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PROBLEMS OF LINKING SINGLE-REGION AND MULTIREGIONAL ECONOMIC MODELS

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Abstract

Norway has, like many other countries, experienced a growth in the development of single-region and multiregional economic models during the last ten years. The models are mainly used for planning purposes and forecasting by national and regional governmental agencies. The majority of the models are applying input-output techniques. This paper discusses general problems of linking such models. Particular attention is paid to coordination problems in using the models. The paper also contains some proposals aiming at improving the treatment of this type of linkages in the Norwegian models. The proposals concern both the structure of the models and the use of the models within the existing planning framework.

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1. INTRODUCTION

The increasing use of quantitative models is an important feature of almost all types of economic planning. The fast development of computer technology makes it possible to take into account an enormous amount of information in such models. Models provide the means for securing logical consistency between various sorts of variables. Models may also serve as efficient tools in the dialogue between planners and politicians.

In the field of regional economic planning it is suitable and common to make a distinction between single-region and multiregional models; see Nijkamp et al. (7). A single-region model highlights one specific spatial unit of the national economy and is normally used by planning authorities on the regional or local level. A multiregional model contains a division of the national economy into a number of spatial units and is in most cases used by national governmental agencies. The major advantages of using a multiregional model compared to a single-region model are due to more satisfactory treatment of interregional linkages and national-regional linkages in the former approach. However, in an economy where decentralized plan elaboration and decision-making plays an important role in the planning system, single-region models can provide valuable insight into the functioning of the regional economy. Besides, a single-region model may be the most suitable framework for taking account of local knowledge and local preferences.

This paper deals with the problems of linking and coordinating the use of single-region and multiregional models in regional planning. This issue concerns the theoretical structure of the models, the use of data and the use of exogenous assumptions. A particularly important aspect is the information flows between the national and regional planning agencies. We will confine our discussion to economic models, mainly input-output type models, and models used for medium-term forecasting and policy impact analysis. The point of departure is the planning system and current modelling practice in Norway. This country has experienced a considerable growth in the application of models in regional planning, particularly at the county and municipality level. It is generally agreed that this development has been favourable. It is also recognized, however, that too little attention has been paid to interregional linkage and coordination aspects. This paper is an attempt to highlight these issues as part of a more general project of model appraisal. Although we are using Norwegian modelling approaches as a frame of reference we hope that our discussion will have relevance to corresponding linkage problems in other countries where models are used as support tools in regional planning.

In applied regional modelling there is a general orientation toward building submodels designed for particular purposes instead of building large-scale and comprehensive models. This development entails increased concern with linkage and integration issues. A variety of such issues is discussed in Batey and Madden (1).

2. THE REGIONAL PLANNING SYSTEM

Regional planning is performed by governmental agencies on different administrative levels. In addition to the national level and the municipality level we find in most countries an intermediate administrative level (counties etc.) with important planning responsibilities. An outline of the main elements in the regional planning system is given in figure 1. The arrows indicate the directions of information flows. We have also specified linkages between regional planning and macroeconomic planning and indicated that statistical data are important inputs to the planning process on all levels. The data are usually compiled and supplied by the Central Bureau of Statistics.

Various aspects related to the coordination of plans elaborated by different agencies are important issues in the general literature on economic planning, see for example Johansen (5). Major inconsistencies in plans and decision-making may lead to less efficient allocation of economic resources. Two extreme systems may be specified as theoretical frameworks. In a highly centralized system the basic planning activity is carried out by the central authority and comprehensive instructions are transmitted to lower level units. In a highly decentralized system the basic planning activity is carried out on low administrative levels and national plans are constructed mainly by aggregation. In these two extremes the problem of achieving consistency in planning is to a certain extent reduced.

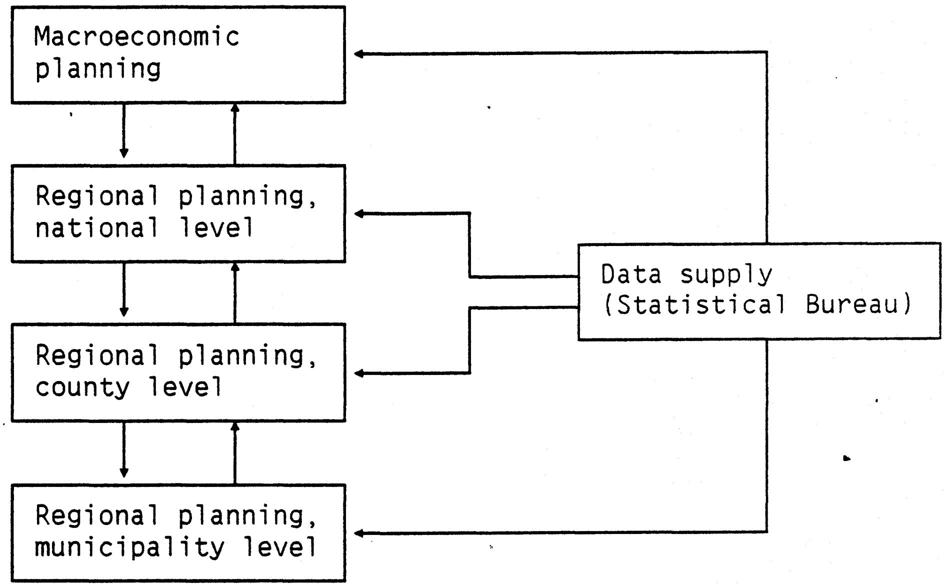

FIGURE 1. Main elements in the regional planning system

However, as pointed out by Johansen (5, ch. 5) the centralization/decentralization issue in economic planning has a multiple of dimensions. We may speak about different degrees of centralization according to the specification of goals, the detailedness of information flows between the levels, the types of decisions which are taken on different levels etc. The planning system in a country may be classified as centralized according to one dimension and decentralized according to another dimension. Various systems give rise to different coordination problems.

In the field of regional planning we find a tendency in many countries to put more emphasis on planning activities on the regional and local level. Increased planning responsibility has been transfered from national to regional agencies. In Norway the scope of the municipality and county planning has been strongly extended in the last decade. This type of planning now contains rather comprehensive forecasts or projections covering both the public and the private sectors of the regional economy. The municipalities and the counties have, however, few policy instruments to influence the decisions of private enterprises. The main policy instruments are related to public activity programmes.

Increased planning activity on the regional level necessitates an increased concern for coordination by the regional planning agencies on the national level. A major task on the national level is to assess the municipality and county plans and to contrast them with macroeconomic plans. Refering to figure 1 we could characterize the information flows both upwards and downwards in the regional planning system as being rather detailed and comprehensive. The information flows comprise goals, policy recommendations and expert forecasts on certain sectors of the economy. The information is transmitted by preparatory notes of different types and by officially adopted planning documents. As to the linkage between regional and macroeconomic planning we could probably in Norway identify a stronger impact from the latter to the former than vice versa.

In the subsequent discussion we will pay most attention to the linkages between regional planning on the national and the county level. The additional coordination problems caused by the fact that the municipalities also form an integral part of the planning system will not be delt with.

The use of quantitative models may facilitate the preparation of information on each of the administrative levels. If the models contain the same variables they may also provide suitable tools in the dialogue between the levels. The precise definition of variables which is essential in quantitative modelling may serve as a common language in the communication process. Through proper use of models it is possible to expose and analyse in a systematic way the causes of plan inconsistencies. It is particularly important to clarify to what extent discrepancies between regionally and nationally based forecasts or projections are due to dissimilar stipulations of fundamental economic assumptions. It is well-known that major or minor conflicts may arise between regional and national authorities on economic development issues. It is also known that information flows may be used as instruments to influence the planning and decision-making of other administrative agencies. For example, it is argued that municipality and county plans may be biased towards pessimism in order to obtain increased governmental transfers etc. The existence of this type of games in the planning system will weaken the informational basis for efficient use of traditional models. There is, however, other modelling approaches (multiobjective decision models) which give a systematic formulation of such conflicts.

3. LINKING SINGLE-REGION AND MULTIREGIONAL ECONOMIC MODELS: A GENERAL OVERVIEW

When models are used as support tools in regional economic planning we may have a system of models which corresponds to the administrative system of planning, as illustrated in figure 2. The arrows indicate potential information flows and linkages between the models. For simplicity we have specified only one type of spatial unit. We assume that the multiregional model and the single-region models comprise the same administrative regions (counties or equivalent), but are used by planning agencies on different levels. The use of administrative instead of functional regions has the well-known disadvantage from a modelling point of view that the interregional linkages become more important.

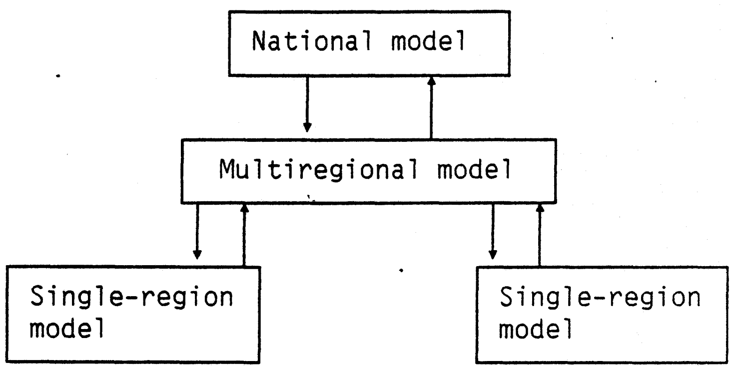

FIGURE 2. A system of models

Starting with the linkages between the national and the multiregional model various approaches could be specified. In a strict top-down approach the variables in the multiregional model are made consistent with corresponding national variables. A common method to achieve consistency is to use proportional adjustment techniques. Consequently the national model generates an important part of the exogenous variables in the multiregional model. This approach is especially suitable for analysing regional impacts of national forecasts or policies. A major disadvantage of top-down models is that they ignore feedbacks from the regions to the national level. In a strict bottom-up approach the regional variables are completely determined at the regional level and the national variables are obtained by aggregation. This implies that the multiregional model does not need a national model as a support tool. The third class of approaches is the integrated regional-national models. This type of multiregional modelling combines top-down and bottom-up approaches so that an interdependent system of national and regional variables is formed.

Another main aspect of multiregional modelling is the treatment of interregional linkages. The majority of applied multiregional models specify interregional trade flows by using input-output techniques or other methods, see Snickars (14). If it is possible to identify the individual origin and destination region of each commodity flow, the linkage structure may be called interdependent. If the interactions between the regions are modelled in a more indirect way, by specifying various types of national-regional linkages, we may, as Snickars (14), classify the model as independent. In the latter case the national level acts as a pool for supply and demand of commodities. A strict interregional approach is most appropriate for the modelling of trade flows if considerable transport costs occur. Interdependent models with bilateral trade flows are, however, rather data demanding.

A single-region model highlights one specific region while the rest of the economy is treated in a more or less incomplete way. Usually the world outside the region concerned is modelled as exogenous elements. In other approaches the outside world is treated as one, complementary region (two-region models). We may, in principle, consider a single-region model and a multiregional model as competitors. From an analytical point of view a multiregional model has certain advantages compared to a single-region model in the handling of national-regional and interregional linkages. It is not easy to achieve national consistency with a system of separate single-region models. As to the interregional linkages a single-region model may be criticized for the lack of feedback effects.

A possible way to overcome these shortcomings is to use a multiregional model as a tool for single-region planning. In such a system the model users on the regional level will provide the regional exogenous information and the model calculates the endogenous results, taking account of various national-regional and interregional linkages. This system has thus very attractive features from a theoretical point of view. A major disadvantage with an arrangement like this is, however, that the distance between the model users and the model will increase. It will be less easy for a regional model user to supervise and assess the model performance. A comprehensive multiregional model will look more like a 'black box' to the model user compared to a single-region model. The consequence will probably be less efficient use of the model system at the regional level.

If a combination of a multiregional model and a set of separate single-region models is to be used profitably as support tools in regional planning, certain conditions ought to be fulfilled. Obviously the models should be based on a common platform regarding definitions of variables and use of data. It is not equally obvious, however, that the structure and content of the models should be harmonized. Intraregional linkages may be modelled in a more elaborate way in the single-region models than in the multiregional model. A multiregional model should naturally pay particular attention to interregional and national-regional linkages. This division of focus may be reflected in the arrows indicating information flows between the multiregional and the single-region models in figure 2. The information flows downwards may comprise projections covering interregional and national aspects, while information upwards may comprise various types of intraregional and local knowledge. By efficient exchange of information regional planning on different levels may, to a certain extent, be built upon a common set of assumptions.

In the subsequent discussion we will use as a point of departure a planning system where both national, multiregional and single-region models are available. This corresponds to the current state of affairs in Norway. This country has a long tradition in applying national models in macroeconomic planning, while the multiregional and the single-region models originated in the late 1970s, see Skoglund (11), Skonhoft (12), and Skonhoft and Stokka (13). Special efforts have been put into developing single-region models which can be handled by planning agencies at the regional level. This development has been supported by national governmental agencies. In the next sections we will briefly present the single-region and the multiregional model currently applied in Norway and discuss various linkage and co-ordination problems in more detail.

4. MAIN FEATURES OF A SINGLE-REGION AND A MULTIREGIONAL INPUT-OUTPUT MODEL

Input-output techniques have played a dominant role in regional and multiregional economic modelling; comprehensive reviews are given in Hewings and Jensen (4) and Richardson (9). A major advantage of this technique is its ability to analyse regional impacts of external impulses. However, regional input-output modelling is rather data-demanding and the assumptions of constant linear coefficients could be criticized from a theoretical point of view.

The single-region input-output model used in the Norwegian County Planning System (CPS) is developed at the Norwegian Institute of Technology and adapted for application in about half of the 19 counties. The basic equation is similar to the standard Leontief formulation:

$$(1) \qquad X_i = \sum_j a_{ij}X_j + C_i + S_i + G_i + A_i + Z_i$$

X_i is gross output in sector i in the region. The intraregional intermediate demand is determined by the coefficients a_{ij}. We have specified three intraregional final demand components: C_i, S_i and G_i denotes household consumption, investments exclusive construction and government consumption respectively. A_i is exports to other countries and Z_i is exports to the rest of the country.

The model contains the following production function using a simplified Cobb-Douglas approach:

$$(2) \qquad X_j = d_j N_j^{\beta_j} e^{\gamma_j t}$$

N_j is employment in sector j, while d_j is a constant, β_j is the elasticity of scale and γ_j is a parameter representing technical progress in the sector. This equation determines sectoral employment and the term $e^{\gamma_j t}$ reflects growth in labour productivity.

A common extension of the simple single-region input-output model is to introduce a consumption function. Various approaches have been applied in the CPS model. One of these is specified below:

$$(3) \qquad C_i = k_i [N. \left(\frac{\sum_j w_j X_j}{N.} \right)^{\varepsilon_i} + \alpha_i Q]$$

In this equation k_i is the constant regional budget share of sector i, w_j is the household disposable income share of gross output, while ε_i represents the income elasticity for the sector. Household income is related to total regional employment (N.) using an 'average income' concept. The consumption function also includes the impact from household income independent of production in the county (government transfers etc.). This is represented by the variable Q. The coefficient α_i indicate the sectoral distribution of the latter type of consumption, relative to k_i.

The last equation in the model is an investment function specified for the construction sector (sector n):

$$(4) \qquad X_n = vX. + S_n + Z_n$$

In (4) the construction investment is partly linked to total gross output in the region (X.). S_n is exogenous construction investments and v is a constant, mainly reflecting a depreciation rate. The investment function may also be specified with 'lagged' variables.

The CPS system also contains models which break down county projections to subregions (labour market regions). This is done by shift-share methods or by using an interregional input-output model based on added information of interregional flows at the subregion level.

The model (1)-(4) is nonlinear, static (conceivably dynamic) and demand driven. It contains two different types of exogenous variables:

(i) Intraregional variables (S_i, S_n, G_i, Q)
(ii) Interregional variables (A_i, Z_i)

Since the counties are rather small and open regions the assumptions concerning the variables A_i and Z_i are crucial elements to the model performance. These variables represent main external links to the regional economy. Another type of external links is related to the demand side of the regional economy. Major or minor shares of the intermediate and final demand may be supplied from outside the region. Hence, the intraregional input coefficient a_{ij} introduced in equation (1) may be conceived as the product of a regional technical coefficient and an intraregional trade coefficient. In a similar way intraregional trade links for household consumption and investments have to be specified.

The multiregional model used for planning purposes in Norway is developed at the Central Bureau of Statistics. The model, which is called REGION, is built around a core of balance equations of the following type:

$$(5) \qquad \sum_j c^r_{ij} X^r_j = t^r_i \left(\sum_j b^r_{ij} X^r_j + C^r_i + S^r_i\right) + G^r_i + A^r_i + Z^r_i$$

We have here used the same symbols as above, but explicitly denoted by the index r that the variables and coefficients pertain to region r. We have also, unlike the formulation used in (1), specified intraregional trade coefficients (t^r_i) and intermediate technical coefficients (b^r_{ij}). The intraregional trade coefficients, indicating regional self-sufficiency assumptions, are not differentiated by demand components.

The main difference between (1) and (5) is, however, that the single-region model is applying an industry-by-industry approach while the multiregional model is applying a commodity-by-industry approach. Secondary products are specified in equation (5) by the output mix coefficient c^r_{ij}. It must be emphasized that this treatment is rather simple and based on the aggregation convention that the number of commodities and the number of industries is the same. The actual classification of commodities and industries in the model is done by adopting a 'main producer' principle. When there are more commodities than industries other types of modelling approaches have to be used, see Oosterhaven (8). The application of a commodity-by-industry framework has the advantage that interregional trade may be interpreted as commodity flows.

The multiregional model REGION contains a consumption function similar to equation (3). Instead of presenting this function in all details we shall only briefly mention the differences compared to the single-region specification. Household consumption is modelled in a more aggregate way in the REGION model than in the CPS model by using actual consumption sectors (aggregation of commodities) instead of industry products as the main level. The functional form is linear, and a total and not an average income concept is applied. Further, the county household consumption is adjusted to be consistent with exogenous national consumption in the multiregional model. This is done by introducing a proportional adjustment parameter in the consumption function.

In contrast to the CPS model the REGION model contains no investment function. The regional investments in REGION are essentially exogenous. The same applies to government consumption.

The labour demand function in REGION is quite simple:

$$(6) \qquad N_j^r = n_j^r X_j^r p_j$$

The parameter p_j, representing growth in labour productivity, is exogenous and derived from employment projections at the national level. While equation (6) implies uniform growth in labour productivity in all regions, the formulation used in the single-region model permits the consideration of regional characteristics.

Exports to other countries are treated in the following way in the multiregional model:

$$(7) \qquad A_i^r = f_i^r A_i$$

This means that county exports of commodity i are assumed to be proportional to exogenous national exports. It is, however, possible to employ exogenous changes in the export coefficients f_i^r.

The modelling of interregional trade flows is particularly important from the linkage point of view. The outflows to other regions are exogenous in the single-region model, but endogenous in the multiregional model. The crucial equation in the latter approach is shown below.

(8) $$Z_i^r = h_i^r[\sum_s (1-t_i^s)(\sum_j b_{ij}^s X_j^s + C_i^s + S_i^s) - M_i]$$

In equation (8) M_i is exogenous national imports from other countries. The expression within brackets is thus the sum over all regions of interregional deliveries of commodity i. The coefficient h_i^r indicate that the total interregional demand for each commodity is supplied by the counties according to constant market shares. Since there are no direct trade links between individual regions the model is not based on a strict interregional approach as defined in section 3. The national level acts as a pool for supply and demand of commodities.

The REGION model is essentially a top-down model using a national model as a point of departure. The endogenous variables (gross output, employment, household consumption) are made consistent with national variables by proportional adjustment methods. However, by relaxing the adjustment process it is also possible to operate the model as a bottom-up model. In certain sectors (agriculture etc.) the regional distribution of gross output may be specified exogenously. The REGION model is static and linear. The model comprises about 30 industries, while the number of industries in the CPS model varies between 20 and 25 in different counties.

The structure of the models outlined is rather simple. The models contain detailed sector specifications, but few adaption mechanisms. These characteristics are shared by most application-oriented models, see Nijkamp et al. (7). The major weakness of both models is the lack of satisfactory treatment of supply factors. The models have been used quite frequently for various planning purposes and also in special research studies, see Schreiner and Skoglund (10) and Westeren (15).

5. MODEL STRUCTURE AND DATA ISSUES

The two model approaches described in the previous section are originally developed for different purposes and are mainly designed independent of each other. An ideally coordinated use of the models within a multi-level planning process may call for a greater degree of harmonizing of model structures. Equally important is, however, to develope similar or common routines for preparation of basic model data.

In Norway the data situation for regional input-output analysis is rather good. The Central Bureau of Statistics prepares regional national accounts estimates ('National accounts by county') every 3 year. The regional accounts are, as the national accounts, following the SNA standard based on two rectangular commodity-by-industry tables. The regional input-output tables are prepared for about 300 commodities and 180 industries (see Furunes and Røgeberg (3)). The regional accounts are consistent with the figures in the national accounts. Thus the main data base for the CPS and REGION models are common, and the technical regional coefficients are identically estimated for identically aggregated commodities and industries.

However, these accounts are lacking information of the regional (county) origin and destination of the commodity flows. In order to estimate intraregional and interregional relationships in I-O models, it is necessary to 'regionalize' the tables by adding information on trade flows (cf. the suggestions by Oosterhaven (8)). Up to now, the county planning authorities have made much effort in collecting information from firms about commodity flows to and from their own county in order to prepare the data basis of the single-region I-O model, while the preparation of corresponding data for the multiregional model has been based on a nonsurvey approach. Lately, the Central Bureau of Statistics has carried out a national survey on interregional and international flows for the manufacturing industries. Considerable improvement in the estimation of intraregional and interregional trade flows is thus expected when combining and coordinating these two types of surveys. The county surveys also provide other local information about firms (existing production capacity, future production plans etc.)

A coordinating effort on the data side does, however, also call for changes in the structure of the models. It is a rather trivial methodological matter to obtain more consistent model structures. The practical consequences may, however, be more comprehensive. The single-region model is now undergoing some changes, which involve the introduction of a commodity-by-industry approach. This changes the formulation in equation (1) to:

$$(1b) \qquad \sum_j c_{ij}X_j = \sum_j a_{ij}X_j + C_i + S_i + G_i + A_i + Z_i$$

The regional input-output coefficients in (1) have been estimated by means of a RAS adjustment procedure. However, this method has the inconvenient characteristics of creating adjustment coefficients ($r_i \cdot s_j$) which may be greater than unity. This is argued to be plausible when national 'average' technical coefficients are the starting-point of the iteration. Since the Norwegian national accounts by county provide regional technical information, the starting-point for the iterations will be actual regional technical coefficients. The experience so far is that these adjustments very seldom exceed the value of unity.

A coordinated process of data preparation will entail a more satisfactory empirical basis for the intraregional coefficients which now may be identical in the two models:

$$(9) \qquad a_{ij} = a^r_{ij} = t^r_{ij}b^r_{ij}$$

Better data information may also permit a differentiation of intraregional trade coefficients by the other demand components.

The commodity-by-industry approach implies that the consumption function has to be specified for commodities. In the multiregional model the consumption function is formulated by more aggregated groups of commodities. The choice between aggregated or disaggregated commodity specification depends, among other things, upon data feasibility.

The investment demand function in the single-region model may be changed from the aggregate formulation in equation (4) to a disaggregated specification where the deliveries from construction (commodity m) are differentiated by demanding industries. This commodity may be produced by different industries:

$$(4b) \qquad \sum_j c_{mj}X_j = \sum_j v_jX_j + S_m + Z_m$$

The same type of investment demand function may also be introduced in the multiregional model.

Further attempts to harmonize the model specifications will concern the nonlinearity of the functions in the single-region model. Because of the size of the current multiregional model, it is most preferable to retain a linear structure in this model. It is desireable to retain the possibility of flexible specifications in the single-region model. Therefore, a simple way of handling the harmonizing problem is to use alternatively unity values of the elasticities.

An important aspect from the linkage point of view is the industrial classification adopted in the two models. The industry structure may vary considerably between counties. One particular industry may be rather important in one county, but be insignificant for other counties and for the nation as a whole. Consequently it is necessary to use a flexible aggregation of industries in the single-region model. The multiregional model should focus on industries with a national or international market. One way of paying attention to the linkage aspect is to establish a common level of industrial classification, which may be more aggregate than actually used in the two models.

6. COORDINATING THE USE OF EXOGENOUS INFORMATION

Successful application of input-output models in regional planning depends heavily on the possibilities of making reliable final demand projections. The models presented in section 4 contain a considerable number of exogenous final demand variables, with a particularly detailed industry/commodity specification. The exogenous and endogenous variables in the models are summarized in table 1. We have in this table focused on the regional variables and not included the national exogenous variables in the multiregional model.

TABLE 1. Exogenous and endogenous regional variables in the CPS and the REGION models

	Exogenous	Endogenous
The single-region model (CPS)	Exports to other countries Exports to other regions Government consumption Investment (partly) Exogenous household income	Gross output Employment Household consumption Investment (partly)
The multi-regional model (REGION)	Exports to other countries Government consumption Investment Exogenous household income	Gross output Employment Household consumption Exports to other regions

A major general problem in forecasting or projecting regional final demand is the lack of data available on a time series basis. In Norway, and probably in most countries, there are in particular little statistical information available on development trends in inter-regional trade and international trade specified by region. The situation is somewhat better when investment and government consumption are considered.

In a decision-theoretic scheme of planning it is useful to make a distinction between two types of exogenous variables: policy instruments and non-controlled exogenous factors. In the models discussed in this paper we may classify government consumption and exogenous household income as policy instruments, while the rest of the exogenous variables may be classified as 'non-controlled'. However, the multiregional model may also be used for analysis of regional impacts of national policies. Since the available national model provides a more sophisticated framework for policy analysis than the regional models, a number of topics may be addressed with this top-down approach (labour market policies, energy policies etc.). This type of information can be utilized in the single-region models only if it is expressed in terms of exogenous variables in these models. An example may be increased national energy prices leading to reduced exports from energy consuming industries.

A problematic aspect of forecasting regional government expenditure is that these variables are influenced by decisions taken on different administrative levels. Public spending and activity on the county level depends on decisions taken by both local governments (municipal and county councils) and the central government. These decisions and plans should ideally, as discussed in section 2, be coordinated in the general planning process. Although some disagreement may arise between local and central governments, it may be feasible to establish a 'reference forecast' for regional public activity as a common starting-point for single-region and multiregional model projections. A submodel, making public services (education, health care) dependent on subgroups of the regional population may be used as a common support tool. Such models are, to a certain extent, available in Norway. We must recognize, however, that the models presented in section 4 treat the public sector in a rather crude way. The main weakness is that infrastructure effects of public activity is not considered.

Regional investment is partly endogenous in the CPS model and essentially exogenous in the REGION model. It is highly desirable to put more, and coordinated, research effort into investment modelling both from the single-region and the multiregional point of view. Some approaches are discussed in Nijkamp et al. (7).

Finally in this section we will pay attention to the vital problem of coordinating the interregional and the international trade projections in the two types of models. We assume that consistent trade data have been compiled for a base year. The most natural approach would be to use uniform foreign export forecasts and to use the forecasts of interregional trade flows which have been projected by the multiregional model as exogenous entries to the single-region models. This approach ignores interregional feedback effects. Empirical results from Miller (6) and others indicate, however, that the sizes of such feedbacks are in most cases quite small. As the models discussed in this paper comprise rather small regions we may assume that interregional feedback effects are of minor importance in our context. The impacts from interregional feedbacks may have been more significant in a multiregional approach with trade flows specified between individual regions.

The suggested top-down method of projecting single-region outflow of commodities may also be criticized for not taking account of regional peculiarities. Industries serving national or international markets embrace normally a small number of establishments on the county level. These establishments may have other growth prospects than the national industry average. If the establishments contribute substantially to the regional economy, the assessment of production prospects will naturally be an important general task for regional planners. Obviously, such information ought to be utilized in single-region model projections. For regional industries with a strong export orientation it may be more convenient to use gross output as exogenous variables instead of demand projections.

Exogenous information on major changes in industrial location and trade patterns may also be utilized in the multiregional model. The main advantage of the multiregional projections is that national consistency is taken into account. The trade assumptions adopted in the current multiregional model, cf. equations (7) and (8), may, however, easily be criticized for the lack of a satisfactory theoretical basis. Possible improvements would be to consider bilateral interregional trade flows, or to apply other types of modelling approaches. Interregional trade relationships may be extended by introducing price or cost information or by specific treatment of transport markets, see Snickars (14).

7. CONCLUSIONS

This paper has adressed the problems of linking and coordinating the use of single-region and multiregional models. The model approaches currently applied in regional planning in Norway may, with certain modifications of model structures and use of data as discussed in section 5, constitute a suitable framework for coordinated use. One major weakness of the existing models is the lack of consistency in the trade flow estimation. The vital issue from the linkage point of view is, however, to coordinate the use of exogenous assumptions. Obviously, we should not strive for exact consistency in all exogenous assumptions. Divergencies may be due to utilization of local information on the regional level. The crucial point is that such divergencies are identified and documented.

We have in this paper emphasized the links to the national level. The application of a top-down based multiregional model restricts the operation range at the regional level and may by this cause discrepancies between multiregional and single-region projections. There is, however, a need for more thorough investigation of the adjustment method applied in the current Norwegian multiregional model. One of the problems to be delt with is that the available national model is updated more frequently than the multiregional (and the single-region) model. Consequently the base years will deviate.

The key to more efficient and better coordinated use of models on different administrative levels is the system of information flows and information circulation. The information from model projections should ideally be exchanged openly between the planning agencies and be available at the right time. The model users are, however, often reluctant to give away preliminary projections and the underlying assumptions. The planning system may be based on a formalized dialogue between the model users, as discussed in Berglund and Holm (2). Through a process of tentative model projections on different levels, exchange of information, revisions of the tentative projections and so on, an approximate degree of consistency may be obtained. If the national model is used actively in this process of iterations, feedbacks from the regions to the national level may be taken into account. In a planning system with well-organized exchange of information and mutual adjustments the multiregional model may play an important role in coordinating single-region and macroeconomic projections.

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