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THE ENVIRONMENT OF MODIS IV*

by

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1. Introduction

The paper on the Norwegian model MODIS IV is written by Mr. Bjerkholt and Mr. Longva who also share the main responsibility for constructing the model.[1] Due to circumstances, neither of them had the opportunity to participate in this seminar. In this introduction to the model I shall try to convey the main content of the paper, going into technical detail as little as possible, and also give supplementary information on some aspects of the model and its environment.

After a few words on the background and history of the MODIS models I shall deal with the main characteristics of MODIS IV and sub-models. The actual or even potential utility of a model can seldom be read out of the mathematical equations. Quite a few promising model projects has never come anywhere close to being a tool for actual planning and policy formation. I shall therefore also give an outline of the administrative environment of the model and by examples try to illustrate its role in policy formation. Finally, I shall make a few scattered remarks on various problems connected with the use of the model and the plans for further development.

2. The background and history of the MODIS models[2]

MODIS IV is the fourth generation in a series of macro-economic models constructed and used by the Central Bureau of Statistics of Norway. MODIS III was dealt with in a paper[3] by Mr. Sevaldson presented at The First Seminar on Mathematical Methods and Computer Techniques in Varna 1970. Like its predecessors, MODIS IV combines a disaggregated input-output framework with a number of additional relations and auxiliary assumptions.

The MODIS-models are closely linked to three parts of its environments, first, the data base of National Accounts, secondly, the main user, which is the Ministry of Finance, and thirdly, the computer.

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1) Bjerkholt, O. and S. Longva: The Integration of Fiscal Budgeting and Income Policy in MODIS IV. Arbeidsnotater fra Statistisk Sentralbyrå IO 74/18. Oslo 1974.

2) The name MODIS is an abbreviation for the term "MOdel of DISaggregated type".

3) Per Sevaldson: Data-Sources and User Operations of MODIS, a 'Macro-Economic Model for Short-Term Planning. Artikler no. 41. Central Bureau of Statistics. Oslo 1971.

The first MODIS-version dates back to a time when matrix inversion was a serious challenge to the model builder. This was one factor which led the model builders at that time to the rather misconceived idea of the model being run only once for each plan to be prepared. This was misconceived for several reasons. The most important were that, first, any simple run will almost always include too many errors, and, second, as the model does not simulate all the relations of the economy, the output must be checked against the input for economic consistency with regard to relations not built into the model. Thus it is a need for iterative use of the model.

As time went on and experience was gained from the use of the models, the model users as well as the model builders became more aware of the problems of the interface between the mathematical models and the administrative agencies and planning bodies, supplying the input and using the results of the model. This is a problem of integration of the models into the administrative and political planning process. I must add here that the models were used by the general departments of the Ministry of Finance, not by any special planning agency like in some other countries. We had to work very seriously with the problem of integrating the models into the administrative process in order that the models would become something more than an experimental appendix to already established administrative processes. This meant spreading information on how to use the model, how to interpret the results of studies undertaken by means of the model, and especially how to coordinate the model with various submodels, formal as well as semi-formal, used by various government agencies. This aspect is a very important aim of the new MODIS-version and I have stressed it at some length because it is often suppressed in presentation of models, and besides, it is a main topic at this seminar.

MODIS IV was constructed partly as a result of the experience gained by using earlier MODIS versions, and partly because a revision of the national accounts of Norway in conformity with the revised SNA[4)] of the UN, had made the use of MODIS III outdated.

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4) A System of National Accounts. United Nations. Studies in Methods, Series F, No. 2, Rev. 3. New York 1968.

3. Main characteristics of MODIS IV and submodels

A very summary outline of the main features of the model is necessary for the following discussion. A more precise description is given in the paper, by Bjerkholt and Longva.[5)]

The model consists of a number of parts or submodels. The structure of the model is shown in the diagram on the following page. Full-drawn lines in the diagram indicate interrelations between formalized parts of MODIS IV. Dotted lines represent interrelationships within the total model structure which have not been formalized as yet.

The envisaged full model system I shall refer to as the "outer model".

The formalized models have a clearcut formal structure given by a set of endogenous variables, a set of exogenous variables, a set of relations equal in number to the number of endogenous variables, and a set of coefficients and parameters entering into the relations. The outer model includes the formalized models as embedded parts. Exogenous variables of the formalized models may be either exogenous in the outer model or determined by relations assumed to exist in the outer model, but not yet formalized. Even coefficients and parameters of the formalized models may be considered as determined in the context of the outer model. From this follows that the outer model provides much of the interpretation and operational meaning of the formalized models.

The main formalized parts are the quantity submodel and the price submodel. At present there exist in addition two submodels for direct and indirect taxes, respectively, and one submodel for capital depreciation (not shown in the diagram). Indicated in the diagram are additional submodels which are not formal models but reside in the administrative environment.

The main variables to be determined in the quantity model are the supply of commodities by imports and domestic industries, and the composition of final demand. Exports, investments and government expenditures and some of the domestic production levels are assumed to be exogenously given.

The quantity model is an input-output model with submodels for imports and private consumption. The production part is related to the traditional Leontief input-output scheme. The standard assumption about

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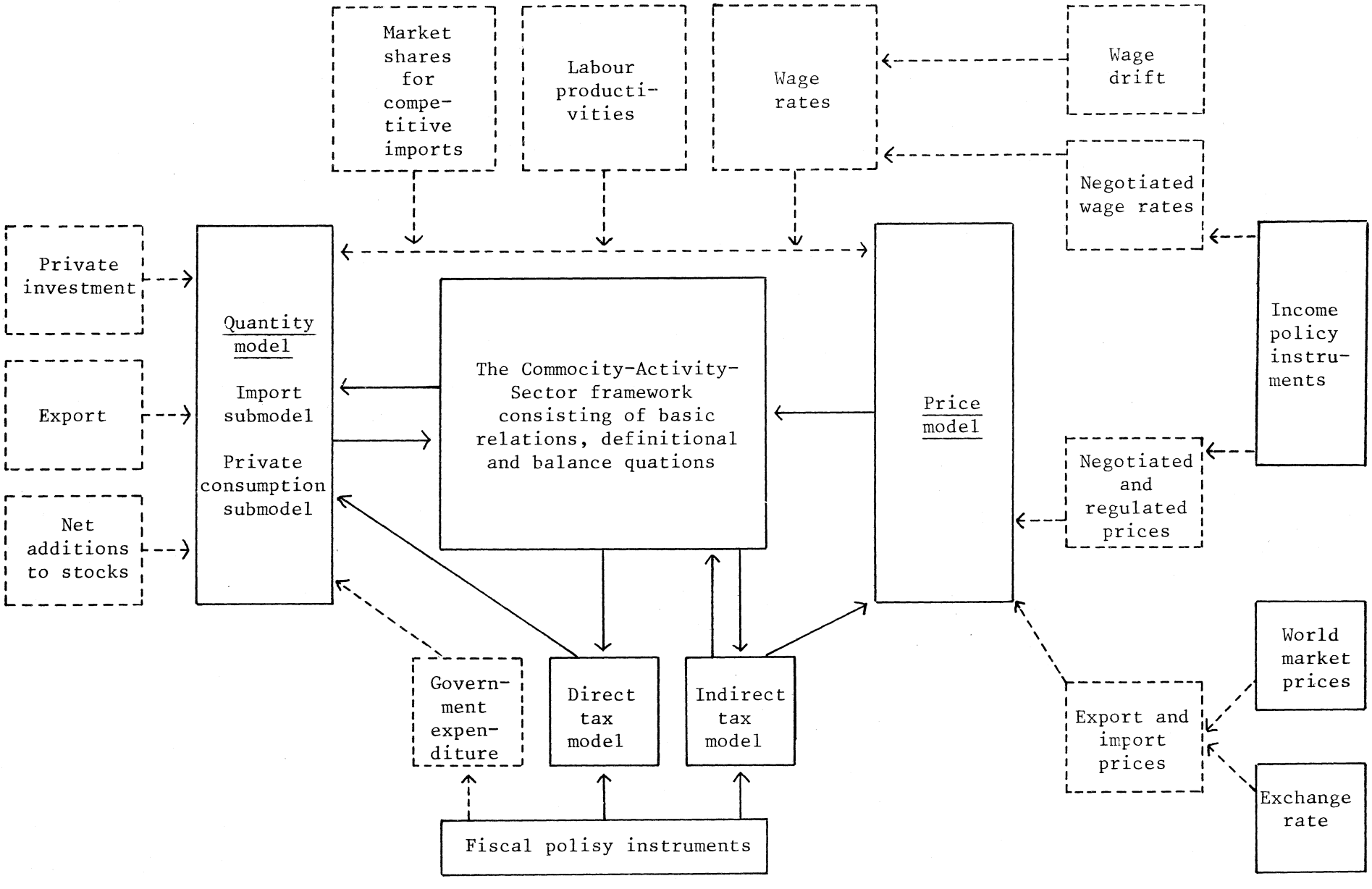
5) Op.cit., pp. 6-21.



Structural map of MODIS IV

fixed ratios between inputs and outputs is maintained. Otherwise, the treatment of production in MODIS differ from the traditional input-output handling in four respects. First, inputs and outputs are defined by a classification of commodities, not by a classification of sectors of origin. Secondly, output of more than one commodity from one single sector is allowed. Thirdly, the same commodity may be produced in different sectors and, fourthly, input-output coeffisients are normalized by value added rather than by gross production.

Imported commodities are divided more or less conventionally in competitive and non-competitive commodities. The import relations for competitive commodities are built around a matrix of relative import shares for each commodity delivered to each receiving sector. The data base for this matrix is the last available final national account. It is possible to change the relative import shares exogenously. The levels of non-competitive imports are directly determined by demand. The same is the case for competitive imports for which domestic production is exogenously stipulated.

The main elements of the submodel for private consumption are a macro consumption function and a set of distribution relations. The macro consumption function determines the total demand for private consumption as a function of real disposable income of (i) wage and salary earners (wages and salaries), (ii) independents (mainly incomes from unincorporated enterprises etc., including agriculture), and (iii) pensioners (pensions). The coefficients of the macro consumption function are determined from regression on time series national accounts data.

A set of distribution relations distributes the total demand for private consumption among the private consumption activities by means of income (Engel) and price (Cournot) derivatives. The Engel and Cournot derivatives are determined from regression on cross section consumer survey data and time series national accounts data applying the Frisch method of independent utilities.

The main types of input variables in the private consumption sub-model are: (i) exogenously given wage rates and labour productivities, (ii) consumer good prices, including the consumer price index (derived from the price model) and (iii) the parameters of the macro tax functions (derived from the direct tax model).

The wage rate and labour productivity estimates tie the private consumption sub-model to the production levels of industries.

The model for capital depreciation is quite simple and corresponds closely to the treatment in the national accounts. Each capital category is assumed to last a distinct number of years. During its lifetime the value of each capital good is reduced with a fixed amount every year (linear depreciaiton).

The main ideas of the price model of MODIS IV are the same as those of MODIS III and PRIM. The commodity prices are the most important variables determined in the price model. The price of a given commodity flow is assumed to differ depending on whether it is imported or domestically produced, and on whether it is exported or delivered to the domestic market. Each commodity may, accordingly, have an import price, an export price, and a domestic price.

The import and export prices are exogenously given. They are assumed to depend on world market prices and on the exchange rate.

Reflecting the openness of the Norwegian economy an important feature of the price model is the distinction between the exposed and the sheltered domestic prices. The exposed domestic prices are prices of commodities sold under strong foreign competition in domestic markets. The model assumes that the exposed domestic prices normally are adjusted to the corresponding import prices (prices of similar imported commodities).

The sheltered domestic prices on the other hand are prices of commodities sold in domestic markets, sheltered - to greater or lesser extent - from foreign competition. For such commodities the model assumes two different kinds of price formation, namely regulated and negotiated prices and cost determined prices. The regulated and negotiated prices are prices which are either controlled by public bodies, or determined through negotiations between the Government and producer organisations (e.g. agricultural prices). The cost determined prices are assumed to be adjusted to changes in the costs of producing the commodities. Wagecosts per unit of production are given by exogenous estimates for labour productivities and wage rates. The model assumes further that the cost determined prices are adjusted so that the ratio of profits to wages in the production of the commodities is left unaffected by changes in costs. The price propagation process which follows from the fact that higher output prices of commodities from one production sector means higher input prices, i.e. higher cost, in others, is taken care of in MODIS IV through an input-output technique.

The description just given of the determination of the commodity prices in the price model shows that the prices are either exogenously given, or explained entirely in terms of costs with no reference to demand.

Corresponding to the private consumption submodel the direct tax model distinguishes between three socio-economic groups of households. (i) wage and salary earners, i.e. households whose earned income comes mainly from wages or salaries, (ii) independents, i.e. households whose earned income comes mainly from unincorporated enterprises etc. including agriculture, and (iii) pensioners, i.e. all other households.

The income distribution by income intervals within groups is represented in the model. The data source is the latest available tax return statistics, updated to the base year of the model.

The model specifies about 30 different types of direct taxes. The proceeds of some of these are wholly exogenous. For the others the tax assessment rules are represented in a very detailed way in the micro part of the model. The micro part can be run as a separate model which requires input of forecasted growth of income, employment, number of pensioners etc. As a part of MODIS IV the micro part is used to estimate parameters of macro tac functions which enter into the private consumption sub-model and therefore into the simultaneous solution of the quantity part of MODIS IV. The model follows the principles adopted for the national accounts that taxes are to be recorded on an accrual basis. This implies that taxes are computed for the same period as the income on which the taxes are levied, was earned. This is the concept used in the calculation of income disposable for consumption in the private consumption sub-model. It differs from a concept based on date of payment, which is the principle used for registration in government accounts in Norway. A special sub-model of the direct tax model makes the transformation from "taxes accrued" to "taxes paid" in the government accounts. The functionally defined governemnt account called Tax collectors holds the margins, or differences, between taxes accrued and taxes paid.

The indirect taxes and subsidies are computed in the submodel for indirect taxes as shown in the diagram. Each indirect tax or subsidy is classified either as a commodity tax or as an industry tax. The proceeds from industry taxes are completely exogenous in the model. The proceeds from commodity taxes are endogenous.

The tax rate for each commodity tax is given by a vector which gives the tax rates on each commodity flow to each receiver of the commodity. These tax rates can be derived from the information contained in the tax rules and the commodity flows in the base year of the model.

The classification of commodities adopted for the model was chosen with a view to avoid aggregating micro commodities with different tax structures; however, it was impossible to achieve this aim completely since we wanted at the same time to limit the number of commodities to be kept separate.

The treatment of indirect taxes in the model has proved advantageous in computing the value added tax which contributes more than 60 per cent of the total receipts from indirect taxation. Another important feature of the indirect tax model is that it allows the possibility to introduce new indirect taxes on any commodity or industry. Hence, the model user is allowed to study the impact on the economy by eliminating taxes, or varying the rates on existing indirect taxes, and by introducing new ones at rates which may be specified freely.

The indirect tax model computes the revenue of each commodity tax. In accordance with the practice of the national accounts, and quite parallel to the treatment of direct taxes, the indirect taxes and subsidies are computed as taxes accrued rather than as taxes paid. As in the direct tax model, a special sub-model of the indirect tax model transforms the taxes accrued to taxes paid as registered in the government accounts.

In addition to the revenue computations by tax category, net indirect taxes by industry group is computed. This provides a subdivision of the gross product in each industry group.

4. The administrative environment of MODIS IV

The administrative environment of MODIS IV is basically the same as for the earlier MODIS versions. The building, maintenance and operation of models are a major task of the Research Department of the Central Bureau of Statistics. The Research Department is also responsible for the national accounts of Norway. This is of great importance for the close links between the model and the national accounts.

The link between the model and the accounting system is provided, first, by the reliance of the model on the national accounts as the basic data source. Second, the price and quantity variables, used in the model correspond to those defined within the national accounting system. The results of the model are presented in tables formally analogous to the tables of the national accounts. Hence, any user well acquainted with the national accounting system is saved the trouble of having to learn a new set of definitions in order to use the model and to interpret model results.

Macro-economic planning in Norway is directed by the cabinet and prepared and executed mainly by the Ministry of Finance. There exists no special planning agency for macro-economic planning in Norway. Ministries, directorates and administrative bodies outside the Ministry of Finance take part in the planning process. The Ministry of Finance coordinates the plan preparations and mediates between the political decision-making at cabinet level and the agencies taking part in the planning process. The Ministry of Finance is thus the main user of the model.

The use of the model by the Ministry is related to a small number of different tasks. Outside this use the model may be called into operation by the Ministry, or other agencies, on a more ad hoc basis. The main use of the model is in the preparation of the annual "national budget". The national budget is a government document containing a declaration of the policy which the government intends to pursue in the coming calendar year, as well as a comprehensive description of the development in the economy which is expected to follow if the proposed policy is put into effect. The national budget is prepared during the summer months and presented to and thoroughly discussed by the Parliament in the autumn of the year prior to the budget year, but it is not formally acted upon by the Parliament. Instead, the policy recommendations implied in the national budget document are formally put before the Parliament for approval in separate documents at a later date. In the first half of the year the government will prepare and present to the parliament a revised national budget for the current year.

The model plays a central role in the preparation of the national budgets. The flow of information in the planning process starts with the Ministry of Finance laying down general conditions for the plan in a circular to all agencies taking part in the planning preparations. The agencies (ministries and government directorates) return to the Ministry their proposals and estimates of plan figures based on their own assessments, taking into regard the directives of the circular. After a discussion round with the agencies, the Ministry is ready to fill in the forms for exogenous variables of the model for the first round of model computations (in some cases the forms are filled in by the relevant agency).

After the first round of computations the results are analysed, and proposals and estimates are revised by the Ministry in cooperation with the relevant agency. The time schedule allows 2-4 rounds of model computations during the preparation of the national budget. Each round may include a number of alternatives. A similar process takes place in the winter as preparation of the revised national budget.

The four-year plans used in Norway are similar to the national budgets in scope and outline, but they are less specific with regard to policy proposals. The model is used in the preparation of these plans in a quite similar way as it is in the national budgeting. The four-year plan has been presented to the Parliament every fourth year, but will now become a rolling plan. For its own use and as a background for the national budgets, the Ministry of Finance usually prepares five-year projections more than once a year by means of the model.

A special Reporting Committee on Income Settlements, "Beregnings-utvalget", use the model in close collaboration with the Ministry of Finance in the analysis of price and income effects of wage and income settlements. Computations are performed - prior to income settlements - in order to estimate the effect of alternative proposals and after settlements in order to assess the effects of the agreements.

Prior to MODIS IV the price-income model PRIM was used for this purpose. The main ideas of PRIM are built into the price sub-model of MODIS IV.

The Reporting Committee on Income Settlements is a committee with representatives from labour unions, the farmers' and the employers' organizations and from the Government, together with an unpolitical chairman. The income settlements in Norway are usually strongly centralized and coordinated. Typically, bi-annual negotiations on wage rates between the organizations of the employers and the employees take place simultaneously with the negotiations between the Government and the farmers' organizations on agricultural prices.

The Reporting Committee uses the model by taking the fiscal policy more or less for granted. Assumptions with regard to world market prices, productivity rates and other variables are evaluated in collaboration with the Ministry of Finance. The results are presented as a set of forecasts, each set relating to one particular combination of changes in the negotiated wage rates and the agricultural prices. These alternative forecasts are intended to bring the negotiating parties in a better position to anticipate the short-run implications for prices and income distribution of the possible outcomes of their negotiations. The model forecasts for prices and income distribution are heavily dependent not only of the outcome of the negotiations, but also of the assessment of the general economic situation. If the forecasts are to be accepted by the negotiating parties as reasonably good estimates of the short-term consequences for prices and income distribution of alternative outcomes of the income settlements, under

the assumption of no changes in the fiscal policy, it is necessary that the parties agree about the main assumptions on which the main forecasts are based. To achieve an agreement is perhaps the main purpose of the Reporting Committee.

The Central Bureau of Statistics uses the model for its own analytical purposes. In preparing the annual publication "Economic Survey", which is a retrospective survey at the end of each year, the model is regularly used.

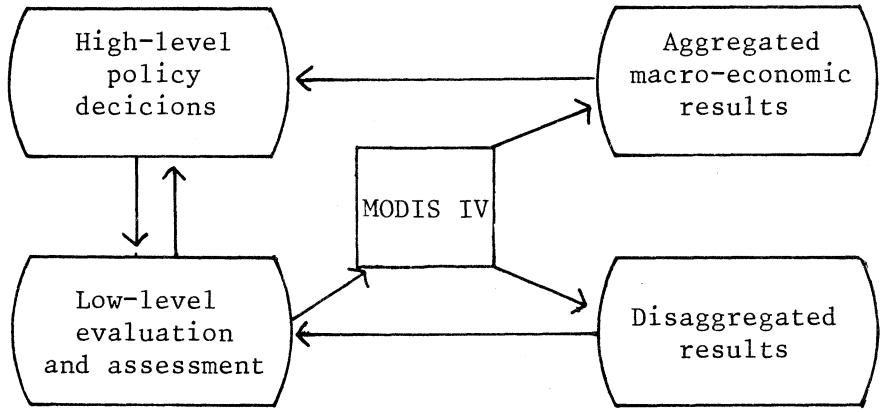
The model is available also to other users. The policy of the Central Bureau of Statistics in this respect is to let the model be available for all potential users on a non-profit basis. A recent example is the use of the model by the Ship Research Institute of Norway to analyze the impact on the Norwegian economy of an assumed expansion and change in product mix in the ship building industry as a consequence of increased demand for ocean platforms for oil and gas exploration. This particular use of the model is an example of how the model can be used to confine a sector plan or prognosis within the limits set by a full macro-economic picture.

5. The function of the model in policy formation

The main function of the model is to serve as an integrative framework within which various policy proposals can be evaluated and compared. As indicated earlier the theoretical content of MODIS IV and submodels is rather meagre. The importance of the model as a tool of policy analysis is the common framework it provides for discussing various alternatives.

The model is basically able to deal adequately with a rather limited range of policy issues, like the effects on production and employment of alternative compositions of final demand, the effects on consumer prices of an increase in world market raw material prices or the effects on disposable income of socio-economic groups of changes in tax rates. When policy issues are more complicated than these examples, the model can be used only after a prior analysis of the policy problem under discussion has been undertaken and the results of this analysis is channeled into the model through exogenous variables and parameters. A couple of examples may illustrate this use of the model and its advantages.

The Norwegian currency was revalued in November 1973. Currency changes have been considered also at other times in the last three to four years. The model does not include the currency rate among its exogenous variables, and can thus not be immediately applied to evaluate currency change proposals. The prior analysis will have to assess the effects of revaluation on all Norwegian export and import prices disaggregated to about 150 commodities. After this stage has been completed the model can be run to calculate the effects of the propagation through the economy of these price impulses. The results from the model will include home market and consumer price indices and income effects for production sectors, socio-economic groups, and government administration. The information flows can roughly be indicated as follows:



By this use of the model we try to achieve, first, full use prior to model calculations of low-level informations too detailed to be dealt with at cabinet level. In this case this means that the effects of revaluation on export- and import prices are assessed for each commodity rather than assuming uniform changes in all price indices. Second, the model is used to give an aggregated macro-economic picture as well as detailed results. The macro-economic results go directly to the level of decision-making, while the detailed results are evaluated at lower levels and reported up from there. Thirdly, the whole context of analysis is the same as that of the current national budget and four-year plan, so that the results are directly comparable to - and often are presented in the same tables as - existing plan figures.

Another example is provided by the efforts undertaken to use the model in the analysis of the effects on the Norwegian economy of the various activities connected with the discovery of crude oil and gas in the North Sea. This new development will have quite consideralbe effects on the Norwegian economy in coming decades. Any model would be

hard put to predict the structural changes stemming from oil exploration, drilling, pipeline transport, refining etc. MODIS has been used here too by having certain primary effects assessed outside the model, and the further consequences of these primary effects calculated by the model. A central issue in the analysis of this problem is the transfer of employment - in a near-full employment economy - to the expanding oil sectors from the rest of the economy, and how this transfer will come about.

The function of the model is foremost to serve as a tool in the preparation of national budgets and four-year plans. Second comes adaptation to contribute to the analysis of important ad hoc policy problems of the type discussed above, and also the integration into the model framework of fiscal budgeting and income policy. Thirdly, the model is available for any other user within or outside the government.

The groundwork to achieve a more integrated treatment of these closely related policy areas was done by integrating the former PRIM model into MODIS IV and also the tax revenue models used in fiscal budgeting. The model is increasing its domain within the administrative environment, but this is a rather slow process, which model builders cannot influence in a better way than by improving the accessibility and reliability of the model.

6. Remarks on various problems connected with the use of the model

We can identify a number of advantages of the system. First, the model facilitates a uniform handling of quite different problems. Aspects of revaluation, income settlements, preparations of one-year plans and consequences of oil exploration in the North Sea have been analysed by the model within the same general framework. Hence, the administrative convenience, with a few optional exceptions, that the exogenous variables are always the same. Secondly, the detailed accounting specifications in MODIS allows translation of fiscal instruments, such as tax and subsidy rates, directly to inputs of the model and compute in the minutest detail the effects on commodity flows and tax revenues. Thirdly, short computational time. At present, the promised delivery schedule is 48 hours from input forms are received to edited tables are made available. The normal delivery schedule is 24 hours, but in pressing cases and with "lucky runs", 6 hours.

There are two main disadvantages of the MODIS-system. First, partly as a conseguence of the detailed accounting system, MODIS IV is relatively poor in behavioural relations. Hence, many important problems are left outside formal treatment. For instance, prices on consumer goods supplies the only formal connection between price- and quantity variables. But of course, it is a matter of opinion what is the best treatment of some variables - formal or unformal. Secondly, the system asks quite a lot from the user. The model is in practice almost impossible to use for anyone else than the Ministry of Finance and the Central Bureau of Statistics, unless given due assistance.

The MODIS models requires much in the way of estimates of exogenous variables. The model has about 2 000 exogenous variables altogether. It is, however, possible to use the model with much more aggregated sets of input variables, amounted to about 250 input variables. Some of them only partly and/or indirectly reflect policy, others are not related to policy at all, or only very remotely. It is essential that the user - especially the planning administration - is familiar with the - very often quite subjective and nearly always rather uncertain - nature of these estimates, a familiarity he will achieve in full measure only if he is actively engaged in the process of preparing the estimates.

The minimal contribution of the model in planning is twofold. The first is a pedagogic one. MODIS IV contributes undoubtedly to increase the insight of the economic mechanisms by the participants in the planning process. The second is a bookkeeping one. The output from the models satisfy the economic balance relations and hence assures planning consistency.

The maximal role of mathematical-economical planning models in general is to figure out the best of the possible decisions. This maximum position is hard to achieve for several reasons. It is difficult to give an adequate representation of preferences. Furthermore, formalized models will always represent the possible decisions and their consequences in an uncomplete way. Important relations between variables in the economy may not be incorporated in the model structure. An example in MODIS IV could be effects on purchases of durable consumer goods by changes in the rules for consumer credit(s).

To adapt the model to ad hoc assumptions by the user there is in MODIS IV built in a system of flexibility. Anyone of the relations for

private consumption, import, production and prices can be suspended and replaced by exogenous estimates for the previous endogenous variables. In the case of private consumption it is also possible to correct the endogenous variables. The user is of course never allowed to interfere with the balance relations.

A great advantage of these optional possibilities is that in case the model user can figure out what he believes to be better estimates for some variables than the model do, he can let these estimates replace some equations in the model, and let the model determine the remaining variables, and assure consistency. In other words, parts of the model system can be considered as an option which the user may choose whether or not he wants to benefit from. In the latter case he still can use the revised model system. These features increases the power of the model system heavily.

However, benefiting from these features claims the demand on the user further. He should 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 has to reckon with. Only in this way he will be able to interpret correctly strange results of model computations, and only in this way he will be able, through iterative adjustments in exogenous variable estimates, to utilize the model fully in developing a set of plan estimates.

The work on the MODIS models which has taken place in the last fifteen years is still an on-going project. Through the period of development the project has changed from an experimental research project to an important tool for policy formation in the short to medium term economic policy. The plans for further development of the model are strongly influenced by the functional role the model has acquired and the interests of the main user in improving the utility from the model.

The further development of the model will go in two directions. First, there will be minor improvements to increase the use-value of the model. These will include improvements in operational efficiency, in the updating of coefficients and parameters from the latest available statistics, in linking the model to other models or semi-formal routines and in the connection between the variables of the model and the policy world of targets and instruments.

Second, apart from the minor improvements, some attempts will be made in improving the relations of the model. Some group of problematic variables which at present are exogenous although they cannot be considered as neither data variables or instruments in any real sense, will be scrutinized in an attempt of replacing exogenous estimates with relations or submodels. Among these groups of variables are productivity rates, local government purchase of goods and services, and private investments. There will also be experimented with changes in technology. The activity framework is particularly well suited for dealing with changes in the technological structure of production.

Basically, all further changes in MODIS IV will belong to the class of minor improvements. The model has grown too big and with too strong ties with the environment to be rebuilt or restructured.