Discussion Paper

Central Bureau of Statistics, P.B. 8131 Dep, 0033 Oslo 1, Norway

No. 57 8. februar 1991

MACROECONOMIC MODELLING: THE NORWEGIAN EXPERIENCE

BY

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ABSTRACT

This paper describes the institutional background of Norwegian large scale macroeconometric modelbuilding. Such models were in general subject of harsh criticism during the 1970s. We discuss how modelbuilders in Norway have responded to this criticism in terms of modelspecification, microfoundations and modeltesting.

Paper presented at the conference on New Approaches to Empirical Research in Macroeconomics, Ebeltoft, Denmark, May 24-27, 1990. A somewhat shorter version of this paper will appear in Scandinavian Journal of Economics.

I. INSTITUTIONAL BACKGROUND

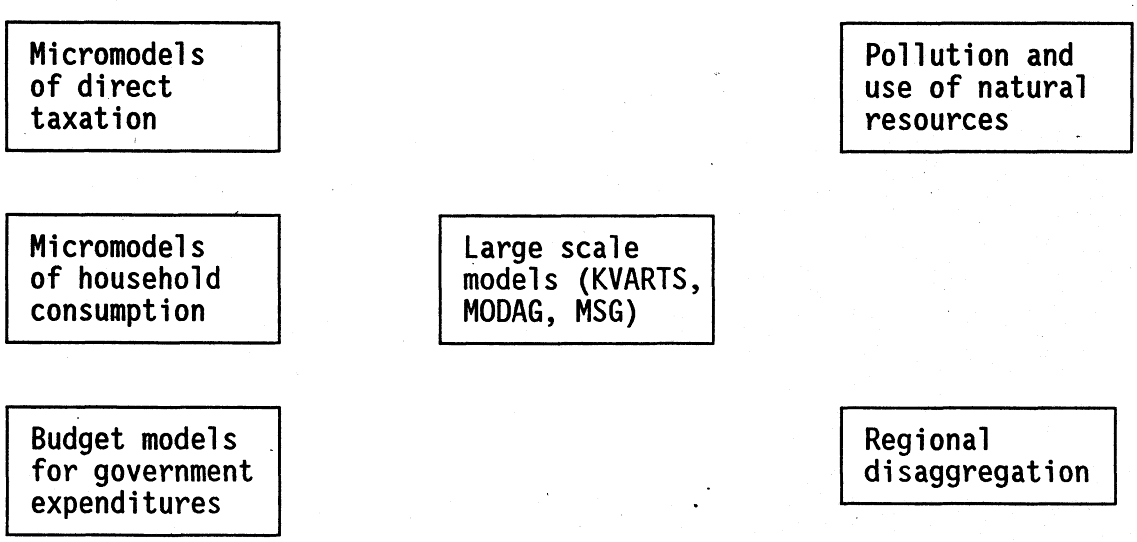
Large scale macroeconomic models of the Norwegian economy were developed in the late 1950s inspired by the postwar modelling efforts of Wassily Leontief and associates and work by Ragnar Frisch and associates throughout the 1950s. The first model to achieve the status of an official government model used in the conduct of economic policy was MODIS, a multisectoral Keynesian income-expenditure model developed in the Central Bureau of Statistics, cf. Sevaldson (1961). This model has through successive versions been the backbone of government policy analysis through 30 years, cf. Bjerkholt and Rosted (1987), Bjerkholt and Longva (1980). In the mid-1960s a multisectoral neoclassical growth model based on Johansen (1960) was taken into use. This model, called MSG, may be the first example of a computable general equilibrium model and has played an important role in government medium to long term analysis since then. The responsibility for running the model was taken over by the CBS in the early 1970s. Neither MODIS nor MSG were estimated using time-series from the National Accounts. Instead the models were calibrated to a base year relying on input-output data for one year based on the National Accounts while parameters characterizing production functions and consumer demand were mainly based on microeconometric studies.

Work on macroeconometric models more similar in spirit to those that have been commonplace in many OECD-countries, started in the late 1970'ies. The annual model (MODAG) described in Cappelen and Longva (1987) and Cappelen (1991) and the quarterly model (KVARTS) described in Biørn et.al. (1987) are both based on the same input-output framework as MSG and MODIS. The annual model has been operative since 1983 and is used by the Ministry of Finance in short and medium term forecasting and policy analysis. It gradually replaced the use of the MODIS-model, and the latter is not used any longer. The quarterly model is used only by the Research Dept. of the Central Bureau of Statistics and mainly for short-term forecasting and contra-factual studies from an "on-looker" point of view. Its role in policy-making is confined to analysis of effects of incomes policy and outcomes of wage negotiations each year.

This paper presents some views on the experience with large scale econometric models in Norway. My discussion will be confined mainly to the two models MODAG and KVARTS mentioned above. Although the most recent version of the MSG-model has a number of econometrically based equations, the use of those econometric studies are similar to the calibration method which is common in the specification of computable general equilibrium (CGE) models. There are other CGE models of the Norwegian economy than the MSG-model, but none of these are large scale econometric models and will therefore not be discussed in this paper.

The construction and use of large scale macroeconometric models in Norway has been closely related to the needs of different government bodies, among which the Ministry of Finance has a predominant position. This relationship has had important implications for the design and specification of the models. For policy purposes the government has expressed a need for a very detailed specification of policy parameters. This has lead to the development of a system of models rather than to one all-embracing model. The level of detail at which this system of models operates makes it at present impossible to include everything within one single model. This complicates the modelling exercise in some ways because it increases the need for coordination of the research. On the other hand it enables the government to analyse the feasibility and consistency of policies in a manner which hardly could be obtained without this level of detail. Figure 1 gives a rough sketch of the system of models. Some issues related to the combined use of micro- and macromodels will be discussed in the third section of this paper on the use of microdata. The micromodels in the left part of the figure need to be solved iteratively with the macromodels in order to obtain consistency, while the models on the right hand side of the figure are based on inputs from the macromodels. In a planning context, however, with policy goals formulated for pollution, regional employment levels etc. an iterative solution is necessary in order to secure consistency.

Figure 1. The system of models in Norwegian planning



I stress the importance of the institutional setting of our large scale models, not to excuse the way we have specified, estimated and tested our models. In these respects we have to meet the same standards as other macromodellers and econometricians in general. However, it is not clear what these standards are in our context, where the combination of models based on cross-section data and time series are essential in our modelling strategy. My point is simply that given these restrictions and our limited resources, our solution will probably differ from others. This also serves to explain why we have several models designed for different purposes.

II. MODEL-EVALUATION

A number of different criteria have been suggested and used when evaluating large scale macroeconometric models, see Kmenta and Ramsey (1981), Pesaran and Smith (1985). For a macromodeller, meeting the desired standards is like shooting at a moving target and because there are costs of adjustment one is seldom where one would like to be. Ten to fifteen years ago the status of large scale macromodels was pretty low. The criticism raised against macromodels and their performance was harsh and came from different directions. In what follows I will try to describe how macromodellers in Norway have responded to that criticism. I will do so by distinguishing between criticism based on economic theory and those based on econometric arguments, i.e. criticism raised against the specification of the model and estimation and testing procedures, respectively. In this section I shall comment on the criticism motivated by economic theory while the ensuing two sections discuss the use of microdata in macroeconomic modelling and problems of testing models, respectively.

The role of economic theory in specifying an econometric model is a controversial issue. We have chosen to use theory in the following way. First, restrictions of exclusion are crucial to traditional macromodelling in determining which variables are candidates for entering an equation or a set of equations. This procedure is criticized by Sims (1980) who argues that claims for identification in large scale macromodels cannot be taken seriously. However, as Sims himself points out, if one sticks to some version of neoclassical microtheory and formulates demand systems or sector models as a system of simultaneous equations and chooses an appropriate estimation method, one rests on safer ground. Thus economic theory may guide ones choice of estimation method. I think that we always have had this problem in mind in our modelling efforts because the "system-approach" is one way of securing sensible results in policy simulations. However, this approach becomes much more complicated if one also stress the short-run forecasting ability of the model and thus is concerned with the dynamic specification of such a system. For an interesting attempt to solve this problem, cf. Anderson and Blundell (1982). I must admit that we still use OLS more often than we perhaps ought to. Our defence for using OLS depends on the error variances being very small which is often the case in a large model where we can take account of most explanatory variables that belong in an equation, cf. Maddala (1981).

Economic theory may sometimes provide the modeller with suggestion wrt. the sign of parameters which may help in testing parameter significance in addition to restrictions due to homogeneity, adding up, symmetry etc. In general we have stuck to these theoretical considerations or restrictions in our models. However, in response to the results of misspecification tests, we have allowed for short run nominal effects in some behavioural equations, such as export volumes where the effect of an increase in an export price is not similar in absolute value to an increase in the world market price (or competitor prices). In many cases homogeneity restrictions are not supported by data and tests of cointegration reveal that long run assumptions in the model are rejected. In most cases we have then chosen to retain theoretical restrictions in spite of the tests because our experience with simulations on the model shows that we otherwise often get nonsensical results. Introducing time trends in an ad hoc way in order to save the restrictions in the model, is avoided as much as possible. The negative test results are instead used as indications of where to respecify the model structure (aggregation, behavioural assumptions etc.) in later work.

Objections based on economic theory have been raised against large scale models for not taking supply-side considerations seriously enough. In his response to parts of this criticism, Klein (1978) expresses the view that a combination of an input-output model and Keynesian income-expenditure model is the way to proceed in supply-side modelling. As mentioned in the first section of this paper, this has been done in the MODIS-model since 1960. However, due to the assumption of constant returns to scale wrt. variable factors, the implicit supply curves were all horizontal in that model. This feature is still very much the case in our present models, but is now based on econometric studies. The input-output structure in our models serves two main purposes; to transmit demand and primary cost impulses to various sectors of the economy including imports. This alone, would hardly qualify as supply-side economics. In our present model versions the supply of labour is the main supply side factor combined with disaggregate wage-equations containing NAIRU-features. Due to the disaggregated nature of the models there is no unique NAIRU in the models, as the effect on wages of changes in labour market pressure varies between sectors. Depending on the level of unemployment in a baseline model run, the effects of expansionary fiscal policy may be strongly crowded out in the long run even if nominal interest rates are constant. This is mainly due to the specification of the labour market where loss of competitiveness affects output and employment. The effects on prices via changes in capacity utilization are, however, quite moderate.

Supply-side economics is also much concerned with effects of tax reforms on capital formation by firms and labour supply by individuals. Although capital formation is sensitive to user costs of capital and labour supply to income taxes, the elasticities are small according to our macro models. Thus they lend little support to "elasticity optimists". The studies of reforms in capital taxation so far give conclusions that seems to be robust to different ways of modelling user costs of capital as well as capital formation, see Biørn and Cappelen (1988) and Holmøy and Vennemo (1990). The studies of the effects of changes in personal taxes on labour supply are however less unanimous in their conclusions, see Lindquist et.al. (1990) and Dagsvik et.al. (1988).

The rational expectations/equilibrium models critique of macromodels has so far not been taken into account in our modelling efforts. Analysis of expectation formation is, however, on our research agenda and we hope to be able to improve our models in this respect soon.

III. THE USE OF MICRODATA

One feature of Norwegian macroeconomic modelling has been the use of microeconometric evidence. The area in which results from microanalyses have been used most intensively is in models of consumer demand. When estimating macroconsumption functions, extraneous information on marginal propensities to consume for different socioeconomic groups has been taken from microeconometric studies, see Cappelen (1980). Systems of consumer demand equations based on standard microeconomic theory have been estimated from cross-section data, and later from panel data based on household surveys, see Biørn (1981) and Aasness et.al. (1989). The advantage of using microdata when studying economic behaviour is that most economic decisions are taken at that level and not on the macrolevel. Microdata allow you to study the heterogeneity of individual units instead of invoking the assumption of one representative agent. Thereby it is possible to estimate marginal responses rather than average responses derived from aggregate time series data. Microdata makes it possible to test hypothesis and indentify structural parameters which are not possible using macrodata alone. Microinformation may therefore be of importance for the analysis of macroeconomic effects. The most obvious need for microeconomic models appears when one is interested in distributional effects of policy changes such as changes in direct or indirect taxation.

Tax reforms have been on the political agenda in most OECD economies during the 1980s. In the Nordic countries high inflation combined with a progressive personal tax system produced very high marginal tax rates for large groups of the population by the early 1980s. This promoted the interest and need for econometric analysis of the effects of the tax system on individual labour/leisure choice, see Dagsvik et.al. (1988) for an analysis using Norwegian data. One problem with the macro results of these studies is the partial nature of the results as they tend to ignore repercussions on prices and quantities in other markets. There is then an obvious need to combine microeconometric simulations and macromodels.

An area where a combination (although of a slightly different nature) of micro- and macromodels has taken place is in the estimation of tax rates used in the macroeconomic models. For the purpose of policy analysis, the Ministry of Finance would like to have the actual tax policy parameters, (tax rates, allowances etc.) represented in the model. As the tax system in Norway is highly progressive one also needs the income distribution in order to estimate revenue effects of changes in the tax rates etc. To represent all these features in a large scale macroeconometric model is virtually impossible. Our solution has been to develop separate models. The average and marginal tax rates for different socioeconomic groups in the macromodel are estimated in a micro tax model using assumptions on nominal income and employment growth taken from the macromodel. The models are then solved iteratively to assure an acceptable level of agreement between the assumptions made in each model. Recently a disaggregated model of consumer demand for analysis of distributional effects of taxation has been developed that may also be solved simultanously with the macromodels.

The ideal way of studying the relationship between econometric results based on microdata versus macrodata is made possible when large sample panel data exist. By aggregating over microobservations one generates time series which can be compared to the time series in the national accounts. The estimation of the structural equations may then be carried out at varying levels of aggregation and one may study what is lost by using aggregate data only. The Norwegian national accounts are based on panel data only for manufacturing industry where virtually complete panel data exist for all establishments from 1972 and onwards. These data have so far been little exploited by macromodellers, but that is now changing. The data from the consumer surveys are however not consistent with the national accounts data on aggregate consumer expenditures. The consumer survey data are used in official statistics mainly to estimate weights in the consumer price index, while the national accounts rely instead on the internal trade statistics which cover most wholesale and retail trade establishments. An additional problem with the consumer survey data is that the sample may not be representative due to systematic non-response by certain households and a very short observation period. Similar problems relates to the use of microdata on incomes based on the official tax forms.

IV. TESTING MODELS

The way macromodellers test their models has changed dramatically over the last ten years or so. This change is obviously a response to the criticism of large scale modelbuilding of the 1970s. The advice to spend more time testing constraints, exogeneity hypotheses and to conduct specification searches is given by Malinvaud (1981). Hendry and Richard (1983) present a framework for such procedures. In the following I shall report how we have responded to this criticism in our modelling efforts and raise a few questions concerning the methods suggested.

The use of simulations

A popular method of model evaluation has been the use of dynamic and static simulations on historical data. Recently the use of root mean square error as a model selection criteria has been criticised by Chong and Hendry (1986) and Pagan (1989). However, as pointed out by Pagan simulation exercises serves other purposes such as calculating dynamic multipliers, studying stability and long run properties of the model, as well as determining the degree of linearity which is of interest when using the model for forecasting. We have used and still use simulations as an important step in our model evaluation. All our large scale models are highly nonlinear models at least for some choices of exogenous variables and also for most of the historical period for which the models were estimated. Together with the fact that our models have eigenvalues close to unity (calculated using the LIMO-command in TROLL, see Kuh, Neese and Hollinger (1985)) produce the well known effect that the models under- or overpredicts for relatively long periods in the sample before returning to historical values at the end of the historical period. I would expect this feature to be even more pronounced in models with rational expectations. The lesson from studies such as Pagan (1989) is that this fact should in itself not be taken as evidence of a misspecified model.

When estimating single equations or subsystems of a large scale macroeconometric model, we sometimes end up with choices between alternative models (nested or non-nested). In these cases simulation of the whole model may provide some additional evidence. However, if there are many possible choices of this binary type (say m) one ends up with 2^m different and competing modelspecifications. There exists a method that makes it possible to have an overview of the effects of different alternatives by selecting only a part of the 2^m alternatives. The statistical theory behind this is described in Box, Hunter and Hunter (1978). I have seen no use of this theory applied to macroeconometric models. We hope however, to look into this method in future simulation exercises with our models.

Static simulation on the complete model can also serve the purpose of generating instruments for the estimation of the model as shown in Hatanaka (1978). Large scale macroeconomic models are usually estimated using ordinary least squares (OLS) in spite of the fact that this may yield inconsistent estimates. This procedure is usually defended by its simplicity and the fact that instrumental variable estimation (using some ad hoc chosen instruments regarded as predetermined in that particular block of the model) gives nearly always very similar estimates. For a critical discussion of this, see Maddala (1981). Hatanaka (1978) showed that even in non-linear models the following two step estimation method yields consistent (but not efficient) estimates. First, estimate the model by OLS. Use these estimates and perform static simulations on the whole model to generate values of the endogenous variables. Second, estimate the model again using the simulated values of the endogenous variables and exogenous variables as instruments. More efficient estimates may be obtained by a third step using the residuals from the second step to estimate the covariance matrix and then estimate the model again similar to 3SLS. The last step, however, depends on the number of observations being larger than the number of "structural" equations. This is often not the case, at least not for any of the Norwegian models referred to above.

Hatanaka's method may be used even if parts of the whole macromodel such as the expenditure functions, are estimated by FIML as a block. It seems worthwile to undertake the two step estimation method suggested by Hatanaka (1978) and compare the estimation results with OLS and the pseudo-instrument method at least to have an idea of the cost of the usual short-cut procedure used by macromodellers.

Post-sample tests

One often suggested and widely used test is that of post-sample testing. I wonder if this may be a waist of time. Say, you have tested your model using a number of misspecification tests and are fairly satisfied with what you have. Then you observe that the model behaves badly in a post-sample test. Your next step is obviously to go back and raise doubts about your model in terms of dynamic specification, functional form, left-out variables and so forth. Suppose you are able to arrive at a model that satisfies all your test-criteria after a few rounds of iteration. What have you learned then that would not have been detected by recursive estimation and Chow tests using the full sample right from the start? Does not the iterative procedure really amount to the same? Another issue in post-sample testing is the fact that data revisions most frequently occur in those years for which you perform the test. What looks like a poor forecasting performance may after a year or two disappear due to data revisions as we have often experienced in our work.

The use of quarterly data

As mentioned earlier we have both a quarterly and an annual macroeconomic model. Their level of aggregation is the same and they are very similar in structure in terms of economic theory etc. If we could persuade the Ministry of Finance to use the quarterly model only, we would probably have scrapped the annual model. The quarterly model is based on seasonally unadjusted data as recommended by most econometricians. Seasonal factors are included in the model using dummies. This deterministic way of modelling seasonality is of course crude although it has some advantages also. We know that there is (at least) one structural change in the seasonality in our data which is taken care of by including an extra set of dummies. One alternative procedure would be to use seasonally adjusted data estimated by some well known method like X11 or X11-ARIMA. However, such a filter method would use some time to "discover" a change in the seasonal pattern and in the transition period the seasonal factors will be biased.

Co-integration and long-run structure

The use of quarterly data has advantages beyond the fact that they enable you to study short run behaviour in a better way than by using annual data.

In recent years tests of co-integration systems have been presented and these new methods are now used intensively by modellers. As is apparent from the critical values for some of these tests, see Engle and Yoo (1987), they vary some with sample size. In fact, for small samples that are available to those using annual data only (often between 20 and 30 observations) critical values are not reported at all. This is a "pity" because tests of co-integration could be a very valuable method also for estimation of CGE-models where long-run features of the data are considered crucial while short-run dynamics often is ignored.

In the model comparison study in Wallis and Whitley (1991), the use of co-integration methodology when modelling wages is suggested as an appropriate way to discover the set of variables to appear in a wage equation. This approach has been used by Stølen (1991) in a recent effort to test competing models of wage determination on annual Norwegian data. One problem when comparing Stølen's study with those referred to in Wallis and Whitley is that Stølen uses annual data and not quarterly. It is well known that if there is integration at the seasonal frequencies, the univariate process for quarterly data is misspecified. This may lead to different conclusions wrt. to the level of integration when using annual and quarterly data. Stølen is not able to reject a Phillips-curve-type of wage equation when tested both against a general dynamic specification and a more parsimonious error-correction model. Actually the Phillips-curve equation is the most parsimonious model according to Stølen as it is nested within a more general error-correction model. A Phillips-curve in itself does not result in a less welldefined supply side of a model, but obviously to a different way of modelling the interaction between demand and supply than using an error-correction model. Anyway, the short- and medium-term multipliers would not have been much different as the estimated error-correction parameters are small.

An important lesson that we have learnt, and one which perhaps is common knowledge, is that with our relatively small samples, the estimated long-run parameters depend heavily on the dynamic specification. Consequently, even if your interest is only in general equilibrium modelling, you need also to consider the short-run features of the data generating process. This fact has proven to be important also when modelling wages. When looking for co-integrating vectors, the estimated long-run wage equation, deviates substantially from the Scandinavian model in the sense that domestic consumer prices and not world market prices are important. When estimating a Phillips-curve this conclusion is turned on its head and the Scandinavian model survives according to Stølen (1991).

Our own experience when modelling the Norwegian economy has been that a more careful consideration of the dynamic structure and a move towards error-correction models as opposed to say Almon-lags and simple partial adjustment models which dominated our work ten years ago, has largely changed the long-run characteristics of our models, while short-run and even medium-term effects are largely unaffected, cf. Cappelen (1991).

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