Discussion Paper

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

No. 13 5 July 1985

KVARTS - A QUARTERLY MODEL OF THE NORWEGIAN ECONOMY

BY

ERIK BIØRN, MORTEN JENSEN, AND MORTEN REYMERT

ABSTRACT

This paper presents the main characteristics of the first version of a quarterly 12 sector macroeconomic model of the Norwegian economy. The general purpose of the project is to obtain a framework for quantitative analysis of the short-term development of the economy. Quarterly national accounts data constitute a main data source, but short term statistics outside the national accounting system also play a significant role in the model structure. We present the model's main structure and basic theoretical properties, report selected estimation results for single equations, and give some experiences from simulation experiments performed on selected model blocks and by means of the complete model.

KVARTS - A QUARTERLY MODEL OF THE NORWEGIAN ECONOMY *)

BY

Erik Biørn, Morten Jensen, and Morten Reymert **)
Central Bureau of Statistics, Oslo, Norway

*) A previous draft of this paper was presented at the LINK meeting, August 27-31, 1984, Stanford University, California, U.S.A.
**) The model presented in this paper is a project to which several persons have contributed during longer or shorter periods. Apart from the authors, the following persons have been engaged in the project leading to the present paper: Per Richard Johansen, Vidar Knudsen, Hilde Olsen, Nils Martin Stølen, and Lars Wahl. We are grateful to Olav Bjerkholt and Ådne Cappelen for constructive comments on a previous draft, and to Heidi Munkelien and Elisabeth Godnes for skill and patience in the typing of the paper.

CONTENTS

I. INTRODUCTION. OVERVIEW

In this paper, we will present the main characteristics of the first version of a quarterly macroeconomic model of the Norwegian economy, which has been constructed in recent years at the Central Bureau of Statistics of Norway. The general purpose of the project is to obtain a framework for quantitative analysis of the short-term development of the economy. The model is intended to be used in essentially the same way as the mainstream of quarterly models in other countries. We consider historical simulations based on alternative time paths for the model's policy variables and other exogenous variables (historical scenarios, impact analysis) as one important field of application. Another application will be to prepare scenarios for the future short-term development of the economy. The model also constitutes a framework for making a consistent set of short-term forecasts.

The model, which has been named KVARTS , or more precisely KVARTS-75[1]), is a multi-sectoral model with main emphasis on explaining the variables in the real sphere of the economy. Financial variables are included in some of the model blocks, but the repercussions from the real markets to the financial markets are fragmentarily represented in the first version of the model. The financial variables are for the most part specified as exogenous. This is due to on the one hand the present data situation, on the other hand the structure of the credit market regulations in Norway during most of our period of observation. It is commonly assumed that these regulations to a large extent have implied a sort of recursivity between the financial and the real markets, with rather weak repercussions from the latter to the former. This structure has, however, undergone changes during the last years, a fact which suggests that the construction of a financial block should be given high priority in subsequent model versions.

KVARTS is an aggregate model by Norwegian standards, although it may be characterized as disaggregate if compared with the majority of quarterly models in other countries. Twelve production sectors are specified, including one primary sector, five manufacturing industries, construction, oil production, shipping, public services, and other services (two sectors). Like most of the existing Norwegian annual models for the real sector of the economy, KVARTS is constructed within the framework of a national accounting system (based on the United Nations'

Standard of National Accounts). Quarterly national accounts data thus constitute a main data source, but short term statistics outside the national accounting system (e.g. statistics on inventories, orders, building activities, foreign trade, and fiscal policy and monetary variables) as well as constructed series for variables not covered by existing statistics also play a significant role in the model structure. The purpose of this paper is to give an overview of the model as it stands at the end of 1984. We will present its main structure and basic theoretical properties, report selected estimation results for single equations, and give some experiences from simulation experiments performed on selected model blocks or by means of the complete model.

The paper is organized as follows: In section II, we present the sector classification of KVARTS and its general characteristics as an empirical macro-economic model. An overview of selected model blocks is given in section III. We focus on the input-output equations and other national accounting equations (section 3.1), behavioural equations for production and stock formation (section 3.2), equations for exports and imports (section 3.3), household consumption (section 3.4), capital formation, including investment in housing (section 3.5), labour demand (section 3.6), and prices (section 3.7). Some other features of the model are also briefly discussed (section 3.8), and we comment on the interplay of quantities and prices as it emerges from the complete model (section 3.9). Section IV gives a brief overview of the data and the estimation procedure. In section V, we report experiences from simulations on the complete model within the sample period: partly an analysis of its historical tracking performance (section 5.1), and partly impact analysis, displaying - in the form of diagrams - the model's response to discretionary changes in its main exogenous variables, fiscal policy instruments, world economic activity, and wage rates (section 5.2). More detailed results are given in the table annex. Finally, section VI contains some concluding remarks.

II. MAIN STRUCTURE OF THE MODEL. GENERAL CHARACTERISTICS

KVARTS-75, as it stands today, contains about 800 equations and 400 exogenous variables. Its relatively large dimension, as far as the number of equations and variables is concerned, is of course to a large extent, due to its fairly disaggregate specification of sectors and commodities. The accommodation of the model structure to the input-output framework of the national accounts - with regard to price indices as well as to quantities - has also contributed to enlarging the model's size. A substantial share of its 800 equations are input-output equations and definitional equations, and only about 80 equations are strictly econometric, in the sense that they are specified stochastically and estimated by econometric methods.

The high number of exogenous variables does not imply, however, that KVARTS is an "open" model. A substantial share of the main variables in the real sphere of the economy is endogenized, and the degree of endogenization is - on the whole - larger than in most of the existing annual macroeconomic models in Norway. The largest block which has to be solved simultaneously in its numerical solution contains about 400 of its 800 equations. This block comprises, inter alia, links between the quantity side and the price side of the economy, e.g. the interaction between prices, quantities, and incomes of households and firms.

The national accounts imply the following basic equilibrium equation (balance equation) for each commodity :

  Domestic production
+ Imports
= Intermediate consumption
+ Final domestic use (gross capital formation and private and public consumption)
+ Exports
+ Increase in stocks.

This equation imposes a fundamental restriction on the modelling of demand and supply responses and the formation of market equilibrium, for the different commodities. More precisely, considering intermediate consumption and final domestic use as endogenized by separate behavioural equations, we cannot introduce independent equations for domestic production, imports, exports, and increase in stocks. At least one of the latter variables should be allowed to be implicitly determined from the rest of the model.

The specification chosen in KVARTS-75 is presented, in compact form, in table 1, which also gives the corresponding commodity and sector codes and names. The symbol X denotes exogenous determination; ER and E indicate that the variable in question is endogenous, i.e. either determined by one specific econometric equation (ER) or implicitly determined from the interplay of several equations (or all the equations of the model) (E). The specification of domestic prices and export prices, as well as of investment and private consumption, is also indicated.

Table 1. Commodity and sector classification, classification of private consumption and investment, and determination of basic variables in KVARTS-75.
The following symbols are used:
exogenous variable: X
endogenous variable: E,
endogenous variable determined by an econometric relation, ER,
and variable does not exist or has insignificant value,-

A. Commodity specific variables

Commodity	Domestic production[1]	Increase in stocks	Exports	Imports	Domestic price	Export price
10. Primary industry products ...	X	X	X	E	X	X
15. Food, clothing, etc.	ER[2]	ER[2]	ER	ER	ER	ER
25. Wood products, printing, etc.	ER[2]	ER[2]	ER	ER	ER	ER
30. Raw-materials from mining and manufacturing	ER[2]	ER[2]	ER	E	ER	ER
45. Machinery and metal products	E	X	ER	ER	ER	ER
50. Ships and drilling platforms	E	X	X	X	X	X
55. Buildings and construction ..	E	-	-	-	ER	-
60. Ocean transport	E	-	ER	-	X	X
66. Crude oil and natural gas ...	X	E	X	E	X	X
67. Drilling and pipeline transport	E	-	X	E	X	X
70. Domestic transport and power supply	E	-	E	E	ER	E
80. Various services	E	-	E	E	ER	E
90. Public goods	X	-	-	-	X	-
Non competing imports:						
00. Food	-	X	-	E	-	-
01. Raw materials	-	X	-	E	-	-
02. Private transport equipment	-	X	-	E	-	-
05. Working expenses in ocean transport	-	X	-	E	-	-
06. Oil production services	-	X	-	E	-	-
07. Direct purchases abroad by resident households	-	X	-	E	-	-

[1] Most sectors also produce other commodities than those of which it is a main producer (cf. table A.1 in the table annex). This has not been taken into account in the classification below.
[2] Increase in stocks and domestic production are determined simultaneously. Confer section 3.2.

Table 1 (cont.).

B. Sectoral demand components

Investment in fixed capital

Sector	Investment in: Buildings	Machinery and equipment	Ships	Oil producing constructions
10. Primary industries ...	ER	ER	-	-
15. Food and clothing industries	ER	ER	-	-
25. Wood and printing industries	ER	ER	-	-
30. Mining and raw-material industries	ER	ER	-	-
45. Metal manufacturing industries	ER	ER	-	-
50. Ship building and manufacture and repair of oil platforms	ER	ER	-	-
55. Buildings and construction	ER	ER	-	-
60. Ocean transport	-	-	X	-
65. Oil production etc.	-	-	-	X
70. Domestic transport and power supply	ER	ER	-	-
80. Various services	ER	ER	-	-
90. Public goods	X	X	-	-

Private consumption

Consumption category	
99. Total consumption	ER
00. Food	ER
10. Other non-durable goods	ER
20. Semi-durable goods	ER
30. Personal transport equipment	ER
40. Other durable goods	ER
50. Gross rents (housing services)	ER
60. Other services	ER

The formulation of the behavioural equations of KVARTS-75 is in some respects fairly standard, but in certain model blocks we have tried to depart from the formulation in the mainstream of quarterly models. In the following, we shall highlight the latter aspects of the model, while giving a more cursory treatment of the other parts.

In a quarterly model, the distinction between long-run and short-run adjustments - i.e. adjustments performed with a long and short horizon relative to the model's quarterly unit period - is important. One reason for this is, roughly speaking, the fact that some decisions are less reversible - and hence have to be based on more long-range plans and expectations - than others. We have not tried to formalize this idea in all of the production sectors of KVARTS, but in the specification of producer behaviour in manufacturing the distinction between long-run and short-run adjustment is made explicit. Briefly, we here assume that production capacity, desired stocks of inventories, capital stocks, and investment are jointly determined from the firms' long-run considerations, whereas actual production, capacity utilization, actual stocks of inventories and employment are results of the firms' short-term adjustments to the actual market situation. A more detailed explanation will be given in sections 3.2, 3.5, and 3.6 below.

It is customary, when characterizing macro-economic models, to draw a borderline between models in which production is passively adjusting to demand, and those in which the firms are assumed to follow a strategy with an active fixation of supply. KVARTS, taken as a whole, cannot be adequately categorized in either of these ways. Output may be said to be completely "determined from the demand side" in some sectors, while being "exogenously determined from the supply side" (usually reflecting capacity constraints) in others (cf. table 1.A). Some of the manufacturing sectors, however, come in an intermediate position, in the sense that the degree of demand responsiveness is, on the whole, assumed to be more pronounced in the long than in the short run. In the long run, production capacity is basically demand determined - although with some "supply side" effects represented (cf. section 3.5 below). Adjustment of production to existing production capacity and desired stocks of inventories play an important role in the short run. This implies that one should be cautious when utilizing the model, as it stands, for long-run forecasting exercises, since the long-run supply behaviour of the producers are not adequately represented.

KVARTS as a whole, displays features which are definitely Keynesian, and as the simulation exercises in section V will show, it exhibits dynamics which are in accordance with standard multiplier - accelerator textbook models. (See for instance Allen (1967, Ch. 17).) It has, however, also notable neo-classical features, represented, inter alia, by the way in which quantities are related to prices in the household consumption block, the investment equations (notably in manufacturing), and the import equations.

III. SELECTED MODEL BLOCKS

In this section, we give an overview of the most important blocks of KVARTS, and the main connections between the different blocks. The technique we will adopt in presenting the empirical results, is not to report detailed single equation estimates, but rather to focus on the outcome of partial simulation experiments performed on each block, and presenting their dynamic multipliers etc. in the form of diagrams. A detailed account of the coefficient estimates, fit statistics etc., equation by equation, is given in Jensen and Reymert (1984). Confer also the papers referred to in the text.

3.1. Input-output equations for quantities and prices

Macro-economic models with an input-output framework used for policy analysis and planning by the central government have a strong tradition in model building and national accounting in Norway. (See Bjerkholt and Longva (1980, pp. 7-22), and Fløttum (1981, p. 24).) KVARTS - although not primarily intended for policy analysis and planning - continues this tradition; its quantity block, as well as its price block, has an input-output kernel.

The accommodation of a quarterly model to the national accounting conventions, stated in the form of input-output tables connecting the various commodity flows at current and constant prices, is not without problems, and it must be admitted that in constructing KVARTS, we have sometimes felt it as a strait-jacket. The modelling of prices, in particular, becomes complicated. But it has obvious advantages. First, we obtain a reconciliation of the production and income accounts; there is no essential problem in defining Gross Domestic Product (GDP). Second, it facilitates the incorporation of the system of indirect taxes and subsidies - in particular the Value Added Tax (V.A.T.), which is a basic fiscal policy variable in Norway. On the other hand, this specification tends to enlarge the model's size; the fact that the representation of the input-output structure in KVARTS-75 occupies as many as about 300 of its 800 equations, the majority for prices, amply illustrates this point.

The basic elements of the real side of the annual national accounts are the sector-commodity and the commodity-sector matrices at current and constant prices. The same concepts are found, although more simply represented, in the quarterly national accounts, and hence the distinction between commodities and sectors becomes essential in KVARTS. (A commodity is defined as a grouping of goods and services, and a sector is a functional unit which is a receiver or a deliverer of commodities.) In a few cases, we also make use of the concept activity, formally defined as a subdivision of a sector characterized by constant input-coefficients.

In modelling the input-output equations of KVARTS-75, we distinguish between three value concepts for the commodity flows - basic value, producers' value and purchasers' value. Producers' value and purchasers' value are the only value concepts used in the national accounts publications, both for annual and quarterly data, and these concepts are thus the most relevant ones for the purpose of evaluating output from the model and presenting simulation results. However, as market values are influenced by variations in trade margins and indirect taxes (over time as well as between different receivers of each commodity), the third concept, basic value, is also required. The basic value of a commodity flow is, in simple terms, defined as its value stripped for (net) indirect taxes and trade margins. Hence, producers' value is equal to basic value plus value of net indirect taxes imposed on production, and purchasers' value is equal to producers' value plus trade margins and net indirect taxes imposed on the commodity flow.

The main elements of the input-output structure of KVARTS-75 are, on the quantity side, equations balancing supply and demand of commodities, and on the price side an implicit representation of the dual price input-output structure in the form of equations determining the sector prices.

The balancing of supply and demand of each commodity at basic value is represented by the following quantity equations:

$$(3.1.1) \qquad I_i + \sum_j \Lambda^X_{ij} X_j = \sum_j \Lambda^M_{ij} M_j + \sum_j \Lambda^C_{ij} C_j + \sum_j \Lambda^J_{ij} J_j + \Lambda^A_{ij} A_j + L_i + U^q_i,$$

where

I_i - imports of commodity i, constant prices,
X_j - gross production in sector j, constant prices,
M_j - intermediate input in sector j, constant prices,
C_j - private consumption of category j, constant prices,
J_j - investment in new goods of kind j, constant prices,
A_j - exports of commodity j, constant prices,
L_i - increase in stocks, constant prices,
U_i^q - residual (see below),

and Λ_{ij}^X, Λ_{ij}^M, Λ_{ij}^C, Λ_{ij}^J, and Λ_{ij}^A are input-output coefficients. Since the sector (or activity) levels are all measured at market values, these coefficients represent a transformation from sector (activity) levels to supply or demand of commodities expressed at basic values.

The Λ coefficients are estimated from the 1975 annual national accounts, 1975 being the model's base year (see tables A.1 - A.3 in the table annex). If the correct annual 1975 values of the variables are inserted, eq. (2.2.1) will be exactly fulfilled, by way of construction, with $U_i^q \equiv 0$. However, when we use the quarterly national account figures, this will not be the case neither in the base year nor any other year. Therefore, we have for each commodity, calculated the vector U_i^q in such a way that (3.1.1) is satisfied when the actual time series for the other variables are inserted. The equation will then reproduce the correct commodity mix over the entire period of observation.

One main reason for the residuals to appear in (3.1.1), is the fact that the input-output structure changes over time. This is not explicitly reflected in the model since the input-output coefficients are estimated from the base year data only. Second, the quarterly national accounts at 1975 values do not satisfy all accounting identities exactly, due to the rebasing of the time series which has taken place. This also contributes significantly to the residuals and is the reason why we have chosen, for the most part, to treat U_i^q as known exogenous time series in historical simulations (cf. section 5.1). We do not try to model accounting discrepancies!

In the dual price block determining sector prices, we distinguish between three different prices (indices) for the (basic) value of each commodity - the import price, the price of domestically produced commodities delivered to the home market (the home price) and the export price. The equations determining the price of the purchasers' value of intermediate input, investment, and private consumption have the following form:

$$(3.1.2)\quad P_j = [\sum_i (1 + T_{Mi} \cdot H_{Mij}) \cdot [(1 + T_{Vi} \cdot H_{Vij}) \cdot (\Lambda_{Hij}\, BH_i + \Lambda_{Iij}\, (BI_i D_{ij} + BH_i\, (1-D_{ij})))]]\, U_j^P,$$

where

P_j - purchasers' price, sector (category) j,

T_{Mi} - relative (current quarter to base year) V.A.T. rate, commodity i,

T_{Vi} - relative (current quarter to base year) rate of net indirect taxes excl. V.A.T., commodity i,

D_{ij} - relative (current quarter to base year) input of imported quantity of commodity i, sector (category) j,

BI_i - basic value import price of commodity i,

BH_i - basic value home price of commodity i,

U_j^P - multiplicative residual.

H_{Mij} and H_{Vij} are base year indirect tax rates, and Λ_{Hij} and Λ_{Iij} are base year input coefficients for domestically produced and imported commodity flows, respectively. (The latter coefficients are obtained by splitting the Λ coefficients on the right hand side of (3.1.1) into two parts, representing domestically produced and imported commodity flows, respectively.)

Given gross production at constant prices, the current basic value may easily be calculated from the output coefficients and the home and export prices. The market values at current prices of gross production and gross product are, however, also influenced by indirect taxes. In principle, the current value of indirect taxes are in KVARTS-75 calculated from the demand side and allocated on the different production sectors according to their market shares. Since the supply and demand of each commodity is balanced both in terms of basic values and in terms of (net) indirect taxes, the current market value of <u>gross domestic product</u> may be defined either as gross production minus total intermediate inputs, or as total final domestic deliveries less net imports - all at current market values. At constant prices, however, these two ways of measuring gross national product at market prices usually give different results. This is due to the fact that base year rates of indirect taxes vary across sectors whereas supply is balanced against demand at basic value in the current quarter only. (See Bjerkholt and Longva (1980, pp. 58-62) for a further discussion.) Conventionally, we use gross production less intermediate inputs as the model's measure of gross domestic product.

An extensive documentation of the construction of the input-output equations, with analysis of residuals etc., is given in Jensen and Wahl (1985).

3.2. Domestic production and stocks of inventories in manufacturing

Production in the non-manufacturing sectors of KVARTS is, as remarked in section II, assumed either to respond instantaneously to changes in demand - as generated by the input-output equations - or treated as exogenous variables, usually reflecting assumed capacity constraints. (Confer table 1.A). In this section, we present the specification adopted for the manufacturing sectors, in which production responds with a lag not only to demand changes, but also to changes in capacity.

We have found it convenient to distinguish between those manufacturing sectors in which <u>stocks</u> of finished products are of importance as a buffer between demand and supply, and those in which the lagged response between demand and production emerges primarily as the result of <u>orders</u> placed by other sectors in previous periods and time lags in production. This distinction is in accordance with Belsley (1966) and Childs (1967). The sectors treated as sectors producing to stocks include three of the five manufacturing sectors in KVARTS, namely Food and clothing industries, Wood and printing industries, and Mining and raw material industries. The prominent sector producing to orders is the Metal manufacturing industries.[2]

The firms' production decisions in the <u>stock-holding sectors</u> are represented by

$$(3.2.1) \qquad X_t = a\overline{X}_{t-1} + (1-a)\,D_t + b(\overline{S}_t - S_{t-1}) \qquad (0<a<1,\ 0<b<1),$$

where X_t denotes actual production (measured as gross production at constant prices), D_t is actual demand directed towards Norwegian producers (measured as the sum of the intermediate consumption, and the final deliveries to the domestic and export markets minus the corresponding imports), S_{t-1} is the stock of inventories at the beginning of quarter t, S_t is the desired stock of inventories at the end of quarter t, and $\overline{X}_{t-1}$ is the initial production capacity (measured in the same units as X_t) in quarter t. At the beginning of each quarter, there is usually an imbalance between the production capacity and the desired stock of inventories on the one hand, and the actual demand and the actual stock of inventories on the other, i.e.,

$\overline{X}_{t-1} \neq D_t$, and $\overline{S}_t \neq S_{t-1}$. This reflects, inter alia, decision errors, costs of adjustments, and imperfect expectations in previous periods, and equality will therefore be satisfied ex post only by coincidence. Eq.(3.2.1) can be regarded as our attempt to formalize the firms' short-run compromise strategy in order to (i) minimize the (actual or latent) costs incurred by running a production which deviates from actual demand and/or production capacity, while (ii) reducing the gap between the actual and desired stock of inventories.

Since, by definition, $X_t = D_t + S_t - S_{t-1}$[3], (3.2.1) implies the following equation for net increase in stocks:

$$S_t - S_{t-1} = X_t - D_t = a(\overline{X}_{t-1} - D_t) + b(\overline{S}_t - S_{t-1}).$$

This is an equation of the (partial) stock adjustment type (since b lies between 0 and 1), reflecting the output decision mechanism described above. There is thus no place for an independent behavioural equation for inventory stock formation in the manufacturing sectors. This feature distinguishes KVARTS from several other econometric short-term models, and follows from the restrictions imposed by the basic equilibrium equation, cf. section II. For more details, see Biørn (1985b).

Two unobservable variables $\overline{X}_t$, and $\overline{S}_t$, occur in the output decision function (3.2.1). Time series for the capacity variable $\overline{X}_t$, are constructed from data on actual production by means of a modified Wharton ("trend through peaks") method. (See Lesteberg (1979).) A common procedure for treating desired stock variables, $\overline{S}_t$, in economic short-term modelling is to postulate its dependence on other observable variables represented in the model (e.g. long-run sales, interest rates, etc.), and eliminate it by simply inserting these relationships into the rest of the model and reinterpreting its coefficients accordingly. (See e.g. Feldstein and Auerbach (1976).) The approach chosen in KVARTS-75 is not to eliminate desired stocks, but treat them as endogenous variables, determined jointly with production and production capacity.

This procedure can, briefly, be explained as follows. (A more elaborate explanation, with interpretation in terms of a logit-model of qualitative choice, is given in Biørn (1982).) We have tried to construct time series for desired stocks by "translating" qualitative information from business surveys regarding the firms' opinions on the gap between actual and desired stocks into a quantitative measure of S_t, expressed in the same units as S_t. Let z_t denote the difference between the share of the firms (weighted according to their employment) responding that their actual stocks are "too large" and those responding that they are "too small" in quarter t. This variable, which lies between -1 and +1, is transformed into a variable with an infinite range as follows:

$$KB_t = \log\left(\frac{1+z_t}{1-z_t}\right).$$

An estimate of desired stocks at the end of quarter t is then, in turn, calculated by means of the formula (confer also INSEE (1981), section 3.1.4)

$$(3.2.2)\quad \bar{S}_t = S_t\left[1 - k * KB_t * \frac{\bar{D}_t}{S_t}\right],$$

where S_t is actual stock, $\bar{D}_t$ is expected demand (formalized as a moving average on actual demand D_t), and k is a normalization constant. In the model, we have endogenized $\bar{S}_t$ by means of the relation

$$(3.2.3)\quad \frac{\bar{S}_t}{S_t} = c + d\,\frac{\bar{D}_t}{S_t} + e\,r_t,$$

where r_t is an interest rate on loans from commercial banks to companies and S_t and D_t are defined as above. In this way, we implicitly endogenize KB_t, and hence z_t.

The ordinary least squares (OLS) estimates of the output decision function (3.2.1) for the three above-mentioned sectors, reported in table 2, indicate that the stock buffer effect is significant in Wood and printing industries and Mining and raw material industries, and insignificant in Food and clothing industries. We see that in all the three sectors, the gap between desired and actual stock has a significantly positive impact on production (b>0).

Table 2. OLS estimates of the output decision function for stock-holding manufacturing sectors.
Period of estimation: 1967.3-1978.4.
Standard errors in parentheses.

Sector	$\hat{a}$	$\hat{b}$	D.W.
Food and clothing industries	0.1300 (0.0905)	0.2281 (0.0793)	1.94
Wood and printing industries	0.4632 (0.1315)	0.1828 (0.0387)	2.16
Mining and raw material industries	0.4553 (0.0798)	0.1575 (0.0524)	0.92

Figure 3.1 shows the effect on production in each of the three stock-holding sectors of a sustained demand increase of 100 million kroner when production capacity is held constant, but with induced changes in desired stocks (cf. eq. (3.2.2)) accounted for. The long-run increase in production is equal to the demand stimulus in all sectors, but the short-run effects differ considerably. Sector 15, Food and clothing industries, is clearly the fastest sector of the three to meet increased demand by higher production; the initial response is more than three fourths of the demand stimulus, the rest is covered by stock reduction. Sectors 25, Wood and printing industries, and 30, Mining and raw material industries, adjust output considerably slower; only half of the demand increase is met by increased output in the current quarter, and the response is sluggish in the following quarters as well. This is especially the case for Wood and printing industries, in which five years are required to attain an output increase equal to three fourths of the original stimulus. The slow output adjustment in the short run implies that demand is, to a large extent, met by stock depletions, which is illustrated in figure 3.2.

If the production capacity had been treated as endogenous in these simulation experiments, the adjustment of production would have become faster, owing to the effect of demand changes on the firms' capacity expansion (cf. section 3.5). But still the adjustment must be judged as being on the slow side, so that the model seems to overestimate the adjustment lag and hence to underestimate the producers' incentives to rebuild stocks of finished merchandize in the short run. This effect should be born in mind when considering the simulations based on the <u>full</u> model in section V below.

Figure 3.3 illustrates the effect on production of a reduction in the interest rate by one per cent unit. This reflects the impact of interest cost on desired inventory stocks, which is formalized in eq.

(3.2.3). Initially, output increases in order to build up higher stocks. This effect is by far strongest in sector 25, Wood and printing industries, in which desired stocks are most sensitive to changes in the interest rate.

Figure 3.1. Effect on production in the stockholding manufacturing sectors of a sustained demand increase of 100 mill.kr. in each sector. Million 1975 kroner.

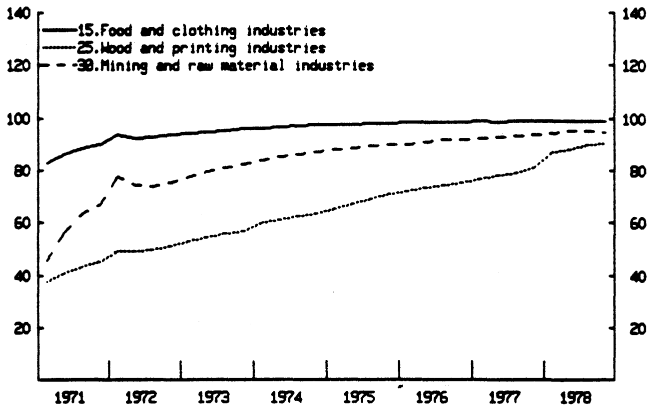


Figure 3.2. Effect on stocks of inventories in the stockholding manufacturing sectors of a sustained demand increase of 100 mill.kr. in each sector. Million 1975 kroner.

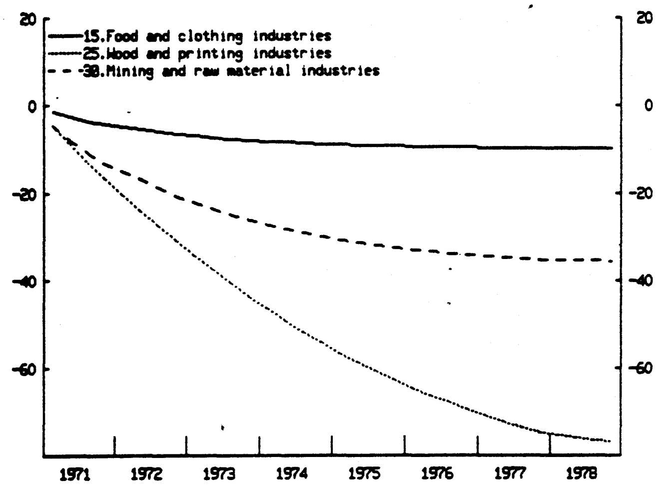
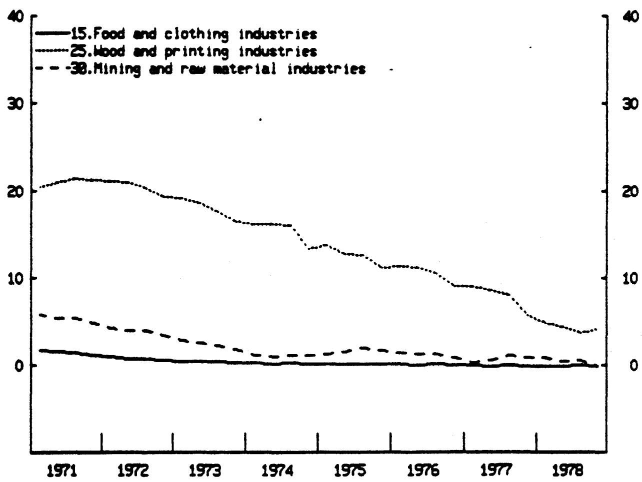


Figure 3.3. Effect on production in the stockholding sectors of a sustained reduction in the interest rate by one percent unit. Million 1975 kroner.



In the sectors which are mainly producing to orders, it is the stock of unfilled orders which acts as a buffer between demand (i.e. new orders) and actual production (i.e. effectuation of orders). It is not easy to formalize this mechanism econometrically. A specification we have worked with - although not yet included in KVARTS-75 - consists of two stochastic equations, one representing the process of effectuation of orders - formalized as a lag distribution between the flow of new orders and the flow of orders effectuated - the other being an output decision function determining actual production (according to the national accounts definition), with actual demand, flow of orders effectuated, and the stock of unfilled orders as the main arguments. The volume of new orders is, in turn, assumed to depend on lagged values of the activity level in the demand sectors (domestic or foreign) and relative prices. Altogether, this mechanism brings a considerable lag between demand (new orders) and production. This specification of the order-production mechanism, although econometrically satisfactorily when considered a separate equation system, did not behave well when used for dynamic simulation experiments within the complete model. We therefore decided, for the present, simply to treat production in Metal manufacturing industries and Ship building and manufacture and repair of oil platforms as demand determined.

One explanation of this state of affairs is the following: Commodities produced to orders by the manufacturing sectors consist for the most part of machinery and equipment for investment purposes. Unfortunately, the Norwegian data on orders (indices) are not well integrated with investment and production as recorded in the historical quarterly national accounts. The problems which this involves for the modelling of the definitional links from the firms' investment decisions, via their placement of orders to the instalment of finished investment goods, have not yet been satisfactorily solved. The fact that KVARTS is a multisectoral model, accentuate these problems. See Hansen and Westphal (1983), Ch. IB) for an interesting attempt to come to terms with these problems in the German quarterly model SYSIFO, which is somewhat more aggregate than KVARTS.

3.3. Imports and exports

The determination of the import volumes is closely connected to the input-output equations in the model. For each commodity is implemented a relation which implicitly equates total supply and demand in basic value (cf. eq. (3.1.1)). For Primary industry products, imports are simply determined as residuals, equal to total demand less domestic production, and for Ships and drilling platforms it is exogenously given. (Confer table 1A.)

For the other commodities, the model contains an import demand equation specified in the following input-output format:

$$(3.3.1)\quad I_i + IE_i = \Sigma_j D^M_{ij}\,\Lambda^{MI}_{ij} M_j + \Sigma_j D^C_{ij}\,\Lambda^{CI}_{ij} C_j + \Sigma_j\, D^J_{ij}\,\Lambda^{JI}_{ij} J_j,$$

where

I_i - imported quantity of commodity i,

IE_i - reexported imports and stock changes of imports, commodity i,

M_j - intermediate input in sector j,

C_j - private consumption of category j,

J_j - investment in new goods of kind j,

Λ^{MI}_{ij}, Λ^{CI}_{ij} and Λ^{JI}_{ij} are base year input coefficients for imported goods (cf. section 3.1) and the D_{ij}'s are the corresponding input coefficients for imported goods in the current quarter relative to their values in the base year. The ratios of the input coefficients of imported and domestically produced goods are not, however, constants as in traditional input-output models, but either treated as exogenous variables (Raw materials for mining and manufacturing and Service commodities) or specified as log-linear functions of the relative prices in the following way:

$$(3.3.2)\quad \log\left[\frac{\text{input coefficient, imports}}{\text{input coefficient, domestic production}}\right] = \text{const} + \sigma_i \log\left(\frac{BH_i}{BI_i}\right),$$

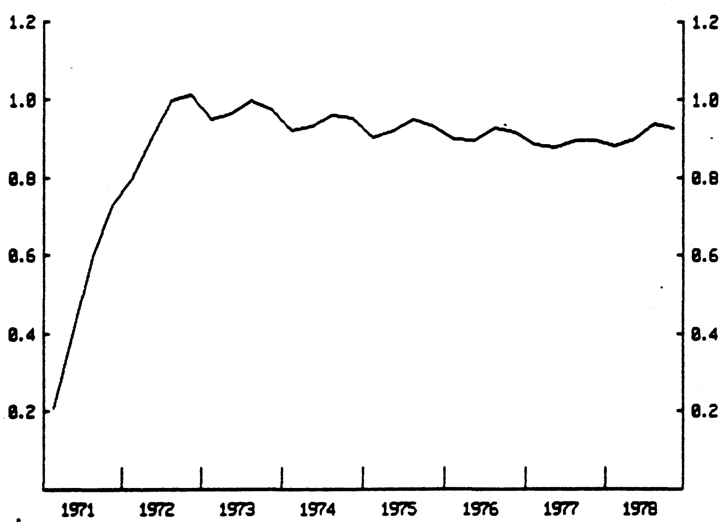
where

BH_i - price of domestically produced goods, commodity i,

BI_i - price of imported goods, commodity i, and σ_i may be interpreted as the elasticity of substitution in demand between domestically produced goods and imported goods of category i. This equation is estimated econometrically, subject to the restriction that σ_i is the same for all sectors receiving commodity i. A lag distribution (linear Almon lag over 8 quarters) is also included, reflecting a gradual adjustment of the import shares to changes in relative prices. The highest (long-run) elasticity of substitution (σ_i = 2.2) is estimated for Wood products, printing etc. For the other manufacturing commodities, the estimates are close to 1.5. The long-run elasticities are reported in table 3. A further documentation of the estimation results is given in Reymert (1984).

The reaction of the quantity of the price sensitive imports to a sustained one per cent increase in the price of Norwegian production, with the import price kept constant, is exhibited in figure 3.4. The initial effect is moderate, with an elasticity of about 0.2. The full effect of the lost competitive edge comes after about six quarters, when imports have risen by slightly less than one per cent, or more than four times the short run effect.

Figure 3.4. Effect on the quantity of price-sensitive imports of a sustained one per cent increase in the price of Norwegian production. Per cent.



Export volumes are for most of the commodities determined by econometric equations. Only exports of Primary industry products, Ships and drilling platforms, and Crude oil and natural gas are exogenous variables.

The formulation of the export equations is related to the hypothesis of behaviour on which the production block is based (see sections 3.2, 3.5, and 3.6). According to this theory, producers are facing downward sloping demand curves both in the foreign and in the domestic markets. Actual deliveries equal actual demand, both in the short and in the long run. But in the short run, deliveries may deviate from production, and changes in stocks will take place.

In general form, the export volume equation of commodity i is:

$$(3.3.3) \quad E_i = E_i\,(PE_i/PK_i,\ MAI_i,\ LAI_i,\ E_{i,-1}),$$

where

E_i - export volume,

PE_i - export price,

PK_i - price index for competitors,

MAI_i - indicator of the size of the Norwegian export markets (excl. change in stocks),

LAI_i - indicator of stock changes in the export markets.

For most of the commodities, this general form is approximated by a log-linear function. The estimated long-run elasticities are given in table 3. The indicator of the market size, MAI_i, is the most important determinant of export changes in the short as well as in the medium term. This indicator is constructed as a weighted average of changes in private consumption, investment in dwellings, and other investments in eight of the most important countries receiving Norwegian exports[4]. It is calculated separately for each of the commodities in the model, the weights reflecting the different composition of exports between countries as well as the different input requirement in the three final demand components mentioned above. (The procedure followed in calculating these market size indicators is explained in Tveitereid and Lædre (1981).)

The elasticity of the export volume with respect to foreign activity shows considerable variation between commodities. For Food, clothing etc. and Raw materials for mining and manufacturing the estimated long run elasticity is close to unity. The income elasticity for Foreigners' consumption expenditures in Norway is estimated to 1.8, and for the other commodities, except Ocean transport (see below), the long run elasticities vary between 2 and 3.

The indicator of stock changes specified in (3.3.3), LAI_i, is only included in the export demand equation for the two commodities, the demand for which are assumed to be most strongly exposed to cyclical changes abroad, namely Wood products, printing etc. and Raw materials for mining and manufacturing.

The price ratio, PE_i/PK_i, is included in all export equations except the one for Domestic transport and power supply. For these commodities, the export price is determined by an econometric equation (see section 3.7).

Although export volumes are specified to depend on relative prices, the estimated price elasticities are rather small, and the adjustment takes place with a considerable lag. The long run price elasticities vary between 0.2 and 0.6 for most commodities. The highest estimate is obtained for Wood products, printing, etc., 1.7.

Figure 3.5 shows the relative increase in total exports and exports of merchandize when world activity level increases by one per cent.

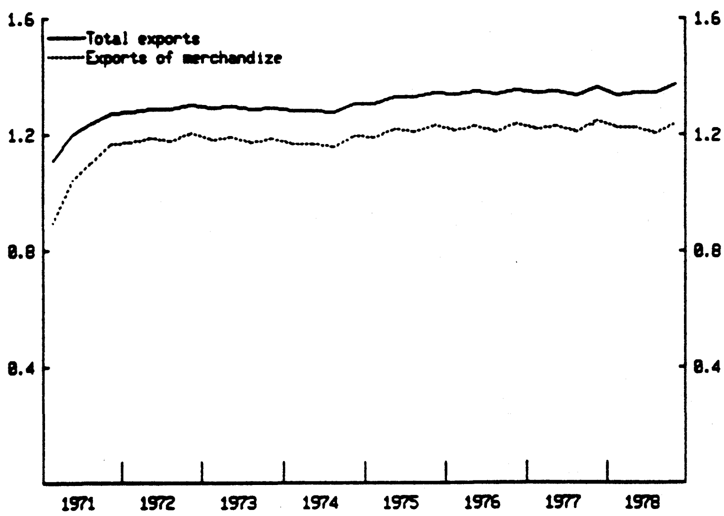
Table 3. Estimated long-run elasticities in import and export equations

Commodity	Imports[1] Elasticity of substitution between domestic and imported goods	Exports Price	Exports Market size
Food, clothing etc.	1.318	-0.526	0.994
Wood products, printing etc.	2.185	-1.725	2.020
Raw-materials from mining and manufacturing	-	-1.657	0.754
Machinery and metal products	1.554	-0.500	2.450
Domestic transport and power supply	-	-	2.907
Various services	-	-0.278	3.224
Foreigners' consumption in Norway	-	-0.557	1.750

[1] The income elasticity (scale elasticity) is a priori set equal to unity for all domestic users; cf. eqs. (3.3.1) and (3.3.2).

Total exports increase swiftly because the non-merchandize sectors are assumed to adjust without a lag. The export of merchandize, on the other hand, reacts with a lag, but most of its adjustment is completed within four quarters.

Figure 3.5. Effect on quantity of exports of a sustained one per cent increase in world activity. Per cent.



Norway's export of Ocean transport services is - tentatively - determined by the following equation:

$$\log (E_{60}/KM_{60}) = \text{const} + h_M \log (IM/TS) + h_T t,$$

where

KM_{60} - capital stock in production of ocean transport services,

IM - indicator of world trade,

TS - total commercial world fleet,

t - trend variable.

Since this equation implies that the ratio between the export volume (i.e. production of ocean transport services) and the capital stock depends on the ratio between the total world trade and the world commercial fleet, an international recession, leaving the world fleet unchanged, will be accompanied by a decline in the relative utilization of the capacity of the commercial fleet. A further documentation of the estimation results for the export equations is given in Reymert (1984).

It follows from the above description that the export and import flows in KVARTS are based on the same commodity classification as domestic production and stock formation (cf. table 1A). Matrices with fixed coefficients, estimated from Norway's foreign trade statistics, link the export and import flows as classified according to the SITC standard with the commodity classification in KVARTS, and vice versa. (Confer Lund and Reymert (1981) for details on the construction of these matrices.)

3.4. Household consumption

The theoretical framework of the model block for household consumption is a variant of the Extended Linear Expenditure System (ELES, see Lluch (1973)), using a classification with 5 categories of non-durables and 2 categories of durables. The consumption categories are specified in table 1.B.

Before settling on the final model formulation, we also experimented with variants of the linear expenditure system (DELES, see Dixon and Lluch (1977)) in which both stocks of durables and estimated service flows from these stocks are specified, and accordingly, with a distinction made between consumption services from durables and purchase expenditures, and between user costs of durables and their acquisition prices. (For more elaborate discussion and interpretation of this model, see Biørn (1979).)

This model formulation - with the purchase of durables integrated into a theory of the consumer's optimization over time - has three attractive properties. First, it gives a theoretically consistent description of the effect of interest changes on consumption of durables and non-durables. Second, it treats the consumer's investment in financial and real assets symmetrically and opens for substitution between these two forms of capital accumulation. Third, its macro consumption function is formulated in terms of consumption services, rather than in terms of purchase expenditures. Results of empirical analyses of several variants of this model are extensively documented in Biørn and Jensen (1983). The strict neo-classical model of stock adjustment, with no decision lags specified, did not perform well on our data. This conclusion agrees with that of Muellbauer (1981). But several of the other model variants, with some rigidities in behaviour specified, gave a reasonably good fit; however, the estimated price responses turned out to be rather weak. This conclusion confirms the statement of Houthakker and Taylor (1970, p. 165) that "the lack of a strong overall influence of prices is consistent with the predominance of habit formation". However, the specification of decision lags and sluggishness in response for durables and - in particular - the treatment of financial restrictions gave rise to problems with keeping the definitional equations "intact" when the consumption block was combined with the rest of KVARTS for dynamic simulation experiments. In particular, it turned out to be a problem that adequate data on the households' financial situation, i.e. household gross debt and bank deposits, integrated with the income accounts of the national accounts, were lacking for the period of estimation. For these reasons we decided to stick to the simpler, and theoretically less interesting, ELES formulation, with no specific treatment of durables, in the first version of KVARTS.

The simple ELES formulation adopted in KVARTS-75 results in a recursive structure in the determination of household consumption: A macro consumption function determines the aggregate value of total consumption expenditure in a first stage, and this total is, in a second stage, disaggregated on the seven consumption categories. The latter equations coincide with the simple LES system (confer Lluch (1973), and Biørn (1979, section 3.3)).

The macro consumption function is specified as a distributed lag equation of the form

(3.4.1) $C = (\alpha + \alpha_1(L)R + \alpha_2(L)K)\cdot$ seasonal factors,

where

C - total household consumption,

R - real disposable household income,

K - real value of the increase in credits to the household sector,

and α_1 and α_2 are lag generating polynomials. The long-term marginal propensity to consume of disposable income, α_1, is 0.914, and the effect is exhausted after eight quarters. The main motivation for including the credit variable, is the severe rationing of household credits which has been in effect during most of our estimation period. A credit expansion has an estimated long-run marginal propensity to consume of α_2 = 0.43, and the effect is exhausted in the course of four quarters.

The seasonal effects are represented by including multiplicative quarterly dummies in (3.4.1). Not surprisingly, we find that total consumption attains its seasonal peak in the fourth quarter, the low-season being in the first quarter (with an average level of consumption about 15 per cent lower than in the fourth quarter).

We then turn to the equations which allocate total consumption expenditure on the seven categories specified in the model. The main determinant of the housing services is the stock of dwellings. In modelling this variable, we have closely adopted the conventions used in the data construction in the national accounts, rather than adhering to the ELES formulation. That formulation is followed for all the remaining six consumption categories, in that we allocate total consumption expenditures less consumption of housing services on these commodities in the following way:

$$(3.4.2)\quad C_j = \gamma_j + \beta_j/P_j\ (VC - VC_h - \Sigma P_j\gamma_j) + \text{seasonal terms},$$

where

C_j - consumption of category j at constant prices,

P_j - price of consumption category j, and

$(VC-VC_h)$ - value of total consumption less housing consumption at current prices.

The system (3.4.2) - with the seasonal variables specified in such a way that the homogeneity and adding-up constraints of the basic ELES model are not violated (see Biørn and Jensen (1983, section 4.1)) - is estimated by means of the full information maximum likelihood method, subject to the restriction $\Sigma\beta_j = 1$. This estimation procedure automatically ensures that the definitional equation $VC = \Sigma P_jC_j + VC_h$ is satisfied. In table 4, we present the sample mean price and income elasticities that follow from the coefficient estimates.

Figure 3.6 shows the effect on consumption of a sustained increase in household real disposable income of 100 million kroner. This simulation experiment is performed within the framework of the consumption submodel combined with the submodel for housing investment (confer section 3.5) in order to capture the effect on the consumption of housing services through the income sensitive housing investment equation. The initial effect on consumption is relatively small, 15 million kroner, reflecting primarily the small coefficient for the first quarter of the income variable in the aggregate consumption function (3.4.1). After one year, the effect has increased to 60 million kroner, and after two years the new equilibrium level of about 90 million kroner has been attained, reflecting a long run marginal propensity to consume of approximately 0.9. Total consumption and total consumption excluding housing consumption behave in much the same way in the first year, because of the considerable lag in the adjustment in the stock of dwellings and hence in consumption of housing services. (Confer section 3.5.) Since total consumption is determined in the aggregate consumption function, the increase in housing consumption after about 5 quarters implies that a part of the initial increase in consumption of other goods is gradually "crowded out". This explains the "wedge" between the two graphs in figure 3.6.

Figure 3.6.Effect on private consumption of a sustained increase in household real disposable income of 100 mill.kr. Million 1975 kroner.

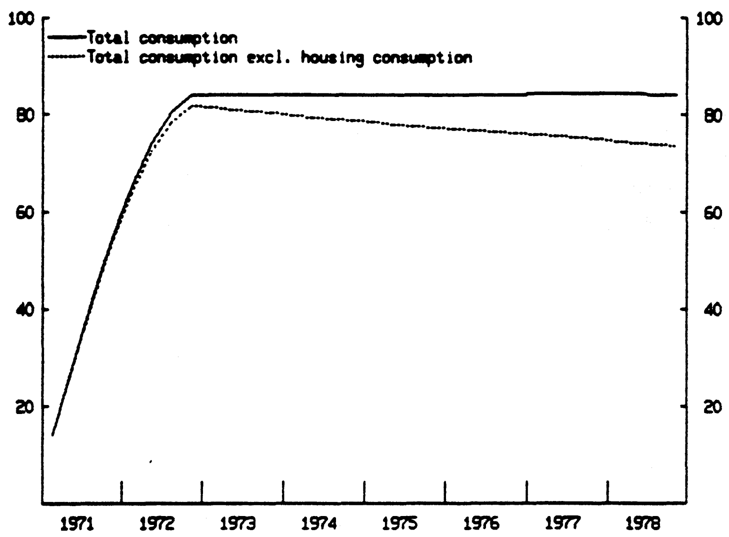


Table 4. Price and income elasticities in the household consumption model. Calculated at sample means

	Food	Other non-durable con-sumption goods	Semi-durable goods	Personal transport equipment	Other durable goods	Other ser-vices
Income elasticity ...	0.542	1.168	0.846	2.049	1.630	0.903
Direct price elasticity	-0.438	-0.893	-0.626	-1.067	-1.074	-0.710
Mean budget share ...	0.257	0.208	0.173	0.052	0.080	0.259

3.5. Investment, replacement, and production capacity

The firms' capital formation is classified according to equipment type and sector. The sectors are specified at the same level of aggregation as production, demand, prices, and employment. (Confer table 1B.) This is an obvious advantage for the modelling of the firms' investment and employment decisions, since we can work with explicit production functions when formulating the behavioural equations.

In the manufacturing sectors, our point of departure is a long-term capacity production function of Cobb-Douglas form in capital and (long-term) employment with constant returns to scale. The long-run capital coefficients (i.e. capital per unit of production capacity) are thus independent of the production scale. Two kinds of capital are specified, machinery/equipment and buildings, and aggregate capital is interpreted as a CES aggregate of these two components. The long-term technology of the manufacturing sectors is thus formally represented as a two level neo-classical production function in three factors; labour and aggregate capital forming the upper level and specified as a Cobb-Douglas function, and a CES function in machinery/equipment and buildings forming the lower level.

Making the assumption that producers minimize long-run average cost and introducing sluggishness in adjustment and lags in the formation of expectations, we obtain the following equations for the adjustment of the capital coefficients:

$$(3.5.1)\quad \Delta\log a_{Mt} = \eta_M \Delta\log a_{M,t-1} + (1-\eta_M)\alpha\lambda(L)\,\Delta\log (w/c)_t - (1-\eta_M)\sigma\eta(L)\Delta\log (c_M/c)_t,$$

$$(3.5.2)\quad \Delta\log a_{Bt} = \Delta\log a_{Mt} + \eta_B(\Delta\log a_{B,t-1} - \Delta\log a_{M,t-1}) - (1-\eta_B)\sigma\eta(L)\,\Delta\log (c_B/c_M)_t,$$

where a_M and a_B are the capital coefficients of machinery/equipment and buildings, respectively, c_M and c_B are the corresponding user costs, and w is the wage rate. The lag polynomials $\lambda(L)$ and $\eta(L)$ and the coefficients η_M and η_B represent sluggishness in adjustment, the lags in the formation of expectations, etc. The average user cost of capital c is constructed from c_M and c_B, using a cost function which is dual to the CES function for the capital aggregate referred to above. Our estimates of these non-linear equations indicate a small, but positive, elasticity of substitution, σ, between the two capital components in this CES element of the production function, and considerable sluggishness in the adjustment of both capital coefficients to changes in relative factor prices (high η_M).

The series for the user cost of capital variables, c_B and c_M, are constructed by a method which is consistent with the construction of the corresponding series for capital and replacement; both are based on the same linear survival profile. A multiplicative tax factor intended to capture the effect of income taxes and depreciation rules, links the investment model to fiscal policy variables. (See Biørn and Fosby (1980) and Biørn (1983) for details.)

The choice of capital intensity in the production, in conjunction with the choice of production capacity, define the actual capital accumulation in the manufacturing sectors. The capital intensity is determined by (3.5.1) and (3.5.2), as explained above. The capacity variable plays an important role in KVARTS-75, with links to several model blocks. Its endogenization has caused some problems, inter alia due to problems of appropriately measuring capacity. The formulation of the capacity expansion process finally adopted is:

$$(3.5.3)\quad \Delta \bar{X}_t = \beta\, \Delta\bar{X}_{t-1} + \gamma(L)\rho_t + \delta(L)\Delta D^*_t,$$

where $\bar{X}_t$ denotes the production capacity, ρ_t is the rate of the profitability of the sector (defined as net operating surplus per unit of capital value), D^*_t indicates demand (from domestic or foreign sectors), and $\gamma(L)$ and $\delta(L)$ are lag polynomials. We find that ρ_t has a significantly positive effect on the capacity expansion in the majority of the manufacturing sectors - which reflects, inter alia, that reduced profits coincided with diminishing investments during the second half of the estimation period (1968-1978). This profitability variable is an important link between the price and income block and the quantity block of the model, and it can be interpreted as representing elements of producer "supply response". Eqs. (3.5.1)-(3.5.3) in conjunction with the definitional equations

$$\Delta\log K_M = \Delta\log a_M + \Delta\log \bar{X} \approx \Delta\log a_M + \Delta\bar{X}/\bar{X},$$

$$(3.5.4)$$

$$\Delta\log K_B = \Delta\log a_B + \Delta\log \bar{X} \approx \Delta\log a_B + \Delta\bar{X}/\bar{X},$$

determine the actual capital accumulation in the manufacturing sectors. See Biørn (1985a), for further details.

Replacement is calculated as a close approximation to the method of linear depreciation followed in the data construction in the national accounts. The definitional equations between gross investment, replacement, and capital stocks are also specified in the model.

Table 5 shows the estimated increase in gross investment following from a maintained increase of 100 million 1975 kroner in demand in three of the manufacturing sectors. The reduction in investment, which results from a maintained increase of one per cent unit in the interest rate, is shown in table 6.

Table 5. The effect on gross investment in manufacturing sectors of a maintained increase of 100 million 1975 kroner in demand directed towards each sector.
Million 1975 kroner

Sector	Type of capital	Quarter after increase 1	2	4	8	12	16	20
Food and clothing industries	Machinery and equipment	0.1	0.4	1.5	3.6	4.6	3.4	1.1
	Buildings	0.2	0.5	1.6	3.8	4.6	3.1	0.4
Wood and printing industries	Machinery and equipment	1.1	2.1	4.0	3.3	2.5	1.6	0.9
	Buildings	0.9	1.8	3.4	2.6	1.8	0.9	0.3
Mining and raw materials industries	Machinery and equipment	1.5	2.9	5.7	5.2	4.9	4.5	1.4
	Buildings	1.5	3.0	5.7	4.9	4.3	3.8	0.6

Table 6. The effect on gross investment in manufacturing sectors of a maintained increase in interest rate of 1 per cent unit.
Million 1975 kroner

Sector	Type of capital	Quarter after increase 1	2	4	8	12	16	20
Food and clothing industries	Machinery and equipment	-33.3	-33.8	-20.3	-38.2	-11.3	-6.1	-2.6
	Buildings	-37.3	-37.2	-21.1	-39.2	-7.9	-1.8	-1.6
Wood and printing industries	Machinery and equipment	-17.8	-23.9	-17.6	-8.5	-5.9	-3.7	-0.6
	Buildings	-15.4	-20.5	-14.5	-6.0	-3.5	-1.5	1.0
Mining and raw materials industries	Machinery and equipment	-33.9	-51.7	-57.3	-35.6	-26.1	-17.9	-7.1
	Buildings	-35.3	-53.1	-56.8	-31.6	-20.9	-11.9	-1.4

Mainly because of the supposed lower data quality, we have chosen a less ambitious model formulation for non-manufacturing sectors. Here we have, for the most part, implemented a simple version of the flexible accelerator of the following form:

(3.5.5) $I_t = \alpha(L)\ (X_t - X_{t-1}) + \text{seasonal factors},$

where I_t is net investment and X_t is gross production. (The coefficients of the seasonal factors are restricted to add to zero, to comply with the requirement in the accelerator theory that the intercept term is zero "on the average".) This formulation is adopted for machinery/equipment and buildings separately. In the Primary industries, operating surplus also plays a role in determining net investment.

The estimated mean lag is typically 5 to 8 quarters and the sum of the lag coefficients, which can be interpreted as the long term marginal capital coefficient, is in most sectors somewhat below the corresponding average coefficient. (See Jensen (1985) for further details.)

Replacement in the non-manufacturing sectors is modelled in the same way as in the manufacturing sectors.

Table 7 shows the effect of a maintained increase of 100 million 1975 kroner in the level of output.

Table 7. The effect on gross investment in non-manufacturing sectors of a maintained increase of 100 million 1975 kroner in gross production.
Million 1975 kroner

Sector	Type of capital	Quarter after increase						
		1	2	4	8	12	16	20
Primary industries	Machinery and equipment	4.1	9.8	24.8	35.8	25.6	8.7	9.1
	Buildings	0.7	3.4	13.5	32.2	34.0	18.8	1.1
Buildings and construction	Machinery and equipment	0.3	1.4	5.7	12.7	10.4	4.3	4.5
	Buildings	0.2	0.4	0.7	1.0	0.8	0.3	0.1
Domestic transport and power supply	Machinery and equipment	5.7	9.4	15.2	21.3	19.7	9.6	6.2
	Buildings	15.8	28.7	47.4	65.5	55.7	17.5	3.7
Various services	Machinery and equipment	6.4	11.3	16.9	9.9	3.9	4.4	4.6
	Buildings	10.8	22.8	43.6	0.6	0.7	0.7	0.7

The effect of sustained output increases of 100 million kroner in each sector on gross investment is summarily depicted in figures 3.7 and 3.8. The producers want to build up capital stocks in response to higher output, and they start investing. We see from figure 3.7 that total gross investment grows quite fast, attaining a maximum of about 220 million kroner after 4-5 quarters. The investment boom lingers on for some time, due to the different lag structures in the different sectors. Even after three years, gross investment is still significantly higher than the new equilibrium level to which investment declines towards the end of the fourth year. The reason why the new equilibrium level of gross investment is higher than the initial one, is that the producers have built up a larger capital stock during the intervening years, which implies a larger replacement investment.

Figure 3.7 shows moreover that investment in the manufacturing and non-manufacturing sectors have quite similar patterns of time response to output changes, but that the manufacturing sectors represent a minor fraction of the total. This reflects on the one hand that manufacturing sectors are not among the dominating investment sectors in Norway, and on the other hand that capacity accumulation in these sectors is not assumed to respond to output changes only, but is also directly motivated by profitability considerations (cf. eq. (3.5.3)). In the partial simulation experiments presented here, the link between output and profit rates has not been taken into account, and it will be represented only when we perform simulations by means of the complete model.

Figure 3.8 shows that the output expansion induces larger investment in buildings than in machinery and equipment and that the response comes faster. The investment boom for buildings peaks at 130 million kroner after 4 quarters, whereas machinery and equipment peaks at 100 million after 6 quarters. The somewhat smaller response of machinery and equipment is, to some extent, due to the fact that the manufacturing sectors are relatively machinery intensive, and, as noted above, these sectors account for only a small part of the total investment. We also note that the new equilibrium level of gross investment is considerably lower for buildings than for machinery and equipment, despite the larger increase in capital accumulation. The reason is, of course, that buildings have by far the longest service lives and hence the smallest replacement rates.

Figure 3.7. Effect on gross investment of a sustained production increase of 100 mill.kr. in each sector. Million 1975 kroner.

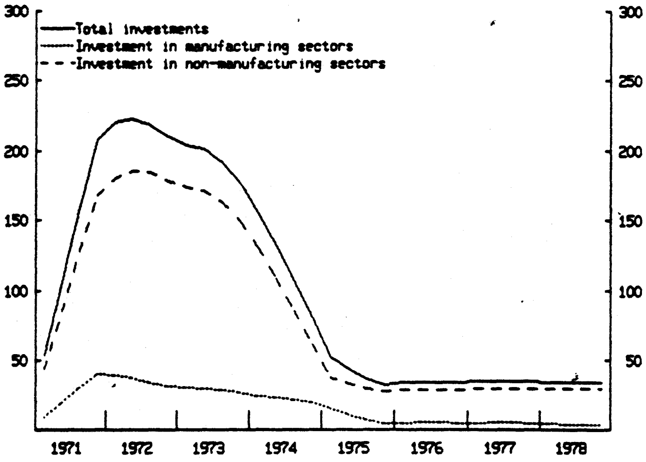
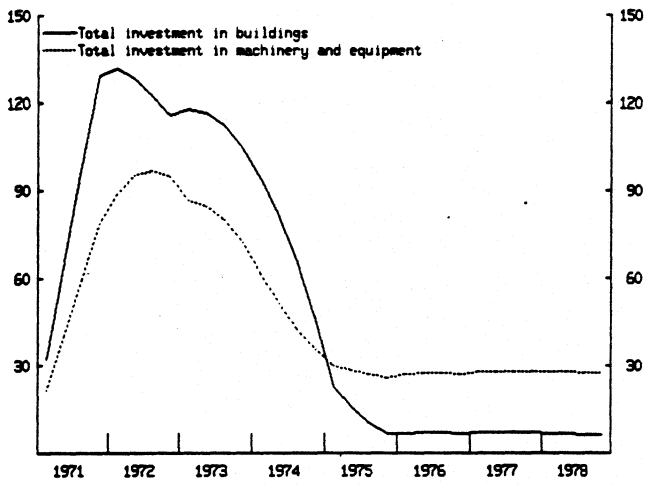


Figure 3.8. Effect on investment in buildings and in machinery and equipment of a sustained production increase of 100 mill.kr. in each sector. Million 1975-kroner.



In modelling the investment in housing, dwellings are treated as durable comsumption goods, and, correspondingly, the investment activity is regarded as the activity through which the households can attain the stock of dwellings that results in the desired size of housing services (cf. section 3.4). KVARTS does not contain an explicit treatment of the various submarkets within the housing market (single units, multiple units etc.), one of the reasons being lack of data. Neither have we tried to model explicitly the extensive regulations in the Norwegian housing market that have prevailed during the entire estimation period. In the equation determining housing starts, however, we have included granted housing loans from the National Housing Bank as one of the explanatory variables. This is intended to represent a kind of credit rationing regime, as we assume that a considerable share of the households were subject to credit rationing during this period.

Nevertheless, it is the demand side of the economy which is the predominant factor in determining the volume of housing starts in the model. The supply side comes in only through the specification of a lag distribution between housing starts and completions. It is estimated from building statistics (vintage data), and turned out to be surprisingly stable during our period of estimation. The equation determining housing starts includes real disposable household income, real price of housing investment, real interest rate, and the real value of granted dwellings loans from the National Housing Bank as the main explanatory variables.

In table 8, we present some results from partial shift analyses performed on the housing investment model. (See Knudsen (1985) for further details.)

Table 8. The effect on housing starts and housing investments of increases in interest rate, income, and dwelling loans.

A. Maintained increase of 1 per cent unit in the real interest rate

	Quarter after increase						
	1	2	4	8	12	16	20
Housing starts 1000 m^2	-10.0	-11.4	-11.7	-11.6	-11.6	-11.1	-10.8
Investment in dwellings, million kroner	-26.7	-23.3	-6.6	-13.2	-21.4	-25.0	-26.1

B. Maintained increase of 1000 million 1975 kroner in real disposable income

	Quarter after increase						
	1	2	4	8	12	16	20
Housing starts 1000 m^2	8.7	99.4	89.3	75.7	62.0	52.4	45.0
Investment in dwellings, million kroner	57.9	115.2	172.1	171.8	152.1	133.4	102.0

C. Maintained increase of 1000 million 1975 kroner in granted dwelling loans from the National Housing Bank

	Quarter after increase						
	1	2	4	8	12	16	20
Housing starts 1000 m^2	167.4	324.7	502.3	439.5	370.6	293.3	240.9
Investment in dwellings, million kroner	109.4	305.6	762.1	978.3	895.6	757.4	558.7

3.6. Employment

The number of wage-earners employed and their total number of hours worked is endogenously determined in all production sectors in KVARTS. The number of self-employed is exogenous.

As noted in section II, the distinction between long-run and short-run adjustments is a basic point in the description of the producers' behaviour in the manufacturing sectors. The long-run considerations determine production capacity, capital stock, and long-run employment (i.e. employment at full capacity utilization). The long-run cost minimization underlying the firms' capital formation (cf. section 3.5) also determines long-run employment per unit of production capacity as a function of relative factor costs.

Short-run cyclical movements in the degree of capacity utilization may, however, lead to discrepancies between realized employment in terms of persons and its optimal long-run level, owing to adjustment costs as well as economies of scale in production in the short run. The realized number of working hours per unit of actual production in the manufacturing sectors is therefore expressed as a function not only of relative factor costs, but also of the degree of capacity utilization. This function is specified as follows, after inclusion of a time trend for technical change:

$$\text{(3.6.1)} \quad \log (X_t/LW_t) = b_0 + b_1(L) \log (w_t/c_t) + b_2 \log (X_t/\bar{X}_t) + b_3 t,$$

where

LW_t - total number of hours worked by wage earners,

$(X_t/\bar{X}_t)$ - relative capacity utilization,

w_t - wage cost per hour,

c_t - user cost of capital,

and $b_1(L)$ is a lag polynomial, with a maximal lag of seven quarters. The estimated coefficients are typically 0.5, both for b_1 and b_2, the latter implying a short-run scale elasticity of 2.

The number of hours worked, LW, has two components: the number of employed workers and the length of their average working day. We hypothesize - in the spirit of Okun's law - that progressively increasing costs are incurred by changing the number of employed. For a given increase in output, the firms must balance these costs against the costs of increasing the total number of hours worked by increasing the use of overtime or by increasing the degree of "internal unemployment". These considerations lead to the following equation for the adjustment of employment:

$$(3.6.2) \quad NW_t/NW_{t-1} = (LW_t/(NW_{t-1}\cdot\bar{H}_t))^{\lambda},$$

where

NW_t - number of employed persons,

$\bar{H}_t$ - length of a normal working day.

In most of the manufacturing sectors, the estimation results in λ-values of about 0.5 which implies a mean lag of approximately 1 quarter. Taken together, the estimates of (3.6.1) and (3.6.2) imply roughly that a one per cent increase in output will increase the number of employed persons by approximately 0.25 per cent in the short run, whereas changes in relative factor costs will have negligible short-run employment effects. See Stølen (1983), for a documentation of the estimation results.

In the non-manufacturing sectors, the number of hours worked is expressed simply as a function of output and a trend, in the following way:

$$(3.6.3) \quad \log LW_t = b_o + b_1(L) \log X_t + b_2 t,$$

one of the reasons being that we lack an acceptable capacity measure for these sectors. The lag between output and employment turned out to be significant in Buildings and construction and Domestic transport and power supply only.

Table 9 shows the estimated effect on employment of a sustained increase in output of one per cent, starting in 1974.1. An overall visual picture of the effect of a one per cent uniform increase in output, with production capacity kept constant, is given in figure 3.9. Most of the effect is exhausted during the first four quarters, the manufacturing sectors reacting somewhat slower than the non-manufacturing sectors. Figure 3.10, which illustrates the response in each of the manufacturing sectors, shows that employment in sectors 30, Mining and raw material industries, and 50, Ship building and manufacture and repair of oil platforms, has the slowest reaction to output changes. The shipbuilding industries, however, have the strongest relative increase. This reflects the low marginal elasticity of labour in this sector, which implies that a relatively larger increase in employment is required to achieve any given output growth.

Figure 3.9. Effect on employment of a sustained one per cent increase in production in each sector. Per cent.

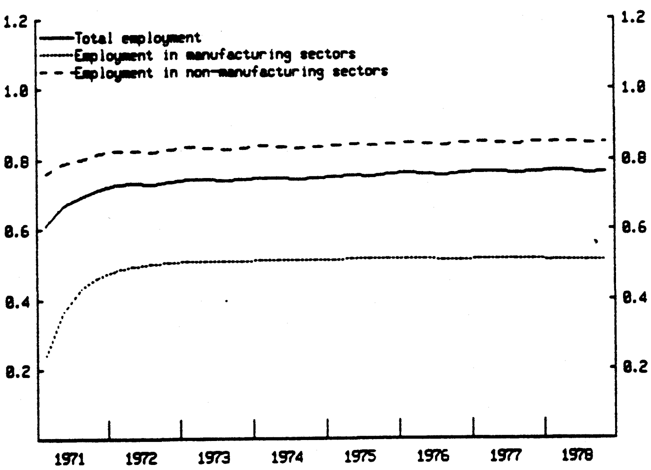


Figure 3.10. Effect on employment in the manufacturing sectors of a sustained one per cent increase in production in each sector. Per cent.

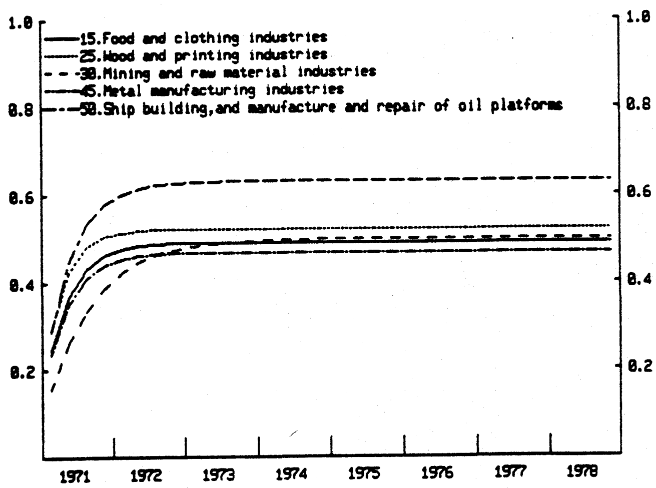


Table 9. The effect on employment of a maintained increase in output of 1 per cent.
Per cent

Sector		Quarter after increase 1	2	4	8	12
Primary industries	Hours worked	1				
	Length of average working day	0				
	Number of employed	1				
Food and clothing industries	Hours worked	0.48				
	Length of average working day	0.23	0.12	0.03	0.00	
	Number of employed	0.24	0.36	0.45	0.48	
Wood and printing industries	Hours worked	0.51				
	Length of average working day	0.21	0.09	0.02	0.00	
	Number of employed	0.29	0.41	0.49	0.51	
Mining and raw material industries	Hours worked	0.48				
	Length of average working day	0.33	0.23	0.11	0.02	0.00
	Number of employed	0.15	0.26	0.38	0.46	0.48
Metal manufacturing industries	Hours worked	0.46				
	Length of average working day	0.22	0.11	0.03	0.00	
	Number of employed	0.23	0.34	0.43	0.46	
Ship building and manufacturing and repair of oil platforms	Hours worked	0.62				
	Length of average working day	0.33	0.18	0.05	0.00	
	Number of employed	0.31	0.44	0.57	0.62	

3.7. Prices

As described in section 3.1, each commodity has, in principle, three different prices - an import price, a price of domestic production delivered to the home market (the home price) and an export price. All the import prices are exogenous in the model. (Cf. table 1.A.) We assume that these prices (in foreign currencies) are determined independently of the cyclical behaviour of the Norwegian economy. In addition, for some of the commodities where export deliveries represent a substantial part of total domestic production, the home price is set equal to the exogenous export price.

In the early stages of the planning of the theoretical framework for the KVARTS model, the price determination as well as the determination of the production and the stock changes were all regarded as integral parts of the firms' optimizing behaviour. Firms were assumed to be price takers in the long run, but were facing downward sloping demand curves in the short run, and hence had some monopolistic power. It followed from this that the determination of prices and quantities produced should be treated as joint decisions.

As described in the previous sections, the basic features of this theoretical scheme has been retained and implemented in the equations determining stock changes, quantities produced, employment, and capital accumulation in the manufacturing sectors. For the price determination, however, we decided to adopt a somewhat simpler model, although with some of the original theoretical elements retained. There are several reasons for this, not least a suspicion that the quality of the price data hardly permits a good discrimination between the hypotheses inherent in the original theory.

For most of the home prices and some of the export prices, KVARTS-75 contains econometric price equations. The general form of the equations for the home prices is:

$$(3.7.1) \qquad \log (BH_i) = \text{const} + a_{1i}\log (UC_i) + a_{2i}\log (BI_i) + a_{3i}CAP_i + a_{4i}\, t,$$

where

BH_i - home price, commodity i,

UC_i - variable unit costs in production of commodity i,

BI_i - import prices, commodity i,

CAP_i - indicator of relative capacity utilization in the sector which is the main producer of commodity i,

The estimated long-run elasticities are reported in table 10. We see that the main determinants of the home prices are unit costs. The estimated influence of import prices is rather weak, and for some commodities it seemed to be nonexistent. In addition, for only a few of the commodities we found a significant effect of the capacity utilization. This effect is, however, theoretically important, as it constitutes a link between the quantity side and the price side of the model. This link will be strengthened when - as is planned - demand pressure indicators are introduced in the price equations.

The adjustment to changes in costs is implemented with lags, but the mean lag turned out to be relatively short, and most of the adjustment of prices to a change in costs takes place in the current and the next quarter. Although in most cases no restrictions to that effect have been imposed a priori, the estimates indicate that domestic prices are nearly linear homogeneous in unit costs and import prices ($a_{1i} + a_{2i} \approx 1$)

The general form of the export price equations are:

$$\text{(3.7.2)} \qquad \log(PE_i) = \text{const} + a_{1i}\log(UC_i) + a_{2i}\log(PK_i) + a_{3i}\,CAP_i,$$

where PK_i is an index of competitors' prices, commodity i, and the other symbols have the same meaning as above. These export price equations are, however, only implemented for the manufacturing commodities Food, clothing etc., Wood products, printing etc., Raw-materials for mining and manufacturing and Machinery and metal products. For the latter, current and lagged unit costs are the sole determinant. The export prices of the three former commodities are mainly determined by competitors' prices , with coefficients equal to 0.87, 0.57, and 0.68, respectively. For Food, clothing etc., the activity level in the fishing industry is included as an additional explanatory variable, according to a hypothesis that increasing production leads to a lower price and hence increasing foreign demand.

The export prices of services other than Ocean transport services are assumed to follow the corresponding home prices. The export prices of Ocean transport services and Crude oil and natural gas are exogenous. (A further documentation of the export price equation is given in Reymert (1984).)

The effect of a one per cent increase in variable unit cost on the home price, as calculated from the econometric price equations, is illustrated in figures 3.11 through 3.13. The short run effect differs quite a lot between commodities, the strongest effect occuring for commodity 45, Machinery and metal products, where close to 80 per cent of a cost increase is passed on in the first quarter. (Figures 3.11 and 3.12.) The prices of the other commodities adjust more slowly, and only between 30 and 50 per cent of the cost increase is passed on in the current quarter. In the long run, approximately all changes in variable costs are reflected in the home price, and the lag distributions of the price equations imply that the adjustment is completed within four quarters for all commodities. The delays in the adjustment of export prices to cost increases are not as significant as those of the corresponding home prices, and the total long run effect is smaller. (Compare figures 3.11 and 3.13.) This is particularly the case for commodities 15, Food, clothing, etc., and 25, Wood products, printing etc., where the producers only pass on a fraction of the cost increase in their export price.

Table 10. Estimated long-run elasticties in price equation for goods delivered to export and home markets

Commodity	Home price equations		Export price equations	
	Elasticity with respect to unit costs	Elasticity with respect to competitors' prices	Elasticity with respect to unit costs	Elasticity with respect to competitors' price
Food, clothing etc.	0.993	-	0.196	0.867
Wood products, printings etc.	0.910	0.099	0.442	0.573
Mining and raw material industries	0.533	0.467	0.316	0.684
Machinery and metal products	1.000	-	0.932	-
Buildings and construction ..	0.994	-	-	-
Domestic transport and power supply	0.992	-	1[1]	-
Various services	1.009	-	1[1]	-

[1] Value a priori fixed.

Figure 3.11.Effect on the home price of selected manufacturing commodities of a sustained one per cent increase in variable unit cost. Per cent.

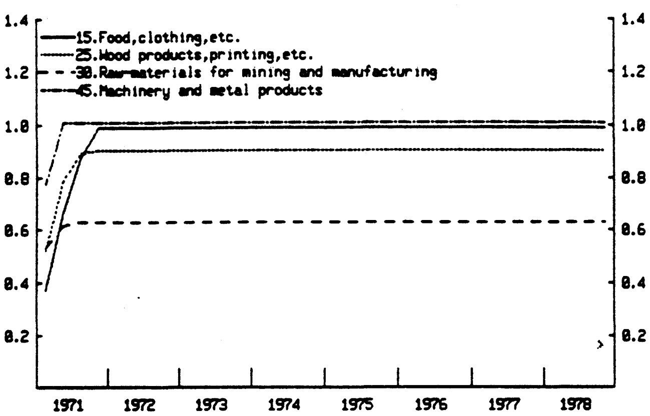


Figure 3.12.Effect on the home price of selected non-manufacturing commodities of a sustained one per cent increase in variable unit cost. Per cent.

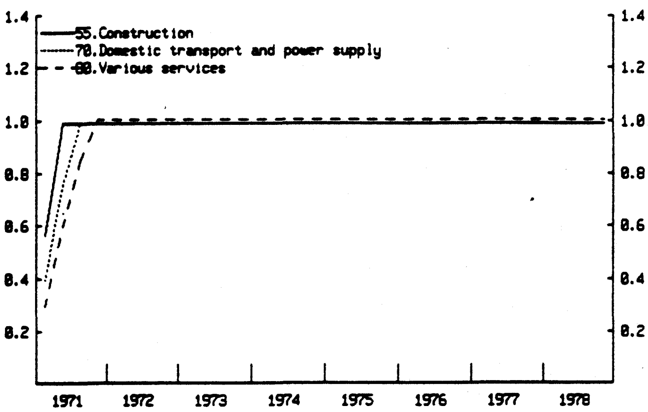
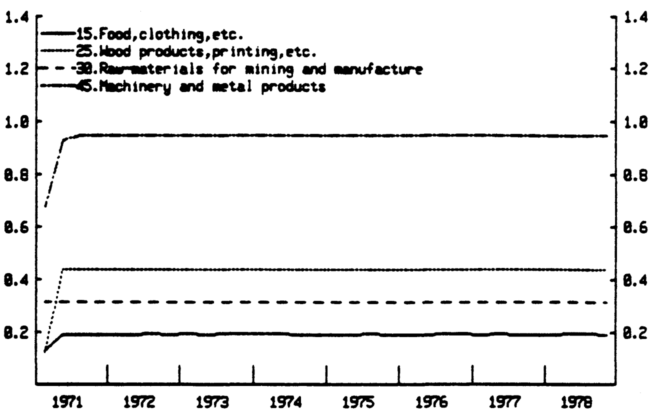


Figure 3.13.Effect on the export price of selected manufacturing commodities of a sustained one per cent increase in variable unit cost. Per cent.



3.8. Other model blocks. Exogenous variables

KVARTS-75 also contains several other, mostly minor, model blocks which will not be dealt with here. Let us only outline briefly the mechanism by which disposable household income is determined. First, factor incomes in the different production sectors are generated by combining the price block and the quantity block of the input-output equations (cf. section 3.1). Second, wage incomes are determined by multiplying hourly wage rates by the number of hours worked (cf. section 3.6), and operating surplus emerge as residuals. Third, the household sector is assumed to receive all wage incomes and a sector specific share of net operating surplus. This gives, after some corrections for interest and transfer payments, gross household income. Fourth, inserting gross household income in an aggregate income tax function, we obtain disposable household income. The parameters of this tax function are estimated from the income tax rates (the policy parameters) in conjunction with micro information on the personal income distribution from income statistics and tax statistics. No tax function for firms are specified in the present version of the model.

The wage rates in all production sectors, all fiscal policy variables (tax rates, public expenditures etc.), and all monetary variables (interest rates, money supply, credit variables etc.) are treated as exogenous variables in the present version of KVARTS. In subsequent model versions, priority will be given to work with econometric wage equations and attempts at modelling a financial block.

3.9. Interplay of quantities and prices - an overview

To give an idea of how the various model blocks and the most important variables interact in KVARTS - and in particular to elucidate the interplay of quantities and prices in the complete model - we have constructed two "structural maps", figures 3.14 and 3.15.

Figure 3.14 illustrates the determination of the quantity variables. Strictly, this figure relates to a stock-producing manufacturing sector, although it will - with suitable modifications - be applicable to all the other production sectors as well. No lags are indicated, and the figure is also in other respects simplified substantially. It illustrates the way in which production capacity is determined by expected demand and profit rate, and how capacity, together with stock imbalance and net demand from the home and export markets, determine actual production and increase in stocks. The net demand is generated by the model's input-output quantity block in conjunction with the equations for domestic demand (household consumption, gross investment, public expenditures), export demand, and imports. Capital formation and labour demand are determined by production capacity, and the ratio between the wage rate and the capital cost - labour demand also having a direct link to actual production.

This system of quantity equations is connected to the price block of the model through the profit rate variable in the capacity equation and the factor price ratio in the equations for labour demand and capital formation. There are also several other links, not indicated on the figure due to the presence of price variables in the equations for domestic demand, exports and imports. Neither is the effect of the monetary variables, for instance the effect of the interest rate on the capital cost and on the firms' desired stocks of inventories, indicated. Similar model blocks - although with smaller or larger modifications - exist for all production sectors of KVARTS. These blocks are "held together" by the model's input-output block, and this ensemble of blocks represents the quantity block of KVARTS as a whole.

A simplified structural map of the model's price side is shown in figure 3.15. The following features are worth noting: The home price of a commodity is determined by the unit variable cost, the relative capacity utilization and the corresponding import price. The two former variables are also effective in the determination of the export price, in addition to the world market price of the corresponding commodity. (The capacity variable occurs in only a few of the price equations, however, and its effect is empirically rather weak.) These variables are inserted into the input-output price block, together with exogenous wage rates, and out of this loop - i.e. when similar price equations for all commodities are combined - come the profit margins (gross operating surplus per unit produced) in the different production sectors. The price blocks for the different commodities of KVARTS are thus "held together" by its input-output price block, and this ensemble of blocks represents the overall price block of the model.

Incomes are generated by the wage rates and profit margins in conjunction with employment and production as determined in the quantity block. This mechanism is indicated, very summarily, in the lower part of figure 3.15.

FIGURE 3.14. QUANTITY EQUATIONS, MANUFACTURING – STRUCTURAL MAP. (LAGS NOT INDICATED).

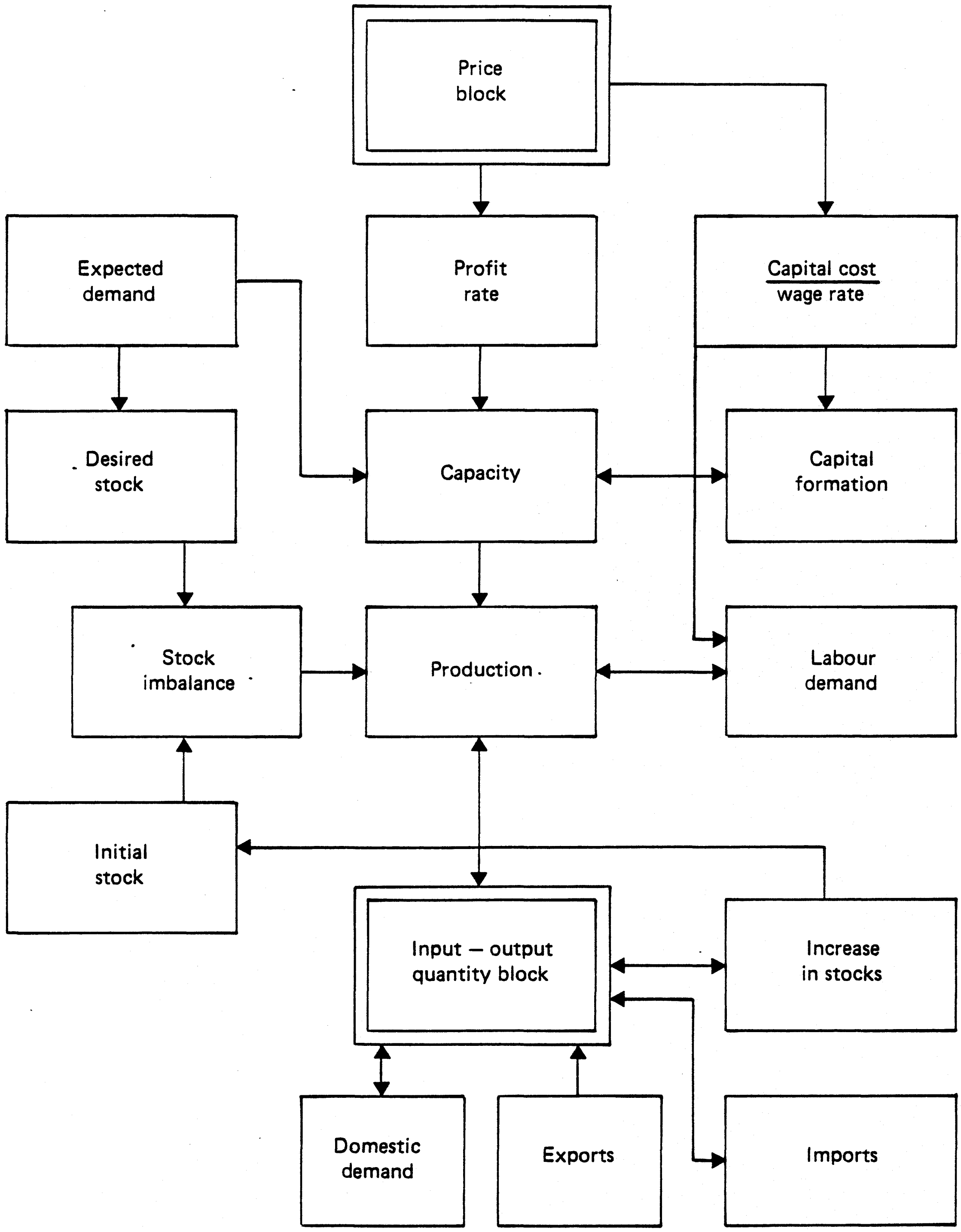
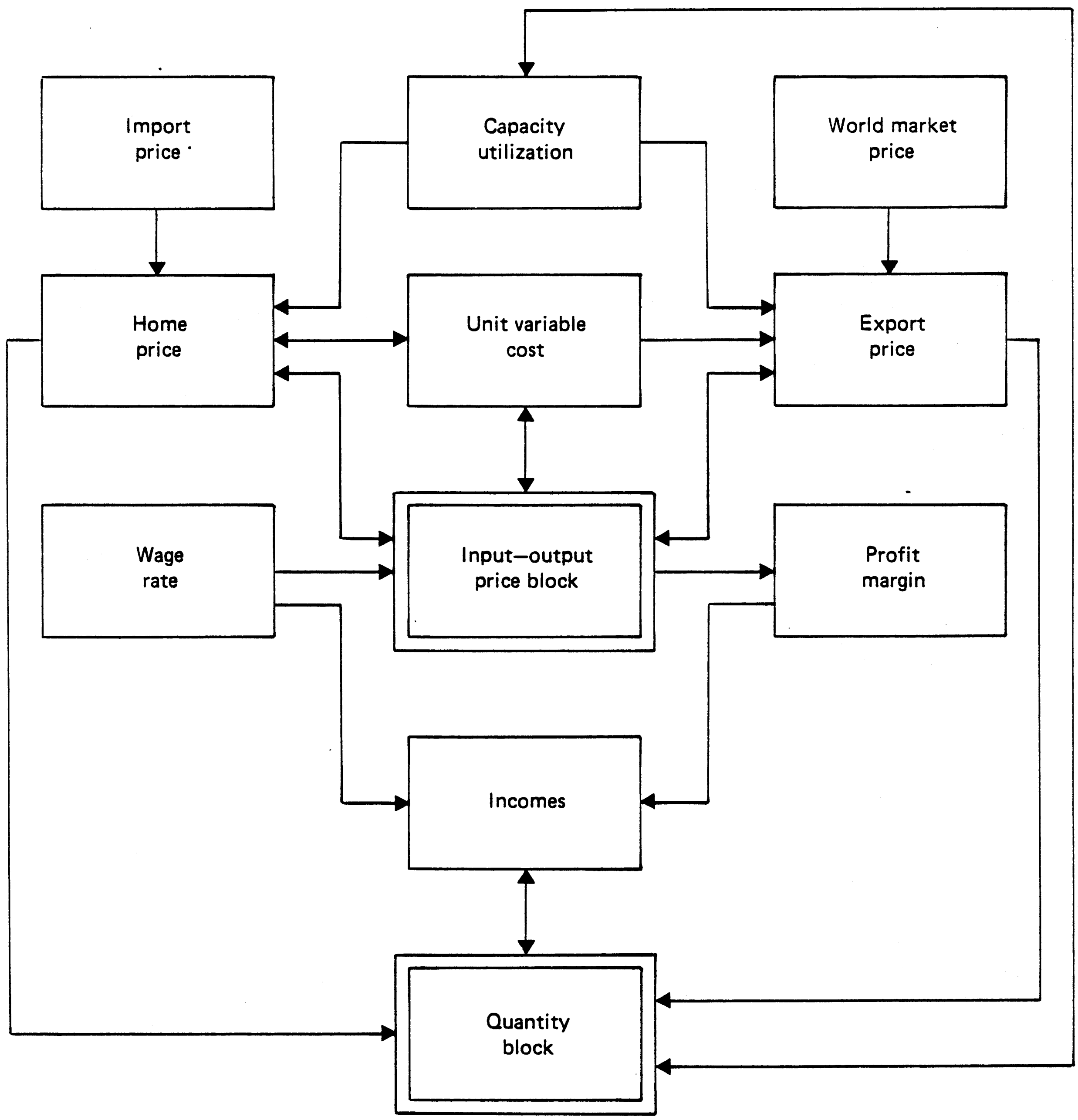


FIGURE 3.15. PRICE EQUATIONS – STRUCTURAL MAP. (LAGS NOT INDICATED).



IV. DATA. ESTIMATION

KVARTS-75 is constructed within a quarterly national accounts framework (see section 3.1), and most of its data base covers the period 1966.1-1978.4 (in some cases with the estimation period ending in 1977.4). When the bulk of the estimation was carried out, quarterly national accounts data were available for this period only. These data have been created by disaggregation of the annual national accounts for the years 1966 - 1978 to a quarterly periodicity, as a separate project in the Central Bureau of Statistics.

During the last years, the Central Bureau of Statistics has been preparing production of current quarterly national accounts, and a regular publication will start early 1985. A data base covering the "missing" years, i.e. 1978-1983, is already available. An updated model version, KVARTS-83, which combines the "old" and the "new" data base will then be implemented.

The structure of the quarterly national accounts is closely related to, but is on the whole simpler than, the annual accounts, including input-output accounts and factor income accounts. These data, as well as the other input data of the model, are, for the most part, seasonally unadjusted.

The fact that KVARTS - in contrast to the mainstream of quarterly macroeconomic models in other countries - is based on seasonally unadjusted data[5] has, of course, affected the formulation and estimation of its econometric equations and the interpretation of the results. It is well known (see e.g. Wallis (1974)) that the usual seasonal adjustment procedures, based on filtering techniques (e.g. the "X11 method"), may have a strong impact on the estimated lag distributions and other dynamic properties of macroeconomic models. Nerlove et al. (1979) also argue in favour of using a seasonally unadjusted data base.[6] In KVARTS, we have tried to capture the seasonal effects through the inclusion of additive quarterly dummy variables in most of its econometric equations - whether specified in linear or log-linear form.[7]

If the model were completely linear, with only additive seasonal dummies included, there would be no interaction between the model's lag distributions and the seasonal components in its reduced (or final) form, i.e. they would affect the solution additively. The specification chosen, implies that such interaction will be present, i.e. some of its dynamic multipliers will exhibit a systematic seasonal pattern. See section 5.2 (figure 5.9. and table 12), for examples of this.

Ordinary Least Squares (OLS) - in several cases with Cochrane-Orcutt adjustment for first-order serial correlation - is the estimation method used for most of the model's econometric equations. In some cases, we have applied a step-wise non-linear estimation procedure (e.g. the equations for capital accumulation in manufacturing. cf. section 3.5), or experimented with methods utilizing instrumental variables (e.g. the equations for short- term production and stock decisions in manufacturing, cf. section 3.2). Full Information Maximum Likelihood is used for joint estimation of the system of equations which allocates total consumption expenditure on the different commodities (cf. section 3.4).

Most of the model's lag distributions are specified as polynomial distributed lags (Almon lags), with degrees between 1 and 3, covering from 4 to 16 quarters. In some cases, rational lag distributions are used.

Most of the econometric equations of KVARTS-75 have been specified and estimated in several variants, and the implemented equations have, in most cases, been selected on a judgemental basis. We have used formal statistical tests, only in a few cases, to discriminate between the competing specifications. Apart from the sign restrictions derived from economic theory, our choice of equations has, to a large extent, been based on standard statistics as residual coefficients of variation, t statistics, Durbin-Watson statistics (first order residual autocorrelation), and Box-Pierce statistics (higher order residual autocorrelation). Cochrane-Orcutt correction for first-order autocorrelation is used to some extent to improve the model's tracking performance. In addition, most of the selected equations have been subjected to simulations over the sample period in order to check their dynamic properties.

The model is estimated and implemented on the TROLL system.

V. SIMULATION EXPERIMENTS AND OTHER EMPIRICAL CHARACTERISTICS

Historical (ex post) simulations are usually considered an integral part of the construction and validation of dynamic forecasting models[8], and priority has also been given to such exercises in the work with KVARTS-75. We have performed dynamic historical simulations on selected model blocks (confer section III), or combinations of blocks - e.g. the household consumption block, the block representing producer behaviour in manufacturing, the combined production/imports/input-output block, etc. - as well as simulations on the entire model. From these simulations we have obtained valuable information about the model's tracking performance and dynamic properties, and our final decision on which equation(s) to include among several competing specifications has, to some extent, been based on the outcome of such experiments. Since we have not had access to an updated data base (confer section IV), we have not performed genuine predictive tests of the model's ex post goodness of fit and dynamic behaviour. Neither have we analyzed systematically the long-run solutions it generates. Such exercises will be given priority in future model versions.

In this section, we report some experiences from the sample period simulations concerning the model's tracking performance (section 5.1) and its dynamic properties when subjected to exogenous shocks in main policy variables and other exogenous variables (section 5.2).

5.1 Historical tracking performance

When performing sample period simulations on the model, we have to make a decision how to treat the residuals in most of its equations. These residuals are of two kinds: (i) residuals in the equations which are estimated econometrically, and (ii) errors in the input-output equations (cf. section 3.1). We shall call the former the econometric and the latter the non-econometric residuals.

Following the textbook approach, we should set all residuals equal to zero[9] - i.e. use the estimated structural part of the model only - when performing ex post simulations. We have, however, chosen to treat only the econometric residuals in that way and "control for" the effect of the non-econometric residuals by treating them formally as exogenous variables with values equal to the historical values (i.e. the values which are generated equation by equation in the process of estimation). Hence, the goodness-of-fit statistics reported below will mainly show the effect of the econometric residuals only. Our main reason for proceeding in this way is that we do not intend to keep the model's input-output matrix fixed for several years when using it for simulation (and possibly forecasting) on current data. Rather we will seek to keep this matrix up to date by estimating it from the latest information available[10] in the annual national accounts - in this way hoping to keep the effect of the non-econometric residuals at a minimum when the model is used for genuine predictive purposes.

Our approach, then, can formally (and very compactly) be described as follows: Let y_t and x_t denote the complete vectors of endogenous and exogenous variables in quarter t, u_{1t} and u_{2t} the non-econometric and econometric disturbances, $\hat{u}_{1t}$ and $\hat{u}_{2t}$ the corresponding residuals. The model's equations can then be expressed compactly as

$$(5.1.1)\quad y_t = F(y_{t-1}, x_t, u_{1t}, u_{2t}; a)$$

$$= F(y_{t-1}, x_t, \hat{u}_{1t}, \hat{u}_{2t}; \hat{a}) \qquad t = 1, 2, \ldots ,$$

where a is the complete coefficient vector, â its estimate, and F is the vector valued function representing all the model's (linear and non-linear) equations, when we recall that any system of difference equations (which the model formally is) can be written as a system of first-order equations, by a suitable redefinition of its variables. A historical simulation starting in quarter 1 and ending in quarter T then consists in solving the following equation system in $\hat{y}_t$:

$$(5.1.2)\quad \begin{aligned} \hat{y}_t &= F(\hat{y}_{t-1}, x_t, \hat{u}_{1t}, 0, \hat{a}), \qquad t = 1, 2, \ldots, T, \\ \hat{y}_0 &= y_0. \end{aligned}$$

In the literature on macro-econometric models, the most common judgemental measures of model accuracy are the root mean squared error (RMSE) and decompositions of it. We have performed simulation exercises with the full model on the seven year period 1971.1-1977.4. This period is part of the period of fit. Table 11 summarizes the results obtained so far. We draw three main conclusions from it.

1. The demand components fall neatly into three categories with respect to simulation accuracy, private consumption achieving the best fit. Exports come in a middle category, and private fixed investment is clearly inferior - especially in the manufacturing sectors. Total employment has a relatively good fit, as measured by RMSE. But recalling that unemployment has the character of a residual, the (relative) variations in this variable will, of course, be much more difficult to track accurately.

2. There seems to be a clear, but not dramatic tendency for the errors to cumulate somewhat as the simulation period is extended. For real gross domestic product, the RMSE is 0.43 percentage points larger in the dynamic simulation than in the static one. We see, however, that the tendency of the errors to cumulate differs between demand components, being most significant for investment demand.

3. There is a non-zero mean component in the simulation errors in some of the demand components, which implies a systematic bias in the generated results. The biases seem, to some extent, to offset each other, and the bias in the model's tracking of real GDP is moderate, but the bias has a tendency to cumulate over time in the dynamic simulation.

These few results cannot, of course, lead to firm conclusions about the model's tracking performance in post sample situations. When compared with, for instance, the main quarterly models for the U.S.A., the performance of KVARTS-75 might be jugded as satisfactory. (See for instance Burmeister and Klein (1976) for U.S. results.) Such comparisons between models are, however, of limited validity, for several reasons. One should here recall two points; first that KVARTS-75 treats the monetary sector and wages exogenously, second that it has seasonally unadjusted data as its data base. (A case in point is that the data smoothing implied by seasonal adjustment procedures usually leads to a reduction in conventional measures of tracking performance.) Our way of treating the model's non-econometric residuals also affects its recorded tracking performance: If the model were completely linear, all elements of x_t and $\hat{u}_{1t}$ in (5.1.1) and (5.1.2) would affect the solution additively. This, in particular, would be the case for the seasonal dummies, which is a subset of x_t. Since the model includes several non-linearities, like additive seasonals in log-linear equations etc., there will be some interaction between e.g. the seasonal components and the non-econometric residuals. Nevertheless, we think it is safe to conclude that the model is not seriously off-track. In any case, the "final" test of a model lies not only in ex post simulations, but also in genuine ex ante forcasting and in the economic content of the relationships it encompasses.

Table 11. Error analysis of KVARTS-75[a].
Simulation period: 1971.1-1977.4.
Million 1975 kroner.

A. Static simulation

Variable	$\bar{A}$	RMSE	RRMSE	Mean error
GDP	35786.3	325.4	0.91	-160.6
Imports	17346.9	250.4	1.44	89.2
Private consumption	18922.5	169.7	0.90	16.3
Private consumption deflator	0.92	0.0059	0.64	0.00035
Gross investment, total	11748.2	222.5	1.89	-74.3
- endogenous	7020.5	222.5	3.17	-74.3
- manufacturing	1559.3	124.3	7.97	-47.2
Exports	15240.7	360.0	2.36	-29.4
Increase in stocks	308.2	238.7		9.7
- manufacturing	208.3	238.2		9.3
Total employment (1000 wage earners)	1395.1	12.7	0.91	-1.9

B. Full dymamic simulation

Variable	RMSE	RRMSE	Mean error
GDP	479.8	1.34	-310.5
Imports	280.2	1.62	14.7
Private consumption	254.4	1.34	-98.8
Private consumption deflator	0.0085	0.92	0.0022
Gross investment, total	448.9	3.89	-220.9
- endogenous	448.9	6.39	-220.9
- manufacturing	278.9	17.89	-189.2
Exports	395.5	2.60	-60.2
Increase in stocks	278.6		58.3
- manufacturing	278.7		57.2
Total employment (1000 wage earners)	15.5	1.11	-3.9

a) RMSE = $(\Sigma(P-A)^2/N)^{\frac{1}{2}}$, where A = observed, P = predicted, N = no. of observations.
RRMSE = 100 * RMSE/$\bar{A}$.

5.2. Impact analysis

In this section, we present - in the form of figures - the partial effects of discretionary changes in the three most important groups of exogenous variables in the KVARTS model; fiscal policy instruments, world economic activity, and wage rates. Corresponding numerical results are given in table A.4 in the table annex.

Figure 5.1 shows the estimated effects of a sustained increase of 100 million 1975 kroner in public expenditure. (Confer also table A.4.a in the table annex.) This increase comes about without increasing the money stock or reducing interest rates. The simulation experiment therefore - in Otto Eckstein's phrazing (Eckstein (1983)) - exhibits "the extreme fiscalist view" of the economy. They are, however, as much a result of the fact that we have not yet modelled the credit markets, than a result of our view on how the real and monetary sectors interact.

The estimated effect of an increase in public expenditure on GDP is an immediate increase of approximately the same size as the fiscal stimulus. The multiplier peaks at 1.5 after 10 quarters, reflecting the sluggish response of private consumption and, not least, private fixed investment. After 5-6 years the multiplier seems to stabilize at 1.3 when the investment boom has ebbed out. There is of course no tendency of crowding out because monetary factors are treated as exogenous.

As is the case with output, employment gains are large and immediate and mostly confined to the public sector. The long-run employment increase is about six thousand wage earners per quarter.

The response of prices to a fiscal expansion is small. This is mainly due to the fact that the estimated coefficients for capacity utilization in the price equations are small and in most cases zero. In addition, an increase in activity will, in the short run, lower unit costs due to the short-run increase in productivity implied by the labour demand equations (confer section 3.6).

As we see from figure 5.1, an increase in public expenditure has a relatively small effect on value added in manufacturing. The reason for this is that there are high marginal propensities to import of manufactured goods. Moreover, the manufacturing sectors meet a demand increase by reducing their stocks of finished products. The stock depletion decreases significantly after 8-10 quarters, which may seem somewhat long.

Figure 5.1.Effects of a sustained increase of
100 mill.kr. in public expenditure.
Million 1975-kroner.

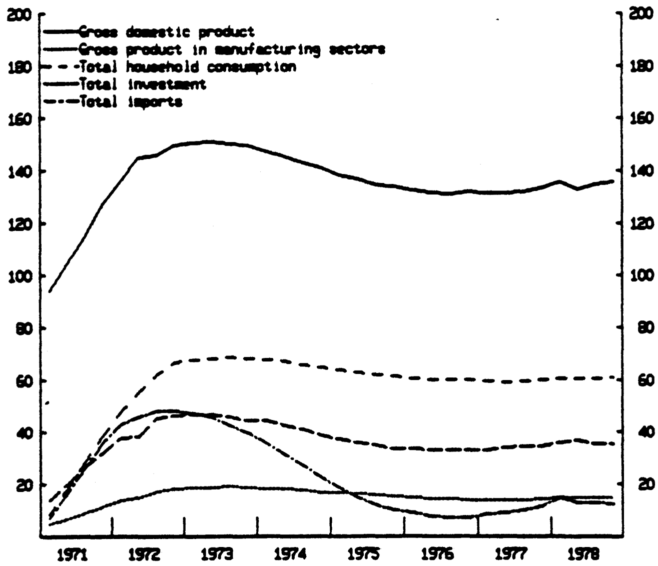
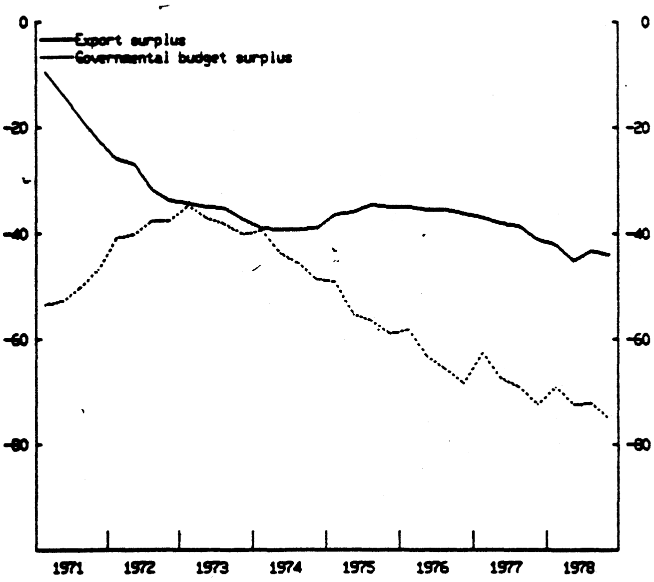


Figure 5.2.Effects of a sustained increase of
100 mill.kr. in public expenditure.
Million kroner.



Both private investment and private consumption increase quite rapidly during the first 6-8 quarters as income and real activity levels increase. The consumption increase is sustained in the long run, but the increase in private investment turns into a decrease after approximately 8 quarters. However, even in the long run the level of investments is higher than without the fiscal expansion due to the increased capital stock and hence a higher replacement.

From figure 5.2 we see that governmental budget surplus decreases quite a lot when expenditures increase. This is also the case for the export surplus which deteriorates mostly because of import increases, particularly imports stimulated by consumption demand.

In figures 5.3 and 5.4 we summarize the effects of a 100 million 1975 kroner increase in the exogenous component of the tax function, i.e. a change of the same size as the increase in governmental expenditures discussed above. The effect on the budget surplus is, of course, different in the two cases. We see that the effect on the economy's activity levels is smaller, the long run multiplier attaining the value 0.8, peaking at 1.2.

Since tax changes initially influence the economy through the consumption function, and this function exhibits a lagged response from income to consumption expenditure, the effects on production and employment are significantly delayed as compared to the case concerning increased public expenditure. The total effects are also smaller, due partly to the well-known Keynesian balanced budget multiplier effect, and partly to the relatively high marginal propensities to import of private consumption expenditures.

Figure 5.3. Effects of a 100 million 1975 kroner increase in the exogenous component of household taxes. 10 million 1975 kroner.

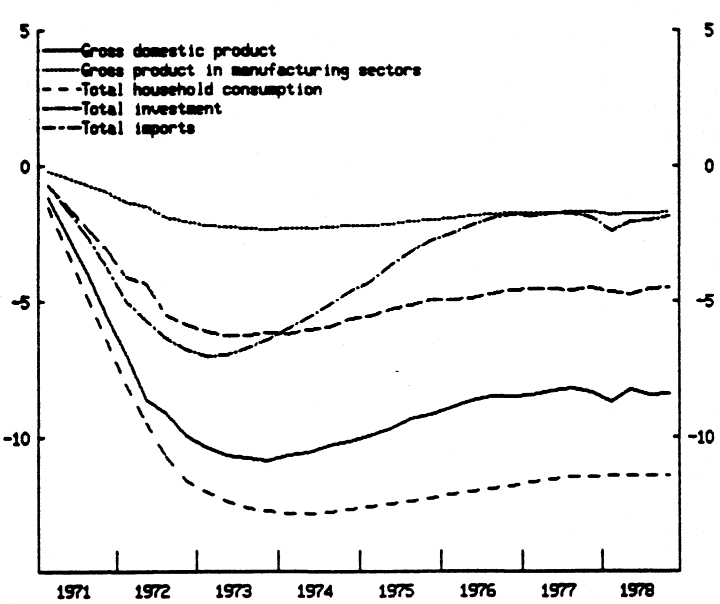
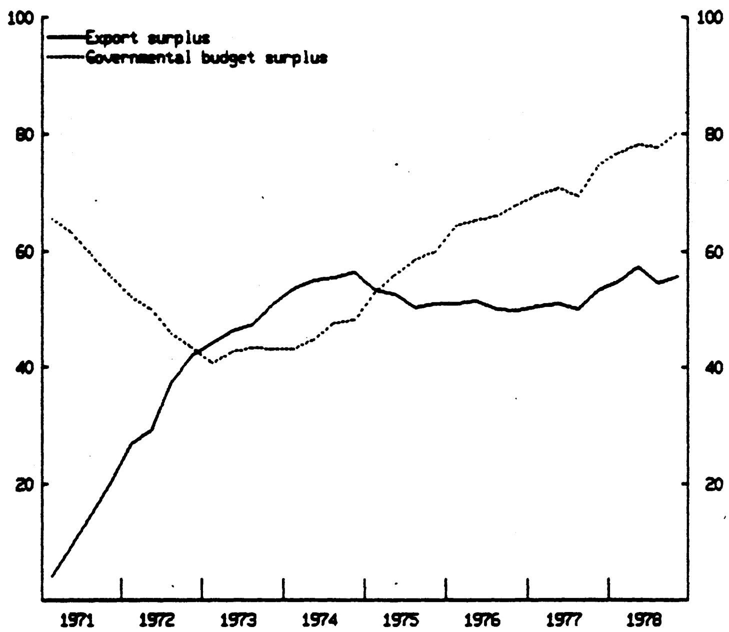


Figure 5.4. Effects of a 100 million 1975 kroner increase in the exogenous component of household taxes. Million kroner.



Norway is a small open economy, and exports are therefore a very important component of final demand. Figures 5.5 and 5.6 show the effects of an increase in world economic activity. We have calibrated the increase in such a way that the long run effect on export demand is approximately 100 million 1975 kroner. The commodity-exporting sectors which are stimulated by this increase are concentrated in manufacturing and represent roughly half of the export increase. In these sectors, however, the increase in activity occurs only with a considerable lag. This reflects partly the lag between the increase in world economic activity and commodity exports[11], and partly the fact that the manufacturing sectors will, to a large extent, meet demand increases by stock reductions in the short run. According to KVARTS' simulation results, a growing international economy therefore increases the employment in Norway slowly and moderately; a long run export increase of 100 million 1975 kroner produces only 2.5 thousand extra jobs after 8-10 quarters. This moderate increase in the employment level reflects the moderate long run output multiplier, about 1.1, and the fact that a relatively large part of the expansion occurs in the manufacturing sectors where labour productivity is high.

When comparing the employment multipliers of a public expenditure increase with those of an export boom one must, however, bear in mind that an export boom also has the effect of increasing the export surplus very significantly; thus leaving room for further increases in domestic demand without deteriorating the initial trade balance.

A wage increase has three main effects in KVARTS. First, it raises household disposable income, and this stimulates consumption demand. Secondly, higher wages raise prices on commodities produced in Norway which reduces Norwegian market shares on export and home markets. Lastly, it alters the relative cost between labour and capital, thereby inducing factor substitution and investment demand.

Figure 5.5.Effects of a sustained increase in world economic activity,calibrated so as to make the long run effect on export demand approximately 100 mill. 1975 kroner. Million 1975 kroner.

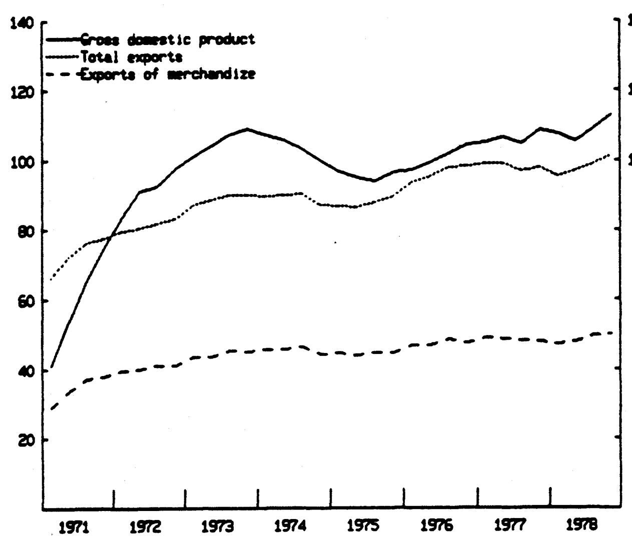
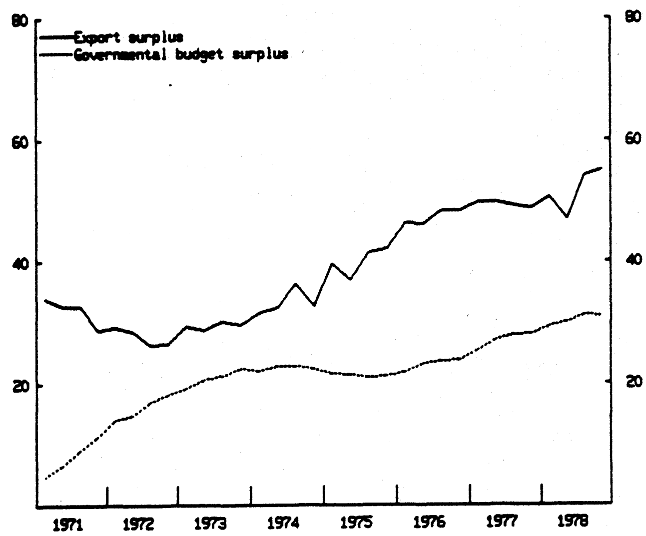


Figure 5.6.Effects of a sustained increase in world economic activity,calibrated so as to make the long run effect on export demand approximately 100 mill. 1975 kroner. Million kroner.



Figures 5.7 and 5.8 show the estimated effects of an increase in overall wages by one per cent, as compared with a baseline simulation. The forces which lead to increasing demand take effect almost immediately,

which results in a slight increase in GDP in the first 6-8 quarters. But the long-run effect on total GDP and employment of a wage increase is weakly contractive.

There is, however, a redistribution of resources between sectors. Whereas we find a significant reduction in employment in the manufacturing sectors (approximately 0.5 per cent), employment increases somewhat in the other sectors. Consequently, the export surplus deteriorates badly. Such results are not at odds with the standard two-sector textbook model of a small open economy, but the channels through which wages affect employment are different. In the textbook approach, prices are taken as given in world markets, and output is determined by profitability considerations only. In KVARTS, there are equations representing demand for domestically produced commodities. This demand is reduced as cost increases lead to higher home prices.

A final comment on the inflation mechanism in KVARTS is appropriate. A wage rate increase of one per cent raises consumer prices swiftly to approximately 0.4 per cent, as is seen from figure 5.8. Demand increases, however, have only a small and negative effect on prices through productivity increases. KVARTS, as it now stands, thus exhibits rather strong cost push effects and almost no demand pull inflation. The endogenization of wage rates and more work on the price equations to include demand pressure indicators should therefore be given high priority and will, probably, alter the above conclusions somewhat.

Figure 5.7. Effects of a sustained one per cent increase in wage rates. Million 1975-krone.

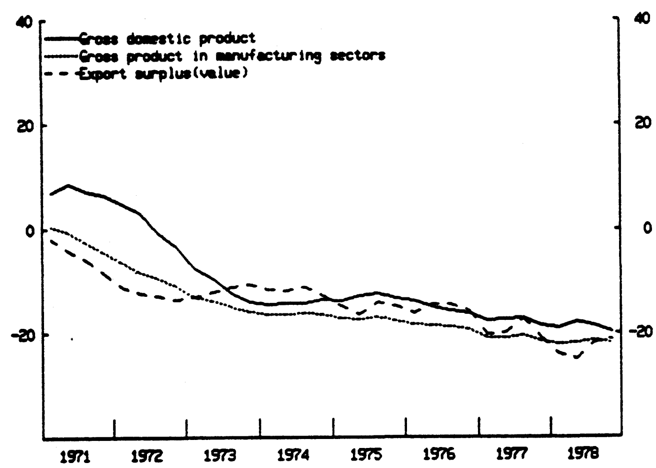
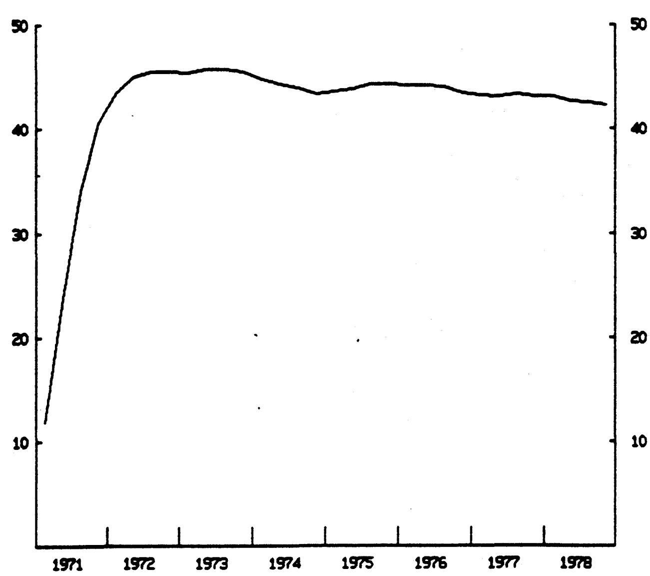


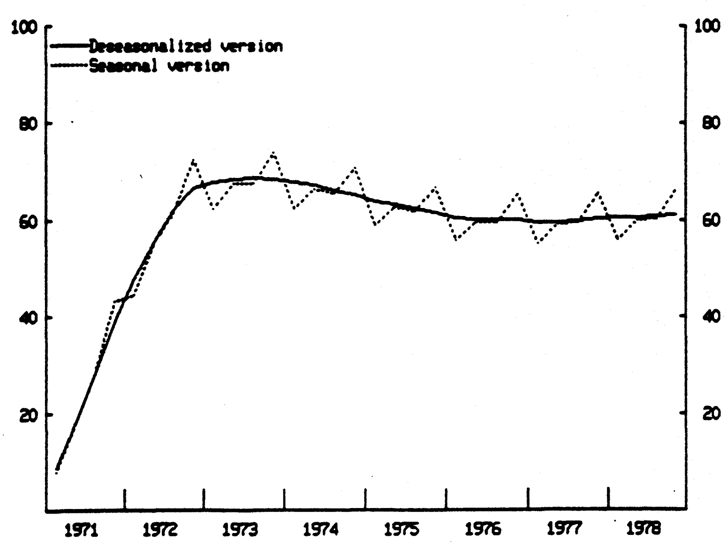
Figure 5.8. Effect on the implicit deflator for total consumption of a sustained one per cent increase in wage rates. Per cent.



Seasonality in the endogenous variables in KVARTS have two possible origins. First it may reflect seasonality in the exogenous variables. Second, it may be the result of the seasonal dummies which appear - additively or multiplicatively - in most of the stochastic equations. These dummies take the value one in their respective quarters and zero elsewhere. As we have set all seasonal dummies equal to 0.25 in all quarters in the simulation experiments reported above, these results may be interpreted as (partially) deseasonalized.

The effect of this deseasonalization is quite striking. Figure 5.9 shows the results from an experiment with an increase in public expenditure and with the seasonal dummies set equal to their original values along with the corresponding deseasonalized results. Since the consumption function is specified with multiplicative seasonal dummies, the fiscal multipliers should exhibit a seasonal pattern. From figure 5.9 we see that this is in fact the case, in particular between the fourth and the first quarter of the year; i.e. between the high and low season. At first, the effect is counteracted by the swift income increase and the lag distribution in the aggregate consumption function. Consumption therefore increases somewhat from quarter 4 to quarter 5. The increase is, however, small and significantly smaller than one would predict by inspecting the estimated consumption function only. In later periods - for example between quarters 8 and 9, and 12 and 13 - there is a substantial temporary decrease in consumption due to the seasonality in the multiplier.

Figure 5.9. Effect of deseasonalization. Effect on total consumption of a sustained increase in public expenditure of 100 mill. 1975-kroner. Million 1975-kroner.



VI. FINAL REMARKS

Like all simplifying empirical models of actual economies, KVARTS also has its pros and cons. A dynamic macro-econometric model may be evaluated - and criticized - from at least three different points of view:

- The choice of hypotheses about economic behaviour which it encompasses.
- The econometric specification and choice of estimation techniques and parametrization of lag distributions etc. for each of its equations.
- The specification of which variables, or variable groups, to treat exogenously.

The second and third of these points have been discussed in some detail in earlier sections of the paper, and they will not be elaborated further here. Suffice it to say that we are not fully content with KVARTS-75 on either of these accounts, and revisions are envisaged or planned in KVARTS-83, or in subsequent model versions. On the first point, however, we have some comments to offer which are related to the fact that Norway is a small open economy.

As noted in section 5.2, both production and exports of manufacturing goods are in the model treated as essentially demand determined in the long run. The demand-for-export equations assume the existence in the world market of explicit, autonomous relations for Norwegian products with relative prices and market size as explanatory variables (cf. section 3.3). Since Norway is a small open economy, with staple products (especially commodity 30 Raw materials from mining and manufacturing) accounting for a substantial part of total exports, it would seem more reasonable to regard Norwegian exporters as price takers in the world market. As we have seen (cf. section 3.7), there is a tendency that movements in Norway's export prices parallel those of our trading partners in the world market. Thus, the price ratio term in the demand-for-export equations will give a very small contribution to explaining variations in Norwegian exports, the dominating determinant being the size of the export markets. In KVARTS, as it stands today, Norway's competitiveness in international markets is only implicitly and indirectly represented - i.e. to the extent that cost increases are passed on to export prices, which in turn lead to reduced export quantities effectuated through the demand-for-export equations. This is an unsatisfactory property of the model, and is clearly unreasonable in the long run. A more satisfactory specification - especially for staple products - would be to include an explicit supply relation, representing directly the effect of profitability considerations on the firms' output decisions. Attempts to pursue this idea econometrically have, however, failed thus far.

The problems related to the modelling of the effect of Norway's competitiveness on export quantities should, however, be regarded more as a <u>structural</u> problem than a problem in the modelling of economic activity over a business cycle. The main application of KVARTS in the Central Bureau of Statistics is intended to be in surveilling business cycles, not in structural analysis. The main determinants of variations in the Norwegian economic activity over a business cycle are swings in the activity levels abroad. They affect the domestic economy through export deliveries, increased production in the sectors producing for exports, and this production increase works it way to the rest of the economy through increased consumption and capital formation. We believe that - in the time perspective of a business cycle - the mechanisms which are presently represented in KVARTS are reasonably well specified for our purpose, its weakest elements being probably the specification of investment demand and its disregard of contractive effects of capacity constraints at cyclical peaks. Then, KVARTS, as it now stands, may mainly prove to be a valuable tool in business cycle analysis. And because some of the most important short run effects of changes in fiscal policy affect the economy through the same channels as those mentioned above, we also believe that it has insights to offer on policy analysis.

FOOTNOTES

1) KVARTS is the name of the project. The suffix '75 indicates that the present, first version of the model is based on national accounts data with 1975 as the base year for the input-output matrices and the price calculations.

2) Shipbuilding and manufacturing and repair of oil platforms, of course, also belongs to this category - being perhaps the order-producing sector par excellence in the Norwegian economy. Due to data limitations, however, this sector is not treated in that way in the first version of KVARTS; on the contrary, production is assumed to respond instantaneously to demand. (Cf. table 1.)

3) Since the national accounts are based on the commodity/sector approach (confer eq. 3.1.1), this equation will not be satisfied exactly, due to the presence of multiple outputs in most of the sectors. When modelling output decisions in manufacturing, demand is, however, slightly redefined so as to make $X_t = D_t + S_t - S_{t-1}$ hold as an identity with the modified definition.

4) These countries are Denmark, France, Germany, Italy, the Netherlands, Sweden, the United Kingdom, and the United States.

5) Confer e.g. Howrey et al. (1981, p. 53).

6) Confer the following quotation:
"..... it is extremely important to make unadjusted data available for use ..... it still seems preferable to work with the unadjusted data; the reason being that use of the unadjusted data at least ensures that the degrees of freedom will be calculated correctly." (Nerlove et al. (1979), pp. 162-163 and 165.)

7) There are some exceptions to this. The most notable exception is the aggregate consumption function (3.4.1), which is linear, but with multiplicative seasonal dummies. In equations specified without an intercept term, we use differences between seasonal dummies in order to ensure an estimated zero constant term in the "average quarter".

8) Confer e.g. the experiences from several large-scale model projects collected by and reported in Howrey et al. (1981, section III).

9) Possibly with a correction for residual autocorrelation.

10) For instance by combining input-output matrices estimated from (annual) national accounts for several successive years, estimating trends in input-output coefficients, etc.

11) A significant part of Norwegian exports of manufacturing commodities actually leads upturns in world economic activity through adjustments in our trading partners' stocks of intermediate goods. This effect is in KVARTS represented by the inclusion of aggregrate stock indices for main imports of domestically produced intermediate goods in the export equations, cf. (3.3.3). These stock indices are kept unchanged in the exercises presented in figures 5.3 and 5.4. For this reason, the simulation experiment reported does not reflect how an actual international economic upturn affects the Norwegian economy.

TABLE ANNEX

THE COEFFICIENTS IN THE INPUT-OUTPUT EQUATIONS OF KVARTS-75

Table A.1: Output coefficients a), b), c)

Sector / commodity	10	15	25	30	45	50	55	60	65	70	80	90	Import share	Export share
00	x	x												
01			x		x									
02														
05														
06														
07														
10	84	x	x										.10	.03
15	x	.85	x	x	x	x							.22	.18
25		x	.77	.02	.02	x				x			.30	.12
30		x	.02	.85	.02	x							.48	.55
45		.02	.04	.02	.80	.16				x			.49	.26
50		x	x	x	x	.78				x			.53	.39
55	03	x	x	.02	x	x	.86		x	.03	x		.00	.00
60								1.00					.00	.99
66									.78				.82	.86
67									.21				.63	.65
70					x	x		x		.82			.01	.07
80		x	x	x	.02	x	x		x	x	.76		.02	.06
90												1.00	.00	.09

a) In this table, the sectors and the commodities are represented only by their sector codes. The interpretation of these codes is given in table 1 of the main text.

b) The twelve first columns contain the values of the Λ^{X}_{ij} coefficients, i.e., the value of output of each commodity in basic value as share of the producers' value of total gross production in each sector. The last two columns show imports of each commodity as a share of total supply of the same commodity and exports of each commodity as a share of total production of the commodity, respectively.

c) Coefficients with values less than 0.02 are not reported, but denoted by x. The coefficients are calculated from data at current prices from the annual national accounts for 1975.

Table A.2: Input coefficients - Intermediate inputs a), b)

Sector / Commodity	10	15	25	30	45	50	55	60	65	70	80	90
00		.06	x	x		x					x	x
01	x	x	x	.03	x		x				x	x
02	x	x	x	x	x	x	x	x	x	x	x	x
05	x							.73		.05		
06									.30			
07	x	x	x	x	x	x	x	x	x	x	.03	.03
10	.31	.36	.06	.04	x	x	x	x	x	x	x	x
15	.26	.25	.02	x	x	x	x	x	x	x	.04	.04
25	.02	.03	.29	.08	.09	.04	.33	x	x	.03	.07	.14
30	.11	.04	.18	.32	.25	.13	.09	x	.02	.06	.03	.05
45	.02	.02	.07	.05	.32	.33	.21	x	.09	.10	.03	.05
50	.06	x	x	x	x	.26	x	.16	.21	.03	x	x
55	.06	x	x	.02	x	x	.07	x	x	.10	.08	.24
60		x	x	x	x	x		x	x	x	x	x
66				.15								
67									.12			
70	.04	.03	.07	.08	.06	.03	x	.05	.04	.40	.18	.10
80	x	.02	.12	.07	.09	.06	.11	.03	.20	.10	.40	.20
90	x	x	x	x	x	x	x	x	x	x	x	x
Σ	.89	.83	.84	.84	.84	.86	.85	1.00	1.00	.88	.89	.88

a) See note a) and c) to table A.1.

b) The table contains the value of the A_{ij}^{M} coefficients, i.e., the input of each commodity at basic value as shares of total inputs at market value in each sector.

Table A.3: Input coefficients - Household consumption and investment [a), b)]

	Consumption sector							Kind of investment			
Commodity	00	10	20	30	40	50	60	JB	JS	JM	JO
00	.03										
01	x										
02				.28				x		.07	x
05										x	
06								.10			.55
07							.21				
10	.09	x	.03				x	x			
15	.55	.10	.32		.10		x	x	x	.02	x
25	x	.08	.19		.19		.03	x	x	.09	x
30	x	.07	x				x	x	x	x	.02
45	x	.02	.04	.05	.22		x	x	.04	.50	.15
50		x	x		.04			x	.92	x	.19
55						x		.78		x	x
60							x				
66											
67								.03			
70		.16	x				.17				.04
80	.26	.19	.26	.30	.26	1.00	.49	x	.03	.16	.04
90		x	x		x	x	0.04				
Σ	.93	.61	.84	.63	.82	1.00	.94	.92	1.00	.84	1.00

a) See notes a) and c) to table A.1.
For investment, the following abbreviations are used:
JB: Buildings
JS: Ships
JM: Machinery and equipment
JO: Oil producing constructions

b) The table contains the value of the A^{C}_{ij} and A^{J}_{ij} coefficients, i.e., the input of each commodity at basic value as shares of total inputs at market value in each sector (activity).

Table A.4. The effects of discretionary changes in various exogenous variables starting in 1971.1[1]

a. Sustained 100 million 1975 kroner increase in public expenditure

Effect in millions. Volume in 1975 prices	Quarter after increase 1	2	3	4	8	12	16	20	24	28
Gross domestic product	94.1	104.4	115.2	127.4	149.9	149.9	141.0	133.0	132.0	133.8
-of which in manufacturing	4.9	7.0	9.4	11.5	18.1	19.0	17.0	15.5	14.1	14.5
Import volume	14.2	20.2	26.8	32.0	46.4	44.7	38.8	33.7	33.0	34.8
Private consumption, 1975-kroner	8.9	18.6	28.8	39.0	66.7	68.5	65.2	61.6	60.2	60.4
Private consumption deflator, per cent increase	-0.00	-0.01	-0.01	-0.01	-0.02	-0.03	-0.02	-0.02	-0.02	-0.02
Private fixed investment	7.5	16.5	26.3	36.1	48.1	39.8	22.8	10.3	7.5	11.7
-of which in manufacturing	0.0	0.5	1.4	2.2	4.9	5.5	4.1	1.9	0.7	0.9
Export volume	.	.	.	.	.	.	.	.	.	.
-of which in manufacturing	.	.	.	.	.	.	.	.	.	.
Increase in stock, manufacturing	-6.1	-7.2	-8.4	-9.6	-8.8	-5.3	-1.4	0.7	1.4	0.3
Export surplus, current price	-9.3	-13.7	-18.1	-22.2	-33.7	-37.2	-38.9	-35.0	-36.0	-41.1
Governmental budget surplus, current prices	-53.5	-52.8	-50.1	-46.8	-37.5	-40.2	-48.6	-59.0	-68.3	-72.3
Employment, 1 000 wage earners	4.5	4.8	5.2	5.4	6.3	6.4	6.1	5.9	5.9	5.9
of which in manufacturing	0.1	0.1	0.2	0.3	0.5	0.6	0.6	0.5	0.5	0.5

[1] A dot (.) means zero or negligible.

b. Sustained 100 million 1975 kroner increase in exogenous taxes

Effect in millions. Volume in 1975 prices	Quarter after increase									
	1	2	3	4	8	12	16	20	24	28
Gross domestic product	-11.5	-25.3	-39.3	-55.1	-99.5	-108.2	-101.1	-91.5	-84.9	-83.2
-of which in manufacturing	-1.8	-4.2	-6.8	-9.4	-20.0	-23.0	-21.6	-19.7	-17.2	-16.7
Import volume	-6.6	-14.5	-22.8	-30.4	-58.3	-61.5	-56.6	-49.4	-45.7	-44.9
Private consumption, 1975-kroner	-15.2	-31.3	-48.0	-64.6	-115.9	-127.5	-126.7	-122.7	-117.9	-114.3
Private consumption deflator, per cent increase	0.00	0.00	0.01	0.01	0.03	0.03	0.03	0.03	0.02	0.02
Private fixed investment	-6.8	16.3	-25.9	-37.0	-67.7	-64.2	-46.3	-27.2	-17.8	-18.4
-of which in manufacturing	-0.0	-0.2	-0.7	-1.4	-5.5	-7.4	-6.1	-3.7	-1.5	-1.0
Export volume	.	.	.	.	.	.	.	.	.	.
-of which in manufacturing	.	.	.	.	.	.	.	.	.	.
Increase in stock, manufacturing	2.1	4.3	6.1	8.0	11.0	7.4	2.8	-0.8	-2.4	-1.5
Export surplus, current prices	4.1	9.5	14.8	20.6	42.0	51.2	56.5	51.0	50.0	53.4
Governmental budget surplus, current prices	65.7	63.3	59.5	55.5	43.5	43.2	48.1	60.2	67.9	74.6
Employment, 1 000 wage earners	-0.3	-0.6	-1.0	-1.3	-2.7	-3.0	-2.9	-2.7	-2.5	-2.4
-of which in manufacturing	-0.0	-0.1	-0.1	-0.2	-0.5	-0.7	-0.7	-0.7	-0.6	-0.6

c. Sustained increase in world market demand, equivalent to a long range export increase of approximately 100 million 1975 kroner

Effect in million kroner. Volume in 1975 prices	Quarter after increase									
	1	2	3	4	8	12	16	20	24	28
Gross domestic product	41.4	53.8	65.2	74.7	97.7	109.1	100.1	96.6	104.6	108.9
-of which in manufacturing	11.0	15.8	19.8	22.8	31.1	35.6	34.1	32.9	34.1	35.8
Import volume	25.4	31.6	37.2	42.7	52.4	54.5	49.0	41.7	46.2	48.0
Private consumption, 1975-kroner	2.7	6.3	10.9	15.9	33.1	38.5	37.2	33.0	33.2	35.9
Private consumption deflator, per cent increase	-0.00	-0.01	-0.02	-0.02	-0.04	-0.04	-0.04	-0.04	-0.04	-0.04
Private fixed investment	8.0	17.2	27.2	37.0	45.1	43.3	26.7	12.4	14.9	19.5
-of which in manufacturing	1.0	2.4	4.2	6.0	8.2	8.5	6.8	3.5	3.0	3.6
Export volume	66.1	72.4	76.4	77.5	83.5	90.2	87.3	90.0	98.4	98.2
-of which in manufacturing	28.9	33.6	37.2	37.9	41.2	45.1	44.3	44.8	47.8	47.9
Increase in stock, manufacturing	-13.3	-13.7	-14.5	-14.6	-11.8	-9.1	-3.0	-0.5	-0.5	-1.5
Export surplus, current prices	33.9	32.7	32.8	29.0	26.5	29.7	32.7	42.1	48.5	48.9
Governmental budget surplus, current prices	4.7	6.7	9.0	11.3	18.2	22.5	22.6	21.4	23.9	28.4
Employment, 1 000 wage earners	0.8	1.1	1.5	1.7	2.4	2.6	2.4	2.3	2.4	2.5
-of which in manufacturing	0.1	0.3	0.4	0.5	0.7	0.9	0.9	0.8	0.8	0.9

d. Sustained one per cent increase in nominal wage rates in all sectors

Effect in millions. Volume in 1975 prices	Quarter after increase									
	1	2	3	4	8	12	16	20	24	28
Gross domestic product	7.1	8.7	7.2	6.7	-3.2	-13.9	-13.5	-13.1	-16.1	-18.5
- of which in manufacturing	0.6	-0.6	-2.5	-4.4	-10.9	-15.7	-16.2	-17.5	-19.3	-21.4
Import volume	8.0	13.1	16.2	18.9	23.6	19.9	20.0	23.4	24.4	27.5
Private consumption, 1975 kroner	7.0	13.3	17.3	21.2	28.3	26.7	29.0	32.3	34.8	37.1
Private consumption deflator, per cent increase	0.12	0.24	0.34	0.41	0.46	0.45	0.43	0.44	0.44	0.43
Private fixed investment	12.4	15.8	15.6	15.7	7.4	-4.2	-4.7	-2.1	-4.5	-5.1
- of which in manufacturing	9.5	10.1	8.1	6.1	5.2	0.8	0.6	0.0	-0.3	-0.7
Export volume	-2.9	-6.0	-9.1	-10.8	-14.8	-16.5	-14.2	-14.4	-15.5	-15.9
- of which in manufacturing	-2.6	-5.2	-7.8	-9.2	-12.5	-14.0	-11.8	-11.8	-12.7	-12.9
Increase in stock, manufacturing	0.2	1.5	3.2	3.9	5.8	5.9	2.5	1.5	1.7	1.7
Export surplus, current prices	-1.8	-4.2	-5.8	-8.4	-13.5	-10.6	-12.7	-14.6	-15.6	-20.8
Governmental budget surplus, current prices	1.4	4.8	7.0	8.9	4.3	0.2	-1.1	-5.6	-5.4	-5.8
Employment, 1 000 wage earners	0.0	-0.1	-0.4	-0.5	-1.1	-1.4	-1.5	-1.5	-1.5	-1.6
- of which in manufacturing	-0.1	-0.4	-0.6	-0.8	-1.4	-1.5	-1.6	-1.6	-1.7	-1.7

REFERENCES

Allen, R. G. D. (1967): Macro-Economic Theory. A Mathematical Treatment. (London: Macmillan, 1967.)

Belsley, D. A. (1966): Industry Production Behaviour: The Order-Stock Distinction. (Amsterdam: North-Holland Publishing Company, 1966.)

Biørn, E. (1979): Teoretisk opplegg for behandling av det private konsum i en korttidsmodell. Reports from the Central Bureau of Statistics of Norway, no. 79/27. (Oslo: Central Bureau of Statistics, 1979.)

Biørn, E. (1982): Kvantifisering av konjunkturbarometerinformasjon. Reports from the Central Bureau of Statistics of Norway no. 82/25. (Oslo: Central Bureau of Statistics, 1982.)

Biørn, E. (1984): Depreciation Profiles and the User Cost of Capital. Paper presented at the European Meeting of the Econometric Society, Pisa, 29 August - 2 September 1983. Discussion Papers no. 6, Central Bureau of Statistics, Oslo, 1984.

Biørn, E. (1985a): En kvartalsmodell for industrisektorers investeringer og produksjonskapasitet. Reports from the Central Bureau of Statistics of Norway, to appear. (Oslo: Central Bureau of Statistics, 1985.)

Biørn, E. (1985b): Produksjonstilpasning og lageradferd i industri - en analyse av kvartalsdata. Reports from the Central Bureau of Statistics of Norway, to appear. (Oslo: Central Bureau of Statistics, 1985.)

Biørn, E. and Fosby, H. E. (1980): Kvartalsserier for brukerpriser på realkapital i norske produksjonssektorer. Reports from the Central Bureau of Statistics of Norway no. 80/3. (Oslo: Central Bureau of Statistics, 1980.)

Biørn, E. and Jensen, M. (1983): Varige goder i et komplett system av konsumetterspørselsfunksjoner. Reports from the Central Bureau of Statistics of Norway no. 83/16. (Oslo: Central Bureau of Statistics, 1983.)

Bjerkholt, O. and Longva, S. (1980): MODIS IV - A Model for Economic Analysis and National Planning. Samfunnsøkonomiske Studier no. 43. (Oslo: Central Bureau of Statistics, 1980.)

Burmeister, E. and Klein, L.R. (1976): Econometric Model Performance. (Philadelphia: University of Pennsylvania Press, 1976.)

Childs, G. L. (1967): Unfilled Orders and Inventories. A Structural Analysis. (Amsterdam: North-Holland Publishing Company, 1967.)

Dixon, P. B. and Lluch, C. (1977): Durable Goods in the Extended Linear Expenditure System. Review of Economic Studies, 44 (1977), 381-384.

Eckstein, O. (1983): The DRI Model of the U.S. Economy. (New York: McGraw Hill, 1983.)

Feldstein, M. and Auerbach, A. (1976): Inventory Behaviour in Durable-Goods Manufacturing: The Target-Adjustment Model. Brookings Papers on Economic Activity, 2 (1976), 351-396.

Fløttum, E. J. (1981): National Accounts of Norway - System and Methods of Estimation. Reports from the Central Bureau of Statistics of Norway no. 81/1. (Oslo: Central Bureau of Statistics, 1981.)

Hansen, G. and Westphal, U. (1983): SYSIFO. Ein ökonometrisches Konjunkturmodell für die Bundesrepublik Deutschland. (Frankfurt a.M.: Haag + Herchen Verlag, 1983.)

Houthakker, H. S. and Taylor, L. D. (1970): Consumer Demand in the United States: Analyses and Projections. (Cambridge, Mass.: Harvard University Press, 1970.)

Howrey, E. P., Klein L. R., McCarthy, M. D., and Schink, G. R. (1981): The Practice of Macroeconometric Model Building and its Rationale. In Large-Scale Macro-Econometric Models, ed. by J. Kmenta and J. B. Ramsey. (Amsterdam: North-Holland Publishing Company, 1981.)

INSEE (1981): METRIC. Une modélisation de'économie francaise. (Paris: Institut National de la Statistique et des Etudes Economiques, 1981.)

Jensen, M. (1985): Kvartalsvise investeringsrelasjoner basert på en utvidet akseleratormodell. Reports from the Central Bureau of Statistics of Norway, to appear. (Oslo: Central Bureau of Statistics, 1985.)

Jensen, M. and Reymert, M. (1984): Kvartalsmodellen KVARTS: Modellbeskrivelse og teknisk dokumentasjon. Reports from the Central Bureau of Statistics of Norway, no. 84/25. (Oslo: Central Bureau of Statistics, 1984.)

Jensen, M. and Wahl, L. (1985): Modellgrunnlag og kryssløp i KVARTS-75. Working paper from the Central Bureau of Statistics of Norway, to appear (Oslo: Central Bureau of Statistics, 1985.)

Knudsen, V. (1985): Boligmodellen i KVARTS. Reports from the Central Bureau of Statistics of Norway, to appear. (Oslo: Central Bureau of Statistics, 1985.)

Lesteberg, H. (1979): Kapasitetsutnytting i norsk industri. Reports from the Central Bureau of Statistics of Norway, no. 79/28. (Oslo: Central Bureau of Statistics, 1979.)

Lluch, C. (1973): The Extended Linear Expenditure System. European Economic Review, 4 (1973), 21-32.

Lund, A. and Reymert, M. (eds.) (1982): Tabeller med fordeling av norsk eksport og import etter nasjonalregnskapets vareinndeling på land og på SITC-varer. Internal Notes from the Central Bureau of Statistics of Norway, no. 82/34.

Malinvaud, E. (1982): Wages and Unemployment. Economic Journal, 92 (1982), 1-12.

Muellbauer, J. (1981): Testing Neoclassical Models of the Demand for Consumer Durables. In A. Deaton (ed.): Essays in the Theory and Measurement of Consumer Behaviour in Honour of Sir Richard Stone. (Cambridge: Cambridge University Press, 1981), pp. 213-235.

Nerlove, M. Grether, D. M. and Carvalho, J. L. (1979): Analysis of Economic Time Series: A Synthesis. (New York: Academic Press, 1979.)

Reymert, M. (1984): Import- og eksportlikninger i KVARTS. Utledning, estimering og simulering med likninger for utenrikshandelen. Reports from the Central Bureau of Statistics of Norway, no. 84/18. (Oslo: Central Bureau of Statistics, 1984.)

Stølen, N. M. (1983): Etterspørsel etter arbeidskraft i norske industrinæringer. Reports from the Central Bureau of Statistics of Norway, no. 83/29. (Oslo: Central Bureau of Statistics, 1983.)

Tveitereid, S. and Lædre, J. (1981): Markedsindikatorer for norsk eksport. Reports from the Central Bureau of Statistics of Norway, no. 81/35. (Oslo: Central Bureau of Statistics, 1981.)

Wallis, K. F. (1974): Seasonal Adjustment and Relations Between Variables. Journal of the American Statistical Association, 69 (1974), 18-31.

ISSUED IN THE SERIES DISCUSSION PAPER

No. 1 I. Aslaksen and O. Bjerkholt: Certainty Equivalence Procedures in the Macroeconomic Planning of an Oil Economy.

No. 2 E. Offerdal: Structural Change, Profitability, and Survival.

No. 3 E. Biørn: On the Prediction of Population Totals from Sample Surveys Based on Rotating Panels.

No. 4 P. Frenger: A Short Run Dynamic Equilibrium Model of the Norwegian Production Sectors.

No. 5 I. Aslaksen and O. Bjerkholt: Certainty Equivalence Procedures in Decision-Making under Uncertainty: an Empirical Application.

No. 6 E. Biørn: Depreciation Profiles and the User Cost of Capital.

No. 7 P. Frenger: A Directional Shadow Elasticity of Substitution.

No. 8 S. Longva, L. Lorentsen, and Ø. Olsen: The Multi-Sectoral Model MSG-4, Formal Structure and Empirical Characteristics.

No. 9 J. Fagerberg and G. Sollie: The Method of Constant Market Shares Revisited.

No. 10 E. Biørn: Specification of Consumer Demand Models with Stochstic Elements in the Utility Function and the First Order Conditions.

No. 11 E. Biørn, E. Holmøy, and Ø. Olsen: Gross and Net Capital, Productivity, and the Form of the Survival Function - Some Norwegian Evidence.

No. 12 J. K. Dagsvik: Markov Chains Generated by Maximizing Components of Multidimensional Extremal Processes.

No. 13 E. Biørn, M. Jensen, and M. Reymert: KVARTS - A Quarterly Model of the Norwegian Economy.