No. 7, 1976

A MICRO-MACRO INTERACTIVE SIMULATION MODEL OF THE SWEDISH ECONOMY

by

Gunnar Eliasson

in collaboration with

Gösta Olavi and Mats Heiman

This is a preliminary Technical Documentation.
Many of the model specifications are provisional.
They are constantly being modified and improved upon.
Quotations should be cleared through the author.

Förvaltningsbolaget Sindex, Stockholm 1977

A MICRO-MACRO INTERACTIVE SIMULATION MODEL OF THE SWEDISH ECONOMY

by
Gunnar Eliasson
December 1976

This is a preliminary Technical Documentation.
Many of the model specifications are provisional.
They are constantly being modified and improved upon.
Quotations should be cleared through the author.

Förvaltningsbolaget Sindex, Stockholm 1977

Author's remark

This paper is a preliminary technical documentation of a theoretical system that in various ways resembles a national economy. It has been loaded with numbers since its properties cannot be studied by ordinary mathematical methods. We have to resort to numerical analysis.

Some of the numbers have been fetched from the Swedish economy. This does not mean that the model as it now stands is a numerical representation of the Swedish economy. However, as the title indicates, that is the ultimate ambition of the study.

Part I contains a brief overview of the model structure and a presentation of the objectives of the modelling project. We also touch upon the problems associated with the ongoing empirical verification of the model, that will be accounted for in detail in a revised and more definite later version of this paper.

Part II contains a specification of all behavioral functions of the model and how the various modules are joined together as well as a discussion of why this or that formulation has been chosen.

Part III the Pseudo-code (written jointly with Gösta Olavi and Mats Heiman), finally, gives the complete model specification in a compact form, quite close to the computer program, but using the symbols of the main text.

This model project is organized as a joint research venture between IBM Sweden and the University of Uppsala. The project team is headed by myself. Gösta Olavi and earlier Mats Heiman from IBM Sweden have contributed with mathematical and programming expertise. The author is now the director of the Industrial Institute for Economic and Social Research and was earlier the chief economist of the Federation of Swedish Industries. Both these organizations are therefore indirect sponsors of the project.

Sollentuna, December 1976
Gunnar Eliasson

Contents

PART I

IDEAS

CHAPTER 1

A MICROSIMULATION MODEL OF A NATIONAL ECONOMY

1. Introduction

This model is of the microsimulation kind in the sense of Orcutt (1960, 1976), Bergman (1974) etc. The philosoph behind it is that we need more knowledge of the interaction between micro agents (firms, households, etc.) to understand important aspects of macro behaviour.

For many types of analyses the conventional macro model approach does not give us the detail that we want. Therefore it is tempting to disaggregate into sub-sectors, and sub-sectors of sub-sectors. Quite soon we have a 1.000 equation system that we have difficulties controlli in our mind.[1] We don't know what our parameters stand for because of estimation problems like collinearity, feed back within the periods etc. and our sub-sub-sectors quite arbitrarily cut right through important decision units like firms.

In principle there is no difference between macro modellir and micro modelling. Everything will be macro in some sense at any level, and much of what we will do here in micro can always be modelled in macro in principle in a more conventional way if we stay within the domain of theory or formal specification.

In practice there is a difference, however. If we attempt to answer the problems we will choose for this study from the macro end we will probably wind up where we start in this study. Sooner or later conventional econometric methods will have to be abandoned and the empirical problems will be the same.

---

1) Cf. for instance, Brook-Teigen; Monetary and Fiscal Policy Experiments on Four Macro Economic Models, forthcoming 1977 in Industrikonjunkturen.

This project has two purposes namely: (1) to study the micro basis for inflation - assuming that this is a relevant and interesting area of inquiry and (2) to study the interaction over time between inflation, profitability and growth.

The two purposes overlap and general experience is that the second purpose requires a micro approach to be meaningful. The first question requires a complete model covering all relevant sectors of the economy, however, with limited detail in specification. As long as we abstain from asking for numerical estimates or forecasts the empirical requirements on specification are reasonable.

They are, however, much higher if we want to deal with the second problem: "inflation, profit and growth" in a relevant way, although, this time, demands on economy-wide coverage are not so large. Emphasis is on the business sector. We may reformulate this problem somewhat as an analysis of the interaction between growth and the business cycle in the medium term.

Of course, if we have built a model that can handle the above problems to our satisfaction it is capable of handling several others as well. In order not to take on an overwhelming task we have struck a convenient compromise in specification that does not - I believe - reduce the explanatory potential of the model or subject us to extreme empirical hardships. For the time being we have constructed a conventional and in no way complex macro model within which a micro (firm) specified industry sector operates. This approach allows us to keep our special feature: namely a micro specification of the behaviour of two markets: The labour market and the product market.

We have to keep in mind that the prime ambition with this modelling project is to have a richly specified model structure capable of responding to a spectrum of interesting what if questions. The purpose is analysis, not forecasting.

This first chapter will contain a non-formal overview of the model (next section). There will be an account of the estimation or calibrating principles involved and a few words on the empirical philosophy or the method: does it differ from conventional econometric method?

This chapter is self-contained for those who are only interested in what the model is all about, without understanding how it functions.

2. Model overview

Table 1 sums up the main blocks of the model and its connection with the outer world.

It should be noted that there are in practice only three sets of exogenous variables (foreign (export) prices, the interest rate and the rate of change in productivity of new investment).[1)]

The model operates by quarter and gives a set of future quarterly values on the exogenous variables. The model will generate a future of any length on the national accounts format, excluding certain sectors like agriculture, shipping-construction, etc. that we have chosen to leave outside the model.

For all practical purposes the problems we have in mind mean that the time horizon should be around five years or one full business cycle. We will come back to the

1) There are some exceptions to this that are not important for the kind of problems we have chosen for analysis. They are left for the later technical chapters. The rate of entry into and exit out of the labour force, for instance, is exogenous.

horizon problem later. However, even if our attention is restricted to a 5 year time span, much of the calibration work that we will perform, requires that we check model behaviour over a much longer period (see section 3 below).

The best way to proceed from here is to go through the central model blocks one by one.

a) Business sector - short-run production planning

Figure 1 gives a flow-chart overview of the short-term decision system of one firm. Figure 2 gives some detail of the production system.

In Figure 1 an experimental run begins at the left hand side from a vector (P, W, M, S) of historic (5 year annual) Price, Wage, Profit margin and Sales data. These data are transformed into expectations in the EXP module. Here we use quadratic smoothing formulae (see (9) CH. 2.)

The profit margin variable is translated into a profit target in the TARG block. Here we also use a conventional smoothing formula. The length of historic time considered is longer than in EXP sector.

Growth expectations feed into the investment module to generate long-term plans as explained below. Long-term expectations are also modified to apply to the next year and are fed into the production system.

Each period (quarter) each firm is identified by a production possibility frontier (QFR(L)) defined as a function of labour input as in Figure 2 and a location within that curve.[1)] The distance between A and B measures the increase in output Q that the firm can achieve

---

1) In fact the production system is more complex than so. See Chapter 4.

during the current period with no extra labour input than indicated by the L coordinate in A. In practice a vertical move between A and B cannot be costless. For the time being we will have to abstract from this. Suffice it to note that in those experimental runs where we have investigated this aspect there seems to be a general tendency among firms to be operating in the A, B range, which is constantly shifted outwards by investment.[1)]

The distance CD measures (for the same period) the extra increase that the firm is capable of, with the application of extra labour, but staying within a commercially viable operating range. Approximate data on A, B, C and D were collected in the annual planning survey for 1976 by the Federation of Swedish Industries.[2)]

The production function QFR(L) in Figure 2 is of the putty-clay type. New investment, characterized by a higher labour productivity than investment from the period before is completely "embodied" with the average technical performance rates of the period before through a change in the coefficients of QFR(L).

The first sales growth expectation from the EXP module now starts up a trial move A in the direction indicated by EXP (S). After each step price and wage expectations are entered and checks against profit margin targets are made. As soon as the firm M-target is satisfied, search stops and the necessary change in the labour force is

---

1) This obviously is an instance of what Leibenstein (1966) has called X-inefficiency or a version of slack. Note here Carlsson's (1972) measurement on the presence of such slack in Swedish manufacturing, especially as regards the degree of capital utilization or (A-B)+(C-D) in Figure 2.

2) See Virin, Industrikonjunkturen Våren 1976, Special Study D.

calculated. If it is a decrease, people are laid off. If it is an increase, the firm enters the labour market to search for new people (see below). After this search has been terminated the firm can calculate its output for the period. The wage level has also been determined and feeds back to update the historic vector (dotted lines in Figure 1).

The firm now checks up against finished goods stocks to determine how much to supply in the market. A certain fraction, determined by the last period's relative domestic and foreign prices is shipped abroad.

The final distribution between sales and inventories for each market and the price level is determined in a confrontation with inputs and household demand (middle right end of Figure 1 and lower end of Figure 5) to be described later. Final price, profit and sales data are now determined and also feed back into the historic vector (dotted lines).

b) Labour market

The labour market process is represented in micro in considerable detail. At this level, however, the requirements on relevant specification are still higher. Hence, the version now to be described should be considered a provisional one and experiments conducted so far have taught us that model behaviour is too sensitive to variations in the random search sequences (in combination with a small number of firms) to be reasonable.

All labour is homogeneous in the present version of the model.

The first step each period is an adjustment of "natural" decreases in the labour force of each sector and firm unit through retirement etc. This adjustment is applied proportionally throughout. Then the unemployment pool is filled with new entrants to the labour market. After that the service and Government sectors enter the labour market in that order. They offer last period's average wage increase in the manufacturing sector and get whatever is available from the pool of unemployed. This sounds a little bit arbitrary and it is. We have had to enter this erroneous specification provisionally to allow for the fact that wage and salary levels differ a lot between sectors despite the fact that labour is homogeneous. The assumption that industry is the wage leading sector is quite conventional in macro modelling. It is probably not quite true at the micro level. With no explicit separation of wage levels (because of skills etc.) and little knowledge as to how the Government, service and industry sectors interact in the labour market this macro simplification should do for the time being.

After the service and Government sectors firms enter one by one in the order by which they desire to increase their labour force. They scan all other firms inclusive of the pool of unemployed. The probability of hitting a particular location of labour is proportional to its size (labour force compared to total labour in industry and the number of unemployed).

The firm offers a fraction of the expected wage increase. From the pool of unemployed people are forthcoming at the wage offered.

If the firm meets a firm with a wage level that is sufficiently below its own, it gets the people it wants up to a maximum proportion of the other firm's labour force. The other firm then adjusts its wage level upwards with a fraction of the difference observed.

If a firm raids another firm with a higher wage level it does not get any people, but upgrades its offering wage for the next trial. After the search is over, firms with relatively low wages, that have learned about the market wage levels around them, have had to upgrade their own wage level by a fraction of the differences observed.

Firms can be given any predetermined number of trials. Obviously the size of wage adjustment coefficients and the number of trials ($\doteq$ intensity of search) each period determines the degree of wage differentiation that can be maintained in the labour market under the homogeneity assumption. We will experiment with various impediments to this adjustment process. We can note already now that overall macro behaviour of the model is very sensitive to the numerical specifications entered here.

c) Business sector: Long-term investment financing system (one firm)

There is a complete separation between operations planning described in the previous section and long-term investment financing decisions to be exhibited here. The two planning decision sequences join together in current (quarterly) cash-management, where the firm interacts with short-term money markets. This organization of decision making corresponds neatly with actual practice in large firms (Eliasson 1976).

For the time being we work in terms of a very simple investment decision routine (that is now in the program) and a sophisticated, real life imitation that is formulated in the main text, but that has not yet been codified in the program. It is exhibited in Figures 3 and 4.

As in short-term planning a vector of historic Price, Wage, Profit margin and Sales (P, W, M, S) data generates a future long run EXP(P,W,S) vector and a long-run TARG(M) vector. The idea is that long-run expectations catch some long-run trend, that will guide investment decisions.

Short-term expectations are formulated as a deviation from that trend.

Long-term EXP(S) initiates a rough calculation scheme that gives a preliminary investment plan. This preliminary investment plan is fed through the production system, described earlier, and combined with EXP(P) and EXP(W). There is a check whether the sales, investment plan combination meets profit margin targets. If not, sales and investments are reduced until SAT(M) (see Figure 3). The convexity of the production system assures that corrections are downward. The long-run plan, furthermore, is calculated on the basis of long-run normal operating (capacity utilization) rates.

Once this provisional plan has been reached, the firm has expectational control of future (5 year) profit performance.

Then dividends (DIV) are decided for the next year.

The next step is to check up on the financing consequences of the provisional growth plan.

A maximum gearing (leverage) ratio is currently calculated as described in Supplement B to Chapter III. The idea is that the ratio between the expected excess cash inflow and firm net worth determines the risk associated with new borrowing. Excess cash inflow is calculated within a typical budget framework. The maximum gearing ratio (Ψ) is then assumed to be a function of the expected nominal return to total assets less the rate of risk-taking and the nominal rate of interest.

The expected gearing ratio (Ψ) and rate of borrowing associated with each growth (S, INV) plan can then easily be calculated.

The provisional (S, INV) plan arrived at earlier is now checked against MAX Ψ, and modified downwards until below MAX Ψ. The convexity of the production system again means that a lower growth plan means higher M ex ante.

We now have all the data needed to build a long-term plan around the conventional budget framework; a set of future balance sheets, a 5 year profit and loss statement and a 5 year cash-flow chart.

To be noted is that no decisions have been taken so far, except those related to fixing numbers in the plan.

We have now arrived at the investment plan for the annual budget. This is shown in Figure 4. The first year of the long-term plan is separated out and modified to fit the next year, e.g. with respect to the expected business cycle. The format is the same as for the long-term plan, but more details enter.

Table 1 Model blocks etc.

1. Business system (firm model)
   A) Operations planning (short term)
      - Production system
      - Inventory system
      - Expectations
      - Targeting
      - (Cash management)

   B) Investment-Financing (long term)
      - Investment plan
      - Long term borrowing

2. Household sector (macro)
   - Buying
   - Saving

3. Service sector (macro)

4. Government sector (macro, not yet ready)
   - Employment
   - Taxes
   - Economic policy

(4) Government parameters (so far only Government employment has been entered into model).

5. Other production sectors - NO or Dummies

6. Foreign connections
   - Prices - exogenous
   - (Exchange rate)
   - Interest rate - exogenous
   - Export volume
   - Import volume

7. Markets
   - Labour market
   - Product market

8. Exogenous variables
   (a) Foreign prices: one for each of the four markets
   (b) Interest rate:
   (c) Technology: The rate of change in labour productivity of new investment, i.e. between vintages.

Figure 1 BUSINESS DECISION SYSTEM (ONE FIRM)

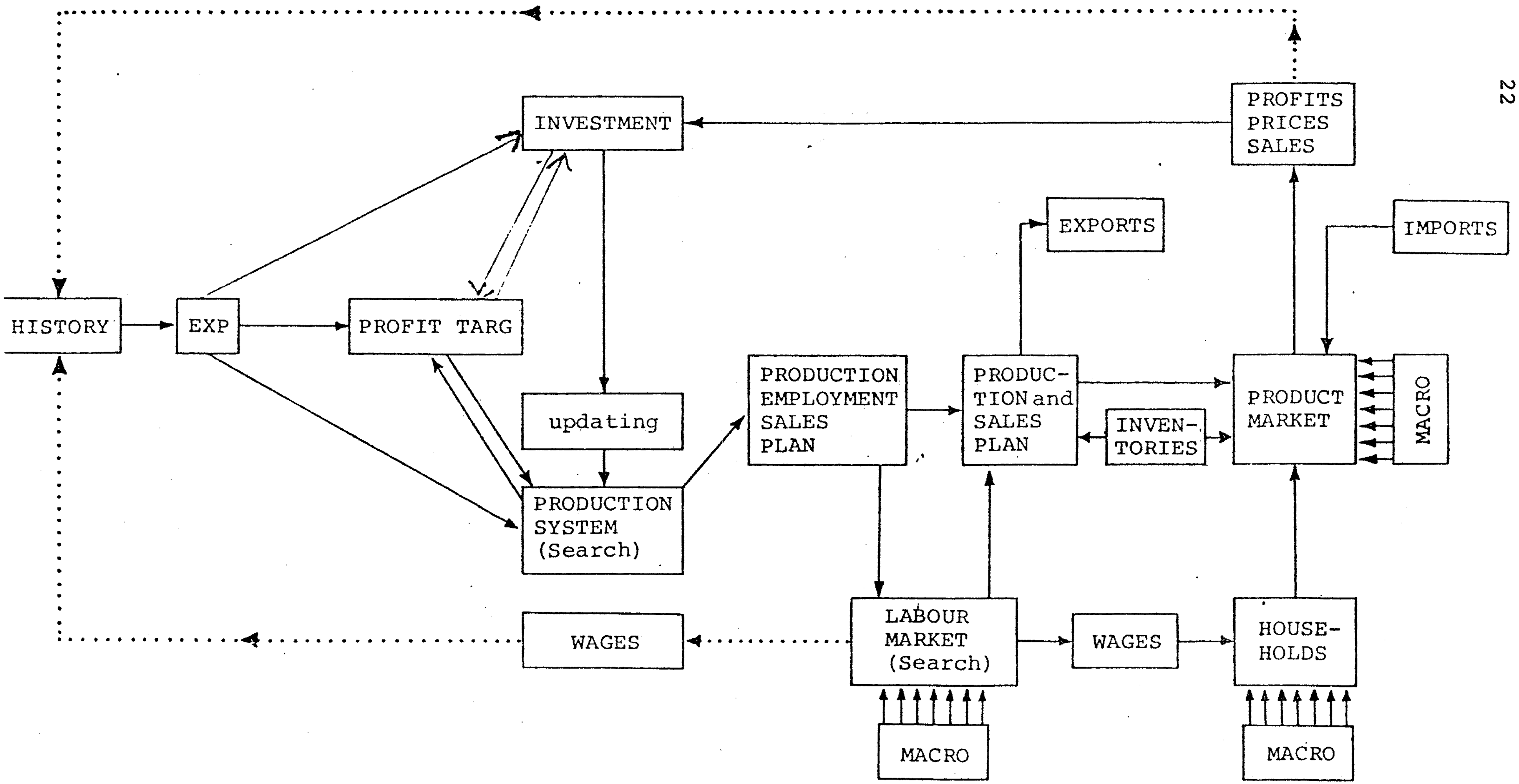


Figure 2 Production System

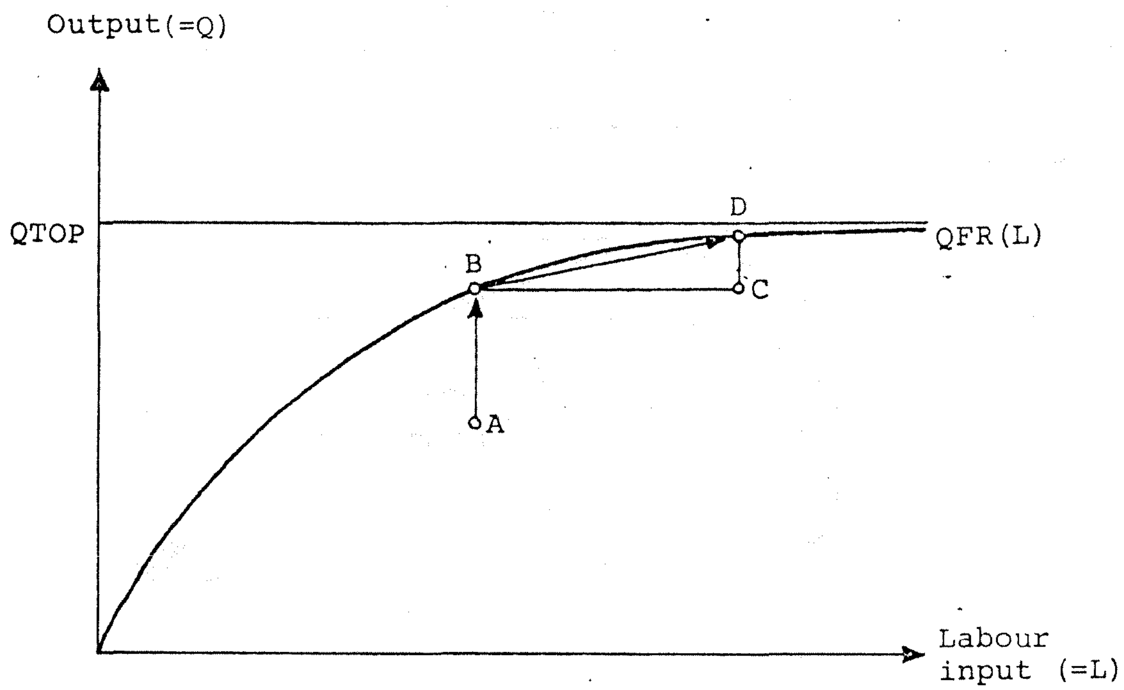


Figure 3 LONG-TERM PLAN

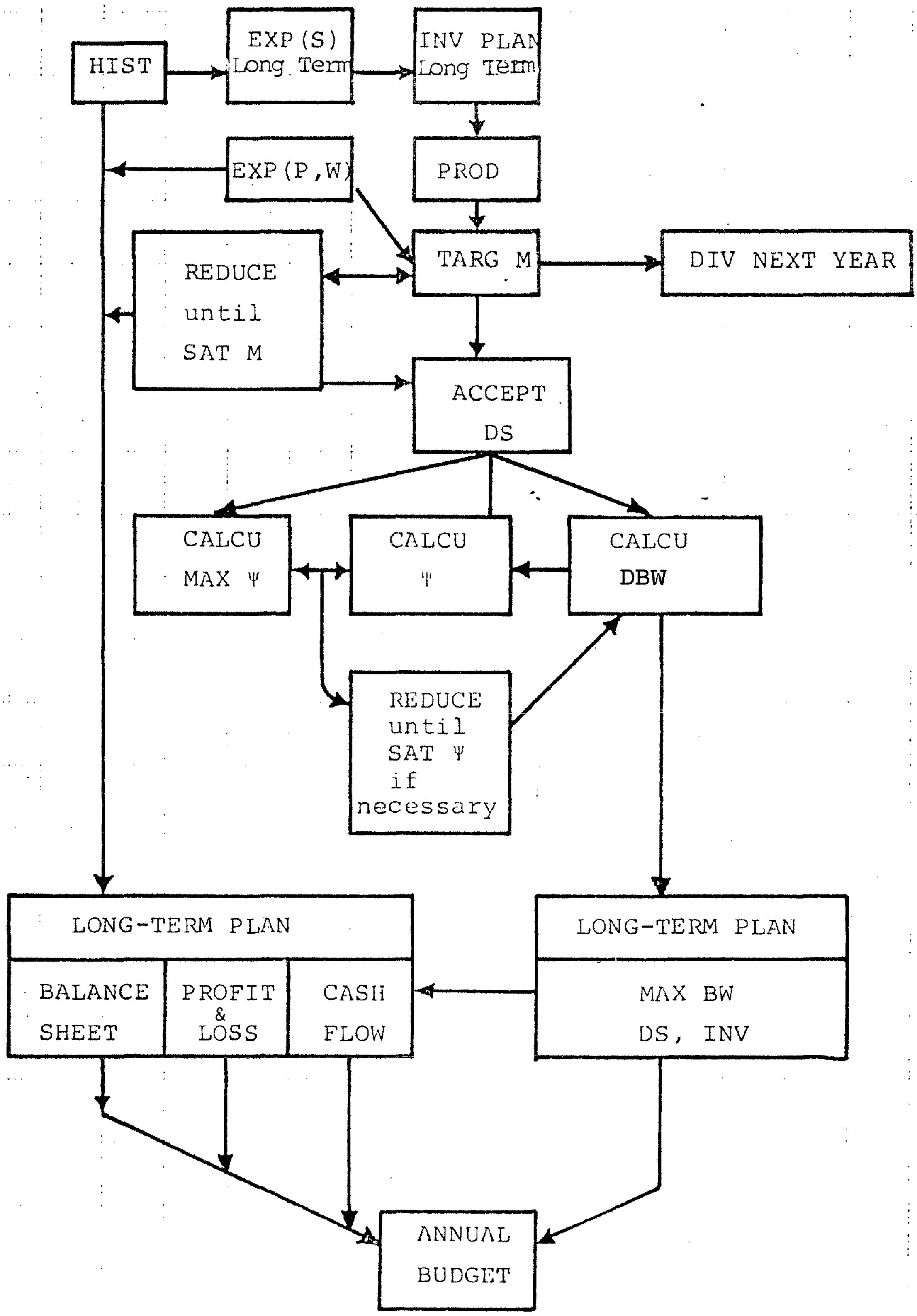


Figure 4 INV-DECISION

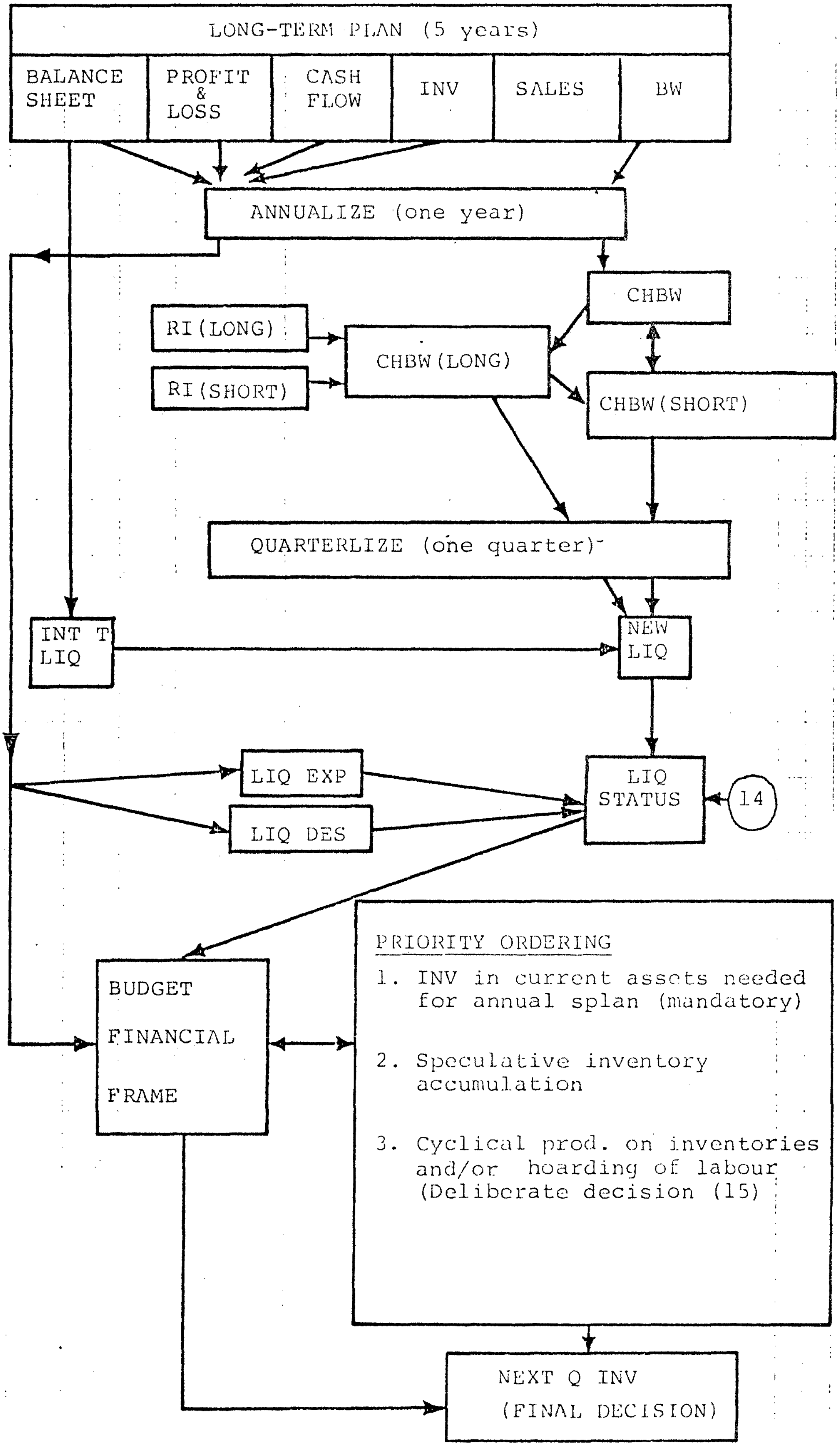
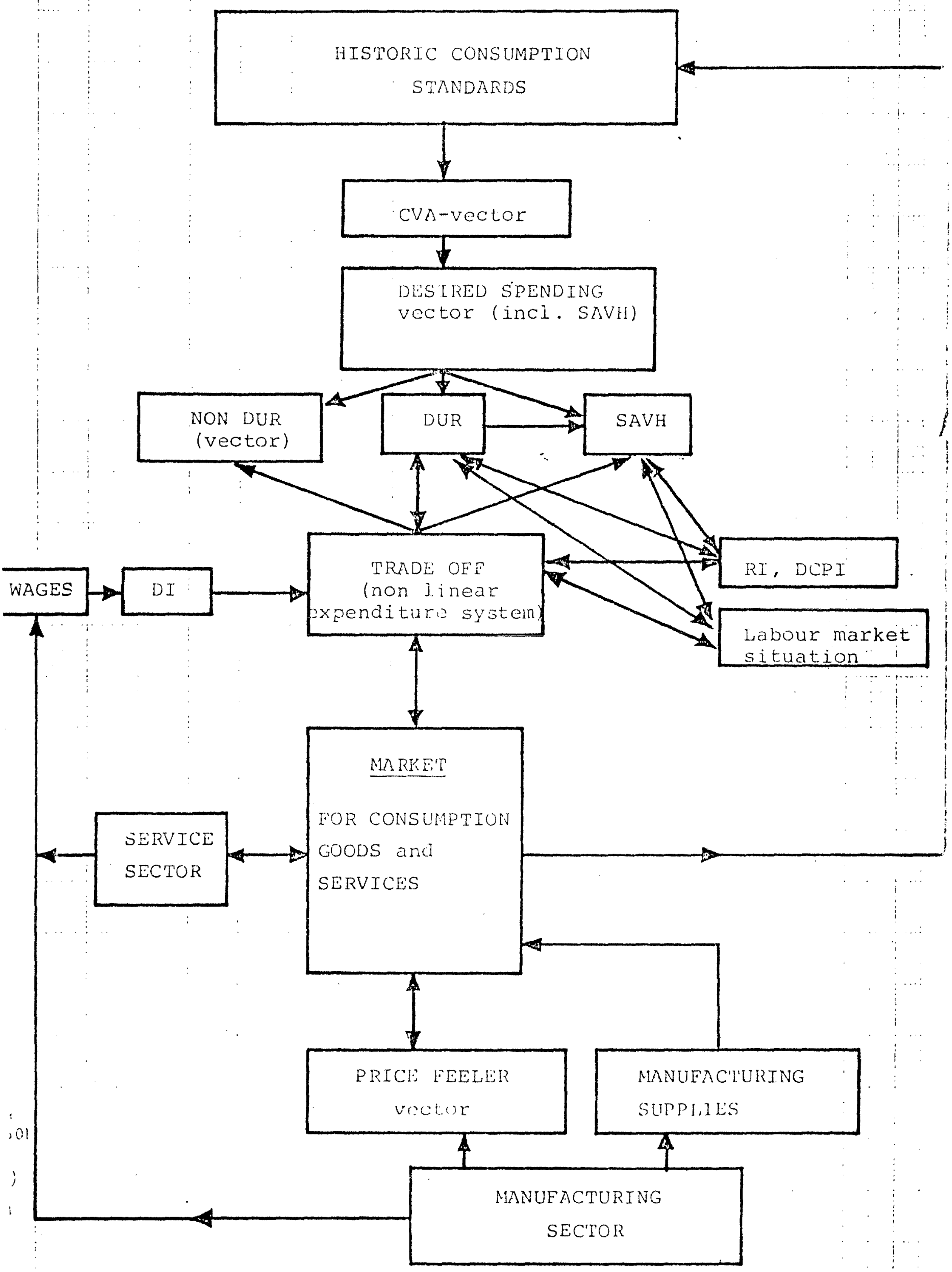


Figure 5 CONSUMPTION SYSTEM AND PROD-MARKETS



It is now time to assess the credit market situation. The long-term and the short-term interest rates are compared with total borrowing requirements from the long-term plan. This decides long-term borrowing for the year. Note that this is the first decision to act that has been taken so far in the long-term planning context. It may mean that short-term borrowing is either planned to be reduced or increased at the going short-term rate to make up for the difference in the annual budget.

Next, the annual budget is broken down into quarters.

The initial liquidity position is compared with the new liquidity position based on the first quarter of the annual budget. These data are in turn compared with expected liquidity over the budget and long-term plan and compared with desired liquidity. From this the financial frame of the budget per quarter is derived.

Mandatory requirements on finance from working capital etc. are subracted. After this, what is left is allocated to investment spending. The decision is now final for each quarter. This corresponds to the so called appropriations procedure in real life.

The way investment affects the production system has already been described in the previous section.

What remains is to note that budget assumptions may go wrong ex post. The buffer that takes up the needed adjustment is liquidity and/or short-term borrowing.

d) The household consumption system (macro)

The household sector today is only specified in macro. However, the module as such is prepared for an easy transfer into micro, in the sense that macro behaviour will be assumed to be formally identical for each micro unit (household), the only difference being the numbers we place on various parameters. The prime reason for staying at the macro level here is empirical. There are practically no empirical micro data for Sweden available on which to base empirical estimates. This is in marked contrast with the situation in the U.S., where practically all the work in this area has been done on the household sector by Orcutt and others. Besides, the author himself does not have the same kind of background experience for the household sector as for the business sector.

The consumption function is a Stone type expenditure system with some non-linear features. One additional novelty is that saving is treated as a consumption (spending) category. There is also a direct interaction (swapping) between saving and spending on household durables, entered as the relation between the rate of interest, inflation and unemployment changes (see (6) in CH 7).

The household spending decision process is described in Figure 5. For the time being we are concerned with macro, the entire economy. Each period a vector of historic consumption data is transformed into a vector of addicted spending levels which in turn can be translated into desired spending. This is very simply done through linear transformations. Desired spending is decomposed into several kinds of nondurable consumption (incl. services), durables and "saving".

In another end of the model the manufacturing, service and Government sectors generate income that feeds into households as disposable income.

There is a residual (positive or negative) between desired spending and disposable income. This residual is allocated on different spending categories by way of marginal elasticities that differ from those that divided up total desired spending.

The production sectors announce their supplies in each market and put out price feeler vectors.

Households tell what they will buy at these prices and there follows a predetermined number of confrontations. The last price feeler vector is then taken as the price for the period (quarter) and firms split their available goods between sales and inventories on the basis of this price. When firms decide on preliminary supply volumes to offer in the market they each check back at their finished goods inventory positions. The guiding principle is to maintain the price level that has entered the production planning-supply decision and to try to move inventories towards optimum levels within a predetermined min-max range (see Chapter 8 and Pseudo Code).

3. Estimation method

Even though based on a micro foundation this model addresses itself to typical macro economic problems, related to inflation and the determinants of economic growth. The advantages of this approach are many. We can move specification down to typical decision units (the firms) instead of having to deal with relationships between statistical artifacts at a more aggregate level, when it comes to observation and measurement. We can draw upon the wealth of relatively high quality statistical micro information that exists on e.g. the business sector. We introduce measurable concepts that are well known and easily understood, and, above all, we construct a consistent "measuring grid" by which micro statistics are organized within the framework of the national accounts. This in itself is worth the modelling effort, and for such statistical organizing purposes the model is already useful.

If we entertain the higher ambition, as we do, to use the model eventually for empirical analysis of the Swedish economy, the approach presents us with one large obstacle. Realism in micro specification in combination with explicit modelling of market processes necessitates that we give up well known, standardized econometric estimation techniques, as far as several sections of the model go. In a way this is no unusual thing today. Practically all large scale macro modelling projects in existence have been forced by formidable statistical problems to break text-book rules of clean procedure much in the same way as we do, and rely on extraneous information and intuition to get out of what would otherwise have been an insoluble task.

Our model addresses itself to macro problems. This means that their solution should meet the same requirements as those of conventional macro models. This in turn means that requirements on realism in micro specification are much less demanding than what would have been the case if our attention had been focussed on some particular micro problem. Hence, we can argue that our model can always be specified in such detail that we can safely assume, a priori, that it contains the correct macro hypotheses, albeit together with a whole lot of incorrect specifications or irrelevant features. Our first and fundamental empirical postulate, hence, is that as we confront the model with new empirical information we discard irrelevant (incorrect) alternatives only, <u>without running the risk of throwing out the correct alternative</u>.

This means that the modelling effort will have to be defined as a never ending process that is continually <u>improved</u> - or abandoned - as it is confronted with new test information. By this simple reformulation we manage to make a virtue out of the difficulties.

Although also a theoretical problem (inflation might be due fundamentally to a micro phenomenon that we have simply forgotten to specify) in practice we have to deal with a numerical (estimation) problem. Which (numerical) parameter combination, among many possible ones that satisfy our requirements of fit, is the correct one? This is no uncommon problem in econometrics although the least squares method provides a procedure to choose namely the parameter combination that gives the best fit in terms of minimizing the sum of squared deviations. In theory we can use that principle of choice also,[1] although it is rather arbitrary if we happen to have a cloud of parameter combinations of equal power in the close neighbourhood of the combination that happens to be picked.

This means that our estimation problem might be even more crudely empirical, namely to choose, without conventional rules of thumb, from a very large number of well defined combinations between which we cannot discriminate easily. Fortunately, our experience has not been of that kind. We have rather found it difficult to find one good alternative.

Hence, we have to turn our problem formulation around again. For those specifications that we are, so to speak, satisfied with in terms of their ability to trace economic development according to our criteria, we have to devise techniques to check carefully that we have not happened to come upon a specification that is incorrect. And if we happen to find several specification alternatives among which we are unable to discriminate, we simply need more empirical knowledge, that we don't have, in order to choose. In science, as in decision making, it is often far more important to see clearly what one doesn't know than being able to account for one's knowledge.

---

1) Search techniques to fit simulation models automatically have been developed for simple cases, see e.g. Powell (1964 & 1965).

This is the way we go about estimating the parameters of the model.

a) Problem (objectives)

This model has been designed to deal with two problems that are not well handled by conventional approaches.

These problems are:

To formulate a micro explanation for inflation

and to

study the relationships between inflation, profits, investment and growth.

The two problems obviously overlap to some extent. The first is a typical macro problem and constitutes the core of current economic debate against the backdrop of more than half a decade of experience of much above normal inflation on a global scale. The second problem requires a micro approach to be tractable for analysis in a meaningful way.

Once ready to handle these two problems, as mentioned earlier, the model will also be capable of handling other problems, that we will leave out here to simplify the exposition.[1]

The inflation task requires that we identify the channels through which foreign price impulses are transmitted through the Swedish economy and the micro parameters that are important for the speed and magnitude of that transmission. We also have to identify domestic sources and how they create inflation. The way in which expectations are formed is thought to be especially important here. We also have to identify how various inflationary processes may

1) See e.g. the experiment described in Eliasson (1976b).

affect macro behaviour in real terms, like employment. The labour market is of particular interest. Finally, we want to identify the strings that can be pulled by policy makers to affect the process. We want to include the conventional fiscal and monetary weaponry in the model eventually. More importantly, the model will offer a unique possibility to experiment with e.g. the structural parameters of the labour market. Some trial experiments of that nature have already been made although the model is not yet complete. There will also be a possibility to introduce rough schemes of wage, profit and price controls and study their impact within the domain of the entire model.

There are two levels of ambition involved here.

We may be satisfied with getting a feel for the magnitudes and direction of effects involved. We might also want to trace time profiles of various effects more precisely. The two dimensions normally cannot be kept apart as is commonly assumed in comparative static analysis. We have found through experimentation, however, that some sets of parameters have a unique influence on long-run trends, others on cyclical behaviour around these trends and others again operate both in the long and the short run. Even though we are far from finished with this classification of parameters, we have used this experience to devise a two stage "estimation" procedure that fits our two problems nicely.

The first step is to calibrate the model so that it traces a chosen set of long-term trends of the Swedish economy well, disregarding altogether the cyclical aspect. Table 2 gives the reference trends and tracing performance of a recent experimental run.

The second stage involves tracing the cyclical behaviour of the same variables satisfactorily.

The precision requirements at this second stage are probably quite small, since most of the cyclical features of inflation seem to originate outside Sweden, by way of our exogenous variables. The second stage becomes important if we want to include other problems in the formulation of our model as well. This is only tentative within the present project, so we leave it out for the time being.

This delimitation of the level of ambition is even more appropriate for the second problem, the relationships between inflation, profit, investment and growth. Here the medium-term development becomes even more central together with micro specifications. It is a well recognized experience that these relationships cannot be identified in macro approaches. Lags between cause and effect are usually long, involving, as a rule, an intricate feed back machinery between experience, expectations, planning and technical delays. This means that macro aggregates are a blend of firms in different stages of development that erase the relevant features, while a momentary cross-section picture does not identify the time dimension. Since the model imitates the whole machinery we can bring out the desired time and cross-section features at will. In a way the analysis will consist in describing what happens to a cluster of variously composed firms when the economy is subjected to various macro happenings, occasioned exogenously, by policy making or by inconsistent, joint behaviour by the firms themselves. We are especially interested in identifying the role of profits for macro behaviour (growth) in an economy (model) populated by firms whose profit responses have been unusually well imitated, we believe.

Again, the first calibration stage, mentioned above, (satisfactory trend tracing) is all we need to reach in order to handle our second problem.

Table 2 Trend comparison (MACRO - INDUSTRY), annual (change in percent)

	Sweden 1950-74 (24 years)	RUN 67 (July 76)	RUN 88 (Oct 76)	RUN 96 (Nov 76)
1) Production (Q)	4.6	2.7	3.5	5.0
2) Hours of labour input (L)	-0.9	-3.9	-2.3	-2.4
3) Productivity (PROD)	6.1	6.8	5.3	6.7
4) Value productivity (PROD x P)	10.0	-	-	11.7
5) Product price (P)	4.7	5.4	3.3	4.7
6) Wage level (W)	9.7	13.6	9.4	11.9
7) Investments, current prices (INV)	9.5	7.7	5.4	8.3
8) Ditto, constant prices (INV/PDUR)	4.3	1.1	2.7	3.8
9) Rate of unemployment (RU)	1.8	17.6	11.9	10.0
10) Sales (S)	8.8	8.2	6.0	9.8

Note: This table has been inserted for illustration only. It makes very little sense for an outside reader until a full description of the experimental set up has been made ready.

b) A priori assumptions

Let us now deal with the a priori inclusion of knowledge in our model. Empirical information enters our model in seven ways:

(1) The causal or hierarchical ordering of model modules. What depends on what and in what order (see e.g. Figure 1).

(2) Structural parameters, e.g. defining the relation between maximum possible inventories and sales or trade credit extensions associated with a given value of sales.

(3) Time response parameters, e.g. how exactly are historic observations transformed into expectations.

(4) Start-up positional data (like capacity utilization rates).

(5) Start-up historic input vector (e.g. on which to apply time reaction coefficients to generate expectations in EXP sector).

(6) Macro parameters and accounts identities[1)] (e.g. in consumption function).

(7) Exogenous inputs (like foreign prices).

The hierarchical ordering is the first step from a completely empty formal structure to saying something about the world. All theory in economics has to have something of type (1) in it to be called economic theory. Without the use of operational, meaningful or measurable variables not much empirical knowledge is brought in. Consumer preference schemes and the marginal productivity of capital are concepts or variables that are close to being empty since we have no good measuring instrument or senses to touch them. We refer to the concept of a Keynesian model and immediately bells start to ring.

---

1) To the extent possible we use outside information from econometric studies here.

Keynesian represents a general class of causal orderings of economic variables that all correspond to a measurement system (the national accounts) that we are familiar with.

The great advantage of our model is that we bring the hierarchical ordering very close to two excellent measurement systems. At the micro firm level we are dealing only in terms of the firm's own accounting systems and at the macro level we are truly Keynesian. It is not necessary to be a professional economist to assess and understand most of the structural micro parameters of type (2) and to provide the start-up historical and positional data (4) and (5). This is definitely an advantage that outweighs the loss of econometric testing potential. This information is brought in as a priori assumption. We take it for given (true) in the causal specification.

Most evidence brought in here is based solidly on internal planning and information routines within firms as described by Eliasson (1976). The specification therefore appears to be as close as one can get to the buttons that are actually being pushed in the decision process.

The causal ordering (1) is essential for the properties at the macro level. Such orderings between periods replace the time reaction coefficients in macro models.

c) Selection criteria

Under this model specification scheme the numerical estimation problem is in practice isolated to the time response parameters under (3). Here we have practically no outside knowledge to draw on except trying out various sets of combinations and to check so that the total model behaves as an economy of our choice. For this we have to design a procedure and to obtain a data base that represents the economy we are studying.

d) Data base

Two sets of data are needed; one set to operate the model and another set to assess performance.

The second set is macro statistics from the Swedish national accounts that will uncritically be said to represent Sweden.

The first set is more specific to our model. We need a micro firm data base of at least 5 years (annual data) and a set of positional data for the last year to get the model started. And we need a forecast or an assumption (or historic data if we trace history) for the exogenous data for the simulation period. We would also like to be able to start simulation at a date of our choice, which means that the micro data base should, preferably, stretch far back in time. In practice this means that except for the last few years, we will not have all the data we need.

Model building, model calibration and data collection must take place simultaneously. Thus much of the data we need for model testing will not be available until most of the calibration work has been done. This is how we solve this dilemma.

Until now we have experimented with the model on historic, five year input vectors for the years 1970-74 for each firm. Fortunately, 1974 is the peak of an inflationary profit boom in the business sector. The simulation run then begins under conditions that are very similar to those prevailing during the year when our historic national accounts test data begin, namely 1950 (the Korean boom).

To get at micro data at an early time we had to be satisfied with synthetic data. For the time being macro subindustry data for 1970-74 (four subindustries) have simply been chopped up into 50 firms applying a random technique that preserves the averages of each subindustry. On the basis of this start-up information we have performed a series of preliminary calibration experiments according to a procedure to be described below. Occasionally we have included one or several real firms in a simulation run to see what happens to them.

The next step, not yet embarked upon, will be to prolong the micro data base back in time, using essentially the same synthetizing technique but also enlarging the number of firms. There are two reasons for this. We have to check stability properties of the model when we vary start-up data by moving back and forth over historic time. In addition we need better and more precise test historic data to evaluate model macro performance. The change-over to this data base will take place at a time when a new, extended version of the model is planned to be ready. We expect that several parameters of the system will have to be recalibrated after this changeover before the model has found its way back to a good trendtracing performance of the quality already achieved under much more primitive conditions.

The final stage is to feed the model with a set of real firms and to apply the same synthetizing technique on the residual that remains between the subindustry total and the aggregate of the real firms in each market. We are thinking in terms of eventually having the 200 largest Swedish firms in the model. When and whether we will reach that ambition, or higher, depends not only on the amount of work associated with arranging a proper data base but also on the exact nature of internal memory limitations on the computer side. For various reasons this stage will be reached very late in the project. We are now experimenting with a sample of 50 firms.

e) Calibration

Calibration has to be defined in at least two dimensions. We need a set of criteria for a good "statistical fit". These criteria, of course, relate back to the precision requirements we have in dealing with the problems we have selected, described already above. In econometrics this corresponds to choosing the level of significance and to some extent the estimation method.

We need a procedure of selection that guides us towards a specification alternative that satisfies our criteria and (NB) that is not a spurious one. These two steps are summarized in Tables 3 and 4.

Table 3 MASTER CRITERIA FOR FIT

A. Certain macro industry trends approximately right (within ± 1/2 percent) over 20 year period (see trend chart Table 2). This criterion is essential.

B. Same inter-industry-trends.
Same criteria for 5 year period.

C. Micro. No misbehaviour of obvious and substantial kind, if it can be identified empirically as misbehavior.[1)]

D. Identify (time reaction) parameters that work uniquely (or roughly so) on cyclical behaviour around trends. (This criterion is not essential to handle the two chosen problems.)

---

1) Since the model has not been designed to exhibit such behavioral features there is no other ways to detect them, if they are there, than by carefully analysing each experiment. There is no use giving a "suspicion list" and then limit attention to that list.

Table 4 CALIBRATION PROCEDURE (TREND FITTING)

1. Find first reference case. Assess its qualities in terms of A above.

2 a) Perform sensitivity analysis with a view to finding new specifications that improve performance in terms of A.

b) Ditto with a view to investigating the numerical properties of the model within a normal operating range (analysis). Check and correct if properties can be regarded as unrealistic.

c) For each new reference case, repeat the whole analysis of 2 b) systematically. The purpose is to ensure, each time, that the new reference case is really a better specification and not a statistical coincidence and that the properties of the system revealed by the sensitivity analysis above, and judged to be desirable, are presented in the new reference case.

d) Subject model to strong shocks. Check for misbehaviour. (Especially fast explosive or strong contractive tendencies that are generated from shocks that are obviously extreme but just outside the range that contains a real but rare possibility.)

3. Define new and better references case. Repeat from 2.

We may say that the model we have designed is a combined medium-term growth and cyclical model although the two prime problems we have chosen only require that it imitates macro reality (Sweden) well over the medium-term, say five years, exhibiting a business cycle although not necessarily a typical Swedish business cycle.

We may say that with these "empirical" requirements we have not moved far above a purely theoretical inquiry into problems of inflation and growth. We have done more in so far as our numerical approach has allowed us to say something not only about the directions of change but also about the relative numerical magnitudes involved, based on data from the Swedish economy. This is also how the ambition of the current project has been defined.

Towards the end of the project we also hope to be close to the following model performance; a specification that traces five year macro trends in Sweden according to A above quite well, irrespective of where in the period 1955-1970 we begin the simulations, (if we have the necessary start-up data), and that reproduces a typical business cycle in all the variables in A, if exogenous variables, including policy parameters and start-up data are correctly specified. For the model to be useful as a support instrument in a forecasting context achievement of this goal is a minimum requirement.

This preliminary paper aims only at a technical documentation of the model specifications and the ideas behind the approach. To understand the empirical problems involved and to assess the potential usefulness of the model a much more detailed account of the calibration process is needed as well as a full description of the experimental runs. The necessary material for such an account is not yet available although it is planned to be included in the next, revised and less preliminary documentation to follow.

PART II

MODEL

Gunnar Eliasson, November 1976

II. EXPECTATIONS AND TARGETS

1. Introduction

This is the sector of the model where the psychology of entrepreneurship enters. The model, as it stands now, is mainly centered around a system of routine management of existing operations of the entity called an industrial firm.

This means that we will be concerned here with the forming of expectations that are relevant to existing operations and the setting of goals (targets) for the same activities. This will have to be a looking in the mirror approach to the future. Any attempt to do anything beyond this requires that we bring in knowledge and information directly and exogenously from firms (which is of course possible) or has to be based on some sort of randomization (like assuming that innovations are randomly distributed over firms), which has no empirical relevance, except at the macro level. We then have to assume, as all econometric models do, that such events really occur as random noise. If we can (which is doubtful) we can do the extra thing of also investigating major noise effects on the economy. This has been done by Forrester, Mass, etc and was done by Frisch already in 1933.

No one has so far been able to model change in the existing economic structure, the creation and introduction of new activities or the Schumpeterian innovative process as endogenous phenomena. The reason of course is the almost complete lack of generalized empirical knowledge about these matters and also the fact that each discipline has to cross its own disciplinary frontiers to bring such knowledge into its theory (Eliasson (1976)). Such interdisciplinary travel seems to have given rise more to personal problems than to praise for those who have tried. Third, most models, that we have seen, would scream if we tried to accomodate such mechanisms.

What we can say so far is that such mechanisms, if we know them, can easily and happily be incorporated in the model structure that we have.

We distinguish between long-term expectations on the one hand. They feed into long-term plans, notably investment-growth plans, and affect the long-term financing decisions as described in the next chapter. On the other hand we have short-term operating expectations that affect production and sales decisions.

Expectations focus on prices, wages, sales (markets) and to some extent interest rates.

Targets focus in on profits only, more specifically profit margins. There is strong evidence that this target variable is the fundamental one when we move up to the level of Corporate Headquarters and that crude experience from the past is what matters, not sophisticated calculations as to what is optimally feasible.[1] Long- and short-run targets are essentially the same, only that short-run targets may be temporarily violated under the long-run target constraint.

Time has three dimensions here:

The long term, which focuses on a trend, which in turn implies a continuation beyond the long-term horizon (H). This way of looking at the future is current practice among firms and it allows a nice and consistent solution to the problem of how terminal stocks should be treated in a decision context.

The short term, which for us is synonymous with the (annual) budget horizon, allows for business cycle considerations in so far as this is an empirically relevant consideration.

Updating each period is on the basis of the current inflow of experience. As for targets

---

1) See Eliasson (1976)

this is a matter of the margin allowed for targets to be violated before corrective action is taken. Targets are only set once a year in the annual planning sequence.

2. Targeting (TARG-sector)

In this section we introduce a set of decision criteria for the firm. They are based on a general objective function that we believe condenses the prime preference structure of Corporate Headquarters of a large firm. We begin by identifying this function in operational terms and proceed to particularize a set of decision rules (restrictions).

Objective function

We assume that profits is the dominant goal variable that guides decision making at firm headquarter level. This assumption seems quite well supported by evidence (see e.g. Eliasson (1976)) if we imply only that all other variables are subordinated the profit objective. We recognize the circumstance that the certainty of information fades with future time and hence warrants a distinction between short-run operational decisions, that can be modified from period to period (here quarters), and decisions that mean long-run irreversible commitments (investment).

Any consistent accounting system allows us to derive the following additive objective function[1]:

---

1) Since this is the first place where symbolic language enters, a few points on notation should be mentioned.

The APL language that we use for programming only takes ordinary letters. Systematic use of only such letters makes reading very slow. To keep good correspondence with the pseudo code and this explanatory text and make these chapters readable at a fairly high speed we use (as systematically as possible) greek letters here, and simply spell them out in the pseudo code. Hence $\alpha 1$ becomes ALFA1 in the pseudo code.

Indexes etc are always kept on level with other symbols. Only when necessary to avoid confusion, brackets are inserted to separate symbols.

CH in front of a variable always represents the time difference or differential. Hence CHP(DUR) means $\Delta P(DUR) \approx \frac{dP(DUR)}{dt} * \Delta t$

D in front of a symbol or a set of symbols always means relative change. Hence, DNW or D(NW) means

$$\frac{CHNW}{NW}$$

Functions are also, and conventionally, indicated by brackets as QFR(L) (see chapter IV) that defines the production (Q) possibility frontier (QFR) as a function of L. It will always be obvious from the text or the context when we are indicating a function.

Finally note the fact that Q both stands for quarter and output. Hence QQ means quarterly production volume. Fortunately, in most of this explanatory text it won't be necessary to distinguish between periods of various lengths.

$$DNW + \theta = \underbrace{M * \alpha}_{A} - \underbrace{RHO * \beta}_{B} + \underbrace{DP(DUR) * \beta}_{C} + \underbrace{(RRN - RI) * \psi}_{D} \qquad (1)$$

$$GOAL = DNW + \theta - DCPI \qquad (2)$$

$$M = 1 - \frac{L}{Q} * \frac{W}{P} \qquad (3)$$

A proof follows at the end of this chapter[1]. The variables are defined verbally and in operational terms as follows:

NW = Net worth defined residually as shown in table III:C in the next chapter.

θ = The rate of dividend (DIV) payout of NW = DIV/NW

α = S/A

S = Sales expressed in current prices

A = Total assets, valued at replacement costs

β = K1/A

K1 = Replacement cost of production equipment as defined by the updating procedure D1 in the next chapter.

W = Wage cost index

P = Product price index

CPI = Consumer price index

---

1) See also Eliasson (1976, p. 291 ff)

RHO = Rate of depreciation of such equipment[1] in terms of K1

$K2 \equiv A - K1$ = Other assets (inventories, given trade credits, cash etc.)[2]

ψ = BW/NW = the debt (BW) net worth or gearing ratio

NW = A - BW

RI = Rate of interest

M = Gross profit margin in terms of sales (S)

$$RRN = \frac{M*S - RHO*K1+K1*DP}{A}$$ = nominal rate of return on total capital.

$$RRNW = \frac{M*S - RHO*K1+K1*DP-RI*BW}{NW}$$

We assume here that all stock entities are valued at replacement costs. This means that firm net worth (NW) has been obtained by a consistent (residual) valuation method as shown in table III:D in the next chapter. It is an entirely empirical matter whether the decision criteria derived from such valuation principles are relevant, a circumstance that we will discuss later.

---

1) This requires that the following identity holds:
$$INV = \frac{dK1}{dt} + RHO * K1 - \frac{K1}{P} * \frac{dP}{dt} + \frac{dK2}{dt}$$ where INV is gross investment.

2) Note that K2 is broken down into several components in the next chapter.

(1) states that the relative change in firm net worth (DNW) plus the period's dividend payout in percent of the same net worth (θ) is the sum of four components:

(A) The profit margin (M) times the ratio between sales and total assets (α).

(B) Calculated economic depreciation (subtracted)

(C) Inflationary (capital) gains on assets[1).]

(D) The leverage contribution defined as the difference between the nominal return to total assets and the (average) interest rate on debt (BW) times the debt net worth ratio (BW/NW).

It is easily demonstrated that:

RRN = A + B + C (4)

It can furthermore be proved that:

DNW + θ = (nominal return to NW) = RRNW (5)

---

1) There is a problem here. If realized inflationary gains are listed under (C) the costing principle used to obtain M has to be based on a replacement valuation of raw materials and intermediate products. This is a problem we have to face when the model is fed with real firm data.

If we can presume that shareholders value their assets in terms of their purchasing power and that their purchasing power is defined in terms of a basket of consumer goods, then their goal variable reads either (from 5):

> the <u>real</u> rate of return on net worth (RRNW-DCPI)

or (from 2):

> the real (or CPI-deflated) growth rate in net worth, inclusive of what is currently made directly available in the form of dividends.

For the consumer-shareowner the appropriate deflator should be the consumer price index (CPI). This is not an appropriate specification for the typical stockholder that influences business decisions. It is quite unlikely that he regards his wealth as a stored up consumption potential, at least not with the weighting system used to compute CPI in a normal country. Since the deflator choice has only been introduced to allow an outside assessment of business performance we need not discuss this matter further here.

The decision criteria that we will introduce are all invariant vis-à-vis this choice.

An additive delegation scheme

(1) tells us that four factors contribute additively to performance in terms of the objective function (1) or (2). Two of these factors are always matched by separate organizational units within firms namely:

Investment-financing (long term) = D

and

operations decision making (short term) = A

(B), the depreciation factor has no real organizational counterpart. It is an important factor but it rather defines the valuation principles that go into asset measurements.

So far capital gains seem to have been neglected in organizational terms (cf. Eliasson (1976)), except for those organizations that live mostly off capital gains like investment companies etc. Recent inflationary experience, however, has made firm management more aware of the benefits as well as dangers of inflation. Maybe the introduction of new inflationary accounting systems in the future will be accompanied by the institution of inflationary departments to manage them as well as to promote a profit contribution under C.

The results of long-term investment financing decisions and operational decision making are mutually dependent in a way that will be modelled in detail in the next chapter. The typical feature of firm management, however, is that decisions under A and D are not simultaneous but managed separately. This feature is the rationale for keeping the long and the short term separate.

The objective function (1) also gives the rationale for the paramount concern with profit margins, especially in U.S. manufacturing firms. As long as sales-asset ratios are fairly stable over time, M is a monotonous indicator of profitability in terms of those factors that are manageable in the short term. Stated in more familiar language: An increase in the profit margin in the short term always means an increase in the return to assets. The short term is defined to mean the production planning period within which production plans cannot be changed during implementation.

By breaking M down further as in (3) the separable, additive targeting function (1) can be further identified with the organizational fabric. In the economy we are for the time being (no purchased intermediate products and no divisional separation of the firm unit assumed) considering M as composed of three factors:

- Labour productivity = Q/L
- Wage costs = W
- Product prices = P.

Prices are typically associated with sales departments while productivity is managed and determined within production departments.

While labour cost can usually be measured properly at the location where it is applied this is not normally so with prices or profit margins. However, if prices and profit margins can be measured only for the end (final) product a whole series of performance indexes based on

$$\frac{W \times L}{Q} \tag{6}$$

usually called unit labour costs, can always be extended far down into the interior of production departments. This also explains the frequent use of unit labour costs as a performance indicator[1].

---

1) In fact unit labour cost is probably a much more useful measure on the shopfloor, where Q is defined by numbers of screws, than at the aggregate, national level where output has to be split into Q and P, a very arbitrary thing to do, however one tries.

With this algebraic exercise, we have identified the interests (goals) of top firm management. We have identified what factors affect these goals. Some are fixed (structural) in the short term, maybe not in the long term. Some can be manipulated from period to period (like productivity) as we will demonstrate later. Some factors cannot as a rule be influenced by firm management other than indirectly. About these variables firm management must form an ex ante opinion (an expectation) in order to make a rational choice as to how to move those variables that they can influence. The most notable expectations variables are prices (P) and wages (W). We will treat the psychology of expectations in the next section.

Thus it only remains to define what should be meant by a rational choice in terms of the goal variables in (1).

Feed back targeting

It is obvious that if firm management knows the best it will choose the best. If it doesn't know some other choice procedure is needed. To understand and to model the remote guidance and control system of a large corporation three empirical circumstances have to be kept in mind.

(1) Top management or CHQ has neither got the knowledge nor the competence to solve lower level decision problems.

(2) Good performance of the entire company, measured in terms of, say, the objective function (1), requires "good solutions" to decision problems all the way down to the shop-floor level.

(3) An alternative plan for the entire corporation has no meaning if not accompanied by an action plan as to <u>HOW</u> to do something else.

From these "axioms" follow several conclusions. Top management is synonymous with a downward delegation of most important decision problems that are solved by others without top management knowing or understanding HOW. Hence, top management is concerned with formulating the Goals of the organization ("the organization's interests"), breaking them down into operational terms that are understood at all levels by setting targets and enforcing them.

Plans as to <u>how</u> to enact alternative plans always require solutions outside the competence of top management. Hence alternative plans are not made up at the CHQ master planning level.

There one is concerned with the required size of financial risk buffers instead (next chapter).

In formula (1) a CHQ goal (objective) function has been broken down into targets to the level needed for our model purposes. What is missing is only a principle for setting the numbers, or a replacement for the conventional profit maximizing principle. Our knowledge is that top managers do not have the knowledge to work out a HOW-plan except as a long winding iterative downward-upward exchange of knowledge and solutions each time a plan is drawn up[1]. We know that such a convergence process towards the optimal solution does not occur in practice in the sense that the overall master solution is transparent and intelligible at the top. (See Eliasson (1976).) To solve our problem and still formulate ourselves in terms that are empirically relevant we introduce the concepts of feed back targeting, and the MIP principle (see below) meaning simply a numerical method of applying the right pressure when tuning the targets. If this pressure is too tough it is not taken seriously. If it is too soft, top management is normally cheated to agree to inefficient solutions.

---

1) Many such decision processes have been modelled during recent years on the basis of the famous Dantzig-Wolfe (1961) algorithm.

Since feasible target performance cannot be calculated without full and open minded co-operation from those who are supposed to do the work, the only substitute method is to look at past performance and gently step up performance requirements without asking for impossible things.

This method can of course be supplemented with external information, say on competitors performance, or by applying some market reference guide e.g. by deriving tailor-made profit margin criteria (or productivity criteria) from a real rate of return requirement in terms of (2)[1).

We will introduce the following simplifications, that seem to be backed by empirical evidence.

(1) Factor C in (1) is disregarded.

(2) Factor D is handled separately as a long-term planning decision (see next chapter) where new external financing is decided on the basis of expected long-term returns on borrowing (the leverage factor) and financial risk considerations.

---

1) See example in Eliasson (1976, p. 170ff)

(3) Short term production, selling, hiring etc decisions are governed mainly by M-criteria.

These M-criteria are fixed on the basis of past experience of what can reasonably be done and the requirement is to maintain or improve (MIP) past performance. The feedback historical reference target is defined:

(A) $MHIST(t) = \lambda * MHIST(t-1) + (1-\lambda) * M(t-1)$
$0 \leq \lambda \leq 1$

On this we apply MIP:

(B) $TARG(M) = MHIST * (1+\varepsilon)$

(C) $\varepsilon \geq 0$, but small.

This is the long run target that may be the same in the short (annual) run or modified by a cyclical factor.

Targets may be enforced more or less. The toughness with which targets are enforced determines how far search for better and better solutions is forced on to the firm organization, especially within the production system (see Chapter IV). We don't have the empirical information to come up with an enforcement formula. This specification will have to await what we can learn from experimentation with the model.

Targets are set once and for all for each year. The toughest enforcement alternative is to enforce these targets through the year without any cyclical and other modifications. This is not realistic, but will be tried.

A second alternative is to apply the same (annual) target for each quarter[1]. There is evidence that schemes similar to these are operated in some well managed firms.

A third step is to allow for cyclically variable targets (empirical evidence does not support such a device)[2] or to allow for a cyclically varying enforcement procedure.

We will experiment with a modification of the last alternative, namely a cyclical target enforcement modifier that depends on the liquidity position of the firm and long-term future prospects. If these are bad and/or the liquidity position bad, firms will be more prone to enforce targets, notably by laying off people.

We note that this choice is based on rationalistic considerations, that are not well supported by evidence. The same holds for the

---

1) The second alternative differs from the first in that failure to satisfy targets the first quarter does not raise targets for the succeeding three quarters.

2) See Eliasson (1974).

introduction of explicit cyclical considerations. However, the purpose of this model is not only to imitate actual behaviour (this we want to do as well as we can) but also to learn how the economy behaves if behavioral specifications are changed.

3. Expectations functions (EXP-sector)

Introduction

Expectations are fix points on the basis of which the firm manipulates its parameters to find a solution that satisfies its targets *ex ante*. We recognize two types of influences on the forming of anticipations. First and most important, expectations are assumed to be generated from internal experience. Such generating functions are labelled EXPI. We will apply throughout modified versions of the feedback learning function formulated in Eliasson (1974 b, p. 79 ff).[1] Second we will allow exogenous influences to enter the forming of expectations in various ways. All such exogenous influences are denoted EXPX.

---

1) *Profits and Wage Determination*, Research Report 11, Federation of Swedish Industries, Stockholm.

We introduce a <u>generalized</u> <u>additive</u> <u>expectations</u> <u>function</u>:

$$EXP(\theta) = (1-R) * EXPI(\theta) + R * EXPX(\theta) \quad (8)$$

$$0 \leq R \leq 1$$

R is the factor that determines the relative importance of internal and outside influences in the forming of expectations. In most instances it will be determined outside the model by ad hoc judgement.

<u>Example</u>: Suppose θ represents the relative change in the firm's product price. EXPI then transforms past internal price experience into a future predictor. EXPX in turn transforms externally available price information into a price forecast for the firm. Such external information may be gathered from other variables, official forecasts, the general mood of the market and sentiment in the economy etc.

In general we will apply the principle that the more consistent and persistent exogenous information the more likely that external signals dominate over internal experience and the higher R.

Since the two transformation functions EXPI and EXPX produce identically defined expectations by assumption, albeit with different numerical any cyclical and other modifications. This is not realistic, but will be tried.

A second alternative is to apply the same (annual) target for each quarter[1]. There is evidence that schemes similar to these are operated in some well managed firms.

A third step is to allow for cyclically variable targets (empirical evidence does not support such a device)[2] or to allow for a cyclically variable enforcement procedure.

We will experiment with a modification of the last alternative, namely a cyclical target enforcement modifier that depends on the liquidity position of the firm and long-term future prospects. If these are bad and/or the liquidity position bad, firms will be more prone to enforce targets, notably by laying off people.

We note that this choice is based on rationalistic considerations, that are not well supported by evidence. The same holds for the

---

1) The difference between the first and the second alternative is that failure to satisfy targets the first quarter does not raise targets for the succeeding three quarters.

2) See Eliasson (1974).

Long-term expectations are fed into the investment-financing and growth decisions. The long-term internal expectations generator is assumed to be of a quadratic, feed back learning type:

$$EXPI(\theta):=\lambda * EXPI(\theta)+(1-\lambda)*(\theta+\alpha*(\theta-EXPI(\theta))+\beta*(\theta-EXPI(\theta))^2) \quad (9)$$

$$0 \leq \lambda \leq 1$$

This formula applies to all expectations variables that we are dealing with; for the time being prices (P), wages (W), sales (S) and interest rates (RI). The variables are normally defined in relative growth terms, and (9) then produces an estimate on the average, annual rate of change for the future period defined as "long-term". Expected change in θ is a time-weighted (declining weights) average of past changes in θ. To this factor is added (1) a fraction of a time-weighted average of past differences between actual and expected changes and (2) a fraction of the same time-weighted differences squared.

λ defines the weighting system. A λ close to zero means a heavy dominance of today in the forming of expectations. The closer λ is to 1, the more important the past[1].

---

1) The formula is identical to an exponentially declining weight system.

α*(θ- EXPI(θ)) is a correction factor for systematic mistakes in the past, also weighted in by λ.

β* (θ- EXPI(θ)^2) defines the effect of variation in expectational hits, irrespective of which way mistakes go. A firm may operate in a completely erratic (random) environment to the extent that (θ-EXPI(θ)) averaged over time is ≈ 0 even though period observations on the same variable may have very large absolute values. If so the mere uncertainty involved should suggest caution, if say a single, very large negative (θ-EXPI(θ)) means something uncomfortable for the firm. Hence β should be negative while should be positive.

The weighting system will be assumed to be identical between firms. Hence differences in expectations between firms depend solely on a different "variable-experience" and on the coefficients α and β in (9) and R, that may be said to signify the firm's learning response (α), the firm's attitude to uncertainty (β) and its degree of extroversion (R), respectively.

Experimentation will start by using five years of historic experience to generate expectations.

Short-term expectations (internal)

Empirical evidence suggests that firms use quite crude transformations of past experience in their planning routines. It happens frequently that no business cycle is allowed to enter plans. A fully calibrated model will have to be as realistic as possible in this respect. For experimental purposes, however, it will always be of interest to ask how the economy behaves with and without such considerations in plans. And the model allows rather sophisticated expectations, moods and sentiments to be experimented with. Since we believe expectations to be an important motor in the economy we will allow for the possibility of entering quite complex devices already now. Until we know more about the importance of expectational mechanisms, experimental "knowledge" will have to do.

We know, furthermore, that executive decision makers are frequently subjected to information generated as in (1) and (2) or apply the same kind of calculation themselves, intuitively. Hence modifications related to the short run should most appropriately be entered as a separate short-term or cyclical modifier of long-term expectations. This is done by applying a cyclical modifier to the internal expectations function EXP(θ) in (9).

$$EXPISHORT(\theta) = CYCLE*EXPI(\theta) \quad (10)$$

CYCLE is a transformation function that spreads EXPI unevenly over a future period. It can be a simple sinus function or a more complex cyclical spectrum that is continuously updated during a simulation. (10) is not yet in the model program.

Periodic updating

Expectations tie in with the annual budget procedure. Operations planning in the model is on a shorter time basis, for the time being by quarter. Experience during the year, hence, is allowed to affect e.g. production planning through updated expectations. This is well in line with business practice.

Updating implies a gradual relaxing of annual expectations if disproved by experience. The firm enters the first quarter expecting one quarter of expected annual change to be realized (no season assumed). For the three consecutive quarters this simple expectation is modified by:

$$QEXP(\theta) = \frac{EXP(\theta)}{4} + \psi * ((Q*\theta) - \frac{EXP(\theta)}{4}) \qquad (11)$$

Thus the realized quarterly deviation from expectations corrects next quarter initial expectation with a factor ψ. Obviously the within-year quarterly, adaptive expectations formula (11) is analogous to the between-year expectations formula (9).

Sales expectations (S)

Sales expectations deserve special mention here, since we have modelled business practice to be to project expected market growth, assess the firm position in terms of its market share, project a preliminary sales plan and then to try it out step by step. This means a departure from conventional economic theorizing in so far as demand and supply (DS) curve analysis has very little relevance. It is the nature of this search that matters and DS curves are so transient that we cannot catch them.

Firms are assumed to begin their sales forecasting by a market assessment based on EXPP. The total market is called MARK and each firm applies (9) to obtain a preliminary appreciation of market growth EXPIDMARK, assumed to be consistent with EXPP. This "harmonic" assumption presumes no strategic market maneuvres by the firm and no expected strategic maneuvres on the part of other competing firms. In other words, if the firm enters the market with its offering price EXPP it also expects to maintain its previous market share ES and:

EXPDS = EXPDMARK

EXPS = EXP(ES * MARK) = ES * EXPMARK

Later on we will try to build more fun into the model by introducing a trade off between offering prices EXPP and market shares ES. In doing so we have to establish a link over time between long-term planning and short-term operational planning.

SUPPLEMENT TO CHAPTER II

PROOF OF ADDITIVE OBJECTIVE FUNCTION (1)

Assume no taxes.[1)]

Cash flow identity

$$\Pi - RI * BW - DIV + \frac{dBW}{dt} \equiv I + \frac{dK_2}{dt} \qquad (A)$$

Definition of gross investment spending:

$$INV \equiv \frac{dK_1}{dt} - \frac{dP}{dt} * \bar{K}_1 + K_1 \qquad (B)$$

Π = Operating profits (gross), inclusive of depreciation

RI = Average rate of interest on net debt (=BW)

K_1 = Replacement value of production equipment on which the depreciation rate (ρ) is applied to obtain depreciation ($= \rho * K_1$)

$\bar{K}_1$ = The corresponding volume measure, obtained by deflating K_1 with the investment goods deflator P^*

K_2 = all other assets, same valuation

NW = Net worth residually determined from: $A \equiv K_1 + K_2 \equiv BW + NW$

---

1) For an extension of the separately, additive targeting formulae (1) with taxes included see Eliasson: Business Economic Planning, (Wiley) 1976, p.293ff. See also Eliasson: Two Papers on Planning and Efficiency, Economic research Repub B13, Federation of Swedish Industries - Stockholm, October 1976.

Now reshuffle terms in (A) and insert in (B):

$$\Pi - \rho * K_1 - RI * BW + \frac{dP}{dt} * \bar{K}_1 \equiv DIV - \frac{dBW}{dt} + \underbrace{\frac{dK_1}{dt} + \frac{dK_2}{dt}}_{\frac{dA}{dt}}$$

From the definition of the <u>nominal</u> <u>rate</u> <u>of</u> <u>return</u> <u>to</u> <u>net</u> <u>worth</u>:

$$RRNW = \frac{\Pi - \rho * K_1 - RI * BW + \frac{dP}{dt} * \bar{K}_1}{NW} = \underbrace{\frac{DIV}{NW}}_{\theta} \underbrace{- \frac{\frac{dBW}{dt}}{BW} * \frac{BW}{NW} + \frac{\frac{dA}{dt}}{A} * \frac{A}{NW}}_{\frac{dNW}{dt/NW}}$$

(θ is dividend pay out rate).

Furthermore follows:

$$RRNW = \underbrace{\frac{\Pi - \rho * K_1 - \frac{\frac{dP}{dt}}{P} * K_2}{A}}_{RRN} * \frac{A}{NW} - RI * \frac{BW}{NW} + \frac{\frac{dP}{dt}}{P} * \frac{P x \bar{K}_1}{NW} + \frac{\frac{dP}{dt}}{P} * \frac{K_2}{NW} = \theta + \frac{\frac{dNW}{dt}}{NW}$$

and

$$RRNW = RRN * (1 + \frac{BW}{NW}) - RI * \frac{BW}{NW} + \frac{\frac{dP}{dt}}{P} * (1 + \frac{BW}{NW}) = \theta + \frac{\frac{dW}{dt}}{W}$$

since $\frac{A}{NW} = 1 + \frac{BW}{NW} = 1 + \psi$

(ψ = leverage factor)

Thus:

$$RRNW = \frac{\frac{dNW}{dt}}{NW} + \psi = RRN + (RRN + \frac{dP/dt}{P} - RI) * \psi + \frac{dP/dt}{P}$$

But:

$$RRN = \underbrace{\frac{\Pi}{S}}_{M} * \frac{S}{A} - \rho * \frac{K_1}{A} - \frac{\frac{dP}{dt}}{P} * \frac{K_2}{A}$$

$$\therefore \frac{\frac{dNW}{dt}}{NW} + \theta = \underbrace{M * \frac{S}{A}}_{A} - \underbrace{\rho * \frac{K_1}{A}}_{B} + \underbrace{\frac{\frac{dP}{dt}}{P} * \frac{K_1}{A}}_{C} + \underbrace{(RRN - RI) * \psi}_{D}$$

QED

Gunnar Eliasson, November 1976

III. INVESTMENT-FINANCING - THE LONG RANGE PLANNING DECISION (sophisticated version, not yet in program)

1. Introduction

A useful way to delimit the concept of a firm is to view it as a financial system (Eliasson (1976, p. 242 f)). Such an approach has a rich operational content. The entity so delimited tends to coincide with something that is usually larger than the judicial firm unit, something closer to the sovereignty domain of a Corporate Headquarter. We are principally concerned with the character and location of the mechanisms that regulate in- and outflows of funds or rather what makes it possible for a financial system to retain its funds and to attract new funds. With this approach we have to model the very complex decision machinery that ties together all the production - distributing and financing activities that go on.

Complex decisions normally cannot be solved simultaneously. As a rule they have no unique solutions even at the application of infinite effort to screen all available information. Solutions are normally engineered by superimposing a separation grid on the organization that delegates decision making under a master constraint. One property of most decision systems, hence, is that sub-decisions as a rule are inconsistent when pieced together and based on different assumptions and information. The consequences of such illfitting machinery, however, are normally marginal in importance for the total organization, compared to the impact of other factors, or they are at least believed to be.

As argued in the preceding chapter one typical dividing line runs between the long run and the short run and separates operational production management, concerned with M in (1), from decisions on investment financing matters. In firms this demarcation line is very clear both in terms of organizational separation and methods of handling problems. In fact the investment financing problem represents the typical CHQ function while production decisions are delegated to operational departments and not integrated sideways and upwards. The business system in the model will have this typical feature built into it.

We have already introduced the master CHQ objective function and broken it down to match various organizational sub-departments. One such department is in charge of the long-term financing function vested with CHQ and oriented towards securing a sufficient and stable flow of long-term finance. This is allocation of resources <u>over</u> <u>time</u>. Not necessarily integrated with this function of course is the internal investment allocative (the "investment institute") function concerned with horizontal trade offs at each point in time. Should investment funds be channelled into division X or Y. Since we are for the time being only concerned with a one product firm, allocation is only over time.[1)] The investment financing sector also introduces the short term commercial banking function being concerned with short-term borrowing and investment activities (cash management).

Hence the investment financing block is built around the following four modules of behaviour:

I. Long term - 5 years:

Long-term profit target and growth plan generates 5 year external financing requirements (balance sheet - profitability criteria)

II. One year, long-term borrowing decision:

Long-term financing requirements from I, plus liquidity assessment and credit market appraisal manifest itself in next year long-term financing decision (final)

---

1) But this is where allocation between firm units has to enter, should we decide later to expand the model.

III. <u>Investment decision and cash management (quarter to quarter)</u>

IV. <u>Realization phase</u>:

The firm enters each period (quarter) with a financial frame allotted for investment. This budget frame is compared with the proposed investment plan. And a compromise solution follows. Excess liquidity is then invested at the short-term deposit rate and needed short-term borrowing is assumed to be available at the going interest rate.

II defines the actual liquidity position and it may seem surprising that the only leverage that the long term has on behaviour (in the model) is through this liquidity position. In fact this specification corresponds well with the typical practice to leave all investment decisions pending or subject to revision until the so called appropriations procedure, which is normally a quarterly or even more frequent affair. This specification corresponds well with typical firm practice of keeping as many hands free as long as possible rather than betting on a probable but not very likely future position (cf. Eliasson, (1976)).

We also have to recognize that we are working within an accounting framework model imitating CHQ planning. We have not modelled how long-term foresight affects R&D spending or the choice of investment projects etc. This is probably appropriate specification. CHQ screens projects or project groups from a budgetary point of view. It does not initiate projects or make technical choices. Neither have we modelled the bindings associated with large investment projects that cannot be stopped once started. This is a misspecification. However, for normal analysis at the macro level this will be of marginal importance since revisions in plans seldom will be larger than allowed by such bindings. In fact, when dramatic events take place even large ventures in progress may be halted.

2. Long term plans

An initial sales projection is entered from the expectations block. After application of simple sales-asset relationships a first, crude investment plan is obtained. This plan is fed through the production system. Assuming normal, operating (capacity utilization) rates, profit margins can be calculated and checked against targets. This procedure is somewhat backward compared to actual practice since investment plans, or rather requests, are normally prepared by operating departments on the basis of sales plans. It is quite possible to generate investment requirements directly out of the production system the way it is actually done, but considering the complexity of the production and investment financing system together it would be technically very awkward and hardly rewarding. We choose not to do so for the time being and the two approaches quite conceivably should give approximately the same results.

If M-targets are not satisfied, sales plans are reduced until satisfaction is reached (in (3.9.4)). Dividends to be paid out next year are now decided on.

In case we decide later on to split firms into a set of production units tied together with a CHQ financial function, this is the place where this function should be. A horizontal M trade off across production units then has to be added to what we already have.

Next follows a balance sheet check.

Maximum debt leverage on the balance sheet is currently calculated along the lines of a Donaldson (1961) type earnings coverage criterion. Financial risks are assumed to be proportional to expected, excess cash outflows divided by net worth, properly valued in current prices (called NW)[1]. Maximum leverage is then assumed to be a (linear) function of the nominal rate of return minus interest cost and calculated risk. We thus arrive at the MAX Ψ factor in (4) which is formally derived in a supplement at the end of the chapter.

Borrowing associated with the long-term growth plan derived earlier (in (3.9.4)) is now checked against the MAX ψ criterion (in 7.1). Borrowing and sales growth are reduced (if necessary) until a state of satisfaction is attained. We now have the long-term plan.

We can now calculate (in 17) total external finance needed to clear the long-term growth plan finally established.

3. The one year, long-term borrowing decision

External finance, expected to be needed, is now desired to be of a long-term quality. How much of needed external funds for the next long-term period (from now to H) that should be borrowed long-term next year depends on the current credit

---

1) NOTE, however, that NW is not market valued. Expected, future profits should not affect the valuation! NW is residually calculated in a balance sheet where assets are valued at replacement costs. See table III:C.

market situation. (Note that the profit side of the long-term growth plan has already been checked and cleared in the previous step.)

We simply assume how much of expected long-term funds to be acquired next year to be determined by the current difference between the long-term and the short-term borrowing rate (11.1). If this formula gives less long-term borrowing next year than the needed total for the year the difference is made up for by short-term borrowing up to planned requirements.

External funds are now acquired and added to LIQ. For the time being we simply spread the new cash evenly over the year.

There is one aberration from this straight forward procedure that has not been modelled yet. It involves an interface with targeting (annual targeting, quarterly targeting or even quarterly target enforcement). (See 15). Since this block already has got two full search processes there is no hurry adding this third complication. In fact there will be a device that allows us to shut off one, two or all three complications in experiments where their presence is not important.

The added device is a target modifier that allows two responses. First, a deliberate internal, cyclical stabilizing of production should be allowed for, through production for inventories, the hoarding of labour and a contracyclical timing of investments. This means absorbing more of the cyclical variation internally by accepting larger cyclical swings in profits. A higher average (long term) profit level should be an expected consequence and the liquidity position plays a crucial role for the financial capacity to take the higher short-term risks.

Second, unforeseen events or strong cyclical swings in profits cannot reasonably mean that average "feed back" profit targets are rigidly maintained each quarter. Here again the size of the liquidity buffer can be substituted for a deliberate cyclical timing of targets.

4. The investment decision

The first step in the investment decision process occurs in the form of a calculated investment budget constraint. This budget constraint is contingent upon expected cash inflows less outflows and the allowed change in LIQ.

Second, current capital categories are regarded as mandatory investment both in the plan and in the actual realization of plans. In order to sell, firms have to follow market practice in trade credit extensions. Hence CHK2(OTHER) in Table III:C depends more or less directly on CHS. Liquidity (LIQ) is a prime concern in financial risk management and provision for a LIQ buffer takes priority over investment. The same holds for purchasing and intermediate stockbuilding needed to keep production and sales going. A problem arises when we want to introduce speculative stock accumulation and decumulation for raw materials and intermediate goods (chapter VIII). We believe it to be realistic to assume that the expected capital gains involved are so large as to make such stockbuilding take priority over INV. Hence the calculated investment budget constraint (INVF in 17.3) has to be reduced by the cash requirements from such extra stock accumulation.

Third (17.2), next period (quarter) planned or desired investment spending from the long range plan is entered, the smallest of planned investment and the revised budget frame constitutes the final investment decision for the period[1]. This is a final decision and QINV so determined enters capital goods markets next period (quarter) as final money demand.

---

1) Even though in reality it is not. See Eliasson (1976, p. 128ff).

We believe that a better alternative specification would be to have the quarterly investment plan derived from the long-run plan, first adjusted downward for the presence of excess, unused capacity on the equipment side. The specification of such an alternative has been entered in the pseudocode as (17.4).

With the specifications now entered in the investment financing block we have made the size of the firm entity dependent upon its internal generation of cash flows (read profitability) and its willingness to acquire new external funds.

This willingness in turn depends on expected long-term profitability over and above the cost for external finance (the rate of interest) after consideration of financial risks. Long-term expected profitability in turn, again, depends on the expected productivity properties of new investment and how this higher quality investment combines with the existing production system and expected prices and wages.

Short-term disturbances (mistaken and revised expectations) affect the rate with which this growth plan is realized.

There is always the possibility that returns to pure financial investments may be so high as to make it more profitable for the firm unit to invest its internal cash flow outside itself. This alternative is only allowed in the model - as it is now specified - as a reduction in its propensity to borrow long-term (which may become negative) and indirectly in so far as a bad profit performance may mean a deteriorating cash position and a need to keep more liquidity invested short-term in the credit market.

We have not tried to model the typical feature of large business firms to transform themselves gradually into investment companies and commercial banks as well as being master planners of a set of production and distribution units (see Eliasson (1976, Ch VII)).

One would perhaps like to see the choice between internal plow-backs of profits versus investing them in the credit market at higher returns (for some companies) explicit in the model. I suggest, however, that we leave out that alternative for the time being. The reason is that firms simply do not plan their operations that way. One of the reasons for this seemingly unrational behaviour probably is the corporate taxation system. A reduction in internal profitability requirements (compared with direct financial investments) is normally associated with tax systems in industrial countries due to the tax leakage that occurs when funds are distributed as dividends. Furthermore, fiscal depreciation allowances that are faster than economically motivated exercise the same cash containing influence on firm management as well as stock owners, who prefer to get their money back as capital gains (from successful investments) in share prices that are taxed at a lower capital gains rate.

Financing accounts and nomenclature

Table III:A Profit and loss statement

Sales ($S = P * \bar{S}$) - Purchases[1] (PZ * Z) - Wages and Salaries (W * L)	X
= Operating Profits (M * S) + Interest Income (RI1xLIQ)	+ Interest charges (RI2*BW) + Depreciation charges (RHO*K1) + Net profits
= Gross profits + Capital Gains a) Inventories (realized) b) Inventories (not realized) c) Other equipment etc (= K1 * DP(DUR)) TOTAL PROFITS	= Gross profits + Capital Gains = TOTAL PROFITS

---

1) When more than one input category is involved we interpret (PZ*Z) as a vector product.

Table III:B Cash flows

Inflows	Outflows
Gross profits (M*S + RIS1*LIQ)	a) Interest (RI*BW) b) Amortization (RAM*BW) c) Dividends (DIV)
New Borrowing (CHBW + RAM*BW(LAG) (Equity Financing)	d) Taxes (T) e) Change in inventories net of unrealized capital gains f) Change in liquidity (CHLIQ) g) Change in accounts receivable etc h) INV
TOTAL INFLOWS	= TOTAL OUTFLOWS

Table III:C Balance sheet

Assets	Liabilities
MACHINERY ETC (K1) INVENTORIES (K2(STOV)=K21) CASH etc (K2(LIQ)=K22) OTHER (K2(OTHER)=K23) *)	Long-term borrowing (BWL) Short-term borrowing (BWS) Net worth (NW) (a) in official balance sheet (b) tax credit (potential tax) (c) net of potential tax but tucked away.
Total assets (A)	= A

*) Mainly trade credit extensions.

D. Updating of balance sheet

(D1) K1:=K1(1+DP(DUR)-RHO)+INV

(D2) K2=STOV+LIQ+OTHER=K21+K22+K23

(D3) K1+K2=A

(D4) K2:=K2+CHSTOV+CHLIQ+CHOTHER

(D5) CHOTHER= $\underbrace{\frac{1-\beta}{\alpha}}_{=\gamma}$ * CHS (trade credit extensions net)

(D6) α=S/A

(D7) β=K1/A $\because$(1-β)=K2/A and K2 = $\frac{1-\beta}{\alpha}$ * S

<u>Note</u>: α and β may vary over time. Since all account tables III:A, B, C will be updated each period, past period α and β can always be calculated and used for next period projections. This seems to be a practice often followed in firm internal planning although at a much more detailed level. See Eliasson (1976, CH. 6.1.).

(D8) CHSTOV:=DP*STOVF+CHSTOF*P
+DPZ*STOVZ+CHSTOZ*PZ

<u>Note</u>: STO stands for <u>volume</u> of inventories (See Block X)

STOV stands for <u>value</u> of inventories (STO * price index)

F stands for <u>finished goods</u>

Z for all intermediate goods (purchases)

(Cf. Chapter VIII. Note the variation in nomenclature.)

(D9) CHLIQ=M*S+RIS*LIQ-INV-
- γ*CHS-CHSTOF*P
-CHSTOZ*PZ-RI*BW-DIV+CHBW
(cash flow identity)

(D10) CHBW:=INV+CHLIQ+CHSTOF*P+CHSTOZ*PZ+$\frac{1-\beta}{\alpha}$*CHS+RI*BW+DIV
-M*S-RIS1xLIQ
(cash flow identity. Same as D9.)

(D11) Updating of INVEFF to be used in Block 4 (4.1.3) to update production possibility frontier:
INVEFF:=S/K1

SUPPLEMENT A:

TECHNICAL SPECIFICATION OF INVESTMENT-FINANCING BLOCK (Sophisticated version, not yet in pseudo code or program)

1.1 EXPL(DS):= γ * EXPL(DS) + (1- γ) * DS (from EXP block)

1.2 DA:= DS

1.3 DK1:= DA

2. INV/K1 := DK1-DP(DUR) + RHO (Definition)

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

3.2 Enter EXPLDP(DUR) from EXP block and RHO from block 4 (exogenous)

3.3 Calculate INV year by year to H from (2).
Note: We choose to obtain the "trial" INV paths this way rather than feeding the preliminary EXPL(DS) etc into the production block to derive (indirectly) investment requirements. Cf. discussion in text on calculation of INV from balance sheet rather than through production system.

3.4 Enter QFR(L) with last period L from (4.01)
Enter NU = normal expected long-term capacity utilization rate[1)]

---

1) Either by assumption or average of past, say, 5 years.

Calculate NU*QFR(L)
Assume no change in L and that DTEC=DQTOP

3.5 Enter INV from 3.3
Quarterlize INV. Deflate by EXPLDP(DUR).
Enter in (4.1.3)
Calculate DQTOP1 each year to H

3.6.1 D(NU*QFR(L)):=DQTOP1

3.6.2 Calculate
NU*QFR(L) on Horizon year (L same as now)

3.7 On H
M:= (EXPLP*NU*QFR(L) - EXPLW*L)/(EXPLP*NU*QFR(L))
(Same formula as (3) in Chapter II).

3.8 Compare M with TARGLM from Block 1
Check for SAT
Note: If we decide later to split the firm into a set of production units held together by a financial function, this is the place to do it

3.9.1 If SAT go to (3.9.4)

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

4.1 EXPRIL:=EXOGENOUS
EXPRIS:=EXOGENOUS

4.2 enter EXPLDS from (1.1) (or final value), EXPLDP(DUR) from (3.2) and M from (3.7) in (4) to obtain MAX ψ.

4.3 Calculate

MAX ψ :=

$$:= \frac{A*((1+RISCO)*M*\alpha-(RHO*\beta+RI-DPDUR)-RISCO*(1-\beta)*DS)+B}{(1+A*RISCO*(1+RAM+(1-\beta)*DS-\alpha*M)}$$

(See derivation in supplement B.)

(5. Enter business cycle in S and calculate consequences for M and INV in H year plan.

Note: Rate of capacity utilization has to enter as determinant of quarter to quarter INV)

5.1 Calculate CHDLIQ:=LIQD-LIQ from (13)

5.2 Calculate for next year:

$$CHBW := (INV+\frac{1-\beta}{\alpha}*CHS+RI*BW(LAG)-M*S+DIV+CHDLIQ)/(1-RI)$$

5.3 and then for following years making CHDLIQ:=CHLIQ

5.4 DIV := θ*NW(LAG)

θ:= EXOGENOUS.

Note: that LAG refers to the previous year. DIV adds up with total income in household sector.

6.1 Calculate

$$NW := \frac{1}{\theta}*(M*S-INV-\frac{1-\beta}{\alpha}*CHS-RI*BW(LAG)-CHBW*(1-RI))$$

Note: Formula (6.1) is identical to (5.2) except that NW has been lagged one period reflecting the fact that dividends are normally calculated on profits realized some period before. When NW is measured for the current period (5.2) is a book identity and in (6) we have simply solved for NW

6.2 Calculate

BW:= BW + CHBW

6.3 Calculate

ψ = BW/NW

7.1 CHECK for $\psi \leq$ MAX ψ each year

(Alternative Check for (7.1) only year H).

IF SAT go to (10)

IF NON SAT take away as much net borrowing as needed (no more) to satisfy ψ-target each year

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

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

$$\left\{\begin{array}{l}\text{Reduction (in percentage}\\ \text{points) of planned long}\\ \text{term annual growth rate}\\ \text{in S}^{1)}\end{array}\right\} := Y = \left(\frac{X(I-RI)}{S(LAG)}\right)$$

7.4 Reduce INV/K1 by:

$$\left\{\begin{array}{l}\text{Reduction in investment}\\ \text{Value planned per year}\end{array}\right\} := \frac{\beta}{\alpha} * Y * S(LAG)$$

7.5 CHBW: = CHBW - X for each year

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

---

1) (7.3) and (7.4) are derived from (5.2). When CHBW is reduced as in (7) only INV and CHS are affected. Since CHK1= β/α * CHS we obtain (7.3). To obtain (7.4) we use (2). A reduction in CHS leaves DP(DUR) and RHO unchanged. Hence (7.4).

8. We now have the long-term (H-year) plan + annual budget (by quarter):
INV from (7.4) and (2)
K1 dito
DS from (7.3)
DA from (1.2)
DBW from (7.5) and so on.
Quarterlize INV as in (3.5) and whatever else that is needed by quarter.

(9. (Tentative). Enter business cycle in long term S by applying the factor CYCLE in (10) in chapter II.
Calculate consequences for M and INV and LIQ (see later) in H-year plan. We then have to enter the rate of capacity utilization as determinant of quarter to quarter INV)

One year, long-term borrowing decision

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

11.1 Calculate long-term borrowing for year immediately ahead as:

$$CHBWL: = \frac{Y}{H} \left(1 + \gamma * \frac{(RIS - RIL)}{RIL}\right)$$

<u>Note</u>: There is the possibility of making RIL firm-local and dependent upon firm ψ. RIS is short-term interest rate and RIL long-term interest rate.

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

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

<u>Note</u>: For the time being we use this simple device.

13. Calculate desired LIQ as:

$$\text{LIQD} = F(S, \begin{matrix}\text{expected excess} \\ \text{cash outflow}\end{matrix})$$

<u>Note</u>: Say, a linear relation. Excess cash outflow is defined as in the following supplement B, but for next year only.

14. Calculate expected LIQE from (12) and <u>expected cash outflow</u>

$$\frac{\text{LIQE} - \text{LIQD}}{\text{LIQD}}$$

defines the firm's short-term (next

year) liquidity status as seen from within the firm.

(15.) Short-term target modifier

$\frac{\text{LIQE - LIQE}}{\text{LIQD}}$

and/or $\frac{\text{LIQ - LIQD}}{\text{LIQD}}$ (per quarter)

determines the extent to which short-term operations M-targets are temporarily modified downwards because of unexpected or excessively strong profit influences.

Such modifications also relate to specific decisions:

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

Note: This tentative device is inserted to handle real life mechanisms. Firm management (I) may want to behave rationally in the long run but dares not because of a perilous LIQ position. (II) It may be rational to take drastic action but social and other considerations suggest otherwise. Hence, we have to make a distinction between firms that deviate upwards and downwards from a normal or average M-trend. I consider this device empirically important.

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

Investment decision

17.1 Investment finance allocated next quarter (final decision):

INVF: = M*QPLANS-$\frac{1-\beta}{\alpha}$*QPLANCHS-(I+RAM)*BW-DIV-CHLIQD

Quarterlize INVF to QINVF.

17.2 QPLANS is obtained from (4.3.10) in PROD planning block as:
QPLANS: = QEXPP * (QPLANQ - OPTSTO + STO)

(17.3 Calculate from chapter VI planned intermediary inventory build up over and above quarter planned use. Call this CHTESS.)

17.4 Enter QINV from (8).
QINV: = MIN (QINV, QINVF-QCHTESS)
Final decision. Repeat every quarter.

17.5 Alternative:
QINV: = MIN(QINV1, QINV2, QINVF-QCHTESS)
QINV1 = QINV2 = QINV in (8)
under normal circumstances. However, when the rate of capacity utilization goes down below a certain level, then QINV2 < QINV1.

Define $(1 - \frac{QQ}{QQTOP})/NU = X$

and $\frac{QINV2}{QINV1} = Y$

NU is entered from (3.4)

For $0 < X \leqslant 1$ $\quad Y = 1$

For $X > 1$ $\quad Y = \frac{1}{X} < 1$

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

19. QINV from (17.4) enters as final money demand in capital goods markets. (Next period).
Market DP(DUR) determines volume QINV that updates production system.

20.1 Residual LIQ invested currently (each quarter) at (RIS - XI).
XI: = Exogenous (difference between short-term borrowing and deposit rate and equal to profit margin in banking system).

SUPPLEMENT B:

DERIVATION OF THE MAXIMUM GEARING RATIO

The global objective function of the corporation has been defined in formulae (1) in chapter II as:

$$GOAL=DNW+\theta-DDEFL=(1+\psi)*(M*\alpha-RHO*\beta+DPDUR*\beta)-RI*\psi-DDEFL \quad (1)$$

ψ = BW/NW = gearing ratio or leverage

θ = DIV/NW = dividend pay out rate

DEFL = chosen general price deflator e.g. CPI

BW + NW = A

α = S/A

β = K1/A

K1+K2 = A

Thus (1-)=K2/A and K2 = $\frac{1-\beta}{\alpha} * S$

Define nominal (money) return to A as:

$$RRN = M*\alpha - RHO*\beta + DPDUR*\beta \quad (2)$$

Define the risk rate associated with borrowing (as assessed by the firm) as:

$$RISK=RISCO* \frac{\text{EXPECTED EXCESS CASH OUTFLOW}}{NW}$$

or more precisely[1]:

---

[1] The factor RISCO may be entered as a constant or be represented by the past variation in, say, M*S/NW. In the second version it can be updated currently.

$$RISK=RISCOx\ \frac{(RI+RAM)*BW+K2*CHS/S-M*S}{NW}$$

RISK is defined to be comparable to RRN or RI.

RAM = rate of amortization on BW.

We know that

$$\frac{K2}{S} * CHS*\frac{1}{NW}=(1-\beta)*(1+\frac{BW}{NW})*DS=(1-\beta) * (1-\gamma)*DS \quad (3)$$

Thus:

$$RISK=RISCO*(\psi*(RI+RAM+(1-\beta)*DS-\alpha*M)+(1-\beta)*DS-\alpha*M) \quad (3B)$$

<u>Assume</u>:

$$MAX\ \psi = A*(RRN-RI-RISK)+B \quad (4)$$

Then from (2) and (3B):

$$MAX\psi=(1-A*RISCO*(RI+RAM+(1-\beta)*DS-\alpha*M))=$$

$$=A*((1+RISCO)*M*\alpha-(RHO*\beta+RI-DPDUR)-RISCO*(1-\beta)*DS)+B \quad (5)$$

(5) is (4) in pseudo code on previous pages. QED.

SUPPLEMENT C:

PROVISIONAL INVESTMENT FINANCING SECTOR
(now in program as block 10)

This provisional I-F sector is designed to be used in a "slimmed" version of the model. The investment function that updates the production system is of a simple cashflow type[1]:

$$INV = M * S - RW * CHS + CHBW - RI \times BW \qquad (1)$$

Investment is assumed to be equal to current (profit) cash inflow (M * S), plus net inflow of borrowed funds (CHBW), less mandatory financing of current assets (RW * CHS) and interest payments (RI x BW). The assumed mandatory claim on financial resources from short-term trade assets is assumed to be proportional (RW) to the change in sales value (CHS) which is a rough but nevertheless reasonable approximation[2].

---

1) It is also a simplified version of my "capital budgeting theory of investment". See p. 31ff in The Credit Market, Investment Planning and Monetary Theory, Uppsala 1969.

2) RW is in the neighbourhood of -0.3 and has been fairly stable over time. See Eliasson op. cit. p. 57.

INV is determined end of each quarter by the data set of the same quarter. It affects the production system the next quarter.

Determination of the rate of borrowing (CHBW)

The borrowing decision is assumed to originate in a trade-off between the nominal expected return on total assets (RRN) and the rate of interest (RI). By definition:

K1 + working capital stock = NW + BW (2)

K1 = The "value" of production equipment

NW = net worth of firm, residually estimated from balance sheet, where all assets are valued at reproduction costs.

Define the stock of current assets as[1]:

$$K2 = RW * S \tag{3}$$

and total assets (see table) as:

$$A = K1 + K2 = BW + NW \tag{4}$$

Define the real rate of return on total assets (RR) as:

$$RR = \frac{M * S - RHO * (1 + DP) * K1}{A} \tag{5}$$

---

1) Note that we deliberately misspecify here, since K2 includes finished goods inventories.

RHO = rate of depreciation on production equipment. Same rate as in production system.

DP(DUR) = rate of change in capital goods price index. Endogenously determined elsewhere in model.

By definition also:

K1:= K1 * (1 - RHO + DP) + INV * (1 - RHO) (6)

Assume that the rate of net borrowing is linearly dependent on the difference between the nominal return to total assets (RRN = RR + DP) and the nominal interest rate (long term).

Thus:

DBW = ALFA + BETA * (RR + DP - RI) (7)

ALFA > 0

BETA > 0

RI(LONG) = Long-term interest rate.

And so:

INV=M*S-RW*CHS-RIxBW+(ALFA+BETA*(RR+DP-RI))*BW	(8)

(8) is assumed to apply each quarter. Updating of K1 is by (6) and working capital stock and BW by the generating formulae (3) and (7). We can then generate a rough balance sheet of each firm each quarter and calculate NW residually as indicated:

Assets	Debt
K1 K2	NW (residually determined) BW
A = SUM =	= SUM = A

Gunnar Eliasson, November 1976

IV. PRODUCTION PLANNING AND LABOUR DEMAND

1. Introduction

This model block describes the firm production system and the choice sequences that finally lead to a preliminary production plan and a labour recruitment plan.

The production system of the firm is assumed to be fully described by four sets of data:

1) A function determining maximum possible output each period for each level of employment, the "production possibility frontier", if one so likes (potential).

2) A function that determines how this function shifts in response to investment (time change).

3) A set of measures of the distance between actual production and maximum possible production (position).

4) A description of HOW the firm approaches or retreats from the production possibility frontier within each period. (Search.)

The production possibility frontier QFR(L) is described by instructions (1) below as a function of labour input[1].

Analytically it is very similar to a conventional production function, except that we do not allow aggregate capital stock volume or a corresponding capital services measure to enter. Rather, a vector of performance coefficients has been substituted for capital. Together with the level of output, called Q, this vector determines productivity each period. The distance between actual production and what is technically feasible, under various conditions, is determined endogenously in the model. We call this "search for profit target satisfaction" within the production system. This search process makes average firm productivity endogenous. It is technically rather involved and is specified by the set of instructions (4.3) in the pseudocode.

The production possibility frontier is gradually shifted from period to period due to investment spending. Investment spending is determined in the long-term investment financing

---

1) We have not yet settled for a definite reference system. Consequetive numbers refer to equations in this chapter. More complex numbers with a 4 and a dot and one or more figures refer directly into the pseudocode.

section (chapter III). New investment is characterized by higher performance (productivity) rates (called MTEC) than average potential productivity (TEC). New investment affects (potential) productivity in proportion to new potential capacity added, net of depreciation. MTEC is entered exogenously by assumption.

The shifting of the production possibility frontier each quarter is described in instruction set (4.1) in pseudo-code.

It is partly a semantic, partly a real question whether we have "disembodied" or "embodied" technological change in our specifications. The breaking in of a production system (read a factory) is usually a long winding thing that takes years. Part of this postponed productivity growth source we pick up by the creation of slack that is later activated (see below) - but not all. We also know that strategic investments or reorganizations (not necessarily involving the spending of large sums) often boosts overall productivity substantially. The model - as it stands - is not capable of telling how this takes place. New technologies are mixed with old and stirred well. The outcome is a shift in the average (Q, L) curve called QFR(L) in the diagrams and MTEC can of course always be manipulated exogenously so that we get the (Q, L) numbers right. We plan later to introduce a distinction between capacity augmenting and productivity augmenting investments. Perhaps the embodiness problem can be better handled then.

Two resource utilization rates are introduced; one that measures the potential increase in production due to an increase in the utilization of unused but "employed" labour (step 1 to 2 in diagram IV:1) and one that measures the extent of unused equipment capacity on top of unused labour by a conventional definition (step 2' to 3'). The two utilization rates added (the distance 1' to 3') correspond to a conventional rate of (equipment) capacity utilization measure, expressed, however, in terms of added output.

To operate the model, positional start up data on these utilization rates are needed. Such data for the 250 largest Swedish firms were collected for the first time in the 1975 planning survey of the Federation of Swedish Industries[1)].

During simulations the utilization rates are endogenously determined and updated from quarter to quarter by changing production plans (search) and investment as described by diagrams IV:2-4.

An extra feature has been added to the production system, namely the possibility to activate "structural" or "reserve slack" (read

---

1) Virin op.cit. 1976.

productivity) called RES in diagrams, when particular management pressure is exercised. This occurs when firms have difficulties in satisfying their profit targets. A necessary complement to this feature is to explain how such reserve slack accumulates within the firm. This accumulation is part of the investment process in so far as that we assume that part of the productivity potential of new investment is not made full use of. "Wasted" productivity is potentially there in the form of a reserve, but up to a limit, above which it becomes true waste for good. Firms that are successful for a long time and never have to resort to slack activation, hence, tend to accumulate slack in the production system and waste potential productivity. On the other hand competitive pressure and frequent target non-satisfaction tend to keep this waste at a minimum and RES below the maximum allowed. This, however, does not necessarily have to be a healthy thing in the long run, since investment spending may be affected negatively. Thus the model contains a continuous balancing of the benefits from competition in terms of static productivity increases and the benefits of profitability in terms of happy firm managers that invest optimistically for future growth.

The presence of various forms of slack within (firm) organizations has been assumed in much theorizing during the last two decades (Simon, March, etc) and strong evidence on its presence in a quite well defined sense can be presented (Eliasson (1976)). This only codifies the principle that when organizations are having an easy time the efficiency in utilization of resources gradually decreases and/or facilities and functions, not necessary for or even injurious to current operations, are instituted - and vice versa when the firm is experiencing difficulties.

Both resource utilization rates and "reserve slack" are what we have called slack variables that are activated according to a predetermined sequence as the firm plans to increase its level of production each period. Unused labour capacity is first put to use. Further increases require the hiring of additional labour to man unused equipment capacity. Additional increases in output in the short run (each quarter) means crowding of production facilities and/or putting relatively low performance equipment into production and, hence, lower returns in terms of output.

2. Production possibility frontier

Somewhat simplified (cf. specifications Block (4.0.1) in pseudocode) the production function or production frontier (QFR) has the following specification:

$$QFR=(1-RES)*QTOP*(1-e^{-\gamma*L}) \qquad (1)$$

This is the static (each period) $\{Q, L\}$ relationship. No capital stock measure is needed. Investment affects the output potential through updating of QTOP and γ (see below). QTOP represents maximum possible output at the application of infinite labour and the activation of the entire slack potential called RES.

The functional form of QFR (shown in Diagram IV.1) has the conventional mathematical property of declining marginal output when expanding labour input along the curve. Furthermore:

$$\frac{dQFR(L)}{dL} = (1-RES) \times QTOP * \gamma * e^{-\gamma*L} \qquad (1B)$$

and:

$$\frac{dQFR(0)}{dL} = (1-RES) \times QTOP * \gamma \qquad (1C)$$

If we <u>define</u>:

$$TEC = \gamma * QTOP \qquad (1D)$$

we have:

$$\frac{dQFR(0)}{dL} = (1-RES) * TEC \qquad (1E)$$

and (1-RES)*TEC measures labour productivity of the last piece of equipment to go out of business as the firm contracts operations along QFR.

Expansion of output along QFR on the other hand clearly yields a declining marginal contribution for each additional input of labour and, hence, a declining average productivity QFR/L. This gives a desirable convexity to the production system. Performance (productivity, profit-margins) will improve as labour is discarded and better and better equipment (on the average) will be put to use as this contraction goes on.

Equipment is updated by investment (see below) from the origo end. The specification of QFR(L), hence, embodies both technology (productivity) vintages and the order by which these vintages are activated in and combined with L or taken out of production. As a consequence the decreasing marginal output of adding more people (L) to an existing production apparatus (we call it "crowding") is automatically taken care of. Since we feel no need or urge to study or explain how this combination takes place we can use this very convenient formulation.

Each period, each firm is described by its QFR(L) and its current operating status somewhere inside QFR(L), say, point 1 in Diagram IV:1. The vertical distance 1 to 2 measures redundant labour in terms of the potential increase in output the firm is capable of without adding to its labour force. The vertical distance 2 to 3 (to QTOP*(1-RES)) measures the maximum, ultimate extra increase in output that the firm is capable of by hiring additional labour but (NB!) without activating any slack. QTOP*(1-RES) is of course out of reach being by definition the asymptot towards which QFR converges when more L is applied. Distance 1 to 3 along the vertical scale can be said to define unused equipment capacity.

From 1975 estimates on 1 to 2 and 2 to 3' are collected from individual firms within the annual planning surveys of the Federation of Swedish Industries. In fact this research project has guided the formulation of the questions asked and the response rate has been surprisingly high considering the complexity of the questions[1].

The reason for the high response rate most probably is that questions have been phrased in a format that corresponds well to thinking and planning routines within large firms.

The question relating to the distance 1 to 2 is quite straight forward and need not be commented on, except, of course, that the questioning technique is new and the assessment of the quality of data will have to await further experience. To measure the distance from 2 to 3' is more complicated since QTOP*(1-RES) is by definition outside

---

1) 87 percent of the number of firms surveyed. See Virin: Industrins utveckling 1974-76 enligt Industriförbundets Planenkät, special study D. Industrikonjunkturen, spring 1976.

the economical operating range. Instead firms have been asked to estimate maximum, economical output under favourable business cycle conditions, say point 3'. Let us assume that they tell us the point where expected marginal value product equals the expected wage. We will not know and there is no need to[1]. Hence, the operating rate estimates we obtain for positioning of firms are rather 1' to 2' ($\equiv$ 1 to 2) and 2' to 3' along the vertical scale. We will call them A21 and A22 respectively.

Besides the positioning of firms within QFR these data (NB!) also provide what is needed to approximate the numerical form of QFR(L).

Since point 3' on the vertical scale is assumed to approximate (1-RES) QTOP in (1)[2] and since

---

1) i.e. where $EXP(P) * \frac{dQFR(L)}{dL} = EXP(W)$. Let us note, that if we believe in our EXP's as representative for firm EXP's this equation should hold if marginal conditions hold. The derivative is immediately available, since we have QFR specified.

2) Firms do not "recognize any Q" larger than Q in 3' as economical. Hence, there will be a kink in QFR that makes dQFR/dL = 0 beyond L in 3'.

$\{QFR(L), L\}$ in 2 is known from the survey, (1) can be solved numerically for γ. Knowledge of L in 3' can then be used to check whether firms have delivered consistent data[1]. I see no way of obtaining an estimate on RES (and hence QTOP) except by a priori assumption[2].

The whole idea about the reserve slack variable RES is that firms do not know themselves about its exact magnitude. CHQ applies top-down pressure when targets are not satisfied. CHQ knows that the reserve is there. Lower level management who knows HOW are forced to activate it. From this position, which is empirically sound (see Eliasson (1976 p 234-239)), we should not attempt any further direct measurement by questioning firms on RES for the very reason that they cannot provide better information than our guesses.

3. Updating QFR(L)

Updating of potential output change by a firm can be separated into two sets of instructions; (1) updating of QFR(L) and (2) updating of the positional description of the firm. Both steps take place each period (quarter).

---

1) In 1975 L data for the point 3 were not asked for.

2) After this positional assumption has been entered, however, RES is endogenously updated by the model. See instructions (4.1.3) through (4.1.6) in pseudo code.

Since capital stock does not enter the production system explicitly, the "coefficients" are updated instead by investment (INV). INV is determined separately as described in the Investment-Financing section in chapter III. New investment originates there each quarter and affects TEC, QTOP and RES. At the same time (or rather before) old equipment is depreciated by writing off potential output in a fashion that preserves the vintage and ordering combination described earlier.

First, old output capacity is written off at the rate RHO (see 4.1.2 in pseudo code) which (ceteris paribus and no new INV) bends the QFR(L) curve in Diagram IV:2 downwards. Second, new INV enters (4.1.3) with a new and superior productivity specification MTEC that is exogenously determined (see 4.1.1). The current investment value INV is transformed into current output value by the ratio between value added and replacement valued production capital (K1). This ratio is currently updated in INV-FIN section (chapter III). This is current procedure in firm planning routines. It allows firms, and us, to avoid to introduce the conspicious concept of a capital stock directly in the production context. Since the tranformation ratio, called INVEFF (see 4.1.3) is always there the replacement value of production equipment is implicitly there as well and can immediately be calculated[1], however, not the volume of capital stock, which is the concept we want to avoid.

The numerical estimation of INVEFF is somewhat arbitrary. For the time being we simply estimate the average ratio from balance sheet data and update the ratio from period to period. The nice thing, however, is that time will provide us with a more satisfactory set of data that links investment spending and our production function directly. From the planning Surveys of the Federation of Swedish Industries we will get a time series of the utilization rates A21 and A22 and investment spending INV for individual firms. This should allow us to estimate the relationships between INV and QTOP and γ change in (1) directly.

A fraction (called LOSS in (4.1.3)) of the new output potential added by investment is immediately sidestepped into the reserve slack (RES) potential that accumulates up to a maximum value (RESMAX in (4.1.2)). Beyond RESMAX the LOSS fraction evaporates and becomes waste (see 4.1.6). This determines the change in QTOP (in

---

1) It also enters each quarter in the balance sheet, table III:C in chapter III.

4.1.3) and MTEC now boosts TEC in proportion to new QTOP in (4.1.7)[1].

As for the change in position of the firm when passing the period line (N.B. NO decision on the part of the firm is involved) two things have to be considered. There is an automatic retirement rate which means a reduction in L i.e. less redundant labour and/or a movement along QFR towards origo. As described elsewhere the new delay lay-off rules in Sweden (called the Åman laws) are explicit in the model[2]. Period change means a reshuffling in this vector in the sense that redundant labour is either employed in production or comes closer to being actually fired. (See 4.1.0 and paragraph 6 in next chapter.) Note, however, that firing only takes place when profit-targeting requirements are not satisfied.

The absence of physical capital stock in the production system may cause both distrust and distress among some readers. It is possible that

---

1) Note that a harmonic average has been used.

2) Experiments can be run with and without these "laws". One set of such experiments are reported in Eliasson (1976 b).

we have made things more difficult for ourselves than is needed.

Literature offers a menu of stereotype devices to solve our specification problem through a production function, where aggregate production capital enters explicitly. We would prefer, however, to avoid this type of specification for two reasons. First, certain features, that I would like to see in the total model on the monetary side, most probably will not agree with the presence of a "physical" production function with aggregate capital explicit. Second, the programmatic approach already taken on the production side is both somewhat novel and more realistic and hence a more desirable specification, that we would like to retain. Besides we can very nicely bypass a perennial controversy in economics. At the same time we land in a new controversy, that, however, to us seems both more meaningful and capable of constructive results. We have to specify the production system numerically firm by firm. Even though we know that the information is available within each firm, it will be difficult to obtain these data by conventional econometric or other measurement techniques. The alternative and possible method will be to proceed by trial and error, to learn from experimenting with the model and checking against available statistics and to be content with the knowledge that we will never know the "truth" of the individual firm. In fact we will be in about the same position as corporate headquarters of a large firm which never controls the numerical structure of its production system, but manages it from a distance on the basis of approximate knowledge and pressure (see Eliasson (1976, p. 234)). This procedure is capable of model imitation, if paired by imagination.

4. Search for satisfying production plan

The firm is now in position to begin deciding on its production plan for the period. All the economic circumstances are now brought to bear on the production system. First firms transform their sales expectations from the EXP section into a preliminary production plan by adding or subtracting a desired change in stock-building:

$$PLAN(Q): = \frac{EXP(S)}{EXP(P)} + \frac{(OPTSTO-STO)}{TMSTO} \qquad (2)$$

The provisional production plan equals the expected sales volume[1] plus a fraction (TMSTO) of the difference between optimum and actual inventory volumes. TMSTO = 1 means that firms plan to close this gap each period.

---

[1] Note that (2) presumes that no raw materials or semimanufactured goods enter production. This is so in the present version of the model program. See however chapter 6.

A complicated search process begins within the production system that is repeated each period (quarter) for each firm. The production system has a specification which means that the firm will follow a particular search sequence that is determined by (1) expectations (2) initial position within QFR(L) and (3) the numerical specification of QFR(L) and TARGM. Search takes place along "segments" that are either curved or linear.

Two devices will be used; one economic called SAT that terminates search and one technical SOLVE that determines the new position of the firm at a (Q, L) point, where the profit target is satisfied. At a target satisfaction (SAT) point the following should hold:

$$1-\frac{PLANL*EXPW}{QFR(PLANL)*EXPP} \geqslant TARGM \qquad (3A)$$

and the L-point is obtained by inverting (1);

$$PLAN(L) = RFQ(Q) = \frac{QTOP}{TEC} * \ln \left\{\frac{(1-RES)*QTOP}{(1-RES)*QTOP-Q}\right\} \qquad (3B)$$

Specification is such that search will normally terminate <u>within</u> one "segment" or "path", not in a corner. This is why we need SOLVE[1].

---

[1] SOLVE only has to be activated when SAT is reached along a non-linear segment of the recognized output limits. It gives an approximate numerical solution using the Newton Raphson method. See (4.3.12) in pseudo code.

SAT is a criterion that determines when profit targets (TARG M, see chapter II) have been met to satisfaction. This search procedure is run through for each firm each period.

a) Expansion within pool of redundant labour

The initial sales estimate for the next period arrived at is found not to require any hiring of new labour. Since there is a steady "natural" retirement this means an actual decrease in employment (4.3.0). Cost calculations on the basis of expected wages and prices, however, show that profit targets are not satisfied. The firm knows by experience or is assumed to believe that production and sales can always be stepped up somewhat to improve profits. This is a rational step to take if there is spare product storage capacity available. Hence the firm tries an increase in production not higher than:

$$X:=MIN(QFR(L), \frac{EXP(S)}{EXP(P)} + MAXSTO - STO) \qquad (4)$$

It stops as soon as target satisfaction is reached (if it is) along the path A to B in diagram IV:3 (A is the initial position). If SAT is not attained, then a lower employment level is checked until SAT within the limits prescribed by the AMAN Laws ((4.3.3), path B to C in diagram IV:3 and (4.3.10). See further next chapter.)

If this does not help, the firm begins to cut down both production and labour along path CD along the production possibility frontier. When target SAT is reached SOLVE[1] for the corresponding production plan.

If target SAT is still out of sight when SEARCH is down at a production plan at D below the initial production level at A middle management begins to sense the first signs of a crisis situation. Normal operating practise does not help to solve the profit problem. Plans to reorganize production, cut out some activities, get rid of redundant staff etc are activated from top down and the fraction of the slack reserve (RES), that can be activated at short notice is put to use, meaning that productivity can be improved by getting rid of people <u>without lowering the level</u> of production (path D to E). Slack activation stops as soon as targets are satisfied (4.3.7)[2].

If SAT is still not reached even when the immediate productivity reserve has been used in full firm management recognizes a crisis situation and begins to discontinue production lines

---

1) Path CD is a non-linear segment and the Newton Raphson method has to be used to solve for QPLAN.

2) Note, however, that the AMAN Laws may constitute a legal impediment to the attainment of SAT until after a 6 month delay.

and contract operations along $(\frac{1+RESDOWN}{1-RES})*QFR$ from E towards the origin. The convexity of the production possibility curve should normally guarantee a solution with target satisfaction before zero, with some production lines in operation.

We should note here again that the labour market laws represented by the AMAN vector (as long as they are called in) are always obeyed until just before the origin, or bankruptcy. Furthermore the strength by which search is pushed all the way through ABCDE and finally to the origin depends on (1) the toughness of profit targets and (2) on top management willingness to relax targets temporarily. For the time being we do not have the possibility to relax targets in the program, although the principles for temporary target relaxation have been discussed in the investment financing chapter. We expect this willingness to depend on the current financial situation, although we know that attitudes on this point differ substantially between firms[1)]. Preliminary experimentation with the model has demonstrated that the firmness with which this target device is exercised is imperative for the behaviour of

---

1) e.g. between U.S. and European firms. See Eliasson (1976).

the whole economic system. This is a desirable property, since the presence of target devices of the kind specified in firm life is now quite well documented (Eliasson (1976)).

b) Expansion beyond present pool of labour

If initial sales expectations are expansive to the extent that additional labour is needed we are at a point A on QFR somewhere beyond B in Diagram IV:4. The first step is to check whether this is an overoptimistic expectation in terms of profits (4.3.5). If OK this is the plan. If not, convexity of QFR and the margin requirement[1)] make us move left towards B. If profit satisfaction is reached before B this is the plan. If not, the whole thing was a mistake and we begin discarding redundant cost items. Since we are already on QFR and have tried the data there the next step is activation of slack (4.3.7) from B to C and then - if this does not help - contraction begins from C in the direction of the origin in Diagram IV:4.

---

1) N.B. we are here in direct formal conflict with the profit maximization rule. If the initial Q plan happens to be at a point where $EXP(P) * \frac{dQFR}{dL} > EXP(W)$ we should move north to increase profits. Now we are moving down, decreasing profits but increasing profit margins.

The difference between the search procedures activated from two different expectational positions illustrates the dominating importance of the hierarchical ordering of the decision machinery over mere numerical specification. Here numerical specification of the entire production system is identical in the two cases. However, differences in initial position and attitudes start up different search sequences that follow different paths and yield different results if not brought to the very end (nullification in the origin). In this case expansionary initial plans means that the firm passes over less beneficial-stopping points below QFR. The only question that remains is whether this difference is an empirically relevant one. The question posed is both operational and testable and it is probably - lacking the empirical information for the time being - quite sound. Expansionary expectations can be expected in rapidly expanding firms. This property is already embedded in our expectations functions. Also targets are determined on the basis of the past. If satisfaction is not reached on path AB in Diagram IV:4 there is no reason for firm management to search for an even less satisfactory solution below QFR. Hence, strong expansion in the past breeds expansionary expectations and contributes to better productivity performance by making firm management more aware of the potential, than would otherwise have been the case. It should be noted, though, that set-backs in profit performance through competition or the business cycle may break this beneficial attitude. In the model this happens through a gradual (feed back) deterioration of expectations and targets.

c) The preliminary operating plan

Once a SAT point has been found this is also the preliminary operating plan. The steps taken are illustrated in Diagram IV:5. First, when passing the period limit, investment updates QFR, that shifts, normally outward. Second, normal retirement etc shifts the initial position of the firm left to a new initial position. When the search process has been completed the new production plan PLANQ has been found. Preliminary labour demand is obtained by solving the inverse of (1) for L and subtracting the existing labour force:

PLAN(CHL): = PLAN(L)-L (5)

The firm is now positioned to adjust its labour force to correspond to its production plan. If this adjustment can take place, then PLANQ = Q.

PLAN(CHL) may be negative and labour is put on file for lay offs in the AMAN vectors that describe the lay off delay required in present Swedish legislation[1].

Otherwise two things can happen that disturb the preliminary plan. The firm may be raided by other firms and loose people or it may look for people (including raiding other firms) in vain. This is described in the next section.

---

1) An experimental analysis on the model of this labour market device is found in Eliasson (1976 b).

DIAGRAM IV:1

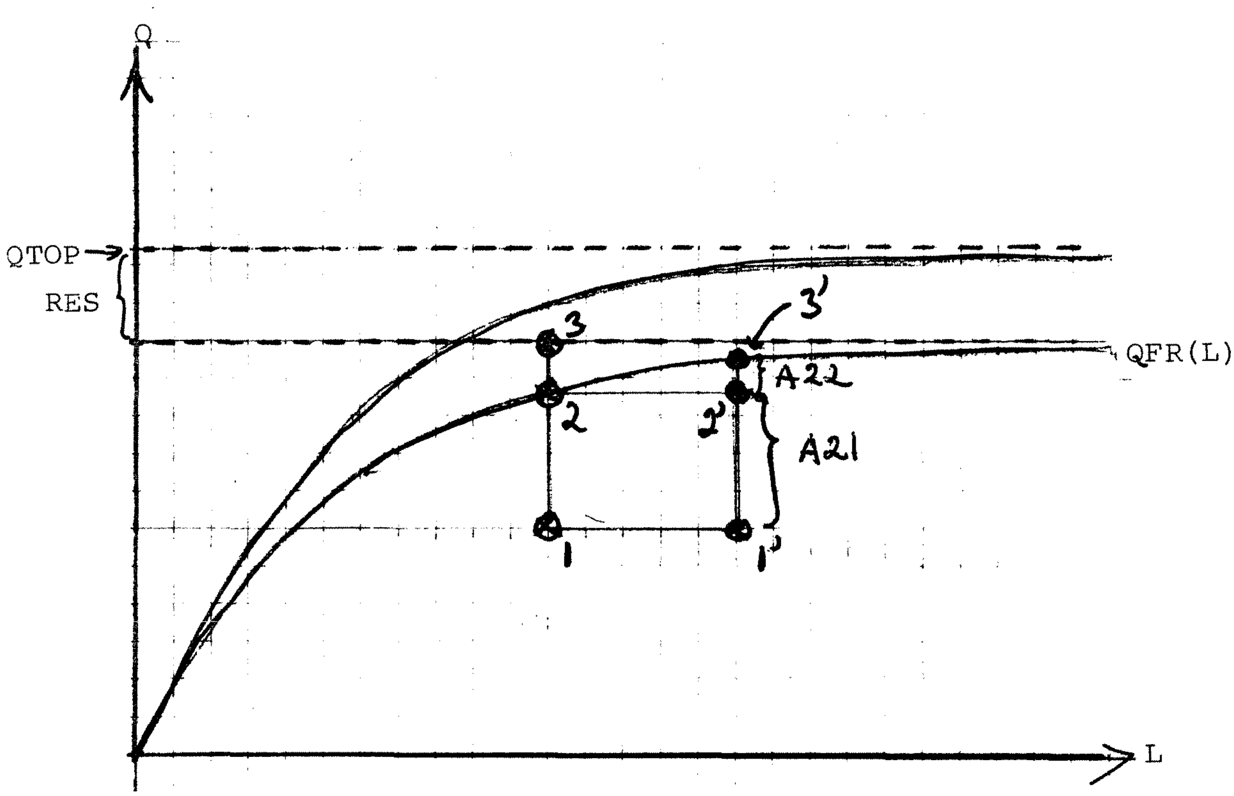


DIAGRAM IV:2

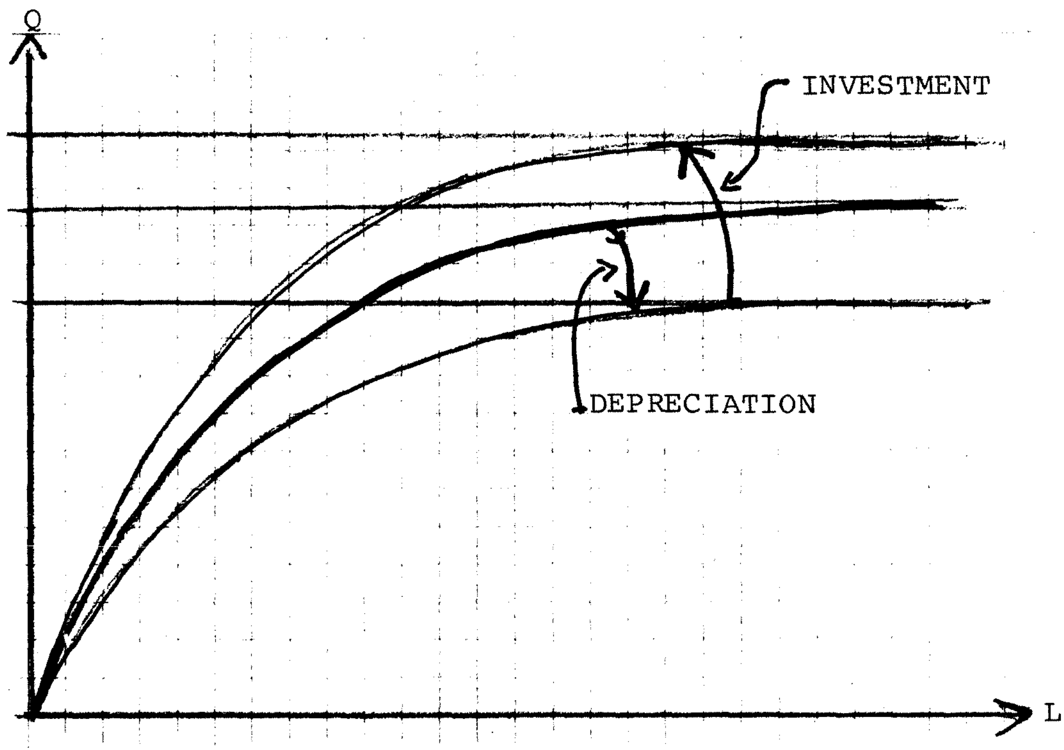


DIAGRAM IV:3

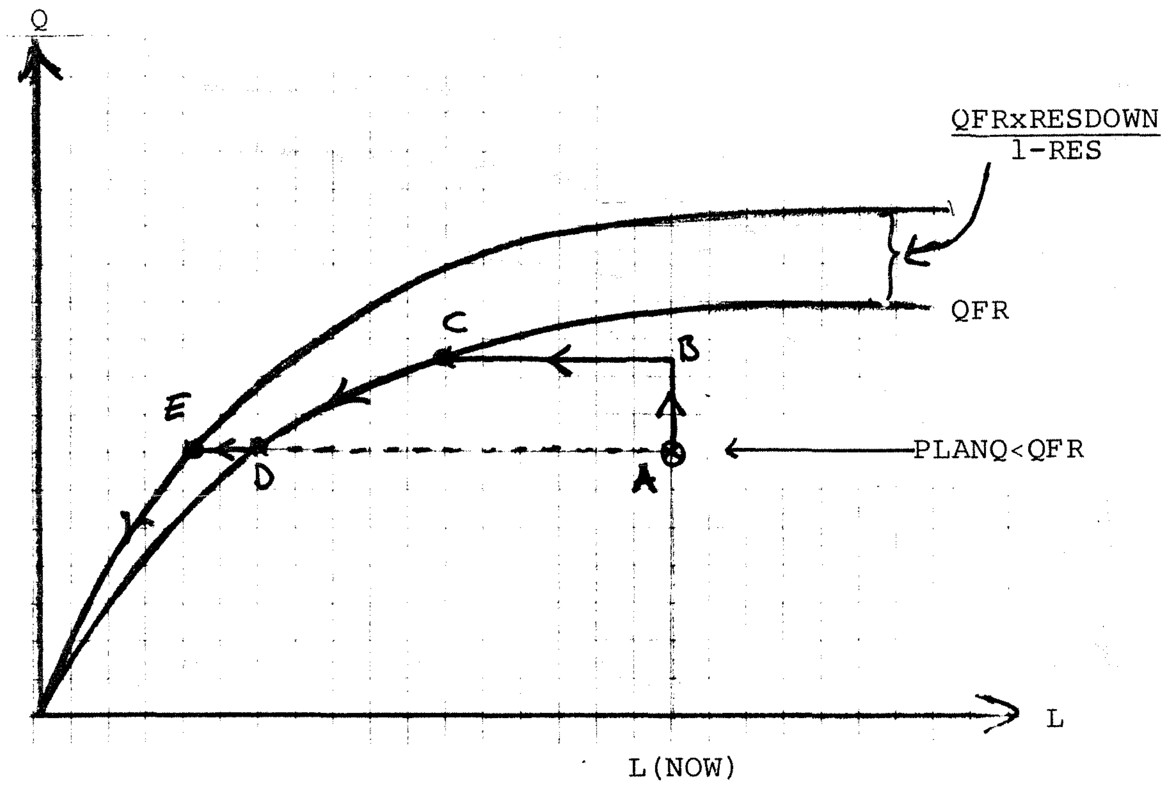


DIAGRAM IV:4

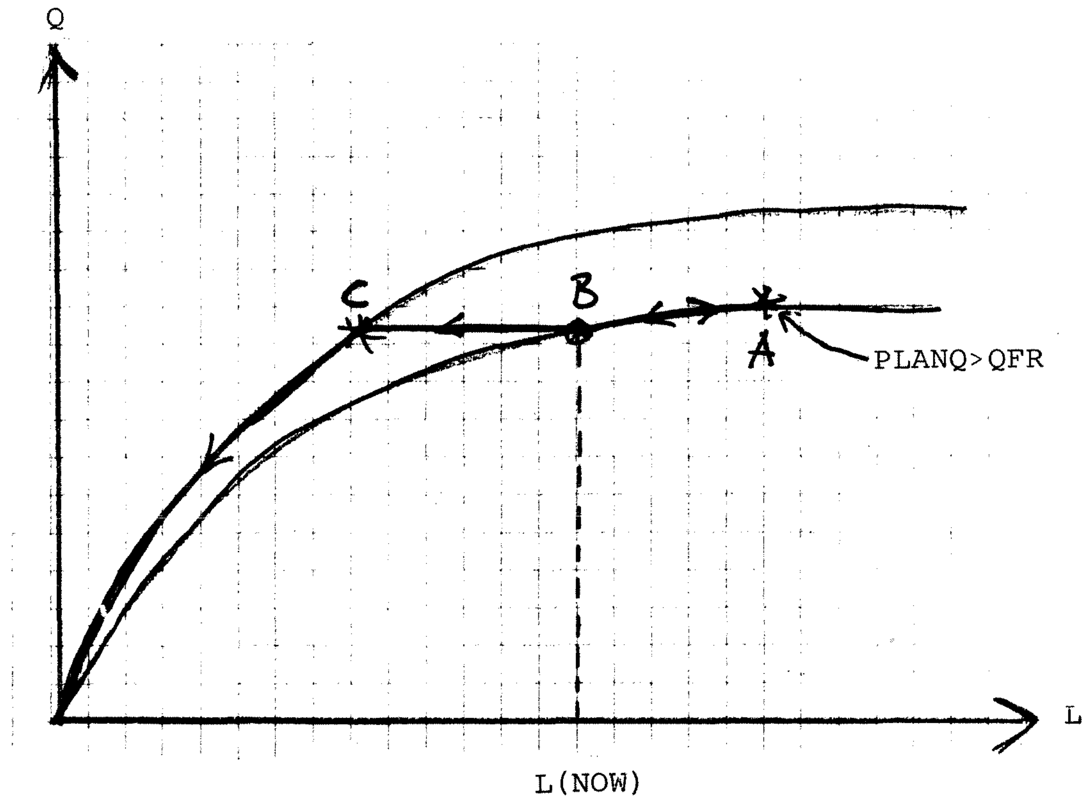
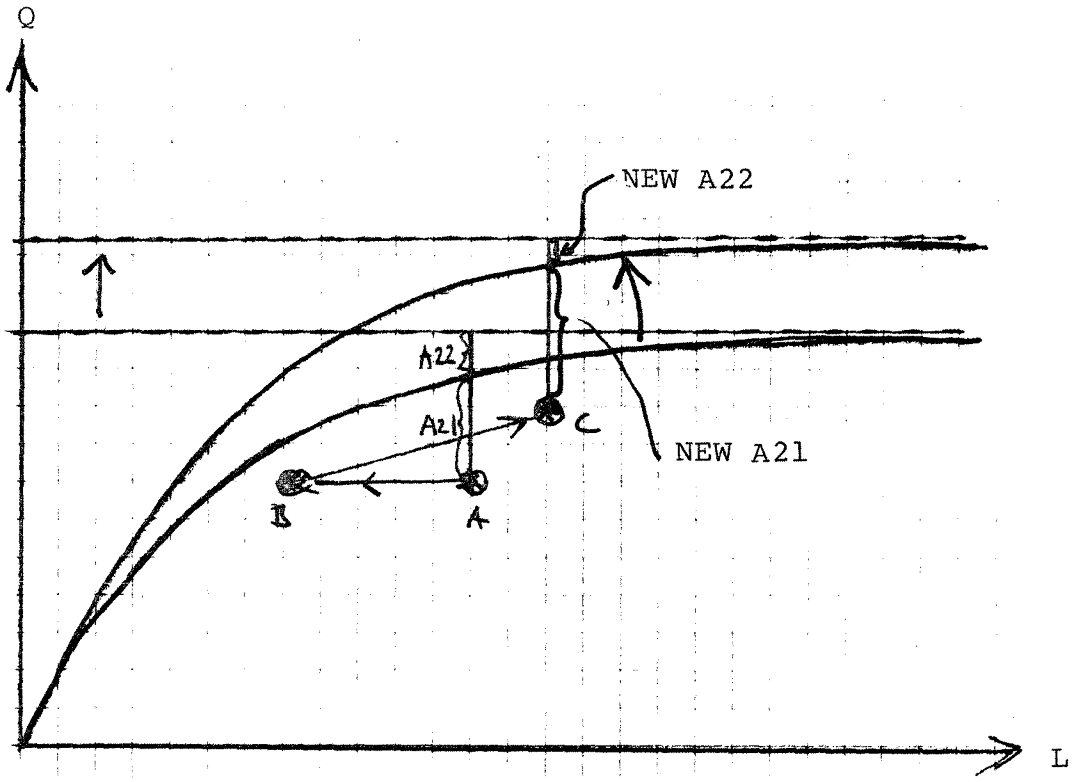


DIAGRAM IV:5



A; initial position

B; new transitory initial position after retirement

c; new preliminary initial position before labour market search.

Gunnar Eliasson, November 1976

V. LABOUR MARKET PROCESS

1. Introduction

The market is the place where micro volume behaviour is welded together by endogenously determined prices into macro aggregates. This is the essence of the micro-macro approach. The proposition has to be that aggregation functions are time dependent and unstable and that the effects on aggregates of such instability over time cannot be treated as additive random noise with negligible variation, as is conventionally assumed.

The labour market process in principle involves the whole labour force. In practice individuals are actively involved if affected by the search process to be described. The penetration of that search process is an indicator of market performance, as is also indirectly, differences in pay for the same volume and quality of labour.

The labour market is a central section in the model. Firms that desire to increase employment are here competing with one another and with the service sector and the Government for a pool of workers. The labour market is already the most complex section of the model, despite several simplifications. There are three reasons; first it is an important sector economically as well as socially. One origin of the inflationary process - a central theme of this inquiry - is located here and this is the place where human beings appear and their material standard is determined. Second, the labour market offers more modelling opportunities than other markets and behavioral blocks, partly because of the availability of statistical information. Hence, this block has been modelled in a way that gives a broad menu of choices as to further elaborations. Third, search processes in themselves require not only involved and intricate chains of program instructions but also more computer time than needed for the solving of a conventional equation system.

Nevertheless the specification now to be presented is what I would like to name an unsophisticated version of what we hope will later be possible to achieve. The most important clash with realism is the restriction to homogenous labour and the absence of overtime work. Furthermore, we will not allow any direct interaction between the business sector on the one hand and the service and Government sectors on the other. The service and Government sectors will be treated as aggregates only, with the simplest possible specification. This is in contrast to the industry sector, which is detailed down to the firm unit.

2. Labour market search

The sector sequence is as follows. At the beginning of each quarter all new entries to the labour market are allocated to the pool of unemployed (LU) or rather the pool of job-seekers. New entries are determined exogenously. Before each sector enters, normal retirement is subtracted on the basis of exogenous input data. The same rate is applied to each firm.

The service sector enters first each period, then comes the Government and finally the firms.

The service sector and the Government are restricted to the pool of unemployed in their choice of people. Since they enter first, this pool, however, is quite large because of the recent fill-in with new entrants to the labour market. The service and Government sectors are not allowed to raid one another or the industry sector. This somewhat unrealistic specification may be relaxed later if we succeed in introducing heterogenous labour. The average wage (and salary) levels differ a lot between sectors, partly because of differences in pay for the same job but mainly because of different mixes between skilled and unskilled labour. Hence, as long as we maintain the homogeneity assumption and work with actual, real-life data, the service sector, for instance, would be unable to recruit people in direct competition with industrial firms, where the average wage is 20 per cent higher. Similarly, if we allow firms to raid the service and Government sector, those sectors might loose a major share of their labour force during a business upswing. This whole problem falls back 100 per cent on the fact that we work with a micro based market process. It would go away by definition in a macro model. It has already within the service sector where we have no micro interaction. For the time being we attend to this by a simple, temporary trick to obtain reasonable behaviour of the model.

3. The service sector

The service sector thus enters the labour market as an aggregate. A profit target is defined for the sector which is assumed to operate without capital and with an exogenously determined rate of productivity change. This target is aimed at each quarter and the sector discards or hires people each quarter to the extent that the profit target is satisfied on the basis of past quarter wages and prices.

Since output is assumed to be proportional to labour input this device also determines next period service output, if the necessary, desired increase in employment can be obtained from the pool of unemployed.

The wage offer is the change in average manufacturing wages the quarter before.

Preliminary offering prices are raised as much as wage-offers less the exogenously determined productivity change.

The service sector can only get people from the pool of unemployed and not yet employed and labour is assumed to be forthcoming out of this pool to the extent they are demanded at wages offered. If the pool is not large enough, planned output is curtailed correspondingly.

Output, so determined, is fixed and offered in the service market. The price level in the service sector, however, is not determined until after the confrontation with the consumer demand function (see chapter VII and Block 7.3 in pseudo code). Profit targets may be violated.

Profits in the service sector is 100 per cent treated as household income in the model, as specified in this paper. The very large profit margin in the service sector is mainly due to the fact that most businesses in the sector are not incorporated. Hence, the owner's income appears as profits in official statistics. There is also a sizable capital invested, mainly in the form of stocks, that we have neglected for the time being.

To introduce stocks here we will have to split the sector in one part of intermediary traders between industry and households[1] and one part devoted to pure service production directly for the households.

This sector approach to the labour market, that we have adopted, may be interpreted as a codification of the business sector as the wage leading sector; this is at least the case as long as wages in the business sector are increasing. It is, however, more or less a matter of periodization that we allow the service sector to enter the labour market first. Alternatively, we could have made the service sector enter <u>after</u> the business sector the period before.

The production-profit system of the service sector has the following specification[2]:

$$CHL := \frac{(M-TARGM)*P*A1*L}{W} + RET * L \qquad (1A)$$

$$Q = OUTPUT\ (Supply) = A1 * L \qquad (1B)$$

---

1) Wholesale and retail sale. See section 3 on market intermediaries in chapter VIII.

2) All Z indices, identifying the service sector, have been deleted for simplicity.

A1 = Exogenous technology factor (1C)

$$M = 1 - \frac{LW}{PQ} = 1 - \frac{W}{A1} * \frac{1}{P} \quad (1D)$$

TARGM = Exogenous[1] (1E)

The offering price is calculated:

PRELP: = P*(1+X-DA1) (1F)

This price equalizes M with TARGM if

a) planned output A1*L can be sold at that price and

b) if CHL can be hired at the wage W*(1+X), when X is the relative wage change in the manufacturing sector the period before.

4. Government Sector

The <u>Government sector</u> is treated almost identically to the service sector. The principal difference is that output this time is exogenously determined. We may even call it a policy parameter. Output is then distributed free of charge. There is no price.

---

1) Maybe we should introduce a smoothing formula here as well.

The Government sector influences the price level only indirectly, through its demand on labour resources. We should be able to analyse the impact on the price level of the Government sector or - by the alternative interpretation - of fiscal policy making, under the qualification that total Government output is restricted upwards by labour available in the pool of unemployed and not yet employed.

Like the service sector the Government can only recruit people from the pool of unemployed. It offers the same wage increase as the service sector, but comes in second and runs a larger risk of not getting enough people. If it cannot, which should be an unlikely situation, Government output decided on is simply not realized.

Specification of the production system is identical to the service sector. Productivity change is exogenous and there are no profits. See pseudo code 5.3.

5. Industry Sector

More sophistication is entered with recruitment by the business or industry sector. Preliminary recruitment plans of each firm were determined in chapter IV:4. (Also see Block 4.3 in pseudo code). Firms are now ranked in decreasing order by PLANDL in (5.4.1.1). They start searching the labour market in that order.

Each firm is given a probability of being raided equal to its employment as a fraction of the total labour force, excluding those <u>now</u> employed by service and Government sectors (5.4.1.6). The probability of search leading to the unemployment pool is calculated analogously.

Each firm has its own expectations as to next period's wage, EXPW. Its offering wage is a fraction λ of its expected wage change:

OFFERW:= W + λ *EXPCHW

When the period starts all firms adjust their own wage levels to their own offering wage.

When the firm searches the unemployment pool, labour is forthcoming at that wage offer up to THETA per cent of the pool each time (see 5.4.1.9).

When the firm raids another firm a matching of wages takes place.

If the offered wage is higher than the offering wage in the searched firm plus a fraction (gamma), then the firm acquires up to THETA per cent of the raided firm's labour force. Thus:

IF OFFERW(I) $\geq$ OFFERW(II) * (1 + GAMMA)
THEN CHL: = MIN(THETA * L(II), PLANCHL(I)) (2)

(Note: I identifies the active, attacking firm and II the raided party.)

The raided firm responds by adjusting its wage level upwards by a fraction of the experienced wage difference to reduce the likelihood of another, similar experience.

W(II)=OFFERW(II):=OFFERW(II)+KSI*OFFER{W(I)-W(II)} (3)

If, instead, the searching firm meets a firm with a higher wage level it obtains no new labour. However, it responds by adjusting its own wage level and offering wage upwards:

OFFERW(I)=W(I):=W(I)+KSI*OFFER(W(II)-W(I)) (4)

This search process is repeated N times each period. The adjusted L and W numbers reached after N attempts are entered as final for the period.

If a firm has lost so much labour that there is no redundant labour, and some more, its preliminary production plan has to be revised downward correspondingly. Ditto for a firm that has not been able to recruit labour according to its plan.

The wage and output change for the period can now be calculated and both figures feed back into the expectations block to update expectations for the next period.

6. The AMAN vector

For firms that still have redundancies in their labour force (= most firms), and that are under target pressure to the extent that they decided in PRODPLAN block to layoff people, a separate device applies. To account for the new Swedish labour market legislation (the Aman laws), that allows lay-offs only after a 6 month delay, a so called AMAN vector has been entered between the decision to lay-off labour and the actual lay-off[1). Redundant labour is filed there in two quarterly cohorts. People in the second cohort at the end of a period can be fired the next period. The cohorts are filled in, emptied or moved one step forward each period for each firm. Actual firing always awaits the end of the labour market search. Then the last cohort is emptied into the pool of unemployed. Note here, that when checking for target SAT in the

---

1) An experimental analysis on the model on this labour market device is found in Eliasson (1976 b).

production system, labour in the AMAN vector is subtracted from total L[1].

It should be noted finally that the unemployment pool is identical to the conventional concept of unemployment only at the end of each quarter. This definition in turn is consistent with the specification that the model only generates quarterly ex post data. Beginning of each quarter the unemployment pool is a variable of considerable magnitude, since it has been amplified by new entrants and those being dismissed (according to plans) by the service sector.

---

1) Note that this does not mean that all redundant labour is in AMAN. This is only the case when the firm cannot reach SAT before being on QFR, where no redundancies exist; see (4.3.10) in pseudo code.

Gunnar Eliasson, November 1976

VI. EXPORTS, INVENTORIES AND INTERMEDIATE GOODS (FIRM LEVEL)

All chapters so far, except the previous one, have dealt with the specification of the model (or theory) of a firm. Before we proceed (in the next two chapters) to allow all firms to be confronted with demand a few additional features of the firm model have to be introduced. These are:

(1) an explanation of how much of firm output that is sold abroad

(2) the inventory planning system and

(3) the input of raw materials and semi-manufactured goods (intermediate products).

The last mentioned mechanism is not yet in the program and has to be treated rather crudely for practical (data availability) reasons. All these three sections could as well have been entered in the expectations-production planning chapters. However, this would have been at the additional expense of whatever pedagogical transparency we have mustered so far. So this is the chapter where we relax the assumption of the purely domestic company that manufactures its product out of thin air with the application of labour and capital equipment.

1. Exports (section 6 in pseudo code)

The majority of the large firms that will dominate the group of identified firms in the model will export well over 50 per cent of their output. For firms in the raw material subsector the export ratio for most firms will be 70 per cent and above.

Exports are said to be the prime mover of the Swedish business cycle. It is in this model. And one of the first and most important experimental questions will be to investigate under what conditions the model can generate a pure domestic business cycle of the kind we have observed during the post-war period and under what circumstances export market changes spread to the domestic economy.

Swedish supplies in foreign markets will be explained consistently with the behavioral specification in the firm model. Exports are part of firm total (sales) planning. Firm management considers the economics of total expansion irrespectively of where its output finally winds up. Foreign sales and price experience also blends with the same domestic experience in the EXP sector. What we have to do here is to complement market supply with an export linkage factor. This factor (the export ratio) is explained by the relative foreign and domestic price development:

```
FOR DPDOM > DPFOR
XR:=XR-XR*γ*(DPDOM-DPFOR)                    (6.1)
ELSE
XR:=XR+(1-XR)*γ*(DPFOR-DPDOM)
```

This export leakage function makes the export share dependent upon the relative development of foreign (PFOR) and domestic prices (PDOM) with a delay. Domestic prices will be endogenously determined. Foreign prices are exogenously entered.

The rationale for having (6.1) of course is the fact that we can roughly assume labour productivity and wages to be the same in production for export and domestic markets. Hence from (3) in chapter II the only variable factor in relative returns on export and domestic business is the price fetched in respective markets[1)].

---

1) This will hold also when we introduce intermediate goods and raw materials later in this chapter, since there is no reason to expect differences in purchase prices for the same inputs in Swedish production for various markets.

Relative returns to capital or relative profit margins should be the guiding variable and we might as well write:

```
FOR CHMDOM ≥ CHMFOR
XR:=XR-XR*γ*(CHMDOM-CHMFOR)                    (6.1.B)
ELSE
XR:=XR+(1-XR)*γ*(CHMFOR-CHMDOM)
```

This expression can be demonstrated to be approximately equal to (6.1)[1]. XR should vary very much in phase in both versions because of the common price impulses.

(6.1) is not synonymous with (6.1.B), but (6.1) is much simpler to use if the price-variables are readily available.

There will normally be a difference in profit margins on export and domestic sales. This variable might very well be of different signs from year to year. If the difference persists over time, however, both formula (6.1) and (6.1.B) will tend to move XR either to 1 or to

---

1) Remember from (3) in chapter II that $M=(1-\frac{L*W}{Q*P})$

Hence CHMFOR = $(\frac{L*W}{Q*PFOR})*DPFOR+XXX$

"XXX" is roughly the same whether you differentiate MFOR, MDOM or M since $\{L/Q, W\}$ are common factors.

zero. This is quite rational in the long run in the kind of oversimplified models that we normally use. The only empirical problem that we have is to assess the rate at which change can take place, by fixing γ.

A more realistic explanation of Swedish exports, however, than this simple version, would have to deal with much more difficult problems than functional form. Our formulation would be fair for a firm that is mainly supported by domestic markets (e.g. a normal U.S. firm) and regards exports as a marginal operation. This is not so for the large Swedish firms that have had to develop foreign markets to support growth. For a large number of Swedish firms Sweden is a marginal market. For some of them formula (6.1) would perhaps be acceptable, since bad margin performance in Sweden compared to elsewhere would tend to increase the export share and perhaps make it close to 1. For the majority of Swedish firms with export shares ranging between 30 and 70 per cent the problem is more difficult. For them the export market is needed to support overall scale economics and efficiency. It is often quite rational for such a firm to operate with substantially reduced margins either in domestic or foreign markets, since the additional products corresponding to one market can be produced at drastically reduced unit costs.

For them a strong reduction in the export share would mean either a very strong increase in the domestic market share or a serious problem. Unfortunately, we cannot model such relevant complexities at the present stage. One empirical requirement that we place on the model is, however, that individual firms do stay within reasonable shackles in simulations.

Despite these relevant considerations the simple formulation (6.1) does pinpoint the variables at work on the firm export share and it should be mentioned finally that we are making it difficult for us by avoiding common scientific short-cuts such as tying firm exports directly to an exogenously given foreign market growth rate, which would have been much "safer".

2. The inventory system

Many economists believe that the origin of business cycles of to-day should be looked for in the inventory cycle; inventories being on the one hand the buffer that picks up the consequences of mistaken expectations and on the other hand a sizable demand component with a series of feed back multiplier effects. One empirical question that we are asking ourselves is whether mistaken expectations are really capable of generating the typical business cycle of an industrialized country, alone, without the oscillatory mode built into the whole sequence of intermediate inventory systems throughout the economy (raw materials, intermediate production through several stages all the way up to the wholesale and retail sectors and households). Do economic agents react on the red and green lights (red light theory) or on the car immediately ahead. (Tailgating theory.) We do not know and have to introduce both versions simultaneously.

For each inventory system (product stored) we will introduce three ratios:

$$\frac{OPTSTO}{S/P} := BETA \qquad (8.3.1)$$

$$\frac{MINSTO}{OPTSTO} := SMALL \qquad (8.3.2)$$

$$\frac{MAXSTO}{OPTSTO} := BIG \qquad (8.3.3)$$

(8.3.1) defines the optimum inventory (volume) level in terms of the current sales volume. Firms are assumed always to gear production (and purchase) plans so that inventories change in the direction of the optimum level calculated on the basis of expected sales. This mechanism has already been explained for finished goods inventories in chapter IV (see (4.2.1)). The determination of BETA, may be very important for the cyclical properties of the economy described by our model.

For each inventory type we also introduce a MIN and a MAX level expressed in terms of the optimum level. The three ratios (BETA, SMALL, BIG) are very operational concepts. They are quite often handled numerically within firm planning routines. They usually vary somewhat over time although there are firms that use a fixed set of coefficients over long periods in their planning and budgeting routines (Eliasson (1976)). Determination of these coefficients, however, requires access to internal information within the firm.

MIN is the level below which management (under normal conditions) will never allow inventories to go. Similarly MAX defines the upper limit. For convenience we will regard MAX as maximum storage capacity disregarding the fact that our definition then requires BIG to vary, since sales volume normally varies more over time than warehouse capacity.

To specify the inventory system numerically (and eventually we will deal with at least two inventory components; finished and intermediate goods) two methods are possible. We can measure actual inventory-sales ratios for all firms in a market and/or for individual firms and assign the ratios by some ad hoc, intuitive method. This will probably do quite well for the kind of macro analysis we have in mind.

The second and more appealing method would be to question firms on their (BETA, SMALL, BIG) ratios and their current STO-sales volume ratio (to measure the degree of start up disequilibrium) and then to assume fixed coefficients in simulation runs.

3. Intermediate products and stocks (not yet in program)

Each firm is identified with one market for finished products. Each firm also has a purchase pattern related to all other markets. There is no possibility of getting hold of this purchase pattern for each firm. Internal accounting routines seem to be devised so that separate, very extensive statistical inquiries are needed for CHQ itself to obtain this information. Our solution is to "aggregate up" the Swedish Input-Output matrix as close as possible to the market segmentation that we use for the model and then apply the average input delivery pattern of each cell (= market) to each firm classified on the market. If enough firms are represented in each market individual errors originating in this deliberate mis-specification should tend to cancel.

In principle, each physical output unit (Q) requires an input (volume) of raw materials and intermediate goods. We expect these input-output coefficients to be constant over time.

The volume to volume input-output coefficients will be estimated by relating purchases to value added, both expressed in current prices.

A point estimate for one year may be all that is possible. If so, it is normally distorted by inventory movements, so hopefully some average over several years can be obtained.

From then on we will allow the input-output coefficients, expressed in current prices, to vary in response to variations in relative input-output prices even though the "physical" coefficient is assumed to be fixed.

Hence we know that the production plan for the year PLANQ consumes

IMQ(I) = IO(I) * PLANQ
IMQ(I) stands for physical units of output from market I.

This will cost the firm an expected:
EXPIMP(I) * IMQ(I)
for the same period.

Each firm is expected to have stocks of such intermediate input goods. For each type of goods we define a MAX, an OPT and a MIN relationship to the level of sales[1], as in the previous section.

Stability of production requires that stocks be kept above MIN levels. MAX levels are determined roughly by physical storage capacity.

The firm purchase decision involves (for each purchase category) an estimate on the current use (consumption) of such goods for the period and a decision as to where between MIN and MAX to adjust stocks. This last decision relates directly to the expected price gain on advance buying and vice versa.

Each firm applies a price expectation function of the conventional smoothing type for each purchase market. We expect the experience of the immediate past to dominate strongly in the formation of expectations for the immediate future (one year or one quarter)[2]

---

1) There will always be a problem to decide which variable each stock type should be related to. Since practically all sequential stocks follow sales indirectly we use sales to avoid confusion with too many scales.

2) Maybe we should even run this EXP function on quarterly data. This requires that (with a smoothing formula) last quarter price information be used as a start-up datum.

The <u>purchasing decision</u> is completely reconsidered each quarter based on what firm management expects price change to be over the next, say, year. Hence we define EXPDP(I) to represent the expected price change over the next 4 quarters and EXPP(I) the price at the end of these 4 quarters. P(I), the price of the current quarter (O) and EXPDP(I) is sufficient to determine EXPP(I) end of quarter 4.

The purchasing decision is taken early in the sequence of planning steps described in earlier blocks, and before the preliminary production plan has been arrived at.

Additional storage capacity plus planned use over a future 4 quarter period defines the scope for inventory build up in response to expected price increases. Planned use is calculated on the basis of planned sales volume for the long-term plan (first year). This estimate of planned use for a 4 quarter period is then rolled on each quarter. The only component that changes is the difference between MAXSTO and actual STO.

If EXPDP 0 we now assume:

$$QIMQ(I) := SPEC * ((\text{planned use}) + MAXSTO(I) - STO(I))$$

$$\text{planned use} := IO * \frac{PLANS}{EXPP}$$

SPEC1 = SPEC11 * EXPDP(I)

$0 \leq$ SPEC11 ≤ 1 (the upper limit has to be enforced)

PLANS is first year in long-term sales expectations from EXP block.

Note that the decision to purchase IMQ(I) refers to the next quarter 1.

If EXPDP < 0 we assume instead:

QIMQ(I): = SPEC2 * ((planned use) - STO(I) + MINST(I))

SPEC2 = SPEC22 * EXPDP(I)

<u>Lower limit</u>:

$$\text{QIMQ(I)} \geq \left(\frac{\text{planned use}}{4} - (\text{STO-MINSTO})\right)$$

<u>Upper limit</u>:

Maximum financing allocated from investment financing block*) (if lower than lower limit, some other financing requirement has to yield).

If within lower and upper bounds we assume that the firm budgets:

$$\left(\text{P(I)} + \frac{\text{EXPP(I) - P(I)}}{4}\right) * \text{QIMQ(I)}$$

---

*) Divided by EXPP.

for next quarter purchases of Q(I) and immediately proceed to realize the decision.

Firms in market (I) have already made up their production plans and their supplies in the market are given. I propose the following two alternative market processes. They should both be experimented with:

(I) Domestic supplies and inputs of I given in physical terms elsewhere in model. Total supply in physical terms and total demand in money terms are added up and the clearing price determined. The clearing price is fed back to producers who decide how much <u>they</u> want to keep in inventories. A new volume supply is then obtained and the clearing prices are recalculated on the basis of an unchanged money demand. That gives the price for the quarter[1] and input goods I are then distributed to firms in proportion to their original money budgets (now all spent).

(II) Alternative II is a little more sophisticated. The first step is as before. When confronted with the new clearing

---

1) This is analogous to the household-firm interaction but it runs in the opposite direction.

price offer, buyers still want to buy originally planned volumes whatever the new price level. If foreign prices are lower than this domestic price offer, imports fill in the remainder at this price preventing the domestic price from going up further this quarter. If foreign prices are relatively higher and/or if supply volume larger than demanded, alternative I decides.

As soon as the purchase has been realized inventories are updated:

STO(I): = STO(I) + QIMQ(I)

As soon as the production plan has been finally settled in (5.4.3.1) actual use of intermediate goods for the quarter can be calculated by applying IO as above and stocks can be updated again.

The above treatment of purchases refers to two sectors in the model, raw materials and intermediate goods. We can, if we wish, merge the two sectors in this context assuming rigid proportions for each firm.

Gunnar Eliasson, November 1976

VII. HOUSEHOLD CONSUMPTION BEHAVIOUR

Introduction

This sector of the model interacts with the industry sector in a way to be described in the next chapter. For didactic reasons I want the presentation of supply and demand sides separated although the two sides will be more or less merged in the program.

In principle household spending and saving behaviour as specified in this section relates to one household. For the time being we will assume, however, that all households are identical. We are in practice presenting a macro model module. As things stand now we have prepared for an easy transfer into micro specification. It is lack of empirical knowledge rather than formal and technical problems that blocks the way.

Consumption of one household follows a priority ordering by a set of spending categories along the lines suggested by Stone (1954), Dahlman-Klevmarken (1971) and others in so called linear expenditure systems. Novel features introduced here are (1) that saving figures as a 'consumption' category. This means that the "budget constraint" is defined as disposable income (DI) rather than total consumption. Also (2) a swap between saving and purchases of consumer durables is allowed for. The idea is that purchases of durables include an element of saving. Total household wealth is the sum of financial assets and the stock of durables. A shift in the direction of more financial assets means consolidating the liquidity position of the household. It is essentially a timing device. It occurs a) when the real return to financial assets increases and b) when the job market goes recessive. Finally (3) the expenditure system formulated is not linear, although the linear version used by Dahlman-Klevmarken (1971) appears as a special case when non linearities when the three novel features mentioned above are removed.

For the time being our ambitions for the household sector are low. We only need a link between income generated in the economy and the markets for goods and services of the production sectors specified. The expenditure system is a device for splitting total disposable income in a rough and ready way into expenditure streams directed towards these markets.

Income available for spending period 1 is income generated the period before. For the time being we identify the period with a quarter. If desired, the model layout is such that a monthly specification can be introduced. To simplify the symbolic representation all Q prefixes, indicating quarterly specification, have been deleted.

For each spending category (I), a desired, or essential, level of consumption is defined (for each household):

CVE(I) = ALFA1(I)+ALFA2(I)*CVA(I) (1)

CVA represents the "addicted" level of consumption and ALFA 1 and ALFA 2 measure the strength with which the household wants to maintain this addicted level. Hence CVE may be labelled the desired level of consumption. ALFA 2 larger than 1 means an urge to increase consumption over time and vice versa for ALFA 2 smaller than 1[1).

For non-durable goods CVA is represented by consumption volume during one or several past periods. For durables CVA is the consumption level desired by the household, which is in turn assumed to be proportional to accumulated household stocks of durables (see below).

---

1) For most applications at the macro level we will not have any reason or knowledge to keep CVE and CVA apart. We simply make ALFA1=0 and ALFA2=1. However, see comments to proof of (9) in the main text below.

For saving CVA is replaced by the gap between a desired level of household wealth and actual wealth (see below).

We will distinguish between the following household spending (market) categories:

(1) Non-industrial goods (homes etc). Prices and volumes determined 100 per cent outside the model.

(2) Domestic, protected industrial goods markets (non-durables, mainly food). Prices determined in the model[1].

(3) Non-durable industrial goods, prices determined partly in model and partly exogenously in international markets.

(4) Service consumption. Prices determined in model.

---

1) Market (2) might turn out too small to make separate attention reasonable. In the experimental runs so far market (1) has simply been disregarded. The investment goods market (5) is shared jointly between households and firms. Preparatory work has been done (see CH.VI) to include a pure inter-business market for intermediate goods. However, intermediate goods are not yet neither in pseudo code nor program.

(5) Durable industrial goods. Prices determined partly in international markets. No distinction will be made between durable household goods markets and investment goods markets.

(6) Saving (Credit market)[1].

Markets 3 and 5 will be supplied by imports as well as domestic producers. Domestic producers for these markets will also sell part of their output abroad. In the experimental set up of the model presented here each firm will sell its entire output in only one of the three markets (2, 3 or 5) for industrial goods.

The following symbols will be used:

C(I)	= consumption value, type (market) I.
P(I)	= corresponding domestic price index.
CPI	= consumer price index.
SP(DUR)	= spending on durable goods (N.B. not consumption).
SP(NDUR)	= spending on nondurable goods and services = C for the corresponding market.
SP(SAV) = SAVH	= household saving.

---

1) The credit market is only represented by an exogenous interest rate.

For didactic reasons we start by defining the "desired" consumption levels, beginning with nondurable consumption (= no accumulation of stocks). Then we introduce a desired wealth function and a function explaining durable consumption.

Desired durable consumption is then transformed into desired spending on durable goods. Finally a function explaining desired saving is introduced. All spending categories are then entered into a price, disposable income trade-off formula that runs off a market specified spending plan for each vector of offering prices presented from the suppliers (industry sector, service sector etc).

After a predetermined number of interactions with the suppliers the then prevailing vector of offering prices is fixed. Households determine the volumes they want at these prices and markets are cleared by adjustment of inventories. Using actual or addicted levels of consumption as weights a consumer price index (CPI) is finally calculated.

2. Nondurable consumption (NDUR)

Nondurable consumption covers those categories where spending and consumption can be considered approximately identical each decision period (= quarter). No stockbuilding is assumed to take place even though this assumption is violated occasionally in reality (e.g. for clothing and food stored in a freezer). We define the addicted level of consumption by introducing a feed back "smoothing" formula of the type[1]:

$$CVA(I) := FE(I) * CVA(I) + (1 - FE(I)) * \frac{C(I)}{P(I)} \qquad (2)$$

CVA(I) is updated each period. We need a start up value on CVA that is based on past consumption (volume) levels in a way that is consistent with (2). This is obtained by weighing together the historic C/P series with a series of exponentially declining weights.

3. Saving

Saving by households (SAVH) is assumed to be governed by a desire to maintain a certain "desired" ratio between household financial wealth (WH) and disposable income (DI):

$$WHRA = \underbrace{ULF + ALFA3 * (RI - DCPI) + ALFA4 * RU}_{\theta} \qquad (3)^{2)}$$

---

1) Note that FE in (2) is called SMOOTH in pseudo code.

2) Temporary saving for some particular purchase goal, like a home, is not allowed by (3). This possibility is introduced through what we later call SWAP.

RI = nominal rate of interest
RU = rate of unemployment
WHRA = wealth disposable income ratio
WH^* = WHRA*DI = desired wealth in terms of (3)

ULF is a factor that varies from household to household. It is entered exogenously. The WH/DI ratio is also assumed to depend linearly on the real rate of return to saving (RI-DCPI) and a measure of Job-market security (the rate of unemployment RU).

Desired saving in terms of (3) is now defined as:

$$SPE(SAV) = (WH^* - WH) \quad (4)$$

which can be reformulated as:

$$SPE(SAV) = WHRA * DI - WH \quad (4B)$$

For later updating purposes we will introduce the following definition of saving already here:

$$CHWH \equiv RI * WH + SAVH \quad (5)$$

Note that desired saving is not the same as actual saving (SAVH)[1]. The change in household

---

[1] In fact SPE(SAV) = (WHRA*DI-WH)+DI*SWAP. See pseudo code (7.4.4.). SWAP is defined in conjunction with the treatment of durable goods purchases.

financial wealth is defined as the sum of interest income on actual wealth and new (actual) saving.

Hence:

WH: = (1+RI)*WH + SAVH (5B)

Updating by this formula will take place end of each period or end of each year depending upon how exactly we want to imitate interest calculations on bank deposits[1]. SAVH is entered end of each period when the household expenditure pattern has been finally determined.

Each period for each household a desire to swap part of desired saving for purchases of durables or vice versa will be defined. This swap is determined by (A) the return to saving when waiting to buy a piece of average durable equipment and (B) by an element of cyclical caution. This factor, that we will call SWAP is derived from θ in (3), and

SWAP=CHθ=ALFA3*CH(RI-DCPI)+ALFA4*CHRU (6)

SWAP is a savings determinant that operates directly on decisions to spend on durable equipment. It belongs to the savings function.

---

1) See pseudo code (7.9.3).

Since we do not have a deterministic formulation of our system it is practicable to have it entered directly as a determinant of durable goods spending. To attain this we will simplify the specification (3) of the desired wealth-disposable income ratio to:

WHRA:=ULF (3B)

and shift the SWAP component over to the next section. The empirical rationale for this is the assumption that the time average of SWAP is zero, or, if different from zero, a long time average of SWAP will change in a constant relation to ULF. By assuming this we will solve the empirical problem of determining ULF exogenously. In fact, we can determine ULF by a smoothing device like (2). We will do so. This will not affect (4B)[1).

---

1) Under our present assumption that each household is the average household ULF can now be determined directly from a national accounts time series of SAVH data. When we split households on different categories later on, we need at least one set of group cross section estimates on ULF. If we can assume that the relative group sizes of ULF from this cross section is maintained <u>over time</u> we can use the aggregate national accounts time series to get a group time series of ULF. The basic reason for entering this "empirical" simplification is that within the foreseeable future we will not be able to obtain more than aggregate SAVH <u>time series</u> data.

4. Durables

Durabels have the property that the accumulated stock value defined as:

$$STODUR := \{SPE(DUR) + (1 + DP(DUR)) * STODUR\} * (1-RHODUR) \quad (7)$$

DP(DUR) = Rate of change in durable goods prices.

SPE(DUR) = Household spending on durables (purchases)

yields a service each period, that in turn constitutes consumption (C(DUR)) of that good. This consumption is defined as a fraction (the rate of depreciation RHODUR) of the stock value accumulated or:

$$C(DUR) := RHODUR * STODUR \quad (8A)$$

$$STODUR := (1-RHODUR) * STODUR \quad (8B)$$

From (8) follows that as long as RHODUR is constant, the value of durable consumption can only be varied through variations in the stock of durable equipment. This stock in turn changes because of changes in the price of durables, the service (consumption) outtake of the stock and the purchase of new durables. The purchase is the action parameter of the household.

Desired purchases of durables are assumed to be geared to a long run desired level of consumption (CVE(DUR)) determined from past consumption levels as in (1) and (2) and a short-term swap factor between saving and spending on durables;

$$SPE(DUR):=\frac{P(DUR)*CVE(DUR)}{RHODUR}-(1+DP(DUR))*STODUR-DI*SWAP \qquad (9)$$

SWAP is brought in from (6). See end of section for proof.

Finally, the desired level of consumption of durables CVEDUR is obtained by feeding (2) or (2B) with past $\frac{C(DUR)}{P(DUR)}$ data.

The new feature of this durable spending function is that in times of jobmarket insecurity or rapid rates of inflation the household may switch between accumulating financial wealth through saving and wealth in the form of durable equipment. SWAP is the switch factor. Since consumption of durables is proportional to the stock of durabels, accumulation means more consumption and vice versa. If you don't buy a new car you cannot compensate for this loss of quality of consumption (maintain your previous consumption) by running (down) your car faster.

Proof of (9)

From (7) and (8A) we get the actual consumption value of durables as:

$$C(DUR) = RHODUR * \{SP(DUR) + (1+DP(DUR)) * STODUR\}$$

Replacing C(DUR) with CVE(DUR) times P(DUR), the desired consumption, gives desired spending (SPE instead of SP):

$$SPE(DUR) := \frac{P(DUR) * CVE(DUR)}{RHODUR} - (1+DP(DUR)) * STODUR$$

Under certain circumstances defined by (6) households plan to reduce desired durable purchasing via SWAP in order to increase saving. Hence the last term in (9).

Note here that if SWAP > 0 follows CVE*P > C. Households then allow their consumption of durables to fall below the desired or essential level in terms of (1). This possibility is intended and motivate that we keep the distinction between CVE and CVA. CVA then is the minimum or addicted level. Extreme circumstances are required for C/P to go below CVA.

5. Adjustment to income constraint

Total spending (NB) has to add up to disposable income by definition. By calling SPE(DUR) in

(9) and SPE(SAVH) in (4B) we have[1)]

$$SUM(SP)=DI \tag{10}$$

where SP is actual, not desired spending.

When confronted with market suppliers households will be presented with several feeler-vectors of offering prices. For each of these vectors the household balances off various spending components against one another and decides on a preliminary spending plan. To obtain this balancing we introduce a STONE-type expenditure, distribution formula:

$$SP(I)=BETA1(I)*SPE(I)+\left\{BETA2(I)+\frac{BETA3(I)}{DI/CPI}\right\}*\left\{DI-SUM(BETA1(I)* *SPE(I)\right\} \tag{11}$$

[2)]

ALL BETA1 $\geqslant$ 0
SUM BETA2(I) = 1
SUM BETA3(I) = 0

---

1) Occasionally saving may turn negative. This also means that total spending is larger than DI. However, we can still keep DI as the income constraint.

2) To obtain a volume estimate of desired durable spending needed in (11) for balancing against the price vector we have to deflate SPE(DUR) in (9) by past period P(DUR).

The first additive component in (11) tells how total available income is distributed on various spending (consumption, saving) categories in the first allocation round. The second component in (11) tells how residual income (what is left) is allocated. Note that this residual income may be negative. The conventional approach by Stone (1954) and his followers have been to use only BETA2 (a linear formulation). BETA2 divided by the share of total income allocated then can be interpreted as the income elasticity. As long as we stick to this formulation (i.e. BETA3=0) we can draw directly on the empirical results of Dahlman-Klevmarken (1971) with the qualification that they have excluded household saving in their linear income allocation model and assumed total disposable income to be income after tax less saving. By introducing BETA3 we have added a non-linear factor. The idea is that BETA3 is negative for spending categories that increase their share in the long run. As real income (DI/CPI) grows the second factor within brackets grows absolutely and the whole elasticity component within $\{\ldots\}$ increases, as intended. The problem with this variable elasticity approach is how to split Dahlman-Klevmarken's (1971) somewhat biased estimates on the time average of $\left\{BETA2(I)+\frac{BETA3(I)}{DI/CPI}\right\}$ into BETA 2 and BETA3 coefficients. For the time being we are experimenting on the assumption that BETA3=0, which allows a more direct access to Dahlman-Klevmarken's results.

After N confrontations with suppliers in each market the Nth offering price vector is fixed as actual prices. Consumers calculate what they will buy of goods and services at those prices from (11). Volumes not bought add to suppliers inventories. Desired saving in (4B) has been entered into each market trial as the same given datum. SWAP has been shifting somewhat depending upon DCPI . After the Nth confrontation SAVH can be determined residually as:

$$SAVH = DI - SUM\{SPE(NDUR, DUR)\} \qquad (12)$$

6. Consumer price index (CPI)

The consumer price index is determined on the basis of the P(I) vector by a conventional weighing formula. It would be of interest to be able to experiment easily with different weighing systems that can be called in as we please. I suggest at least two systems of weights. The conventional:

$$VIKT(I) = \frac{C(I)}{P(I)} \qquad I = 1, 2, \ldots 5, \ldots \qquad (13A)$$

and the less conventional with "addicted" consumption levels as weights:

$$VIKT(I) = CVA(I) \qquad I = 1, 2, \ldots 5, \ldots \qquad (13B)$$

from (2) or (2B).

In (13A) C and P refer one period back in time.

SUPPLEMENT TO CHAPTER VII

MODEL SPECIFICATION: HOUSEHOLD BLOCK

1. In data: (I = market = consumption category)

CVA initial (see (4.1.A)).

P feeler price vector from business system.

DI from labour market and business system.

2. Aggregation to household gives household disposable income (DI).

(Under this provisional specification aggregation will be to all households. This means that total disposable income is SUM QW in industry, service and Government sectors!)

3. Consumer price index (CPI)

$$CPI = \frac{SUM\{QC(I)\}}{SUM\left\{\frac{QC(I)}{QP(I)}\right\}} \quad \text{or} \quad CPI = \frac{SUM(CVA(I)*P(I))}{SUM(CVA(I))} \qquad (3)$$

Note: Inclusive of service sectors from Block 5.2 and Block 7.3.

4. General transformations

Addicted consumption level

Initial: $$CVA(I):=\sum_{t=-T}^{-1}\left(VIKT(t)*\frac{C(I;t)}{P(I;t)}\right) \qquad (4.1A)$$

Feed back: $$CVA(I):=FE*CVA(I)+(1-FE)*\frac{C(I)}{P(I)} \qquad (4.1B)$$

Desired level:

$$CVE(I):=ALFA1(I)+ALFA2(I)*CVA(I) \qquad (4.2)$$

5. Non-durable consumption (2, 3, 4)

$$SP=C \qquad (5.1)$$

Note: SP = spending.

Use: (4.1) and (4.2)

Desired spending:

$$SPE(NDUR):=P(NDUR)*CVE(NDUR) \qquad (5.2)$$

6. Durables

$$C(DUR):=RHODUR*STODUR \qquad (6.1)$$

Use: (4.1) and (4.2)

Desired spending:

$$SPE(DUR): = \frac{P(DUR)*CVE(DUR)}{RHODUR} - (1+DP(DUR))*STODUR-DI*SWAP \quad (6.2)$$

$$SWAP: = ALFA3*CH(RI-DCPI) + ALFA4 * CHRU \quad (6.3)$$

Updating:

$$STODUR: = (1-RHODUR)*\{SP(DUR)+(1+DP(DUR))*STODUR\} \quad (6.4)$$

7. Saving

To obtain the "addicted" financial Wealth/Disposable income ratio WHRA use (4.1) on past WH/DI for T years.

Desired level of saving:

$$SPE(SAV): = (WHRA*DI-WH) + DI * SWAP \quad (7.1)$$

Note: in (4.2);

$$ALFA1: = +DI * SWAP \quad (7.2)$$

$$ALFA2: = 1$$

Updating:

$$WH: = (1+RI) * WH + SAVH \quad (7.2)$$

8. Adjustment to income constraint (by quarter)

$$SP(I): = BETA1(I)*SPE(I)+\left\{BETA2(I)+\frac{BETA3(I)}{DI/CPI}\right\} * \quad (8.1)$$

$$*\{DI - SUM(BETA1(I)*SPE(I)\}$$

ALL BETA 1 $\geq$ 0
SUMBETA2(I) = 1 (8.2)
SUMBETA3(I) = 0

Note 1: SPE(I) from (5.2), (6.2) and (7.1) after division by 4.

Note 2: SP(I) can be split into a price and volume component by (5.2) and (6.2) for I = 1, 2, ... 5. In (6.2) for durables suppliers offering price is simply entered at two places to calculate SP(DUR). SP(DUR) is then divided by the same price to obtain spending volume as a return signal to suppliers.

9. Interaction with suppliers

See next chapter. From this interaction final prices and consumption volumes are obtained.

10. Then calculate

SAVH = DI - SUM SP(NDUR,DUR)

Then update by (7.3) by annualizing SAVH.

11. Then calculate

CPI by (3).

12. Then update by (6.4) by entering SP(DUR) and DPDOM(DUR).

Gunnar Eliasson, November 1976

VIII PRODUCT MARKETS, IMPORT COMPETITION AND INVENTORY ADJUSTMENT

1. Introduction

We have now reached the stage where ex ante supply and demand have to be merged into a unique quantity-price solution. This is again accomplished through a trial and error (search) process in the product markets. For practical reasons obviously differentiated products in each market are forced to be homogenous and to catch the same price in each market wherever they come from and wherever they go. Thus market imitation here is more rough and ready than in the labour market. In fact, firms are marketing homogenous units of consumption quality (units of consumer bliss) in a market that works so well that no price differences[1)] appear. In fact, firms are competing with their profit margins which define their survival and growth potential, as we have demonstrated in chapter I (formula (1)). Differences in profit

---

1) Since there will be no opportunity to measure such things we do not model them.

margins in turn derive from labour market imperfections (differences in wages) and/or from differences in productive efficiency. Prices are, as noted, identical per unit of output.

Four market functions have to be treated in this chapter. First, we have to define how exactly imports compete with domestic producers. Second, we specify the relationship between producers and market intermediaries (wholesale and retail sector). Third, we model the interactive trial and error search between suppliers and households and fourth, we describe the final inventory adjustment.

2. Imports

Formally imports enter Sweden much in the same way as exports leave Sweden. Price differentials between Swedish domestic and foreign markets push goods flows in the direction where better trading margins are to be fetched, that is where prices are highest. Thus:

$$\left.\begin{array}{l} \text{FOR DPFOR} \geqslant \text{DPDOM} \\ \text{IMPR:= IMPR - IMPR} * \alpha * \text{(DPFOR-DPDOM)} \\ \text{ELSE} \\ \text{IMPR:= IMPR + (1-IMPR)} * \alpha * \text{(DPDOM-DPFOR)} \end{array}\right\} \quad (1)$$

IMPR is the market import quota or ratio[1]. If domestic inflation rates are higher than abroad, domestic markets tend to attract imports, IMPR increases, and vice versa[2].

As for exports, importers or foreign exporters react with a lag (one quarter). Because of transport distances we assume no trade-off between domestic and foreign markets within the period. Once IMPR has been decided on the basis of past quarter data, delivery volumes are fixed and are assumed to be marketed in full at whatever price the market determines.

Thus, in each trial and error interaction between suppliers and households within one particular period the same, fixed import supply volume is entered.

---

1) Note the possibility of studying import controls at the level of an entire market by making $\alpha=0$ or simply fixing IMPR.

2) NOTE IMPR as determined in (1) above is applied to the market size the previous quarter to determine import volume this quarter.

3. Market intermediaries (not yet in program)

It is very unusual for households to buy their goods directly from the producers. Wholesalers and retailers enter in between as distributors. Such intermediaries mean a lot for the competitive features of consumer goods markets. Since this model does not operate in terms of differentiated products and direct product competition in each market, wholesale and retail intermediaries won't figure in their most important capacity, namely as competitors (or collusionists) and exhibitors of what range of products are available. In this model they will only appear in their third function of moving the goods from the factory gates to the retail shops. With this in mind it is quite reasonable to lump them all together into one body for each market that charges a mark up for their transport service, much in the same way as the service sector is treated in chapter III.

There is one important distinction. This sector holds inventories and takes a certain risk if consumer behaviour is erratic.

Hence, the following things happen between producers and households in each goods market.

Intermediaries are assumed to be very myopic in their expectations since they can always correct their mistakes in full the next period. On the basis of last quarter volume sales, they assess their inventory position and plan initially to order new goods from producers and to move stocks to optimum levels and to realize a sales volume increase of the same magnitude as the previous quarter. Hence, intermediaries enter the market with the following opening bid[1]:

$$\begin{cases} \text{ORDV:} = (1+\text{DSV}) * \text{XSV} * (1-\text{TARGM}) + \text{OPTSTO} - \text{STO} \\ \text{EXPDP} = \text{offering price} \end{cases} \qquad (2)$$

ORDV stands for ordering value and XSV for expected sales value of the same product.

Producers respond by telling whether they can supply this and their offering price. Intermediaries respond by offering to buy:

$$\begin{cases} \text{ORDV:} = (1+\text{DSV}) * \text{XSV} * (1-\text{TARGM}) + \text{SPEC} * \{\text{MAXSTO} - \text{STO}\} \\ \text{SPEC} = \text{F} * \{\text{EXPDP} - \text{OFFERDP}\} \end{cases} \qquad (3)$$

SPEC is a time reaction coefficient (SPEC for speculation) that determines the rate at which dealers want to fill up their warehouses. This rate depends on how much they expect prices to change over the next four quarter period compared to the price they are offered now.

---

1) Everything quarterlized.

We may stop here or continue iterations, as we wish.

When stocks have been updated intermediaries stand ready to supply households with:

$$SU = (STO-MINSTO)*(1-TARGM) \tag{4}$$

at EXPP and in competition with an import volume supply already fixed. Market prices are then determined as described in the next section.

Profit margins, labour demand and productivity are treated as in the service sector specified by (1A-F) in chapter V. Profits from this sector feed into the household sector in total since they consist of either wages to employed labour or owners income by definition.

4. Household demand and supply interactions[1)]

Household demand derives from the expenditure system introduced in the previous chapter. This system simply tells how households will divide up their income between saving on the one side and various consumption categories on the other in response to a given price vector.

---

1) I here explain what is now in the program. In the program households and firms (= producers) face one another directly.

Firms supply this price feeler PRELPDOM at which they are willing to supply[1]:

OPTSU: = Q+(STO-OPTSTO) (5)

With foreign supply added, total initial market supply is:

OPTSUDOM: = Q+(STO-OPTSTO)+SUFOR (5B)

Initial firm supply is entered from the production system after labour market search, when the production plan has been finally fixed on the basis of a given and known labour force (see pseudocode (5.4.3.1)).

Households now tell firms what volumes they are willing to buy by feeding the PRELPDOM feeler vector into their consumption function. On the basis of this information firms respond by stepping up the offering price slightly if demand (volume) turns out to be larger than expected and vice versa.

Households again respond to this revised price feeler by telling a new demand volume and the whole thing is repeated N times within the limits

---

1) Note that we have to treat firms as a group here. The offering price hence is the average offering price. See (7.1.2) in pseudo code.

set by total supply volumes in (5B) and total household income. Thereafter period prices and household purchases are assumed set.

On the household side saving can now be calculated residually.

On the firm side we now know how much exports and households together have taken out of their production and what has happened to <u>total</u> stocks.

Since we have chosen not to individualize firm behaviour in the market a substitute distribution algoritm for inventory change has to be entered (see (8.1) in Pseudo Code).

The total change in finished goods inventories is determined at the end of product market iterations and is distributed proportionally to size over firms. For individual firms this may mean that stocks will exceed upper storage limits or fall down below minimum storage requirements. This is solved by setting STO equal to MAX or MIN STO respectively for these individual firms.

The adjusted total change in STO is then distributed proportionally over the remaining firms.

TECHNICAL SPECIFICATIONS

by

Gunnar Eliasson, Mats Heiman, Gösta Olavi

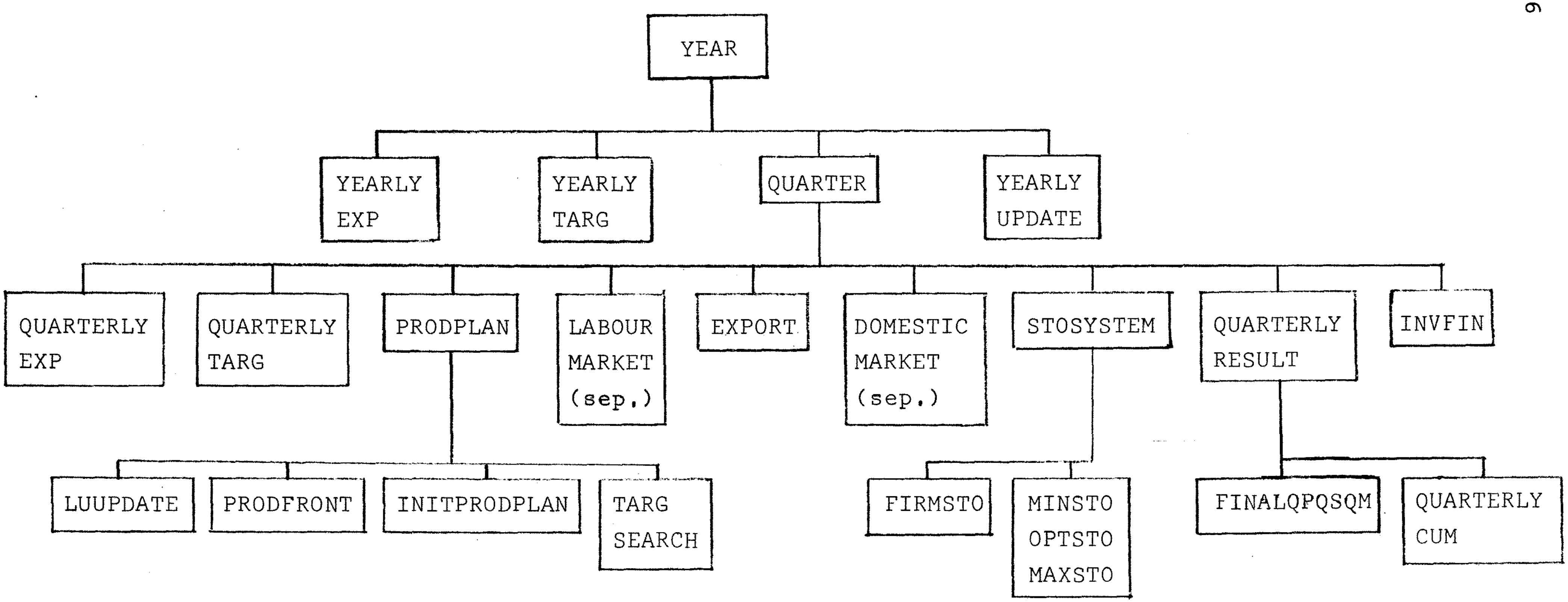
MODEL PSEUDO CODE

The MOSES computer simulation program is written in the APL language. In this publication we do not include a listing of the program; instead we give the following "pseudo-code" specifications, which in a more English-like syntax depicts the APL program.

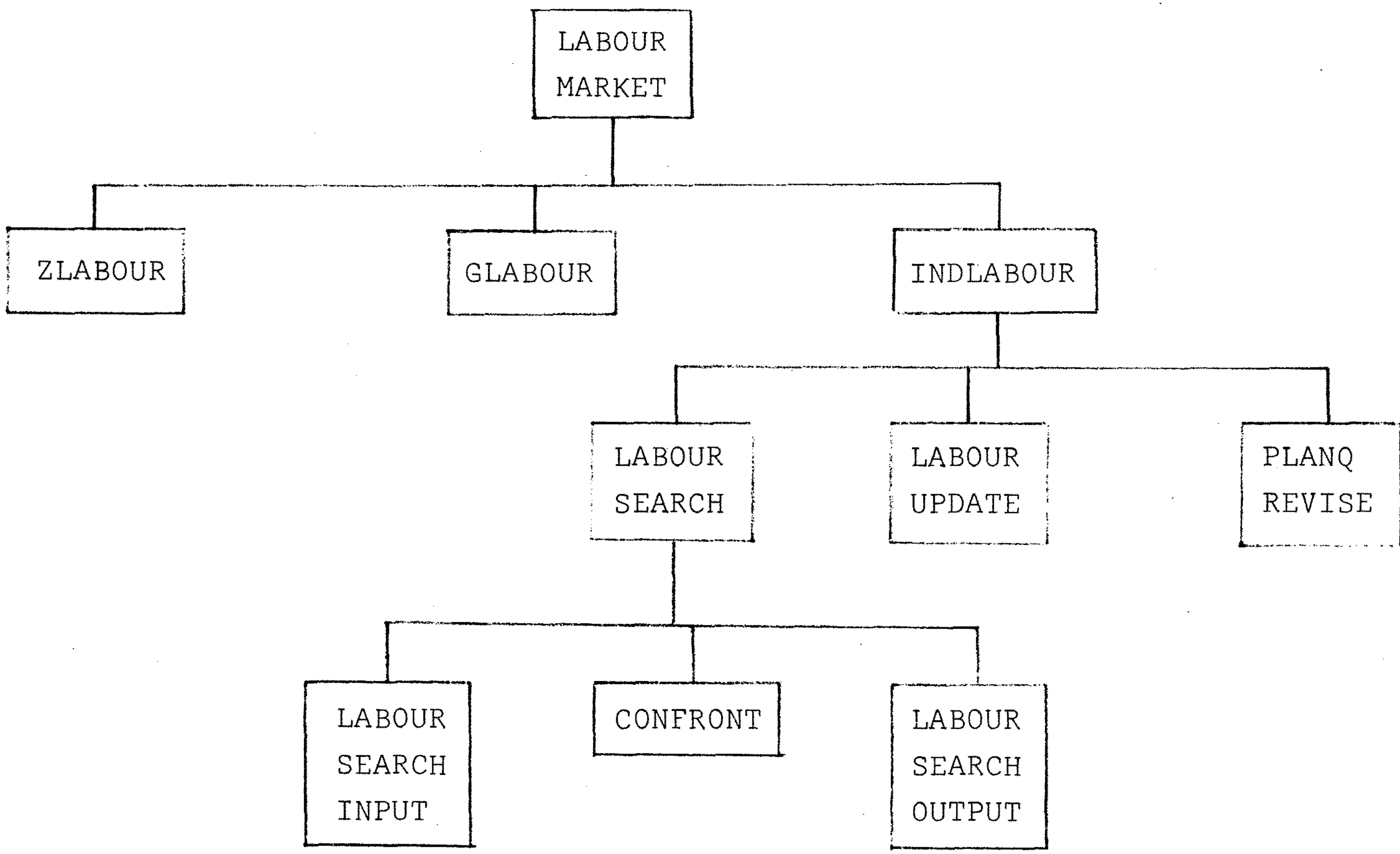
The computer simulation is forwarded through time in a very straight-forward way. Unless otherwise indicated by branching instructions, etc, the equations are executed one by one. (For one year, the quarterly blocks 3-9 are repeated 4 times).

Note that, Moses being a micro-based model, the execution of one equation often means several assignments, for firms, markets, household groups, etc. We do not use an indexing system in the pseudo-code; in general it will be clear from the context if equations (and variables and parameters) refer to global entities or to firms, markets, etc. This information can also be found in the variable listing which concludes this section.

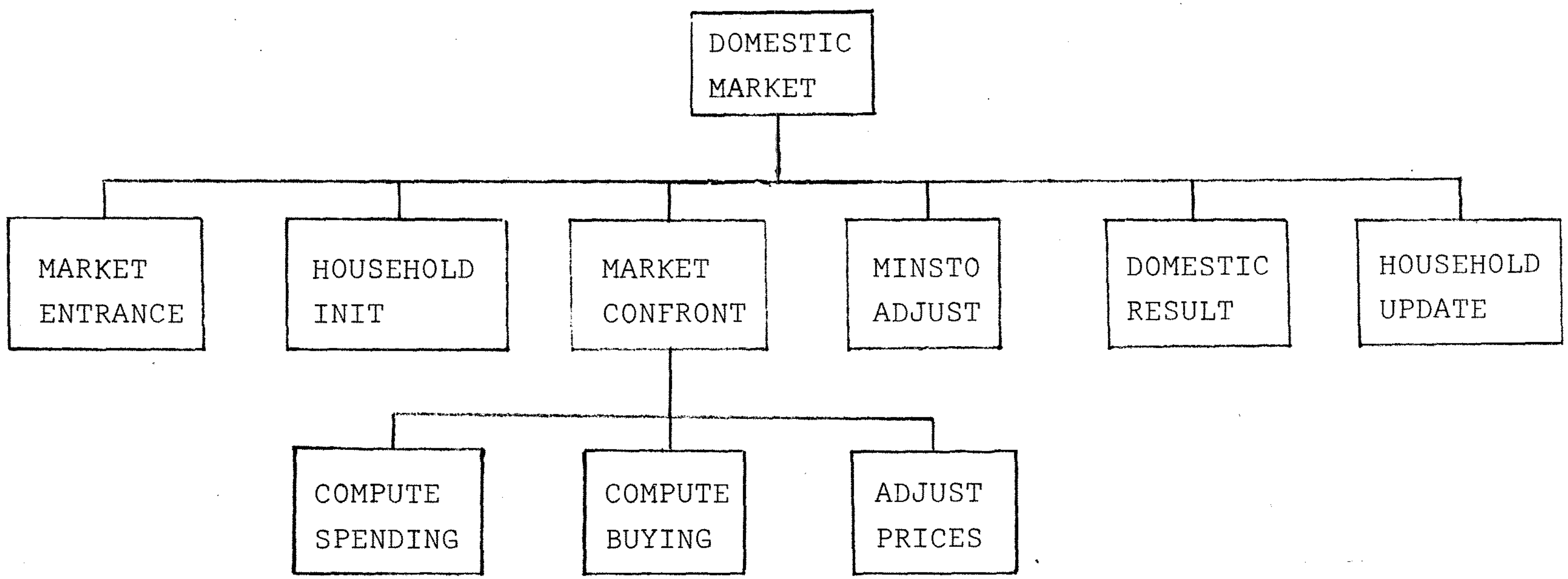
Part 1 of 3



MOSES Block Diagram



<u>MOSES Block Diagram:</u>
Detail of Labour Market block



MOSES Block Diagram:
Detail of Domestic Market block

0. Yearly initialization

(YEARLY INIT)

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

CUMQ, CUMM, CUMSU, CUMS, CUMWS, CUML

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

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 and the exogenous constants E1, E2 and the "extroversion" coefficient R do not vary between firms. DP, DW, DS were computed last year in block "Yearly update".

1.1 Prices

1.1.1 EXPIDP:= SMP x EXPIDP +

$$\{1-SMP\} \times \{DP + E1 \times (DP-EXPDP) - E2 \times (DP-EXPDP)^2\}$$

1.1.2 EXPXDP:= EXOGENOUS

1.1.3 EXPDP:= (1-R) x EXPIDP + R x EXPXDP

1.2 Wages

1.2.1 EXPIDW:= SMW x EXPIDW

$$+ \{1-SMW\} \times \{DW+E1 \times (DW-EXPDW) - E2 \times (DW-EXPDW)^2\}$$

1.2.2 EXPXDW:= EXOGENOUS

1.2.3 EXPDW:= (1-R) x EXPIDW + R x EXPXDW

1.3 Sales.

1.3.1 $EXPIDS := SMS \times EXPIDS + \{1-SMS\} \times \{DS + E1 \times (DS-EXPDS) - E2 \times (DS-EXPDS)^2\}$

1.3.2 EXPXDS:= EXOGENOUS

1.3.3 $EXPDS := (1-R) \times EXPIDS + R \times EXPXDS$

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 fed-back value of margin M is computed in the block "Yearly update". The fraction EPS increases target pressure (if it is not = zero).

2.1 MHIST:= SMT x MHIST + (1-SMT) x M

2.2 TARGM:= MHIST x (1 + EPS)

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.

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 x (QDP - QEXPDP)

QEXPDW:= QEXPDW + FIW x (QDW - QEXPDW)

QEXPDS:= QEXPDS + FIS x (QDS - QEXPDS)

3.1.3 QEXPP:= QP x (1 + QEXPDP)

QEXPW:= QW x (1 + QEXPDW)

QEXPS:= QS x (1 + QEXPDS)

3.2 Quarterly Targeting

(QUARTERLY TARG)

CUMM from block "Quarterly cumulation"

3.2.1 $$QTARGM := TARGM + \frac{NRS-1}{5-NRS} \times (TARGM-CUMM)$$

(This formula may generate too high "target pressure" on firms. As a consequence, an unrealistically large number of firms contract production to zero and go out of production. A device called NOPRESSURE can be used in simulation experiments to assure that always QTARGM = TARGM)

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 + LZ + LG + SUM(L)

4.LU.2 L:= L x (1-RET)

4.LU.3 AMAN1,2,3:= AMAN1,2,3 x (1-RET)

4.LU.4 LU:= LU x (1-RET)

4.LU.5 LU:= LU + ENTRY x 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:

$$4.0.1 \qquad QFR(L) = (1\text{-}RES) \times QTOP \times (1 - e^{-\frac{TEC}{QTOP} \times L})$$

The inverse of this function will also be used:

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

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

investment-financing block)

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

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

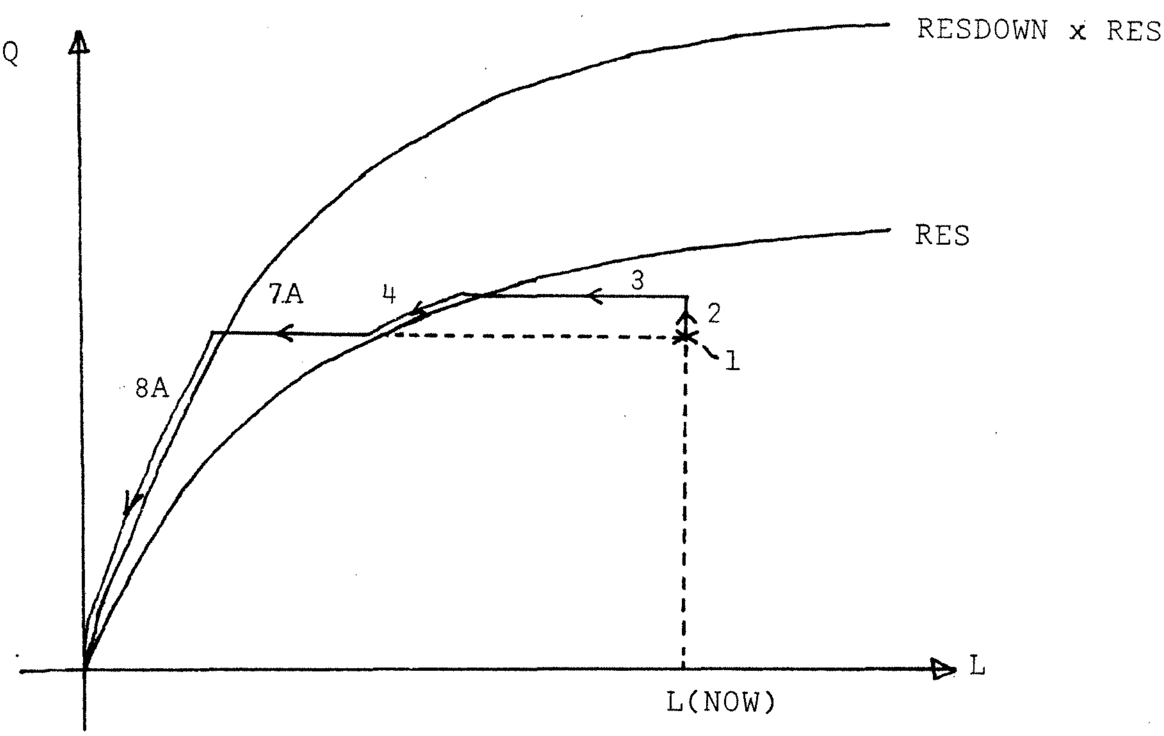
4.3 Search for Target Satisfaction (TARGSEARCH)

This block describes how a firm varies its combination of labour input and production level to satisfy its profit margin requirement (TARGM). 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.

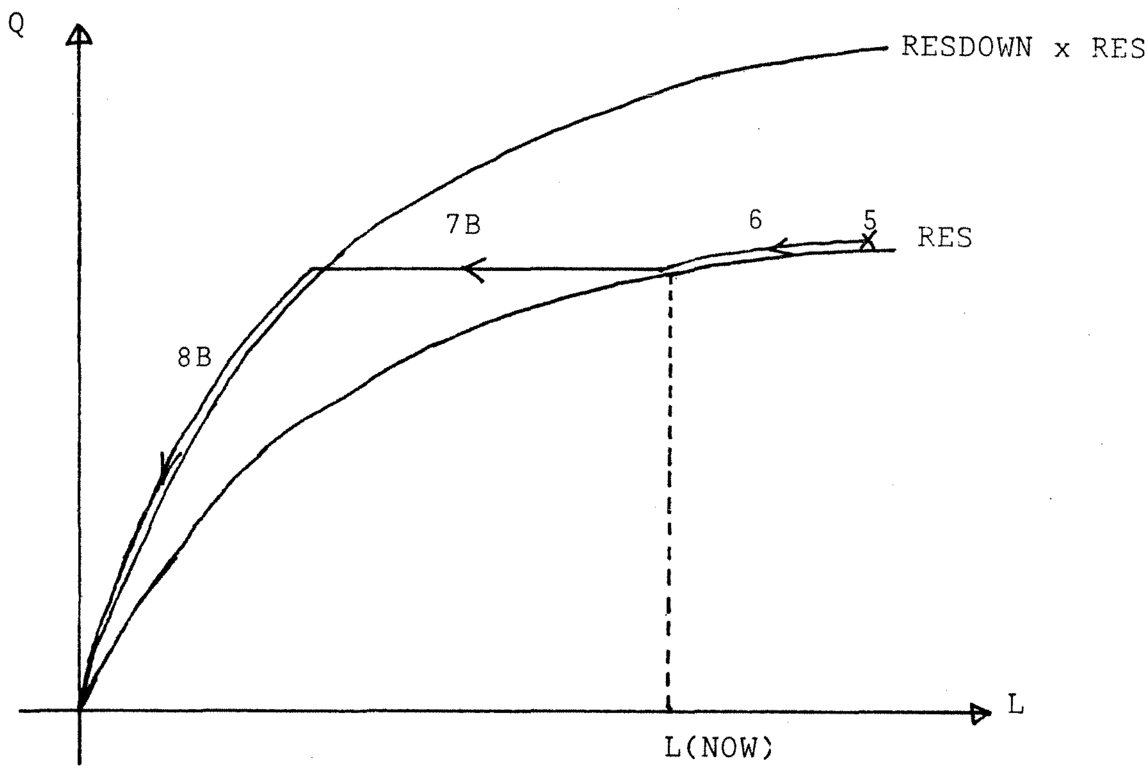
The diagrams and search paths on the next page explain how this search process has been modelled. Note that search will probably terminate within one of the paths, and not at a corner. Two cases can be distinguished, depending on whether the initial plan implies recruitment or not.

Two devices called "SAT" and "SOLVE" are referred to throughout the block; they are described in 4.3.11 and 4.3.12.

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



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



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

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

```
IF QPLANQ ≥ QTOP x (1-RES)
   THEN GOTO 4.3.6
   ELSE IF QPLANQ > QFR(L)
           THEN GOTO 4.3.5
           ELSE CONTINUE
```

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

```
IF SAT(QPLANQ,L)
   THEN QPLANL:=L
        GOTO 4.3.10
```

4.3.2 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 x (QEXPW/4) / ((1-QTARGM) x QEXPP)

        QPLANL:=L
        GOTO 4.3.10
   ELSE IF Q2=QFR(L)
           THEN GOTO 4.3.4
           ELSE CONTINUE
```

4.3.3 Cut down labour force, still producing up to the stock limit (path 3).

```
IF SAT(Q2,RFQ(Q2))
    THEN QPLANQ:=Q2
         QPLANL:= (1-QTARGM)xQ2xQEXPP / (QEXPW/4)
         GOTO 4.3.10
```

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

```
IF SAT (QPLANQ,RFQ(QPLANQ))
   THEN QPLANQ,QPLANL:=SOLVE
        GOTO 4.3.10
   ELSE Q7:=QPLANQ
        GOTO 4.3.7
```

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

```
IF SAT(QPLANQ, RFQ(QPLANQ))
   THEN QPLANL:= RFQ(QPLANQ)
        GOTO 4.3.10
```

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

```
IF SAT(QFR(L),L)
   THEN QPLANQ,QPLANL:=SOLVE
        GOTO 4.3.10
   ELSE Q7:=QFR(L)
```

4.3.7 Keep production at the level Q7 (as it resulted from 4.3.4 or 4.3.6), but reduce the slack RES and thereby the labour force. RESDOWN is an exogenous constant (path 7), telling how much slack can be reduced during a single quarter.

IF SAT(Q7,RFQ($\frac{1\text{-RES}}{1\text{-RESDOWNxRES}}$ x Q7))

THEN QPLANQ:=Q7

$$\text{QPLANL} := \frac{(1\text{-QTARGM})\text{xQ7xQEXPP}}{\text{QEXPW}/4}$$

$$\text{RES} := 1 - \frac{\text{Q7x}(1\text{-RES})}{\text{QFR}(\text{QPLANL})}$$

GOTO 4.3.10

ELSE RES:=RESDOWNxRES

4.3.8 With the new, lower, slack from 4.3.7, try to reach target by reducing production and labour force (path 8).

```
IF SAT(0,0)
   THEN QPLANQ,QPLANL:=SOLVE
        GOTO 4.3.10
```

4.3.9 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
```

4.3.10 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
```

4.3.11 "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> $MARGIN := 1 - \frac{L x (QEXPW/4)}{Q x QEXPP}$

<u>ELSE</u> $(L=0)$ $MARGIN := 1 - \frac{QEXPW/4}{(1-RES) x TEC x QEXPP}$

(The case L=0 is used in 4.3.8)

<u>IF</u> $MARGIN \geqslant QTARGM$

<u>THEN</u> SAT:= TRUE

<u>ELSE</u> SAT:= FALSE

4.3.12 "SOLVE": This device solves the equation:

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

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

QPLANQ:= QFR(QPLANL)

(See the program for details on how the equation is solved, using the Newton-Raphson iteration method).

4.3.12 SOLVE in detail

The equation is

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

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

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

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

With a substitution this gives

$$1-e^{-y}=b.y$$

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

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

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

We want to use Newton-Raphson's formula

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

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

Exemple of one-firm SOLVE:

```
    ∇ SOLVE
[1]   Y←÷B←QEXPW÷(1-QTARGM)×(1-RES)×TEC×QEXPP×4
[2]  LOOP:→LOOP+D<0.001×Y←Y-D←((B×Y)+(*-Y)-1)÷(B-(*-Y))
[3]   QPLANQ←QFR QPLANL←Y×QTOP÷TEC
    ∇
```

For b 1, this algorithm gives the correct result y = 0. The possibility of b 0 must be checked, however.

The algorithm is easily modified to the case where it should be applied to several equations simultaneously.

5. LABOUR MARKET

(LABOUR MARKET)

5.1 Updating of unemployment

(LUUPDATE)

(This block has been moved to block 4).

5.2 Service sector labour market

(ZLABOUR)

Service sector takes the labour it wants from the pool of unemployed. Wage increase in service sector is equal to average wage increase in industry last quarter. Offering price is calculated.

5.2.1 TECZ:= TECZ x (1 + QDTECZ)

(QDTECZ is entered exogenously)

5.2.2 QCHLZ is calculated to use last quarter's surplus (or deficit) profit (compared with targets) to increase (or diminish) labour force. Notice that QCHLZ also includes substitutes for the retired.

$$QCHLZ := \frac{(QMZ-QTARGMZ) x QPZ x TECZ x LZ}{QWZ/4} + RET x LZ$$

(QTARGMZ is entered exogenously)

(If QCHLZ $>$ LU we put QCHLZ=LU)

5.2.3 LZ:=LZ+QCHLZ-RETxLZ

5.2.4 LU:=LU-QCHLZ

Notice that if QCHLZ $<$ 0, this means that people are fired from service sector.

5.2.5 QWZ:=QWZx(1+QDWIND)

5.2.6 QQZ:= TECZ x LZ

5.2.7 Offering price is calculated to make QMZ=QTARGMZ

QPRELPZ:=QPZx(1+QDWIND-QDTECZ)

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. As government services are provided free, there are no prices or profit margins.

5.3.1 QCHLG:=LGxRET+REALCHLG

(REALCHLG is entered exogenously)

(If QCHLG LU we put QCHLG=LU)

5.3.2 LG:=LG+QCHLG-RETxLG

5.3.3 LU:=LU-QCHLG

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

5.3.4 QWG:=QWGx(1+QDWIND)

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 probability for a given firm to be chosen is proportional to its size). 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 an exogenouosly given number).

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

5.4.1.0 Help variables and initial wage offering:

CHL:= QPLANL - L

WW:= QW + IOTA x (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 - 5.4.1.10 NITER times (one time representing one attack from each firm).

5.4.1.3 Repeat 5.4.1.4 - 5.4.1.11 NTOT times (one time representing an attack from one 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 <u>IF</u> CHL(I) $\leq$ 0 <u>THEN</u> go to 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 CHOOSE. The probability for a certain firm to be choosen is the size of its labour force, divided by the sum of the labour forces in all firms plus the number of unemployed).

5.4.1.7 We now check whether the attacked firm really was a firm (II $\leq$ NTOT), or whether it was the unemployed (II=NTOT+1) (cf comment to 5.4.1.0).

```
IF II≤ NTOT
   THEN go to 5.4.1.8
   ELSE go to 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 WW(II):=WW(II)+KSISUCCx(WW(I)-WW(II))
        go to 5.4.1.9
   ELSE WW(I):=WW(I)+KSIFAILx(WW(II)*(1+GAMMA)-WW(I))
        go to 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) the attack is always a success.
(In the program 5.4.1.9 is a function called TAKE L FROM)

```
CHLNOW:=MIN(THETA*LL(II),CHL(I))
LL(I):=CHL(I)+CHLNOW
CHL(I):=CHL(I)-CHLNOW
LL(II):=LL(II)-CHLNOW
IF II ≤ NTOT
   THEN CHL(II):=CHL(II)+CHLNOW
```

5.4.1.10 One attack is completed, go to 5.4.1.3.

5.4.1.11 All firms have had the opportunity to attack once, go to 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

(LABOUR UPDATE)

Layoff is accomodated. Wage increase in the industry is computed. Labour force and wage is updated for each firm, as described 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:

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

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

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

5.4.2.3 Update labour force and wage:

L:= L + QCHL

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

QW:= QW + QCHW

5.4.2.4 Unemployment:

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

RU:= RU + CHRU

5.4.3 Revision of Production Plans (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 new level of production assigned to the variable QQ is determined in this block. Optimum sales volume is computed.

5.4.3.1 QPLANQ:= MIN(QPLANQ, QFR(L))

(QFR is the production frontier as described in block 4.0)

5.4.3.2 $QDQ := \frac{QPLANQ}{QQ} - 1$

5.4.3.3 $QQ := QQ \times (1 + QDQ)$

5.4.3.4 $QOPTSU := MAX\left\{0, QEXPSU \times \frac{QQ}{QEXPSU + \frac{OPTSTO-STO}{4 \times TMSTO}}\right\}$

6. EXPORT MARKETS

(EXPORT)

Export share and supply, price and sales in foreign markets are determined.

6.1.1 IF QPDOM $\geqslant$ QPFOR

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

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

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 x QOPTSU

6.1.3 QPFOR:= (1 + QDPFOR) * QPFOR

(QDPFOR is entered exogenously).

6.1.4 QSFOR:= QSUFOR * QPFOR

7 Domestic Product Market

(DOMESTIC MARKET)

This block describes the interaction between firms and households, resulting in domestic prices and sales volumes for a quarter (service sector is also treated). It consists of the following parts:

1. Market Entrance
2. Household Initialisation
3. Market Confrontation
4. Computation of Household Spendings
5. Computation of Total Buyings
6. Price Adjustments
7. Adjustment to Minimum Stock
8. Domestic Result
9. Updating of Households´ Data

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

Functionally, blocks 1, 6, 7, 8 describe the behaviour of firms. Blocks 2, 4, 9 form an integrated model of household behaviour and can be studied separately.

Block 3 is the link between firms and households. Block 5 is included to adjust demand to import competition and to handle the firms´ investments.

The following abbreviations denote household spending cathegories:

NDUR - Services and non-durable goods.

Z - Service (subset of NDUR).

DUR - Durable goods.

MKT - All NDUR and DUR, with the exception of the service sector.

SAV - Household saving.

7.1 Market Entrance

(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 similarily.

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

7.1.2 $$QPRELPDOM := QPDOM \times \frac{SUM\left\{QOPTSUDOM \times \frac{QEXPP}{QP}\right\}}{SUM(QOPTSUDOM)}$$

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

7.2 Household Initialisation

(HOUSEHOLD INIT)

7.2.1 Disposable income per household

$$QDI:=\left\{QMZ \times QSZ + LZ \times \frac{QWZ}{4} + LG \times \frac{QWG}{4} + SUM(L \times \frac{QW}{4})\right\} /NH$$

$$+ WH \times \frac{RI}{4}$$

7.2.2 "Essential" consumption volume (NDUR,DUR)

$$CVE(I):= ALFA1(I) + ALFA2(I) \times CVA(I)$$

(CVA, "addicted" volume, is updated each quarter in 7.9.4).

7.3 Market Confrontation

(MARKET CONFRONT)

(This market specification subroutine is provisional. We should 1) Have a more sophisticated termination criterion than simply a fixed number of iterations or 2) Let each iteration correspond to a period of time within the quarter, having the cumulated lapse of time terminate iterations at the end of a quarter).

Adjust import shares IMP. Form the vector PT of trial prices. Let firms and households interact a pre-specified number of times.

7.3.1 IF QPDOM $\geq$ QPFOR

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

$$\text{ELSE IMP} := \text{IMP} - \frac{\text{IMP}}{4 \times \text{TMIMP}} \times \frac{\text{QPFOR} - \text{QPDOM}}{\text{QPDOM}}$$

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):= QPRELPDOM

PT(Z):= QPRELPZ

7.3.3 Perform 7.3.3 - 7.3.5 MARKET-ITER times:

7.3.4 Compute household spendings (see 7.4)

7.3.5 Compute total buyings (see 7.5)

7.3.6 (Not in the last iteration)
Adjust prices (see 7.6)

7.4 Computation of Household Spendings

(COMPUTE SPENDING)

This block describes how households react to a set of trial offering prices in respective spending categories. It will interact with firms several times in an iterative manner. The spending categories correspond to the firms' markets and the service sector. Prices are called PT (trial) and QPH (last quarter's final prices). QDI and CVE come 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 spending cathegories:

$$QPRELCPI := \frac{SUM(QC(I))}{SUM\left\{\frac{QC(I)}{PT(I)}\right\}} \quad ^{x)}$$

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

7.4.2 Nondurables consumption, essential spending

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

7.4.3 Durables, essential spending

$$SWAP := ALFA3 \times \left(\frac{CHRI}{4} - CHDCPI\right) + ALFA4 \times CHRU$$

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

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

---

x) Experiments will also be made with the following formula:

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

7.4.4 Essential level of saving:

QSPE(SAV):= (WHRAxQDI-WH)+QDIxSWAP

(WHRA is updated in 7.9.4)

7.4.5 Adjustment to income constraint

("I" denotes NDUR,DUR,SAV)

$$QSP(I):=BETA1(I)xQSPE(I) + \left\{BETA2(I) + \frac{BETA3(I)}{QDI/QPRELCPI}\right\} x \left\{QDI - SUM(BETA1(I)xQSPE(I))\right\}$$

where all BETA1 $\geqslant$ 0

SUM(BETA2)=1

SUM(BETA3)=0

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

7.5 Computation of total buyings

(COMPUTE BUYING)

Sum over households to obtain total spending for each spending category (= market). Add firms' investment to demand in durables sector (fixed sum of money, no matter what the price is).
Adjust for import (an exogenous fraction) and convert from money to volume.

7.5.1 QTSP:= SUM(QSP)

(Sum over households, not over categories)

7.5.2 QTSP(DUR):= QTSP(DUR) + SUM(QINVLAG)

(Sum over all firms).

7.5.3 QTBUY:= (1-IMP) x QTSP/PT

7.6 Price Adjustments

(PRICE ADJUST)

This block describes how firms (in each iteration) adjust their prices, once households have responded to a set of prices with provisional spendings.

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

7.6.1 IF QTBUY < SUM(QOPTSUDOM)

$$\text{THEN PT:= PT} - \frac{\text{ABS(EXPXDP) x PT}}{\text{4 x (MARKET ITER-1)}}$$

$$\text{ELSE PT:= PT} + \frac{\text{ABS(EXPXDP) x PT}}{\text{4 x (MARKET ITER-1)}}$$

7.7 Adjustment to Minimum Stock

(MINSTO ADJUST)

Market interactions may result in a demand that would lower stocks below minimum levels. In that case, spending is reduced in this block. (Equations 7.7.1-7.7.4 hold for markets, not for individual firms. 7.7.2 - 7.7.3 also hold for service).

7.7.1 $\text{QMAXTSUDOM} := \text{MAX}\{0, \text{SUM}[\text{QQ} + (\text{STO}-\text{MINSTO}) - \text{QSUFOR}]\}$

7.7.2 $\text{REDUCE} := \text{MIN}\ (1, \frac{\text{QMAXTSUDOM}}{\text{QTBUY}})$

(For service, $\text{REDUCE} := \text{MIN}\ (1, \frac{\text{QQZ}}{\text{QTBUY}})$

7.7.3 $\text{QSP} := \text{QSP} \times \text{REDUCE}$

7.7.4 $\text{QTBUY} := \text{QTBUY} \times \text{REDUCE}$

7.7.5 $\text{QINVLAG} := \text{QINVLAG} \times \text{REDUCE(DUR)}$

(Holds for each firm).

7.8 Domestic Result

(DOMESTIC RESULT)

Domestic price is updated in each market (cf. QPH in 7.9.5 which also contains the service sector price).

Total change in stock level is computed for each market. If demand was so small that the maximum (total) stock level is exceeded, the excess quantity is assumed "burned".

7.8.1 $$QDPDOM := \frac{PT(MKT)}{QPDOM} - 1$$

7.8.2 QPDOM:= PT(MKT)

7.8.3 QPZ:= PT(Z)

7.8.4 QCHTSTO:= MIN(SUM(MAXSTO-STO), SUM(QQ-QSUFOR)-QTBUY)

7.8.5 QSZ:= QTBUY(Z) x QPZ

7.9 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 spending pattern. Trial prices (PT) are then made final (QPH).

7.9.1 Nondurables consumption

QC(NDUR):= QSP(NDUR)

7.9.2 Durables consumption and update

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

$$QC(DUR) := RHODUR \times STODUR$$

$$STODUR := (1-RHODUR) \times STODUR$$

7.9.3 Saving

$$QSP(SAV) := QSAVH := QDI - SUM\{QSP(NDUR,DUR)\}$$

$$WH := WH + QSAVH$$

7.9.4 Addicted levels

(I denotes NDUR and DUR)

$$CVA(I) := SMOOTH(I) x CVA(I) + (1 - SMOOTH(I)) x \frac{QC(I)}{PT(I)}$$

$$WHRA := SMOOTH(SAV) x WHRA + (1 - SMOOTH(SAV)) x \frac{WH}{QDI} \quad xx)$$

7.9.5 Prices

QPH:= PT

OLDQCPI:= QCPI

$$QCPI := \frac{SUM(QC(I))}{SUM\left\{\frac{QC(I)}{QPH(I)}\right\}} \quad x)$$

QDCPI:= (QCPI - OLDQCPI)/OLDQCPI

---

x) See note to 7.4.1

xx) In a first phase of the project, SMOOTH(SAV)=1 will be used. This will have the effect of a fixed (exogenous) WHRA.

8. INVENTORY SYSTEM
(STOSYSTEM)

8.1 Distributing change in inventories over firms
(FIRMSTO)

Change in inventories industry by industry (from block 7) is distributed over individual firms in each industry. Thereafter domestic sales are calculated as a residual.

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

```
IF STO > MAXSTO
   THEN QCHTSTO:=QCHTSTO+STO-MAXSTO
        STO:=MAXSTO
   ELSE IF  STO < MINSTO
            THEN QCHTSTO:=QCHTSTO+STO-MINSTO
                 STO:=MINSTO
```

8.1.2 The rest of QCHTSTO is distributed over the firms.

IF QCHTSTO > 0

THEN $STO:=STO+\frac{MAXSTO-STO}{SUM(MAXSTO-STO)}$

ELSE $STO:=STO+\frac{MINSTO-STO}{SUM(MINSTO-STO)}$

8.1.3 Domestic sales are calculated.

QSUDOM:= QQ-QSUFOR-QCHSTO

QSDOM:= QSUDOM x QPDOM

(Where QCHSTO for each firm is the sum of the changes in inventories made in 8.1.1 and 8.1.2.)

8.2 Reference Inventory Levels

The levels MINSTO, MAXSTO, OPTSTO are computed based on last quarter´s sales as follows:

8.2.1 $\text{MINSTO} := \text{SMALL} \times (4 \times \frac{QS}{QP})$

8.2.2 $\text{MAXSTO} := \text{BIG} \times (4 \times \frac{QS}{QP})$

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

(In the computer program, these levels are not implemented as variables but as value-returning sub-routines).

9.1 Calculating final prices, sales and profits (FINALQPQSQM)

We have the values of prices and sales in foreign and domestic markets, and calculate total sales and average prices. 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 $QM := 1 - \frac{L \times (QW/4)}{QS}$

9.1.7 $QMZ := 1 - \frac{LZ \times (QWZ/4)}{QSZ}$

9.2 Quarterly Cumulation

(QUARTERLY CUM)

Production, sales, wage sum, and labour force are cumulated. An up-till-now margin is computed.

9.2.1 $$CUMQ := CUMQ + QQ$$

9.2.2 $$CUMS := CUMS + QS$$

9.2.3 $$CUMSU := CUMSU + QSU$$

9.2.4 $$CUMWS := CUMWS + L \times \frac{QW}{4}$$

9.2.5 $$CUML := \frac{(NRS-1) \times CUML + L}{NRS}$$

9.2.6 $$CUMM := 1 - \frac{CUMWS}{CUMS}$$

10. Investment Financing (provisional)
(INVFIN)

Update book value of production equipment, and calculate this quarter's rate of return. New borrowing depends on inflation and on current rate of interest.
Investment has a one-quarter delivery lag. Profits and new borrowing are used for investment, except for an amount RW x 4 x QCHS used to keep working capital at a certain fraction RW of sales.

10.1 $K1 := K1 \times (1 - RHO + QDPDOM(DUR)) + QINV \times (1 - RHO)$

10.2 $QRR := 4 \times \frac{QM \times QS - RHO \times K1}{K1 + K2 + STO \times QP}$

10.3 $QCHS := QS \times \frac{QDS}{1 + QDS}$

10.4 $QCHK2 := RW \times 4 \times QCHS$

10.5 $K2 := K2 + QCHK2$

10.6 $QCHBW := BW \times (ALFABW + BETABW \times (\frac{QRR}{4} + QDPDOM(DUR) - \frac{RI}{4}))$

10.7 BW:= BW + QCHBW

10.8 NW:= K1 + K2 + STO x QP - BW

10.9 QINV:= QINVLAG

10.10 $QINVLAG := MAX\left\{0, QMxQS - QCHK2 + QCHBW - \frac{RI}{4} \times BW\right\}$

10.11 $INVEFF := \frac{QTOPxQP}{K1}$

11. Yearly Update

(YEARLY UPDATE)

Yearly production, price, wage, sales, and margin are computed, based on cumulation in block "Quarterly Cum".

11.1 $DQ := \frac{CUMQ}{Q} - 1$

$Q := Q \times (1 + DQ)$

11.2 $DP := \frac{CUMS/CUMSU}{P} - 1$

$P := P \times (1 + DP)$

11.3 $DW := \frac{CUMWS/CUML}{W} - 1$

$W := W \times (1 + DW)$

11.4 $DS := \frac{CUMS}{S} - 1$

$S := S \times (1 + DS)$

11.5 $CHM := CUMM - M$

$M := M + CHM$

Listing of Variables and Parameters

The following pages give a description of all variables and parameters occuring in the pseudo-code (and hence in the computer program). Variables and parameters described in the textual documentation, but not yet included in the computer program, are explained in the main text when they are first introduced.

Exogenous Variables:

The following variables are treated as exogenous, as the model now stands (see the following pages for an explanation of each variable):

Related to foreign markets: QDPFOR

Related to technological progress: QDMTEC, QDTECZ

Related to expectations: EXPXDP, EXPXDS, EXPXDW

Related to public sector: REALCHLG, RI

Others: ENTRY; TARGMZ

ALFABW - CONSTANT USED IN 'INVFIN' TO DETERMINE FIRMS' CHANGE IN BORROWING.

ALFA1 - CONSTANTS USED IN 'HOUSEHOLD INIT' TO DETERMINE 'ESSENTIAL' CONSUMPTION VOLUME FOR EACH SPENDING CATEGORY.

ALFA2 - CONSTANTS USED IN 'HOUSEHOLD INIT' TO DETERMINE 'ESSENTIAL' CONSUMPTION VOLUME FOR EACH SPENDING CATEGORY.

ALFA3 - CONSTANT USED IN 'COMPUTE SPENDING' TO DETERMINE THE SHORT-TERM SWAP BETWEEN SAVINGS AND SPENDINGS ON DURABLES.

ALFA4 - CONSTANT USED IN 'COMPUTE SPENDING' TO DETERMINE THE SHORT-TERM SWAP BETWEEN SAVINGS AND SPENDINGS 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 THIS QUARTER, ETC.

BETA - CONSTANTS USED TO COMPUTE OPTIMUM INVENTORY LEVELS IN RELATION TO 'MINSTO' AND 'MAXSTO'. SAME FOR ALL FIRMS WITHIN A MARKET.

BETA1 - CONSTANTS USED IN 'COMPUTE SPENDING' TO ADJUST SPENDINGS IN DIFFERENT CATEGORIES TO THE INCOME CONSTRAINT. ALL BETA1≥0

BETA2 - CONSTANTS USED IN 'COMPUTE SPENDING' TO ADJUST SPENDINGS IN DIFFERENT CATEGORIES TO THE INCOME CONSTRAINT. SUM(BETA2)=1.

BETA3 - CONSTANTS USED IN 'COMPUTE SPENDING' TO ADJUST SPENDINGS IN DIFFERENT CATEGORIES TO THE INCOME CONSTRAINT. SUM(BETA3)=0.

BIG - ON EACH MARKET, THE FRACTION OF YEARLY SALES THAT FIRMS CONSIDER AS INVENTORY MAXIMUM.

BW - A FIRM'S TOTAL BORROWING. UPDATED IN 'INVFIN'.

CHDCPI - ATTEMPTED RISE IN CONSUMER PRICE INDEX BETWEEN QUARTERS (A FRACTION). COMPUTED IN 'COMPUTE SPENDING' EACH TIME HOUSEHOLDS MEET AN OFFERING PRICE VECTOR 'PT'.

CHL - EACH FIRM'S CHANGE IN LABOUR FORCE. A HELP VARIABLE USED WITHIN 'LABOUR SEARCH' TO ACCOMODATE MARKET INTERACTIONS.

CHM - FOR EACH FIRM, ITS CHANGE IN PROFIT MARGIN FROM ONE YEAR TO ANOTHER (A DIFFERENCE BETWEEN FRACTIONS). COMPUTED IN 'YEARLY UPDATE'.

CHRU - QUARTERLY CHANGE IN RATE OF UNEMPLOYMENT (A DIFFERENCE BETWEEN FRACTIONS). COMPUTED IN 'LABOUR UPDATE'.

CUML - FOR EACH FIRM, A CUMULATION OVER THE YEAR OF THE NUMBER OF EMPLOYED. UPDATED IN 'QUARTERLY CUM'.

CUMM - FOR EACH FIRM, A CUMULATION OVER THE YEAR OF ITS PROFIT MARGIN. UPDATED IN 'QUARTERLY CUM'.

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'.

CUMSU - FOR EACH FIRM, A CUMULATION OVER THE YEAR OF ITS SALES VOLUME. UPDATED IN 'QUARTERLY CUM'.

CUMWS - FOR EACH FIRM, A CUMULATION OVER THE YEAR OF ITS WAGE SUM. UPDATED IN 'QUARTERLY CUM'.

CVA - A HOUSEHOLD'S 'ADDICTED' CONSUMPTION VOLUME IN EACH SPENDING CATEGORY (UNITS PER QUARTER). UPDATED IN 'HOUSEHOLD UPDATE'.

CVE - A HOUSEHOLD'S 'ESSENTIAL' CONSUMPTION IN EACH SPENDING CATEGORY (UNITS PER QUARTER). COMPUTED IN 'HOUSEHOLD INIT'.

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 'DURABLES'/'INDUSTRIAL INVESTMENT GOODS' DATA FROM A VECTOR.

DW - FOR EACH FIRM, ITS YEARLY WAGE CHANGE (A FRACTION). COMPUTED IN 'YEARLY UPDATE'.

ENTRY - A PARAMETER REGULATING THE INFLOW OF NEW PERSONS TO THE LABOUR MARKET (QUARTERLY FRACTION OF THE TOTAL LABOUR FORCE). SOFAR 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'.

EXPIDP - 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'.

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 UPDATE 'INTERNAL' EXPECTATIONS ON PRICES, SALES, AND WAGES.

E2 - A CONSTANT USED IN 'YEARLY EXP' TO UPDATE 'INTERNAL' EXPECTATIONS ON PRICES, SALES, AND WAGES.

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'.

GAMMA - A CONSTANT TELLING HOW BIG WAGE INCREASE IS NEEDED FOR A PERSON THAT HE SHOULD LEAVE HIS JOB FOR A NEW ONE. USED IN 'LABOUR SEARCH'.

IMP - IMPORT SHARE IN EACH MARKET. UPDATED IN 'MARKET CONFRONT'.

INVEFF - FOR EACH FIRM, ITS INVESTMENT EFFECIENCY (INCREASE IN QUARTERLY PRODUCTION VALUE, DIVIDED BY INVESTMENT). COMPUTED IN 'INVFIN'.

IOTA - A CONSTANT USED BY FIRMS TO FORM THEIR INITIAL WAGE OFFER IN 'LABOUR SEARCH'.

KSIFAIL - 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.

KSISUCC - A CONSTANT, USED IN 'LABOUR SEARCH', WHICH TELLS BY HOW MUCH AN ATTACKED FIRM RAISES ITS WAGE LEVEL AFTER IT HAS LOST PART OF ITS LABOUR FORCE.

K1 - FOR EACH FIRM, THE BOOK VALUE OF ITS PRODUCTION EQUIPMENT. UPDATED IN 'INVFIN'.

K2 - FOR EACH FIRM, ITS CURRENT ASSETS. UPDATED IN 'INVFIN'.

L - FOR EACH FIRM, ITS LABOUR FORCE. UPDATED IN 'LUUPDATE' (RETIREMENTS) AND IN 'LABOUR UPDATE' (OTHER CHANGES).

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'.

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.

LU - NUMBER OF PEOPLE UNEMPLOYED. UPDATED IN 'LUUPDATE' AND AT VARIOUS PLACES WITHIN BLOCK 'LABOUR MARKET'.

LZ - SERVICE SECTOR LABOUR FORCE. UPDATED IN 'ZLABOUR'.

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'.

MAXSTO - FOR EACH FIRM, ITS 'MAXIMUM' INVENTORY LEVEL (VOLUME TERMS). COMPUTATION IS DESCRIBED WITHIN BLOCK 'STOSYSTEM'.

MHIST - FOR EACH FIRM, AN AVERAGE OF PAST PROFIT MARGINS (A FRACTION). UPDATED IN 'YEARLY TARG'.

MINSTO - FOR EACH FIRM, ITS 'MINIMUM' INVENTORY LEVEL (VOLUME TERMS). COMPUTATION IS DESCRIBED WITHIN BLOCK 'STOSYSTEM'.

MKT - INDEX VARIABLE, EXTRACTING FROM 'SPENDING CATEGORY' VECTORS DATA THAT APPLY TO INDUSTRIAL MARKETS.

MTEC - ON EACH MARKET, TECHNOLOGY FACTOR OF MODERN EQUIPMENT (POTENTIALLY PRODUCED UNITS PER PERSON AND QUARTER). UPDATED IN 'PRODFRONT'.

NDUR - INDEX VARIABLE, EXTRACTING FROM 'SPENDING CATEGORY' VECTORS DATA THAT APPLY TO NON-DURABLE CONSUMPTION CATEGORIES.

NH - NUMBER OF HOUSEHOLDS - A CONSTANT, AS THE MODEL NOW STANDS.

NITER - NUMBER OF ITERATIONS ON THE LABOUR MARKET EACH QUARTER. USED IN 'LABOUR SEARCH'.

NW - FOR EACH FIRM, ITS NET VALUE AS THE RESIDUAL BETWEEN TOTAL ASSETS AND BORROWING. COMPUTED IN 'INVFIN'.

OPTSTO - FOR EACH FIRM, ITS 'OPTIMUM' INVENTORY LEVEL (VOLUME TERMS). COMPUTATION IS DESCRIBED WITHIN BLOCK 'STOSYSTEM'.

ORDER - 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. UPDATED IN 'YEARLY UPDATE'.

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, FIRMS' COMMON OFFERING PRICE TO HOUSEHOLDS IN ONE ITERATION. FIRST COMPUTED IN 'MARKET CONFRONT'; LATER UPDATED IN 'ADJUST PRICES'.

Q - FOR EACH FIRM, ITS TOTAL PRODUCTION FOR A YEAR (VOLUME). UPDATED IN 'YEARLY UPDATE'.

QC - A HOUSEHOLD'S CONSUMPTION IN EACH OF THE SPENDING CATEGORIES (VALUE PER QUARTER). COMPUTED IN 'HOUSEHOLD UPDATE'.

QCHBW - FOR EACH FIRM, ITS QUARTERLY CHANGE IN BORROWING. COMPUTED IN 'INVFIN'.

QCHK2 - FOR EACH FIRM, ITS QUARTERLY CHANGE IN CURRENT ASSETS. HELP VARIABLE USED IN 'INVFIN'.

QCHL - FOR EACH FIRM, ITS QUARTERLY LABOUR FORCE CHANGE DUE TO LABOUR MARKET INTERACTIONS (RETIREMENTS ARE NOT INCLUDED). COMPUTED LAST 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).

QCHLZ - NUMBER OF NEW PERSONS IN SERVICE SECTOR LABOUR FORCE EACH QUARTER (INCLUDING REPLACEMENTS FOR RETIREMENTS).

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 IS DIRECTED TO THE FIRM'S SLACK. COMPUTED IN 'PRODFRONT'.

QCHS - FOR EACH FIRM, ITS QUARTERLY CHANGE IN SALES (ABSOLUTE VALUE TERMS). HELP VARIABLE IN 'INVFIN'.

QCHTSTO - ON EACH MARKET, TOTAL QUARTERLY CHANGE IN INVENTORY TO BE DISTRIBUTED BETWEEN FIRMS. COMPUTED IN 'DOMESTIC RESULT'.

QCHW - FOR EACH FIRM, ITS QUARTERLY WAGE CHANGE IN ABSOLUTE TERMS. COMPUTED LAST IN 'LABOUR SEARCH'.

QCPI - CONSUMER PRICE INDEX, UPDATED IN 'HOUSEHOLD UPDATE'.

QDCPI - QUARTERLY CHANGE IN CONSUMER PRICE INDEX (A FRACTION). COMPUTED IN 'HOUSEHOLD UPDATE'.

QDI - A HOUSEHOLD'S DISPOSABLE INCOME FOR ONE QUARTER. COMPUTED IN 'HOUSEHOLD INIT'.

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'.

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'.

QDTECZ - QUARTERLY UPGRADE OF TECHNOLOGY FACTOR FOR THE SERVICE SECTOR (A FRACTION). EXOGENOUSLY ENTERED IN 'ZLABOUR'.

QDW - FOR EACH FIRM, ITS QUARTERLY WAGE INCREASE (A FRACTION). COMPUTED IN 'LABOUR UPDATE'.

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'.

QEXPP - FOR EACH FIRM, ITS EXPECTED SALES PRICE FOR THE NEXT QUARTER. COMPUTED IN 'QUARTERLY EXP'.

QEXPS - FOR EACH FIRM, ITS EXPECTED SALES VALUE FOR THE NEXT QUARTER. COMPUTED IN 'QUARTERLY EXP'.

QEXPW - FOR EACH FIRM, ITS EXPECTED WAGE LEVEL FOR THE NEXT QUARTER (EXPRESSED ON A YEARLY BASIS). COMPUTED IN 'QUARTERLY EXP'.

QFR - FOR EACH FIRM, ITS PRODUCTION POSSIBILITY FRONTIER (VOLUME PER QUARTER) AS A FUNCTION OF ITS LABOUR FORCE. COMPUTATION IS DESCRIBED WITHIN BLOCK 'PRODPLAN'.

QINV - FOR EACH FIRM, ITS QUARTERLY INVESTMENT (VALUE TERMS). COMPUTED IN 'INVFIN'.

QINVLAG - FOR EACH FIRM, ITS INVESTMENT FOR THE NEXT QUARTER (VALUE TERMS). COMPUTED IN 'INVFIN'.

QM - FOR EACH FIRM, ITS PROFIT MARGIN DURING A QUARTER (A FRACTION). COMPUTED IN 'INVFIN'.

QMAXTSUDOM - FOR EACH MARKET, MAXIMUM SALES VOLUME FOR A QUARTER DUE TO 'MINSTO' CONSIDERATIONS. HELP VARIABLE USED WITHIN 'MINSTO ADJUST'.

QMZ - PROFIT MARGIN IN THE SERVICE SECTOR DURING A QUARTER (A FRACTION). COMPUTED IN 'FINALQPQSQM'.

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'.

QPDOM - ON EACH MARKET, THE DOMESTIC PRICE DURING ONE QUARTER. UPDATED IN 'DOMESTIC RESULT'.

QPFOR - ON EACH MARKET, THE FOREIGN PRICE DURING ONE QUARTER. UPDATED IN 'EXPORT'.

QPH - DOMESTIC PRICE IN EACH SPENDING 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 SPENDING' EACH TIME HOUSEHOLDS MEET AN OFFERING PRICE VECTOR 'PT'.

QPRELPDOM - ON EACH MARKET, THE FIRMS' INITIAL OFFERING PRICE TO HOUSEHOLDS. COMPUTED IN 'MARKET ENTRANCE'.

QPRELPZ - PRELIMINARY PRICE IN THE SERVICE SECTOR DURING THE QUARTER TO COME. COMPUTED IN 'ZLABOUR'.

QPZ - PRICE IN THE SERVICE SECTOR DURING ONE QUARTER. COMPUTED IN 'DOMESTIC RESULT'.

QQ - PRODUCTION FOR A FIRM (UNITS PER QUARTER). COMPUTED IN 'PLANQREVISE'.

QQZ -	(POTENTIAL) PRODUCTION IN THE SERVICE SECTOR DURING ONE QUARTER (VOLUME). COMPUTED IN 'ZLABOUR'.
QRR -	FOR EACH FIRM, ITS RATE OF RETURN (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 -	HOUSEHOLD SAVINGS (PER QUARTER AND HOUSEHOLD). COMPUTED IN 'HOUSEHOLD UPDATE' AS A RESIDUAL.
QSDOM -	FOR EACH FIRM, ITS DOMESTIC SALES VALUE DURING ONE QUARTER. COMPUTED IN 'FIRMSTO'.
QSFOR -	FOR EACH FIRM, ITS FOREIGN SALES VALUE DURING ONE QUARTER. COMPUTED IN 'EXPORT'.
QSP -	HOUSEHOLD SPENDING IN EACH SPENDING CATEGORY (VALUE PER QUARTER). COMPUTED IN 'COMPUTE SPENDING' IN EACH ITERATION ON THE DOMESTIC MARKET.
QSPE -	'ESSENTIAL' HOUSEHOLD SPENDING IN EACH SPENDING CATEGORY (VALUE PER QUARTER). HELP VARIABLE USED WITHIN 'COMPUTE SPENDING'
QSU -	FOR EACH FIRM, ITS SALES VOLUME DURING ONE QUARTER. COMPUTED IN 'FINALQPQSQM'.
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'.
QSZ -	QUARTERLY SALES VALUE IN THE SERVICE SECTOR. COMPUTED IN 'DOMESTIC RESULT'.
QTARGM -	FOR EACH FIRM, ITS PROFIT-MARGIN TARGET FOR A QUARTER (A FRACTION). COMPUTED IN 'QUARTERLY TARG'.
QTBUY -	TOTAL BUYING IN EACH SPENDING CATEGORY (UNITS PER QUARTER). COMPUTED IN 'COMPUTE BUYING' IN EACH ITERATION ON THE DOMESTIC MARKET.
QTOP -	POTENTIAL OUTPUT FOR A FIRM (UNITS PER QUARTER) AT ZERO SLACK AND INFINITE LABOUR FORCE. UPDATED IN 'PRODFRONT'.

QTSP - AGGREGATE HOUSEHOLD SPENDING IN EACH SPENDING CATEGORY (VALUE PER QUARTER). HELP VARIABLE USED WITHIN 'COMPUTE BUYING'.

QW - FOR EACH FIRM, ITS WAGE LEVEL (EXPRESSED ON A YEARLY BASIS) DURING ONE QUARTER. UPDATED IN 'LABOUR UPDATE'.

QWG - GOVERNMENT WAGE LEVEL (EXPRESSED ON A YEARLY BASIS) DURING ONE QUARTER. UPDATED IN 'GLABOUR'.

QWZ - SERVICE SECTOR WAGE LEVEL (EXPRESSED ON A YEARLY BASIS) DURING ONE QUARTER. UPDATED IN 'ZLABOUR'.

Q2 - FOR EACH FIRM, MAX PRODUCTION FOR A QUARTER REGARDING SALES PLAN AND INVENTORY MAXIMUM. HELP VARIABLE USED WITHIN 'TARGET SEARCH'.

Q3 - FOR EACH FIRM, MAX 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 REALIZED. HELP VARIABLE USED WITHIN 'TARGET SEARCH'.

R - A CONSTANT IMPLYING HOW MUCH FIRMS RELY ON EXTERNAL INFORMATION WHEN THEY FORM EXPECTATIONS (IN 'YEARLY EXP')

REALCHLG - NET CHANGE IN GOVERNMENT EMPLOYMENT (PERSONS PER QUARTER). ENTERED EXOGENOUSLY IN 'GLABOUR'.

REDUCE - FOR EACH SPENDING CATEGORY, A FRACTION BY WHICH SPENDINGS MUST BE REDUCED DUE TO LIMITED SUPPLY. HELP VARIABLE USED WITHIN 'MINSTO ADJUST'.

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).

RFO - 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)'.

RHO - DEPRECIATION RATE OF PRODUCTION EQUIPMENT (A FRACTION ON QUARTERLY BASIS).

RHODUR - DEPRECIATION RATE OF CONSUMER DURABLE GOODS (A FRACTION ON QUARTERLY BASIS).

RI - RATE OF INTEREST, EXPRESSED ON A YEARLY BASIS. ENTERED EXOGENOUSLY.

RU - RATE OF UNEMPLOYMENT (A FRACTION). UPDATED IN 'LABOUR UPDATE'.

RW - A CONSTANT GIVING FIRMS' DESIRED AMOUNT OF WORKING CAPITAL AS A FRACTION OF SALES.

S - FOR EACH FIRM, ITS SALES VALUE DURING ONE YEAR. UPDATED IN 'YEARLY UPDATE'.

SACK - FOR EACH FIRM, NUMBER OF PEOPLE FIRED DURING A QUARTER. HELP VARIABLE WITHIN 'LABOUR UPDATE'.

SAV - INDEXING VARIABLE, GIVING SAVINGS COMPONENT OF HOUSEHOLD SPENDING VECTORS.

SMALL - ON EACH MARKET, THE FRACTION OF YEARLY SALES THAT FIRMS CONSIDER AS INVENTORY MINIMUM.

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 HISTORY.

SMW - CONSTANT USED BY FIRMS TO (EACH YEAR) TIME-SMOOTH THEIR WAGE EXPERIENCES.

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'.

SWAP - A FACTOR DETERMINING THE SHORT-TERM TRADE-OFF BETWEEN SAVINGS AND SPENDINGS ON CONSUMER DURABLES. COMPUTED IN 'COMPUTE SPENDING'.

TARGM - FOR EACH FIRM, ITS PROFIT-MARGIN TARGET FOR ONE YEAR (A FRACTION). COMPUTED IN 'YEARLY TARG'.

TARGMZ - PROFIT-MARGIN TARGET IN THE SERVICE SECTOR (A FRACTION). ENTERED EXOGENOUSLY.

TEC - TECHNOLOGY FACTOR FOR A FIRM (UNITS PER MAN AND QUARTER). UPDATED IN 'PRODFRONT'.

TECZ - TECHNOLOGY FACTOR FOR THE SERVICE SECTOR (POTENTIALLY PRODUCED VOLUME PER MAN AND QUARTER). UPDATED IN 'ZLABOUR'.

THETA - MAXIMUM FRACTION OF A FIRM'S LABOUR FORCE THAT IT CAN LOOSE AT ONE LABOUR MARKET ATTACK. USED IN 'LABOUR SEARCH'.

TMIMP - FOR EACH MARKET, THE TIME CONSTANT TO ADJUST IMPORT SHARE.

TMSTO - TIME CONSTANT FOR FIRMS WHEN ADJUSTING INVENTORY DISCREPANCY (YEARS). USED IN 'INITPRODPLAN' AND IN 'PLANQREVISE'.

TMX - TIME CONSTANT FOR FIRMS WHEN ADJUSTING EXPORT SHARE IN 'EXPORT' (YEARS; COMMON TO ALL FIRMS ON A MARKET).

W - FOR EACH FIRM, ITS AVERAGE WAGE DURING ONE YEAR. COMPUTED IN 'YEARLY UPDATE'.

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'.

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'.

Z - INDEXING VARIABLE, EXTRACTING SERVICE SECTOR DATA FROM A SPENDING CATEGORY VECTOR.

BIBLIOGRAPHY

Bennett, R.L.- Bergmann, B.R., 1975: The transactions model of the U.S. economy: The treatment of the business sector, mimeographed paper presented at the NBER workshop on microanalytic models at the Urban Institute, Washington D.C. (May 1975).

Bennett, R.L.- Bergmann, B.R., 1976: Macroeconomics through Microsimulation: Simulating Humphrey-Hawkins paper presented to the 1976 AEA conference in Atlantic City, September 16-18.

Bergmann, B.R., 1973: Labor Turnover, Segmentation and Rates of Unemployment. A Simulation-Theoretic Approach, Project on the Economics of Discrimination, University of Maryland, (August).

Bergmann, B.R., 1974: A Microsimulation of the Macro Economy with Explicitly Represented Money Flows, Annals of Social and Economic Measurement, (July).

Brook, S.- Teigen, R., 1977: Monetary and Fiscal Policy Experiments on Four Macro Economic Models, forthcoming, Industrikonjunkturen, Spring 1977.

Dantzig-Wolfe, 1961: The Decomposition Algoritm for Linear Programs, Econometrica No 29.

Day, R.H.-Morley, S.- Smith, K.R., 1974: Myopic Optimizing and Rules of Thumb in a Micro-Model of Industrial Growth, The American Economic Review (March).

Donaldson, 1961: Corporate Debt Capacity, Boston.

Eliasson, G., 1969: The Credit Market, Investment Planning and Monetary Policy (IUI), Uppsala.

Eliasson, G., 1974: Business Cycles in Business Planning, No 8. Economic Research Reports, Federation of Swedish Industries, Stockholm.

Eliasson, G., 1974b: Profits and Wage Determination, Economic Research Reports No. 11., Federation of Swedish Industries, Stockholm.

Eliasson, G., 1976: Business Economic Planning - theory, practice and comparison (Wiley).

Eliasson, G., 1976b: Competition and Market Processes in a Simulation Model of the Swedish Economy, paper presented at the American Economic Association, September 1976 meeting in Atlantic City. (Also entered as research report B 14, Federation of Swedish Industries, Stockholm.)

Genberg, H., 1975: World Inflation and the Small Open Economy, Economic Research Report No. 17, The Federation of Swedish Industries (November).

Holt,Ch.C.-Modigliani,F. -Muth,J.F.-Simon,H.A. 1960: Planning Production, Inventories and Work Force, Prentice-Hall, Inc.

Carlsson, B., 1972: The Measurement of Efficiency in Production: An Application to Swedish Manufacturing Industries 1968, The Swedish Journal of Economics 1972:4 (Also published by the IUI as no. 49 in their reprint series).

Klevmarken - Dahlman, 1971: Den Privata Konsumtionen 1931-1975 (IUI) Uppsala 1971.

Leibenstein, H., 1966: Allocative Efficiency vs. 'X-efficiency'. American Economic Review 56 (3).

McLeod, J., 1976: Exploring the Simulation Spectrum: uses and abuses of system dynamics, mimeographed paper from International Conference on Systems Analysis in Geilo, Norway.

Mass, N.J., 1976: Economic Cycles: An Analysis of Underlying Causes, Wright-Allen Press, Inc. Cambridge, Mass.

Naylor, Th.H., 1971: Computer Simulation Experiments with Models of Economic Systems, John Wiley & Sons, Inc.

Nelson, R.R. - Winter, S.G., 1976: Simulation of Schumpeterian Competition, Mimeographed paper presented at the AEA meeting in Atlantic City, (September).

Orcutt, G., 1960: Simulation of Economic Systems, American Economic Review Vol. 6 (December).

Orcutt, G.-Greenberger, M.-Korbel, J.-Rivlin, A. 1961: Microanalysis of Socioeconomic Systems: A simulation study, New York.

Orcutt, G.-Caldwells-Wertheimer II, R., 1976: Policy Exploration through Microanalytic Simulation. The Urban Institute, Washington D.C.

Papandreou, A.G., 1963: Theory Construction and Empirical Meaning in Economics, AER (May).

Powell, M.J.D., 1964: An efficient method for finding the minimum of a function of several variables without calculating derivatives, The Computer Journal.

Powell, M.J.D., 1965: A method for minimizing a sum of squares of non-linear functions without calculating derivatives, The Computer Journal.

Stone, R., 1954: Linear expenditure systems and demand analysis - an application to the pattern of British demand, <u>Economic Journal</u>, Vol. LXIV (September).

Winkler, R.L., 1967: The Quantification of Judgement: Some Methodological Suggestions, <u>Journal of the American Statistical Association</u>, (December).

Winter, Sidney G.: Optimization and Evolution in the Theory of the Firm from <u>Adaptive Economic Models</u>, Day - Th. Groves (eds).

Virin, O., 1976: Industrins Utveckling 1974-76 enligt Industriförbundets Planenkät 1975/76, Specialstudie D, <u>Industrikonjunkturen</u> Spring 1976.

Wold, H.O., 1969: Econometrics as Pioneering in Non-experimental Model Building, <u>Econometrica</u> Vol. 37, No 3 (July).