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MODAG A - A MEDIUM TERM ANNUAL MACROECONOMIC MODEL OF THE NORWEGIAN ECONOMY

BY

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ABSTRACT

This paper presents the structure and main empirical characteristics of MODAG A, a medium term annual macroeconomic model of the Norwegian economy. The model has an input-output structure with 41 commodities and 33 production sectors and is closely linked to the national accounting system. The version presented in this paper models only the real sector of the economy, and its structure is very much in the Klein-Tinbergen tradition with elements from the Scandinavian model of inflation. The main purposes of the model are the preparation of medium term economic projections and policy studies in the Ministry of Finance and in the Central Bureau of Statistics.

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CONTENTS

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1 INTRODUCTION

Most Norwegian macroeconomic models have been developed for economic policy purposes and reside within government agencies. The Norwegian planning system is an integral part of government decision making and the models have for many years been an integrated part of the planning environment. The two main policy documents are white papers called, respectively, the "National Budget" (an annual plan and economic report) and the "Long Term Programme" (a quadrennial programme which also includes a long term perspective). Macroeconomic models play an important part in improving communication, understanding and consistency within the planning process.

The use of macroeconomic models when analyzing alternative economic policies as part of the decision making process of the government, is quite different from that of providing the best possible forecasts of the development of the national economy. Ragnar Frisch expressed this distinction very succinctly many years ago:

> "How can it be possible to make a projection without knowing the decisions that will basically influence the course of affairs? It is as if the policy maker would say to the economic expert: "Now you expert try to guess what I am going to do, and make your estimate accordingly. On the basis of the factual information thus received I will then decide what to do". The shift from the on-looker view-point to the decision view-point must be founded on a much more coherent form of logic. It must be based on a decision model, i.e. a model where the possible decisions are built in explicitly as essential variables". (Frisch, 1961, p.4).

The Norwegian use of macroeconomic models adheres to this view with due regard of the partial nature and structural limitations of existing models. Economic policy is formulated, analyzed, and implemented within the framework of economic models with important policy instruments specified in great detail.[1)]

A distinctive feature of the Norwegian modelbuilding tradition is the use of detailed multisectoral input-output based models. Short- and

medium-term planning of the Norwegian economy in the last 20-25 years has been based on such models where also elements from the Scandinavian model of inflation and Keynesian macro theory play a central role. These models are oriented towards demand management and income policy formulation. While demand management is mainly the responsibility of the central government, the formulation of an income policy involves also the labour market organizations etc., especially in connection with the income settlements, cf. Cappelen and Longva (1984). A decision model in the sense of Frisch, called MODIS IV, forms the core of the model system (se Bjerkholt and Longva (1980)).[2] MODIS IV is an "open" model in the sense that much is left unexplained and determined exogenously. The model serves mainly as a tool to secure consistency in the policy-making process, but also as a system for gathering, evaluating, and presenting sectorial information. The shortcomings of MODIS IV with regard to its theoretical content and some of its other weaknesses are "compensated" for in some way or other within the administrative environment of the model. The "openness" of MODIS IV has in fact been regarded as a virtue, given the role the model plays in the administrative planning process.

The demand and income policy orientation of the MODIS model is in contrast to the long-term general equilibrium model MSG where the factors influencing growth (growth in labour force, capital accumulation, and technical progress) and the corresponding equilibrium prices, i.e. supply side factors, are the driving forces (see Johansen (1960, 1974) and Longva, Lorentsen and Olsen (1985)). The separate modelling approaches for short- and medium-term and for long-term planning reflect the fact that the explicit policy instruments in Norway are related mostly to demand management and income policy.

In this paper we shall present the main structure of an annual, medium term macroeconomic model called MODAG A. It is a complete and self-contained model, but for policy application it is designed to be used as a supplementary model to MODIS IV. The incomplete character of the MODIS model and the increased emphasis on market oriented economic policies in recent years have naturally raised the question of extending the model system to also include models with more behavioural relationships. The sheer size of MODIS IV and the fact that the model so deeply embedded in the administrative planning routines have in practice prevented the extension of MODIS IV to comprise more behavioural relationships.

The first version of MODAG A became operational in 1983 and has been

further developed since then. As MODIS, MODAG is designed mainly for demand management and income policy analysis. Even though MODAG A contains a more comprehensive set of behavioural relations than MODIS IV, the Norwegian economy is of course not completely modelled. MODAG A is meant to reside within a planning environment and to be used together with other models, as a tool, and not as a "black box", in preparing planning documents and to perform policy analysis. The commodities and sectors in MODAG are aggregates of those in MODIS, and model blocks of MODIS, i.e. submodels for direct and indirect taxes, may be used to transform in a consistent way the specific and detailed changes in policy instruments as specified in that model into the broader aggregates of MODAG.

This paper is organized as follows. The main features of MODAG A are presented in section 2 and in Appendix A. A discussion of "missing equations", i.e. important variables and relationships that are exogenous in the model but endogenous in the economy, is also included. Section 3 and Appendix B contain a more detailed description of the main submodels. Those readers who are not interested in the details of the model may skip this section. The empirical characteristics of the complete model are illustrated by impact analysis (multipliers) in section 4 and in Appendix C.

2 MAIN FEATURES OF MODAG A

MODAG A is an input-output based model intended for use in medium term macroeconomic planning and policy analysis. The structure of MODAG A is obviously influenced by MODIS IV which, as mentioned in the introduction, combines certain elements of the Scandinavian model of inflation, with its distinction between exposed and sheltered commodity markets, Keynesian macro theory, and input-output modelling. The Norwegian national accounting system forms the conceptual framework and the empirical basis of the model. Most parameters of the various submodels are estimated econometrically from national accounts time series, while the coefficients of the input-output structure are estimated from national accounts for the base year of the model. The model is rebased every year, and the base year will normally only lag one or two years behind the current year.

The description of the commodity flows is one of the main elements of MODAG A. Just as in the national accounts, commodity transactions are represented by means of two commodity by sector matrices, one for the flow of commodities to each sector and one for the flow of commodities from each sector. The principal concept for evaluating commodity flows is (approximate) basic values. The commodity flows are flows between (functional) sectors. MODAG A has 41 commodities, 33 production sectors and 19 categories of private consumption. Real capital and investments are grouped into 8 categories for each of the production sectors.

In modelling the commodity markets the notion of a small price-taking economy producing competing commodities identical to goods produced in other countries is modified by assuming that the same commodity with different countries of origin (domestically produced or imported) or delivered to different markets (domestic or foreign market) are imperfect substitutes (cf. Armington (1969)). This means that the model has been constructed on the assumption that it is possible to identify separate price equations and demand curves for competing Norwegian products both on foreign and domestic markets.

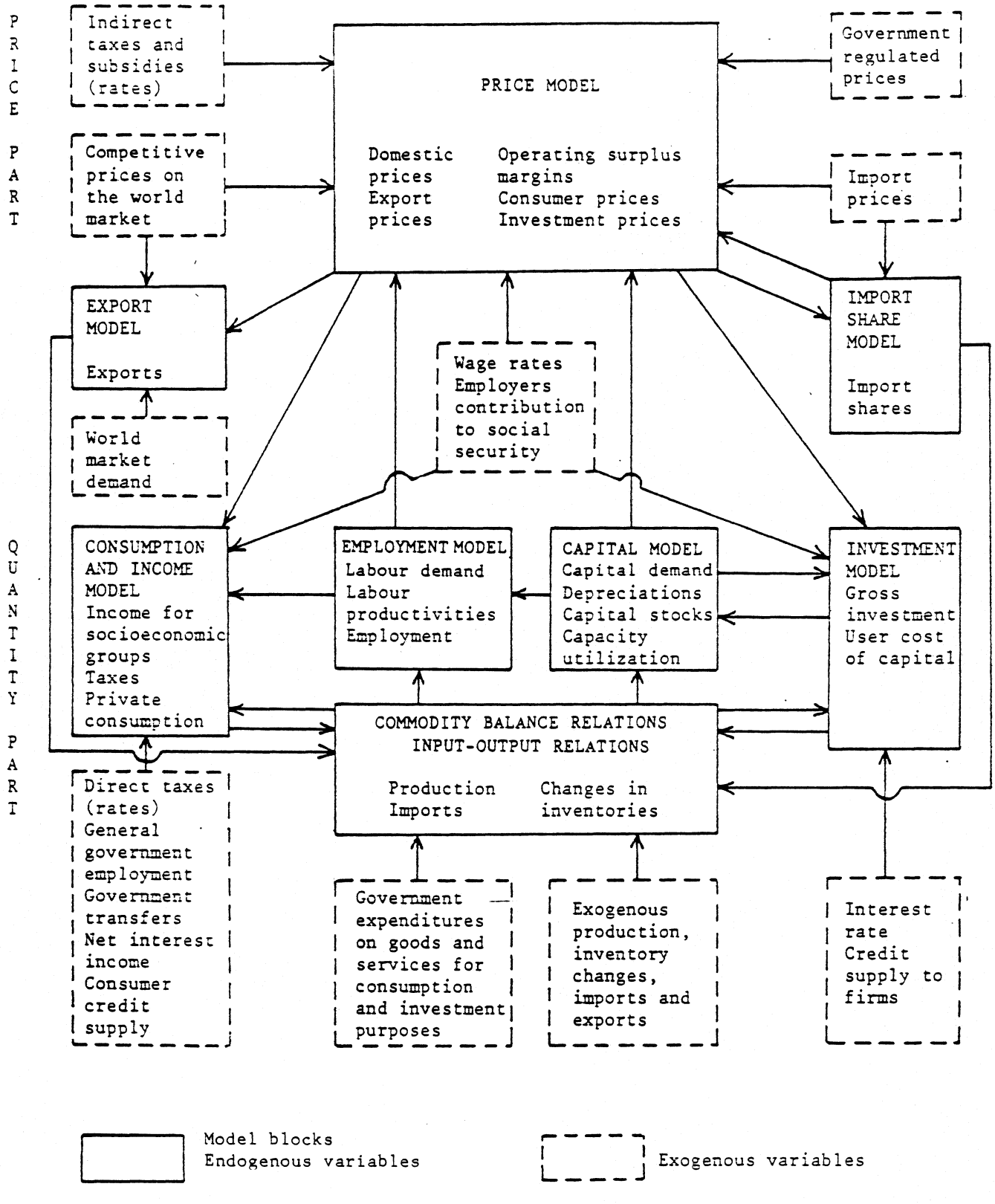
THE MAIN MODEL BLOCKS

In the description of the model, see figure 1, it is convenient to make a distinction between the price part and the quantity part even though MODAG A, as opposed to MODIS IV, is formally a simultaneous model in prices and quantities. The quantity part is mainly a demand driven model while the price part is supply or cost oriented. As may be seen in the lower part of figure 1, the demand components distinguished in MODAG A are private consumption, gross investment in industries, government expenditures on goods and services for consumption and investment purposes, exports, and changes in inventories. In addition we have the intermediate demand for material inputs, from the production sectors, which is handled by input-output relations. Government expenditures and most changes in inventories are exogenous variables in the model.[3)]

Private consumption, income, and direct taxes

Private consumption is determined endogenously in the consumption and income model by a macro consumption function and a system of demand functions. The macro consumption function determines private consumption as a function of real disposable consumption-motivating income accruing to each socioeconomic group (wage earners, self-employed persons, pensioners) as well as of consumer credit supply. Current income consists of wages (determined by exogenous estimates of wage rates and endogenously determined employment in industries, and exogenously given government employment), endogenous "consumption-motivating operating surplus" (dependent on operating surplus margins and production), and exogenously given government transfers and net interest income to households. By deducting endogenously determined direct taxes and deflating by the consumer price index we arrive at real disposable consumption-motivating income. Direct taxes are determined through estimates of average and marginal macro tax rates. These tax rates are generated in a separate micro based model for direct taxes. Total private consumption is allocated among the consumption categories through a system of demand functions with total consumption expenditures and prices as the explanatory variables.

Figur 1. The main structure of MODAG A



Exports

Exports of resource-based products (e.g. crude oil and natural gas) are assumed to be supply determined and given exogenously in the model. Due to difficulties in determining stable export relations the same is true for exports of ocean transport services and some minor services. For most manufactured goods and some services, covering about thirtyfive per cent of total exports, demand equations determine exports as a function of exogenously given world market growth "indicators" and of the ratio between the Norwegian export price and an exogenously given competitive price.

Domestic production, inventory changes and imports

Exogenously and endogenously determined commodity demand is subdivided into domestic production, changes in inventories, and imports in the commodity balance equations. The import of most manufactured goods, covering about fifty percent of total imports, is determined by endogenously calculated changes in the import share of each commodity. Changes in import shares are determined in the import share model. In this submodel the change in each import share is assumed to be a function of the ratio between the domestic and the import price. The import share for each commodity is demand (purchaser) differentiated, so that changes in the demand composition also influence the demand for imports. Changes in inventories of imported goods are exogenously given. This is also true for changes in most inventories of domestically produced goods. For certain important export oriented products (paper and paper products, industrial chemicals and metals) inventory changes are functions of changes in demand, but after some time inventories again return to "normal".[4] For given demand, imports and inventory changes, Norwegian production is determined residually. For the resource-based industries, production is exogenously given and imports of these products are usually determined residually from the commodity balance equations. The same is the case for non-competitive imports.

Factor demand (labour, capital, materials and energy)

The demand for both labour and capital (primary factor demand) is derived from the assumption of cost minimizing behaviour. Production is

modelled as a function of labour hours and the capital stock in place, while materials and aggregate energy input are related to output by fixed coefficients by quantity input-output relations.

In the capital model the desired capital stock by industry is modelled by assuming that producers minimize long-run costs of labour and capital for any given output, making the desired capital stock dependent on the level of production and relative factor prices. Depreciation in constant prices is calculated as a function of time series for gross investment and depreciation rates according to capital category and industry. The depreciation rates are aggregates of those in the national accounts and is based on a linear survival function for each vintage of capital, cf. Biørn (1983). Gross investment by (private) industry are modelled in the investment model by assuming the presence of capital adjustment costs and that the speed of adjustment to the optimal level of captial stock depends on internally generated funds (approximated by gross operating surplus) and credit supply. Investments in oil and gas extraction and ocean transport, covering forty per cent of private gross investments, are exogenously given. The production capacity in each industry is assumed to be proportional to the real capital stock adjusted by a trend.

In the employment model labour demand is modelled by assuming that short-run labour costs, incl. hiring and firing costs, are minimized given current output and the capital stock at the end of the previous year. Employment is thus determined by output and the capital stock through a partial adjustment mechanism. When labour input has been determined, labour productivity can be calculated. Labour productivities are included in the equations for variable unit costs in the price model.

Prices

In the the price part of MODAG A (see the upper part of figure 1), commodity prices, price indices for various final demand groups, as well as gross operating surplus margins are determined. Each commodity can in MODAG A, in principle, have three different prices; an import price, a price for the domestically produced commodity sold on the domestic market (a domestic price), and an export price. Import prices are stipulated exogenously based on assumptions about international price development, i.e we assume infinitely elastic supply of imports. The domestic prices of commodities that are directly determined by negotiations (i.e. agricultural

prices) or by government regulations, are exogenous in MODAG A. The remaining domestic prices and export prices (apart from prices of crude oil, natural gas and ocean transport services which are exogenous) are determined endogenously in the price model by a set of price equations which determines prices as functions of variable unit costs, prices on competing foreign products and capacity utilization indices. Variable unit costs are defined as the sum of labour, energy and material input costs, calculated per unit produced. The labour input cost per unit produced is determined by the wage rate per man-year, the tax rate for employers' contribution to social security and labour productivity. The material and energy input cost is determined through the input-output relations, the changes in import shares, and the indirect tax and subsidy rates. The estimated importance of variable unit cost versus the competitive price index varies between goods and is normally related to the size of the market share and on the homogeneity of the products. Changes in the competitive prices are important in the determination of export prices and of domestic prices of commodities produced and marketed domestically under strong foreign competition (exposed domestic prices). Changes in variable unit costs determine the domestic prices of commodities sheltered from foreign competition (sheltered domestic prices). The market situation indicated by capacity utilization indices, influences price setting on certain export markets and mainly for manufactured goods while services are virtually unaffected. Price equations are made dynamic by assuming that prices have lagged responses to changes in unit costs and competitive prices.

THE INTERRELATION BETWEEN PRICES AND QUANTITIES AND THE WORKING OF THE MODEL

In the presentation above we have looked at the most important submodels of MODAG A. As mentioned, these submodels constitute a simultaneous system. However, the main effects in MODAG A go from the price part to the quantity part. As we can see from figure 1 the quantity part of the model can only affect the price part through changes in labour productivities and capacity utilization. The estimated effects of changes in capacity utilization are, in fact, fairly modest, so that the primary influence is through labour productivity which may change considerably in the short run if labour adjusts slowly to changes in production. However, the significance of this for price setting, even in industries where cost-plus pricing is

dominating, is dampened by the sluggishness of the price adjustments. On the other hand, for the operating surplus margin the effect of changes in labour productivity may be considerable. In the long run labour productivity will be affected both by changes in production (because of increasing returns to scale) and the capital stock. Quantity changes will thus have some endogenous effects on prices also in the long run.

In contrast to this the effects going from the price part to the quantity part are strong even in the short run. The effects work partly through factor prices such as wage rates and operating surplus margins, and partly through commodity prices (consumer, export and import prices).

From what is said above concerning producer behaviour it follows that prices adjust to changes in costs and competitive prices, while they are only to a limited degree influenced by changes in demand. Changes in demand, however, will rather quickly influence production and inventories.[5] Output may therefore be said to be determined from the demand side while prices are almost independent of demand.

This description of producer behaviour applies mainly to the manufacturing and service industries. For the resource based industries (agriculture, forestry, fishing, hydroelectricy production and crude oil and natural gas extraction) in addition to ocean transport, which are very important in Norway, output may be said to be supply determined (capacity constrained). In the present version of MODAG A production, employment, investment, exports, and prices are usually exogenously given for these industries with either changes in inventories or imports determined endogenously. Due to the importance of these industries for the Norwegian economy, MODAG A can therefore not be characterized as a completely demand and cost driven model.[6]

If in order to simplify, we ignore the effects going from the quantity part of the model to the price part the model has a recursive structure, since the price and the import share models may be viewed as independent of the quantity part. The workings of the model can then be explained as follows. From exogenous estimates of wage rates, indirect tax and subsidy rates and foreign market prices, the price model and the import share model, as a simultaneous system, determine domestic prices, export prices, operating surplus margins, and import shares. Prices and operating surplus margins enter the private consumption and income model and the

investment model of the quantity part. Together with exogenous estimates of wage rates, certain income components (government transfers and interest flows) and direct tax rates, private consumption demand is determined as a function of the level of production. For exogenously given wage rates, nominal rate of interest and credit supply investment demand is also determined as a function of production. Export prices and exogenous estimates of competitive prices and world market demand determine exports. Together with estimates of exogenous demand and endogenous import shares, production is then determined through a traditional multiplier mechanism.

THE PARTIAL NATURE OF THE MODEL

In MODAG A there are a number of important economic variables which are exogenous in the model, but may be regarded as endogenous in the economic system of which the model is only a partial representation (model-exogenous but economy-endogenous variables). This applies i.a. to:

- wage formation and labour supply
- financial variables

Wage formation and labour supply are exogenous in the model as it is presented in this paper[7]. This means that the most important "supply side" effect and resource constraint in an economy like the Norwegian with nearly full employment is left out of the model. When MODAG A is used for policy purposes its administrative environment comprises a submodel developed by the Ministry of Finance in which wages and salaries are endogenized by wage formation equations (see Eriksen and Qvigstad (1983)). When MODAG A is used in studies related to income policy, which may be viewed as an attempt to reach a "feasible" wage development without relying on the labour market as a regulator, the absence of a wage formation block is in accordance with the use of the model.

Financial variables do play an important role in the present version of MODAG A. In particular, increased credit supply by state and private banks influences both consumer spending and private investment significantly. The nominal interest rate enters the investment equation in

many industries and net interest income for households is important in determining total consumption. All these variables are however exogenous in the model. There is no feedback from the real side of the economy to the financial as the model is now formulated. With reference to the IS-LM diagram in macroeconomic textbooks, we may say that MODAG A is a disaggregated model of the IS-curve only. This is obviously a serious shortcoming but it must be viewed in light of some institutional characteristics of the Norwegian economy. During most of the post-war period the financial sector has been subject to detailed regulation by the government. A very detailed financial model is used by the government in order to work out the implications for the financial sector of developments on the real side of the economy. Certain deregulations in the financial markets in recent years do however increase the need for developing integrated models. The switches of "regimes" may however make the estimation of such models difficult.

OTHER MAIN SHORTCOMINGS

In addition to the "missing" model blocks discussed above there are, of course, many parts of the model as it now is formulated and estimated, which are not satisfactory. This applies to the modelling of supply behaviour for exposed industries which in the medium term probably face given prices both on the domestic and the world market. Marginal costs and not demand should then determine the level of production, i.e. the export demand equations are replaced by export supply equation.

Another part of the present version of MODAG A which is not modelled in a satisfactory way is factor demand. Two aspects are important in this area; the substitution between production factors and whether to impose constant returns to scale or allow increasing returns to scale. In the present model version there is substitution between labour and capital in more than half of the industries (mainly in manufacturing) and between fuels and electricity in most sectors, but no substitution between primary inputs and material inputs. The model specification also allow for increasing returns to scale. How we model the production structure is obviously of importance for the long-run solution of the model.

A third aspect of the model which will be important to study more closely is the specification of expectations. This theme has been the

subject of heated debates in macroeconomics for some years but no clear conclusion has emerged so far. Our specification varies between traditional adaptive or backward-looking expectations and myopic but perfect foresight. Our present choices are more dictated by goodness of fit and restrictions on the sign of parameters than by modelling expectations more explicitly. Whether this is a fair description of rational behaviour or not, is an open question, allthough it is obviously not what is usually meant by "rational expectations".

3 A CLOSER LOOK AT SOME OF THE SUBMODELS

In this chapter, we take a closer look at some of the submodels of MODAG A. The submodels for private consumption and direct and indirect taxation are almost the same in MODAG A as in MODIS IV. The description of these submodels in the following is therefore rather brief. A survey of the most important price and quantity elasticities in the submodels of MODAG A is presented in tables A1 to A8 in Appendix A.

3.1 EXPORTS

In MODAG A export demand equations have been introduced for about half of the commodities, covering thirtyfive percent of total exports. Exports of resource-based products such as Crude oil and Natural gas, Fish and Agricultural products etc., covering about forty percent of total exports, are assumed to be capacity constrained and thereby supply determined. Capacity changes in production of these commodities are strongly influenced by economic policy and exports are therefore exogenously fixed, given the medium term character of the model. For export of Ocean transport services, exports of some minor services and secondhand real capital etc. we have been unable to establish stable export equations (cf. also table A1 in Appendix A).

The implemented export equations cover most of the exports from manufacturing industries. A basic feature of the specification of these equations is that the volume of exports is assumed to depend on world market demand. Thus we assume that Norwegian producers face specific demand curves on the world market which may be represented by

$$(3.1) \quad A_t = f(P^A_t/P^K_t, V_t)$$

(3.1) expresses the assumption that the volume of Norwegian exports (A) is a function of the ratio between the Norwegian export price (P^A) and a price index for competing commodities (P^K), and a variable (V) which denotes the size of the world market. The usual argument for adopting a

specification like (3.1) is that Norwegian produced commodities are imperfect substitutes for commodities originating in other countries. For given prices exports are then determined on the demand side. This is an argument which may be reasonable for relatively detailed groups of manufactured goods. For more homogeneous commodities, the assumption that there exist separate demand curves for Norwegian commodities is reasonable only if they constitute a considerable share of the total amount of the commodity available on the world market. However, for small countries this will only be the case for a few commodities and it is customary to assume that exports may be better modelled by constructing a so-called "small-open-economy-model". This implies that exports are assumed to consist of homogeneous commodities which are sold at given prices on the world market. Exports are thereby determined by supply conditions. For three staple commodities (Paper and paper products, Industrial chemicals and Metals) we have attempted to estimate a more supply-oriented model for exports where exports are dependent upon export prices (the producers are assumed to be price-takers, see also the modelling of export prices in section 3.3), capacity and factor prices. This formulation was unfortunately not successful. The capacity variables were the only variables which seemed to have any significance, while the relative factor prices and therefore export prices were insignificant. Also for these commodities exports are therefore determined by demand functions in the present version of MODAG A. However, work will continue on the construction of alternative models for these commodities.

In the model we have generally chosen the following log-linear form

$$(3.2)\quad \log A_t = C_A + a_1 \log(P^A/P^K)_t + a_2 \log V_t$$

where C_A, a_1 and a_2 are coefficients. a_1 and a_2 may be interpreted as price and income elasticities, respectively. Estimates have been made for two different dynamic formulations of this relation. In the first formulation a two year price lag is stipulated, i.e.

$$(3.3)\quad \log A_t = C_A + a_1^0 \log(P^A/P^K)_t + a_1^1 \log(P^A/P^K)_{t-1} + a_1^2 \log(P^A/P^K)_{t-2} + a_2 \log V_t .$$

The coefficient a_1^0 expresses the "immediate" effect of a relative price change on export demand, while a_1^1 and a_1^2 express the lagged effects of price changes. In the second formulation we have assumed that equation (3.2) expresses the expected demand, and that there is sluggishness in the export adjustment ("partial adjustment"). Changes in actual exports are considered to be dependent upon the difference between expected demand and actual export the year before

$$(3.4) \quad \log A_t - \log A_{t-1} = \lambda (\log A_t^D - \log A_{t-1}),$$

where $\log A_t^D$ is given by (3.2). (3.4) inserted into (3.2) gives

$$(3.5) \quad \log A_t = C_A' + \lambda a_1 \log(P^A/P^K)_t + \lambda a_2 \log V_t + (1-\lambda) \log A_{t-1}.$$

Equations (3.3) and (3.5) are estimated using annual data covering the period 1962 to 1981. For the volume of Norwegian exports and for export prices, data from the national accounts have been used, while the figures for world market demand are based on consumption and investment data for Norway's major trading partners (various OECD countries), see Tveitereid and Lædre (1981). As indicator of the competitive price for Norwegian exports of various commodities we have in some cases used the corresponding price index for the world market indicator and in other cases the import prices of the corresponding MODAG commodity.

For most commodities the ordinary least squares (OLS) have been used in the estimation. For some commodities, however, the instrument variables method gave more accurate and reasonable estimates. The results may be summarized in the following way (cf. also table A1 in Appendix A):

(i) The estimated parameters indicate a considerable sluggishness in export adjustment. Equation (3.5) is preferred for all commodities. The long run elasticities of changes in both relative prices and market volume for many commodities are larger (in numerical values) than the corresponding immediate effects.

(ii) The results imply in general reasonable price elasticities. However, for four of the commodities and for all services the estimates of (long-run) price elasticities are less than 1 in absolute value. If we weigh the elasticities together by using the export values for 1984 as weights we get an average price elasticity (for the commodities for which export equations have have been specified) of approximately -1.3.

(iii) All estimated (long-run) world market growth elasticities are, with one exception, greater than 1. The average export weighted market demand (income) elasticity is close to 1.7.

The specification and the estimation of the export model are discussed in detail in Bergan and Olsen (1985).

3.2 IMPORTS

The commodity imports in MODAG A are, with two exceptions (Ships and oil platforms, and Electricity), determined endogenously. The determination of imports, however, is different for different groups of commodities. For so-called non-competitive imports (commodities of which, by definition, there is no comparable Norwegian production), imports are demand determined directly from the commodity balance equations. This is also the case for imports of resource based commodities (primary industry products, Crude oil, and Natural gas). In MODAG A the the production of these commodities is stipulated exogenously and imports are thereby determined residually. For the remaining commodities, imports are determined with the help of import shares (imports of the commodity relative to domestic use). For manufacturing goods covering about fifty percent of total imports, these import shares are specified and estimated as functions of the ratio between the domestic and the corresponding import price (cf. also table A2 in Appendix A). For the imports of services (except tourism), the import shares are changed exogenously.

As is the case for the export model, the specification of the import share equations in MODAG A is based on the assumption of separate demand curves facing Norwegian producers. It is also assumed that quantities on

the domestic market, for given prices, are determined by demand. The same objections may be raised to this model formulation as the objections in the previous section regarding the determination of exports. Especially for relatively homogeneous products there is reason to believe that supply side variables are important factors in the allocation of demand between Norwegian production and imports.

The specified import share relations in MODAG A are, however, as mentioned above, derived as demand functions. Consumers and producers are assumed to minimize their total expenditures for purchase of a commodity, whether imported or produced domestically. Total demand for the commodity concerned is defined as a CES-aggregate homogeneous of degree one in the input of domestically produced commodity and imported commodity. The elasticity with respect to domestic market growth (the demand or income elasticity) is thus assumed to be one. The specification is based on the assumption of weak separability in demand between the input of this commodity and other commodities. The ratio between import and Norwegian production of corresponding commodities may thereby be expressed as a function of the price ratio between these two commodities alone.[8] More precisely, in MODAG A the following set of import share equations are specified

$$(3.6)\quad DIS_t = \left[IS_0 + (1-IS_0) \left(\prod_{T=t-2}^{t} (P^N/P^I)_T^{\theta_T} \right)^{1-\sigma} \right]^{(\sigma/(1-\sigma))}$$

This relationship determines the import share index of a commodity, DIS (the import share relative to the import share in the base year (IS_0)), as a function of the ratio between domestic price (P^N) and import price (P^I). The parameter σ is the elasticity of substitution between imported and Norwegian goods. The θ's are lag parameters, and express the fact that it may take time before changes in relative prices have completed their effects on the allocation of demand between Norwegian and imported goods.

Equation (3.6) is estimated for the manufactured goods in the model on the basis of national accounts data for 1962 to 1980. Ordinary least squares (OLS) was used in the estimation. For some of the commodities in MODAG A, equation (3.6) has also been estimated including a trend term in order to investigate the possibility that some variables may have been left out. The results can be summarized in the following way (cf. also table A2 in Appendix A):

(i) As a result of the relatively limited number of observations a priori restrictions on the lag structure in the model were imposed. The specification which fitted the data best was chosen. For most commodities this resulted in a specification where about 50 per cent of the effect of a relative price change on the import share was realized the first year. For three commodities - Textiles and wearing apparels, Wood and wood products and Paper and paper products - a specification without lag effects gave the best results, while the "immediate" effect was estimated to be zero for Mining products.

(ii) The estimates of the elasticity of subsitution vary for most products from 1.0 to 1.5. Exceptions are Paper and paper products and Printing and publishing, with substitution elasticities less than 1, and Industrial chemicals and Chemical and mineral products where this essential parameter was estimated to be approximately 2. The corresponding direct price elasticities - which are defined as the substitution elasticities multiplied by the cost shares - vary from about 0.5 to a little over 1 in absolute value. Using the import values for 1984 as weights we get an average long run price elasticity of approximately -0.75.

(iii) For some groups of commodities, mainly consumer goods (Textile and wearing apparels, Paper and paper products, Printing and publishing, Beverages and tobacco) equation (3.6) also includes a trend. There are tendencies toward auto-correlation in the error term and the effects of relative prices are insignificant. By introducing a trend, the estimation results for these commodities become much more satisfactory. For these commodities the (significant) trend indicate an autonomous increase in the import shares by about 8 percent per annum. These results should be viewed in the context of the specified model and its possible inherent weaknesses, which were pointed out above. Of obvious importance is the assumption of identical income elasticities for Norwegian goods and imports, and the fact that Norwegian production of many commodities may be

determined by supply side factors so that imports are determined residually and not according to import share relations.

The import model is documented in more detail in Stølen (1983).

3.3 PRICES

As MODAG A is a simultaneous model in prices and quantities, we speak of the "price model" here as that part of the model where the price and cost equations are specified. In MODAG A each commodity has three associated prices, dependent on its origin and destination. We distinguish between the import price, the domestic price and the export price. The differentiation between the import price and the price of the domestically produced commodity sold on the domestic market (domestic price) can be justified by pointing out that imports and domestic production of the same commodity will not be perfect substitutes. The differentiation between domestic price and export price can be justified in the same way, but in this case the possibility of price discrimination may be added. The differentiation between export and domestic price implies that the simple "law of one price" in the Scandinavian model of inflation needs to be somewhat modified. Firms may be especially exposed to competition on the export market while on the domestic market they may occupy a sheltered position if they actually (or potentially) have very little competition from imports.

The prices of energy (Crude oil, Natural gas and Electricity) and some prices of primary industry products are exogenous, as are the production of these goods. The resource-based ("extractive") production is determined by supply at given prices which are either genuinely exogenous to the Norwegian economy, such as Crude oil and Natural gas prices, or are determined administratively such as Agricultural prices or Electricity prices. The model is, however, not explicit on this point.

If we ignore the dynamic specification, the equations for the endogenously determined prices in MODAG A can generally be written in the following way

$$(3.7)\quad \log P^N_t = C_{PN} + a \log UC_t + b\, CAP_t + c\, CAP^2_t + (1-a) \log P^I_t.$$

where P^N is either the export or the domestic price, UC is the unit variable cost (wages and material input costs), CAP is a capacity utilization index and P^I is the import price. C_{PN}, a, b and c are coefficients. Homogeneity of degree one in absolute prices is assumed.

The price equations are made dynamic by assuming partial adjustment. This lag distribution is obviously very simple and restrictive, but it requires few extra parameters and can be justified by the slowness of adjustment to changes in unit costs and competitive prices. We have experimented with other lag formulations as well, such as lagged changes in unit costs or import prices which are significant for some products.

Price equations are estimated on the basis of annual data from the national accounts for the period 1962 to 1984. A variable representing the effect of price controls was included and found significant in most domestic price equations for services.[9] The results of the estimation may be briefly summarized as follows:

(i) Domestic prices. The service industries, including Building and construction, seem to follow a mark-up pricing rule. The same is true for some of the manufacturing industries (production of Food and of Beverages and tobacco). These industries may, as in MODIS IV, be classified as sheltered industries. The other industries are to varying degrees exposed to import competition as indicated by the estimate of a in (3.7), and may be classified as exposed industries (cf. also table A3 in Appendix A).

(ii) Export prices. For traditional Norwegian exports (Paper and paper products, Industrial chemicals and Metals) export prices are heavily influenced by world market prices but (domestic) unit costs also seem to play a significant role. One possible explanation of this result may be that Norwegian producers have market shares that allow them some freedom to set prices even on markets for staple goods. For those exposed industries which are primarily oriented towards the domestic market and for which the export markets are secondary, we found that export prices and domestic prices have developed fairly similarly. For

sheltered industries the mark-up pricing rule gives a reasonable description of export price determination (cf. also table A4 in Appendix A).

(iii) The estimation results show that on the average more than half of the total effects on prices of changes in costs and competitive prices appear during the first year.

(iv) In general, changes in capacity utilization does not seem to have very much impact on prices. However, for industries exposed to foreign competition capacity utilization do affect price behaviour and in some industries the effect is U-shaped, i.e. at very low capacity utilization there is short run increasing returns. This is in accordance with the employment model.[10)]

We have thus obtained results which correspond reasonably well to the more or less a priori assumptions about price behaviour which have for a long time characterized Norwegian macro models. On the other hand our results give a somewhat different picture of price formation than empirical studies based on statistical data from the 1960s, where the degree of costs passed on to prices in exposed industries was clearly higher (Ringstad (1974)). One explanation of this difference may be that the Norwegian economy was more sheltered in the 1960s than it was in the 1970s and that this change has modified pricing behaviour.

3.4 FACTOR DEMAND

In MODAG A the factors of production are separated in four main groups: real capital, labour, materials, and energy. In general the model assumes substitution between labour and capital while the inputs of materials and total energy are used in fixed proportions to gross output. However, there is substitution between the two energy commodities Fuels and Electricity based on the assumption that producers minimize total energy costs where total energy is a CES-aggregate of the two energy commodities.

The demand for capital is derived from the assumption that producers

minimize long run costs of labour and capital for any given output. Labour demand is modelled by assuming that short run labour costs are minimized given current output and the capital stock by the end of the previous year. The submodels are presented in more detail below.

3.4.1 EMPLOYMENT

MODAG A distinguishes between wage earners and self-employed persons. The number of persons in the latter group is exogenously given. The employment of wage earners, however, is determined endogenously with the exception of Local and Central government, Ocean transport, and resource based industries, covering about thirty percent of the total employment (cf. also table A5 in Appendix A).

Short-term demand for labour (wage earners) by industry are modelled by assuming that, for given production (X) and the capital stock (K) by the end of the previous year, industries minimize their short run labour cost. The number of employees (N) is a quasi-fixed factor where adjustment to the desired level occurs gradually because of the costs ("hiring and firing costs") associated with rapid adjustment. The number of hours worked per worker (H) is the only completely flexible factor in the short run. Using a simplified version of the relation between hourly wages and actual hours worked it can be shown that the optimum number of hours per worker equals normal working hours (H^N) (see Bergland and Cappelen (1981)).

The production functions for the manufacturing industries do not have constant marginal elasiticities w.r.t labour as is the case with e.g the Cobb-Douglas function. Instead, we have chosen a production function where the elasticity of labour decreases in proportion to increases in the capacity utilization rate (CAP). For the other industries Cobb-Douglas production functions have been chosen.

The short run production function for each of the manufacturing industries is specified as

$$(3.8)\quad X_t e^{\theta CAP_t} = A N_t^{\alpha} H_t^{\beta} e^{\varrho t}.$$

where θ, α, β, A and ϱ are positive constants. The elasticity of labour

w.r.t X is $\alpha/(1+\theta CAP)$ which decreases as CAP increases.

The capacity utilization rate is estimated as a modified Wharton index

$$(3.9)\quad CAP_t = \gamma_t X_t / K_t , \qquad \gamma_t > 0,$$

where γ_t is the trend-through-peak capital-output ratio. The elasticity of substitution between labour and capital implied by (3.8) and (3.9) varies between 0.5 and 1.0.

From the assumptions outlined above, we can express the desired number of employees in each industry as a function of X, CAP (or log K for industries outside manufacturing) and H^N. By imposing a partial adjustment mechanism with λ representing the adjustment parameter we get

$$(3.10)\quad \log N_t = C_N + \lambda/\alpha \log X_t - \lambda\beta/\alpha \log H^N + \lambda/\alpha(CAP_t - \varrho t) + (1-\lambda) \log N_{t-1}.$$

The estimation is based on data from the national accounts from 1962 to 1979. The OLS method of estimation was used. In the estimation we did not get accurate estimates of the effects of H^N, and this variable was therefore left out of the model.[11] The most important results may be summarized as follows (cf. also table A5 in Appendix A):

(i) Generally, the estimation results indicate increasing returns to scale. For most manufacturing industries the elasticity of labour demand w.r.t production (current output) is close to 1 at full capacity utilization. The trend term, which expresses technological change (the parameter ϱ), is zero for many of the manufacturing industries and has a low value for the others. This is probably due to the estimated increasing returns to scale.

(ii) For other industries (service industries as well as the Building and construction industry) the estimates show a elasticity of labour w.r.t production of less than one and non-significant technological trend terms, but the returns to

scale here is lower than in the manufacturing industries. This is partly because significant estimates of the parameter for real capital stock were found only for the Building and construction industry and for Wholesale and retail trade.

(iii) For manufacturing industries using unskilled labour we got relatively high figures (0.7-0.8) and clearly significant estimates of the adjustment parameter λ. This indicates a rapid adjustment of labour. For other manufacturing industries λ was estimated to be between 0.4 and 0.6, i.e. a much slower adjustment. For other industries than manufacturing the estimates of the adjustment parameter vary greatly from industry to industry. The results for the Building and construction industry are close to those we obtained in the manufacturing industries which use a great deal of skilled labour.

3.4.2 CAPITAL AND INVESTMENT

Assuming firms minimize long run factor costs to any given output level, the desired capital stock K_t^D may be written as a function of relative factor prices and output

$$(3.11)\quad K_t^D = f(p_t^J/w_t, X_t, t),$$

where X is the level of output, p_t^J is the user cost of capital and w_t the wage rate per man-year. p_t^J is defined in accordance with the framework of Biørn (1984) (see also Bergan et. al. (1985)), and depends on investment prices, tax rates, the interest rate and depreciation rates.

In the presence of adjustment costs it is optimal for firms to adjust their capital stock only partially towards the desired or optimal level

$$(3.12)\quad K_t - K_{t-1} = \lambda(K_t^D - K_{t-1}).$$

Due to imperfect capital markets and the existence of credit rationing during the estimation period the speed of adjustment λ is assumed to depend on internally generated funds approximated by gross operating

surplus (RYR) and credit supply to firms (KREDB), both in real terms, in the following way

$$(3.13)\quad \lambda = \lambda_0 + \lambda_1(KREDB_t + \sum_{l=1}^{4} \beta_{t-l} RYR_{t-l})/(K_t^D - K_{t-1}).$$

This way of specifying λ assumes that K_t^D is always different from K_{t-1} which may be a reasonable approximation for the industries in the period we study. We admit, however, that our specification is rather ad hoc.

Substituting (3.13) and (3.11) into (3.12) we get

$$(3.14)\quad K_t - K_{t-1} = \lambda_0 f(p_t^J/w_t, X_t t) - \lambda_0 K_{t-1} + \lambda_1(KREDB_t + \sum_{l=1}^{4} \beta_{t-l} RYR_{t-l})$$

By definition $K_t - K_{t-1} = J_t - D_t$, where J is gross investment and D is depreciation. If we as a simplification assumes $D_t = \delta K_{t-1}$ we have the following equation for gross investment by industry

$$(3.15)\quad J_t = \lambda_0 f(p_t^J/w_t, X_t, t) + (\delta - \lambda_0)K_{t-1} + \lambda_1(KREDB_t + \sum_{l=1}^{4} \beta_{t-l} RYR_{t-l})$$

To simplify further, the f-function is assumed to be linear. Almon-lag distributions (normally of length 1 to 4 years) are specified for production, relative factor prices and gross operating surplus.

Investment equations like (3.15) have been implemented for 20 of the 28 private industries in the model, once again leaving out most of the resource based industries and Ocean transport (cf. table A6 in Appendix A). The estimation is based on data for the period 1962-82. The results vary a lot between industries but some systematic differences occur:

(i) Output is the main explanatory factor in manufacturing. However, only gross operating surplus seems to have any influence on investment in the export oriented industries (Paper and paper products, Industrial chemicals and Metals). Strictly speaking this implies that the model (3.15) is rejected for these industries.

(ii) Relative factor prices seem to have some impact on investments in labour intensive industries. Credit supply does not seem to be an important factor in determining investment in a disaggregate study like ours.

A problem is that the estimated values of $(\delta-\lambda_0)$ are often positive or very close to zero. In some cases (3 out of 20) we have had to implement equations with $(\delta-\lambda_0)=0$. This implies that when production or relative factor prices change the investment process will persist for a very long time until the new desired capital stock is reached. This may produce some implausible short run and medium term results from the model. A detailed presentation of the empirical results is given in table A6 in Appendix A.

Gross investment in housing (JH) is determined by an equation quite different from (3.15) due to the fact that the decisions to invest in housing are made by households, not firms. The chosen equation is

$$(3.16)\quad JH_t = C_{JH} + 0{,}0668\,(RWE_{t-1} + RSE_{t-1}) - 0{,}048\,KH_{t-1} - 18600\,r_t - 13600\,(P^{JH}/P^{C})_t + \text{demografic variables.}$$

Only lagged real disposable incomes for Wage earners (RWE) and Self-employed (RSE) (see section 3.6) are included because we do not believe that Pensioners are important investors in housing. The demographic variables which consist of a breakdown of the total population between 20 and 60 years also seem to indicate that people belonging to the oldest age group 40-60 years do not contribute much to investment in housing compared to younger age groups with equal income. KH_{t-1} is the real capital stock in the housing sector. We tried, without success, to include a variable showing the increase in (real) credit supply from the state bank for investment in housing. The variable r is the nominal rate of interest in commercial banks. The variable (P^{JH}/P^{C}) is the relative price between new houses and consumer goods.

The investment analysis is further documented and discussed in Bergan et. al. (1985).

3.4.3 ELECTRICITY AND FUELS

We assume that the energy aggregate by industry is a linear homogeneous function of Electricity and Fuels and is related to gross output by fixed coefficients. Assuming the CES-function we have

$$(3.17)\quad 1 = \left[\delta_E (a_E/\delta_E)^{-\varrho} + \delta_F (a_F/\delta_F)^{-\varrho}\right]^{-1/\varrho}$$

where a_E and a_F are input coefficients and δ_E, δ_F and ϱ are parameters. We assume that producers minimize the cost of using Electricity and Fuels. It then follows that

$$(3.18)\quad a_E/a_F = (\delta_E/\delta_F)\left[P_E^C/P_F^C\right]^{-\sigma},$$

where σ is the elasticity of substitution between Electricity and Fuels and (P_E^C/P_F^C) the relative price. (3.18) is estimated adding the lagged input coefficient ratio, so that this ratio is partially adjusted to its optimal level given by (3.18) when the relative energy price changes. The short and long run effects of an increase in the price of Electricity on the relative use of Electricity compared to Fuels are given in table A7 in Appendix A. The general result is that the estimated elasticity of substitution centers around one with one or two important exceptions; manufacturing of Paper and paper products where it is 0.5 and manufacturing of Metals where σ is almost zero. The latter result is important since this sector uses a quarter of total electricity production in Norway. Energy demand in MODAG A is presented more fully in Bye and Frenger (1984).

3.5 DIRECT AND INDIRECT TAXES

Direct taxes are treated in the same way in MODAG A as in MODIS IV. In the models, direct taxes are paid by different socio-economic groups (Wage earners, Self-employed persons, Pensioners). The taxes are determined by a two-step procedure. In a separate micro based model, average and marginal macro tax rates are calculated for each socio-economic group. For given tax rates direct taxes are determined by relationships of the type

$$(3.19)\quad T_t = \left[t_g Y_0/N_0 + t_m(Y_t/N_t - Y_0/N_0)\right]N_t + TE_t,$$

where T is total direct taxes (for each socio-economic group), TE is exogenous (income independent) direct taxes, t_g and t_m are the average and marginal macro tax rates, respectively. Y/N is income (liable to taxes) per tax payer. The number of tax payers N is exogenous for self-employed persons and pensioners. The number of tax paying wage earners are assumed to be proportional to the number of man-years worked by wage-earners (see Bjerkholt and Longva (1980) pp. 137-144 for a further discussion).

The tax rates t_g and t_m are calculated in a separate model as mentioned above. The actual rules of the tax system are included in this model, in addition to information on income distribution and on the number of tax payers in the various income groups. Assumptions on income growth in the forecasting years are also included. In order for marginal tax rates to be correctly estimated, the (exogenous) assumptions of income growth (the variable Y/N) in the separate model ought to correspond fairly well with the endogenously determined income development in the macro model. Iterative calculations may therefore be necessary if deviations are too large.

The treatment of indirect taxes and subsidies is extremely simplified in the MODAG model compared to MODIS IV. This is partly because it is almost impossible, at MODAGs level of aggregation, to link each indirect tax and subsidy directly to commodities in the same way as it is done in MODIS IV. More important, however, is the fact that without the simplifications the MODAG model would have had a great number of additional variables and a far more complicated model structure. In practice, the model uses only rates for non-refundable value added taxes

and other value taxes (net), since quantity taxes and subsidies are interpreted as value taxes (net). The indirect tax rates used in MODAG A are generated by MODIS simulations, since routines have been developed to convert MODIS results to estimates of exogenous variables in MODAG A. For a discussion of the treatment of indirect taxes in MODIS, see Bjerkholt and Longva (1980) pp. 144-160.

3.6 PRIVATE CONSUMPTION

The private consumption model in MODAG A consists of three parts:

i) Equations which determine consumption-motivating income according to socio-economic groups (Wage earners, Self-employed persons, Pensioners).

ii) A macro consumption function which determines total consumption as a function of real disposable consumption-motivating income according to socioeconomic groups.

iii) A linear expenditure system which, based on the macro consumption function's estimate of total consumption and relative prices, determine the consumption of each consumption category.

Consumption-motivating income by socio-economic group (Wage earners (WE), Self-employed (SE) and Pensioners (TE)) is, in general terms, defined as

$$WE = g_{WW}YW_t + g_{EW}\bar{YE}_t + g_{UW}YU_t + g_{TW}YT_t - TW_t,$$

$$SE = g_{WS}YW_t + g_{ES}YE_t + g_{US}YU_t + g_{TS}YT_t - TS_t, \quad (3.20)$$

$$TE = g_{WT}YW_t + g_{ET}YE_t + g_{UT}YU_t + g_{TT}YT_t - TT_t.$$

YW is wages and salaries.[12] Total wages and salaries is determined by multiplying the model estimate of the number of wage earners by industry, with exogenously given wage rates. Income from self-employment (YE) is determined as shares of the operating surplus (which is endogenous) in each industry. Transfers (YU) are exogenous, as is net interest income (YT). Each kind of income is allocated among the three sosio-economic groups by means of a set of shares, represented by the g-parameters, derived from income statistics. Direct taxes (TW, TS, TT) are determined by the tax equations (see (3.19)).

Total private consumption excluding health care consumption, which is exogenous, is determined by the following aggregate consumption func-

tion, estimated on the basis of national accounts data from 1962-82

$$C_t = C_C + 0.652\, R_t + 0.217\, R_{t-1} + 0.714\, KREDH_t,$$

$$R_t = RWE_t + 0.623\, RSE_t + 0.905\, RTE_t \qquad (3.21)$$

where RWE is the wage-earners' real disposable consumption-motivating income, RTE is the same for the pensioners and RSE for the self-employed, while KREDH is the real value of the increase in credit supply to households. The ratios between the marginal propensities to consume of the various socio-economic groups are estimated using cross-sectional data (see Cappelen (1980)). The estimated propensity to consume proved to be very stable when the estimation period was changed. The long-run marginal propensities to consume are 0.87 for wage-earners, 0.54 for self-employed and 0.79 for pensioners.

The total consumption arrived at by (3.21) is allocated on consumption categories by a set of linear expenditure relations (LES)

$$C_{jt} = \alpha_j + \beta_j (P^C_t C_t - \Sigma_k \alpha_k P^C_{kt}) / P^C_{jt} + \gamma_j CU_t \,, \qquad (3.22)$$

where C_j is the consumption of category j and P^C_j is a price index for this consumption category, calculated as a weighted sum of domestic and import prices. P^C is the price index for total consumption C which is also used to deflate the variables included in the macro consumption function. CU represents foreigners' consumption in Norway and is endogenously determined in the export model. The parameters of (3.22) are estimated indirectly by using estimates of income elasticities from various sources (mainly cross-section studies) and budget shares and a formula for translating these estimates in to the parameters of (3.22) (cf. Bojer (1966)).

For the two energy categories Electricity and Fuel the model is somewhat more complex. As energy is a CES-aggregate of the two inputs Electricity and Fuel we may write the dual price index PU^C as

$$(3.23)\quad PU^C_t = \left[\delta_E P^{C\,1-\sigma}_{Et} + \delta_F P^{C\,1-\sigma}_{Ft}\right]^{1/(1-\sigma)}, \qquad \delta_F = 1 - \delta_E,$$

where δ_E and σ are estimated coefficients. Assuming that consumers minimize the cost of buying Electricity (C_E) and Fuel (C_F) we arrive at the following equation from which δ_E and σ have been estimated

$$(3.24)\quad C_{Et}/C_{Ft} = \delta_E/(1-\delta_E)\left[P^C_{Et}/P^C_{Ft}\right]^{-\sigma}.$$

We have estimated (3.24) using OLS and experimented with different lag-specifications using national accounts data for 1962-1984. The result for σ centered around 2 with substantial lag-effects in relative prices. We have chosen, however, to implement the model without lags mainly to make the model simple. But there are also reasons to believe that consumers will adapt more quickly to changes in relative energy prices in the future than what we have observed as responses to changes due to OPEC one and two.

The demand equations for Electricity and Fuel may now be written as (see Frenger (1985))

$$(3.25)\quad C_{it} = \alpha_i + \beta_u\left[P^C_t C_t - \Sigma_k \alpha_k P^C_{kt}\right]/P^C_{it}\left[\delta_i PU^C_t/P^C_{it}\right], \qquad i=E,F.$$

Note that in (3.22), which determine consumer demand for non-energy goods, one of the P^C_{kt} is PU^C_t as given by (3.23). With this model specification Electricity and Fuel are alternative in demand while energy in total is complementary to other goods as is generally the case in the LES.

4 MULTIPLIERS ESTIMATED BY MODAG A

We have carried out some simple model calculations to illustrate the main features of the model. Hopefully the results can also be used to shed some light on the working of the Norwegian economy. However, as clearly indicated in the discussion above, MODAG A is not a complete model of the Norwegian economy. Several important groups of variables which are obviously endogenously determined in the economy are treated as exogenous in the model. This applies both to variables that should interact simultaneously with other specified variables of the model, e.g. wage rates and financial variables, and to variables that are determined by economic and other processes not included in the present model, e.g. production, investment and exports of industries based on natural resources. This means that the model will, at least for some types of sensitivity analysis yield unrealistic, counterintuitive or even adverse results.

The usefullness of MODAG A can only be reviewed when the model is regarded in its proper setting, i.e. as a tool in a planning or a policy analysing process. The empirical characteristics of MODAG A presented below will therefore first and foremost illustrate the functioning of the model as such and only with certain qualifications the working of the Norwegian economy. It is not the purpose of this paper to give a comprehensive presentation of the working of the Norwegian economy.

For the calculations below our point of departure has been a reference scenario for the Norwegian economy calculated with the use of MODAG A. Along this reference scenario we have calculated multipliers which represent the impact of sustained changes in exogenous variables on important model determined (endogenous) variables. Both the effect on the endogenous variables and the change in the exogenous variables are measured as deviations from the reference scenario. Because of lagged adjustments to changes in exogenous variables, deviations (in relation to the reference scenario) are calculated up to ten years after the change has taken place. After five years most impacts are minor, however, and the major effects have already become visible.

In the presentation below some main effects of sustained increases in a selection of important exogenous variables are presented. Appendix C contains a more comprehensive set of impact-tables.

WAGE RATES

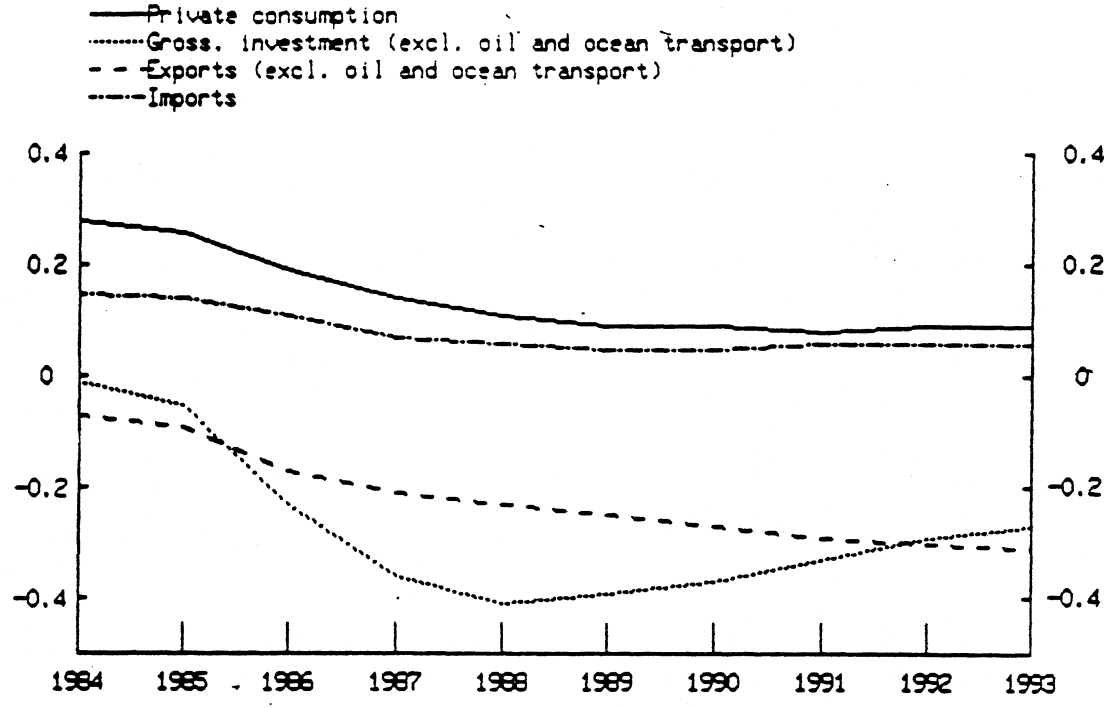
Figures 2 and 3 show some main effects of a sustained increase of one per cent in wage rates from 1984 (cf. Appendix C, table C1). This implies a change in the distribution of income between households, general government and private enterprises. Higher wages increase the nominal income of households while operating surplus (profits) in private enterprises is reduced. The increase in consumer demand is the most important quantitative short-run effect of increased wages. The increase in tax revenues is larger than the increase in government wage costs. A wage increase thus increases the government budget surplus. This is due to the fact that except for taxes related to crude oil and natural gas production most taxes in Norway are related to wages either directly as tax on income or tax on wage costs in the business sector or indirectly as taxes on consumption.

Another effect of higher wage rates comes via changes in relative prices of commodities, i.e. changes in price-competitiveness, as domestic and export prices increase in relation to world market prices. Thus the volume of endogenous exports decreases, but the effect is small in the short run. The reason why endogenous exports are not reduced more is the relatively small effect of wage increases on costs in many export oriented industries and a price elasticity only somewhat above one in the long run as mentioned in section 3.1. In addition, exports from resource based industries and ocean transport are exogenously given in the model. The increase in imports in the short run is due both to higher import shares and higher domestic demand. In the long run the loss in price-competitiveness becomes more important and imports increase even though total demand is reduced.

Higher wage rates also changes the relative (primary) factor price of labour and capital and demand for capital increases as capital is substituted for labour. However, from figure 3 we can see that, in spite of increased capital intensity, the effect on employment is smaller than on production in the longer run. This is partly explained by the shift from exposed (and labour extensive) industries to sheltered (and labour intensive) industries, in addition to the effects from increasing returns to scale. The total effect of higher wage rates on investment demand is negative due to the reduction in total demand (in the long run) and in operating surplus (profits).

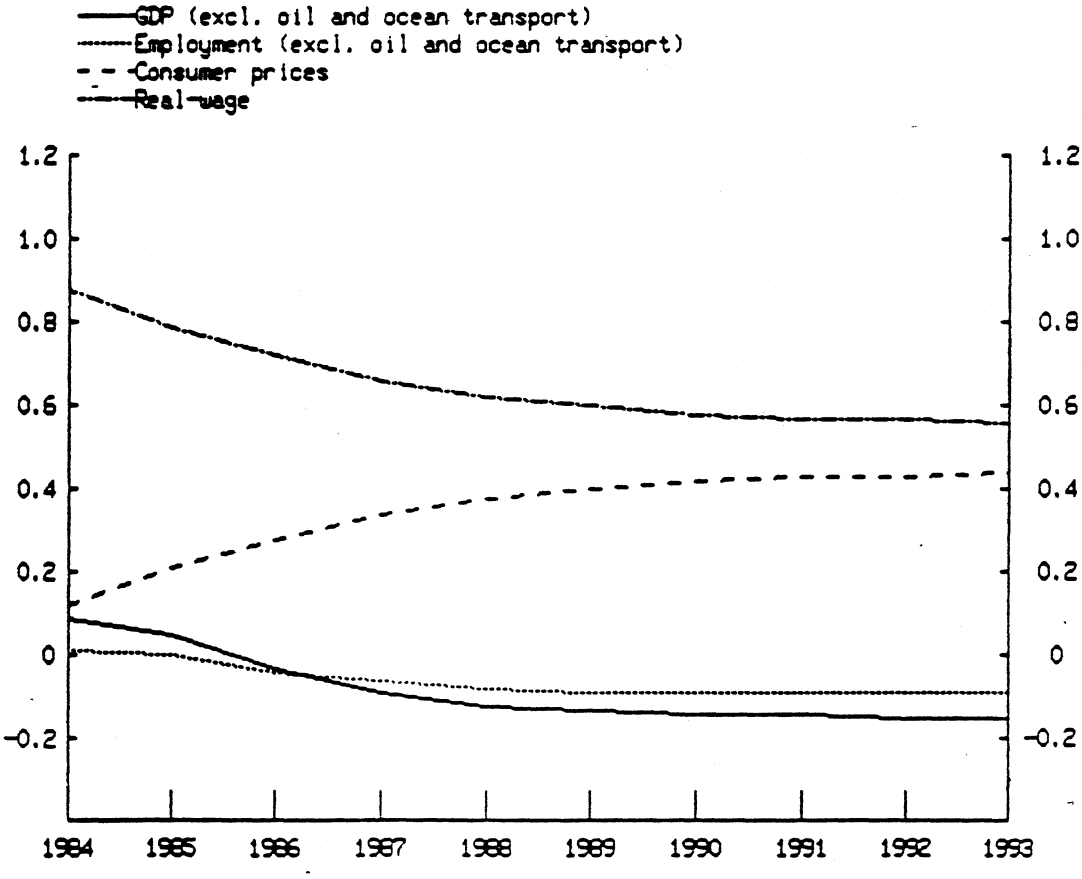
Figur 2.

Effects on main components of GDP in percent
of an increase in wage-rates by one percent.



Figur 3.

Effects on GDP, employment and consumerprices in percent
of an increase in wage-rates by one percent.



The effect of one per cent higher wage rates on consumer prices is low in the short run, approximately 0.1 per cent, but increases over a long period to somewhat above 0.4. The estimated inertia in price behaviour is mainly due to partly government regulated industries like transport and housing where the lags between cost and price increases, are rather long. This delayed effect on consumer prices is the main reason why production increases in the short run and decreases in the long run. Export prices (excl. oil and gas prices) increase in the long run by about 0.3 which is lower than the effect on consumer prices.

In the long run the employment real wage elasticity (excl. oil, ocean transport and Governemt) is slightly below - 0.2.

WORLD MARKET PRICES

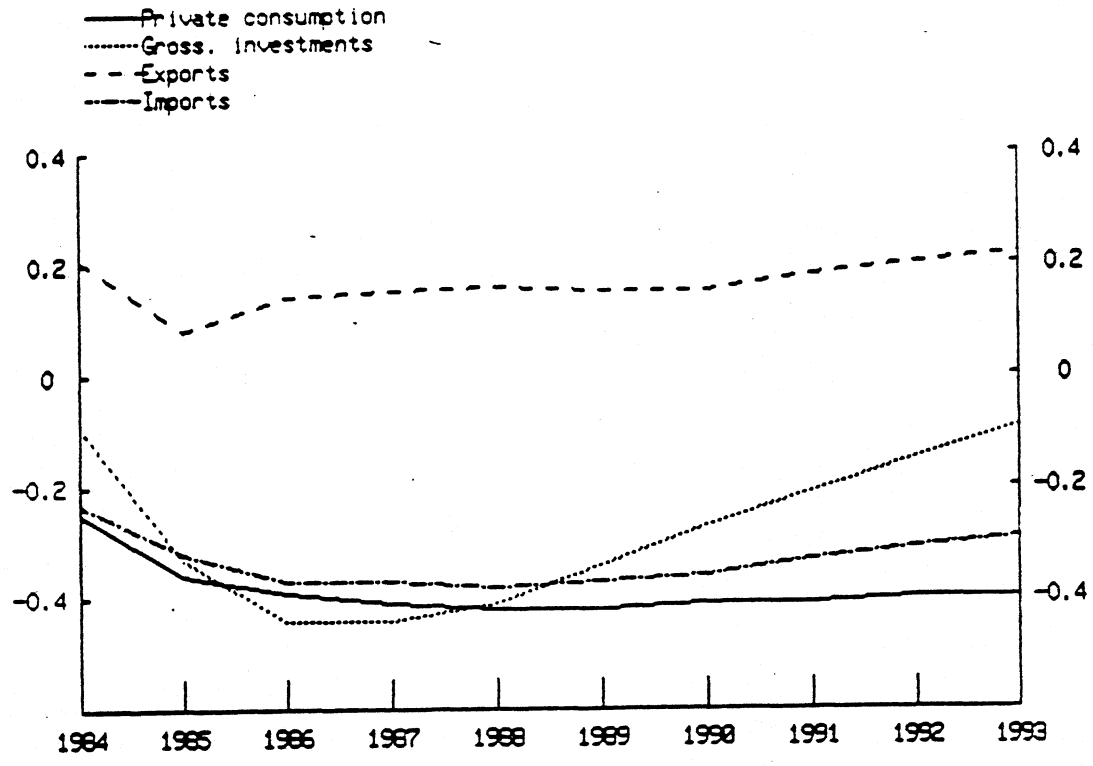
Figures 4 and 5 show the effects of a sustained increase in the level of world market prices of one per cent from 1984 compared to the reference path (cf. Appendix C, table C3). By world market prices we mean all prices on imports and on competitive goods on the world market in addition to some domestic and export prices which are believed to follow world market prices rather closely (oil and gas prices, prices on ocean transport services, forestry products and fish). The importance of world market prices for the Norwegian economy is clearly revealed in figure 5. Consumer prices increase by 0.3 per cent the first year and almost 0.5 in the long run. Prices on investments and exports (excl. oil and gas prices) increase in the long run by as much as 0.6 and 0.8 per cent, respectively.

World market prices are very important for variable unit costs in manufacturing. Actually, the effect on variable unit costs in manufacturing of an increase in world market prices is slightly higher than the effect of increased wage rates (both between 0.40 and 0.45). This illustrates the specific type of openness that is characteristic for the Norwegian economy and explaines to a large extent why changes in wage rates have a perhaps surprisingly small effect on exports and import shares as long as important quantitative elements of supply side behaviour are disregarded as is the case in MODAG.

The increase in consumer and investment prices leads to lower consumer demand, production and investment. However, after the initial reduction in investment the deviation from the reference scenario is

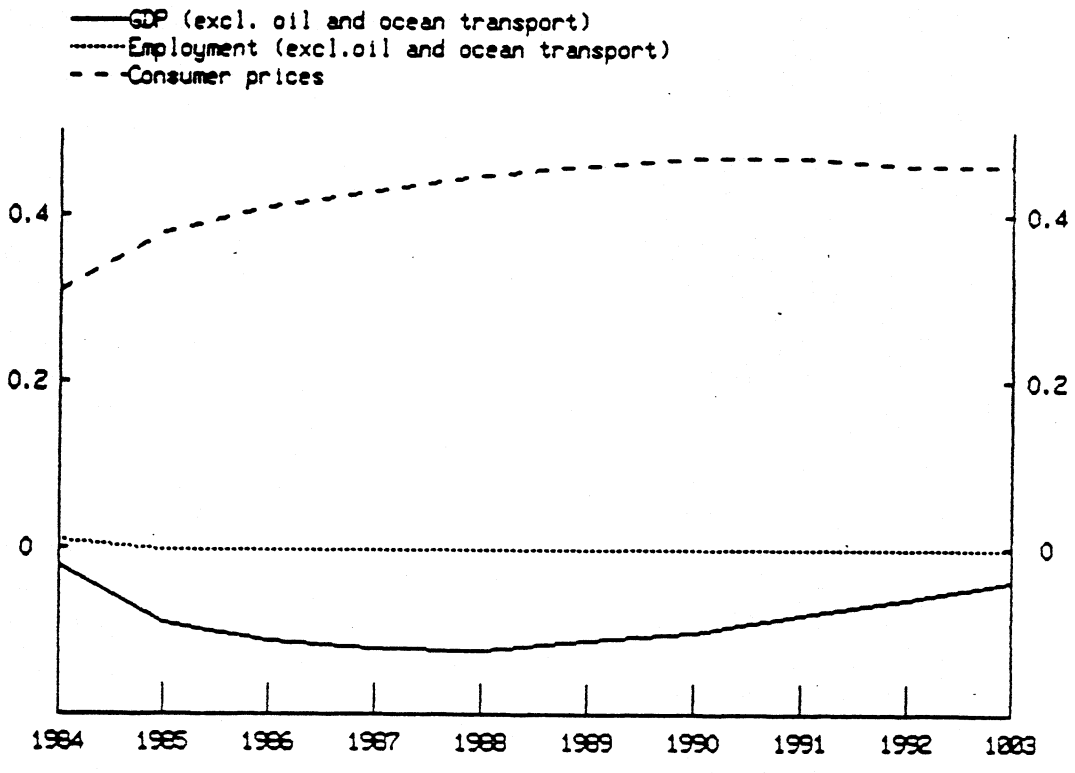
Figur 4.

Effects on main components of GDP in percent
of an increase in world market prices by one percent.



Figur 5.

Effects on GDP and consumer prices in percent
of an increase in world market prices by one percent.



reduced as investment picks up in the most export oriented manufacturing industries where production and operating surplus increase considerably. The rather small change in relative prices between domestic and foreign products implies that exports and import shares do not change very much.

The reason why the impact on the volume of exports decline from 1984 to 1985 is that the increase in the export volume in 1984 increases capacity utilization in many important export-oriented industries which raises their export prices the next year. When investments in these industries pick up, capacity is increased and export prices lowered and exports increase again.

GOVERNMENT EXPENDITURES ON GOODS FOR CONSUMPTION PURPOSES

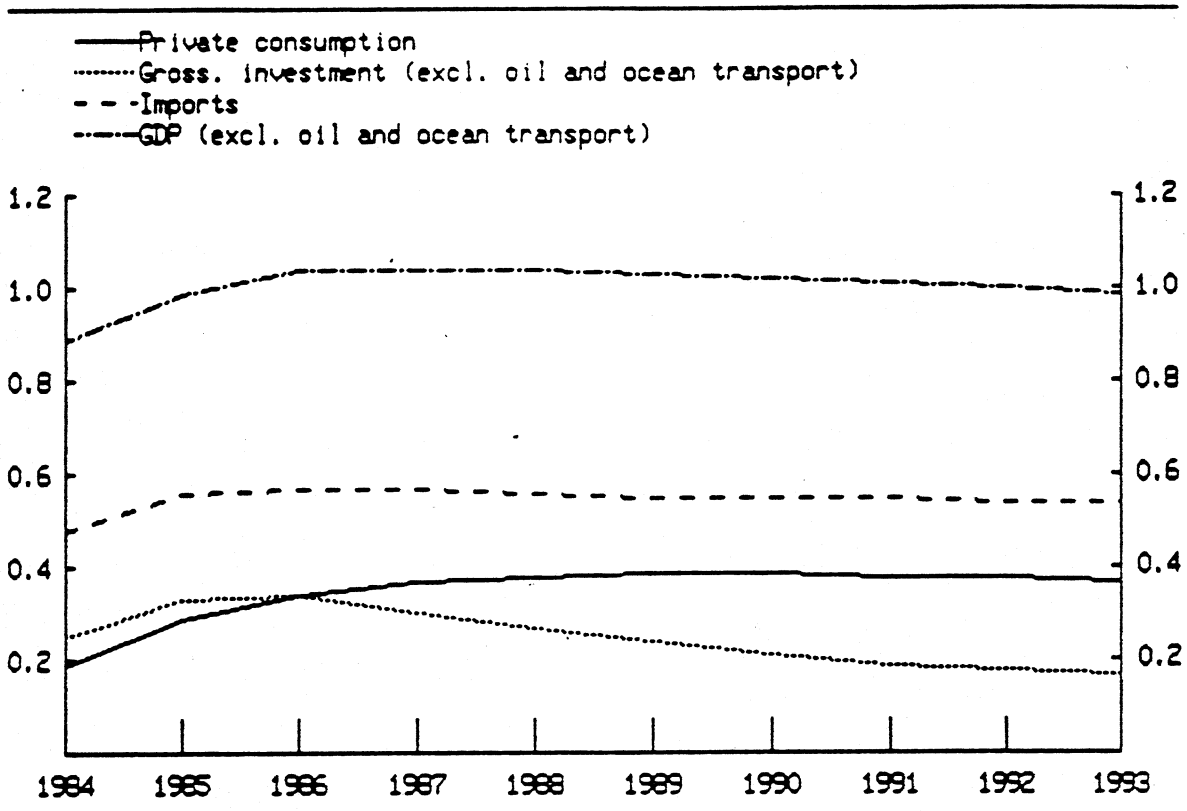
Figure 6 shows the effects on main components of GDP of a sustained increase in government expenditures on goods for consumption purposes by one billion NOK (cf. Appendix C, table C5). (In 1984 total GDP was approximately 450 billion NOK.) Thus the first year multiplier is 0.9 and the second year multiplier is 1.0 which is also very close to the multipliers of the following years. Price effects are negligible in all years, but due to procyclical behaviour of productivity and increasing returns to scale, prices fall slightly.

The lagged response of increased government expenditure is partly due to lags in the macro consumption function and in the investment equations. The lags in the employment equations are also important. Gross investments reach a peak after three years while private consumption continues to increase much longer. Thus the GDP multiplier is almost constant and falls only after six to seven years. The movements in imports mirror changes in gross investment goods rather closely as import shares for investment goods are relatively high.

In the version of the model presented in this paper there is, almost by definition, no long run "crowding out" effects in the private sector neither through changes in wage rates, exchange rates nor financial variables since these variables are exogenous. Initially there is a small crowding out effect on exports due to increased capacity utilization and loss of price competitiveness on export markets. In the long run, as investment increases capacity, this effect on export prices vanishes.

Figur 6.

Effects on main components of GDP of an increase in gouverment purchases of goods by 1 billion NOK in fixed 1984-prices
Changes in billion NOK.



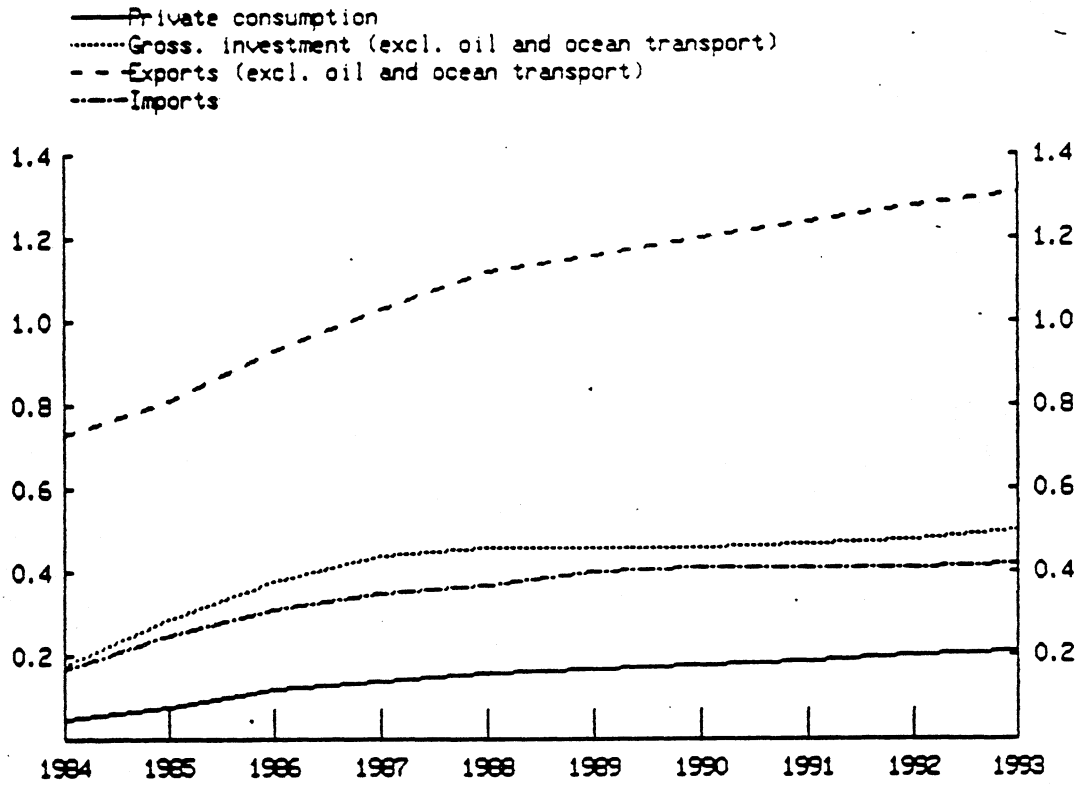
WORLD MARKET DEMAND

In MODAG A world market demand is proxied by a weighted sum of consumption and investment in the eight most important trading countries for Norway. In the simulations presented here these market indicators are increased by one per cent every year from 1984 and onwards. As only 35 per cent of total exports are endogenous in MODAG A, the change in demand has only moderate effects on production in Norway. The effects on some macroeconomic variables are shown in figures 7 and 8 (cf. Appendix C, table C11).

The short run effect on exports (traditional goods) is 0.7 per cent due to lags in the export equations. Export prices (excl. oil and gas prices) increase quite substantially during the first years because of increased capacity utilization in export oriented industries. As profits

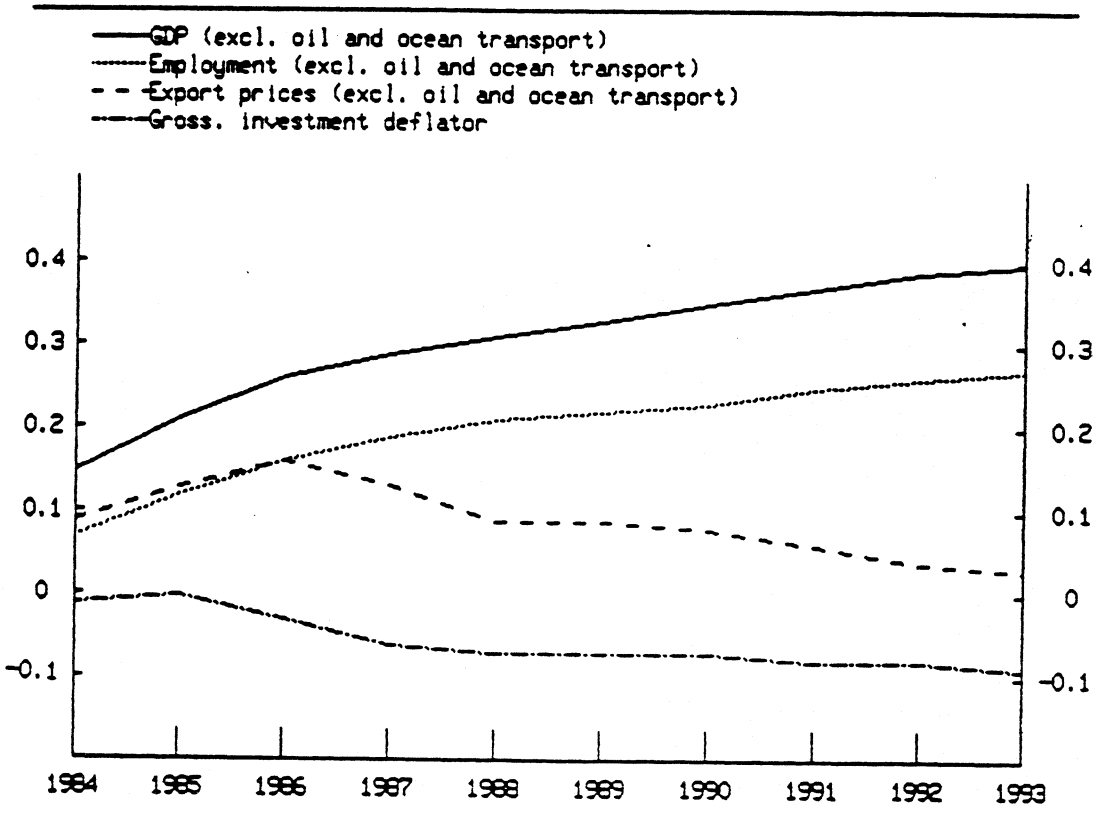
Figur 7.

Effects on main components of GDP in percent
of increased world market demand by one percent.



Figur 8.

Effects on GDP, employment and prices in percent
of increased world market demand by one percent.



and production increase and investment follow suite, capacity is increased and export prices return to the reference path. This improves price-competitiveness and exports continue to increase.

Prices on investment goods decline when investment increases as there are almost no capacity effects on these prices and the procyclical effects on productivity and increasing returns to scale reduce unit costs. This also explains some of the increase in investments which continues although in a moderate pace even after ten years. A long run stable solution is not visible after ten years, but judging from figures 7 and 8 a stable solution will be reached later.

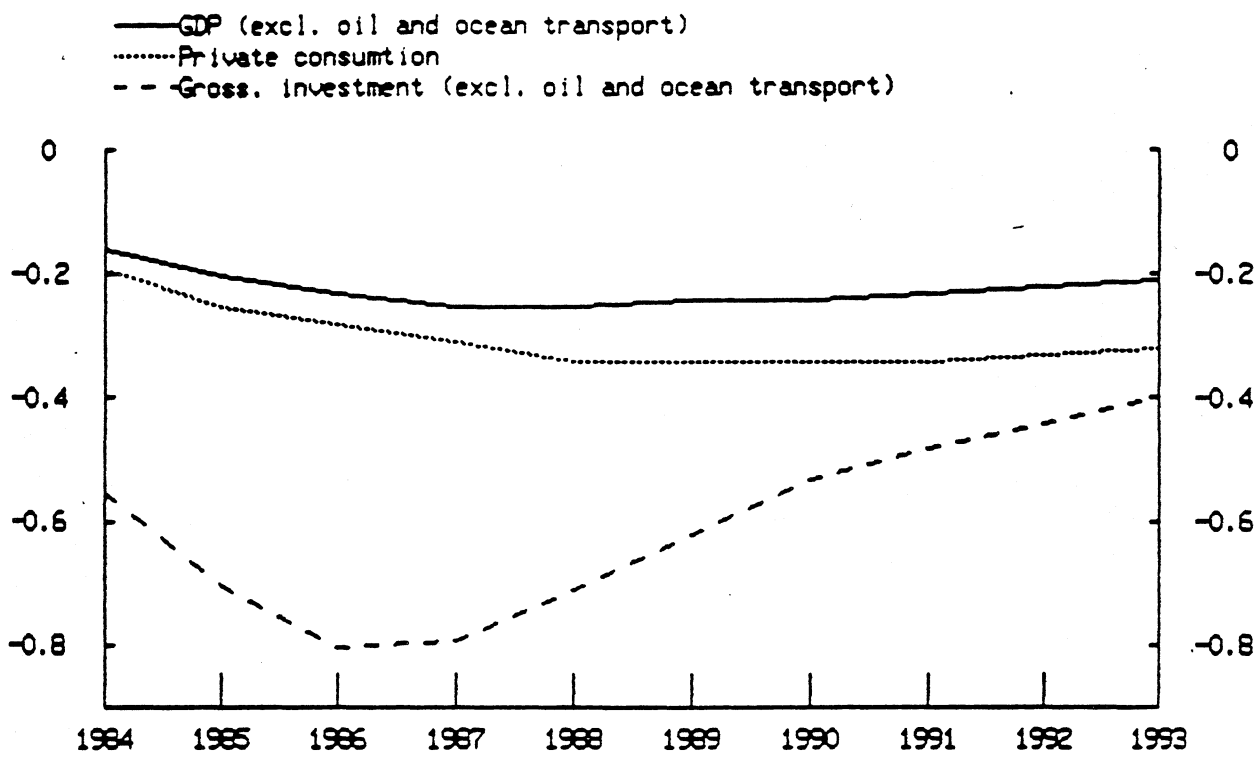
INTEREST RATE

Interest rates are exogenous in MODAG A. The main interest rate indicator in the model is the average rate on loans from commercial banks. This rate enters the user cost term in the investment equations. Net financial income for households is also exogenous and in the simulations this income is changed by the same factor as the interest rate, implying a constant interest rate margin in the financial sector. Figure 9 shows the effects on GDP, private consumption and investment of an increase these interest variables by 10 per cent, equivalent to an increase in the rate of interest by one percentage point, from 1984 and onwards (cf. Appendix C, table C13). As is seen from figure 9 there is a rather substantial negative effect on gross investment (excl. oil, ocean transport and Government). The largest effect is on gross investment in housing which in the long run is reduced by one per cent.

The effect on consumption is mainly due to higher interest payments, but in the longer run lower investments reduce the capital stock and increase unit costs compared to the reference scenario. Thus prices will increase somewhat. In addition, the rate of interest affects consumer prices directly via the price on housing services. The long run effect on consumer prices is 0.25 and this price increase further reduces consumer demand. Employment is not much affected by higher interest rates. This is of course a result of the lower capital stock due to the higher user cost of capital when interest rates are increased.

Figur 9.

Effects of an increase in rate of interest on GDP, consumption and investment by one percent.



SOME MAIN CONCLUSIONS

In reviewing the empirical characteristics of the working of the Norwegian economy especially the openess of the economy, the importance of resource based industries and the excistence of many partly or totally government regulated industries must be taken into account. In using MODAG A as a tool in such an analysis the absence of modelling of the financial markets, wage formation and supply behaviour for the resource based industries makes the model analysis only partial. Having these very important qualifications in mind when interpreting the results, some of the main empirical characteristics of MODAG A are the following:

i) Domestic cost increases (mainly increases in wage rates) have a strong impact on the development of consumer and investment

prices and a much smaller impact on export prices. The net effect on the activity level (GDP and employment) are negative but rather small. The net effect on exports and imports is significantly negative (exports decrease and imports increase).

ii) Increases in world market prices are decisive for the development of export and investment prices but the consumer prices are also strongly influenced. The net effect on the activity level (GDP and employment) are negative but rather small. The net effect on exports and imports is significant (imports decrease and exports increase).

iii) Increases in government expenditures (on goods) have an expansionary effect on the economy while the effects on prices are negligible.

iv) Increases in world market demand have a strong impact on the domestic activity level (GDP and employment) while the effects on prices are small.

APPENDIX A

A SURVEY OF IMPORTANT PRICE AND QUANTITY ELASTICITIES IN THE SUBMODELS OF MODAG A

Table A1. Determinants of exports

Commodity	Shares of exports in 1984 (per cent)	Elasticities w.r.t.			
		Relative prices		Market growth	
		1 year	Long run	1 year	Long run
Agricultural products	0.3		X		
Forestry products	0.1		X		
Fish	0.5		X		
Mining products	0.7		X		
Food products	3.9	-0.26	-0.39	0.59	0.89
Beverages and tobacco	0.1	-0.67	-0.92	1.68	2.29
Textiles and wearing apparels	0.5	-0.50	-1.50	0.35	1.08
Wood and wood products	0.6	-0.50	-1.02	1.07	2.16
Paper and paper products	2.9	-1.37	-1.86	1.04	1.41
Industrial chemicals	3.0	-0.68	-1.00	1.31	1.93
Refined petroleum products	2.4		X		
Other chemical and mineral products	2.4	-0.47	-0.93	1.48	2.92
Iron, steel and metals	9.2	-1,77	-1.77	1.42	1.42
Machinery and metal products	5.3	-0.15	-1.90	0.48	2.06
New ships and oil platforms	0.9		X		
Printing and publishing	0.1	-1.18	-1.51	1.67	2.15
Electricity	0.3		R		
Wholesale and retail trade	3.0	-0.38	-0.67	X 1.03	1.81
Crude oil and natural gas	36.4		X		
Oil drilling	1.1		X		
Pipeline services	1.3		X		
Ocean transport	16.1		X		
Domestic transport	2.2	-0.22	-0.37	1.34	2.23
Government services	0.2		X		
Re-export of non-competing imports.	0.4		X		
Second-hand ships and platforms	2.5		X		
Tourism	2.5	-0.31	-0.31	1.77	1.77
Other services	0.9		X		
Correction for oil fields	0.9		X		

X means that the export of this commodity is exogenously determined.
R means that the export is endogenously determined by the commodity balance equation.

Table A2. Determinants of imports and import shares[1)]

Commodity	Shares of imports in 1984 (per cent)	Relative price elasticities	
		1 year	Long run
Agricultural products	0.8	R	
Forestry products	0.2	R	
Fish	0.0	MX	
Mining products	0.7	0	0.76
Food products	1.8	-0.60	-1.19
Beverages and tobacco	0.3	MX	
Textiles and wearing apparels	5.5	-0.33	0.33
Wood and wood products	2.2	-0.68	-0.68
Paper and paper products	1.6	-0.76	-0.76
Industrial chemicals	3.2	-0.49	-0.99
Refined petroleum products	2.7	R	
Other chemical and mineral products	10.2	-0.45	0.90
Iron, steel and other metals	5.0	-0.19	-0.37
Machinery and metal products	21.7	-0.39	-0.77
Ships and oil platforms	6.7	X	
Printing and publishing	0.7	-0.28	0.57
Electricity	0.0	X	
Wholesale and retail trade	0.6	MX	
Crude oil and natural gas	2.0	R	
Oil drilling	0.4	MX	
Other services	1.6	MX	
Non-competing imports	24.5		
- Food	1.8	R	
- Raw materials	0.5	R	
- Manufacturing products	4.0	R	
- Gross expenditure for shipping	13.0	R	
- Gross expenditure in oil drilling etc	2.3	R	
- Other	2.9	R	
Tourism abroad	7.0	R	

X means that the import of this commodity is exogenous
MX means that the import share is exogenous
R means that the import is determined from the commodity balance equation
1) All market growth (income) elasticities are unity as long as the composition of demand is unchanged.

Table A3. Determinants of domestic prices

Commodity	Elasticities w.r.t						
	Unit costs		World market price		Capacity utilization [1]		Price controls [2]
	1 year	Long run	1 year	Long run	1 year	Long run	1 year
Agricultural products			X				
Forestry products ...	0.281	0.310	0.627	0.690	0.004	0.005	0
Fish products	0.283	0.433	0.370	0.567	0	0	0
Mining products.....	0.248	1.000	0	0	0	0	0
Food products	0.530	1.000	0	0			-0.015
Beverages and tobacco	0.703	1.000	0	0	0	0	0
Textiles and wearing apparels	0.395	0.764	0.122	0.236	0.003	0.006	-0.023
Wood and wood products	0.287	0.664	0.135	0.336	-0.001	-0.003 [3]	0
Paper and paper products	0.313	1.000	0	0	0.015	0.047	0
Industrial chemicals.	0.329	1.000	0	0	0	0	0
Petrol	0.258	0.386	0.410	0.612	0	0	0
Other fuels	0.209	0.225	0.721	0.775	0	0	0
Other chemical and mineral products	0.739	0.922	0.063	0.078	0.005	0.007	0
Iron, steel and other metals	0.106	0.228	0.357	0.772	0	0	0
Machinery and metal products	0.941	1.000	0	0	0	0	-0.076
Ships and oil platforms	0.703	1.000	0	0	0	0	0
Printing and publishing	0.431	0.901	0.047	0.099	0	0	-0.029
Electricity			X				
Construction	0.722	1.000	0	0	0	0	0
Wholesale and retail trade	0.449	1.000	0	0	0	0	-0.065
Crude oil and natural gas			X				
Oil drilling			X				
Ocean transport.....			X				
Domestic transport ..	0.311	1.000	0	0	0	0	-0.047
Banking and insurance	0.971	1.000	0	0	0	0	0
Housing services	0.305	1.000	0	0	0	0	-0.024
Other services	0.262	1.000	0	0	0	0	-0.030
Government fees.....	0.700	1.000	0	0	0	0	0
Non-competing imports			X				

X means that the domestic price of this commodity is exogenous.

1) Due to the U-shape of the cost-curves in some industries this effect is calculated when capacity utilization increases from 0.95 to 0.96.

2) In the long run the direct effect of price control is assumed to be zero, i.e. it is assumed that the control is lifted as has been the case with all controls historically.

3) Variable costs reach a minimum when capacity utilization is 96 per cent.

Table A4. Determinants of export prices

Commodity	Elasticities w.r.t.					
	Unit costs		World market price		Capacity utilization [1]	
	1 year	Long run	1 year	Long run	1 year	Long run
Agricultural products		X				
Forestry products	0	0	0.360	1.000	0	0
Fish	0	0	0.365	1.000	0	0
Mining products	0.117	0.580	0.077	0.420	0.005	0.025
Food products	0.401	0.401	0.599	0.599	0.013	0.013
Beverages and tobacco	0.609	1.000	0	0	0	0
Textiles and wearing apparels	0.034	0.064	0.498	0.936	0.004	0.007
Wood and wood products	0.541	0.671	0.265	0.329	0.004	0.005
Paper and paper products	0.340	0.897	0.039	0.103	0.028	0.074
Industrial chemical	0.399	1.000	0	0	0	0
Petrol	0.515	0.684	0.238	0.316	0	0
Other fuels	0.848	1.000	0	0	0	0
Other chemicals and mineral products	0.394	0.485	0.419	0.515	0	0
Iron, steel and other metals.	0.717	0.780	0.202	0.220	0.006	0.006
Machinery & metal products...	0.242	0.400	0.364	0.600	0.003	0.005
Ships and oil platforms	0	0	0.488	1.000	0	0
Printing and publishing	0.640	0.414	0.906	0.586	0	0
Electricity		X				
Wholesale and retail trade ..	0.517	1.000	0	0	0.003	0.006
Crude oil and natural gas ...		X				
Oil drilling		X				
Ocean transport		X				
Domestic transport	0.185	1.000	0	0		
Banking and insurance	0.662	1.000	0	0	0	0
Housing services						
Other services	0.225	1.000	0	0	0.004	0.019
Government fees	1.000	1.000	0	0	0	0
Non-competing imports		X				
Second-hand ships and platforms		X				
Other exports related to oil activities		X				
Tourism		E				

X means that the export price of this commodity is exogenous.

E means that the export price of Tourism is determined as a weighted average of domestic consumer prices.

1) Due to the U-shape of the cost-curves in some industries this effect is calculated when capacity utilization increases from 0.95 to 0.96.

Table A5. Determinants of employment (wage earners)

Sector	Share of total employment 1984 (per cent)	Elasticities w.r.t.					
		Production		Capital stock		Time	
		1 year	Long run	1 year	Long run	1 year	Long run
Agriculture	5.5		X				
Forestry	0.5		X				
Fishing	0.3		X				
Mining	0.4	0.370	0.740	0	0	-0.023	-0.056
Food, beverages and tobacco	3.2	0.363	0.462	-0.267	-0.340	0	0
Textiles and wearing apparels.....	0.9	0.429	0.549	-0.208	-0.266	-0.016	-0.020
Wood and wood products	1.8	0.263	1.000	-0.174	-0.398	-0.006	-0.014
Paper and paper products	0.8	0.195	0.353	-0.115	-0.208	-0.015	-0.027
Industrial chemicals.	0.5	0.195	0.353	-0.115	-0.208	-0.015	-0.027
Refined petroleum products	0.1		X				
Other chemical and mineral products	1.8	0.690	0.980	-0.504	-0.716	0	0
Iron, steel and other metals	1.4	0.422	1.000	-0.275	-0.652	-0.006	-0.014
Machinery and metal products	4.4	0.626	1.000	-0.328	-0.524	-0.003	-0.005
Ships and oil platforms	2.2	0.431	0.907	0	0	0	0
Printing and publishing	2.1	0.291	0.600	0	0	0	0
Electricity	1.0		X				
Construction	7.7	0.295	0.612	-0.087	-0.180	0	0
Wholesale and retail trade	13.4	0.570	0.850	-0.150	-0.230	0	0
Production of oil and gas	0.6		X				
Oil drilling	0.2		X				
Ocean transport	1.5		X				
Domestic transport ..	8.3	0.064	1.391	0	0	0	0
Banking and insurance	2.5	0.671	0.913	0	0	0	0
Housing services	0.2	0.070	0.583	0	0	0	0
Other private services	13.8	0.319	0.822	0	0	0	0
Government	23.7		X				

X means that employment in this industry is exogenous.

Table A6. Determinants of gross investment

Sector	Share of total investment in 1982 (per cent)	The derivative w.r.t								
		Rel. factor prices		Production		Gross profits		Credit supply	Time	Lagged capital stock
		1 year	Long run	1 year	Long run	2 year	Long run			
Agriculture	3.4	0	0	0	0	0.867	1.002	0	0	-0.076
Forestry	0.4	0	0	0.071	0.071	0.022	0.091	0	0	-0.004
Fishing	0.9	0	0	0.021	0.021	0.178	0.178	1.756	0	-0.205
Mining	0.3	-41	-41	0.238	0.238	0.508	0.508	0	0	-0.058
Food, beverages and tobacco	1.8	-137	-137	0.043	0.067	0	0	0	0	0
Textiles and wearing apparels	0.2	0	0	0.022	0.022	0	0	0.009	0	0
Wood and wood products	0.6	0	0	0.055	0.115	0.155	0.155	0	0	-0.105
Paper and paper products	0.4	0	0	0	0	0.118	0.590	0	0	-0.008
Industrial chemicals	0.5	0	0	0	0	0.121	2.298	0	0	-0.120
Refined petroleum products	0.1					X				
Other chem. and mineral products	0.9	0	0	0	0.067	0	0	0	0	-0.030
Iron, steel and other metals	1.1	0	0	0	0	0.190	0.375	0	0	-0.035
Machinery and metal products	1.6	-63	-317	0.086	0.086	0	0	0	0	-0.043
Ships and oil platforms	0.6	-134	-134	0.004	0.004	0	0	0	0	-0.003
Printing and publishing	0.6	-53	-130	0.167	0.167	0.217	0.217	0	0	-0.128
Electricity	7.0					X				
Construction	1.8	-79	-392	0.053	0.053	0	0	0.038	0	-0.138
Wholesale and retail trade	3.7	-919	-2 340	0.063	0.190	0.047	0.117	0	-192	-0.470
Production of oil and gas	25.4					X				
Oil and gas drilling	0.8					X				
Pipeline transport	3.6					X				
Ocean transport	2.9					X				
Domestic transport	7.4	-31	-77	0.486	0.486	0	0	0.07	-271	-0.242
Banking and insurance	3.4	0	0	0	0.235	0.133	0.679	0	0	-0.493
Housing services	14.4					E				
Other private services	4.5	-236	-1 180	0.101	0.101	0	0	0.053	0	0
Government	11.7									

X means that gross investment in this industry is exogenous.
E means that there is a special investment model/equation for Housing services.

Table A7. Determinants of relative energy input (Electricity and Fuels).

Sector	Relative price elasticities	
	1 year	Long run
Agriculture	-0.550	-1.113
Forestry	0	0
Fishing	0	0
Mining	-0.168	-1.135
Food, beverages and tobacco	-0.399	-1.239
Textiles and wearing apparels	-0.761	-0.899
Wood and wood products	-0.650	-1.072
Paper and paper products	-0.491	-0.491
Industrial chemicals	-0.062	-1.372
Refined petroleum products	0	0
Other chemical and mineral products	-0.222	-0.716
Iron, steel and other metals	-0.006	-0.014
Machinery and metal products	-0.634	-1.062
Ships and oil platforms	-0.049	-0.230
Printing and publishing	-0.686	-1.472
Electricity	0	0
Construction	-1.261	-2.759
Wholesale and retail trade	0	0
Production of oil and gas	0	0
Oil drilling	0	0
Ocean transport	0	0
Domestic transport	-0.522	-1.075
Banking and insurance	0	0
Housing services	0	0
Other private services	-0.403	-1.092
Government		
- Defence	-0.835	-0.999
- Public administration	-0.585	-0.887
- Education	-0.506	-1.317
- Health services	-0.509	-0.705

Table A8. Determinants of consumption demand by category

Consumption category	Budget share 1984 (per cent)	Direct price elasticity	Expenditure elasticity
Food	20.2	-0.30	0.45
Beverages and tobacco	6.3	-0.40	0.75
Clothing and footwear	7.4	-0.54	1.00
Electricity	5.2	-0.63	1.09
Fuel	1.1	-0.24	1.09
Petrol and car maintenance	5.1	-0.81	1.60
Furnitures etc.	4.5	-0.64	1.25
Purchases of cars	5.5	-0.73	1.42
Other consumer durables	1.7	-0.73	1.45
Household equipment	1.8	-0.51	1.00
Goods for recreation and entertainment	4.2	-0.71	1.40
Other goods	3.1	-0.47	0.90
Rents (Housing services)	11.1	-0.60	1.09
Public transport services	4.7	-0.60	1.16
Public entertainment	2.2	-0.38	0.75
Various household services	1.4	-0.26	0.50
Other services	6.9	-0.72	1.40
Tourism abroad	6.3	-0.82	1.60
Medical care and health services	4.3	X	

X means that consumption of Medical care and Health services are exogenous as they are mainly financed by the government.

A P P E N D I X B

A SIMPLIFIED EQUATION SYSTEM AND A SUMMARY OF MAIN DIMENSIONS OF MODAG A

B.1. A SIMPLIFIED EQUATION SYSTEM

Below we have attempted to indicate the main structure of MODAG A by a set of equations which gives a very simplified representation of the model. The main simplifications consist in suppressions of

(i) the input-output structure, both for prices and quantities,
(ii) the disaggregation by commodity, industry, final demand categories, kind of taxes and by socioeconomic groups,
(iii) the differentiation between domestic and export prices, and between import prices and competitive prices on the export markets,
(iv) the explicit functional forms, and
(v) the dynamic structure (expectation formation, adjustments to desired or optimal levels etc.)

In addition, the division between exogenous (marked by an asterisk) and the endogenous variables in the equation system below is more clear-cut than in the actual model. Some of the detailed model variables included in the aggregated exogenous or endogenous variables of the simplified equation system may belong to the other category. This is of special importance for regulated and negotiated prices and resource based production (and exports) which are all exogenous in the actual model.

PRICES

(1) $P = f_p(UVC, PK^*, CAP)(1+ti^*)$,

(2) $UVC = w^* N/X$.

(1) is the price equation, stating that the price of Norwegian production is a function of variable unit costs (UVC), the competitive world market price (PK) and the capacity utilization index (CAP). ti is the net indirect tax rate. (2) defines variable unit costs, here reprecented by wage costs per man year (w) and labour input in man years (N), per unit of production (X).

FACTOR DEMAND (LABOUR AND CAPITAL)

(3) $N = f_N(X, CAP, t)$.

Labour demand (employment) is a function of production (X), capacity utilization (CAP) and technical change (t). Capacity utilization is defined by

(4) $CAP = f_{CAP}(X/K_{-1})$.

Thus implicitly (3) and (4) makes N a function of X and K_{-1}.

(5) $K = f_K(p^J/w^*, X, t)$.

Demand for capital (desired capital stock) is a function of production (X), technical change (t) and relative factor prices p^J/w, where p^J is the user cost of capital which depends on the rate of interest (r), prices (P), depreciation rates, tax rules etc. For simplicity we write

(6) $p^J = f_Q(r^*, P)$.

INVESTMENT DEMAND

By definition

(7) $J = K - K_{-1} + D$,

where D is depreciation given by

(8) $D = f_D(K)$,

and J is gross private investment.

PRIVATE CONSUMPTION

$$(9) \quad C = f_C((YH-TD)/P,\ KREDH^*/P),$$

$$(10) \quad YH = w^*N + YU^* + h\ YR,$$

$$(11) \quad YR = PX/(1+t_i^*) - w^*N,$$

$$(12) \quad TD = f_T(YH).$$

Private consumption (C) is a function of real disposable income ((YH-T)/P) and real credit supply to households (KREDH/P). Income for households is, according to (10), defined as wage income (w N) + transfers from the government and net interest income (YU) + profits going to households (h YR). Profits (operating surplus) (YR) is accoring to (11) defined as factor income (PX/(1+ti)) less wage income (w N). Direct personal taxes (TD) is a function of household income.

EXPORTS

$$(13) \quad A = f_A(P/PK^*,\ V^*).$$

In (13) export demand is written as a function of relative prices (P/PK) and a growth indicator for the world market (V).

IMPORTS

$$(14) \quad B = f_B(P/PK^*)\ \left[c\ C + g\ G^* + j\ J + a\ A)\right].$$

c, g, j, a are import coefficients relative to the average import coefficient (given by f_B as a function of relative prices). C (private consumption), G (government consumption and investment), J (private investment) and A (export) represent final demand categories.

DOMESTIC PRODUCTION

GDP (domestic production) X is defined by the commodity balance equation

(15) $X = C + G^{*} + J + A - B.$

The model above has 15 equations determining

(i) 15 endogenous variables: X, C, J, A, B, K, D, CAP, N, P, PJ, UVC, YR, YH, TD, given values of the

(ii) 8 exogenous variables: G, YU, ti, KREDH, r, w, PK and V.

B.2. *SUMMARY OF MAIN DIMENSIONS*

Table B1. gives a list of variables and equations in MODAG A, categorizing the variables as exogenous or endogenous and the equations as stochastic or non-stochastic. At any point in time a number of lagged or predetermined values of endogenous variables enter the model as "exogenous" variables. These are left out of table B1. MODAG A is mainly built for the Ministry of Finance for policy purposes and not for forecasting purposes by an independent agency. Of the exogenous variables, 155 are economic policy variables. To some extent some of the financial variables may also be caracterized as policy variables. A few exogenous variables in the group "Other" are also heavily policy influenced or represent "external forces" of the economy. Among the 218 "other" exogenous variables, 75 are zero almost by definition or by assumption.

Table B1. Number of variables and equations in MODAG A

Variables		
Exogenous		439
of which:		
Government expenditures	28	
Direct and indirect tax rates	127	
World market demand and prices	57	
Financial variables	9	
Other	218	
Endogenous		1225
Total		1664
Equations		
Stochastic		183
of which:		
- domestic and export prices	49	
- import shares and exports	26	
- consumer demand	19	
- investment and inventories	39	
- labour demand	24	
- energy demand	26	
Non-stochastic and identities		1042
Total		1225

Related to the MODAG A model described in this paper, there exists a separate recursive accounting model with nearly 1400 equations which is solved after the main model. The purpose of this model is mainly to transform the model results into the form of complete "national accounts" for the future years for which the model is solved.

A P P E N D I X C

IMPACT TABLES

On the following pages we present the results of some impact calculations on MODAG A.

Table C1. Effects of a one per cent increase in Wage Rates.

	1984	1985	1986	1987	1988	1990	1993
Changes in constant prices. Per cent							
Private consumption.	0.28	0.26	0.19	0.14	0.11	0.09	0.09
Gov. consumption ...	-0.01	-0.01	-0.00	0.00	0.00	0.01	0.01
Gross investment ...	-0.00	-0.03	-0.12	-0.20	-0.24	-0.22	-0.17
Excl. oil, ocean transp. and Gov...	-0.01	-0.05	-0.23	-0.36	-0.41	-0.37	-0.27
Manufacturing	0.07	-0.34	-0.77	-1.02	-1.01	-0.79	-0.63
Increase in stocks .	-	-	-	-	-	-	-
Exports	-0.03	-0.04	-0.08	-0.09	-0.10	-0.12	-0.13
Trad. goods	-0.09	-0.09	-0.19	-0.23	-0.26	-0.29	-0.34
Imports	0.15	0.14	0.11	0.07	0.06	0.05	0.06
Gross dom. product .	0.06	0.03	-0.02	-0.05	-0.07	-0.08	-0.09
Excl. oil, ocean transp. and Gov...	0.09	0.05	-0.03	-0.09	-0.12	-0.14	-0.15
Manufacturing	-0.05	-0.14	-0.27	-0.34	-0.38	-0.42	-0.46
Changes in price indices. Per cent							
Private consumption.	0.12	0.21	0.28	0.34	0.38	0.42	0.44
Gross investment ...	0.21	0.31	0.37	0.42	0.45	0.46	0.47
Exports	0.05	0.09	0.10	0.11	0.12	0.14	0.16
Excl. oil and gas.	0.08	0.14	0.16	0.19	0.21	0.25	0.29
Gross dom. product .	0.27	0.36	0.42	0.47	0.51	0.53	0.54
Changes in current prices. Million Nkr.							
Wage costs	2 168	2 336	2 454	2 583	2 742	3 158	3 969
Operating surplus ..	-1 012	-765	-790	-748	-702	-680	-755
Manufacturing	-268	-220	-240	-241	-248	-287	-341
Export surplus	-215	-178	-174	-115	-79	-68	-120
Government budget surplus	319	563	510	489	490	542	655
Changes in employment, wage earners. Per cent							
Total	0.01	-0.00	-0.03	-0.05	-0.06	-0.07	-0.07
Excl. oil, ocean transp. and Gov...	0.01	-0.00	-0.04	-0.06	-0.08	-0.09	-0.09
Manufacturing	-0.03	-0.09	-0.16	-0.20	-0.22	-0.22	-0.21

Table C2. Effects of a one per cent increase in Government Regulated Prices.

	1984	1985	1986	1987	1988	1990	1993
Changes in constant prices. Per cent							
Private consumption.	-0.06	-0.09	-0.11	-0.12	-0.13	-0.14	-0.16
Gov. consumption ...	0.00	0.00	0.00	0.00	0.01	0.01	0.01
Gross investment ...	0.09	0.10	0.05	0.02	0.00	0.03	0.02
Excl. oil, ocean transp. and Gov...	0.16	0.16	0.10	0.03	0.01	0.05	0.04
Manufacturing	-0.02	-0.28	-0.57	-0.74	-0.67	-0.30	-0.18
Increase in stocks .	-	-	-	-	-	-	-
Exports	-0.00	0.00	-0.01	-0.01	-0.02	-0.02	-0.03
Trad. goods	-0.00	0.01	-0.02	-0.04	-0.06	-0.04	-0.04
Imports	0.02	0.00	-0.02	-0.03	-0.04	-0.04	-0.04
Gross dom. product .	-0.01	-0.02	-0.03	-0.04	-0.05	-0.05	-0.06
Excl. oil, ocean transp. and Gov...	-0.01	-0.03	-0.05	-0.07	-0.08	-0.09	-0.10
Manufacturing ...	-0.01	-0.02	-0.04	-0.07	-0.08	-0.09	-0.11
Changes in price indices. Per cent							
Private consumption.	0.10	0.12	0.13	0.13	0.14	0.14	0.14
Gross investment ...	0.00	0.00	0.01	0.01	0.01	0.02	0.02
Exports	0.01	0.02	0.03	0.04	0.06	0.06	0.05
Excl. oil and gas.	0.01	0.03	0.05	0.07	0.09	0.10	0.10
Gross dom. product .	0.05	0.07	0.08	0.09	0.10	0.10	0.10
Changes in current prices. Million Nkr.							
Wage costs	-3	-10	-23	-39	-53	-69	-111
Operating surplus ..	138	174	191	229	273	334	368
Manufacturing	-109	-93	-72	-45	-20	-6	-28
Export surplus	-15	51	88	153	198	224	271
Government budget surplus	76	82	72	55	46	47	17
Changes in employment, wage earners. Per cent							
Total	-0.00	-0.00	-0.01	-0.01	-0.01	-0.02	-0.02
Excl. oil, ocean transp. and Gov...	-0.00	-0.00	-0.01	-0.02	-0.02	-0.03	-0.03
Manufacturing	0.00	0.00	0.00	0.00	0.00	0.01	0.00

Table C3. Effects of a one per cent increase in World Market Prices.

	1984	1985	1986	1987	1988	1990	1993
Changes in constant prices. Per cent							
Private consumption.	-0.25	-0.36	-0.39	-0.41	-0.42	-0.42	-0.40
Gov. consumption ...	0.00	0.00	0.00	0.00	0.00	0.01	0.01
Gross investment ...	-0.05	-0.20	-0.23	-0.25	-0.24	-0.16	-0.06
Excl. oil, ocean transp. and Gov...	-0.09	-0.33	-0.44	-0.44	-0.41	-0.27	-0.09
Manufacturing	0.17	-0.04	-0.16	-0.23	-0.21	0.13	0.47
Increase in stocks .	-	-	-	-	-	-	-
Exports	0.09	0.04	0.06	0.06	0.07	0.07	0.09
Trad. goods	0.21	0.03	0.11	0.12	0.14	0.15	0.22
Imports	-0.23	-0.32	-0.37	-0.37	-0.38	-0.36	-0.29
Gross dom. product .	-0.01	-0.06	-0.07	-0.07	-0.07	-0.06	-0.03
Excl. oil, ocean transp. and Gov...	-0.02	-0.09	-0.11	-0.12	-0.12	-0.10	-0.04
Manufacturing ...	0.19	0.19	0.20	0.19	0.19	0.23	0.32
Changes in price indices. Per cent							
Private consumption.	0.31	0.38	0.41	0.43	0.45	0.47	0.46
Gross investment ...	0.47	0.56	0.59	0.61	0.61	0.59	0.55
Exports	0.80	0.91	0.90	0.91	0.91	0.91	0.90
Excl. oil and gas.	0.69	0.86	0.84	0.85	0.85	0.85	0.81
Gross dom. product .	0.29	0.40	0.41	0.42	0.43	0.44	0.44
Changes in current prices. Million Nkr.							
Wage costs	25	10	4	-5	-10	4	68
Operating surplus ..	696	1 095	1 181	1 286	1 403	1 796	2 532
Manufacturing	131	442	484	536	586	700	803
Export surplus	592	883	1 004	1 098	1 200	1 456	2 063
Government budget surplus	-41	-120	-135	-143	-143	-117	-53
Changes in employment, wage earners. Per cent							
Total	0.01	0.00	-0.00	-0.00	-0.01	-0.00	0.01
Excl. oil, ocean transp. and Gov...	0.01	0.00	0.00	-0.01	-0.01	-0.00	0.01
Manufacturing	0.09	0.13	0.15	0.15	0.16	0.17	0.20

Table C4. The effects of increased government employment. Wage costs increased by 1 billion 1984-Nkr.

	1984	1985	1986	1987	1988	1989	1990	1993
Changes in constant prices. Million Nkr								
Private consumption	441	634	678	708	728	742	753	770
Gov. consumption ..	990	986	984	984	984	983	983	983
Gross investment ..	57	141	157	159	151	140	129	107
Excl. oil, ocean transp. and Gov..	56	141	157	159	151	140	129	107
Manufacturing ...	12	19	23	25	27	26	24	18
Increase in stocks.	-5	-6	-5	-5	-7	-7	-6	-7
Exports	-7	-14	-12	-9	-4	0	4	14
Trad. goods	-8	-15	-14	-12	-9	-6	-3	5
Imports	171	268	289	299	303	306	307	311
Gross dom. product.	1304	1474	1513	1537	1549	1553	1556	1556
Excl. oil, ocean transp. and Gov..	303	472	512	535	547	551	554	554
Manufacturing ...	33	51	59	62	64	65	65	67
Changes in price indices. Per cent								
Private consumption	-0.01	-0.01	-0.02	-0.02	-0.03	-0.03	-0.02	-0.02
Gross investment ..	-0.01	-0.01	-0.02	-0.03	-0.03	-0.03	-0.03	-0.02
Exports	0.00	0.00	-0.00	-0.01	-0.01	-0.01	-0.01	-0.01
Excl. oil and gas	0.01	0.00	-0.00	-0.01	-0.01	-0.02	-0.02	-0.02
Gross dom. product.	-0.01	-0.01	-0.00	0.00	0.01	0.01	0.02	0.01
Changes in current prices. Million Nkr								
Wage costs	1045	1162	1263	1358	1452	1548	1650	1992
Operating surplus .	143	196	173	149	130	118	110	112
Manufacturing ...	26	59	33	20	14	12	10	12
Export surplus	-171	-297	-330	-357	-379	-399	-420	-488
Government budget surplus	-460	-416	-429	-453	-481	-510	-543	-658
Changes in employment, wage-earners. 1000 man-years								
Total	7.37	7.70	7.87	7.96	8.00	8.01	8.02	8.01
Excl. oil, ocean transp. and Gov..	0.37	0.70	0.87	0.96	1.00	1.01	1.02	1.01
Manufacturing ...	0.07	0.14	0.17	0.18	0.18	0.17	0.15	0.13

Table C5. The effects of increasing government purchases of goods and services by 1 billion Nkr in fixed 1984-prices.

	1984	1985	1986	1987	1988	1989	1990	1993
Changes in constant prices. Million Nkr								
Private consumption	188	290	342	370	383	386	386	374
Gov. consumption ..	973	970	969	968	968	968	968	969
Gross investment ..	250	334	336	305	270	238	213	169
Excl. oil, ocean transp. and Gov..	250	334	336	305	270	238	213	169
Manufacturing ...	43	55	58	62	61	57	53	40
Increase in stocks.	-19	-4	-5	-8	-13	-9	-9	-9
Exports	-28	-44	-34	-22	-10	-2	7	29
Trad. goods	-29	-47	-39	-31	-22	-16	-9	12
Imports	478	556	573	570	561	554	547	537
Gross dom. product.	885	990	1035	1044	1037	1028	1019	995
Excl. oil, ocean transp. and Gov..	878	982	1028	1036	1030	1020	1011	987
Manufacturing ...	147	152	163	165	166	166	167	171
Changes in price indices. Per cent								
Private consumption	-0.02	-0.03	-0.05	-0.06	-0.06	-0.06	-0.06	-0.05
Gross investment ..	-0.05	-0.05	-0.06	-0.08	-0.09	-0.08	-0.07	-0.06
Exports	0.01	-0.00	-0.01	-0.01	-0.02	-0.02	-0.03	-0.03
Excl. oil and gas	0.01	-0.00	-0.01	-0.02	-0.03	-0.04	-0.04	-0.05
Gross dom. product.	-0.02	-0.03	-0.04	-0.05	-0.05	-0.05	-0.05	-0.04
Changes in current prices. Million Nkr								
Wage costs	226	340	410	454	487	516	546	652
Operating surplus .	426	338	275	195	140	111	91	83
Manufacturing ...	114	167	94	58	43	43	41	55
Export surplus	-486	-642	-666	-689	-708	-730	-755	-849
Government budget surplus	-664	-625	-622	-643	-673	-707	-746	-888
Changes in employment, wage-earners. 1000 man-years								
Total	1.56	2.23	2.55	2.66	2.69	2.68	2.67	2.63
Excl. oil, ocean transp. and Gov..	1.56	2.23	2.55	2.66	2.69	2.68	2.67	2.63
Manufacturing ...	0.34	0.46	0.50	0.50	0.48	0.45	0.42	0.35

Table C6. The effects of increasing government investment by 1 billion Nkr in fixed 1984-prices.

	1984	1985	1986	1987	1988	1989	1990	1993
Changes in constant prices. Million Nkr								
Private consumption	178	250	303	341	359	366	368	358
Gov. consumption ..	-5	3	12	21	31	41	51	84
Gross investment ..	1233	1272	1281	1288	1278	1264	1243	1189
Excl. oil, ocean transp. and Gov..	233	272	281	288	278	264	243	189
Manufacturing ...	40	53	59	65	66	67	66	55
Increase in stocks.	-23	5	5	0	-8	-4	-4	-3
Exports	-19	-43	-35	-29	-19	-12	-1	32
Trad. goods	-19	-44	-38	-34	-26	-20	-11	20
Imports	419	482	494	500	497	497	492	480
Gross dom. product.	946	1006	1071	1121	1143	1159	1166	1178
Excl. oil, ocean transp. and Gov..	936	985	1040	1080	1091	1097	1093	1073
Manufacturing ...	180	165	183	194	198	202	205	214
Changes in price indices. Per cent								
Private consumption	-0.01	-0.02	-0.03	-0.04	-0.05	-0.05	-0.05	-0.05
Gross investment ..	-0.12	-0.09	-0.10	-0.15	-0.17	-0.16	-0.15	-0.12
Exports	0.01	0.01	0.01	-0.00	-0.01	-0.01	-0.02	-0.02
Excl. oil and gas	0.02	0.02	0.01	0.00	-0.01	-0.02	-0.02	-0.04
Gross dom. product.	-0.03	-0.03	-0.04	-0.05	-0.06	-0.06	-0.06	-0.06
Changes in current prices. Million Nkr								
Wage costs	228	332	398	444	476	503	528	606
Operating surplus .	426	373	324	250	200	181	166	162
Manufacturing ...	151	258	123	63	44	48	51	77
Export surplus	-412	-527	-555	-592	-619	-647	-672	-743
Government budget surplus	-638	-622	-618	-632	-661	-694	-735	-877
Changes in employment, wage-earners. 1000 man-years								
Total	1.59	2.18	2.47	2.59	2.62	2.60	2.56	2.43
Excl. oil, ocean transp. and Gov..	1.59	2.18	2.47	2.59	2.62	2.60	2.56	2.43
Manufacturing ...	0.47	0.59	0.64	0.65	0.64	0.61	0.58	0.47

Table C7. The effects of reducing personal income taxation by 1 billion 1984-Nkr.

	1984	1985	1986	1987	1988	1989	1990	1993
Changes in constant prices. Million Nkr								
Private consumption	702	986	1029	1052	1063	1066	1066	1055
Gov. consumption ..	-15	-23	-24	-24	-24	-24	-24	-24
Gross investment ..	90	222	240	236	218	196	177	139
Excl. oil, ocean transp. and Gov..	90	222	240	236	218	196	177	139
Manufacturing ...	18	30	35	38	39	37	34	24
Increase in stocks.	-9	-9	-7	-8	-10	-9	-9	-9
Exports	-12	-22	-19	-12	-4	2	8	22
Trad. goods	-12	-23	-21	-17	-12	-8	-3	10
Imports	272	417	439	444	441	436	430	423
Gross dom. product.	484	738	781	800	801	795	787	761
Excl. oil, ocean transp. and Gov..	482	736	779	797	799	793	785	758
Manufacturing ...	52	80	89	93	93	93	92	92
Changes in price indices. Per cent								
Private consumption	-0.01	-0.02	-0.03	-0.04	-0.04	-0.04	-0.04	-0.03
Gross investment ..	-0.01	-0.01	-0.03	-0.04	-0.04	-0.04	-0.04	-0.02
Exports	0.01	0.00	-0.00	-0.01	-0.01	-0.02	-0.02	-0.02
Excl. oil and gas	0.01	0.00	-0.00	-0.01	-0.02	-0.03	-0.03	-0.03
Gross dom. product.	-0.01	-0.01	-0.02	-0.03	-0.03	-0.03	-0.03	-0.03
Changes in current prices. Million Nkr								
Wage costs	82	162	209	238	258	274	288	336
Operating surplus .	229	305	263	218	184	163	149	146
Manufacturing ...	42	92	51	30	20	16	14	17
Export surplus	-272	-462	-502	-531	-553	-572	-593	-665
Government budget surplus	-772	-678	-688	-711	-743	-778	-817	-962
Changes in employment, wage-earners. 1000 man-years								
Total	0.59	1.10	1.34	1.44	1.47	1.47	1.45	1.40
Excl. oil, ocean transp. and Gov..	0.59	1.10	1.34	1.44	1.47	1.47	1.45	1.40
Manufacturing ...	0.12	0.22	0.26	0.27	0.26	0.24	0.22	0.17

Table C8. The effects of increasing transfers to households by 1 billion 1984-Nkr.

	1984	1985	1986	1987	1988	1989	1990	1993
Changes in constant prices. Million Nkr								
Private consumption	596	796	817	835	845	850	851	849
Gov. consumption ..	-13	-18	-19	-19	-19	-19	-19	-19
Gross investment ..	76	141	150	146	134	120	108	86
Excl. oil, ocean transp. and Gov..	76	141	150	146	134	120	108	86
Manufacturing ...	16	23	26	28	29	27	25	18
Increase in stocks.	-7	-6	-6	-7	-8	-7	-7	-7
Exports	-10	-17	-14	-9	-3	2	6	17
Trad. goods	-10	-18	-16	-13	-9	-6	-2	7
Imports	231	325	337	341	340	338	335	333
Gross dom. product.	411	570	592	606	610	608	604	593
Excl. oil, ocean transp. and Gov..	409	568	590	604	608	606	602	591
Manufacturing ...	44	60	65	68	68	69	69	70
Changes in price indices. Per cent								
Private consumption	-0.01	-0.02	-0.02	-0.03	-0.03	-0.03	-0.03	-0.03
Gross investment ..	-0.01	-0.01	-0.02	-0.03	-0.03	-0.03	-0.02	-0.02
Exports	0.00	0.00	-0.00	-0.01	-0.01	-0.01	-0.01	-0.01
Excl. oil and gas	0.01	0.00	-0.00	-0.01	-0.02	-0.02	-0.02	-0.03
Gross dom. product.	-0.00	-0.01	-0.02	-0.02	-0.02	-0.02	-0.02	-0.02
Changes in current prices. Million Nkr								
Wage costs	69	125	157	177	192	205	217	258
Operating surplus .	194	229	197	167	143	129	120	121
Manufacturing ...	36	65	37	23	15	13	11	11
Export surplus	-231	-362	-386	-408	-426	-443	-461	-524
Government budget surplus	-686	-579	-601	-624	-652	-683	-716	-843
Changes in employment, wage-earners. 1000 man-years								
Total	0.50	0.85	1.01	1.07	1.10	1.10	1.10	1.08
Excl. oil, ocean transp. and Gov..	0.50	0.85	1.01	1.07	1.10	1.10	1.10	1.08
Manufacturing ...	0.10	0.16	0.19	0.19	0.18	0.17	0.16	0.13

Table C9. A 5 per cent increase in value added tax-rates.

	1984	1985	1986	1987	1988	1989	1990	1993
Changes in constant prices. Million Nkr								
Private consumption	-1079	-1609	-1763	-1889	-1986	-2065	-2126	-2252
Gov. consumption ..	20	35	39	43	45	47	48	51
Gross investment ..	-165	-394	-490	-519	-514	-488	-458	-380
Excl. oil, ocean transp. and Gov..	-165	-394	-490	-519	-514	-488	-458	-380
Manufacturing ...	-33	-65	-86	-105	-117	-118	-116	-97
Increase in stocks.	16	17	17	19	23	22	22	24
Exports	8	21	6	-15	-29	-63	-86	-151
Trad. goods	20	37	27	13	-4	-22	-40	-96
Imports	-414	-670	-753	-802	-833	-855	-870	-910
Gross dom. product.	-786	-1260	-1438	-1559	-1638	-1691	-1728	-1798
Excl. oil, ocean transp. and Gov..	-784	-1256	-1434	-1555	-1634	-1686	-1724	-1793
Manufacturing ...	-93	-147	-182	-204	-218	-228	-236	-260
Changes in price indices. Per cent								
Private consumption	0.61	0.67	0.70	0.73	0.75	0.76	0.76	0.75
Gross investment ..	0.28	0.31	0.33	0.38	0.40	0.39	0.38	0.36
Exports	0.01	0.02	0.04	0.05	0.07	0.08	0.09	0.09
Excl. oil and gas	0.01	0.03	0.06	0.08	0.10	0.12	0.14	0.17
Gross dom. product.	0.40	0.44	0.46	0.49	0.51	0.51	0.51	0.50
Changes in current prices. Million Nkr								
Wage costs	-141	-281	-382	-457	-517	-567	-614	-757
Operating surplus .	-565	-647	-569	-472	-402	-360	-332	-328
Manufacturing ...	-100	-189	-111	-66	-47	-43	-39	-37
Export surplus	442	786	908	1012	1101	1184	1267	1524
Government budget surplus	1218	1168	1169	1229	1307	1399	1500	1849
Changes in employment, wage-earners. 1000 man-years								
Total	-1.01	-1.90	-2.44	-2.75	-2.93	-3.02	-3.08	-3.15
Excl. oil, ocean transp. and Gov..	-1.01	-1.90	-2.44	-2.75	-2.93	-3.02	-3.08	-3.15
Manufacturing ...	-0.22	-0.39	-0.50	-0.56	-0.56	-0.54	-0.51	-0.42

Table C10. The effects of increasing oil prices by 10 per cent.

	1984	1985	1986	1987	1988	1989	1990	1993
Changes in constant prices. Per cent								
Private consumption	-0.26	-0.41	-0.45	-0.44	-0.42	-0.43	-0.43	-0.49
Gov. consumption ..	0.01	0.02	0.02	0.02	0.02	0.02	0.02	0.02
Gross investment ..	-0.06	-0.22	-0.28	-0.31	-0.29	-0.25	-0.22	-0.25
Excl. oil, ocean transp. and Gov..	-0.11	-0.38	-0.52	-0.55	-0.50	-0.42	-0.38	-0.40
Manufacturing ...	-0.17	-0.46	-0.74	-0.90	-0.82	-0.62	-0.49	-0.46
Increase in stocks.	-	-	-	-	-	-	-	-
Exports	-0.04	-0.04	-0.06	-0.07	-0.08	-0.09	-0.09	-0.11
Trad. goods	-0.09	-0.10	-0.14	-0.17	-0.19	-0.21	-0.23	-0.26
Imports	-0.17	-0.27	-0.32	-0.33	-0.33	-0.33	-0.33	-0.33
Gross dom. product.	-0.09	-0.26	-0.18	-0.18	-0.17	-0.17	-0.17	-0.20
Excl. oil, ocean transp. and Gov..	-0.13	-0.24	-0.28	-0.29	-0.28	-0.28	-0.28	-0.32
Manufacturing ...	-0.09	-0.17	-0.22	-0.23	-0.23	-0.24	-0.24	-0.30
Changes in price indices. Per cent								
Private consumption	0.28	0.38	0.44	0.45	0.46	0.47	0.48	0.51
Gross investment ..	0.08	0.12	0.15	0.18	0.18	0.17	0.17	0.18
Exports	2.65	2.64	2.57	2.74	2.68	2.87	3.02	3.89
Excl. oil and gas	0.39	0.35	0.36	0.37	0.37	0.39	0.41	0.50
Gross dom. product.	1.28	1.39	1.34	1.43	1.40	1.49	1.57	1.86
Changes in current prices. Million Nkr								
Wage costs	-54	-143	-216	-261	-286	-305	-328	-471
Operating surplus .	5118	5947	5993	6869	7173	8262	9484	13840
Manufacturing ...	-405	-365	-196	-141	-109	-166	-190	-472
Export surplus	5120	6060	6041	6770	6962	7999	9167	13450
Government budget surplus	-21	-125	-136	-170	-154	-116	-116	-198
Changes in employment, wage-earners. Per cent								
Total	-0.02	-0.06	-0.08	-0.09	-0.09	-0.09	-0.09	-0.10
Excl. oil, ocean transp. and Gov..	-0.03	-0.08	-0.11	-0.12	-0.12	-0.12	-0.12	-0.14
Manufacturing ...	-0.04	-0.09	-0.12	-0.14	-0.13	-0.12	-0.12	-0.13

Table C11. Effects of a one per cent increase in World Market Demand.

	1984	1985	1986	1987	1988	1990	1993
Changes in constant prices. Per cent							
Private consumption	0.05	0.08	0.12	0.14	0.16	0.18	0.21
Gov. consumption ..	-0.01	-0.02	-0.02	-0.02	-0.02	-0.03	-0.03
Gross investment ..	0.12	0.20	0.25	0.30	0.32	0.33	0.37
Excl. oil, ocean transp. and Gov..	0.22	0.35	0.46	0.53	0.55	0.55	0.59
Manufacturing ...	0.33	0.57	0.83	1.05	1.12	1.10	1.16
Increase in stocks.	-	-	-	-	-	-	-
Exports	0.33	0.37	0.41	0.45	0.48	0.51	0.56
Trad. goods	0.68	0.71	0.82	0.93	1.03	1.12	1.26
Imports	0.17	0.25	0.31	0.35	0.37	0.41	0.42
Gross dom. product.	0.12	0.17	0.20	0.22	0.23	0.26	0.30
Excl. oil, ocean transp. and Gov..	0.18	0.26	0.32	0.36	0.38	0.43	0.50
Manufacturing ...	0.29	0.42	0.51	0.58	0.63	0.75	0.90
Changes in price indices. Per cent							
Private consumption	-0.01	-0.01	-0.03	-0.04	-0.05	-0.06	-0.07
Gross investment ..	-0.01	0.00	-0.03	-0.06	-0.07	-0.07	-0.09
Exports	0.06	0.09	0.14	0.14	0.14	0.13	0.05
Excl. oil and gas	0.09	0.13	0.16	0.13	0.09	0.08	0.03
Gross dom. product.	0.02	0.04	0.04	0.01	-0.00	-0.01	-0.04
Changes in current prices. Million Nkr							
Wage costs	127	246	352	444	524	683	979
Operating surplus .	420	663	729	688	656	755	870
Manufacturing ...	264	521	520	477	461	581	660
Export surplus	558	622	692	742	829	1000	1348
Government budget surplus	151	255	342	410	468	586	816
Changes in employment, wage-earners. Per cent							
Total	0.05	0.09	0.12	0.14	0.16	0.18	0.20
Excl. oil, ocean transp. and Gov..	0.07	0.12	0.17	0.19	0.21	0.24	0.28
Manufacturing ...	0.12	0.22	0.29	0.34	0.36	0.40	0.44

Table C12. Effects of a one per cent increase in Nominal Credit Variables.

	1984	1985	1986	1987	1988	1990	1993
Changes in constant prices. Per cent							
Private consumption	0.11	0.14	0.13	0.12	0.12	0.12	0.11
Gov. consumption ..	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01
Gross investment ..	0.07	0.08	0.07	0.07	0.06	0.05	0.04
Excl. oil, ocean transp. and Gov..	0.13	0.14	0.13	0.12	0.11	0.09	0.07
Manufacturing ...	0.09	0.11	0.10	0.10	0.10	0.08	0.06
Increase in stocks.	-	-	-	-	-	-	-
Exports	-0.00	-0.00	-0.00	-0.00	0.00	0.00	0.00
Trad. goods	-0.01	-0.01	-0.01	-0.00	-0.00	0.00	0.01
Imports	0.06	0.08	0.07	0.07	0.07	0.07	0.06
Gross dom. product.	0.04	0.05	0.05	0.04	0.04	0.04	0.04
Excl. oil, ocean transp. and Gov..	0.07	0.08	0.07	0.07	0.07	0.07	0.06
Manufacturing ...	0.05	0.06	0.05	0.05	0.05	0.04	0.04
Changes in price indices. Per cent							
Private consumption	-0.00	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01
Gross investment ..	-0.01	-0.01	-0.01	-0.02	-0.02	-0.02	-0.01
Exports	0.00	-0.00	-0.00	-0.00	-0.01	-0.01	-0.01
Excl. oil and gas	0.00	-0.00	-0.00	-0.01	-0.01	-0.01	-0.01
Gross dom. product.	-0.00	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01
Changes in current prices. Million Nkr							
Wage costs	34	56	62	65	68	75	90
Operating surplus .	88	92	63	47	37	24	18
Manufacturing ...	19	29	13	6	3	0	-3
Export surplus	-111	-161	-152	-155	-162	-175	-205
Government budget surplus	88	123	117	118	122	132	154
Changes in employment, wage-earners. Per cent							
Total	0.01	0.02	0.02	0.02	0.02	0.02	0.02
Excl. oil, ocean transp. and Gov..	0.02	0.03	0.03	0.03	0.03	0.03	0.03
Manufacturing ...	0.02	0.03	0.03	0.02	0.02	0.02	0.02

Table C13. The effects of increasing all interest variables by 10 per cent.

	1984	1985	1986	1987	1988	1989	1990	1993
Changes in constant prices. Per cent								
Private consumption	-0.19	-0.25	-0.28	-0.31	-0.34	-0.34	-0.34	-0.32
Gov. consumption ..	0.02	0.03	0.03	0.03	0.04	0.04	0.04	0.04
Gross investment ..	-0.37	-0.50	-0.52	-0.53	-0.49	-0.43	-0.37	-0.30
Excl. oil, ocean transp. and Gov..	-0.67	-0.84	-0.96	-0.95	-0.84	-0.74	-0.63	-0.48
Manufacturing ...	-0.53	-0.64	-0.69	-0.74	-0.67	-0.59	-0.51	-0.34
Increase in stocks.	-	-	-	-	-	-	-	-
Exports	0.00	0.01	0.00	-0.00	-0.01	-0.02	-0.02	-0.03
Trad. goods	0.01	0.02	0.02	0.01	-0.00	-0.02	-0.03	-0.07
Imports	-0.15	-0.18	-0.20	-0.22	-0.21	-0.20	-0.18	-0.13
Gross dom. product.	-0.12	-0.15	-0.17	-0.18	-0.19	-0.18	-0.17	-0.16
Excl. oil, ocean transp. and Gov..	-0.19	-0.24	-0.28	-0.30	-0.30	-0.30	-0.29	-0.26
Manufacturing ...	-0.13	-0.15	-0.18	-0.20	-0.20	-0.19	-0.19	-0.17
Changes in price indices. Per cent								
Private consumption	0.07	0.12	0.17	0.20	0.23	0.24	0.25	0.25
Gross investment ..	0.04	0.05	0.07	0.09	0.09	0.08	0.08	0.03
Exports	-0.00	0.01	0.02	0.03	0.03	0.04	0.04	0.04
Excl. oil and gas	-0.00	0.01	0.02	0.04	0.04	0.05	0.07	0.08
Gross dom. product.	0.05	0.08	0.10	0.13	0.14	0.15	0.15	0.14
Changes in current prices. Million Nkr								
Wage costs	-95	-152	-193	-218	-230	-233	-233	-244
Operating surplus .	-128	-66	27	126	220	309	387	498
Manufacturing ...	-5	-6	-11	-15	-18	-16	-10	-91
Export surplus	258	389	460	518	540	541	530	519
Government budget surplus	79	51	40	-3	-77	-63	-41	3
Changes in employment, wage-earners. Per cent								
Total	-0.04	-0.06	-0.07	-0.07	-0.07	-0.07	-0.06	-0.05
Excl. oil, ocean transp. and Gov..	-0.05	-0.08	-0.09	-0.10	-0.09	-0.09	-0.08	-0.07
Manufacturing ...	-0.06	-0.08	-0.09	-0.09	-0.09	-0.07	-0.06	-0.04

N O T E S :

1) Some recent general references to the use of models in economic planning in Norway are Aukrust (1978), Bjerkholt and Longva (1980), and Johansen and Strand (1981). See also Bjerkholt (1983) and Larsen and Schreiner (1985).

2) The first version of MODIS became operational in 1960 (see Sevaldson (1964)). The first coherent presentation of what later came to be known as the Aukrust model or the Scandinavian model of inflation is given in Utredningsutvalget (1966a, 1966b). Later references are Aukrust (1970,1977) and Edgreen, Faxen and Odhner (1970). The short-term version of the inflation model was included in MODIS as early as in 1965. MODIS IV has approximately 200 commodities and 150 production sectors.

3) Government consumption, i.e., government purchases of goods and services for consumption purposes, plus depreciation of government consumption capital, less the sales of services to the private sector (fees), are endogenously determined since the latter two items are endogenous in MODAG A.

4) See Persson (1982) for a more detailed discussion of inventory behaviour.

5) See, for example, Bruno (1979) for a model which has certain similarities to our formulation of producer behaviour.

6) The relative importance of these industries for the Norwegian economy is brought out in the table below. The percentages are based on figures from the 1984 preliminary national accounts.

	Value added	Exports	Investment	Employment
Resource based industries	26,5	39,0	40,5	9,0
Ocean transport	2,5	15,5	3,0	1,5
General government	13,5	0,5	11,5	23,5
Other sectors	57,5	45,0	45,0	66,0
Total	100,0	100,0	100,0	100,0

7) Wage formation and labour supply equations are included, however, in the latest version of MODAG. This version of the model, which is called MODAG W, is still on an experimental basis.

8) The assumption of a homothetical aggregate would have sufficed for this result.

9) We have also tested whether the increase in the degree of foreign competition as measured by the import share has had any influence on the domestic price. With one exception we were not able to find any significant effects.

10) Due to the way in which unit costs are defined, including current and not normalized labour productivity among other things, increased production would result in lower prices in the short run because of increased productivity even without the U-shaped capacity term in the price equation.

11) With annual data, H^N has a trendlike development which makes it difficult to distinguish the effect of H^N from the trend term.

12) In this presentation we ignore some minor differences between tax liable income and consumption motivating income before taxes. For a short discussion of this see Cappelen, Garaas and Longva (1981), section 4.2.6.

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