇
```

Part 2 Updating the Model

```
    ∇  RESULT←TWO NUMBER
     ⍝
     ⍝ TO REPRESENT ANY NUMBER WITH TWO INTEGER PLACES.
     ⍝ FRACTIONAL PART IS ROUNDED, BIGGER THAN 99 GETS TRUNCATED,
     ⍝ AND SMALLER THAN 10 GETS LEADING ZEROES.
     ⍝
      ALWAYS '(NUMBER≥0)∧(0=⍴⍴NUMBER)'
      RESULT←¯2↑'00',⍕⌊0.5+NUMBER
    ∇
```

```
    ∇  MOSES∆VARIANTS
      NEG∆IMSTO
      IND∆PURCH∆SHARES
      POSITIVE∆NET∆WORTH
      PRICE∆CHANGES
    ∇
```

```
    ∇  NEG∆IMSTO
     ⍝ ALLOWS INPUT-GOODS INVENTORIES TO HAVE LEVELS BELOW ZERO
      ENS 1=1↑⍴'PLANQREVISE' MODFNP 'SHORTAGE←0⌈⍵SHORTAGE←0×'
      VARIANTS←VARIANTS,' NEG-IMSTO'
    ∇
```

Part 2 Updating the Model

```
    ∇  INDΔPURCHΔSHARES
[1]    ⍝ PURCHASING-SHARE INDIVIDUALIZED IN THE FOLLOWING WAY :
[2]    ⍝ I/O-MATRIX ENDOGENOUS IN VOLUME TERMS
[3]    ⍝ PURCHASING SHARE: (SUM I=1...10 IO[X I])÷(SUM I=1...13 IO[X I])
[4]    ⍝ PURCH.-SHARES ARE INDIVIDUAL FOR MKT X=1...4
[5]    ⍝ THE RELATION (IO[X I])÷(IO[X J]); I,J∊[1,10],I≠J; IS
[6]    ⍝ FIXED THOUGH........
[7]    ⍝ NOTE: IF FN. *ADDFIRM* SHOULD BE USED, CHANGE LINES
[8]    ⍝ 'Q←' AND 'QQ←'
[9]    ⍝
[10]   ⍝ FROM FRED OCT-80
[11]   ⍝
[12]    'TARGΔSEARCH' MODSUBST 'QEXPPNET←ωQEXPPNET←QEXPP-SHARE×(QEXPPIM+.
       ×IO)[MARKET]'
[13]    'MAXIMSTO' MODSUBST 'R←(⍉IOωR←((⍉IO)[MARKET;] MULT7 SHARE)MULT7 R
       EFQIMSTO × IMBIG'
[14]    'MINIMSTO' MODSUBST 'R←(⍉IO)ωR←((⍉IO)[MARKET;] MULT7 SHARE)MULT7
       REFQIMSTO × IMSMALL'
[15]    'OPTIMSTO' MODSUBST 'R←(⍉IO)ωR←((⍉IO)[MARKET;] MULT7 SHARE)MULT7
       REFQIMSTO × IMSMALL+IMBETA×IMBIG-IMSMALL'
[16]    'PLANQREVISE' MODSUBST 'MAT←(⍉IO)ωMAT←(⍉IO)[MARKET;] MULT7 SHARE'
[17]    'PLANQREVISE' MODSUBST 'IMSTO←ωIMSTO←MAXIMSTO⌊IMSTO+QIMQ-MAT MULT
       7 QQ'
[18]    'PLANQREVISE' MODSUBST 'QIMQ←0⌈((⍉IOωQIMQ←0⌈(MAT MULT7 QPLANQSAVE
       )+(OPTIMSTO-IMSTO)÷4×TMIMSTO'
[19]    'FINALQPQSQM' MODSUBST 'QVA←ωQVA←QVA×1+QDVA←¯1+(QQ×QP-SHARE×((QPD
       OM×1-TXVA2)+.×IO)[MARKET])÷QVA'
[20]   ⍝ WE ALSO SHRINK VAR. *SHARE* IN NULLIFY
[21]   ⍝
[22]    VARIANTS←VARIANTS,'  INDIVIDUAL-PURCHASING-SHARES '
    ∇
```

Part 2 Updating the Model

```
    ∇  POSITIVEΔNETΔWORTH
[1]    ⍝ FROM 81-02-02 A COMBINATION WITH 'NULLIFYΔNEGΔNW'
[2]    ⍝
[3]    ⍝ TO MAKE SURE BORROWING DO NOT EXCEED ASSETS,
[4]    ⍝ AND TO , THOUGH IN QUITE A CRUDE WAY , ADJUST
[5]    ⍝ NEW-BORROWING TO THE DEBT/EQUITY-RATIO
[6]    ⍝ STEP 1: QΔBW ≤ REDCHBW(=.15)×BW
[7]    ⍝      2: QΔBW REDUCED IF 0.1<(NW/A)≤0.3
[8]    ⍝      3: QΔBW =0        IF 0.1≥(NW/A)
[9]    ⍝      4: FIRMS ARE NULLIFIED THE 6'TH QUARTER WITH   NW<0
[10]   ⍝
[11]    'INVFIN' MODADD 'QDESCHBW←(0ωQDESCHBW[THO]←REDCHBW×BW[THO←(QDESCH
       BW>REDCHBW×BW)/⍳⍴BW]'
[12]    'INVFIN' MODADD 'QDESCHK2←(RWωQDESCHBW←(BWΔCHECK ((BW+QDESCHBW)÷(
       K1+(K2+QDESCHK2)+K3)))×QDESCHBW'
[13]   ⍝
[14]    'INVFINΔADJUSTMENTS' MODADD '⍝ NW ISωBAD←BAD+(NW<0)'
[15]    'INVFINΔADJUSTMENTS' MODADD 'BADωREALLYΔBAD←BAD=6'
[16]    'INVFINΔADJUSTMENTS' MODADD 'REALLYω⍎(0<(+/REALLYΔBAD))/'' NULLIF
       YΔNW REALLYΔBAD '''
[17]   ⍝
[18]    'NULLIFY' MODADD 'SHRINK ''AMANωSHRINK ''BAD'''
[19]    'NULLIFY' MODADD 'SHRINK ''QW''ωSHRINK ''REALLYΔBAD'''
[20]   ⍝
[21]    VARIANTS←VARIANTS,'  POS-NET-WORTH-ELSE-NULLIFY '
[22]   ⍝
    ∇
```

```
    ∇  PRICEΔCHANGES
[1]     'DOMESTICΔMARKET' MODSUBST 'MARKETΔCONFRONTωMARKETΔCONFRONTΔNEWP'
[2]     'DOMESTICΔMARKET' MODSUBST 'COMPUTEΔIMPORTSωCOMPUTEΔIMPORTSΔNEWP'
[3]     'DOMESTICΔMARKET' MODSUBST 'DOMESTICΔRESULTωDOMESTICΔRESULTΔNEWP'
[4]    ⍝
[5]    ⍝  ...ΔNEWP MADE BY C. HARTLER
[6]    ⍝
    ∇
```

Part 2 Updating the Model

```
    ∇  PREPARE2
     ⍝ THIS LINE GIVES THE WORKSPACE A NEW NAME,
     ⍝ FOR EXAMPLE  S3V7
     ⍝
      ⍎')WSID S',(⍕NUM),'V',1↓INITWORKSPACE
      DSCR←DSCR,'  ,ISTART= ',1↓INITWORKSPACE
      DSCR←DSCR,'   *****'
    ∇
```

When removing the comment on line [24] in **UPDATEMOSES, TRACE1** will be executed.

```
    ∇  TRACE1
     ⍝UTSKRIFT KVARTALSVIS AV VARIABLER SOM HAR MED UTBUD OCH EFTERFRAG
     AN ATT GORA...
      'THIS IS A DOCUMENTATION OF RUN   ',⍕LOEPNR
      'THE  MARKET-PROCESS '
      '************************************************   '
     ⍝ TRACE1 SHOULD BE CALLED AS THE LAST LINE IN TRACEMOSES
     ⍝ TRACEMOSES IS A REPLICA OF UPDATEMOSES EXCEPT FOR THIS
     ⍝
      'QUARTER' MODADD 'QΔEXO⍵RUBRIK'
      'INITPRODPLAN' MODADDLAST ' ''EXPECTED SALES VOLUME,INCLUDING EXP
     ORTS'' '
      'INITPRODPLAN' MODADDLAST 'SUM1 QEXPSU'
     ⍝ 'INITPRODPLAN' MODADDLAST ' ''FIRST PRODUCTION-PLAN'' '
     ⍝ 'INITPRODPLAN' MODADDLAST ' SUM1 QPLANQ '
      'TARGΔSEARCH' MODADDLAST ' ''SECOND PRODUCTION-PLAN'' '
      'TARGΔSEARCH' MODADDLAST ' SUM1 QPLANQ '
      'PLANQREVISE' MODADDLAST ' ''ACTUAL PRODUCTION'' '
      'PLANQREVISE' MODADDLAST 'SUM1 QQ'
      'EXPORTΔMARKETS' MODADDLAST ' ''EXPORT SUPPLY = EXPORT SALES'' '
      'EXPORTΔMARKETS' MODADDLAST 'SUM1(X×QOPTSU)'
      'EXPORTΔMARKETS' MODADDLAST ' ''PLANNED DOMESTIC SUPPLY'' '
      'EXPORTΔMARKETS' MODADDLAST 'SUM1((1-X)×QOPTSU)'
      'MARKETΔENTRANCE' MODADDLAST ' ''CHANGE IN DOMESTIC PRICE  DUE TO
     SUPPLY-SIDE'' '
      'MARKETΔENTRANCE' MODADDLAST '¯1+QPRELPDOM÷QPDOM[MKT]'
      'ADJUSTΔPRICES' MODADDLAST '→(J=2)/NEXT'
      'ADJUSTΔPRICES' MODADDLAST ' ''DEMAND ON DOMESTIC MARKET'' '
      'ADJUSTΔPRICES' MODADDLAST 'QTBUY[MKT]×( 1-IMP[MKT])'
      'ADJUSTΔPRICES' MODADDLAST ' ''DIFFERENCE BETWEEN DEMAND ON DOMES
     TIC MARKET AND PLANNED DOMESTIC SUPPLY'' '
```

```
[27]   'ADJUSTΔPRICES' MODADDLAST '(QTBUY[MKT]×1-IMP[MKT])-SUM1 QOPTSUDO
      M'
[28]   'ADJUSTΔPRICES' MODADDLAST ' ''IMPORT SHARES,DEMAND  '' '
[29]   'ADJUSTΔPRICES' MODADDLAST 'IMP[MKT]'
[30]   'ADJUSTΔPRICES' MODADDLAST 'NEXT: '
[31]   'DOMESTICΔRESULT' MODADDLAST ' ''CHANGES IN DOMESTIC PRICE DURING
       THE QUARTER'' '
[32]   'DOMESTICΔRESULT' MODADDLAST 'QDPDOM[MKT]'
[33]   'DOMESTICΔRESULT' MODADDLAST ' ''ACTUAL DOMESTIC SUPPLY =DOMESTIC
       SALES'' '
[34]   'DOMESTICΔRESULT' MODADDLAST 'QTSUDOM'
[35]   'FINALQPQSQM' MODADDLAST ' ''TOTAL SALES'' '
[36]   'FINALQPQSQM' MODADDLAST 'SUM1 QSU'
[37]   'FINALQPQSQM' MODADDLAST ' ''EXPORT-SHARE'' '
[38]   'FINALQPQSQM' MODADDLAST ' (SUM1 X×QOPTSU)÷(SUM1 QSU) '
[39]   'QUARTERLYΔCUM' MODADDLAST 'CUMQDPDOM←CUMQDPDOM+QDPDOM[MKT]'
[40]   'QUARTERLYΔCUM' MODADDLAST '⍎(NRS=4)/''YEARLYΔMESSAGE'' '
[41]   'YEARLYΔINIT' MODADDLAST 'CUMQDPDOM←4⍴0 '
[42]  ⍝UNDERTRYCKER OVRIGA UTSKRIFTER PA TERMINAL...
[43]   'RUNEXP' MODSUBST 'PAGEH⍵PAGEHEADER ''YEARLYΔINDUSTRYΔTOTAL'' '
[44]   'REPORTΔNULLIFIED' MODDEL '⍎'
     ∇
```

Part 3 Transcription Functions

```
    ∇  RUNEXP AR
        YR
      ⍝ QR
      ⍝ YRΔFIRM
      ⍝ YRΔENTRY
      ⍝ SEND EDΔPARMS
      ⍝ SEND EDΔFLOWS
        PAGEHEADER FRONT←'YEARLYΔINDUSTRYΔTOTAL'
        I←0
      START:→END×⍳AR<I←I+1
        RUN 1
      ⍝  ⍎(I>10)/NOQR
      ⍝⍎(I=10)/SEND EDΔPARMS
      ⍝    ⍎(I=10)/SEND TRENDS
        ⍎(I=1)/'EDΔFLOWS'
        ⍎(I=6)/'EDΔFLOWS'
        →START
      END:
    ∇
```

```
    ∇  YR
        YΔRΔPRICES
        YΔRΔINDUSTRYΔTOTAL
        YΔRΔFOREIGNΔTRADE
        YΔRΔCOUNTRYΔTOTAL
        YΔRΔMARKET
        YΔRΔHOUSEHOLDS
        YΔRΔGOVERNMENT
        YΔRΔBANKΔTRANSACTIONS
        YΔRΔBANKΔPOSITION
        YΔRΔFINANCE
        YΔRΔGNP
      ⍝ YΔRΔRATEΔOFΔRETURN
      ⍝ QΔRΔREF HERE, EVEN THOUGH IT IS A QUARTERLY REPORT
        ⍎(0≠⎕NC 'REF')/'QΔRΔREF'
      ⍝ ONE NEW TABLE CREATED 5/7 1983:
      ⍝ YΔRΔDISTRIBUTION
      ⍝YΔRΔDISTRIBUTION CALLS YΔDISTRIBUTION WHICH IN TURN CALLS YΔDIST2
        AND CASE1..CASE4
    ∇
```

Part 3 Transcription Functions

The following 2 functions are used in the transcription functions. The tables are text matrices which are stored in WS during the runs. The **YΔR**-functions prepare a given table, i.e. prepare titles to the tables etc., and call the "central table-function" **YΔ**-function.

```
    ∇  NAME OPEN LINE
[1]    ⍎NAME,'←(1,⍴,LINE)⍴LINE'
[2]    ⍎(FRONT EQUALS NAME)/'LINE'
    ∇
```

```
    ∇  NAME STORE LINE
[1]    ⍎NAME,'←',NAME,',[1](⍴',NAME,')[2]↑LINE'
[2]    ⍎(FRONT EQUALS NAME)/'LINE'
    ∇
```

OPEN and **STORE** handle the table through the formation of a first line in the table (**OPEN**), and concatenate new lines running (**STORE**) to the table during the simulation.

Part 3 Transcription Functions

```
    ∇  YΔRΔPRICES;HEADER;SNET
[1]    SNET←VA
[2]    HEADER←(24⍴' QPDOM'),(24⍴' QPFOR'),(28⍴'      W '),(24⍴'     M '),(
      20⍴'  RR ')
[3]    'YEARLYΔPRICES' OPEN HEADER
[4]    'YEARLYΔPRICES' STORE ''
[5]    YΔPRICES
[6]    'YEARLYΔPRICES' STORE '---'
[7]    'YEAR' MODADDLAST 'YΔPRICES'
    ∇


    ∇  YΔPRICES;MSLASK;LOGICAL
[1]    LOGICAL←(⍴M)⍴0
[2]   ⍝TILLAGG DEN 3 DECEMBER AV FREDRIK BERGHOLM
[3]   ⍝THE FRACTION PROFIT÷VALUE ADDED  MIGHT BE ENORMOUSLY LAGRE AND NE
      GATIVE IF VALUE ADDED HAPPENS TO BE JUST BELOW ZERO
[4]   ⍝THIS MEANS A BREAKDOWN OF PRINTING-FUNCTION,WHICH COULD BE AVOIDE
      D BY SETTING M TEMPORARILY TO ¯1 OR SOMETHING LIKE THAT...
[5]    LOGICAL←M≤¯10
[6]    MSLASK←M[LOGICAL/⍳⍴M]
[7]    M[LOGICAL/⍳⍴M]←¯1
[8]    LOGICAL←M≥100
[9]    MSLASK←M[LOGICAL/⍳⍴M]
[10]   M[LOGICAL/⍳⍴M]←10
[11]   'YEARLYΔPRICES' STORE(6 1 ⍕QPDOM[MKT],QPFOR),(7 IFMT L AVG1 W),(
      6 1 ⍕100×S AVG1 M),(5 1 ⍕100×(NW+BW)AVG1 RR)
[12]   M[LOGICAL/⍳⍴M]←MSLASK
    ∇


    ∇  YΔRΔINDUSTRYΔTOTAL;HEADER
[1]   ⍝

[2]    HEADER←'    QTOP    TEC         L     PROD     DQ    A21    A22    SUM    A
      23     M×S'
[3]    HEADER←HEADER,'     STO     DS      DP      DW        M     INV     LTOT
      RU'
[4]   ⍝

[5]    'YEARLYΔINDUSTRYΔTOTAL' OPEN HEADER
[6]    'YEARLYΔINDUSTRYΔTOTAL' STORE ''
[7]   ⍝

[8]    'YEAR' MODADDLAST 'YΔINDUSTRYΔTOTAL'
[9]   ⍝

    ∇
```

Part 3 Transcription Functions

```
    ∇  YΔINDUSTRYΔTOTAL;QTOP;TEC;L;PROD;DQ;A;MΔS;STO;DS;DP;DW;M;QINV;
       LTOT;RU;LINE;TOP;LOGICAL
[1]    ⍝
[2]     QTOP←1.000000000E¯6 ×SUM2 TOP←QTOP×IMPLPΔREF[MARKET]
[3]     TEC←(SUM2 TOP)÷SUM2 TOP÷TEC
[4]     L←SUM2 L
[5]     DQ←100×(Q×P)AVG2 DQ
[6]    ⍝
[7]    ⍝ NEW SPEC. FOR BO CARLSSON 1986-11-13:
[8]    ⍝ PROD←(SUM2 Q×IMPLPΔREF[MARKET])÷L
[9]     PROD←(SUM2 Q)÷L
[10]   ⍝
[11]    A←A,+/A←(TOP AVG2 A21),(TOP AVG2 A22)
[12]    A←A,TOP AVG2 A23
[13]    A←100×A
[14]    MΔS←1.000000000E¯6 ×SUM2 M×SNET
[15]    DS←100×S AVG2 DS
[16]    STO←100×(SUM2 P×STO)÷(SUM2 P×OPTSTO)
[17]    DP←100×S AVG2 DP
[18]    DW←100×(W×L)AVG2 DW
[19]    M←100×SNET AVG2 M
[20]    LOGICAL←(M<¯1000)∨(M>1000)
[21]    M←M×(~LOGICAL)
[22]    QINV←1.000000000E¯6 ×SUM2 CUMINV
[23]    LTOT←LG+LZ+SUM2 L
[24]    RU←100×LU÷LU+LTOT
[25]   ⍝
[26]    LINE←(7 IFMT QTOP),(6 IFMT TEC),(8 IFMT L,PROD),(6 2 ⍕DQ,A),(7
       IFMT MΔS)
[27]    LINE←LINE,(6 1 ⍕STO),(6 2 ⍕DS,DP,DW),(7 2 ⍕M),(7 IFMT QINV),(8
       IFMT LTOT),(6 2 ⍕RU)
[28]    'YEARLYΔINDUSTRYΔTOTAL' STORE LINE
    ∇
```

Part 3 Transcription Functions

```
    ∇  YΔRΔFOREIGNΔTRADE;HEADER
[1]     HEADER←(30ρ'     X '),(30ρ'  IMP1'),(30ρ'  IMP2')
[2]     'YEARLYΔFOREIGNΔTRADE' OPEN HEADER
[3]     'YEARLYΔFOREIGNΔTRADE' STORE ''
[4]    ⍝ 'YEARLYΔFOREIGNΔTRADE' STORE(6 2 ⍕100×((QS÷QP)AVG1 X)),'
       (6 2 ⍕100×IMP[MKT])
[5]    ⍝ 'YEARLYΔFOREIGNΔTRADE' STORE '---'
[6]     'YEAR' MODADDLAST 'YΔFOREIGNΔTRADE'
    ∇
```

```
    ∇  YΔFOREIGNΔTRADE;EXP;IMP1;IMP2;PROD;DOM
[1]     EXP←EXP,+/EXP←MFLOWS[MKT;(ρMFLOWS)[2]]
[2]     IMP1←IMP1,+/IMP1←MFLOWS[MKT;2]
[3]     IMP2←IMP2,+/IMP2←MFLOWS[MKT;3]
[4]     PROD←PROD,+/PROD←MFLOWS[MKT;1]
[5]     DOM←DOM,+/DOM←+/MFLOWS[MKT;3+⍳3+ρMKT,IN]
[6]     'YEARLYΔFOREIGNΔTRADE' STORE 6 2 ⍕100×(EXP÷PROD),(IMP1÷DOM),(IMP2
       ÷DOM)
    ∇
```

```
    ∇  YΔRΔCOUNTRYΔTOTAL;HEADER
[1]     HEADER←' GNPFIX  GNPCUR   MONEY     VEL      RI   PRINT  CHLIQB'
[2]     HEADER←HEADER,'    CHINV   CHDIV   CHKIN    REST'
[3]     'YEARLYΔCOUNTRYΔTOTAL' OPEN HEADER
[4]     'YEARLYΔCOUNTRYΔTOTAL' STORE ''
[5]     'YEARLYΔCOUNTRYΔTOTAL' STORE(23 IFMT 1.000000000E¯6 ×MONEY), 16 3
       ⍕100×RI
[6]     'YEARLYΔCOUNTRYΔTOTAL' STORE '---'
[7]     'QUARTER' MODADDLAST 'YΔCOUNTRYΔTOTAL'
[8]     CTΔZERO
    ∇
```

```
    ∇ YΔCOUNTRYΔTOTAL;TOT;LINE
[1]   CTΔCHINV←CTΔCHINV+QTCHINV
[2]   CTΔCHDIV←CTΔCHDIV+QTCHDIV
[3]   CTΔCHKZ←CTΔCHKZ+QCHKZ
[4]   CTΔCHKIN←CTΔCHKIN+QCHKIN
[5]   CTΔCHLIQB←CTΔCHLIQB+QCHLIQB
[6]   →(NRS<4)/0
[7]  ⍝
[8]   ALWAYS 'CTΔCHKZ=0'
[9]   TOT←MPRINT-CTΔCHINV+CTΔCHDIV+CTΔCHKIN+CTΔCHLIQB
[10] ⍝
[11]  LINE←(7 IFMT 1.000000000E¯6 ×GNPFIX),(8 IFMT 1.000000000E¯6 ×
     GNPCUR,MONEY),(8 3 ⍕GNPCUR÷MONEY),(8 3 ⍕100×RI)
[12]  LINE←LINE,8 IFMT 1.000000000E¯6 ×MPRINT,CTΔCHLIQB,CTΔCHINV,
     CTΔCHDIV,CTΔCHKIN,TOT
[13]  'YEARLYΔCOUNTRYΔTOTAL' STORE LINE
[14]  CTΔZERO
    ∇
```

```
    ∇ CTΔZERO
[1]   CTΔCHINV←CTΔCHDIV←CTΔCHKZ←CTΔCHKIN←CTΔCHLIQB←0
    ∇
```

```
    ∇ YΔRΔMARKET;HEADER;I
[1]  ⍝
[2]   HEADER←'  QTOP   TEC      L     PROD    DQ   A21   A22   SUM   A
     23    M×S'
[3]   HEADER←HEADER,'    STO    DS    DP    DW      M    INV   QPDOM   Q
     PFOR'
[4]  ⍝
[5]   I←0
[6]  L:I←I+1
[7]   ('YEARLYΔMARKET',⍕I)OPEN HEADER
[8]   ('YEARLYΔMARKET',⍕I)STORE ''
[9]   →(I<NMARKETS)/L
[10] ⍝
[11]  'YEAR' MODADDLAST 'YΔMARKET'
    ∇
```

Part 3 Transcription Functions

```
    ∇  YΔMARKET;QTOP;TEC;L;PROD;DQ;A;MΔS;STO;DS;DP;DW;M;QINV;LTOT;RU;
      LINE;I;LOGICAL
[1]    ⍝

[2]     QTOP←0.001×SUM1 QTOP
[3]     TEC←(SUM1 QTOP)÷SUM1 QTOP÷TEC
[4]     L←SUM1 L
[5]     DQ←100×Q AVG1 DQ
[6]     PROD←(SUM1 Q×IMPLPΔREF[MARKET])÷L
[7]     A←A,[2]+/A←⍉(2,NMARKETS)⍴(QTOP AVG1 A21),(QTOP AVG1 A22)
[8]     A←A,[2]QTOP AVG1 A23
[9]     A←100×A
[10]    MΔS←1.000000000E¯6 ×SUM1 M×SNET
[11]   ⍝
[12]   ⍝ HERFINDAL-INDEX:
[13]   ⍝  HI←+/((4↑S[⍒S[((MARKET∊1)/⍳⍴MARKET)]])÷(SUM1 S)[1])*2
[14]   ⍝  HI←HI,(+/((4↑S[⍒S[((MARKET∊2)/⍳⍴MARKET)]])÷(SUM1 S)[2])*2)
[15]   ⍝ HI←HI,(+/((4↑S[⍒S[((MARKET∊3)/⍳⍴MARKET)]])÷(SUM1 S)[3])*2)
[16]   ⍝ HI←HI,(+/((4↑S[⍒S[((MARKET∊4)/⍳⍴MARKET)]])÷(SUM1 S)[4])*2)
[17]   ⍝
[18]    DS←100×S AVG1 DS
[19]    STO←100×(SUM1 STO)÷(SUM1 OPTSTO)
[20]    DP←100×S AVG1 DP
[21]    DW←100×(W×L)AVG1 DW
[22]    M←100×SNET AVG1 M
[23]    LOGICAL←(⍴M)⍴0
[24]    LOGICAL←(M<¯1000)∨(M>1000)
[25]    M[LOGICAL/⍳⍴M]←0
[26]   ⍝TILLAGG DEN 4/12 1980
[27]    QINV←1.000000000E¯6 ×SUM1 CUMINV
[28]   ⍝

[29]   ⍝ IF [10] ABOVE IS TO BE ACTIVATED AGAIN, [32] BELOW
[30]   ⍝ SHOULD END WITH: (7 IFMT MΔS[I])
[31]   ⍝
[32]   ⍝ AND IF [13-16] :(7 2⍕HI[I]), OR POSSIBLY >7
[33]   ⍝
[34]    I←1
[35]   GGG:LINE←(7 IFMT QTOP[I]),(6 IFMT TEC[I]),(8 IFMT L[I],PROD[I]),(
      6 2 ⍕DQ[I],A[I;]),(7 IFMT MΔS[I])
[36]    LINE←LINE,(6 1 ⍕STO[I]),(6 2 ⍕DS[I],DP[I],DW[I]),(7 2 ⍕M[I]),(7
      IFMT QINV[I]), 8 2 ⍕((QPDOM×1-TXVA2)[I]),(QPFOR[I])
[37]    ('YEARLYΔMARKET',⍕I)STORE LINE
[38]    →(NMARKETS≥I←I+1)/GGG
    ∇
```

Part 3 Transcription Functions

```
    ∇  YAR∆HOUSEHOLDS;LINE;SP;KEEP
[1]    ⍝ DON'T REPORT ZERVICE EXPLICIT SECTOR (ALL ZEROES)
[2]     KEEP←(88⍴1),(8⍴0),(30⍴1)
[3]     HEADER←'      DDI',(HHTRIX '     SP'),'     SAVH  DCPI','    PURCH
        SAVH'
[4]     'YEARLY∆HOUSEHOLDS' OPEN KEEP/HEADER
[5]     'YEARLY∆HOUSEHOLDS' STORE ''
[6]     'HOUSEHOLD∆UPDATE' MODADDLAST 'Y∆HOUSEHOLDS'
[7]     SP←4×SP,(QDI+,×NH)−+/SP←QPH×CVA+,×NH
[8]     LINE←'          ',(8 2 ⍕100×SP÷+/SP),(6 2 ⍕100×4×QDCPI)
[9]     'YEARLY∆HOUSEHOLDS' STORE KEEP/(⍴HEADER)↑LINE
[10]    'YEARLY∆HOUSEHOLDS' STORE '---'
[11]    HH∆OLDDI←4×(QDI+,×NH)×1−0.375×L AVG2 DW
[12]    HH∆OLDCPI←QCPI
[13]    HH∆DI←HH∆SP←0
    ∇
```

```
    ∇  Y∆HOUSEHOLDS;LINE
[1]     HH∆DI←HH∆DI+QDI+,×NH
[2]     HH∆SP←HH∆SP+QSP[MKT,IN,SAV;]+,×NH
[3]     →(NRS<4)/0
[4]     LINE←(8 2 ⍕100×¯1+HH∆DI÷HH∆OLDDI),(8 2 ⍕100×HH∆SP÷+/HH∆SP),(6 2 ⍕
       100×¯1+QCPI÷HH∆OLDCPI)
[5]     LINE←LINE,8 IFMT 1.000000000E¯6 ×(+/¯1↓HH∆SP),¯1↑HH∆SP
[6]     'YEARLY∆HOUSEHOLDS' STORE LINE
[7]     HH∆OLDDI←HH∆DI
[8]     HH∆OLDCPI←QCPI
[9]     HH∆DI←HH∆SP←0
    ∇
```

```
    ∇  YAR∆GOVERNMENT;HEADER
[1]     HEADER←'      LG     WG   DWG      WSG  PURCHG    TRANS     SUBS      S
       PG     INVG     ITAX    WTAX   VATAX    CTAX   INCOME'
[2]     HEADER←HEADER,'  INTPAY SURPLUS'
[3]     'YEARLY∆GOVERNMENT' OPEN HEADER
[4]     'YEARLY∆GOVERNMENT' STORE ''
[5]     'YEAR' MODADDLAST 'Y∆GOVERNMENT'
    ∇
```

Part 3 Transcription Functions

```
    ∇  YAR∆BANK∆TRANSACTIONS;HEADER
[1]    HEADER←'     INTF    INTK2     INTH     INTG INTGFOR     CHBW     CHK2
         SAVH  CHDEPG CHDEPGF'
[2]    HEADER←HEADER,'  EXPORT FASSPAY  IMPORT   FDPAY   CHNWB'
[3]    'YEARLY∆BANK∆TRANSACTIONS' OPEN HEADER
[4]    'YEARLY∆BANK∆TRANSACTIONS' STORE ''
[5]    'QUARTER' MODADDLAST 'Y∆BANK∆TRANSACTIONS'
[6]    BT∆ZERO
    ∇
```

```
    ∇  Y∆GOVERNMENT;LINE;TOTTAX
[1]    TOTTAX←ITAX+WTAX+VATAX+CTAX
[2]    LINE←(7 IFMT CUMLG,WG),(5 1 ⍕100×DWG)
[3]    LINE←LINE,8 IFMT 1.000000000E¯6 ×WSG,(+/PURCHG),TRANS,SUBS,SPG,
      INVG,ITAX
[4]    LINE←LINE,(7 IFMT 1.000000000E¯6 ×WTAX,VATAX,CTAX),(8 IFMT
      1.000000000E¯6 ×TOTTAX,(-INTG),SURPLUSG)
[5]    'YEARLY∆GOVERNMENT' STORE LINE
    ∇
```

```
    ∇  Y∆BANK∆TRANSACTIONS;ITEMS
[1]   ⍝

[2]    BT∆INTF←BT∆INTF+QINTF
[3]    BT∆INTK2←BT∆INTK2+QINTK2
[4]    BT∆INTH←BT∆INTH+QINTH
[5]    BT∆INTG←BT∆INTG+QINTG
[6]    BT∆INTGFOR←BT∆INTGFOR+QINTGFOR
[7]    BT∆K2←BT∆K2+QTCHK2
[8]    BT∆SAV←BT∆SAV+QSAVH
[9]    BT∆BW←BT∆BW+QTCHBW
[10]   BT∆POSG←BT∆POSG+QCHPOSG
[11]   BT∆POSGFOR←BT∆POSGFOR+QCHPOSGFOR
[12]   BT∆FASS←BT∆FASS+QFASSPAY
[13]   BT∆FD←BT∆FD+QFDPAY
[14]   →(NRS<4)/0
[15]  ⍝

[16]   ITEMS←BT∆INTF,BT∆INTK2,BT∆INTH,BT∆INTG,BT∆INTGFOR,BT∆BW,BT∆K2,
      BT∆SAV,BT∆POSG,BT∆POSGFOR
[17]   ITEMS←ITEMS,EXPORT,BT∆FASS,IMPORT,BT∆FD,(NWB-BT∆OLD∆NWB)
[18]   'YEARLY∆BANK∆TRANSACTIONS' STORE 8 IFMT 1.000000000E¯6 ×ITEMS
[19]   BT∆ZERO
    ∇
```

Part 3 Transcription Functions

```
      ∇BTΔZERO[⎕]∇
    ∇  BTΔZERO
[1]     BTΔINTF←BTΔINTK2←BTΔINTH←BTΔINTG←BTΔINTGFOR←BTΔBW←BTΔK2←BTΔSAV←
      BTΔPOSG←BTΔPOSGFOR←BTΔFASS←BTΔFD←0
[2]     BTΔOLDΔNWB←NWB
    ∇


    ∇  YΔRΔBANKΔPOSITION;HEADER
[1]     HEADER←'          BW          K2          HH           G        LIQB    LIQB
      FOR       FASS          FD'
[2]     HEADER←HEADER,'      FNASS    NETFOR          NW     (GFOR)'
[3]     'YEARLYΔBANKΔPOSITION' OPEN HEADER
[4]     'YEARLYΔBANKΔPOSITION' STORE ''
[5]     YΔBANKΔPOSITION
[6]     'YEARLYΔBANKΔPOSITION' STORE '---'
[7]     'YEAR' MODADDLAST 'YΔBANKΔPOSITION'
    ∇


    ∇  YΔBANKΔPOSITION;ITEMS
[1]     ITEMS←(SUM2 BW),(SUM2 K2),(WH+.×NH),POSG,LIQB,LIQBFOR,FASS,FD,(
      FASS-FD),(LIQBFOR+FASS-FD),NWB,POSGFOR
[2]     'YEARLYΔBANKΔPOSITION' STORE 10 IFMT 1.000000000E¯6 ×ITEMS
    ∇

    ∇  YΔRΔFINANCE;HEADER;MAT;I;NAME
[1]     HEADER←'     M×S  INTPAY  (DEPR)   TAXES     DIV    SUBS    CHBW     INV
       CHK2'
[2]     HEADER←HEADER,'        K1        K2    K3-IN   K3-OUT       BW        NW
       TOT'
[3]     I←0
[4]     MAT←FINΔPOS
[5]    L:→((NMARKETS+1)<I←I+1)/END
[6]     NAME←'YEARLYΔFINANCE',(I≤NMARKETS)/'Δ',⍕I
[7]     NAME OPEN HEADER
[8]     NAME STORE ''
[9]     NAME STORE(63⍴' '),8 IFMT 1.000000000E¯6 ×MAT[;I]
[10]    NAME STORE '---'
[11]    →L
[12]   END:
[13]    'YEAR' MODADDLAST 'YΔFINANCE'
    ∇
```

Part 3 Transcription Functions

```
    ∇  YΔFINANCE;MAT1;MAT2;I
[1]     MAT1←FINΔFLOWS
[2]     MAT2←FINΔPOS
[3]     I←0
[4]    L:→((NMARKETS+1)<I←I+1)/END
[5]    ¯('YEARLYΔFINANCE',(I≤NMARKETS)/'Δ',⍕I)STORE(7 IFMT
      1.000000000E¯6 ×MAT1[;I]),(8 IFMT 1.000000000E¯6 ×MAT2[;I])
[6]     →L
[7]    END:
    ∇
```

```
    ∇  YΔRΔGNP;HEADER
[1]     HEADER←'        TOT       RAW      IMED INV/DUR      NDUR    A/F/F       ORE
          BLD        EL SERVICE'
[2]     'YEARLYΔGNPCURΔPROD' OPEN HEADER,'      VATAX     SUBS       WSG'
[3]     'YEARLYΔGNPCURΔPROD' STORE ''
[4]     'YEARLYΔGNPFIXΔPROD' OPEN HEADER,'       WSG'
[5]     'YEARLYΔGNPFIXΔPROD' STORE ''
[6]     HEADER←'        TOT      GTOT       WSG   PURCHG        HH INV-TOT INV-MKT
       INV-EXT INV-BLD    INV-G    CHSTO   EXPORT   IMPORT'
[7]     'YEARLYΔGNPCURΔUSE' OPEN HEADER
[8]     'YEARLYΔGNPCURΔUSE' STORE ''
[9]     'YEARLYΔGNPFIXΔUSE' OPEN HEADER
[10]    'YEARLYΔGNPFIXΔUSE' STORE ''
[11]    'YEAR' MODADDLAST 'YΔGNP'
    ∇
```

```
    ∇  YΔGNP
[1]     'YEARLYΔGNPFIXΔPROD' STORE EDΔGNPΔPROD(1+ρMKT,IN)↑GNPFIX
[2]     'YEARLYΔGNPCURΔPROD' STORE EDΔGNPΔPROD(3+ρMKT,IN)↑GNPCUR
[3]     'YEARLYΔGNPFIXΔUSE' STORE EDΔGNPΔUSE ¯10↑GNPFIX
[4]     'YEARLYΔGNPCURΔUSE' STORE EDΔGNPΔUSE ¯10↑GNPCUR
    ∇
   ∇YΔRΔRATEΔOFΔRETURN[⎕]∇
    ∇  YΔRΔRATEΔOFΔRETURN
[1]     HELPKP←(OMEGA+.×QPDOM)×(1-TXVA1)÷(1-TXVA2)
[2]     HEADER←(20ρ'   RT  '),(20ρ'   RW  '),(20ρ'  RTN  '),(20ρ'  RWN  '),(20ρ'
      RWT  '),(20ρ'  RWNT')
[3]     'YEARLYΔRATEΔOFΔRETURN' OPEN HEADER
[4]     'YEARLYΔRATEΔOFΔRETURN' STORE ' '
[5]     'YEAR' MODADDLAST 'YΔRATEΔOFΔRETURN'
    ∇
```

Part 3 Transcription Functions

```
    ∇  YΔRATEΔOFΔRETURN;HP;SNET;TLRT;TLRW;TLRTN;TLRWN;T;WΔTC;TLRWT;
      TLRWNT
       HP←(OMEGA+.×QPDOM)×(1-TXVA1)÷(1-TXVA2)
       DPKAP←¯1+HP÷HELPKP
       HELPKP←HP
       SNET←VA
       TLRT←RR
       TLRW←RR+(RR-RIF)×BW÷NW
       TLRTN←((M×SNET)-(4×K1×RHO)-(DPKAP×K1))÷K1+K2+K3
       TLRWN←TLRTN+(TLRTN-RIF)×BW÷NW
       T←TXC×((M×SNET)-(4×K1BOOK×RHOBOOK)+(RIF×BW))
       WΔTC←NWBOOK+(1-TXC)×(NW-NWBOOK)
       TLRWT←RR+(((RR-RIF)×BW-T)÷NW)×NW÷WΔTC
       TLRWNT←((1-TXC)×TLRWN+(TXC×(DPKAP+4×RHOBOOK-RHO)×K1÷NW))×NW÷WΔTC
       'YEARLYΔRATEΔOFΔRETURN' STORE(5 1 ⍕100×(NW+BW)AVG1 TLRT),(5 1 ⍕
      100×(NW+BW)AVG1 TLRW),(5 1 ⍕100×(NW+BW)AVG1 TLRTN),(5 1 ⍕100×(NW+
      BW)AVG1 TLRWN),(5 1 ⍕100×(NW+BW)AVG1 TLRWT),(5 1 ⍕100×(NW+BW)AVG1
      TLRWNT)
    ∇
```

```
    ∇  YΔRΔDISTRIBUTION;HEADER
       HEADER←'RR',(8⍴' '),'VA',(8⍴' '),'PERCENT    ','W'
       HEADER←HEADER,(9⍴' '),'VA',(8⍴' '),'PERCENT    '
       HEADER←HEADER,'DQ',(8⍴' '),'VA,PERCENT'
      ⍝ THE LENGTH OF THE HEADER DETERMINES THE LENGTH OF THE TABLE
       'YEAR' MODADDLAST 'YΔDISTRIBUTION'
       'DISTRIBUTION' OPEN HEADER
       'DISTRIBUTION' STORE ' '
       ALLREPORTS←ALLREPORTS ABOVE 'DISTRIBUTION'
      ⍝ WRITTEN 4TH OF JULY 1983
      ⍝ BY FREDRIK BERGHOLM, IUI
    ∇
```

```
       ∇YΔDISTRIBUTION[⎕]∇
     ∇  YΔDISTRIBUTION
       ⍝CALLS YΔDIST2 WHICH MAKES THE TABLES..
       ⍝ THISΔYEAR IS A GLOBAL VARIABLE FROM SIMULATION..
       ⍝
        →(~∨/THISΔYEAR=(72+5×⍳10))/END
        ⍎(THISΔYEAR=77)/'XCUM←(⍴Q)⍴0'
        YΔDIST2
        XCUM←(⍴Q)⍴0
       END:XCUM←XCUM+DQ
       ⍝ WRITTEN 4/7 1983 BY FREDRIK BERGHOLM
     ∇
```

Part 3 Transcription Functions

```
    ∇  YΔDIST2;N;CC;U;NUMBERS;MAX;MAT;LINE;RESRR;RESW;STEP;WIDTH;RESQ
[1]   ⍝SUBFUNCTIONS: CASE1,CASE2,CASE3 AND CASE4
[2]   ⍝ RR,CUMVA,W ARE GLOBAL VARIABLES FROM THE SIMULATION
[3]   ⍝ RR=RATE OF RETURN,W=WAGE-LEVEL,CUMVA=VALUE ADDED FOR A YEAR
[4]    N←0
[5]    TRENDQ←XCUM÷5
[6]   ⍝XCUM COMES FROM YΔDISTRIBUTION
[7]    STEP← 0.03 5000 0.01
[8]    WIDTH←20
[9]    WIDTH←2×⌊WIDTH÷2
[10]  START:N←N+1
[11]   NUMBERS←⍳⍴RR
[12]  ⍝
[13]   CC←1
[14]   U←(CASE1 N)/NUMBERS
[15]   MAT←((WIDTH+2),100)⍴0
[16]   MAT[1;⍳⍴U]←CUMVA[U]
[17]  S1:CC←CC+1
[18]   U←((CASE2 N)∧(CASE3 N))/NUMBERS
[19]   ⍎((⍴U)>100)/'MAT←MAT,((WIDTH+2),(¯100+⍴U))⍴0'
[20]   MAT[CC;⍳⍴U]←CUMVA[U]
[21]   →(CC=WIDTH+1)/C1
[22]   →S1
[23]  C1:MAT[CC+1;⍳⍴U]←CUMVA[U←(CASE4 N)/NUMBERS]
[24]  ⍝
[25]   ⍎(N=1)/'RESRR←+/MAT '
[26]   ⍎(N=2)/'RESW←+/MAT '
[27]   ⍎(N=3)/'RESQ←+/MAT '
[28]   →(N=3)/END
[29]   →START
[30]  END:
[31]   ⍎' ''DISTRIBUTION'' STORE ''YEAR= ',(⍕THISΔYEAR+1900),''''
[32]   ⍎' ''DISTRIBUTION'' STORE ''PRICE-INDEX= ',(⍕+/QPFOR÷400),''''
[33]   CC←0
[34]  S3:CC←CC+1
[35]   LINE←'<',(5 2 ⍕(CC-1)×STEP[1]),(4⍴' ')
[36]   LINE←LINE,(10 2 ⍕RESRR[CC]÷10*9),(5 2 ⍕RESRR[CC]÷+/RESRR),5⍴' '
[37]   LINE←LINE,'<Px',(7 0 ⍕(CC+2)×STEP[2]),(10 2 ⍕RESW[CC]÷10*9)
[38]   LINE←LINE,(5 2 ⍕RESW[CC]÷+/RESW),(5⍴' '),'<'
[39]   LINE←LINE,(9 2 ⍕STEP[3]×(¯1×WIDTH÷2)+(CC-1))
[40]   LINE←LINE,(10 2 ⍕RESQ[CC]÷+/RESQ)
[41]   'DISTRIBUTION' STORE LINE
[42]   →(CC=(WIDTH+1))/C3
[43]   →S3
[44]  C3:
[45]   LINE←'>',(5 2 ⍕(CC-1)×STEP[1]),(4⍴' '),(10 2 ⍕RESRR[CC+1]÷10*9)
[46]   LINE←LINE,(5 2 ⍕RESRR[CC+1]÷+/RESRR),(5⍴' '),'>Px'
[47]   LINE←LINE,(7 0 ⍕(CC+2)×STEP[2]),(10 2 ⍕RESW[CC+1]÷10*9)
[48]   LINE←LINE,(5 2 ⍕RESW[CC+1]÷+/RESW),(5⍴' ')
[49]   LINE←LINE,'>',(9 2 ⍕STEP[3]×(¯1×WIDTH÷2)+(CC-1)),(10 2 ⍕RESQ[CC+1
      ]÷+/RESQ)
[50]   'DISTRIBUTION' STORE LINE
[51]   LINE←'SUM:',(6⍴' '),(10 2 ⍕+/RESRR÷10*9),' (BILLIONS)',(9⍴' ')
[52]   LINE←LINE,(10 2 ⍕+/RESW÷10*9),(20⍴' '),(10 2 ⍕+/RESQ÷10*9)
[53]   'DISTRIBUTION' STORE LINE
[54]  ⍝WRITTEN 13TH OF JULY 1983 BY FREDRIK BERGHOLM ,I U I
    ∇
```

Part 3 Transcription Functions

```
    ∇  Z←CASE1 N;PRISINDEX
   ⍝GLOBAL VARIABLES: W,RR,CC,QPFOR,TRENDQ,STEP,WIDTH
   ⍝SUBFUNCTION TO YΔDIST2
   ⍝
    →(N=2)/F2
    →(N=3)/F3
    Z←RR<0
    →E
   F2:PRISINDEX←(1÷4)×+/QPFOR÷100
    Z←W<3×STEP[2]×PRISINDEX
   ⍝QPFOR IS A PRICE-INDEX.
   ⍝WAGE-LEVEL IS UPDATED WITH INFLATION
    →E
   F3:Z←TRENDQ<STEP[3]×WIDTH÷2×¯1
   E:
   ⍝WRITTEN 5TH OF JULY 1983, BY FREDRIK BERGHOLM
    ∇
```

```
    ∇  Z←CASE2 N;PRISINDEX
   ⍝GLOBAL VARIABLES : RR,W,CC,QPFOR,STEP,TRENDQ,WIDTH
   ⍝SUBFUNCTION TO YΔDIST2
   ⍝
    →(N=2)/F2
    →(N=3)/F3
    Z←RR>(CC-2)×STEP[1]
    →E
   F2:PRISINDEX←(1÷4)×+/QPFOR÷100
    Z←W>(CC+1)×STEP[2]×PRISINDEX
    →E
   F3:Z←TRENDQ>STEP[3]×(¯1×WIDTH÷2)+(CC-2)
   E:
   ⍝WRITTEN 5/7 1983 BY FREDRIK BERGHOLM
```

Part 3 Transcription Functions

```
    ∇  Z←CASE3 N;PRISINDEX
       ⍝SUBFUNCTION TO YΔDIST2
       ⍝GLOBAL VARIABLES:RR,W,CC,QPFOR,STEP,TRENDQ,WIDTH
       ⍝
        →(N=2)/F2
        →(N=3)/F3
        Z←RR<(CC-1)×STEP[1]
        →E
       F2:PRISINDEX←(1÷4)×+/QPFOR÷100
        Z←W<(CC+2)×STEP[2]×PRISINDEX
        →E
       F3:Z←TRENDQ<STEP[3]×(¯1×WIDTH÷2)+(CC-1)
       E:
       ⍝WRITTEN 5\7 1983 BY FREDRIK BERGHOLM I U I
    ∇
```

```
    ∇  Z←CASE4 N;PRISINDEX
       ⍝SUBFUNCTION TO YΔDIST2
       ⍝GLOBAL VARIABLES:RR,W,QPFOR,CC,STEP,TRENDQ,WIDTH
       ⍝
        →(N=2)/F2
        →(N=3)/F3
        Z←RR>(CC-1)×STEP[1]
        →E
       F2:PRISINDEX←(1÷4)×+/QPFOR÷100
        Z←W>PRISINDEX×(CC+2)×STEP[2]
        →E
       F3:Z←TRENDQ>STEP[3]×(¯1×WIDTH÷2)+(CC-1)
       E:
       ⍝WRITTEN 5/7 1983 BY FREDRIK BERGHOLM
    ∇
```

```
    ∇  FILENAME SEND OBJECT;C
        C←⎕ASS FILENAME
        DUMMY←OBJECT⌷C
        DUMMY←⎕AV[269]⌷C
        ⎕CLS C
    ∇
```

Part 3 Transcription Functions

```
    ∇  R←ED∆PARMS;A;B;LLL
[1]    LLL←23
[2]    A←(LLL↑'KSI'),⍕KSI
[3]    A←A ABOVE(LLL↑'NITER'),⍕NITER
[4]    A←A ABOVE(LLL↑'IOTA'),⍕IOTA
[5]    A←A ABOVE(LLL↑'SKREPA'),⍕SKREPA
[6]    A←A ABOVE(LLL↑'GAMMA'),⍕GAMMA
[7]    A←A ABOVE(LLL↑'THETA'),⍕THETA
[8]    A←A ABOVE(LLL↑'RTRANS'),⍕RTRANS
[9]    A←A ABOVE(LLL↑'RLU'),⍕RLU
[10]   A←A ABOVE(LLL↑'MAXDP'),⍕MAXDP
[11]   A←A ABOVE(LLL↑'MARKET-ITER'),⍕MARKET∆ITER
[12]   A←A ABOVE(LLL↑'TMX'),⍕TMX
[13]   A←A ABOVE(LLL↑'TMIMP'),⍕TMIMP
[14]   A←A ABOVE(LLL↑'FIP'),4⍕FIP
[15]   A←A ABOVE(LLL↑'FIS'),4⍕FIS
[16]   A←A ABOVE(LLL↑'FIW'),4⍕FIW
[17]   A←A ABOVE(LLL↑'SMP'),4⍕SMP
[18]   A←A ABOVE(LLL↑'SMS'),4⍕SMS
[19]   A←A ABOVE(LLL↑'SMW'),4⍕SMW
[20]   A←A ABOVE(LLL↑'SMT'),4⍕SMT
[21]   A←A ABOVE(LLL↑'R'),⍕R
[22]   A←A ABOVE(LLL↑'E1'),⍕E1
[23]   A←A ABOVE(LLL↑'E2'),⍕E2
[24]  ⍝
[25]   B←(LLL↑'DMTEC'),4⍕QDMTEC DDIV 0.25
[26]   B←B ABOVE(LLL↑'ELINV'),⍕ELINV
[27]   B←B ABOVE(LLL↑'RHO (YEARLY)'),⍕RHO DDIV 0.25
[28]   B←B ABOVE(LLL↑'RHOBOOK (YEARLY)'),⍕RHOBOOK DDIV 0.25
[29]   B←B ABOVE(LLL↑'ALFABW (YEARLY)'),⍕ALFABW DDIV 0.25
[30]   B←B ABOVE(LLL↑'BETABW'),⍕BETABW
[31]   B←B ABOVE(LLL↑'TMINV'),⍕TMINV
[32]   B←B ABOVE(LLL↑'UTREF'),⍕UTREF
[33]   B←B ABOVE(LLL↑'KAPPA1'),⍕KAPPA1
[34]   B←B ABOVE(LLL↑'KAPPA2'),⍕KAPPA2
[35]   B←B ABOVE(LLL↑'LAMDA1'),⍕LAMDA1
[36]   B←B ABOVE(LLL↑'LAMDA2'),⍕LAMDA2
[37]   B←B ABOVE(LLL↑'RFUND1'),⍕RFUND1
[38]   B←B ABOVE(LLL↑'RFUND2'),⍕RFUND2
[39]   B←B ABOVE(LLL↑'MAXQCHRI'),⍕MAXQCHRI
[40]   B←B ABOVE(LLL↑'MAXRIDIFF'),⍕MAXRIDIFF
[41]   B←B ABOVE(LLL↑'MB'),⍕MB
[42]   B←B ABOVE(LLL↑'TMFASS'),4⍕TMFASS
[43]   B←B ABOVE(LLL↑'TMFD'),4⍕TMFD
[44]   B←B ABOVE(LLL↑'MAXRI'),⍕MAXRI
[45]   B←B ABOVE(LLL↑'MINRI'),⍕MINRI
[46]  ⍝
[47]   R←('PARAMETER SETTING IN RUN NR ',⍕LOEPNR)ABOVE ' '
[48]   R←R ABOVE⍉((⍉A)ABOVE(⍉' ',' ',' ','*',' ',' ',B))
    ∇
```

Part 3 Transcription Functions

```
    ∇  OUT←PAGEHEADER REPORTNAME
[1]    ⍝
[2]     REPORTNAME[('∆'=REPORTNAME)/⍳⍴REPORTNAME]←' '
[3]     REPORTNAME[('X̲'=REPORTNAME)/⍳⍴REPORTNAME]←','
[4]     OUT←'RUN NR ',(⍕LOEPNR),'   **   ',TIMESTAMP,'   **   ',REPORTNAME
[5]     OUT←OUT ABOVE ' '
[6]     OUT←OUT ABOVE 12 CUT VERSION,'   ',VARIANTS
[7]     OUT←OUT ABOVE ' '
[8]     OUT←OUT ABOVE 'FIRST SIMULATED YEAR IS 19',TWO FIRST∆SIM∆YEAR
[9]     OUT←OUT ABOVE ' '
[10]    OUT←OUT ABOVE 12 CUT ' ***   ',DSCR
[11]    OUT←((3+1↑⍴OUT),⎕PW)↑OUT
    ∇
```

Part 4 Run the Model

```
    ∇  RUN N∆YEARS
[1]   BEGIN:→(0>N∆YEARS←N∆YEARS-1)/END
[2]    ⍎(FRONT EQUALS 'NONE')/''''''
[3]    THIS∆YEAR←THIS∆YEAR+1
[4]    YEAR
[5]    LAST∆YEAR←LAST∆YEAR+1
[6]    →BEGIN
[7]   END:
    ∇
```

```
    ∇  YEAR
[1]    Y∆EXO
[2]    YEARLY∆INIT
[3]    YEARLY∆EXP
[4]    YEARLY∆TARG
[5]    QUARTER 1
[6]    QUARTER 2
[7]    QUARTER 3
[8]    QUARTER 4
[9]    YEARLY∆UPDATE
    ∇
```

```
    ∇  Y∆EXO
[1]    ⍎(1+THIS∆YEAR≥AMAN∆YEAR)WITHIN ' NOAMAN ⍵ DOAMAN '
[2]   ⍝

[3]    TXC←EXO∆TXC[1]
[4]    EXO∆TXC←1↓EXO∆TXC
[5]    TXW←EXO∆TXW[1]
[6]    EXO∆TXW←1↓EXO∆TXW
[7]    TXWG←EXO∆TXWG[1]
[8]    EXO∆TXWG←1↓EXO∆TXWG
[9]    TXI1←EXO∆TXI1[1]
[10]   EXO∆TXI1←1↓EXO∆TXI1
[11]  ⍝ INDEXED ITAX ENTERED FROM 1978

[12]  ⍝ ⍎(THIS∆YEAR≤LAST∆TXI2∆YEAR)/'TXI2←EXO∆TXI2[1]'
[13]  ⍝ ⍎(THIS∆YEAR≤LAST∆TXI2∆YEAR)/'EXO∆TXI2←1↓EXO∆TXI2'
[14]  ⍝ ⍎(THIS∆YEAR>LAST∆TXI2∆YEAR)/'TXI2←TXI2×1+(1-TXI3)×(QDCPI-QCHTXVA
      2)'
[15]  ⍝

[16]   RSUBS←EXO∆RSUBS[;1]
[17]   EXO∆RSUBS← 0 1 ↓EXO∆RSUBS
    ∇
```

Part 4 Run the Model

```
    ∇  NOAMAN
[1]    ⍝
[2]    ⍝ TO ELIMINATE THE EFFECT OF THE SWEDISH 'AMAN' LABOUR MARKET LAWS
[3]    ⍝ CAN BE USED BEFORE OR WITHIN A SIMULATION RUN.
[4]    ⍝
[5]     ENS 1≥1↑⍴'LABOURΔUPDATE' MODFNP 'DOAMAN:⍵⍝ NOAMAN:'
    ∇
```

```
    ∇  DOAMAN
[1]    ⍝
[2]    ⍝ TO INCLUDE THE EFFECT OF THE SWEDISH 'AMAN' LABOUR MARKET LAWS.
[3]    ⍝ CAN BE USED BEFORE OR WITHIN A SIMULATION RUN.
[4]    ⍝
[5]     ENS 1≥1↑⍴'LABOURΔUPDATE' MODFNP '⍝ NOAMAN:⍵DOAMAN:'
    ∇
```

0 *

```
    ∇  YEARLYΔINIT
[1]     CUMQ←CUMM←CUMSU←CUMS←CUMWS←CUMINV←CUML←CUMVA←CUMSNET←0×L
[2]     CUMWTAX←CUMITAX←CUMINVG←CUMVATAX←CUMCTAX←CUMWSG←CUMLG←CUMGNPFIX←
       CUMGNPCUR←CUMEXPORT←CUMIMPORT←0
[3]     CUMPURCHG←CUMTRANS←CUMSUBS←0
[4]     JΔCUM←0
[5]     CUMMPRINT←CUMINTG←0
[6]     MFLOWS←0
[7]     BFA←0
[8]     CUMINTPAYF←CUMDEPR←CUMTAXF←CUMDIV←CUMSUBSF←CUMCHBWF←CUMCHK2F←0×L
    ∇
```

* The numbers refers to the Technical Specification, Chapter IV.

Part 4 Run the Model

1

```
    ∇  YEARLYΔEXP;EXPIDP;EXPIDW;EXPIDS
     ⍝
      HISTDP←(SMP×HISTDP)+(1−SMP)×DP
      HISTDPDEV←(SMP×HISTDPDEV)+(1−SMP)×(DP−EXPDP)
      HISTDPDEV2←(SMP×HISTDPDEV2)+(1−SMP)×(DP−EXPDP)*2
      EXPIDP←HISTDP+(E1×HISTDPDEV)−(E2×HISTDPDEV2*0.5)
      EXPDP←(R×EXPXDP)+(1−R)×EXPIDP
     ⍝
      HISTDW←(SMW×HISTDW)+(1−SMW)×DW
      HISTDWDEV←(SMW×HISTDWDEV)+(1−SMW)×(DW−EXPDW)
      HISTDWDEV2←(SMW×HISTDWDEV2)+(1−SMW)×(DW−EXPDW)*2
      EXPIDW←HISTDW+(E1×HISTDWDEV)+(E2×HISTDWDEV2*0.5)
      EXPDW←(R×EXPXDW)+(1−R)×EXPIDW
     ⍝
      HISTDS←(SMS×HISTDS)+(1−SMS)×DS
      HISTDSDEV←(SMS×HISTDSDEV)+(1−SMS)×(DS−EXPDS)
      HISTDSDEV2←(SMS×HISTDSDEV2)+(1−SMS)×(DS−EXPDS)*2
      EXPIDS←HISTDS+(E1×HISTDSDEV)−(E2×HISTDSDEV2*0.5)
      EXPDS←(R×EXPXDS)+(1−R)×EXPIDS
    ∇
```

2

```
    ∇  YEARLYΔTARG
      MHIST←(SMT×MHIST)+(1−SMT)×M
    ∇
```

```
    ∇  QUARTER NRS
     ⍝
     ⍝
     ⍝
      QΔEXO
      QUARTERLYΔEXP
      QUARTERLYΔTARG
      PRODPLAN
      LABOURΔMARKET
      EXPORTΔMARKETS
      DOMESTICΔMARKET
      STOSYSTEM
      QUARTERLYΔRESULT
      INVFIN
      GOVERNMENTΔACCOUNTING
      MONETARYΔSECTOR
      NATIONALΔACCOUNTING
     ⍝
      ALWAYS '1>|QMPRINT−QTCHINV+QTCHDIV+QCHKZ+QCHKIN+QCHLIQB'
     ⍝ SHOULD HAVE BEEN EQUAL TO ZERO, BUT ROUNDOFF ERRORS OCCUR
      ALWAYS '(QFASSPAY+QINTGFOR)=(QFDPAY+QCHPOSGFOR+QCHLIQBFOR)'
      ALWAYS '((SUM2 QM×QSNET)+QINTK2+QTCHBW+QSUBSΔCASH)=(QINTF+QCTAX+Q
     TDIV+QTCHK2+(SUM2 QINVLAG))'
    ∇
```

Part 4 Run the Model

```
    ∇  Q∆EXO
     ⍝
      ⍎(RI∆IS∆EXOGENOUS)/'RI←RI+QCHRI←EXO∆RI[1]-RI'
      ⍎(~RI∆IS∆EXOGENOUS)/'RI←RI+QCHRI←(MINRI⌈MAXRI⌊RI+QCHRI)-RI'
      EXO∆RI←1↓EXO∆RI
      RIBWFOR←EXO∆RIBWFOR[1]
      EXO∆RIBWFOR←1↓EXO∆RIBWFOR
      RIDEPFOR←EXO∆RIDEPFOR[1]
      EXO∆RIDEPFOR←1↓EXO∆RIDEPFOR
     ⍝
      QDPFOR←EXO∆QDPFOR[;1]
      EXO∆QDPFOR← 0 1 ↓EXO∆QDPFOR
      QDPIN←EXO∆QDPIN[;1]
      EXO∆QDPIN← 0 1 ↓EXO∆QDPIN
     ⍝
      TXVA1←TXVA1+QCHTXVA1←EXO∆QCHTXVA1[1]
      TXVA2←TXVA2+QCHTXVA2←EXO∆QCHTXVA2[1]
      TXVAZ←TXVAZ+QCHTXVA2
      QDPIN←QDPIN+QCHTXVA2
      EXO∆QCHTXVA1←1↓EXO∆QCHTXVA1
      EXO∆QCHTXVA2←1↓EXO∆QCHTXVA2
     ⍝
      QDWG←⍎(1+0<ρEXO∆QDWG)WITHIN ' QDWIND ω EXO∆QDWG[1] '
      EXO∆QDWG←1↓EXO∆QDWG
      QREALCHLG←⍎(1+0<ρEXO∆REALCHLG)WITHIN ' 0 ω EXO∆REALCHLG[1]'
      EXO∆REALCHLG←1↓EXO∆REALCHLG
     ⍝
     ⍝
      QINVIN←QINVIN×(1+EXO∆QDINVIN[1])×(1+OMEGAIN+.×QDPDOM+QCHTXVA1)
      EXO∆QDINVIN←1↓EXO∆QDINVIN
      QINVBLD←QINVBLD×(1+EXO∆QDINVBLD[1])×(1+OMEGABLD+.×QDPDOM+QCHTXVA1
     )
      EXO∆QDINVBLD←1↓EXO∆QDINVBLD
      QINVG←QINVG×(1+EXO∆QDINVG[1])×(1+OMEGAG+.×QDPDOM+QCHTXVA1)
      EXO∆QDINVG←1↓EXO∆QDINVG
    ∇
```

Part 4 Run the Model

3.1

```
     ∇  QUARTERLYΔEXP;QEXPDP;QEXPDW;QEXPDS;QCHTXVA2IN
[1]    ⍝
[2]     QEXPDP←EXPDP÷4
[3]     QEXPDW←EXPDW÷4
[4]     QEXPDS←EXPDS÷4
[5]     →(NRS=1)/L
[6]     QEXPDP←QEXPDP+FIP×QDP−QEXPDP
[7]     QEXPDW←QEXPDW+FIW×QDW−QEXPDW
[8]     QEXPDS←QEXPDS+FIS×QDS−QEXPDS
[9]    L:
[10]    QEXPP←QP×1+QEXPDP
[11]    QEXPW←QW×1+QEXPDW
[12]    QEXPS←QS×1+QEXPDS
[13]   ⍝
[14]    QEXPPIM←(1−TXVA2)×QPDOM×1+(QQ AVG1 QEXPDP),QDPIN−QCHTXVA2IN←(ρMKT
       )↓(ρMKT,IN)ρQCHTXVA2
     ∇
```

3.2

```
     ∇  QUARTERLYΔTARG
[1]     QTARGM←TARGM
     ∇
```

```
     ∇  Z←TARGM
[1]     ENS(1,NMARKETS)∨.=ρ,EPS
[2]     ⍎(NMARKETS=ρ,EPS)/'Z←MHIST MULT1 1+EPS'
[3]     ⍎(1=ρ,EPS)/'Z←MHIST×1+EPS'
[4]    ⍝ WE WILL ALSO MAKE EXPERIMENTS WITH THE FOLLOWING FORMULA:
[5]    ⍝    Z←(MHIST×1+EPS)⌈((1−R)×MHIST×(1+EPS))+R×TARGXM
[6]    ⍝ WHERE TARGXM COULD BE E.G. ACTUAL MARGIN FOR A MARKET LEADER
     ∇
```

4

```
     ∇  PRODPLAN
[1]    ⍝
[2]     LUUPDATE
[3]     PRODFRONT
[4]     INITPRODPLAN
[5]     TARGΔSEARCH
[6]     INTERMEDIATEΔPRODUCTS
     ∇
```

Part 4 Run the Model

4 LU

```
    ∇  LUUPDATE;LF
[1]   ⍝
[2]   LF←LU+LZ+LG+SUM2 L
[3]   ⍝
[4]   L←L×1-RET
[5]   AMAN←AMAN×1-RET
[6]   LU←LU×1-RET
[7]   ⍝
[8]   LU←LU+ENTRY×LF
    ∇
```

4.1

```
    ∇  PRODFRONT;QCHQTOP;QCHQTOP1;QCHQTOP2
[1]   ⍝

[2]   MTEC←MTEC×1+QDMTEC
[3]   QTOP←QTOP×1-RHO
[4]   QCHQTOP1←(1-LOSS)×QINV×INVEFF÷QP
[5]   QCHQTOP2←(LOSS×(QINV×INVEFF÷QP)×(RESMAX-RES)÷RESMAX)⌊(QTOP+
     QCHQTOP1)×(RESMAX-RES)÷(1-RESMAX)
[6]   QCHQTOP←QCHQTOP1+QCHQTOP2
[7]   RES←(QCHQTOP2+RES×QTOP+QCHQTOP1)÷(QTOP+QCHQTOP)
[8]   ALWAYS '(RES≥0)∧(RES≤RESMAX)'
[9]   TEC←(QTOP+QCHQTOP)÷(QTOP÷TEC)+(QCHQTOP DIV1 MTEC)
[10]  QTOP←QTOP+QCHQTOP
    ∇
```

4.2

```
    ∇  INITPRODPLAN
[1]   QEXPSU←QEXPS÷QEXPP
[2]   QPLANQ←0⌈QEXPSU+(OPTSTO-STO)÷(4×TMSTO)
    ∇
```

```
    ∇  RESULT←OPTSTO
[1]   RESULT←REFQSTO×SMALL+BETA×BIG-SMALL
    ∇
```

QFR2 and RFQ2 are help-functions in TARGΔSEARCH

```
    ∇  QI←I QFR2 L
[1]   QI←WTIX×(1-RES[I])×QTOP[I]×1-*-L[I]×TEC[I]÷QTOP[I]
    ∇
```

```
    ∇  LI←I RFQ2 Q
[1]   LI←-(QTOP[I]÷TEC[I])×⍟1-(0.99⌊Q[I]÷QTOP[I]×WTIX×1-RES[I])
    ∇
```

Part 4 Run the Model

4.3

```
    ∇  TARGΔSEARCH;NEXT;I;OK;II;Q2;Q3;Q7;LAYOFF;QEXPPNET;WHERE;L5
[1]    ⍝

[2]    ⍝ SIMULTANEOUS SEARCH FOR ALL FIRMS:

[3]    ⍝   NEXT - INDICATES NEXT STEP TO BE TRIED FOR EACH FIRM

[4]    ⍝   I    - INDICES OF THE FIRMS TO BE HANDLED IN A STEP

[5]    ⍝   OK   - TELLS WHICH FIRMS IN 'I' THAT ARE SUCCESSFUL IN A STEP

[6]    ⍝   II   - SHORT FOR 'OK/I'

[7]    ⍝

[8]     Q3←QFR1 L
[9]     Q7←Q3⌊QPLANQ
[10]    Q2←Q3⌊QEXPSU+MAXSTO-STO
[11]    QPLANL←(⍴L)⍴¯1
[12]    QEXPPNET←QEXPP-(QEXPPIM+.×IO)[MARKET]
[13]    ALWAYS 'QEXPPNET≥0'
[14]   ⍝

[15]    NEXT←(1 5 6)[1+(QPLANQ≥QTOP×WTIX×1-RES)+(QPLANQ≥Q3)]
[16]   ⍝

[17]    WHERE←(⍴L)⍴9
[18]    II←(OK←QPLANQ[I]SAT L[I])/I←(NEXT=1)/⍳⍴QPLANQ
[19]    WHERE[II]←1
[20]    QPLANL[II]←L[II]
[21]    NEXT[I]←(2 10)[1+OK]
[22]   ⍝

[23]    II←(OK←Q2[I]SAT L[I])/I←(NEXT=2)/⍳⍴QPLANQ
[24]    QPLANQ[II]←(QPLANL[II]←L[II])×QEXPW[II]÷4×(1-QTARGM[II])×QEXPPNET
       [II]
[25]    WHERE[II]←2
[26]    NEXT[I]←(3 4 10 10)[1+(Q2[I]=Q3[I])+2×OK]
[27]   ⍝

[28]    II←(OK←Q2[I]SAT I RFQ2 Q2)/I←(NEXT=3)/⍳⍴QPLANQ
[29]    WHERE[II]←3
[30]    QPLANL[II]←(1-QTARGM[II])×(QPLANQ[II]←Q2[II])×QEXPPNET[II]÷QEXPW[
       II]÷4
[31]    NEXT[I]←(4 10)[1+OK]
[32]   ⍝

[33]    II←(OK←QPLANQ[I]SAT I RFQ2 QPLANQ)/I←(NEXT=4)/⍳⍴QPLANQ
[34]    SOLVE II
[35]   ⍝ΔΔΔ:(I RFQ2 QPLANQ)SOLVEΔMONEY(I RFQ2 Q2)

[36]    QPLANQ[II]←II QFR2 QPLANL
[37]    WHERE[II]←4
[38]    NEXT[I]←(7 10)[1+OK]
```

Part 4 Run the Model

```
[39]  ⍝
[40]   II←(OK←QPLANQ[I]SAT L5[I]←I RFQ2 QPLANQ)/I←(NEXT=5)/⍳⍴L5←(⍴L)⍴LU+
      SUM2 L
[41]   WHERE[II]←5
[42]   QPLANL[II]←II RFQ2 QPLANQ
[43]   NEXT[I]←(6 10)[1+OK]
[44]  ⍝
[45]   II←(OK←Q3[I]SAT L[I])/I←(NEXT=6)/⍳⍴QPLANQ
[46]   SOLVE II
[47]  ⍝ΔΔΔ:L[I] SOLVEΔMONEY L5[I]
[48]   QPLANQ[II]←II QFR2 QPLANL
[49]   WHERE[II]←6
[50]   NEXT[I]←(7 10)[1+OK]
[51]  ⍝
[52]   II←(OK←Q7[I]SAT I RFQ2 Q7×(1-RES)÷(1-RESDOWN×RES))/I←(NEXT=7)/⍳⍴
      QPLANQ
[53]   WHERE[II]←7
[54]   QPLANL[II]←(1-QTARGM[II])×(QPLANQ[II]←Q7[II])×QEXPPNET[II]÷QEXPW[
      II]÷4
[55]   RES[II]←1-QPLANQ[II]×(1-RES[II])÷II QFR2 QPLANL
[56]   RES[(~OK)/I]←RESDOWN×RES[(~OK)/I]
[57]   ALWAYS '(RES≥0)∧(RES≤RESMAX)'
[58]   NEXT[I]←(8 10)[1+OK]
[59]  ⍝
[60]   II←(OK←(I×0)SAT(I×0))/I←(NEXT=8)/⍳⍴QPLANQ
[61]   SOLVE II
[62]  ⍝ΔΔΔ:0 SOLVEΔMONEY(I RFQ2 Q7)
[63]   QPLANQ[II]←II QFR2 QPLANL
[64]   WHERE[II]←8
[65]   NEXT[I]←(9 10)[1+OK]
[66]  ⍝
[67]   ⍎(0<⍴I←(NEXT=9)/⍳⍴QPLANQ)/'NULLIFYΔTARG (⍳⍴QPLANQ)∊I'
[68]  ⍝ WARNING: 'NEXT','Q2','Q3','Q7' ARE NOT SHRINKED.
[69]  ⍝
[70]   AMAN←(0 1 ↓AMAN),L
[71]   LAYOFF←0⌈L-QPLANL
[72]   AMAN←0⌈AMAN-0⌈(+\AMAN)MINUS7 LAYOFF
[73]  ⍝
[74]   ALWAYS 'QPLANQ≥0'
[75]   ALWAYS '0<SUM1 (⍴MARKET)⍴1'
[76]   ALWAYS 'QPLANL≥0'
[77]   I←⍳⍴QPLANQ
[78]   ALWAYS 'QPLANQ SAT QPLANL'
    ∇
```

Part 4 Run the Model

```
    ∇  S←QI SAT LI;OK;J
[1]     OK←QI≠QI
[2]     OK[J/⍳⍴OK]←QTARGM[J/I]≤1-QEXPW[J/I]÷4×WTIX×(1-RES[J/I])×TEC[J/I]×
       QEXPPNET[(J←(QI=0)∧(LI=0))/I]
[3]     OK[J/⍳⍴OK]←QTARGM[J/I]≤1.0001-(J/LI)×QEXPW[J/I]÷4×(J/QI)×QEXPPNET
       [(J←QI>0)/I]
[4]     S←OK
    ∇
```

```
    ∇  SOLVE I;B;Y;J;D
[1]     J←⍳⍴Y←÷B←QEXPW[I]÷4×(1-QTARGM[I])×WTIX×(1-RES[I])×TEC[I]×QEXPPNET
       [I]
[2]     ALWAYS 'B>0'
[3]    NR:→NR+0=⍴J←(D>0.001×Y[J]←Y[J]-D←((B[J]×Y[J])+(*-Y[J])-1)÷B[J]-*-Y
       [J])/J
[4]     QPLANL[I]←Y×QTOP[I]÷TEC[I]
    ∇
```

```
    ∇  LEFTL SOLVEΔMONEY RIGHTL;LΔ;OKΔ;IIΔ;LΔΔ
[1]    ⍝ GLOBALS USED: I QTOP TEC QEXPW QEXPPNET WTIX RES
[2]    ⍝ GLOBALS MODIFIED: QPLANL OK II
[3]     LΔ←(-QTOP[I]÷TEC[I])×⍟QEXPW[I]÷4×QEXPPNET[I]×WTIX×TEC[I]×1-RES[I]
[4]     OKΔ←LΔ≥LEFTL
[5]     IIΔ←OKΔ/I
[6]     LΔΔ←OKΔ/LΔ⌊RIGHTL
[7]     QPLANL[(IIΔ∊II)/IIΔ]←((IIΔ∊II)/LΔΔ)⌈QPLANL[(II∊IIΔ)/II]
[8]     QPLANL[(~IIΔ∊II)/IIΔ]←(~IIΔ∊II)/LΔΔ
[9]     OK←OK∨OKΔ
[10]    II←OK/I
    ∇
```

```
    ∇  NULLIFYΔTARG OUT
[1]     'REPORTΔNULLIFIED' MODSUBST 'LINE←''**⍵LINE←''******NULLIFIED (TA
       RG) (YEAR='',⍕THISΔYEAR'
[2]     NULLIFY OUT
[3]     QEXPPNET←(~OUT)/QEXPPNET
    ∇
```

Part 4   Run the Model

```
    ∇  NULLIFY OUT
[1]    LU←LU+OUT+.×L
[2]    REPORTΔNULLIFIED(LEFT\OUT)/⍳⍴LEFT
[3]    LEFT←LEFT∧LEFT\~OUT
[4]    SHRINK 'MARKET'
[5]   ⍝
[6]    SHRINK 'AMAN'
[7]    SHRINK 'BIG'
[8]    SHRINK 'BW'
[9]    SHRINK 'CHM'
[10]   SHRINK 'CUMINV'
[11]   SHRINK 'CUML'
[12]   SHRINK 'CUMM'
[13]   SHRINK 'CUMQ'
[14]   SHRINK 'CUMS'
[15]   SHRINK 'CUMSNET'
[16]   SHRINK 'CUMSU'
[17]   SHRINK 'CUMVA'
[18]   SHRINK 'CUMWS'
[19]   SHRINK 'DELAYΔINV'
[20]   SHRINK 'DP'
[21]   SHRINK 'DQ'
[22]   SHRINK 'DS'
[23]   SHRINK 'DVA'
[24]   SHRINK 'DW'
[25]   SHRINK 'EXPDP'
[26]   SHRINK 'EXOΔQDSUFOR'
[27]   SHRINK 'EXPDS'
[28]   SHRINK 'EXPDW'
[29]   SHRINK 'HISTDP'
[30]   SHRINK 'HISTDPDEV'
[31]   SHRINK 'HISTDPDEV2'
[32]   SHRINK 'HISTDW'
[33]   SHRINK 'HISTDWDEV'
[34]   SHRINK 'HISTDWDEV2'
[35]   SHRINK 'HISTDS'
[36]   SHRINK 'HISTDSDEV'
[37]   SHRINK 'HISTDSDEV2'
[38]   SHRINK 'IMBIG'
[39]   SHRINK 'IMSMALL'
[40]   SHRINK 'IMSTO'
[41]   SHRINK 'INVEFF'
[42]   SHRINK 'K1'
[43]   SHRINK 'K1BOOK'
[44]   SHRINK 'K2'
[45]   SHRINK 'L'
[46]   SHRINK 'DL'
[47]   SHRINK 'LLASTYR'
[48]   SHRINK 'M'
```

Part 4 Run the Model

```
[49]    SHRINK  'DNW'
[50]    SHRINK  'MHIST'
[51]    SHRINK  'NWLASTYR'
[52]    SHRINK  'P'
[53]    SHRINK  'Q'
[54]    SHRINK  'QDP'
[55]    SHRINK  'QDQ'
[56]    SHRINK  'QDS'
[57]    SHRINK  'QDSUFOR'
[58]    SHRINK  'QDVA'
[59]    SHRINK  'QDW'
[60]    SHRINK  'QEXPP'
[61]    SHRINK  'QEXPS'
[62]    SHRINK  'QEXPSU'
[63]    SHRINK  'QEXPW'
[64]    SHRINK  'QIMQ'
[65]    SHRINK  'QINV'
[66]    SHRINK  'QINVLAG'
[67]    SHRINK  'QM'
[68]    SHRINK  'QOPTSU'
[69]    SHRINK  'QP'
[70]    SHRINK  'QPLANL'
[71]    SHRINK  'QPLANQ'
[72]    SHRINK  'QQ'
[73]    SHRINK  'QS'
[74]    SHRINK  'QSDOM'
[75]    SHRINK  'QSFOR'
[76]    SHRINK  'QSNET'
[77]    SHRINK  'QSU'
[78]    SHRINK  'QSUDOM'
[79]    SHRINK  'QSUFOR'
[80]    SHRINK  'QTARGM'
[81]    SHRINK  'QTOP'
[82]    SHRINK  'QVA'
[83]    SHRINK  'QW'
[84]    SHRINK  'RES'
[85]    SHRINK  'S'
[86]    SHRINK  'SHARE'
[87]    SHRINK  'SMALL'
[88]    SHRINK  'SNET'
[89]    SHRINK  'STO'
[90]    SHRINK  'SYMBOL'
[91]    SHRINK  'TEC'
[92]    SHRINK  'TYPE'
[93]    SHRINK  'VA'
[94]    SHRINK  'W'
[95]    SHRINK  'X'
[96]    SHRINK  'RW'
[97]    SHRINK  'RSUBSΔCASH'
```

Part 4 Run the Model

```
      SHRINK 'RSUBS∆EXTRA'
      SHRINK 'RVA'
      SHRINK 'CUMINTPAYF'
      SHRINK 'CUMDEPR'
      SHRINK 'CUMTAXF'
      SHRINK 'CUMDIV'
      SHRINK 'CUMSUBSF'
      SHRINK 'CUMCHBWF'
      SHRINK 'CUMCHK2F'
      SHRINK 'TRENDQ'
      SHRINK 'XCUM'
    ∇
```

```
    ∇ REPORT∆NULLIFIED FIRMS;I;M;F;LINE
      FIRMS←,FIRMS
      ALWAYS '0<⍴FIRMS'
      LINE←'****** NULLIFIED (YEAR=',⍕THIS∆YEAR
      ⍎(2≤⎕NC 'NRS')/'LINE←LINE,'' QUARTER='',⍕NRS'
      LINE←LINE,'):'
     L:I←1↑FIRMS
      M←ORIGMARKET[I]
      F←(+\ORIGMARKET=M)[I]
      LINE←LINE,' ',(⍕M),'.',(⍕F)
      →(0<⍴FIRMS←1↓FIRMS)/L
      LINE
      ED∆NULLIFIED←ED∆NULLIFIED ABOVE LINE
    ∇
```

```
    ∇ SHRINK VECTOR∆NAME
     ⍝
     ⍝ TO ERASE NULLIFIED FIRMS' DATA FROM A VECTOR OR FROM A MATRIX:
     ⍝ 'VECTOR∆NAME' IS A STRING, GIVING NAME OF VARIABLE TO BE SHRINKE
     D.
     ⍝    IF IT HAS >1 AXES, THE FIRST MUST DENOTE FIRMS.
     ⍝ GLOBAL VECTOR 'OUT' IS A MASK, TELLING HOW TO SHRINK.
     ⍝
      →(2≠⎕NC VECTOR∆NAME)/0
      ⍎VECTOR∆NAME,'←(~OUT)⌿',VECTOR∆NAME
    ∇
```

Part 4 Run the Model

4.4

```
    ∇  INTERMEDIATEΔPRODUCTS
      ⍝ TO SAVE MEMORY SPACE (NOT DOUBLE-STORE 'QIMQ'), THIS COMPUTATION
      ⍝ IS MOVED TO LAST IN BLOCK 'PLANQREVISE', WHERE OLD 'QIMQ' NEED
      ⍝ NO LONGER BE SAVED.
      ⍝ WE JUST SAVE THE VALUE OF 'QPLANQ', BEFORE IT IS CHANGED IN
      ⍝ LABOUR MARKET BLOCK.
       QPLANQSAVE←QPLANQ
    ∇
```

5

```
    ∇  LABOURΔMARKET
      ⍝
       ZLABOUR
       GLABOUR
       INDLABOUR
    ∇
```

```
    ∇  ZLABOUR;QCHLZ
       TECZ←TECZ×1+QDTECZ
       QCHLZ←0
       LZ←LZ+QCHLZ-RET×LZ
       LU←LU-QCHLZ
       QWZ←QWZ×1+QDWIND
       QQZ←TECZ×LZ
       QPRELPZ←(QPZ×1+QDWIND-QDTECZ)÷1-TXVAZ
    ∇
```

5.3

```
    ∇  GLABOUR;QCHLG
       QCHLG←LU⌊(LG×RET)+QREALCHLG
       LG←LG+QCHLG-RET×LG
       LU←LU-QCHLG
       QWG←QWG×1+QDWG
    ∇
```

5.4

```
    ∇  INDLABOUR;QCHW;QCHL
       LABOURΔSEARCH
       LABOURΔUPDATE
       PLANQREVISE
    ∇
```

Part 4 Run the Model

5.4.1

```
     ∇  LABOURΔSEARCH;CHL;LL;WW
[1]     LABOURΔSEARCHΔINPUT
[2]     CONFRONT
[3]     LABOURΔSEARCHΔOUTPUT
     ∇
```

```
     ∇  LABOURΔSEARCHΔINPUT
[1]     CHL←((CHM>0)×QPLANL-L)+((CHM≤0)×((⍳⍴QPLANQ)RFQ2 QPLANQ)-L)
[2]     LL←L,LU
[3]     WW←QW+IOTA×QEXPW-QW
     ∇
```

```
     ∇  CONFRONT;ORD;N;J;K;I;II;NOW;SKR
[1]     SKR←(L=L),SKREPA
[2]     J←0×N←⍴ORD←⍋CHL÷L
[3]    ITR:→(NITER<J←J+1)/K←0
[4]    ATK:→(N<K←K+(0<CHL[K↓ORD])⍳1)/ITR
[5]     →(WW[I]≥(1+GAMMA)×(WW,0)[II←HIT LL×SKR×(I←ORD[K])≠⍳1+N])/SUC
[6]     →ATK,WW[I]←WW[I]+KSI×(WW[II]×1+GAMMA)-WW[I]
[7]    SUC:→(II>N)/ATK+0×CHL[I]←CHL[I]-NOW++/0×LL[I,II]←LL[I,II]+NOW,-NOW
       ←CHL[I]⌊THETA×LL[II]
[8]     →ATK,CHL[II]←CHL[II]+NOW
     ∇
```

```
     ∇  II←HIT V
[1]     II←1+(?⌊+/V)+.>+\V
     ∇
```

```
     ∇  LABOURΔSEARCHΔOUTPUT;EXIT
[1]     LU←¯1↑LL
[2]     QCHL←(¯1↓LL)-L
[3]     QCHW←WW-QW
[4]     EXIT←0⌈-QCHL
[5]     AMAN←0⌈AMAN⌊(+\AMAN)MINUS7 EXIT
     ∇
```

Part 4 Run the Model

5.4.2

```
    ∇  LABOURΔUPDATE;SACK
[1]   ⍝
[2]    SACK←0⌈L+QCHL-QPLANL
[3]   DOAMAN:SACK←SACK⌊AMAN[;1]
[4]    QCHL←QCHL-SACK
[5]    AMAN[;1]←AMAN[;1]-SACK
[6]    LU←LU+SUM2 SACK
[7]    QDWIND←¯1+((L+QCHL)AVG2(QW+QCHW))÷(L AVG2 QW)
[8]    L←L+QCHL
[9]    QDW←QCHW÷QW
[10]   QW←QW+QCHW
[11]   RU←RU+QCHRU←(LU÷LU+LZ+LG+SUM2 L)-RU
    ∇
```

5.4.3

```
    ∇  PLANQREVISE;MAT;SHORTAGE;QRED
[1]   ⍝

[2]    QPLANQ←QPLANQ⌊QFR1 L
[3]   ⍝

[4]    MAT←(⍉IO)[MARKET;]
[5]    SHORTAGE←0⌈(MAT MULT7 QPLANQ)-(QIMQ+IMSTO-MINIMSTO)
[6]    QPLANQ←QPLANQ-QRED←⌈/(MAT≠0)×SHORTAGE÷MAT
[7]   ⍝

[8]    QQ←QQ×1+QDQ←¯1+QPLANQ÷QQ
[9]    ALWAYS 'QQ>0'
[10]   IMSTO←MAXIMSTO⌊IMSTO+QIMQ-(⍉IO)[MARKET;]MULT7 QQ
[11]   QOPTSU←0⌈QQ×(QEXPSU÷QEXPSU+(OPTSTO-STO)÷(4×TMSTO))
[12]  ⍝

[13]  ⍝ NOW FOLLOWS COMPUTATION MOVED FROM BLOCK 'INTERMEDIATEΔPRODUCTS'

[14]   QIMQ←0⌈((⍉IO)[MARKET;]MULT7 QPLANQSAVE)+(OPTIMSTO-IMSTO)÷4×
      TMIMSTO
[15]   DUMMY←⎕EX 'QPLANQSAVE'
[16]   ALWAYS 'QIMQ≥0'
    ∇
```

6

```
    ∇  EXPORTΔMARKETS
[1]   ⍝

[2]    X←1⌊0⌈X+(X+(1-2×X)MULT1(QPDOM×1-TXVA2)[MKT]<QPFOR)MULT1(÷4×TMX)×(
      QPFOR-(QPDOM×1-TXVA2)[MKT])÷(QPFOR⌊(QPDOM×1-TXVA2)[MKT])
[3]    QSUFOR←X×QOPTSU
[4]    QPFOR←QPFOR×1+QDPFOR
[5]    QSFOR←(1+RSUBS)×QSUFOR MULT1 QPFOR
[6]    QSUBSFOR←QPFOR+.×SUM1 RSUBS×QSUFOR
[7]    QEXPORT←SUM2 QSFOR÷1+RSUBS
[8]    ALWAYS '(SUM2 QSFOR)=QEXPORT+QSUBSFOR'
    ∇
```

Part 4 Run the Model

```
     ∇   R←RSUBS
[1]      R←RSUBS[MARKET]+RSUBSΔEXTRA
     ∇
```

7

```
     ∇   DOMESTICΔMARKET;QOPTSUDOM;QPRELPDOM;PT;INMONEYHH;QSPSAVREQ
[1]      MARKETΔENTRANCE
[2]      HOUSEHOLDΔINIT
[3]     ⍝
[4]      MARKETΔCONFRONT
[5]     ⍝
[6]      COMPUTEΔIMPORTS
[7]      NOTIFY 'QTBUY[MKT,IN]=0'
[8]      DOMESTICΔRESULT
[9]      EXTERNALΔSECTORS
[10]     HOUSEHOLDΔUPDATE
[11]     INDIRECTΔTAXES
[12]    ⍝
[13]     ALWAYS 'INMONEYHH=QWTAX+QITAX+QSAVH++/QSP[NDURΔDUR;]+.×NH'
[14]     ALWAYS '((+/QPURCHG+QSP[MKT,IN;]+.×NH)+(QINVG+QINVIN+QINVBLD+SUM2
         QINVLAG)+(+/QIMPURCHΔIN)+((SUM2 QIMQ)+.×QPDOM×1-TXVA2))=(+/QVATAX
        [MKT,IN])+(+/QSDOMΔIN)+QIMPORT+QTSUDOM+.×(QPDOM×1-TXVA2)[MKT]'
     ∇
```

7.1

```
     ∇   MARKETΔENTRANCE
[1]      QOPTSUDOM←(1-X)×QOPTSU
[2]      QPRELPDOM←(QPDOM×1+QCHTXVA2)[MKT]×QOPTSUDOM AVG1 QEXPP÷QP
     ∇
```

7.2

```
     ∇   HOUSEHOLDΔINIT;QTWS;QTI
[1]     ⍝
[2]      QTRANS←(RTRANS×(LG×QWG÷4)×1++/GKOFF)+RLU×0.25×LU×L AVG2 QW×1-TXW
[3]      INMONEYHH←QTRANS+QINPAY+QTDIV+QDIVZ+(SUM2 L×QW÷4)+(LG×QWG÷4)+(LZ×
        QWZ÷4)+(QINTH←NH+.×RIH×WH÷4)
[4]      QTWS←(LG×QWG÷4),(LZ×QWZ÷4)+SUM2 L×QW÷4
[5]      QTWS←QTWS+0,QINPAY
[6]      QWTAX←QTWS+.×(TXWG,TXW)÷1+(TXWG,TXW)
[7]      QTI←QTDIV+QDIVZ+QTRANS+((+/QTWS)-QWTAX)+QINTH
[8]      QITAX←0.25×AGGRITAX 4×QTI
[9]      QDI←(⍴NH)⍴(QTI-QITAX)÷+/NH
[10]     QSPSAVREQ←(⍴NH)⍴QSAVHREQ÷+/NH
     ∇
```

Part 4 Run the Model

```
    ∇  R←AGGRITAX Y
[1]    DO:R←AGGRITAXΔPROP Y
    ∇
```

```
    ∇  R←AGGRITAXΔPROP Y
[1]    R←TXI1×Y
    ∇
```

7.3

```
    ∇  MARKETΔCONFRONT;J
[1]    ⍝

[2]     IMP[MKT]←1⌊0⌈IMP[MKT]-(IMP[MKT]+(1-2×IMP[MKT])×(QPDOM×1-TXVA2)[
       MKT]>QPFOR)×(÷4×TMIMP)×(QPFOR-(QPDOM×1-TXVA2)[MKT])÷(QPFOR⌊(QPDOM×
       1-TXVA2)[MKT])
[3]     QPURCHG←GKOFF×LG×QWG÷4
[4]     PT←QPRELPDOM,(QPDOM[IN]×1+QDPIN),QPRELPZ
[5]     J←1
[6]    L:
[7]     COMPUTEΔSPENDING
[8]     COMPUTEΔBUYING
[9]     →(MARKETΔITER<J←J+1)/0
[10]    ADJUSTΔPRICES
[11]    →L
    ∇
```

MARKETΔCONFRONTΔNEWP is now used instead of **MARKETΔFRONT** (see line 4 in **MOSESΔVARIANTS**)

```
    ∇  MARKETΔCONFRONTΔNEWP;J
[1]    ⍝

[2]     IMP[MKT]←1⌊0⌈IMP[MKT]-(IMP[MKT]+(1-2×IMP[MKT])×(QPDOM×1-TXVA2)[
       MKT]>QPFOR)×(÷4×TMIMP)×(QPFOR-(QPDOM×1-TXVA2)[MKT])÷(QPFOR⌊(QPDOM×
       1-TXVA2)[MKT])
[3]     QPURCHG←GKOFF×LG×QWG÷4
[4]     PT←(((1-IMP[MKT])×QPRELPDOM)+(IMP[MKT]×QPFOR[MKT])÷(1-TXVA2)),(
       QPDOM[IN]×1+QDPIN),1
[5]     QPURCHG←QPURCHG×PT[⍳10]×(1÷(QWG÷WGAREF))÷100
[6]     J←1
[7]    L:
[8]     COMPUTEΔSPENDING
[9]     COMPUTEΔBUYING
[10]    →(MARKETΔITER<J←J+1)/0
[11]    ADJUSTΔPRICESΔNEWP
[12]    →L
    ∇
```

Part 4 Run the Model

7.4

```
    ∇  COMPUTE∆SPENDING;QPRELCPI;QCHDCPI;QSPE;SWAP
[1]    ⍝

[2]     QCHDCPI←((QPRELCPI←CPI1 PT)÷QCPI)-1+QDCPI
[3]    ⍝

[4]     QSPE←((⍴NDUR∆DUR,SAV),(⍴NH))⍴0
[5]     QSPE[NDUR;]←CVA[NDUR;]MULT7 PT[NDUR]
[6]    ⍝

[7]     SWAP←(ALFA3×(QCHRI÷4)-QCHDCPI)+(ALFA4×QCHRU)
[8]     QSPE[DUR;]←0⌈(PT[DUR]×CVA[DUR;]÷RHODUR)-((PT[DUR]÷QPH[DUR])×(1-
       RHODUR)×STODUR)+(QDI×SWAP)
[9]     QSPE[SAV;]←((WHRA×QDI)-WH)+(QDI×SWAP)
[10]   ⍝

[11]    ALWAYS '(0≤BETA1)∧(1=+/BETA2)∧(0=+/BETA3)'
[12]    QSP←(QSPE MULT7 BETA1)+((BETA3∘.÷(QDI-QSPSAVREQ)÷QPRELCPI)PLUS7
       BETA2)MULT8((QDI-QSPSAVREQ)-+⌿QSPE MULT7 BETA1)
[13]    QSP[NDUR∆DUR;]←0⌈QSP[NDUR∆DUR;]
[14]    QSP[SAV;]←QSP[SAV;]+QSPSAVREQ
    ∇
```

7.5

```
    ∇  COMPUTE∆BUYING;QINVTOT
[1]     QBUY←((⍴MKT,IN,Z),(3+⍴MKT,IN))⍴0
[2]     QBUY[MKT,IN;MKT]←⍉SUM1 QIMQ
[3]     QBUY[MKT,IN;1+⍴MKT,IN]←QPURCHG÷PT[MKT,IN]
[4]     QBUY[;2+⍴MKT,IN]←(QSP[NDUR∆DUR;]+.×NH)÷PT
[5]     QINVTOT←(OMEGAG×QINVG)+(OMEGABLD×QINVBLD)+(OMEGAIN×QINVIN)+(OMEGA
       ×SUM2 QINVLAG)
[6]     QBUY[MKT,IN;3+⍴MKT,IN]←QINVTOT÷(PT[MKT,IN]×(1-TXVA2)÷(1-TXVA1))
[7]    ⍝ NOTE ON NEXT LINE THAT QBUY[IN;IN] IS STILL ZERO

[8]     QQIN←(⌹((⍳⍴IN)∘.=⍳⍴IN)-IO3 MULT7(1-NMARKETS↓IMP)÷1-XIN)+.×(+/QBUY
       [IN;])×(1-NMARKETS↓IMP)÷1-XIN
[9]     QBUY[MKT,IN;IN]←(IO2,[1]IO3)MULT8 QQIN
[10]    ALWAYS 'QBUY≥0'
[11]    QTBUY←+/QBUY
    ∇
```

Part 4 Run the Model

7.6

```
    ∇ ADJUST∆PRICES
      PT[MKT]←PT[MKT]×1+(|MAXDP÷4×MARKET∆ITER-1)×(×(QTBUY[MKT]×1-IMP[
     MKT])-SUM1 QOPTSUDOM)
    ∇
```

ADJUST∆PRICES∆NEWP is now used instead of **ADJUST∆PRICES** (see line 4 in **MOSES∆VARIANTS**)

```
    ∇ ADJUST∆PRICES∆NEWP
      MAXDP2←(1-IMP)×MAXDP
      PT[MKT]←PT[MKT]×1+(|MAXDP2[MKT]÷4×MARKET∆ITER-1)×(×(QTBUY[MKT]×1-
     IMP[MKT])-SUM1 QOPTSUDOM)
    ∇
```

7.7

```
    ∇ COMPUTE∆IMPORTS;IMPZ;QMAXTSUDOM
      QTBUYFOR←QTBUY×IMP,IMPZ←0
      QTBUYDOM←QTBUY-QTBUYFOR
      QTBUYDOM[MKT]←QTBUYDOM[MKT]⌊QMAXTSUDOM←SUM1 0⌈QQ+(STO-MINSTO)-
     QSUFOR
      QTBUYFOR←⍉(2,⍴NDURA∆DUR)⍴QTBUYFOR,QTBUY-QTBUYDOM+QTBUYFOR
      ALWAYS 'QTBUYFOR≥0'
      ALWAYS '0=QTBUYFOR[Z;]'
      QIMPORT←(PT×1-TXVA2)[MKT;IN]+.×+/QTBUYFOR[MKT;IN;]
      G
    ∇
```

COMPUTE∆IMPORTS∆NEWP is now used instead of **COMPUTE∆IMPORTS** (see line 4 in **MOSES∆VARIANTS**)

```
    ∇ COMPUTE∆IMPORTS∆NEWP;IMPZ;QMAXTSUDOM
      QTBUYFOR←QTBUY×IMP,IMPZ←0
      QTBUYDOM←QTBUY-QTBUYFOR
      QTBUYDOM[MKT]←QTBUYDOM[MKT]⌊QMAXTSUDOM←SUM1 0⌈QQ+(STO-MINSTO)-
     QSUFOR
      QTBUYFOR←⍉(2,⍴NDURA∆DUR)⍴QTBUYFOR,QTBUY-QTBUYDOM+QTBUYFOR
      ALWAYS 'QTBUYFOR≥0'
      ALWAYS '0=QTBUYFOR[Z;]'
      QIMPORT←(QPFOR[MKT],(1-TXVA2)×(QPDOM[IN]×1+QDPIN))+.×+/QTBUYFOR[
     MKT;IN;]
    ∇
```

Part 4 Run the Model

```
     ∇  NOTIFY STRING
[1]     →(∧/,~⍱STRING)/0
[2]     '*****      ',STRING,'     (',(⍕THISΔYEAR),':',(⍕NRS),')'
     ∇
```

7.8

```
     ∇  DOMESTICΔRESULT
[1]     QDPDOM←¯1+PT[MKT,IN]÷QPDOM
[2]     QPDOM←PT[MKT,IN]
[3]     QPZ←PT[Z]×1-TXVAZ
[4]     QTSUDOM←QTBUYDOM[MKT]
[5]     QSZ←QTBUYDOM[Z]×QPZ
[6]     ALWAYS 'QSZ=(1-TXVAZ)×NH+.×QSP[Z;]'
     ∇
```

DOMESTICΔRESULTΔNEWP is now used instead of **DOMESTICΔRESULT** (see line 4 in **MOSESΔVARIANTS**)

```
     ∇  DOMESTICΔRESULTΔNEWP
[1]     QDPDOM[MKT]←((PT[MKT]-IMP[MKT]×QPFOR[MKT])÷((1-IMP[MKT])×
      QPRELPDOM[MKT]))×(QPRELPDOM[MKT]÷QPDOM[MKT])-1
[2]     QDPDOM[IN]←(PT[IN]÷QPDOM[IN])-1
[3]     QPDOM←(1+QDPDOM)×QPDOM
[4]   ⍝ QPZ←PT[Z]×1-TXVAZ
[5]     QTSUDOM←QTBUYDOM[MKT]
[6]   ⍝ QSZ←QTBUYDOM[Z]×QPZ
[7]     ALWAYS 'QSZ=(1-TXVAZ)×NH+.×QSP[Z;]'
     ∇
```

Part 4 Run the Model

7.9

```
    ∇ EXTERNALΔSECTORS;OLD
      OLD←QINPAY
      QEXPORTΔIN←QQIN×XIN×QPFORΔIN
      QEXPORT←QEXPORT++/QEXPORTΔIN
      QSDOMΔIN←QTBUYDOM[IN]×(QPDOM×1-TXVA2)[IN]
      QIMPURCHΔIN←(QPDOM×1-TXVA2)+.×QBUY[MKT,IN;IN]
      QVAΔIN←QSDOMΔIN+QEXPORTΔIN-QIMPURCHΔIN
      QINPAY←(+/QVAΔIN)-QINVIN+QINVBLD
      QCHKIN←QINPAY-OLD
    ∇
```

```
    ∇ R←QPFORΔIN
      R←(QPDOM×1-TXVA2)[IN]
    ∇
```

7.10

```
    ∇ HOUSEHOLDΔUPDATE
      QC[NDUR;]←QSP[NDUR;]
     ⍝
      QC[DUR;]←RHODUR×STODUR←QSP[DUR;]+STODUR×PT[DUR]÷QPH[DUR]
      STODUR←STODUR×1-RHODUR
     ⍝
      QSAVH←NH+.×QSP[SAV;]←QDI-+⌿QSP[NDURΔDUR;]
      WH←WH+QSP[SAV;]
     ⍝
      CVA←(CVA MULT7 SMOOTH[NDURΔDUR])+(QC MULT7(1-SMOOTH[NDURΔDUR])÷PT
     )
      WHRA←(WHRA×SMOOTH[SAV])+((WH÷QDI)×(1-SMOOTH[SAV]))
     ⍝
      QCPI←QCPI×1+QDCPI←¯1+(CPI1 QPH←PT)÷QCPI
    ∇
```

7.11

```
    ∇ INDIRECTΔTAXES;MORE
      QVATAX←(TXVA2×QPURCHG+QSP[MKT,IN;]+.×NH),(TXVAZ×QSP[Z;]+.×NH)
      →(0∧.=,TXVA1)/END
      MORE←(QPDOM×(1-TXVA2)÷(1-TXVA1))×+/QBUY[MKT,IN;3+⍴MKT,IN]
      QVATAX[MKT,IN]←QVATAX[MKT,IN]+TXVA1×MORE
     END:
      QVATAXΔIMP←QVATAX+.×(+/QTBUYFOR)÷QTBUY
    ∇
```

Part 4 Run the Model

8

```
      ∇STOSYSTEM[⎕]∇
    ∇  STOSYSTEM
[1]     FIRMSTO
[2]    ⍝ NO FUNCTION 'STOUPDATE' EXISTS.
[3]    ⍝ INSTEAD, OPTSTO, MINSTO, MAXSTO ARE VALUE-RETURNING FUNCTIONS
    ∇
```

8.1

```
    ∇  FIRMSTO;PRIMCHSTO;PROPCHSTO;DISTR;CORRCHSTO;LOWER;UPPER;LIMSTO;
      TOTCHSTO
[1]     LIMSTO←STO+QQ-QSUFOR
[2]     LOWER←LIMSTO⌊MINSTO
[3]     UPPER←LIMSTO⌊MAXSTO
[4]     TOTCHSTO←(SUM1 UPPER-STO)⌊(SUM1 QQ-QSUFOR)-QTSUDOM
[5]     QCHTSTO←TOTCHSTO
[6]     QWASTE←((SUM1 QQ-QSUFOR)-QTSUDOM)-TOTCHSTO
[7]     ALWAYS '(SUM1 LOWER)≤TOTCHSTO+SUM1 STO'
[8]     ALWAYS '(SUM1 UPPER)≥TOTCHSTO+SUM1 STO'
[9]     STO←STO+PRIMCHSTO←((STO>UPPER)×UPPER-STO)+((STO<LOWER)×LOWER-STO)
[10]    TOTCHSTO←TOTCHSTO-SUM1 PRIMCHSTO
[11]    DISTR←((UPPER-STO)MULT1 TOTCHSTO>0)+((LOWER-STO)MULT1 TOTCHSTO<0)
[12]    STO←STO+PROPCHSTO←(DISTR DIV1 SUM1 DISTR)MULT1 TOTCHSTO
[13]    QSUDOM←QQ-QSUFOR+PRIMCHSTO+PROPCHSTO
[14]    ALWAYS 'QSUDOM≥0'
[15]    QSUDOM←QSUDOM MULT1 QTSUDOM÷SUM1 QSUDOM
[16]    QSUBSDOM←(QPDOM×1-TXVA2)[MKT]+.×SUM1 RSUBS×QSUDOM
[17]    QSDOM←(QSUDOM×1+RSUBS)MULT1(QPDOM×1-TXVA2)[MKT]
    ∇
```

```
    ∇  RESULT←MINSTO
[1]     RESULT←REFQSTO×SMALL
    ∇
```

```
    ∇  R←REFQSTO
[1]     R←4×(QCUR 'S')÷CUR 'P'
    ∇
```

```
    ∇  RESULT←MAXSTO
[1]     RESULT←REFQSTO×BIG
    ∇
```

Part 4 Run the Model

```
∇  QUARTERLY∆RESULT
    ⍝
    FINALQPQSQM
    QUARTERLY∆CUM
∇
```

9.1

```
∇  FINALQPQSQM
    ⍝
    QSU←QSUFOR+QSUDOM
    QDS←(QSFOR+QSDOM-QS)÷QS
    QS←QSFOR+QSDOM
    ALWAYS 'QS>0'
    QDP←((QS÷QSU)-QP)÷QP
    QP←QS÷QSU
    QVA←QVA×1+QDVA←¯1+(QQ×QP-((QPDOM×1-TXVA2)+.×IO)[MARKET])÷QVA
    QM←1-(L×QW)÷4×QSNET←QS-QIMQ+.×QPDOM×1-TXVA2
    QMZ←1-(LZ×QWZ÷4)÷QSZ
    QCHKZ←QSZ-(LZ×QWZ÷4)+QDIVZ+(TXC×QMZ×QSZ)
    QDIVZ←QMZ×QSZ×1-TXC
∇
```

9.2

```
∇  QUARTERLY∆CUM
    J∆CUM←J∆CUM+1
    ⍝
    CUMINV←CUMINV+QINVLAG
    CUMQ←CUMQ+QQ
    CUMVA←CUMVA+QVA
    CUMS←CUMS+QS
    CUMSU←CUMSU+QSU
    CUMSNET←CUMSNET+QSNET
    CUMWS←CUMWS+L×QW÷4
    CUML←(L+CUML×NRS-1)÷NRS
    ⍝
    CUMM←1-CUMWS÷CUMSNET
    MFLOWS←MFLOWS+QMFLOWS
    ALWAYS '(+/MFLOWS[;⍳3])=(+/0 3↓MFLOWS)'
∇
```

Part 4 Run the Model

10

```
    ∇  INVFIN;QDEPR;QDEPRBOOK;QREV;QDIV;QTAX;QDPK
[1]    QREV←(QM×QSNET)+(K2×RIK2÷4)−(BW×RIF÷4)
[2]    QDPK←OMEGA+.×QDPDOM−QCHTXVA2−QCHTXVA1
[3]    K1←K1−QDEPR←RHO×K1←QINV+K1×1+QDPK
[4]    K1BOOK←K1BOOK−QDEPRBOOK←0⌈QREV⌊RHOBOOK×K1BOOK←QINV+K1BOOK×1+QDPK
[5]   ⍝ K3 IS CALCULATED IN VALUE−RETURNING SUBROUTINE

[6]    QTAX←TXC×0⌈QREV−QDEPRBOOK
[7]    QDIV←RTD×QTAX
[8]    QCASH←(RSUBSΔCASH×QS)+QREV−QTAX+QDIV
[9]    QRR←4×(QREV−QDEPR)÷(K1+K2+K3)
[10]   QDESCHBW←(0⌈1−ELINV×UTREF−QQ÷QTOP×WTIX×1−RES)×BW×ALFABW+BETABW×
      QDPK+(QRR−RIF)÷4
[11]   ALWAYS '0≤BW+QDESCHBW'
[12]   QDESCHK2←(RW×4×QCUR 'S')−K2
[13]   QINV←QINVLAG DELAY TMINV
[14]   INVEFF←QTOP×QP÷K1
[15]  ⍝

[16]   QCTAX←(SUM2 QTAX)+(TXC×QMZ×QSZ)
[17]   QINTF←SUM2 RIF×BW÷4
[18]   QTDIV←QTDIV+QTCHDIV←(SUM2 QDIV)−QTDIV
[19]   QINTK2←SUM2 RIK2×K2÷4
[20]  ⍝

[21]   QBFA←(SUM1 QM×QSNET),[1](SUM1 RIF×BW÷4),[1](SUM1 RIK2×K2÷4),[1](
      SUM1 QDEPRBOOK),[1](SUM1 QTAX)ABOVE(SUM1 QDIV)
[22]   QBFA←QBFA,[1](SUM1 RSUBSΔCASH×QS)
[23]   QSUBSΔCASH←SUM2 RSUBSΔCASH×QS
[24]  ⍝

[25]   CUMINTPAYF←CUMINTPAYF+(RIF×BW÷4)−(RIK2×K2÷4)
[26]   CUMDEPR←CUMDEPR+QDEPRBOOK
[27]   CUMTAXF←CUMTAXF+QTAX
[28]   CUMDIV←CUMDIV+QDIV
[29]   CUMSUBSF←CUMSUBSF+RSUBSΔCASH×QS
    ∇


    ∇  R←K3
[1]    R←K3ΔIMED+K3ΔFINISH
    ∇


    ∇  R←K3ΔIMED
[1]    R←IMSTO+.×QPDOM×1−TXVA2
    ∇


    ∇  R←K3ΔFINISH
[1]    R←STO×QP
    ∇
```

Part 4 Run the Model

11

```
    ∇ GOVERNMENTΔACCOUNTING
      ⍝ QWTAX,QITAX,QVATAX,QCTAX ARE ALREADY AVAILABLE FROM THROUGHOUT T
      HE QUARTER
       QINTG←(DEPG×RIDEPG÷4)-(BWG×RIBWG÷4)
       QINTGFOR←(DEPGFOR×RIDEPGFOR÷4)-(BWGFOR×RIBWGFOR÷4)
       QWSG←LG×QWG÷4
       QSUBS←QSUBSFOR+QSUBSDOM+QSUBSΔCASH
       QSPG←QWSG+(+/QPURCHG)+QTRANS+QSUBS
       QSURPLUSG←(QTTAX←QWTAX+QITAX+(+/QVATAX)+QCTAX)+QINTG+QINTGFOR-
      QSPG+QINVG
       QMPRINT←0⌈MONEY×⍎(1+2=⎕NC 'QDGNPCUR')WITHIN ' S AVG2 0.25×DS ⍵ QD
      GNPCUR '
       POSGFOR←POSGFOR+QCHPOSGFOR←0
       POSG←POSG+QCHPOSG←QSURPLUSG+QMPRINT-QCHPOSGFOR
      ⍝

       CUMWTAX←CUMWTAX+QWTAX
       CUMITAX←CUMITAX+QITAX
       CUMVATAX←CUMVATAX++/QVATAX
       CUMCTAX←CUMCTAX+QCTAX
       CUMWSG←CUMWSG+QWSG
       CUMLG←(LG+CUMLG×NRS-1)÷NRS
       CUMPURCHG←CUMPURCHG+QPURCHG
       CUMTRANS←CUMTRANS+QTRANS
       CUMSUBS←CUMSUBS+QSUBS
       CUMMPRINT←CUMMPRINT+QMPRINT
       CUMINTG←CUMINTG+QINTGFOR+QINTG
       CUMINVG←CUMINVG+QINVG
       →(NRS<4)/OUT
       WTAX←CUMWTAX
       ITAX←CUMITAX
       VATAX←CUMVATAX
       CTAX←CUMCTAX
       MPRINT←CUMMPRINT
       INTG←CUMINTG
       INVG←CUMINVG
       WG←WG×1+DWG←¯1+CUMWSG÷CUMLG×WG
       WSG←WSG×1+DWSG←¯1+CUMWSG÷WSG
       PURCHG←CUMPURCHG
       TRANS←CUMTRANS
       SUBS←CUMSUBS
       SPG←WSG+(+/PURCHG)+TRANS+SUBS
       SURPLUSG←WTAX+ITAX+VATAX+CTAX+INTG-SPG+INVG
      OUT:
    ∇
```

Part 4 Run the Model

```
     ∇  M←MONEY
[1]     M←DEPG+(WH+.×NH)+(SUM2 K2)
     ∇
```

```
     ∇  R←DEPG
[1]     R←0⌈POSG
     ∇
```

12

```
     ∇  MONETARYΔSECTOR;QCHBW
[1]     BANKΔTRANSACTIONS
[2]     CREDITΔMARKET
[3]     INVFINΔADJUSTMENTS
[4]     BANKΔUPDATE
     ∇
```

12.1

```
     ∇  BANKΔTRANSACTIONS;RFPAY
[1]     RFPAY←LAMDA2×1⌊¯1⌈(RI-RIBWFOR)÷MAXRIDIFF
[2]     FASS←FASS+QCHFASS←QEXPORT-QFASSPAY←(FASS+QEXPORT)÷1+4×TMFASS×1-
       RFPAY
[3]     FD←FD+QCHFD←QIMPORT-QFDPAY←(FD+QIMPORT)÷1+4×TMFD×1+RFPAY
[4]     LIQBFOR←LIQBFOR+QCHLIQBFOR←QFASSPAY+QINTGFOR-QFDPAY+QCHPOSGFOR
[5]     QCHLIQB←QINTF+QSAVH+QCHPOSG+QIMPORT+QCHPOSGFOR-QINTK2+QINTH+QINTG
       +QEXPORT+QINTGFOR
[6]    ⍝ THAT WAS TEMPORARY ONLY - WE STILL AWAIT UPDATES OF FIRMS BW AND
        K2
     ∇
```

Part 4 Run the Model

12.2

```
    ∇  CREDITΔMARKET;QSUPFUND1;QSUPFUND2
[1]     QDEMFUND←(0⌈-QCHPOSG)+(SUM2 0⌈QDESCHBW)
[2]    ⍝ STIPULATE LIQB[AFTER]≥RFUND1×((SUM2 BW)+BWG+(0⌈-WH+.×NH))[AFTER]

[3]     QSUPFUND1←(LIQB+QCHLIQB+(SUM2 QDESCHK2)-RFUND1×(SUM2 BW)+BWG+(0⌈-
       WH+.×NH))÷1+RFUND1
[4]    ⍝ STIPULATE LIQB[AFTER]≥RFUND2×((SUM2 K2+QDESCHK2)+DEPG+(0⌈WH+.×NH
       ))
[5]     QSUPFUND2←LIQB+QCHLIQB+(SUM2 QDESCHK2)-RFUND2×(SUM2 K2+QDESCHK2)+
       DEPG+(0⌈WH+.×NH)
[6]     QSUPFUND←0⌈QSUPFUND1⌊QSUPFUND2
[7]     ⍎(FUNDSΔAREΔENOUGH)/'QSUPFUND←QDEMFUND'
[8]     QSAVHREQ←(KAPPA1×0⌈QDI+.×NH)⌊(0⌈QDEMFUND-QSUPFUND)
[9]     QREDTBW←(KAPPA2×SUM2 0⌈QDESCHBW)⌊(0⌈QDEMFUND-QSAVHREQ+QSUPFUND)
[10]    QCHBW←QDESCHBW-QREDTBW×(0⌈QDESCHBW)÷SUM2 0⌈QDESCHBW
[11]    QCHRI←(-MAXQCHRI)⌈MAXQCHRI⌊LAMDA1×(QDEMFUND-QSUPFUND)÷(1⌈QDEMFUND
       )
[12]   ⍝ UPDATING OF RI IS DEFERRED TIL NEXT QUARTER IN QΔEXO, SO REPORT
       GENERATORS WON'T GET CONFUSED
    ∇
```

```
    ∇  R←BWG
[1]     R←0⌈-POSG
    ∇
```

12.3

```
    ∇  INVFINΔADJUSTMENTS;QCHK2;OLDINV
[1]     OLDINV←SUM2 QINVLAG
[2]    ⍝
[3]     BW←BW+QCHBW
[4]     QINVLAG←0⌈QCASH+QCHBW-QDESCHK2
[5]     K2←K2+QCHK2←QCASH+QCHBW-QINVLAG
[6]     ALWAYS '0≤BW'
[7]    ⍝ NW IS COMPUTED IN VALUE-RETURNING SUBROUTINE
[8]    ⍝
[9]     QTCHBW←SUM2 QCHBW
[10]    QTCHINV←(SUM2 QINVLAG)-OLDINV
[11]    QTCHK2←SUM2 QCHK2
[12]   ⍝
[13]    QBFA←QBFA,[1](SUM1 QCHBW),[1](SUM1 QINVLAG)ABOVE(SUM1 QCHK2)
[14]    ALWAYS '1>|+⌿QBFA MULT7 1 ¯1 1 0 ¯1 ¯1 1 1 ¯1 ¯1'
[15]    BFA←BFA+QBFA
[16]   ⍝
[17]    CUMCHBWF←CUMCHBWF+QCHBW
[18]    CUMCHK2F←CUMCHK2F+QCHK2
    ∇
```

Part 4 Run the Model

```
    ∇  R←NW
[1]    R←K1+K2+K3-BW
    ∇
```

```
    ∇  R←NWBOOK
[1]    R←K1BOOK+K2+K3-BW
    ∇
```

12.4

```
    ∇  BANKΔUPDATE
[1]    LIQB←LIQB+QCHLIQB←QCHLIQB+QTCHK2-QTCHBW
[2]    NWB←NWB
    ∇
```

13

```
    ∇  NATIONALΔACCOUNTING;QCHTSTOCURF;QCHTSTOCURM;OLD
[1]    TSTOCURF←TSTOCURF+QCHTSTOCURF←(SUM1 K3ΔFINISH)-TSTOCURF
[2]    TSTOCURM←TSTOCURM+QCHTSTOCURM←(QPDOM[MKT]×SUM1 STO)-TSTOCURM
[3]    ⍎(2=⎕NC 'QGNPCUR')/'OLD←QGNPCUR'
[4]    QGNPCUR←((SUM1 QSNET)+QCHTSTOCURF),QVAΔIN,((+/QVATAX)+(+/
      QCHTSTOCURM)-(+/QCHTSTOCURF)+QVATAXΔIMP),(-QSUBS-QSUBSΔCASH),QWSG
[5]    QGNPCUR←QGNPCUR,(+/QPURCHG),(+/QSP[MKT,IN;]+.×NH),((SUM2 QINVLAG)
      -QTCHINV),QINVIN,QINVBLD,QINVG,(+/QCHTSTOCURM)
[6]    QGNPCUR←QGNPCUR,QEXPORT,(-QIMPORT+QVATAXΔIMP)
[7]    ALWAYS '(+/(3+⍴MKT,IN)↑QGNPCUR)=(+/(2+⍴MKT,IN)↓QGNPCUR)'
[8]    ⍎(2=⎕NC 'OLD')/'QDGNPCUR←¯1+QGNPCUR÷OLD'
[9]    CUMGNPCUR←CUMGNPCUR+QGNPCUR
[10]  ⍝

[11]   QGNPFIX←(PΔREF×((SUM1 QQ)-QWASTE),QQIN)-(PΔREF+.×QBUY[MKT,IN;MKT,
      IN])
[12]   QGNPFIX←QGNPFIX,LG×WGΔREF÷4
[13]   QGNPFIX←QGNPFIX,(PΔREF+.×QPURCHG÷QPDOM),(PΔREF+.×(QSP[MKT,IN;]+.×
      NH)÷QPDOM)
[14]   QGNPFIX←QGNPFIX,PΔREF+.×OMEGA×((SUM2 QINVLAG)-QTCHINV)÷QPDOM×(1-
      TXVA2)÷(1-TXVA1)
[15]   QGNPFIX←QGNPFIX,PΔREF+.×OMEGAIN×QINVIN÷QPDOM×(1-TXVA2)÷(1-TXVA1)
[16]   QGNPFIX←QGNPFIX,PΔREF+.×OMEGABLD×QINVBLD÷QPDOM×(1-TXVA2)÷(1-TXVA1
      )
[17]   QGNPFIX←QGNPFIX,PΔREF+.×OMEGAG×QINVG÷QPDOM×(1-TXVA2)÷(1-TXVA1)
[18]   QGNPFIX←QGNPFIX,(PΔREF[MKT]+.×QCHTSTO),(PΔREF+.×(SUM1 QSUFOR),(
      XIN×QQIN)),(-PΔREF+.×+/QTBUYFOR[MKT,IN;])
```

Part 4 Run the Model

```
[19]  ALWAYS '(+/(1+ρMKT,IN)↑QGNPFIX)=(+/(ρMKT,IN)↓QGNPFIX)'
[20]  CUMGNPFIX←CUMGNPFIX+QGNPFIX
[21] ⍝
[22]  CUMEXPORT←CUMEXPORT+QEXPORT
[23]  CUMIMPORT←CUMIMPORT+QIMPORT
[24] ⍝
[25]  →(NRS<4)/OUT
[26]  GNPFIX←CUMGNPFIX
[27]  GNPCUR←CUMGNPCUR
[28]  EXPORT←CUMEXPORT
[29]  IMPORT←CUMIMPORT
[30] OUT:
    ∇
```

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```
    ∇ YEARLY∆UPDATE
[1]  ⍝
[2]   Q←Q×1+DQ←¯1+CUMQ÷Q
[3]   P←P×1+DP←¯1+CUMS÷CUMSU×P
[4]   W←W×1+DW←¯1+CUMWS÷CUML×W
[5]   S←S×1+DS←¯1+CUMS÷S
[6]   VA←VA×1+DVA←¯1+CUMVA÷VA
[7]   SNET←CUMSNET
[8]   M←M+CHM←CUMM-M
    ∇
```

APPENDIX A Frequent Occurring Functions

Modification of APL–programs:

The APL–functions **MODDEL**, **MODADD** and **MODSUBST** are used to change lines in the initialization program.

Example 1:

```
    ∇  EXAMPLEΔ1
[1]    ⍝
[2]     'MARKETSΔDATA' MODSUBST 'GAMMA←⍵GAMMA←0.5'
[3]     'MARKETSΔDATA' MODSUBST 'KSI←'
[4]     'MARKETSΔDATA' MODSUBST 'NITER←⍵KSI←0.3'
    ∇
```

Line 2, example 1, means that we will change a line in the subfunction **MARKETSΔDATA**. The text before **MODSUBST** (all text strings should stand between '–symbols) tells the name of the function where the changes are to be made. The text after **MODSUBST** tells what line to be changed and defines the new line. The beginning of the old line stands before the "omega–symbol" (ω) and the new line after this symbol. **MODSUBST** deletes the old line beginning with "GAMMA" and puts in the new line: GAMMA ← 0.5. **MODADD** looks like **MODSUBST**, with one exception. **MODADD** does not delete the old line. The new line is put immediately after the old line. Line 4 means that we will delete any line in the subfunction **MARKETSΔDATA** beginning with KS1 ← .

APPENDIX A Frequent Occurring Functions

```
    ∇  NAME MODADD OLDNEW;BREAK;CR;ROWS
        ENS 'MOD'∨.≠3↑NAME←,NAME
        ENS 3=⎕NC NAME
        ENS(BREAK>1),1=⍴BREAK←('⍵'=OLDNEW)/⍳⍴OLDNEW
        ENS 1=⍴ROWS←(CR←⎕CR NAME)SCANMAT(BREAK-1)↑OLDNEW
        ENS ⎕EX NAME
        ENS(PACK NAME)EQUALS ⎕FX CR[⍳ROWS;]ABOVE(BREAK↓OLDNEW)ABOVE(ROWS,
       0)↓CR
    ∇
```

```
    ∇  NAME MODADDLAST STRING;CR
        ENS 'MOD'∨.≠3↑NAME←,NAME
        ENS 3=⎕NC NAME
        CR←⎕CR NAME
        ENS ⎕EX NAME
        ENS(PACK NAME)EQUALS ⎕FX CR ABOVE STRING
    ∇
```

```
    ∇  N←NAME MODDEL STRING;CR;ROWS
        ENS~'MOD'∧.=3↑NAME←,NAME
        ENS 3=⎕NC NAME
        N←''⍴⍴ROWS←(CR←⎕CR NAME)SCANMAT STRING
        ENS~1∊ROWS
        ENS ⎕EX NAME
        ENS NAME EQUALS ⎕FX(∧⌿ROWS∘.≠⍳1↑⍴CR)/[1]CR
    ∇
```

```
      ∇MODDELNP[⎕]∇
    ∇  NAME MODDELNP STRING;DUMMY
        DUMMY←NAME MODDEL STRING
    ∇
```

```
    ∇  CHANGES←NAME MODFNP OLDNEW;BREAK;NEW;OLD;CR;ROWS;I
        ENS 'MOD'∨.≠3↑NAME←,NAME
        ENS 3=⎕NC NAME
        ENS(BREAK>1),1=⍴BREAK←('⍵'=OLDNEW)/⍳⍴OLDNEW
        NEW←BREAK↓OLDNEW
        ROWS←(CR←⎕CR NAME)SCANMAT OLD←(BREAK-1)↑OLDNEW
        I←0
      L1:→(0=I←''⍴1↑(ROWS>I)/ROWS)/L2
        →L1,⍴CR←CR[⍳I-1;]ABOVE(MODLN CR[I;])ABOVE(I,0)↓CR
      L2:ENS ⎕EX NAME
        ENS(MODLN PACK NAME)EQUALS ⎕FX CR
        CHANGES←(4 0 ⍕((⍴ROWS),1)⍴ROWS-1),(((⍴ROWS),4)⍴' ** '),CR[ROWS;]
    ∇
```

APPENDIX A Frequent Occurring Functions

```
    ∇  NAME MODFN OLDNEW;DUMMY
[1]    DUMMY←NAME MODFNP OLDNEW
    ∇
```

```
    ∇  RES←LINE MODLNP OLDNEW;BREAK;OLD;NEW
[1]    LINE←,LINE
[2]    ENS(BREAK≥1),1=ρBREAK←('ω'=OLDNEW)/⍳ρOLDNEW
[3]    NEW←BREAK↓OLDNEW
[4]    OLD←(BREAK-1)↑OLDNEW
[5]    RES←MODLN LINE
    ∇
```

```
    ∇  MODP STRING;NAMES;I;CHANGES
[1]    NAMES←ALLFNS
[2]    I←0
[3]   L:→((ρNAMES)[1]<I←I+1)/0
[4]    →('MOD'∧.=3↑NAMES[I;])/L
[5]    →(0=1↑ρCHANGES←NAMES[I;]MODFNP STRING)/L
[6]    (((1↑ρCHANGES),1↓ρNAMES)ρNAMES[I;]),CHANGES
[7]    →L
    ∇
```

```
    ∇  NAME MODSUBST OLDNEW;BREAK;CR;ROWS
[1]    ENS 'MOD'∨.≠3↑NAME←,NAME
[2]    ENS 3=⎕NC NAME
[3]    ENS(BREAK≥1),1=ρBREAK←('ω'=OLDNEW)/⍳ρOLDNEW
[4]    ENS 1=ρROWS←(CR←⎕CR NAME)SCANMAT(BREAK-1)↑OLDNEW
[5]    ENS ⎕EX NAME
[6]    ENS(PACK NAME)EQUALS ⎕FX CR[⍳ROWS-1;]ABOVE(BREAK↓OLDNEW)ABOVE(
      ROWS,0)↓CR
    ∇
```

```
    ∇  R←M SCANMAT S
[1]    R←(∨/∧⌿(Φ(ρ,S)≤⍳¯1↑ρM)/(⍉((1↑ρM),ρ,S)ρ¯1+⍳ρ,S)Φ(,S)∘.=M)/⍳1↑ρM
    ∇
```

APPENDIX A Frequent Occurring Functions

Multiplication, Division, Summation, Mean Value:

```
    ∇  A←W AVG1 D
      ⍝
      ⍝ TO GET MARKET AVERAGES FROM FIRM DATA:
      ⍝ 'D' IS THE FIRM (VECTOR) DATA TO BE AVERAGED.
      ⍝ 'W' IS A WEIGHTING VECTOR.
      ⍝ GLOBAL VECTOR 'MARKET' TELLS MARKET NUMBER OF EACH FIRM.
      ⍝ GLOBAL 'NMARKETS' TELLS NUMBER OF MARKETS.
      ⍝ 'A' IS THE (VECTOR) AVERAGE.
      ⍝
       A←((W×D)+.×MARKET∘.=⍳NMARKETS)÷(W+.×MARKET∘.=⍳NMARKETS)
    ∇
```

```
    ∇  A←W AVG2 D
      ⍝
      ⍝ TO GET A COUNTRY AVERAGE FROM FIRM DATA:
      ⍝ 'D' IS THE FIRM (VECTOR) DATA TO BE AVERAGED.
      ⍝ 'W' IS A WEIGHTING VECTOR.
      ⍝ 'A' IS THE (SCALAR) AVERAGE.
      ⍝
       A←(+/W×D)÷(+/W)
    ∇
```

```
    ∇  Z←F DIV1 M
      ⍝
      ⍝ TO DIVIDE FIRMS' DATA WITH A MARKET VECTOR:
      ⍝ 'F' IS THE FIRMS' DATA VECTOR.
      ⍝ 'M' IS THE MARKET VECTOR.
      ⍝ GLOBAL VECTOR 'MARKET' CONTAINS MARKET NUMBER OF EACH FIRM.
      ⍝ 'Z' IS THE RESULTING (FIRM VECTOR) DATA.
      ⍝
       Z←F÷M[MARKET]
    ∇
```

```
    ∇  Z←M DIV7 V
       ENS(ρV)=(ρM)[1]
      ⍝
      ⍝ TO DIVIDE A MATRIX WITH A VECTOR:
      ⍝ EACH ELEMENT 'M[I;J]' IS DIVIDED BY 'V[I]'.
      ⍝ THUS, 'M' MUST HAVE AS MANY ROWS AS 'V' HAS ELEMENTS.
      ⍝
       Z←M÷⍉(⌽ρM)ρV
    ∇
```

APPENDIX A Frequent Occurring Functions

```
    ∇  Z←M DIV8 V
       ENS(⍴V)=(⍴M)[2]
      ⍝ TO DIVIDE A MATRIX WITH A VECTOR:
      ⍝ EACH ELEMENT M[I;J] IS DIVIDED BY V[J].
      ⍝ THUS, M MUST HAVE AS MANY COLUMNS AS V HAS ELEMENTS.
       Z←M÷(⍴M)⍴V
    ∇
```

```
    ∇  Z←M MINUS7 V
      ⍝
      ⍝ TO SUBTRACT A VECTOR FROM A MATRIX:
      ⍝ FROM EACH ELEMENT 'M[I;J]' IS SUBTRACTED 'V[I]'.
      ⍝ THUS, 'M' MUST HAVE AS MANY ROWS AS 'V' HAS ELEMENTS.
      ⍝
       Z←M-⍉(⌽⍴M)⍴V
    ∇
```

```
    ∇  Z←F MULT1 M
      ⍝
      ⍝  TO MULTIPLY FIRMS' DATA WITH A MARKET VECTOR:
      ⍝ 'F' IS THE FIRMS' DATA VECTOR.
      ⍝ 'M' IS THE MARKET VECTOR.
      ⍝ GLOBAL VECTOR 'MARKET' CONTAINS MARKET NUMBER OF EACH FIRM.
      ⍝ 'Z' IS THE RESULTING (FIRM VECTOR) DATA.
      ⍝
       Z←F×M[MARKET]
    ∇
```

```
    ∇  Z←M MULT7 V
       ENS((⍴V)=(⍴M)[1]),(2=⍴⍴M),(1=⍴⍴V)
      ⍝
      ⍝ TO MULTIPLY A MATRIX WITH A VECTOR:
      ⍝ EACH ELEMENT 'M[I;J]' IS MULTIPLIED WITH 'V[I]'.
      ⍝ THUS, 'M' MUST HAVE AS MANY ROWS AS 'V' HAS ELEMENTS.
      ⍝
       Z←M×⍉(⌽⍴M)⍴V
    ∇
```

APPENDIX A Frequent Occurring Functions

```
    ∇  Z←M MULT8 V
[1]     ENS((⍴V)=(⍴M)[2]),(2=⍴⍴M),(1=⍴⍴V)
[2]    ⍝ TO MULTIPLY A MATRIX WITH A VECTOR:
[3]    ⍝ EACH ELEMENT 'M[I;J]' IS MULTIPLIED WITH 'V[J]'.
[4]    ⍝ THUS, 'M' MUST HAVE AS MANY COLUMNS AS 'V' HAS ELEMENTS.
[5]    ⍝
[6]     Z←M×(⍴M)⍴V
    ∇
```

```
    ∇  A←SUM1 V
[1]    ⍝
[2]    ⍝ TO SUM FROM FIRMS TO MARKETS:
[3]    ⍝ 'V' IS THE FIRM DATA TO BE AGGREGATED. IF IT HAS MORE THAN
[4]    ⍝ ONE AXIS, FIRST DIMENSION MUST INDICATE FIRM NUMBER.
[5]    ⍝ GLOBAL VECTOR 'MARKET' TELLS MARKET NUMBER OF EACH FIRM.
[6]    ⍝ GLOBAL 'NMARKETS' TELLS NUMBER OF MARKETS.
[7]    ⍝ 'A' IS THE AGGREGATE.
[8]    ⍝
[9]     A←((⍳NMARKETS)∘.=MARKET)+.×V
    ∇
```

```
    ∇  A←SUM2 V
[1]    ⍝
[2]    ⍝ TO SUM FROM FIRMS TO A COUNTRY TOTAL:
[3]    ⍝ 'V' IS THE FIRM DATA TO BE AGGREGATED. IF IT HAS MORE THAN
[4]    ⍝ ONE AXIS, FIRST DIMENSION MUST INDICATE FIRM NUMBER.
[5]    ⍝ 'A' IS THE AGGREGATE.
[6]    ⍝
[7]     A←+⌿V
    ∇
```

APPENDIX A Frequent Occurring Functions

Inventory Management:

```
     ∇  UT←CUR X;L;J
[1]     J←⍎'0',(2=⎕NC 'JΔCUM')/'+JΔCUM'
[2]     L←'(÷4+J)×(4×',X,'×(1+HISTD',X,'÷4)*1,5+J)'
[3]     L←L,(J>0)/'+J×CUM',X,'×(1+HISTD',X,'÷4)*0,5×J-1'
[4]     UT←⍎L
     ∇
```

```
     ∇  R←K3
[1]     R←K3ΔIMED+K3ΔFINISH
     ∇
```

```
     ∇  R←K3ΔFINISH
[1]     R←STO×QP
     ∇
```

```
     ∇  RESULT←MAXSTO
[1]     RESULT←REFQSTO×BIG
     ∇
```

```
     ∇  RESULT←MINSTO
[1]     RESULT←REFQSTO×SMALL
     ∇
```

```
     ∇  R←OPTIMSTO
[1]     R←(⍉IO)[MARKET;]MULT7 REFQIMSTO MULT1 IMSMALL+IMBETA×IMBIG-
       IMSMALL
     ∇
```

```
     ∇  UT←QCUR X;L;J
[1]     J←⍎'0',(2=⎕NC 'JΔCUM')/'+JΔCUM'
[2]     L←'(÷4+J)×(',X,'×(1+HISTD',X,'÷4)*1,5+J)'
[3]     L←L,(J>0)/'+CUM',X,'×(1+HISTD',X,'÷4)*0,5×J-1'
[4]     UT←⍎L
     ∇
```

```
     ∇  R←REFQIMSTO
[1]     R←4×(QCUR 'S')÷CUR 'P'
     ∇
```

```
     ∇  R←REFQSTO
[1]     R←4×(QCUR 'S')÷CUR 'P'
     ∇
```

APPENDIX A Frequent Occurring Functions

The Swedish "Aman" Labour Market Laws:

```
    ∇  DOAMAN
[1]    ⍝
[2]    ⍝ TO INCLUDE THE EFFECT OF THE SWEDISH 'AMAN' LABOUR MARKET LAWS.
[3]    ⍝ CAN BE USED BEFORE OR WITHIN A SIMULATION RUN.
[4]    ⍝
[5]     ENS 1≥1↑⍴'LABOURΔUPDATE' MODFNP '⍝ NOAMAN:⍵DOAMAN:'
    ∇
```

```
    ∇  NOAMAN
[1]    ⍝
[2]    ⍝ TO ELIMINATE THE EFFECT OF THE SWEDISH 'AMAN' LABOUR MARKET LAWS.
[3]    ⍝ CAN BE USED BEFORE OR WITHIN A SIMULATION RUN.
[4]    ⍝
[5]     ENS 1≥1↑⍴'LABOURΔUPDATE' MODFNP 'DOAMAN:⍵⍝ NOAMAN:'
    ∇
```

The Production Function:

```
    ∇  Z←A21
[1]    Z←¯((QFR1 L)-QQ)÷QTOP×WTIX
    ∇
```

```
    ∇  Z←A22
[1]    Z←¯((QTOP×WTIX×1-RES)-QFR1 L)÷QTOP×WTIX
    ∇
```

```
    ∇  Z←A23
[1]    Z←¯RES
    ∇
```

APPENDIX A Frequent Occurring Functions

The Bank:

```
     ∇  R←BWG
[1]     R←0⌈-POSG
     ∇

     ∇  R←BWGFOR
[1]     R←0⌈-POSGFOR
     ∇

       ∇DEPG[⎕]∇
     ∇  R←DEPG
[1]     R←0⌈POSG
     ∇

     ∇  R←DEPGFOR
[1]     R←0⌈POSGFOR
     ∇

     ∇  NET←NWB
[1]     NET←(SUM2 BW)+FASS+LIQBFOR+LIQB-(SUM2 K2)+(WH+.×NH)+POSG+FD
     ∇

     ∇  R←RIBWGFOR
[1]     R←RIBWFOR
     ∇

     ∇  R←RIDEPG
[1]     R←RI-MB
     ∇

     ∇  R←RIDEPGFOR
[1]     R←RIDEPFOR
     ∇

     ∇  R←RIK2
[1]     R←RI-MB
     ∇
```

APPENDIX A Frequent Occurring Functions

Control Functions:

```
    ∇  ALWAYS A
       →0
    ∇
```

```
    ∇  ENS STRING
       →(∧/STRING=1)/0
       'ERROR'
    ∇
```

```
    ∇  Z←A EQUALS B
       →((ρρA)≠ρρB)/Z←0
       →((,ρA)∨.≠,ρB)/0
       Z←(,A)∧.=,B
    ∇
```

Investment Delay:

```
    ∇  QINV←QINVLAG DELAY TMINV;Δ
       Δ←1÷1+(4×TMINV[MARKET])÷3
       DELAYΔINV[;3]←DELAYΔINV[;3]+QINVLAG
       DELAYΔINV[;2]←DELAYΔINV[;2]+Δ×DELAYΔINV[;3]
       DELAYΔINV[;3]←DELAYΔINV[;3]-Δ×DELAYΔINV[;3]
       DELAYΔINV[;1]←DELAYΔINV[;1]+Δ×DELAYΔINV[;2]
       DELAYΔINV[;2]←DELAYΔINV[;2]-Δ×DELAYΔINV[;2]
       QINV←Δ×DELAYΔINV[;1]
       DELAYΔINV[;1]←DELAYΔINV[;1]×1-Δ
    ∇
```

APPENDIX A Frequent Occurring Functions

Transcription of the National Account:

```
    ∇  R←GNPCUR
[1]    R←+/(3+ρMKT,IN)↑GNPCUR
    ∇
```

```
    ∇  R←GNPFIX
[1]    R←+/(1+ρMKT,IN)↑GNPFIX
    ∇
```

```
    ∇  R←QGNPFIX
[1]    R←+/(¯1+ρMKT,IN)↑QGNPFIX
    ∇
```

```
    ∇  Z←WIDTH
[1]    Z←⎕PW
    ∇
```

APPENDIX A Frequent Occurring Functions

Others:

```
    ∇  Z←A̲1;HELP
[1]    Z←H̄ELP÷(*HELP←TEC×L÷QTOP)-1
    ∇
```

```
    ∇  M←M1 ABOVE M2
[1]   ⍝ TO FORM A MATRIX WITH M1 ABOVE M2, PADDING WITH BLANKS OR ZEROES
       IF NEEDED.
[2]   ⍝ EACH OF M1 AND M2 IS MATRIX, VECTOR, OR SCALAR.

[3]    M←(((1↑⍴M1),1↓(⍴M1)⌈⍴M2)↑M1),[1]((1↑⍴M2),1↓(⍴M2)⌈⍴M1←(¯2↑ 1 1 ,⍴
      M1)⍴M1)↑M2←(¯2↑ 1 1 ,⍴M2)⍴M2
    ∇
```

```
 R←A BETWEEN B
[1]    R←A+(B-A)×0.01×¯1+?101×B=B
    ∇
```

```
    ∇  R←N CONTINUE1 V
[1]    R←N↑V,N⍴¯1↑V
    ∇
```

```
    ∇  R←N CONTINUE2 M
[1]    R←((1↑⍴M),N)↑M,⍉(N,1↑⍴M)⍴M[;(⍴M)[2]]
    ∇
```

```
    ∇  Z←CPI1 PRICES
[1]    Z←(+/QC+.×NH)÷((QC+.×NH)+.÷PRICES)
    ∇
```

```
    ∇  Z←A DDIV B
[1]   ⍝
[2]   ⍝ TO 'DIVIDE' A TREND PERCENTAGE.
[3]   ⍝ 'Z' IS COMPUTED AS THE SOLUTION TO: (1+A)=(1+Z)*B
[4]   ⍝
[5]    Z←¯1+*(⍟1+A)÷B
    ∇
```

APPENDIX A Frequent Occurring Functions

```
    ∇  A←DEV X
[1]    A←X-+/X÷ρX
    ∇
```

```
    ∇  R←DIFF F
[1]    R←((((¯1+ρρF)ρ0),1)↓F)-((((¯1+ρρF)ρ0),¯1)↓F)
    ∇
```

```
    ∇  Z←NUM DUP EL
[1]   ⍝ Z←(NUM[1]ρEL[1]),(NUM[2]ρEL[2]), ... ,(NUM[N]ρEL[N])
[2]    ENS(1≥ρρNUM),(1≥ρρEL)
[3]    ENS(1≤ρ,NUM),(2≤ρ,EL)
[4]    ENS(1=ρ,NUM)∨((ρ,NUM)=(ρ,EL))
[5]    NUM←(ρEL)ρNUM
[6]    Z←EL[(0≠Z)/Z←,⍉(((⌈/NUM),ρNUM)ρ⍳ρNUM)×(⍳⌈/NUM)∘.≤NUM]
    ∇
```

```
    ∇  R←SM HISTORY DATA;W
[1]    R←DATA+.×W÷+/W←⌽×\(¯1↑ρDATA)ρSM
    ∇
```

```
    ∇  Z←PACK S
[1]    Z←1↓(Z∨1⌽Z←0,' '≠S)/' ',S
    ∇
```

```
      ∇QFR1[⎕]∇
    ∇  Q←QFR1 L
[1]    Q←(1-RES)×QTOP×1-*-L×TEC÷QTOP
    ∇
```

APPENDIX A   Frequent Occurring Functions

```
    ∇  A←REAL∆SUM1 V
[1]    ⍝
[2]    ⍝ TO SUM FROM FIRMS TO MARKETS:
[3]    ⍝ 'V' IS THE FIRM DATA TO BE AGGREGATED, IF IT HAS MORE THAN
[4]    ⍝ ONE AXIS, FIRST DIMENSION MUST INDICATE FIRM NUMBER.
[5]    ⍝ GLOBAL VECTOR 'NAMN∆MARKET' TELLS MARKET NUMBER OF EACH FIRM.
[6]    ⍝ GLOBAL 'NMARKETS' TELLS NUMBER OF MARKETS.
[7]    ⍝ 'A' IS THE AGGREGATE.
[8]    ⍝
[9]     A←((⍳NMARKETS)∘.=NAMN∆MARKET)+.×V
    ∇
```

```
    ∇  LI←I RFQ2 Q
[1]     LI←-(QTOP[I]÷TEC[I])×⍟1-(0.99⌊Q[I]÷QTOP[I]×WTIX×1-RES[I])
    ∇
     ∇WITHIN[⎕]∇
```

```
    ∇  SVA←SUMVA VADES
[1]     SVA←0
[2]     SVA←SVA,(⍴VADES)⍴0
[3]     SVA[1]←VADES[1]
[4]     I←1
[5]    ST:→END×⍳(⍴VADES)<I←I+1
[6]     SVA[I]←SVA[I-1]+VADES[I]
[7]     →ST
[8]    END:
    ∇
```

```
    ∇  OUT←REAL USING V
[1]     OUT←REAL,(REAL RANDOMIZE V)
    ∇
```

```
    ∇  S←N WITHIN SS
[1]    ⍝ TO SELECT ONE OF SEVERAL STRINGS, DELIMITED BY "ω"
[2]     S←1↓(N=+\'ω'=SS)/SS←'ω',SS
    ∇
```

APPENDIX B Functions Related to Entry Simulations in Alphabetical Order

```
    ∇  A←W AVGΔTOP V;INDEX;PICK;REALF;W1;V1;AI
       REALF←MARKET[⍳(+/LEFT[⍳154])]
       AI←ENTRYΔEPSILON[⍳⍴REALF]
       V1←V
       V←V[⍳⍴REALF]
       W1←W
       W←W[⍳⍴REALF]
       PICK←1⌈PICK←⌈¯0.5+(0.25×(+/REALF=MM))
       INDEX←PICK↑((REALF[⍒AI]=MM)/⍒AI)
       →ELSE×⍳INDEX[1]=0
       A←(+/(V×W)[INDEX])÷(+/W[INDEX])
       →0
      ELSE:A←(W1 AVG1 V1)[MM]
    ∇
```

```
    ∇  MMM FIRMENTRY2 PARMS;ΔTEC;ΔRES;I;MM;NUM;RELSIZE;SCALE;A22;A21;S;
      DP;DVA;L;M;P;B;BP;BB;BTOP;BVA;RES;SHARE;VA;W;K1;TEC;DS;DB;INVEFF
      ⍝ TO INSERT NEW FIRM(S) INTO ONE MARKET; TO BE USED AT A YEAR LIMI
      T ONLY.
       ENS(1=⍴⍴PARMS),(2≤⍴PARMS)
       MM←MMM[1]
       NUM←MMM[2]
       ΔTEC←NUM↑PARMS
       ΔRES←NUM↑ΔRES←NUM↓PARMS
       RELSIZE←(−NUM)↑PARMS
      ⍝ MM IS MARKET NUMBER
      ⍝ ΔTEC AND ΔRES ARE EXOGENOUS CHANGE RELATIVE TO TOPAVG
      ⍝ RELSIZE IS SIZE OF NEW FIRM(S) AS A FRACTION OF CURRENT MARKET A
      GGREGATE
      ⍝
      ⍝
      ⍝ THIS SECTION IS A BIT OUT OF DATE......
      ⍝I←0
      ⍝L1:→S1×⍳NUM<I←I+1
      ⍝ SCALE←10
      ⍝ ⍎(RELSIZE[I]≥0.2)/'SCALE←1'
      ⍝  ⍎(RELSIZE[I]≤0.04)/'SCALE←100'
      ⍝ NEWNUM←NEWNUM+(MKT∊MM)
      ⍝ FNO←⍎(⍕MM),('.'),(⍕NEWNUM[MM])
      ⍝ SCALE YARΔFIRM FNO
      ⍝ SCALE YARΔFIRMΔFINANCE FNO
      ⍝ SCALE YARΔFIRMΔENTRY FNO
      ⍝ →L1
      ⍝S1:
      ⍝
       ENS 0=⎕NC 'NRS'
      ⍝ THAT WAS TO ENSURE A YEAR LIMIT
      ⍝
       RW←RW,(⍴RELSIZE)⍴S AVGΔTOP RW
      ⍝
       A21←(⍴RELSIZE)⍴0
       A22←(⍴RELSIZE)⍴(VA AVGΔTOP A22)
      ⍝
       K1←K1,K1←RELSIZE×(K1 AVGΔTOP K1)
       K1BOOK←K1BOOK,RELSIZE×(K1BOOK AVGΔTOP K1BOOK)
       K2←K2,RELSIZE×(K2 AVGΔTOP K2)
       BW←BW,RELSIZE×(BW AVGΔTOP BW)
       BINV←BINV,RELSIZE×(BINV AVGΔTOP BINV)
       BINVLAG←BINVLAG,RELSIZE×(BINVLAG AVGΔTOP BINVLAG)
       DELAYΔINV←DELAYΔINV,[1](⍉(3,⍴RELSIZE)⍴RELSIZE)×(((⍴RELSIZE),3)⍴((
      +/DELAYΔINV)AVGΔTOP(+/DELAYΔINV)))
      ⍝
       X←X,(⍴RELSIZE)⍴S AVGΔTOP X
      ⍝
       P←P,P←(⍴RELSIZE)⍴S AVGΔTOP P
       BP←BP,BP←(⍴RELSIZE)⍴BS AVGΔTOP BP
       DP←DP,DP←(⍴RELSIZE)⍴S AVGΔTOP DP
```

APPENDIX B   Functions Related to Entry Simulations in Alphabetical Order

```
[48]   ⍝
[49]    W←W,W←(ρRELSIZE)ρL AVGΔTOP W
[50]    DW←DW,(ρRELSIZE)ρVA AVGΔTOP DW
[51]    QDW←QDW,(ρRELSIZE)ρ(L×QW)AVGΔTOP QDW
[52]    QW←QW,(ρRELSIZE)ρL AVGΔTOP QW
[53]   ⍝
[54]    ⍎(0≠⎕NC 'CHM')/'CHM←CHM,(ρRELSIZE)ρS AVGΔTOP CHM'
[55]   ⍝ M←M,M←0.1⌈(0.7⌊((ρRELSIZE)ρΔ+(1+A21)×S AVGΔTOP M))
[56]   ⍝
[57]    DVA←DVA,DVA←(ρRELSIZE)ρVA AVGΔTOP DVA
[58]    VA←VA,VA←RELSIZE×(S AVGΔTOP VA)
[59]    QVA←QVA,QVA←RELSIZE×(S AVGΔTOP QVA)
[60]    SHARE←SHARE,SHARE←(ρRELSIZE)ρS AVGΔTOP SHARE
[61]    Q←Q,Q←VA÷P−SHARE×((QPDOM×1−T×VA2)+.×IO)[MM]
[62]    QQ←QQ,QQ←QVA÷QP−SHARE×((QPDOM×1−T×VA2)+.×IO)[MM]
[63]    DQ←DQ,DQ←DVA−DP
[64]   ⍝
[65]    S←Q×P
[66]    DS←DS,DS←(Q×DP+DQ×P)÷S
[67]    QS←QS,QQ×QP
[68]   ⍝
[69]   ⍝   L←L,L←VA×(1−M)÷W
[70]   ⍝   LU←LU−+/,L
[71]   ⍝   ENS LU≥0
[72]    AMAN←((ρAMAN)+(ρRELSIZE),0)↑AMAN
[73]   ⍝
[74]    EXPDP←EXPDP,(ρRELSIZE)ρS AVGΔTOP EXPDP
[75]    EXPDS←EXPDS,(ρRELSIZE)ρS AVGΔTOP EXPDS
[76]    EXPDW←EXPDW,(ρRELSIZE)ρS AVGΔTOP EXPDW
[77]    HISTDP←HISTDP,(ρRELSIZE)ρS AVGΔTOP HISTDP
[78]    HISTDPDEV←HISTDPDEV,(ρRELSIZE)ρS AVGΔTOP HISTDPDEV
[79]    HISTDPDEV2←HISTDPDEV2,(ρRELSIZE)ρS AVGΔTOP HISTDPDEV2
[80]    HISTDS←HISTDS,(ρRELSIZE)ρS AVGΔTOP HISTDS
[81]    HISTDSDEV←HISTDSDEV,(ρRELSIZE)ρS AVGΔTOP HISTDSDEV
[82]    HISTDSDEV2←HISTDSDEV2,(ρRELSIZE)ρS AVGΔTOP HISTDSDEV2
[83]    HISTDW←HISTDW,(ρRELSIZE)ρS AVGΔTOP HISTDW
[84]    HISTDWDEV←HISTDWDEV,(ρRELSIZE)ρS AVGΔTOP HISTDWDEV
[85]    HISTDWDEV2←HISTDWDEV2,(ρRELSIZE)ρS AVGΔTOP HISTDWDEV2
[86]   ⍝
[87]    CUMINV←CUMINV,(ρRELSIZE)ρ0
[88]    CUML←CUML,(ρRELSIZE)ρ0
[89]    LLASTYR←LLASTYR,(ρRELSIZE)ρ1
[90]    DL←DL,(ρRELSIZE)ρ0
[91]    DNW←DNW,(ρRELSIZE)ρ0
[92]    NWLASTYR←NWLASTYR,(ρRELSIZE)ρ1
[93]    CUMM←CUMM,(ρRELSIZE)ρ0
[94]    CUMQ←CUMQ,(ρRELSIZE)ρ0
[95]    CUMS←CUMS,(ρRELSIZE)ρ0
[96]    CUMSNET←CUMSNET,(ρRELSIZE)ρ0
[97]    CUMSU←CUMSU,(ρRELSIZE)ρ0
[98]    CUMVA←CUMVA,(ρRELSIZE)ρ0
[99]    CUMWS←CUMWS,(ρRELSIZE)ρ0
[100]   CUMINTPAYF←CUMINTPAYF,(ρRELSIZE)ρ0
[101]   CUMDEPR←CUMDEPR,(ρRELSIZE)ρ0
[102]   CUMTAXF←CUMTAXF,(ρRELSIZE)ρ0
[103]   CUMDIV←CUMDIV,(ρRELSIZE)ρ0
[104]   CUMSUBSF←CUMSUBSF,(ρRELSIZE)ρ0
[105]   CUMCHBWF←CUMCHBWF,(ρRELSIZE)ρ0
[106]   CUMCHK2F←CUMCHK2F,(ρRELSIZE)ρ0
[107] ⍝ TRENDQ←TRENDQ,(ρRELSIZE)ρ0
[108] ⍝   XCUM←XCUM,(ρRELSIZE)ρ0
[109]   SNET←SNET,(ρRELSIZE)ρ0
[110]   REALLYΔBAD←REALLYΔBAD,(ρRELSIZE)ρ0
[111]   QDP←QDP,(ρRELSIZE)ρ0
[112]   QDQ←QDQ,(ρRELSIZE)ρ0
[113]   QDS←QDS,(ρRELSIZE)ρ0
[114]   QDVA←QDVA,(ρRELSIZE)ρ0
[115]   QM←QM,(ρRELSIZE)ρ0
[116]   QOPTSU←QOPTSU,(ρRELSIZE)ρ0
[117]   QSDOM←QSDOM,(ρRELSIZE)ρ0
[118]   QSFOR←QSFOR,(ρRELSIZE)ρ0
[119]   QSNET←QSNET,(ρRELSIZE)ρ0
[120]   QSU←QSU,(ρRELSIZE)ρ0
[121]   QSUDOM←QSUDOM,(ρRELSIZE)ρ0
[122]   QSUFOR←QSUFOR,(ρRELSIZE)ρ0
[123]   STO←STO,(ρRELSIZE)ρ0
[124]   IMSTO←IMSTO,[1](⍉(10,ρRELSIZE)ρRELSIZE)×(((ρRELSIZE),10)ρ(IO+.×((
       +/IMSTO)AVGΔTOP(+/IMSTO))))
[125]   QIMQ←QIMQ,[1](⍉(10,ρRELSIZE)ρRELSIZE)×(((ρRELSIZE),10)ρ(IO+.×((+/
       QIMQ)AVGΔTOP(+/QIMQ))))
[126] ⍝
[127]   RES←RES,RES←(ρRELSIZE)ρ(1−ΔRES)×(S AVGΔTOP RES)
[128]   QTOP←QTOP,QTOP←QQ÷1−A21+A22+RES
[129]   TEC←TEC,TEC←(ρRELSIZE)ρ(1+ΔTEC)×(TEC AVGΔTOP TEC)
```

APPENDIX B Functions Related to Entry Simulations in Alphabetical Order

```
 L←L,L←1⌈((QTOP÷TEC)×⍟(1-RES)÷A22)
 INVEFF←INVEFF,INVEFF←QTOP×QP÷K1
 M←M,M←0.1⌈(1-W×L÷VA)
 MHIST←MHIST,M×0.5
 LU←LU-+/,L
 ENS LU≥0
⍝
⍝
 RSUBS⍙CASH←RSUBS⍙CASH,0×RELSIZE
 RSUBS⍙EXTRA←RSUBS⍙EXTRA,0×RELSIZE
 BIG←BIG,(⍴RELSIZE)⍴S AVG⍙TOP BIG
 SMALL←SMALL,(⍴RELSIZE)⍴S AVG⍙TOP SMALL
 IMBIG←IMBIG,(⍴RELSIZE)⍴S AVG⍙TOP IMBIG
 IMSMALL←IMSMALL,(⍴RELSIZE)⍴S AVG⍙TOP IMSMALL
 BAD←BAD,(⍴RELSIZE)⍴0
 RWC←RWC,RWC←(⍴RELSIZE)⍴S AVG⍙TOP RWC
 ENTRY⍙EPSILON←ENTRY⍙EPSILON,RWC-(⍴RWC)⍴RIF
 S←S,S
⍝
 MARKET←MARKET,(⍴RELSIZE)⍴MM
 ORIGMARKET←ORIGMARKET,(⍴RELSIZE)⍴MM
 LEFT←LEFT,RELSIZE=RELSIZE
⍝
⍝ FIRMCHARC←FIRMCHARC ABOVE(15 0 ⍕(100×M),L,VA,QQ,QP,DS,K1,QTOP,TE
C,100×(INVEFF,RES,A22))
∇
```

```
∇ START⍙ENT1;XX
  FIRMCHARC← 1 1 ⍴' '
 ⍝
  START⍙ENT⍙MOD
 ⍝ ENTRYREPORTS←'ED⍙PARMS'
 ⍝ ENTRYREPORTS←ENTRYREPORTS ABOVE 'ED⍙NULLIFIED'
 ⍝ ENTRYREPORTS←ENTRYREPORTS ABOVE 'ED⍙ENTRY'
 ⍝
  MM⍙ENTRY← 0 1 2 3 4
  XX←93+120
  XX PERFORM⍙YEAR 'START⍙ENTRY MM⍙ENTRY'
 ⍝ 85 PERFORM⍙RUN '1 NEW⍙FIRM⍙REPS 3.83'
∇
```

```
∇ R←START⍙ENT2 E;MM;EEMKTAVG;A;B;MAX;MIN;NUMF;R1;R2
  MM←ENTRY⍙MKTNR
  EEMKTAVG←(K1+K3)AVG⍙TOP E
  A←1
  B←0
  MAX←1
  MIN←0
  R1←⌈(A+B×EEMKTAVG)
  NUMF←+/MARKET=MM
  R2←0⌈(5-NUMF)
  R←R1⌈R2
∇
```

```
∇ R←START⍙ENT3 A;ATEC;ARES;RELSIZE
  ATEC←A[2]⍴0.05
  ARES←A[2]⍴0.05
  RELSIZE←A[2]⍴0.5
  R←ATEC,ARES,RELSIZE
∇
```

APPENDIX B Functions Related to Entry Simulations in Alphabetical Order

```
    ∇ STARTΔENTRY MMΔENTRY
      ENTRYΔINDICATOR←ENTRYΔEPSILON
     ⍝ ENTER NEW FIRMS BY MARKET
      I←1
     ST:→END×⍳(⍴MMΔENTRY)<I←I+1
      ENTRYΔINDICATOR←ENTRYΔEPSILON
      ENTRYΔMKTNR←1⍴MMΔENTRY[I]
      ENTRYΔMKTNR←ENTRYΔMKTNR,(STARTΔENT2 ENTRYΔINDICATOR)
      →(ENTRYΔMKTNR[2]=0)/ST
      ENTRYΔPARMS←STARTΔENT3 ENTRYΔMKTNR
      ENTRYΔMKTNR FIRMENTRY2 ENTRYΔPARMS
      →ST
     END:
    ∇
```

```
    ∇ STARTΔENTΔMOD
      'YEARLYΔINIT' MODADD 'BFA∧LLASTYR←L'
      'YEARLYΔINIT' MODADD 'BFA∧NWLASTYR←NW'
      'YEARLYΔUPDATE' MODADD 'M←∧DL← ¯1+CUML÷LLASTYR'
      'YEARLYΔUPDATE' MODADD 'M←∧DNW←¯1+NW÷NWLASTYR'
      'YEARLYΔUPDATE' MODADD 'M←∧CHBWDBW←CUMCHBWF÷BW'
      'NULLIFY' MODADD 'SHRINK ''RES''∧SHRINK ''RWC'''
      'NULLIFY' MODADD 'SHRINK ''DW''∧SHRINK ''ENTRYΔEPSILON'''
    ∇
```