1982-12-01

A list of Working Papers on the last pages

No. 72, 1982

THE MICRO INITIALIZATION OF MOSES

by

James W Albrecht and Thomas Lindberg

December, 1982

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1. Introduction and Overview

1.1 Introduction

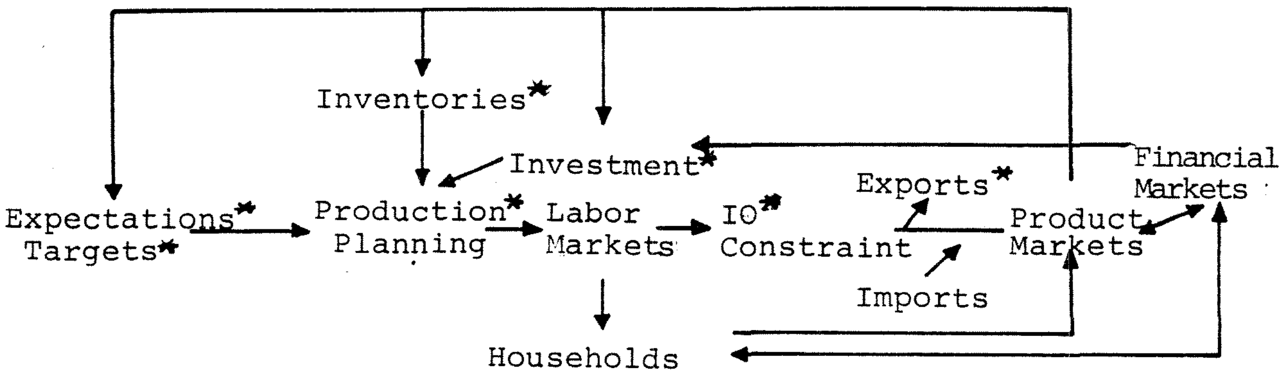
This paper is part of the description and documentation of IUI's MOSES model. In particular, it describes how the model is "initialized" using two micro-datasets, one a collection of "firms-level" data taken primarily from annual reports and other public sources and the other a "division- or establishments-level"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

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

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

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

Figure 1 Modular Representation of the MOSES Economy



Starting from the left-hand side of the diagram, in each quarter each establishment begins by forming price, wage and sales expectations and a profit margin target. These expectations and targets are then used as inputs into the production planning module in which each establishment sets a preliminary production/employment plan. There are three basic inputs to this planning procedure. The first is a specification of each establishment's initial position (level of employment, stock of inventories, etc). The second is a specification of the technical possibilities open to the estab-

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

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

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

To summarize, the model begins by computing production/employment plans for each establishment. These plans are then modified (made consistent) in the labor market and I/O constraint modules. Next, "supplies are confronted with demands" in the product mar-

EXPX, and the weighting factor, R, are treated as free parameters to be set exogenously; that is, the data problem pertains to the internally generated expectations, EXPI. These are in turn set as

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

where

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

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

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

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

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

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

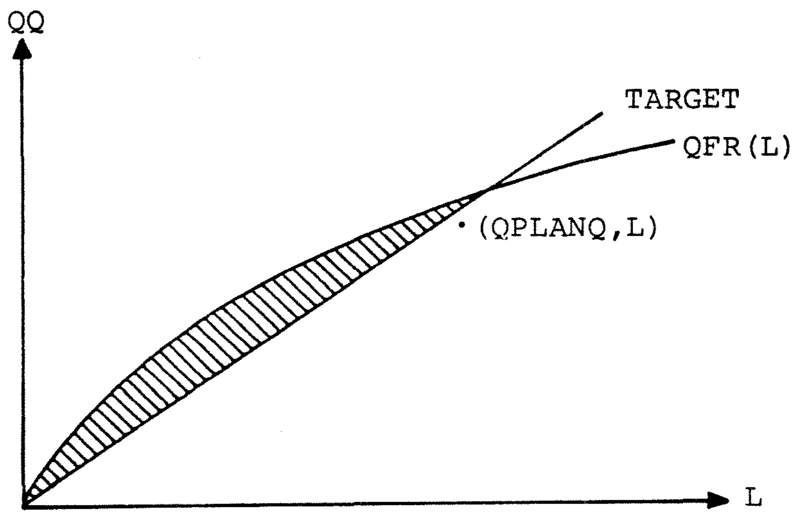
$$TARGM := MHIST \cdot (1+EPS),$$
$$MHIST := SMT \cdot MHIST + (1-SMT) \cdot M,$$

where EPS and SMT ($0 \leq SMT \leq 1$) are parameters and MHIST and M are the "profit margin history" and the actual realized (previ-

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

Figure 2.

The Production Planning Module



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

If (QPLANQ,L) is simultaneously feasible and satisfactory, i.e., lies within the lens, then that point is adopted as the production/employment plan. If on the other hand (QPLANQ,L) does not lie within the lens (as is the case in Figure 2), then adjustment mechanisms are called into play. It is the specification of these ad-

QFR(L) = QQ(1+A21)

QTOP·(1-RES) = QQ(1+A21+A22);

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

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

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

where STO is the existing stock of product inventory

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

MINSTO: = SMALL·4·(QS/QP)

MAXSTO: = BIG·4·(QS/QP)

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

input goods inventory is a 10-tuple), i.e., four inventory concepts are involved -- the actual level of inventories (IMSTO), the desired (optimal) level of inventories (OPTIMSTO), and the maximum and minimum allowable levels of inventories (MAXIMSTO and MINIMSTO). MAXIMSTO and MINIMSTO are determined by multiplying QIMQ by the establishment-specific coefficients IMBIG and IMSMALL, respectively.

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

Summing Up

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

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

1.4 Investment Finance

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

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

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

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

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

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

where

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

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

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

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

where RW is an exogenous constant.

The above determines the firm's preliminary investment budget. These planned expenditures (and borrowings) are reduced if the degree of capacity utilization (computed using data from the production planning module) is lower than an exogenous reference

1.5 The Initialization Procedure

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

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

Within each micro sector some of the establishments are "real" and some are "synthetic". To say that an establishment is real simply means that it is initialized directly from the micro-data. In particular, each real establishment in the model has a counterpart in the Planning Survey data. Thus, if we have data on a particular Volvo plant (establishment) in the Planning Survey, we can use those data directly to initialize a corresponding MOSES establishment. Alas, the Planning Survey data are purely establishment-level data whereas the corresponding MOSES entity is

1.6 The Databases

Planning Survey Data

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

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

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

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

the start-up year has primarily to do with the problem of macro consistency. Although merging firm data with establishments data involves tedious work matching "by hand," it poses no problem in principle. The real problem is the difficulty involved in updating the I/O system in a consistent way. The benefit of being able to have start-up years other than 1977 does not currently seem worth the large cost in terms of the effort involved in "imposing consistency" on the macro-database for later years. Rather, if the Planning Survey data from years after 1976 are to be used in the model project, effort for the time being is better directed towards using them for calibration purposes.

Firms Data

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

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

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

Table 3 Matching of Firms and Establishments

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

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

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

Macro Data

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

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

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

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

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

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

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

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

2.2 The Workspace SI76

When establishments-level data were incorporated into the micro-initialization procedure in 1980, the starting year for the simulations was changed to 1977. The previously used year for initialization (1968) therefore was replaced with 1976. The reason for this

2.3 The Function ESTABLISHMENTS

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

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

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

same for markets 2, 3 and 4. Finally, we create the sales vector (the variable S) by concatenating ("stringing together") the vector of sales from the real establishments (i.e., the data taken directly from X) with the vectors of sales from the synthetic establishments.

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

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

In practice we apply the randomization procedure to ratio variables. Thus, for example, we create a vector of synthetic employment by randomizing the real employment/sales ratio on sales

3. Conclusion

Assessment

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

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

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

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

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

Suggestions for Improvement

In our opinion there are two likely sources of significant improvement in the micro-initialization procedure, one of which, perhaps surprisingly, has to do with the macro-database. That database was created by transforming sectoral data according to the classification used by the Central Bureau of Statistics (many sectors) to sectoral data according to the MOSES classification (4 sectors). If this transformation is significantly incorrect for any va-

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

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

The obvious way to solve this "small-sample" problem would be to collect more data on firms operating in the Non-Durables sector, i.e., to expand the FTGS dataset. Perhaps less obviously, the Non-Durables establishment data from the Planning Survey could be used without collecting any new firm data. This would involve dealing with three types of micro-entities in the model initializa-

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

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

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

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

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

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

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

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

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

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

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

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

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

```
      ∇ESTABLISHMENTS[⎕]∇

    ∇  ESTABLISHMENTS;R;F;ALPHA;SCALE;RATIO;RATIO1;RATIO2;HELP;FLAG;
       DUMMY
[1]    ⍝ THIS COMMENTED VERSION OF THE FUNCTION ESTABLISHMENTS IS
[2]    ⍝ TO BE USED IN CONJUNCTION WITH THE DOCUMENTATTION PAPER
[3]    ⍝ ALBRECHT/LINDBERG, 'MICRO-INITIALIZATTION OF MOSES'
[4]    ⍝ DATED AUGUST 1982
[5]    ⍝ PAGE CITATIONS IN THESE COMMENTS REFER TO THAT PAPER
[6]    ⍝
[7]    ⍝
[8]     ⍎')COPY SI76 X FΔDATA FIRMID   LIST RΔMARKET'
[9]    ⍝
[10]   ⍝ INPUT DATA FROM WORKSPACE SI76
[11]   ⍝ X IS ESTABLISHMENTS DATA (PROCESSED FROM WS PD76)
[12]   ⍝ FΔDATA IS FIRMS DATA (PROCESSED FROM WS FTGS)
[13]   ⍝ FIRMID IS KEY LINKING ESTABLISHMENT ID TO FIRM ID
[14]   ⍝ RΔMARKET GIVES MARKET ID FOR EACH ESTABLISHMENT
[15]   ⍝ LIST GIVES LIST OF ESTABLISHMENTS TO BE USED IN INITIALIZATION
[16]   ⍝
[17]   ⍝ IN ADDITION THERE ARE 2 VARIABLES THAT ARE GLOBAL TO THIS FUNCTI
       ON:
[18]   ⍝.....IO (INPUT/OUTPUT MATRIX--SET IN FUNCTION MARKETS)
[19]   ⍝.....SYNTHΔFIRMS (NMBR OF SYNTH ESTABLISHMENTS PER MARKET--SET IN
        ISTARTXX)
[20]   ⍝
[21]   ⍝ OUTPUT FROM THIS FUNCTION
[22]   ⍝MARKET,P,QP,DP,W,QW,DW,S,QS,DS,Q,QQ,DQ,
[23]   ⍝L,EXPDP,EXPDS,EXPDW,HISTDP,HISTDS,HISTDW,
[24]   ⍝HISTDPDEV2,HISTDWDEV2,HISTDSDEV2,MHIST,CHM
[25]   ⍝VA,QIMQ,QVA,DVA,M,AMAN,STO,IMSTO,
[26]   ⍝QTOP,TEC,QINV,QINVLAG,DELAYΔINV,K1,K1BOOK,K2,BW,
[27]   ⍝QTDIV,RSUBSΔCASH,RSUBSΔEXTRA,RES,INVEFF,RESMAX,BETA,
[28]   ⍝IMBETA,TMINV,BIG,SMALL,IMBIG,IMSMALL,FΔINKOP,BRINKOP,
[29]   ⍝SHARE,X,ORIGMARKET,LEFT
[30]   ⍝
[31]   ⍝ THE NEXT SET OF LINES MERGES FIRMS DATA WITH ESTABLISHMENTS DATA
[32]   ⍝ IN ADDITION A ~REDUCTION~ ON LIST IS CARRIED OUT
[33]   ⍝    IE DATA NOT PERTAINING TO INCLUDED ESTABLISHMENTS ARE DROPPED
[34]   ⍝ THE FLAGGING PROCEDURE CHECKS THAT THE SUM OF ESTABLISHMENT
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```
[35]  ⍝  SALES DO NOT EXCEED PARENT FIRM SALES.
[36]  ⍝  IN CASE THEY DO THEN WE DROP ESTABLISHMENTS ONE-BY-ONE
[37]  ⍝  UNTIL THE CONSTRAINT IS MET.
[38]  ⍝  THIS IS DONE BY DROPPING THE SMALLEST ESTABLISHMENT
[39]  ⍝  FIRST, THEN THE SECOND SMALLEST, ETC.
[40]  ⍝  OTHER PATTERNS MIGHT BE PREFERABLE.
[41]  L0:F←FIRMID[(X[;1]∊LIST)/⍳⍴X[;1]]
[42]   NAMNΔMARKET←RΔMARKET[(X[;1]∊LIST)/⍳⍴X[;1]]
[43]   ALPHA←(+/X[(X[;1]∊LIST)/⍳⍴X[;1]; 7 12])÷FΔDATA[F;15]
[44]  ⍝ CHECK ON ALPHA
[45]  ⍝..ALPHA=ESTABLISHMENT SALES ÷ PARENT FIRM SALES
[46]   →(0=⍴FLAG←(1<ALPHA+.×F∘.=⍳⌈/F)/⍳⌈/F)/L2
[47]   HELP←⍳0
[48]  L1:HELP←HELP,ALPHA⍳⌊/ALPHA[((1↑FLAG)=F)/⍳⍴F]
[49]   →(0<⍴FLAG←1↓FLAG)/L1
[50]   'DROPPING ',(5 2 ⍕LIST[HELP]),' FROM LIST.'
[51]   LIST←(~(⍳⍴LIST)∊HELP)/LIST
[52]   →L0
[53]  L2:X←X[(X[;1]∊LIST)/⍳⍴X[;1];]
[54]  ⍝
[55]  ⍝ THE FOLLOWING VARIABLES ARE GLOBAL FOR HELP FUNCTIONS USED BELOW
[56]  ⍝ R=NUMBER OF REAL ESTABLISHMENTS
[57]  ⍝ MARKET=VECTOR WITH MARKET NUMBERS FOR EACH ESTABLISHMENT
[58]  ⍝...(FOR EXAMPLE:  1 1 1 2 1 3 1 4 1 4 ...ETC.)
[59]  ⍝ NAMNΔMARKET=VECTOR WITH MARKET NUMBER FOR REAL ESTABLISHMENTS
[60]  ⍝...(NAMNΔMARKET COMES FROM ~LIST-REDUCTION~ ON RΔMARKET)
[61]  ⍝ SΔMARKET=VECTOR WITH MARKET-NUMBERS FOR SYNTHETIC ESTABLISHMENTS
[62]  ⍝
[63]   SΔMARKET←SYNTHΔFIRMS DUP⍳4
[64]   MARKET←NAMNΔMARKET,SΔMARKET
[65]   R←1↑⍴X
[66]  ⍝
[67]   'SIZE-UTSKRIFT 2'
[68]   ⍎')SIZE'
[69]  ⍝
[70]  ⍝ SETTING SCALE FOR SYNTHETIC ESTABLISHMENTS (CF PP.XX)
[71]   SCALE←⍳0
[72]   SCALE←SCALE,SYNTHΔFIRMS[1]SCALE 0.02
[73]   SCALE←SCALE,SYNTHΔFIRMS[2]SCALE 0.001
[74]   SCALE←SCALE,SYNTHΔFIRMS[3]SCALE 0.02
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[75]   SCALE←SCALE,SYNTH∆FIRMS[4]SCALE 0.0001
[76]  ⍝
[77]  ⍝ ENS (AND SISTER FUNCTION ALWAYS) ARE INTENDED TO ~ENSURE~ THAT
[78]  ⍝   THE STIPULATED CONDITION IS TRUE. IF NOT, THEN ~ERROR~ IS RETU
      RNED
[79]  ⍝
[80]   ENS 1=SYNTH∆SUM1 SCALE
[81]  ⍝
[82]  ⍝ THE HELP FUNCTIONS SUM1, REAL∆SUM1 AND SYNTH∆SUM1 ARE USED
[83]  ⍝ EXTENSIVELY IN THE SEQUEL
[84]  ⍝ THESE FUNCTIONS SUM ESTABLISHMENT VARIABLES TO MARKET TOTALS
[85]  ⍝ SUM1 OPERATES ON REAL AND SYNTHETIC DATA
[86]  ⍝...REAL∆SUM1 ON REAL DATA ONLY
[87]  ⍝...SYNTH∆SUM1 ON SYNTHETIC DATA ONLY
[88]  ⍝
[89]  ⍝ SALES IS THE FIRST VARIABLE CREATED. NOTE THE USE OF SCALE
[90]  ⍝     IN THE SETTING OF SYNTH∆SALES
[91]   REAL∆SALES←(+/X[; 7 12]×1000000)
[92]   RES∆SALES←SALES76-REAL∆SUM1(REAL∆SALES)
[93]   SYNTH∆SALES←SCALE×RES∆SALES[S∆MARKET]
[94]   S←REAL∆SALES,SYNTH∆SALES
[95]  ⍝
[96]   ⎕RL←123476
[97]  ⍝
[98]  ⍝ ⎕RL SETS THE SEED FOR THE RANDOM-NUMBER GENERATOR
[99]  ⍝RANDOMIZATION IS USED IN SETTING ALL VARIABLES AFTER SALES (THE ~
      BASE~ VARIABLE)
[100] ⍝THE RANDOMIZATION FUNCTION IS CALLED USING
[101] ⍝THIS FUNCTION IS OF THE FORM A USING B, WHERE
[102] ⍝    A IS A VECTOR OF REAL-ESTABLISHMENTS DATA (1ST VARIABLE)
[103] ⍝    B IS A VECTOR OF REAL- AND SYNTHETIC-ESTABLISHMENTS DATA (2ND
      VARIABLE)
[104] ⍝ USING ~EXTENDS~ A TO BE A REAL- AND SYNTHETIC-ESTABLISHMENTS DAT
      A VECTOR
[105] ⍝(CF PP.XX...SEE ALSO THE FUNCTIONS USING AND RANDOMIZE)
[106] ⍝
[107] ⍝ THE FIRST VARIABLE TO BE CREATED USING RANDOMIZATION IS LABOR
[108] ⍝NOTE THE NORMALIZATION ON MACRO-SECTOR TOTALS USED IN SETTING SYN
      TH∆LABOUR
[109]  REAL∆LABOUR←X[;3]
```

```
[110]  RESΔLABOUR←(TIM÷HOURSΔPERΔYEAR)-REALΔSUM1(REALΔLABOUR)
[111]  SYNTHΔLABOUR←R↓S×RATIO←(REALΔLABOUR÷REALΔSALES)USING S
[112]  SYNTHΔLABOUR←SYNTHΔLABOUR×(RESΔLABOUR÷(SYNTHΔSUM1 SYNTHΔLABOUR))[
      SΔMARKET]
[113]  ¯L←REALΔLABOUR,SYNTHΔLABOUR
[114] ⍝
[115] ⍝ NOW ALL OTHER VARIABLES ARE SET IN ESSENTIALLY THE SAME WAY AS L
[116] ⍝
[117] ⍝EXPORT FRACTIONS   (EXPORTS÷SALES)   :
[118] ⍝ PRODUCTION USED TO APPROXIMATE SALES
[119] ⍝ XM=EXPORTS (MKTS 1,2,3,4) ÷ PRODUCTION (MKTS 1,2,3,4)
[120]  XM←IO76[⍳4;18]÷IO76[14;⍳4]
[121]  REALΔRATIO←(X[;7]÷(+/X[; 7 12]))
[122]  SYNTHΔRATIO←REALΔRATIO RANDOMIZE S
[123]  RESΔEXPORT←(XM×(SUM1 S))-REALΔSUM1(REALΔRATIO×REALΔSALES)
[124]  SYNTHΔRATIO←SYNTHΔRATIO×(RESΔEXPORT÷(SYNTHΔSUM1(SYNTHΔRATIO×
      SYNTHΔSALES)))[SΔMARKET]
[125]  X←REALΔRATIO,SYNTHΔRATIO
[126]  'TEST PA EXPORTANDEL:X>0.95  '
[127]  (X<0)∨(X>0.95)
[128]  X←0⌈0.95⌊X
[129] ⍝
[130] ⍝PRICES
[131]  P←(⍴MARKET)⍴100
[132] ⍝
[133] ⍝ PRODUCT INVENTORIES
[134] ⍝RATIO=ACTUAL STOCK-RATIO=STOCK÷SALES
[135] ⍝ RATIO1=~NORMAL~ LEVEL OF STOCK÷SALES
[136]  RATIO←(X[;48]÷100)USING S
[137]  STO←(S÷P)×RATIO
[138]  RATIO1←(X[;50]÷100)USING RATIO⌈0.01
[139] ⍝
[140] ⍝ NOTE WE ARE SETTING BIG AND SMALL FOR EACH ESTABLISHMENT
[141] ⍝
[142]  BIG←RATIO⌈(1+Δ←0.5)×RATIO1
[143]  SMALL←RATIO⌊(1-Δ)×RATIO1
[144]  BIG[HELP/⍳⍴BIG]←(HELP←(RATIO<(1-Δ)×RATIO1))/(2×RATIO1)-RATIO
[145]  BIG←0⌈0.5⌊BIG
[146]  SMALL[HELP/⍳⍴BIG]←(HELP←(RATIO>(1+Δ)×RATIO1))/(2×RATIO1)-RATIO
[147]  SMALL←0⌈SMALL
```

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

```
[185] ⍝      COMING FROM SECTOR J
[186] ⍝
[187] ⍝ INPUT GOODS PURCHASES (PRELIMINARY TO QIMQ)
[188] ⍝ HELP=TOTAL INPUT GOODS PURCHASES BY SYNTH ESTABS.
[189] ⍝ INP=INPUT GOODS PURCHASES FOR EACH ESTABLISHMENT
[190] ⍝     SUMMED OVER SECTORS
[191] ⍝
[192]  REAL∆INP←X[;17]×1000000
[193]  QCURR←S+∆K̄3∆FINISH
[194]  HELP←(+/(⍉IO)[⍳4;]MULT7 SUM1 QCURR)-(REAL∆SUM1(REAL∆INP-R↑
      ∆K3∆IMED))
[195]  HELP←HELP+SYNTH∆SUM1(R↓∆K3∆IMED)
[196]  INP←REAL∆INP,(R↓S×INPUTRATIO)×(HELP÷(SYNTH∆SUM1 R↓S×INPUTRATIO))[
      S∆MARKET]
[197] ⍝
[198] ⍝ QIMQ
[199] ⍝ QIMQ=INP SPREAD ACROSS THE 10 SECTORS, JUST LIKE IMSTO ABOVE.
[200]  QIMQ←((((⍉IO)DIV7+/⍉IO)[MARKET;])MULT7 INP)÷100
[201]  QIMQ←QIMQ÷4
[202] ⍝ SAME COMMENT AS APPLIES TO THE DEFLATION OF IMSTO
[203] ⍝
[204] ⍝ VALUE ADDED
[205]  VA←QCURR+∆K3∆IMED-INP
[206] ⍝
[207] ⍝ THE NEXT FUNCTION PERFORMS SOME ~HOUSE-CLEANING~
[208] ⍝ IE, SOME UNNEEDED VARIABLES ARE EXPUNGED
[209]  DISPOSE1∆FIRMS
[210] ⍝
[211] ⍝ SOME VARIABLES USED IN FUNCTION CONTROLS
[212] ⍝
[213]  RES∆FORVF←SYNTH∆SUM1(R↓VA)
[214]  FORVF←SUM1(VA)
[215]  REAL∆FORVF←R↑VA
[216]  SYNTH∆FORVF←R↓VA
[217] ⍝
[218] ⍝ WAGES
[219]  REAL∆KR∆LON←X[;5]×1000000
[220]  REAL∆W←REAL∆K̄R∆LON÷(R↑L)
[221]  SYNTH∆W←R↓S×(RATIO←(REAL∆KR∆LON÷REAL∆SALES)USING L)÷L
[222]  RES∆KR∆LON←LON-REAL∆SUM1(REAL∆W×(R↑L))
```

```
SYNTHΔW←SYNTHΔW×(RESΔKRΔLON÷(SYNTHΔSUM1(R↓L)×SYNTHΔW))[S̲ΔMARKET]
W←REALΔW,SYNTHΔW
SYNTHΔKRΔLON←SYNTHΔW×(R↓L)
DW←(¯1+(×/X̲[; 2 5])÷×/X̲[; 3 4])USING W
QDW←DW÷4
QW←((⍉((2,(ρW))ρ(W,W+DW)))+.×(0.625,0.375))
⍝
⍝ SOME PCT CHANGE AND QUARTERLY VARIABLES
DVA←DS←(¯1+(+/X̲[; 7 12])÷+/X̲[; 6 11])USING DW
QS←((⍉((2,(ρS))ρ(S,S+DS)))+.×(0.625,0.375))÷4
QVA←VA×(1+DVA÷4)÷4
⍝
⍝ MARGINS
⍝ MHIST=PROFIT MARGIN FOR 1975
M←1-W×L÷VA
M75←1-(X̲[;4]÷+/X̲[; 6 11])×R↑S÷VA
HELP←(R↑M)-M75
MHIST←0.5×(2×M)-CHM←HELP USING DS
⍝
⍝
OVERSKOTT←SUM1(M×VA)
SYNTHΔOVERSKOTT←R↓(M×VA)
REALΔOVERSKOTT←R↑(M×VA)
⍝
DP←((R↑DS)-X̲[;26]÷100)USING DS
QP←((⍉((2,(ρP))ρ(P,P+DP)))+.×(0.625,0.375))
⍝ QUANTITIES
Q←(S+ΔK3ΔFINISH)÷P
QQ←(QS+ΔK3ΔFINISH÷4)÷QP
DQ←DS-DP
⍝
⍝ SOME VARIABLES ADDED 27 OCT 1980...
⍝ FΔINKOP=AGGREGATE INPUT PURCHASE/OUTPUT FOR EACH ESTAB
⍝ BRΔINKOP=AGGREGATE INPUT PURCHASE/OUTPUT (SECTORAL AVERAGES)
⍝ SHARE INDIVIDUALIZES ESTABLISHMENT I/O COEFFICIENTS
FΔINKOP←(INP-ΔK3ΔIMED)÷(100×Q)
BRINKOP←4↑(+/[1]IO)
SHARE←FΔINKOP÷BRINKOP[MARKET]
⍝
⍝ A21 AND A22
```

```
[263]  A22←(-/X[; 30 32]÷100)USING A21←(-/X[; 32 26]÷100)USING M
[264]  A21←0⌈0.5⌊A21
[265]  A22←0.025⌈0.5⌊A22
[266] ⍝ MUST ENSURE A22>0 SO TEC CAN BE COMPUTED..
[267] ⍝ AMAN--BASED ON APPROXIMATION GIVEN IN INDUSTRIKONJUNKTUREN PAPER
[268]  AMAN←⍉(3,⍴L)⍴(L×A21÷1+A21)÷3
[269] ⍝
[270] ⍝ EXPECTATIONS
[271]  HISTDS←EXPDS←(¯1+(+/X[; 8 13])÷+/X[; 7 12])USING DS
[272]  HISTDSDEV2←(HISTDSDEV←-0.02 BETWEEN(⍴HISTDS)⍴0.02)*2
[273]  HISTDP←EXPDP←((R↑EXPDS)-X[;28]÷100)USING EXPDS
[274]  HISTDPDEV2←(HISTDPDEV←-0.02 BETWEEN(⍴HISTDP)⍴0.02)*2
[275]  HISTDW←EXPDW←EXPDS-EXPDP
[276]  HISTDWDEV2←(HISTDWDEV←-0.02 BETWEEN(⍴HISTDW)⍴0.02)*2
[277] ⍝
[278] ⍝ PRODUCTION FUNCTION PARAMETERS.
[279]  QTOP←(QQ×1+A21+A22)÷1-RES←(⍴QQ)⍴0.5×RESMAX←0.2
[280]  TEC←¯1×(⍟A22÷1+A21+A22)×QTOP÷L
[281]  ENS(QQ-QFR1 L)<0.5
[282] ⍝
[283] ⍝ FINANCIAL VARIABLES
[284]  K1BOOK←S×((÷/FΔDATA[F; 5 15])USING S)
[285]  K1←S×((÷/FΔDATA[F; 26 15])USING K1BOOK)
[286]  K2←K1BOOK×(((+/FΔDATA[F; 1 2 4 6])÷FΔDATA[F;5])USING K1)
[287]  A←K1+K2+K1BOOK×((÷/FΔDATA[F; 3 5])USING S)
[288]  BW←K1BOOK×(((+/FΔDATA[F; 8 9 10])÷FΔDATA[F;5])USING K1)
[289]  BAD←(⍴BW)⍴0
[290] ⍝ QTDIV IS A MARKET-VARIABLE (⍴QTDIV=4)
[291]  QTDIV←SUM2 ¯0.25×K1BOOK×((÷/FΔDATA[F; 20 5])USING M)
[292]  INVEFF←QTOP×QP÷K1
[293]  QINV←S×(((+/X[; 21 24])÷+/X[; 7 12])USING S)÷4
[294]  QINVLAG←QINV×1+(VA AVG1 DP¯DDIV 4)[DUR←3]
[295]  TMINV← 2 1 1 0.5
[296]  DELAYΔINV←⍉(3,⍴QINV)⍴QINV MULT1(4×TMINV)÷3
[297]  RSUBSΔCASH←RSUBSΔEXTRA←L×0
[298] ⍝
[299] ⍝ CONSISTENCY CONTROL FUNCTION
[300] ⍝
[301]  CONTROLS
[302] ⍝
```

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

```
      ∇AVG1[⎕]∇

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

```
      ∇BETWEEN[⎕]∇

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

```
     ∇CONTROLS[⎕]∇

   ∇  CONTROLS;DIFF
[1]    ⍝
[2]    ENS(LON+OVERSKOTT)=FORVF
[3]    ENS LON=(REAL∆SUM1 REAL∆KR∆LON)+(SYNTH∆SUM1 SYNTH∆KR∆LON)
[4]    ENS OVERSKOTT=(REAL∆SUM1 REAL∆OVERSKOTT)+(SYNTH∆SUM1
     SYNTH∆OVERSKOTT)
[5]    ENS FORVF=(REAL∆SUM1 REAL∆FORVF)+(SYNTH∆SUM1 SYNTH∆FORVF)
[6]    DIFF←SALES76-(SUM1 S)
[7]    ENS DIFF<1.000000000E¯6 ×(SUM1 S)
[8]    ENS(TIM÷HOURS∆PER∆YEAR)=(REAL∆SUM1 REAL∆LABOUR)+SYNTH∆SUM1
     SYNTH∆LABOUR
[9]    ENS(REAL∆FORVF-(REAL∆KR∆LON+REAL∆OVERSKOTT))<1.000000000E¯7
[10]   ENS(SYNTH∆FORVF-(SYNTH∆KR∆LON+SYNTH∆OVERSKOTT))<1.000000000E¯7
[11]   ENS(SYNTH∆SUM1(SYNTH∆W×SYNTH∆LABOUR))=SYNTH∆SUM1(SYNTH∆KR∆LON)
[12]   ENS(REAL∆SUM1(REAL∆W×REAL∆LABOUR))=REAL∆SUM1(REAL∆KR∆LON)
[13]   ENS(SYNTH∆SUM1((R↓M)×SYNTH∆FORVF))=SYNTH∆SUM1(SYNTH∆OVERSKOTT)
[14]   ENS(REAL∆SUM1((R↑M)×REAL∆FORVF))=REAL∆SUM1(REAL∆OVERSKOTT)
[15]   ENS X≥0
[16]   ENS X≤1
[17]   ENS((SUM1 VA)÷(SUM1 QCURR))=(1-BRINKOP[⍳4])
[18]   ENS((SUM1(INP-AK3∆IMED))÷(SUM1 QCURR))=(BRINKOP[⍳4])
[19]   DIFF←(XM×SUM1 S)-(SUM1 X×S)
[20]   ENS DIFF<(0.01×SUM1 S)
   ∇


     ∇DDIV[⎕]∇

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

```
      ∇DEV[⎕]∇

    ∇  A←DEV X
[1]     A←X−+/X÷ρX
    ∇


      ∇DISPOSE1ΔFIRMS[⎕]∇

    ∇  DISPOSE1ΔFIRMS
[1]     →(TESTUTSKRIFT=0)/START
[2]     'REALΔRATIO'
[3]     REALΔRATIO
[4]     'SYNTHΔRATIO'
[5]     SYNTHΔRATIO
[6]     'INPUTRATIO'
[7]     INPUTRATIO
[8]     'REALΔSALES'
[9]     REALΔSALES
[10]    'SYNTHΔSALES'
[11]    SYNTHΔSALES
[12]    'SLUT PA TESTUTSKRIFT I DISPOSE1ΔFIRMS  '
[13]   START:
[14]   ⍝
[15]    KILL 'SCALE MAKEQUARTERS'
[16]    KILL 'RΔMARKET FIRMID RESΔLABOUR SYNTHΔSALES RESΔSALES RATIO1 RAT
       IO2 INPUTRATIO'
[17]    KILL 'REALΔRATIO SYNTHΔRATIO RESΔEXPORT REALΔINP LIST K3ΔIMED '
[18]   ⍝THIS FUNCTION DELETES VARIABLES AND FUNCTIONS OF NO FURTHER USE.
    ∇


      ∇DISPOSE2ΔFIRMS[⎕]∇

    ∇  DISPOSE2ΔFIRMS
[1]     →(TESTUTSKRIFT=0)/START
[2]     'SΔMARKET'
[3]     SΔMARKET
[4]     'A21'
[5]     A21
[6]     'A22'
[7]     A22
[8]     'INP'
```

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

∇


```
      ∇DIV7[⎕]∇

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


      ∇DUP[⎕]∇

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


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

```
      ∇KILL[⎕]∇

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


      ∇MULT1[⎕]∇

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


      ∇MULT7[⎕]∇

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

```
      ∇RANDOMIZE[⎕]∇

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


      ∇REALΔSUM1[⎕]∇

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

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

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

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

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

```
      ∇SUM1[⎕]∇

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

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

```
      ∇SYNTH∆SUM1[⎕]∇

    ∇  A←SYNTH∆SUM1 V
[1]    A←((⍳NMARKETS)∘.=S∆MARKET)+.×V
    ∇


      ∇USING[⎕]∇

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

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