ARTIKLER 41

DATA SOURCES AND USER OPERATIONS OF MODIS, A MACRO-ECONOMIC MODEL FOR SHORT TERM PLANNING

By Per Sevaldson

DATAGRUNNLAG OG BRUKERMEDVIRKNING VED MODIS, EN MAKROØKONOMISK MODELL FOR PLANLEGGING PÅ KORT SIKT

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FORORD

Tidligere offentliggjorte beskrivelser av MODIS-modellene har lagt hovedvekten på å gjøre rede for i hvilken utstrekning og på hvilke måter de økonomiske struktursammenhengene blir representert i modellene og hvilken rolle modellene spiller i den økonomiske planleggingsprosessen.

Denne artikkelen gjør rede for hvordan strukturkoeffisientene i modellen blir bestemt, enten på grunnlag av spesielle analyser, eller ved at modellprogrammet selv regner dem ut på grunnlag av løpende data. Videre forklares det hvordan de eksogene anslag som utgjør forutsetningene for den enkelte modellprognose blir spesifisert og "matet" inn i programmet. I denne forbindelse blir også en del problemer som reiser seg i samordningen av det arbeid som skal utføres av modellenes brukere med det som utføres av dem som ivaretar bygging og drift av modellene, tatt opp.

Artikkelen bygger på et foredrag som forfatteren holdt ved Det første seminar om matematiske metoder og EDB-teknikk arrangert av de Forente Nasjoners Økonomiske Kommisjon i Varna (Bulgaria) 28. september - 9. oktober 1970.

Forfatteren takker Olav Bjerkholt og andre kolleger i Statistisk Sentralbyrå for nyttige kommentarer til utkastet til artikkelen.

Statistisk Sentralbyrå, Oslo, 14. april 1971

Odd Aukrust

PREFACE

Whereas the formal, mathematical frameworks of the MODIS-models are quite well documented and their general function in the process of government planning has also been described elsewhere, this paper gives a description of how the structural coefficients of the model are determined from separate studies or current data which are processed by the model program. It explains how exogenous estimates are specified and introduced into the programs. In this connection some problems of cooperation between model users and model builders and operators are taken up.

This paper was prepared for the First Seminar on Mathematical Methods and Computer Techniques organized by the United Nations Economic Commission for Europe, Varna (Bulgaria) 28 September - 9 October 1970.

The author expresses his gratitude to Olav Bjerkholt and other colleagues in the Central Bureau of Statistics for helpful comments to the draft of this paper.

Central Bureau of Statistics, Oslo, 14 April 1971

Odd Aukrust

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A p p e n d i x

The treatment of Construction and Trade in MODIS III 25

I. Description of the model and its economic interpretation[1)]

The model of disaggregated type, MODIS, which is being developed by the Central Bureau of Statistics of Norway is not one or a limited number of well defined specific models. The present version, MODIS III, is the third operational specification of a body of data, specifications and hypotheses, which is being more or less continually developed. The development is still going on, and it is foreseen that it will be possible in the future to assemble alternative operational versions simultaneously, where the specifications in each version depends on the purposes for which it is going to be used and on the choices between certain sets of alternative hypotheses which the analysts may choose as the basis for their analysis. A detailed and concise description of the equation system of MODIS III has been given by Olav Bjerkholt[2)], and an account of the use of the model in government planning, which is still generally valid, is given by Per Sevaldson[3)]. Information covered by these two papers will only be summarily reproduced in the present paper.

A very summary outline of the main features of the model is nevertheless necessary as a background for the following discussion.

The central part of the model in its present version is an ordinary input-output model with 142 sectors of production, and with private consumption treated endogenously. The model contains a submodel for prices which may be solved separately and in advance of the solution of the remainder of the model. In this way prices may be considered as known, when the main body of the model is solved, and terms in current price values, which are products of price and volume variables, are linear in the unknowns when only the volume variables are considered as unknowns.

N o t e s :

1) For formal descriptions of the MODIS-models and of their uses in the process of government planning see:

   BJERKHOLT, O.: "A Precise Description of the System of Equations of the Economic model MODIS III". Artikler fra Statistisk Sentralbyrå no. 24, Oslo 1968.

   SEVALDSON, P.: "MODIS II a Macro-economic Model for Short-Term Analysis and Planning". Artikler fra Statistisk Sentralbyrå no. 23, Oslo 1968. Also as: "Norway, A Short term model for planning" in "Macro-economic Models for Planning". United Nations Economic Commission for Europe, Geneva 1967.

   SEVALDSON, P.: "An Interindustry Model of Production and Consumption for Economic Planning in Norway", in ed. Colin Clark and Geer Stuvel: "Income Redistribution and the Statistical Foundations of Economic Policy", Income and Wealth, Series X, Bowes and Bowes, London 1964.

2) Op.cit.

3) Op.cit. 1968.

The price sub-model takes as given: import- and export-prices, prices of products from domestic sectors competing with imports, and government regulated prices. Prices for domestic sectors which do not compete with imports or have their prices determined by government regulations, are then determined endogenously from input costs, including exogenous assumptions about wage-costs, indirect taxes and profit rates.

In sectors with exogenously given prices it is the profit rates which are determined endogenously, namely as the residual when all cost elements have been deducted from the stipulated product price. In this way all price elements in the model are determined from exogenous estimates, and by help of the input-output coefficients, which give the relative weights for the cost elements of each sector of production.

When prices are known, additional exogenous estimates are needed in order to solve for the volume and value variables of the model.

Final demand for exports, government consumption and gross investment in fixed assets, all specified into a total of 247 commodity groups[1)], and inventory changes for each sector, are estimated exogenously.

Private consumption in a specification of 47 commodity groups[1)] is determined by relative prices (determined by the price-submodel) and disposable incomes deflated by a consumers' price index. (The price index is also determined from the price-submodel.)

Commodity groups are assumed to be composed of sector deliveries in fixed proportions, and intermediate demand and total production are determined by input-output relationships. Disposable incomes are determined by wage and profit rates (from the price-submodel), production levels, and exogenously given labour productivity indexes and taxation rates.

Final demands for imports are determined by the fixed proportions in the commodity groups, and intermediate demand for imports are determined by input-output coefficients and production levels in the sectors. All imports are treated as structural (non-competitive).

Employment is determined by exogenously given productivity indexes applied to base year labour input coefficients and production levels.

The model results are computed in great detail, and a large number of the variables are computed in current as well as in base year prices.

No capacity limits are imposed on production in the model.

The model in its present version is formulated in terms of changes in the variables, and is thus dependent on the availability of accounts data

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N o t e :

1) 13 of the 47 commodity groups of private consumption, notably rents, are among the 247 commodity groups which are estimated exogenously.

for a base year in order to develop absolute levels for the year of analysis.[1)]

From an aggregate, macro-economic point of view it must be said that the model covers only a fraction of the important structural relations in the economy. The majority of variables characterizing a situation which is to be analyzed must be given independently as exogenous estimates.

The price sub-model determines the prices for only 67 production sectors, whereas prices for the other 75 sectors and for imported commodities have to be given exogenously. Of total final demand, only private consumption is endogenous, but the distribution of total demand on gross national product and imports is determined by the model.

Possibly the gross macro-economic characteristics of the economic situation might have been determined equally well on the basis of a simple macro-model.

However, in economic planning, and in many types of analysis, finer specifications in prices, volumes and values per sector etc. are required, and these can be estimated by using MODIS. In particular, the effects of stimuli and reactions which are important, even if they do not appreciably affect the most aggregate macrovariables, will be accounted for in the model.

To stipulate future values for the exogenous variables in a model like MODIS is a many-sided venture, entailing both decisions about policy variables and prophecies about other variables. By building these forecasts on factual information and more or less well founded and more or less explicitly formulated hypotheses about structural interdependences, it may be possible to reduce to a minimum the elements of pure sorcery in this undertaking. But considerations of structural interdependencies will very often imply that the plausibility of an estimate of an exogenous variable cannot be assessed until it can be compared with corresponding estimates for some of the endogenous variables, to which it may be related in ways which are not represented in the structural relationships of the model. For this reason, an a priori set of exogenous estimates should always be considered as preliminary, and not be finally accepted until it has been examined in combination with the set of endogenous estimates to which it leads. ("Are exogenous price forecasts consistent with volume forecasts, also from a more general point of view than within the explisit relationships of the model?" "Are investment assumptions in the same way consistent with forecasts of production and profits?" etc.)

N o t e :

1) A number of modifications to the above sweeping description will be found in the cited Artikler no. 24.

The discovery of inconsistencies, should lead to adjustments in the exogenous variables and recalculation of estimates for the endogenous variables, until an acceptable combination is found.

A partial and imperfect model, like MODIS, can only be used to its full advantage for planning purposes in an iterative process of this kind, where a good deal more analysis and knowledge about the economy is brought to bear on the estimates, than that which is rigidly formalized in the explicit relationships of the model.

It should finally be pointed out, that, since the model is "nearly linear", reduced form coefficients may be computed, in full detail as well as in the form of coefficients for aggregated variables. Detailed as well as aggregate reduced form coefficients may be used with confidence for analysis of the effects of moderate variations in the exogenous variables, and they may also be grafted on to sub-models for other structural relationships than those covered by MODIS itself.

II. Purposes and uses of the model

The development of MODIS has been quite closely tied to the process of one year planning (the "national budget") in the Norwegian government. It might be said that the successive operative versions of the model have been designed with a view to serving the process of one-year-planning. However, the underlying body of data, specifications and structural analysis has been developed with a less specific purpose, and with a stronger emphasis on the conditions for fruitful quantitative economic research in general, than with priorities derived from the needs of the one-year-planning process.

The interest of the Central Bureau of Statistics in input-output analysis dates back to the construction of the Norwegian system of national accounts, immediately after the second World War.

Studies of consumer budgets and consumer behaviour in the Bureau date even further back.

The analysis of the tax system and its effects on private and public incomes was assigned to the Bureau as a special field of research in the early post-war years.

These are the three main sources on which the model formulations are founded, apart from the detailed and comprehensive system of national accounts.

Even before 1961 simple input-output models were used to test the consistency in national budget (one year plan) estimates, but with the preparation of the plan for that year the use of a formal model was integrated into the administrative planning process in the government. The model version

which was used had no prices in it, and had a fixed base year as long as it was in use.

Prices were introduced in MODIS II, which was used for the first time in preparing the national budget for 1966. For this model the data basis was revised every year. The present version, MODIS III, is with respect to economic content not very different from MODIS II.

In addition to the use for one-year-planning, the model has from the beginning also been used as a tool in preparing four-year plans.

In the one-year and four-year planning process the Ministry of Finance is the user of the model. The Ministry acts as coordinator of the planning process and is directly responsible for the final stipulations of the alternative sets of values of exogenous variables which are inserted in the model. The formulation and technical operation of the model has all the time been the responsibility of the Central Bureau of Statistics.

The model is also used regularly by the Central Bureau of Statistics for specifically analytical purposes. In the Annual Survey of the economy (See e.g.: Economic Survey, 1969) of the expired year, published in January of the following year, the model is used to assess the components of changes in endogenous variables which are due to the observed changes in each of the principal groups of exogenous variables.

These computations provide the basis for a quantitative analysis of the impulses that have been at work in various parts of the economy, and of the isolated effects of each type of impuls through the system.

Discrepancies between the total computed change in a variable and the observed (total) change in the same variable serve as a general check on the precision in model estimates.

III. Input data of the model: How they are derived from current statistical series and other sources

The input data for the model may be classified into the following groups, which will be commented upon separately:

a) Independently developed estimates of structural coefficients

b) Data for the computation of structural coefficients

c) Accounting data for the variables in the base year

d) Prognoses of non-policy exogenous variables

   i) "truly" independent of endogenous variables of the model

   ii) dependent on endogenous variables of the model, but in ways which are not represented in the model

e) Programs for policy-variables

   i) Policy variables under direct government control

   ii) Policy variables indirectly or partially controlled by the government

a) The following structural coefficients have been estimated independently:

i) Marginal propensity to consume out of disposable wage and salary incomes and marginal propensity to consume out of disposable entrepreneurial incomes. These two coefficients were estimated on the basis of national accounting data in constant (1959-) prices for the 11 years 1952-1962 by taking the linear multiple regression of total private consumption on the two disposable income concepts[1].

ii) Elasticities in regard to total consumption (Engel elasticities) for 46 commodity groups. The basic data were national accounts figures for the 10 years 1952-1961 for total private consumption and private consumption of each of 46 commodity groups in constant (1955-) prices and national accounts implicit price indexes for the same 46 commodity groups and for total consumption.

A first approximation estimate of the Engel elasticities was obtained by taking the multiple regression of the logarithm of each of the 46 commodity groups on the logarithm of total consumption and the logarithm of the relative price of the same commodity groups. The regression coefficient in respect of

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N o t e :

1) Let $\overline{C}_t$ = total private consumption in constant prices in year t (exogenous commodity groups excluded)

$\overline{W}_t$ = disposable wage and salary income in year t deflated by a consumer price index

$\overline{Y}_t$ = disposable "entrepreneurial income" (Entrepreneurial income accruing in production sectors (exclusive of depreciation charges) and minus direct taxes on (personal and company) entrepreneurial incomes) in year t, deflated by a consumer price index.

Then we estimated the regression coefficients α_1, α_2 and α_3 in

$$\overline{C}_t = \alpha_1\overline{W}_t + \alpha_2\overline{Y}_t + \alpha_3 + u_t,$$

where u_t is a residual term. The estimates were $\alpha_1 = 0.870$ (0.022), $\alpha_2 = 0.142$ (0.056) and $\alpha_3 = 2\ 750$ million kroner. The figures in parenthesis are the estimates of the variances. The multiple coefficient of correlation was 0.998 and the residual variance 126 million kroner.

The procedure has been described by ØIEN, A. in:"MODIS II. En samfunnsøkonomisk modell med kryssløps-, konsum- og prisrelasjoner" (MODIS II an economic model with interindustry-, consumption- and price-relationships). Working paper IO 66/3 from the Central Bureau of Statistics. Mimeographed in Norwegian only, Oslo 1966.

total consumption was then an estimate of the Engel elasticity[1].

These estimates of the Engelelasticities are not uncritically accepted. It is realized that statistical accident, particular conditions in the period of observation as well as the fact that only the direct price effects are taken into account, may have caused distortion in the estimates. These were consequently compared with other estimates, in particular estimates based on consumer budget studies, and were adjusted on the basis of a general judgment of their plausibilities[2].

The resulting estimates are again adjusted annually, so that their sum, when they are weighted by the budget percentages of the new base year, equals 1, see point b) below.

iii) The flexibility of the marginal utility of money, defined as

$$\hat{\omega} = \frac{du_r}{d\bar{C}} \cdot \frac{\bar{C}}{u_r} \left(= \frac{d\,\frac{u_r}{P_r}}{d\bar{C}} \cdot \frac{\bar{C}}{\frac{u_r}{P_r}} \right)$$

when u_r is the marginal utility of commodity no. r, $\bar{C}$ is total private consumption in constant (1955-) prices and P_r is the implicit price index for commodity no. r. This parameter is necessary for the derivation of price elasticities of consumption (see b) below) and a value of -3 has been chosen on the basis of somewhat general considerations[3].

N o t e s :

1) We write

$\bar{C}_t$ = total private consumption in constant (1955-) prices in year t

$\bar{C}_t^r$ = private consumption of commodity group r in constant (1955-) prices in year t

P_t^r = implicit price index for commodity group r in year t divided by implicit price index for total private consumption in year t

We obtained a first approximation estimate of the Engel elasticity as the regression coefficient, β_r, when the coefficients in the following form were estimated by multiple least squares regression.

$$\ln \bar{C}_t^r = \beta_r \ln \bar{C}_t + \gamma_r \ln P_t^r + \delta_r + w_t$$

ln means natural logarithm of, β_r, γ_r and δ_r are constants and w_t is an error term.

2) See ØIEN, A.: op.cit.

3) This choice has been explained and commented upon in "Private Consumption in Norway 1930-1970" by AMUNDSEN, A. In Ed. SANDEE, J.: "Europe's future Consumption", Amsterdam 1964.
A Norwegian version: "Konsumelastisiteter og konsumprognoser bygd på nasjonalregnskapet (Consumer Demand Elasticities and Consumer Expenditure Projections Based on National Accounts Data)" Artikler 7 from the Central Bureau of Statistics, Oslo 1963.

iv) Basic structural coefficients for subsectors of the sectors Trade and Construction in the National accounts. (These basic structural coefficients are automatically adjusted, so that the average for each of the national accounts sectors equals the overall coefficients which may be calculated for these sectors on the basis of the base year accounts. See appendix 1 for a further description.)

b) Data for the computation of structural coefficients

A majority of the coefficients of the model are estimated directly on the basis of national accounts data for the base year, and since the base year is moved, as accounts for a new year become available every year, these coefficients are also revised every year.

The strong systematic ties to the national accounts is a distinguishing feature of the MODIS-models. The specification in a detailed input-output framework of the annual national accounts is the empirical foundation of the model, and specifications in the national accounts are conditioned by the requirements of the model, to such an extent that they may be looked upon as members of a common system. This observation is relevant to the use of the national accounts as a basis for estimation of structural coefficients and it is equally relevant for the use of the national accounts to supply the statistical description of the base year, from which changes are computed by the model. (See point c) below.)

The following coefficients are estimated:

i) Regular input-output coefficients, i.e. the ratios in each sector of production between the values of each input and total production. Coefficients are computed for inputs from each domestic sector of production, each import sector, depreciation, each type of indirect taxes and subsidies, for wages and for entrepreneurial incomes as well as for total gross product; (i.e. total value added).

ii) Final demand proportions, i.e. the relations for each final demand item between the value of deliveries from each domestic or import sector and total value of the item.

It is an important feature of the model, that sector deliveries are in "producers' prices" (including indirect taxes paid by the producers and less subsidies received by the producers), and import deliveries are in prices c.i.f. On the other hand, final demand items are measured in purchasers' prices, i.e. including trade and transportation margins and net indirect taxes (including customs duties for imports) levied in trade. Thus final demand proportions also entail coefficients for the proportions between deliveries from the trade sectors and the total value of each final demand

item. In this way input-output relationships in producers' prices can be used whereas exogenous estimates of final demand can be made in purchasers' prices.

iii) Sector distribution coefficients for each of the (92) types of fixed assets, i.e. the proportion of each type of capital which is engaged in each of the production sectors.

iv) Depreciation ratios, i.e. for each type of fixed capital the ratio between depreciation and capital stock at the end of the year. These and the data under iii) above are needed because depreciation in each sector is computed not as a fixed ratio of gross production, but as the sum of depreciations on each of the types of fixed capital engaged in the sector, and for each type of capital depreciation is a fixed proportion of the total amount at the end of the year.

v) 1) Total inputs into the national accounts sector Construction from each domestic sector and from each import sector, as well as all value added elements on these inputs.

11) Total production in each of the six subsectors of construction. (The national accounts give gross production but not inputs and value added for each of these subsectors. For the use of these data, see appendix 1.)

vi) Deliveries in producers' prices from each domestic sector of production and in c.i.f. prices from each import sector to each of the following categories of use: private and government consumption, gross investment in fixed assets, exports, and intermediate use; total trade margins on each of these deliveries. (For the use of these data, see appendix 1.)

vii) Budget proportions for each of the 46 items of private consumption.

viii) Coefficients for the distribution of entrepreneurial incomes in each sector of production on the following income recepients: Private self employed, private corporations, central government, municipal governments.

c) Accounting data for endogenous and exogenous variables in the base year

i) The majority of these data are taken directly from the national accounts. (See point b) above).

However, some special aggregations are necessary.

ii) Detailed specifications of indirect taxes and subsidies in the base year are taken from statistics of public finance.

Stock of each type of fixed capital in each sector at the end of the base year are taken from capital accounts and used together with exogenous

investment figures and sector distribution coefficients (b) iii) above) to obtain each type of fixed asset in each sector at the end of the plan year, and this again is the basis for the depreciation estimates.

d) Prognoses of non-policy exogenous variables

i) Variables which are "truly" independent of endogenous variables of the model.

Without going into the problem of dependence and independence, we may decide that some variables are to be considered as independent, such as import prices, export prices and possibly export quantities. For the prognoses of such variables one could establish separate, possibly simple, submodels, based on available information. However, resources have not been available for systematic work in this direction. Instead, a system of mobilizing expert guesses has been established by the Ministry of Finance; the prognoses are produced with the help of experts located at various points in the administration or in independent organizations.

Until recently it was a problem that these experts could not be supplied with historical time series in sufficient detail, in specifications corresponding to the variables for which they were to make prognoses. From 1970 on, however, the Central Bureau of Statistics has organized the detailed national accounts estimates for the entire period from 1949 up to the present in a systematic file. From this file time series in current or constant price values, in absolute or relative form and in almost any specification can be extracted in suitable tables through relatively simple computer programs. It is hoped that when experts, who through their regular jobs have special insight in a field, apply their judgment to making prognoses on the basis of these series, the results will be sufficiently realistic.

iii) Variables which depend on endogenous variables of the model, but in ways which are not represented in the model.

Some of these variables are also partially controlled by the government and are also referred to under a subsequent heading (e) ii)).

Under the present heading we may group variables such as unit entrepreneurial incomes (profit rates) in sheltered sectors of production, wage rate indexes, productivity indexes, changes in inventories, gross investments in fixed assets, consumption by municipalities a.s.o. These are all variables, which ideally should be treated as endogenous, but where we do not have sufficient information about the structural relationships to make them determinate. In this way, these variables illustrate the short-comings of the model. The problem of their estimation can only be definitively solved by enlarging the model.

In the meantime, more provisory methods have to be used. Even here the use of expert guesses are resorted to. But here the initial guesses should also be checked against model outcomes for the endogenous variables. Because, even if we do not know enough about the relationships which determine these variables to incorporate them into the model, we may know enough to form an opinion about whether or not the initial guesses are consistent with the magnitudes of endogenous variables resulting from the model computations.

If the initial guesses and the results of the computations are deemed to be inconsistent, the initial guesses must be adjusted, and new computations performed, and so on.

e) Programs for policy variables

i) Policy variables under direct government control.

So far MODIS has been used as what one might term a "policy exploration model". We mean by this that a small number of sets of values are chosen for the policy variables, the model is solved and the resulting sets of values for endogenous variables are considered together with the corresponding values of exogenous variables. That set of policy variables which gives the most "pleasant" result altogether is chosen. There is no rigid enumeration of target variables, or concrete standards of evaluation. In particular, the method of target setting, where the targets are determined exogenously and a corresponding number of policy variables are determined endogenously has not been applied. Neither has formal optimization procedures been used.

ii) Policy variables only indirectly or partially controlled by the government.

Variables which are not entirely and directly determined by the government may be influenced by truly exogenous factors as well as by endogenous variables in ways which are not represented in the model. Unless such influences can be foreseen or counteracted, one cannot be certain that the stipulated values can be achieved. Apart from that, the model does not say anything about which acts of the government are necessary in order to bring about the stipulated values of these "quasi"-policy variables.

This is another field where there is a need for extensions of the model.

IV. Numerical solutions

In principle the model may be looked upon as two simple systems of linear equations, recursively connected.

The numerical-computational problems are all caused by the large amount of data in the system.

These problems may be discussed under the following headings:

a) The need for an integrated processing system
b) Inputs of structural and accounting data
c) Regrouping of data and production of model coefficients
d) Inputs of problem data (exogenous estimates)
e) Solutions of the model
f) Organization and presentation of commutational results
g) Some remarks about programming techniques and equipment

a) The need for an integrated processing system

Early experience demonstrated the necessity of developing an integrated computational process, which minimized manual handling of cards or tapes. Still, for several reasons, it was necessary to arrange the computations in a number of successive steps, where a set of tapes produced by one step are inputs into the next step.

b) Inputs of structural and accounting data

The bulk of these data are the national accounts. Every year a new set of accounts comprising some 10 000 entries becomes available, and a large proportion of these entries are to be absorbed in the model framework. Since the accounts are produced on magnetic tape, it was essential that this tape could be directly read into the MODIS program.

The remaining structural data could be taken over in the form of tapes from earlier versions of the model, or, to the extent that they had to be revised, be punched and absorbed from cards.

c) Regrouping of data and production of model coefficients is an internal operation of the program. It is the major part of the computer job, and since it need not be repeated unless new accounts or new data for the other structural coefficients have to be introduced, it is considered as a separate stage of the program.

d) Inputs of problem data

The number of exogenous variables in the model is very large, 1 400 in total. And for many of these the model user may want to try several alternatives.

The model program can compute the solutions for 20 alternative sets of exogenous estimates in one run. Normally, 2 or 3 alternatives will be specified for each of the principal groups into which the exogenous variables may be divided, e.g. internal prices, import prices, export deliveries etc. and up to 20 complete alternatives are formed as combinations of the group alternatives.

Since so much of the economy is "outside" the model, many of the variables, which are treated as exogenous are in reality structurally connected. Consequently, the model user ought to be able to form some opinion of the consistency of the set of exogenous estimates he chooses, even before they are inserted in the model. But if this is to be possible, the 1 400 estimates must be grouped and aggregated immediately, and before they are sent to the computer. This is a problem which has not quite been solved up till now. To some extent it is met by a systematic scheme for the writing out of the exogenous estimates.

This scheme consists of a set of 22 standard forms, one for each of the principal types of exogenous estimates: estimates of internal prices, estimates of import prices, estimates of export deliveries etc. Each form has definitions and rubrics for writing in the sets of alternatives for exogenous variables in one of the groups.

The formalisation provides an assurance that correct definitions are used, and that no variables are forgotten.

It also makes it possible in a simple and perspicuous way to form complete policy alternatives through the combination of alternative stipulations concerning individual groups of items (e.g.: "alternative I for gross fixed asset formation <u>and</u> alternative III for government consumption and ...). Finally the forms make it possible to simplify the punching and processing routines for the exogenous data, so that handling time is minimized and the hazard of errors is reduced.

Still, the full specification of estimates for all the exogenous variables of the model is a major operation, and would make the use of the model impossible for many purposes, where a detailed analysis is neither required, nor possible with available resources. In order to meet the needs for such uses, a program for conversion to model terms of estimates of aggregates of exogenous variables has been developed. The principle here is that rates of change, e.g. in prices may be estimated for whole groups of variables, and one estimate will be applied to all items in a whole group. Estimates may also be given for aggregates in current or constant price values, and the aggregates will automatically be spread over the individual items in predetermined proportions. These proportions may for instance be the proportions assumed in a central, and fully specified alternative, or the proportions of base year deliveries.

e) Solutions of the model

Solutions may be computed simultaneously for any number of alternative sets of exogenous estimates from 1 up to 20.

f) Organization and presentation of computational results

Also the model estimates for endogenous variables is a large body of figures. And the user will want to compare these estimates to base year figures and to exogenous estimates, both in detail and at various levels of aggregation, both in absolute values and in percentages. In addition to this, results for alternative sets of exogenous estimates will have to be compared.

It is consequently necessary that the program entails a considerable amount of processing of the solution data, together with some of the input data.

The results must be presented in standard form, in such ways that relevant comparisons can be made, and items can be immediately identified.

The way this is solved in MODIS is through the presentation of the results in the form of standard tables, with all texts printed by the computer program.

Alternative tabulation programs will be needed for alternative uses. In MODIS so far only two programs are available: one is a general program of rather aggregate specifications, and one a very detailed tabulation program for use by the Ministry of Finance in working with one- and four-year plans.

g) Some remarks about programming techniques and equipment

The basic system of programming was developed already for MODIS II.

The computer used for MODIS II and for MODIS III until the end of 1969 was a Univac 1107.

This computer was not controlled by the Central Bureau of Statistics, and computer time was bought on favorable terms from "Norsk Regnesentral" a non-profit-organization, which owned the machine. The reason why computing time had to be purchased on an outside machine was that the computer needs of the Central Bureau of Statistics are not of such a nature that a computer of the size required for MODIS could be fully employed by the Bureau.

The use of an outside computer has created some problems of compatibility with tapes produced by the Bureau's own equipment, e.g. the national accounts. However, these problems have all been solved with relative ease.

The computer program is in general developed as a control program, organizing the use of an extensive system of sub-routines.

The control program was largely developed by economists of the group working with the model, but it has also benefitted from professional advice. Original computer time for a solution in 10 alternatives, from the input of structural data until the presentation of the final tables, was about 10 hours.

With the structural data given, and processed in advance, the computer time for a new set of 10 alternatives for the exogenous variables was approximately 7.30 hours. By successive improvements in the control program and in the sub-routines, these times were brought down first to 3.40 hours and 1 hour respectively for sets of 20 alternatives in MODIS III and to 2.40 hours and 1 hour by the end of 1969.

From January 1970 the model has had to be transferred to a Univac 1108. This transition was effected with as little as possible of disturbances in the original program, but was still a rather costly operation in terms of time spent for programming and for test runs on the computer. The results were, however, very satisfactory and reduced the two time factors to 17 min. and 8 min. respectively.

V. Role of the model in the decisionmaking and planning process

Descriptions of the use of MODIS in the decision process of government economic planning have been given elsewhere[1)].

Only a few general observations based on the experiences of ten years' use shall be given here:

The usefulness of a model like MODIS in a government planning process is limited by its shortcomings in representing relevant economic structure. This is rather obvious and needs no comments.

The usefulness is also limited to the extent that definitions and specifications in the model deviate from the concepts used in formulating policy decisions or evaluating policy effects.

However, there are some rather important consequences. As long as a policy model does not give a full and correct representation of reality, it can only be advantageously used by somebody who is able to interpret the results correctly. He must know what structural relationships are taken into account in the model, and which have been ignored. He should also know something about the accuracy with which structural relations are represented in the model. Only in this way can he realize which additional relationships he ought to have in mind in evaluating the plausibility and consistency of model results, and which margins of errors he must consider. Only in this way will he be able to interpret correctly strange results of model computations, and only in this way will he be able, through iterative adjustments in exogenous variable estimates, to utilize the model fully in developing a set of plan estimates.

N o t e :

1) See SEVALDSON, P., op.cit. See also: "Concepts and Methods in National Budgetting", Royal Norwegian Ministry of Finance, Oslo 1965. (A reprint of Appendix 1 of "The National Budget of Norway 1966) and BJERVE, P. J.: "Trends in Quantitative Economic Planning in Norway" Artikler fra Statistisk Sentralbyrå No. 21, Oslo 1968.

Between sector experts and decision makers on one side and the model "operators" on the other, a team of "model interpreters" is consequently required. This function of model interpretation should preferably penetrate as deep as possible into the central plan preparing administration. It is one of the experiences from the use of the MODIS models that knowledge and understanding of the working of the model has been limited to a too small group of people in the central plan preparing administration in the Ministry of Finance.

The MODIS models place a heavy burden of estimating exogenous variables on the shoulders of the user. The exogenous variables are not only direct policy variables. Some of them only partly and/or indirectly reflect policy, others are not related to policy at all, or only very remotely.

These variables give occation to a dilemma: The planning administration may have no particular qualifications and no resources for preparing the estimates.

Still it is essential that the planning administration is entirely familiar with the - very often quite subjective and nearly always rather uncertain - nature of these estimates, a familiarity it will only achieve in full measure if it is actively engaged in the process of preparing the estimates.

Another source of problem is that definitions and specifications in the model do not in all cases precisely correspond to the concepts used in the formulation of policy decisions or in the evaluation of policy effects. In MODIS a considerable amount of work has had to be devoted to the removal of such differences, and still more must be done.

VI. Brief evaluation of the model and possible further developments

Relatively few tests of performance of the MODIS-models have been undertaken. In the choice between using scarce resources for tests of the current version and using the same resources for introduction of improvements in a new version, the work on improvements has always seemed to be more interesting[1)].

One of the reasons is that a good deal is known about the weakness of the model a priori, even if the consequences of these weaknesses in regard to the accuracy of estimates are not known. Another reason is the difficulty in interpreting test results for a complex and composite assembly of hypotheses, like a MODIS model.

Partial tests of model structures are performed, i.a. in efforts to improve formulations and re-estimate coefficients.

N o t e :

1) See, however, SEVALDSON: Op.cit. 1964 for tests of MODIS I.

Still, it is true that more statistics about performance are urgently needed.

A new version of the model, MODIS IV, is under construction, but (at the time of writing) it is still in the early stages. The following changes will probably be introduced:

i) The conventional input-output model of production will be replaced by an activity model, allowing joint production and alternative techniques.

ii) Labour productivity will be made endogenous in the model, instead of exogenous as in MODIS III.

iii) More possibilities of substitution between imports and domestic production will be taken into account than the minimum introduced in MODIS III[1].

iv) Possibilities for working with alternative aggregated versions of the model will be included in the program.

v) The influence of costs and competitive pricing on price formation will be more flexibly represented than in MODIS III.

A further discussion of concepts and methods in MODIS IV will be given in the Norwegian contribution to the Fifth International Conference on Input-Output Techniques[2].

N o t e :

1) See BJERKHOLT: Op.cit.

2) See BJERKHOLT, O. and LONGVA, S.: "MODIS IV. The Basic Framework of an Input-Output Planning Model, with a Commodity-Activity-Sector Approach" Paper presented to the Fifth International Conference on Input-Output Techniques in Geneva, January 11-15, 1971. Mimeographed as Working paper IO 70/23 from the Central Bureau of Statistics. Oslo 1970.

Appendix

The treatment of Construction and Trade in MODIS III

I. Construction

The National Accounts give output figures for 6 construction sectors:

- Building and repairing of agricultural buildings
- Building and repairing of buildings in manufacturing
- Building of dwellings
- Building of commercial and public buildings
- Repairing of dwellings, commercial and public buildings
- Other construction

Due to lack of statistics inputs cannot be allocated to each of these sectors. Instead all inputs into construction sectors are channelled through a common dummy sector,

- Construction, debit

However, one set of estimates of input-output coefficients for the individual sectors for one particular year is available[1]. In spite of their being old and based on very shaky statistics, these coefficients are still utilized. However, they are adjusted in such a way, that when the adjusted coefficients are applied to outputs in the base year in each of the six production sectors in construction, the sum of the computed inputs of each item over the six sectors will equal the registered input of the same item into the dummy sector, as recorded in the national accounts for the base year.

The adjustment is "as nearly as possible" proportional for all coefficients relating to the same type of input into the sectors. However, a final adjustment must be made in order to obtain coefficient sums of 1 for total inputs into each sector. The adjustments are made automatically by the computer program.

Note:

1) "Kryssløpsanalyse av Produksjon og Innsats i Norske Næringer 1954. Input-Output Analysis of Norwegian Industries 1954". SØS No. 9, Central Bureau of Statistics, Oslo, 1960.

II. Trade

The national accounts have only two sectors producing "trade and transportation margins"

- Trade and
- Customs duties

The first of these sectors receives as inputs all the inputs of trading establishments, including indirect taxes paid by such establishments, and in addition customs duties and all the costs of external transportation of commodities between producer or place of importation and user or place of exportation. This sector delivers as outputs to each sector of use - or to each commodity group specified in final demand - the total trade margins (difference between purchasers' price and producers' price) on all commodities going to that sector or commodity group.

The second sector has as inputs only customs duties on imports and delivers these as "services" to the sector Trade.

In the model the total trade margin in volume terms on all commodities delivered to a production sector is assumed to be a fixed proportion of total output in the sector, and the total trade margin in volume terms on a commodity group in final demand is assumed to be a fixed proportion of the total volume of the commodity group. However, the model ought to reflect the fact that trade margins on deliveries to different uses will be composed in different proportions of inputs into the trade sector: some will include high indirect taxes, others e.g. much transportation, etc. In other words "trade margins" is not a homogenous commodity, and it should be subdivided into more homogenous commodities. In input-output analysis, this can only be done by subdividing the sector Trade into more homogenous sub-sectors. This could be handled by constructing different trade sectors for different types of deliveries. Such a solution would imply a decomposition of the trade sector by type of commodities and by the type of user, and might require a relatively large number of sub-sectors.

An alternative solution is to look upon the various items which make up the trade margins, and which are registered in the national accounts as inputs into the sector Trade. Sub-sectors may then be constructed for individual items or groups of such items. If this is done, the "inputs" and total outputs of each of the sub-sectors in the base year may be read directly off from the national accounts, and it only remains to dissolve the registered total trade margin on deliveries to each type of use into its content of "deliveries" from each of the sub-sectors.

This solution was chosen for MODIS II and III, and the sector Trade was disintegrated into the following 25 sub-sectors

- Commissions
- Wages in trading establishments
- Entrepreneurial incomes in trading establishments
- Depreciation in trading establishments
- Transportation of commodities by other than trading establishments
- Transportation of commodities by trading establishments
- Rents in trading establishments
- Packaging
- Insurance, office supplies etc.

and in addition 1 sector for each of 16 kinds of indirect taxes and subsidies.

Total output in the base year, as well as all inputs into each of these "sectors" can be read directly out of the national accounts figures for the sector Trade.

Coefficients for total trade margins on deliveries to production sectors and commodity groups may also be derived from the national accounts for the base year. It remains to decompose these total margin coefficients into coefficients for deliveries from each of the trade sub-sectors.

On the basis of a special investigation the composition of trade margins on deliveries to each type of use could be determined for a bench mark year. The relative compositions of trade margin coefficients are now assumed to remain stable; except for adjustments which make the sum of deliveries from each of the trade sub-sectors, computed on the basis of the adjusted trade margin coefficients, equal to the total output of the corresponding trade sub-sector as given by the national accounts for the base year.

The entire calculation of adjusted trade margin coefficients for inputs from each of the trade sub-sectors is performed automatically by the model program.

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