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## A MODEL OF THE MECHANISM OF WAGES, PRICES AND INCOME DISTRIBUTION IN AN OPEN ECONOMY

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## I. Introduction

1. The model discussed in this paper may be described, in brief, as a short-term, cost push, input-output type representation of the mechanism which determines prices and income distribution in the Norwegian economy. The model is short-term i.e. in that it takes wages and agricultural prices as given. This is an accurate description of reality, under Norwegian conditions, since wages and agricultural prices are fixed by negotiations and may be taken in the short run to follow a pre-determined course as set by these negotiations. The model is cost push in that it explains prices entirely in terms of costs. There is no reference to demand. The model is of the input-output type in recognizing the fact that higher output prices asked by one industry means higher input prices, i.e. higher costs, in other industries. This results in a price propagation process which can be studied through an input-output technique in very much the same way as input-output technique is used for the study of quantitative inter-relationships.

2. The ideas contained in the model have grown out of research work undertaken at the Central Bureau of Statistics over a number of years. The model itself was formulated in 1966 by a group of three experts ("The Reporting Committee for the Income Settlement 1966") who were called upon to provide background material for that year's round of negotiations on wages and agricultural prices, and it was published in their first report.<sup>1)</sup> The experts intended the model

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1) Innstilling fra Utredningsutvalget for inntektsoppgjørene 1966, avgitt 22. januar 1966 ("Report by the Reporting Committee for the Income Settlement 1966, of January 22nd 1966), published 1966 by the Prime Minister's Office. A summary of the report in English has been published by the Royal Norwegian Ministry of Finance and may be obtained by writing to the Ministry. (Copies will be made available in Warszawa). Members of the Committee were myself (Chairman), Associate Professor Fritz C. Holte, the Agricultural College of Norway, and Professor Gerhard Stoltz, The Norwegian School of Economics and Business Administration. The Committee, known informally as "Aukrust-utvalget" (The Aukrust Committee) was asked again later to continue its work and a second report on the causes of long-run price developments in Norway was published by the Prime Ministers Office in 1967: Innstilling II fra Utredningsutvalget for inntektsoppgjørene i 1966, avgitt 20. oktober 1966 ("Second Report of October 20th 1966 by the Reporting Committee for the Income Settlement 1966"). - The present paper draws heavily on the first of these two reports, and the concluding paragraph below gives a hint about the content of the second. I am happy to have this opportunity to acknowledge my great debt to Professors Holte and Stoltz, in particular I owe the mathematical formulation of the model largely to Professor Holte. I am indebted, furthermore, to colleagues at the Central Bureau of Statistics, in particular to Mr. Per Sevaldson and Mr. Arne Øien who conducted the tests reported in section VI below and commented on a first draft of the paper, and to Mr. Erik Homb who guided the work needed to rearrange the national accounts data as required by the model.

first and foremost as an instrument for forecasting the effects of changes in wages and agricultural prices on consumers' prices and income distribution.

While, naturally, the model was designed for use under Norwegian circumstances it contains features which may be applicable also in other countries.

In order that the reader may be better placed to judge its usefulness elsewhere the following facts about Norway should be noted:

(i) The Norwegian economy is an extremely open one, hence national prices are probably more directly influenced by prices abroad than they are in most other countries. (ii) Wage negotiations in Norway are strongly centralized. Typically, the wage level is negotiated for 2-year periods with most wage- and salary-earners receiving wage increases simultaneously and by about the same percentage. (iii) Agriculture is heavily protected and subsidized. The prices of most agricultural products are fixed through negotiations between the farmers and the government also for 2 year periods, the negotiations taking place simultaneously with the negotiations over wages.

## II. Sheltered and exposed industries

3. An important distinction in the model is between sheltered industries and exposed industries. Exposed industries are those which market their products abroad, or on the domestic market under strong foreign competition. For these exposed industries the prices of outputs are assumed to be determined on the world market. These industries, therefore, can not compensate for a cost increase through an upward adjustment of prices. If their costs increase, they must sustain the whole effect in the form of reduced profits (entrepreneurial incomes). The sheltered industries, on the other hand, are those industries whose products are marketed at home under conditions such as to leave them free of foreign price competition.<sup>1)</sup> The sheltered industries will tend to raise output prices when costs increase. Available statistics indicate that the sheltered industries tend to pursue a price policy such that, for the group as a whole, the ratio <sup>of</sup> profits to wages is left unchanged apart from a trend due to an increase in the relative number of employees (see section V).

4. The difference in price behaviour between the exposed and the sheltered industries is an important feature of the Norwegian economy, and it determines the mechanism of price and income distribution in the model. There is a difference between exposed and sheltered industries also in that labour productivity,

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1) Either because of the physical nature of their products (services, constructions) or because of government protection (agriculture).

in Norway at least, rises much quicker in the former than in the latter. This fact, which is often overlooked, ought to have important implications for the formulation of the goals of an incomes policy, as we shall see later.

### III. Description of the model

5. In the model the following classification of industries is used:

- |   |   |                      |
|---|---|----------------------|
| 1. agriculture (excluding forestry and fishing but including dairies) | } | sheltered industries |
| 2. other sheltered industries   |   |                      |
| 3. import-competing manufacturers                                     | } | exposed industries   |
| 4. fisheries  |   |                      |
| 5. shipping   |   |                      |
| 6. other export-oriented industries                                   |   |                      |

Within the sheltered industries agriculture is singled out as a separate group because of the special position of this industry in income negotiations. Among the exposed industries fisheries is specified for rather similar reasons, and shipping is treated separately because of its unique role in the Norwegian economy. The remaining exposed industries are divided into "import-competing manufacturers" and "other export-oriented industries".

6. An input-output table for the six industries (with all figures expressed, for convenience, as percentages of net domestic product) is reproduced in table 1. From this table input-output coefficients (columns 1-6) and the weights of the consumers' price index may be computed.

7. The following assumptions are made for wages and prices:

- (i) The model assumes wages per man-year for any given year to be given. Changes from one year to the next in wages per man-year may be in part due to a wage settlement, and partly due to a wage drift, but this is inessential for the argument.
- (ii) The model assumes the development of wages and salaries to be the same in all industries.<sup>1)</sup>
- (iii) The model assumes agricultural prices to be given, stipulated by the income settlement for farming.

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1) This is a reasonably realistic assumption in most cases. It has the advantage, furthermore, of allowing the total of wages and salaries, as a share of total income, to be contrasted easily with other income shares so that the model will answer directly the questions most often asked in income policy. However, it would be quite simple to treat wages and salaries of individual industries as different variables.

Table 1. Input - output table 1965. Normalized, i.e. all figures as percentages of net national product

Delivering sector \ Receiving sector	Agri-culture	Sheltered industries	Import-competing manufacturers	Export-competing industries	Fisheries	Shipping	Private consumption	Publ.cons. + gross cap. form	Exports	Total
Agriculture .....	-	2,7	0,1	0,1	-	-	3,9	-	0,8	7,6
Sheltered industries .....	2,1	-	2,2	3,0	0,3	1,3	42,7	42,0	5,9	99,5
Import-competing manufacturers .....	0,1	3,4	-	0,5	0,1	0,1	6,7	6,9	4,5	22,3
Export-competing industries .....	0,7	4,2	1,4	-	-	0,1	1,3	1,5	13,1	22,2
Fisheries .....	0,1	1,1	-	0,8	-	-	0,2	0,1	0,2	2,5
Shipping .....	-	0,7	-	-	-	-	0,2	0,1	18,5	19,5
Import .....	0,3	6,4	5,6	5,7	0,1	5,8	8,4	14,5	0,2	47,0
Dummy Accounts .....	-	-	-	-	-	-	-	-3,1	3,1	-
Value added <sup>1)</sup> .....	4,3	81,0	13,0	12,2	2,0	12,2	-	-	-	124,7
<b>Total .....</b>	<b>7,6</b>	<b>99,5</b>	<b>22,3</b>	<b>22,3</b>	<b>2,5</b>	<b>19,5</b>	<b>63,4</b>	<b>62,0</b>	<b>46,3</b>	<b>345,4</b>

1)

Of which:

Wages .....	0,6	39,0	6,9	5,2	0,2	4,0				55,9
Profits .....	4,1	17,7	3,7	4,6	1,2	1,7				33,0
Ind. taxes .....	-	14,3	1,5	0,1	-	-				15,9
Subsidies .....	2,1	2,4	0,1	0,1	-	0,2				4,9
Depreciation .....	1,7	12,4	1,0	2,4	0,6	6,7				24,8

- (iv) The model assumes import and export prices to be given, determined by the world market.
- (v) Changes in output prices are percentagewise the same for all deliveries from any one industry, (that is, for all entries in one row in the input-output table).
- (vi) The price of products from sheltered industries excluding agriculture ("other sheltered industries") are stipulated in such a way that profits in this industry has a fixed ratio to wage costs, determined (in normal years) by the trend value of the share of profits in factor income.
- (vii) In the exposed industries prices of goods are fixed to be consistent with foreign enterprises' prices of comparable products. The model, therefore, construes the prices of products of "import-competing industries" to follow the (given) prices of competing imports and the prices of products of export-oriented industries (including fishing and shipping) to follow the (given) export prices.

The realism of assumptions (v) and (vi) is discussed in sections V and VI below.

8. With respect to volumes the following assumptions are made:

- (i) Changes in product volume may occur in all industries. Such changes may be due partly to changes in employment and partly to changes in productivity, i.e. production per man-year worked.<sup>1)</sup>
- (ii) It is assumed that changes in output neither alter the quantities of intermediate goods consumed per unit of output nor the total volume of depreciation; in other words, the model assumes constant input-output coefficients in volume terms for intermediate goods, and constant absolute volumes of depreciation given by the volume of capital employed.
- (iii) The model does not endeavor to explain how changes in wages, prices and productivities affect final demand, and figures relating to final demand are excluded from the model. The model simply assumes that there is always sufficient demand somewhere for the products of each of the industries.

9. For all industries except agriculture and fishing the model distinguishes between wages and profits. In agriculture and fishing wages and profits are combined into variables called "income from agriculture" and "income from

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1) This is the only point where the model is dependent on volume flows. Changes in employment and productivity are important reasons why prices and/or profits in an industry may change. They must therefore be explicitly considered in a model designed for the study of price and income changes. It is believed, for reasons of simplicity, that other possible interactions between volumes and prices may be neglected.

fishing" respectively.<sup>1)</sup> The endogenous variables or groups of variables of the model, (variables which the model tries to explain) therefore include i.a. the following price and income variables:

- a. price index of products of "other sheltered industries"
- b. price indices for consumers' goods
- c. price index for depreciation
- d. incomes (wages and profits) from agriculture and fishing, in nominal and real terms
- e. profits of industries other than farming and fishing, in nominal and real terms
- f. total wages, in nominal and real terms.

10. The variables which will influence prices and the distribution of income, i.e. the exogenous variables of the model, include i.a.:

- a. price index of outputs from farming
- b. the wage index
- c. productivity indexes, by industries
- d. employment indexes, by industries
- e. price indexes of exports and imports, specified as required by the model
- f. indexes of changes in indirect taxes and subsidies<sup>2)</sup>
- g. volume indexes of depreciation, by industries.

11. The model assumes i.a. the following parameters (structural coefficients) to be given:

- a. input-output coefficients, or inter-industry deliveries and imports of raw materials per unit of output, by industries
- b. a coefficient for the distribution of income (profits as a percentage of factor income) in "other sheltered industries"
- c. the weights in the price indices of depreciation, by industries
- d. the weights in the index of consumers' prices.

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1) The combination of wages and profits in agriculture and fishing is, of course, not essential to the model. It was made in order that the model should reflect as well as possible the issues discussed during income settlements where, in the case of farming, the focus is on total farming income.

2) Since indirect taxes and subsidies are represented in the model by two strongly aggregated indices only, the model is not really suited for an analysis of the effects on prices of changes in taxation. Such effects can be judged with greater accuracy by more direct methods.

Most of the structural coefficients used may be computed from an input-output table of a base year, e.g. table 1.

12. One way of gauging the implications of the model is to study the system of equations in its "reduced form". The formulae are given in the appendix. However, the economic content of the model can also be illustrated by describing, in words, and by way of examples, the effects to be expected from partial changes in some of the variables.

13. For instance, a rise in the wage and salary level will, ceteris paribus, have the following effects:

- (i) Prices of goods from "other sheltered industries" will rise because wage and salary costs increase and this leads to higher prices of goods in these industries.
- (ii) Prices of goods from other industries will not be affected, but profits in these industries will be reduced (see (iv) below).
- (iii) The rise in prices of goods from "other sheltered industries" will be reflected in a similar, but smaller rise in the level of prices of consumers' goods.
- (iv) Total real income will not be affected. But the distribution of incomes will change in favour of wages and salaries and of profits in "other sheltered industries": Real wages will rise because the rise in consumers' prices will be smaller than the rise in the wage level. Profits in "other sheltered industries" will rise in proportion to wages (due to the assumed constancy of the profits-to-wages ratio of this industry). Income from agriculture and income from fishing will decline slightly in nominal terms because some of the intermediate products of these industries derived from "other sheltered industries" become more expensive. Profits of other exposed industries will decline for the same reason, but also because of higher wage and salary costs.

14. A change in productivity, if it is the same in all industries, will affect prices and incomes in very much the same way as would an equally big (percentage-wise) change in the wage-level, only with opposite sign, since a change in productivity means a change in the opposite direction of wage and salary costs per unit of output. The main difference is that in this case total real income would increase since output per man-year has increased. If a change in productivity is limited to a single industry, however, the effects depend on the industry affected:

- (i) An increase in productivity in agriculture, or fishing, will, ceteris paribus, increase the incomes from the same industry, while prices and



other incomes will remain unaffected. An increase in productivity in one of the exposed industries will, ceteris paribus, affect the profits of that industry only. In all these cases the gain in real income corresponding to the productivity increase will remain with income earners in the industry where the increase in productivity occurs.

- (ii) The gain in real income originating from an increase in productivity in "other sheltered industries", on the other hand, will be shared ceteris paribus, by all income groups. First, prices of goods from "other sheltered industries" must go down, according to the model, for the assumed constancy of the profits-to-wages ratio of that industry to be maintained. This means lower prices of consumers' goods and a proportional increase in all real incomes. In addition, nominal incomes from farming and fishing, and nominal profits in the exposed industries increase somewhat because the intermediate products they buy from "other sheltered industries" will have become cheaper.

It is rare, of course, that productivity increases uniformly in all industries and the above should serve as an indicator that the effects on prices and income distribution of productivity <sup>changes</sup> may be extremely complex and, I should add, extremely important in the context of an incomes policy. I shall have more to say on this in section VII.

15. Also the effects of changes in foreign prices, to give one last example, depends much on the nature of the price changes. For instance:

- (i) An increase in the prices of imported consumers' goods will, ceteris paribus, raise the costs of living but leave all other prices, and all nominal incomes, unaffected. In this case, therefore, the drop in real income, corresponding to the worsening of terms of trade, will be sustained by all income recipients in proportion to their consumption expenditures.
- (ii) An increase in prices of imported intermediate inputs to the exposed industries and to agriculture will, ceteris paribus, lower the profits of these industries. All other prices, and all incomes, will remain unaffected. The loss in real income caused by the worsening of the terms of trade will be sustained wholly by the receivers of these profits.
- (iii) An increase in the prices of imported intermediate inputs to "other sheltered industries" will, ceteris paribus, increase the prices of this industry. As a consequence the prices of consumers' goods will also rise. In this way the loss in real income due to the worsening of terms of trade will be split among all income groups. However, there will be some

secondary effects, resulting in smaller nominal incomes from farming and fishing and smaller nominal profits in the exposed industries, because the costs to all industries of intermediate inputs from "other sheltered industries" will have gone up.

- (iv) An increase in the prices of competitive imports, according to the model, will, ceteris paribus, allow the "import-competing manufacturers" to raise their output prices. As a consequence the prices of consumers' goods will also rise. Therefore, the real incomes of all other income groups will decline while profits of "import-competing manufacturers" will increase in real as well as in nominal terms. There will be some <sup>secondary</sup> ~~complex~~ effects because the costs to all other industries of intermediate inputs from "import-competing manufacturers" will have gone up. These secondary effects will result ultimately in a further rise in the prices of consumers' goods (via a rise in the price of products from "other sheltered industries") and a further decline both in nominal and real incomes from farming and fishing and in nominal and real profits in the exposed industries.

In an analogue way the effects of changes in export prices may be analyzed.

#### IV. Uses of the model

16. The examples given have shown, I believe, that the effects of changes in factors affecting the income distribution and the national price level can be difficult to trace through verbal reasoning. This is so even though, so far, our concern has been only with partial changes of one factor at the time. The difficulties multiply if we are to study the effects of changes in two or more variables simultaneously, and especially if we are to state these effects quantitatively. It is for such purposes that our numerical model offers considerable help.

17. One important use of the model - indeed, the one for which it was originally designed - has been to estimate the consequences to be expected for prices and income distribution of changes in the wage level and in agricultural prices. Such forecasts were made for the first time before the 1966 round of negotiations on wage and agricultural prices and again before the 1968 round, and their purpose was to form the basis for an incomes policy. In both cases a number of alternative forecasts were made. Each alternative related to one particular possible combination of changes in the wage level and the level of prices of agricultural output. The idea was that, through these forecasts, the negotiating

parties could be brought into a better position to anticipate the consequences, for themselves and for the national economy, of alternative courses open to them. Since the model has recently been programmed for a computer so that the solutions for 50 alternative sets of values of exogenous variables can be provided within 5 minutes of computing time, any number of alternatives which the negotiating parties might ask for can easily be presented to them.<sup>1)</sup>

18. One convenient way of using the model is to compute a "table of effects", a part of which (for 1965) is reproduced in table 2. At the left side of this table are listed a selected number of important exogenous variables of the model, and the income distribution parameter ( $r$ ) of "other sheltered industries". Endogenous variables are entered at the top. The table shows, along the rows, the effects which, according to the model, are to be expected from a partial one per cent change of the exogenous variable of that row on each one of the endogenous variables listed at the top. The effects are expressed as percentages though, in case of income variables, they could equally well have been expressed in kroner. Row 1 tells us, for instance, that a 1 per cent increase in the wage level, ceteris paribus, may be expected to raise the prices of consumers' goods by .46 per cent, to increase the total of nominal factor incomes by .55 per cent, to decrease income from farming by .48 per cent, to decrease profits of "import-competing manufacturers" by 2.80 per cent, etc. If read columnwise, the table gives, for each endogenous variable, information about which exogenous variables are particularly influential on that variable.

19. All effects specified in the table are additive for small changes in the exogenous variables. Therefore, the combined effect of a simultaneous change in two or more exogenous variables may be gauged by adding together the effects of each variable taken separately. For instance, a parallel increase of all import

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1) Any forecast requires, of course, estimates of expected changes in a large number of exogenous variables (productivities, foreign prices, etc.) besides wages and agricultural prices. These estimates (or guesses) were provided in 1966, in one alternative, by independent experts. It was argued against this practice that, since the prognoses depend heavily on these estimates, the negotiating parties should have a chance to influence the assumptions made. As a result of this criticism the choice of values for all exogenous variables for the prognoses to be used in the 1968 negotiations will be made by a group consisting of non-partisan experts in co-operation with representatives of the negotiating parties. It is possible that, as a result of this, several alternative forecasts will be made for, say, foreign prices.

Table 2. Effects on prices, income and the distribution of income caused by changes in wages, agricultural prices, productivity, foreign prices and the share of entrepreneurial income in other sheltered industries. ("Table of Effects for 1965").

		Prices (change in per cent)			Income (change in per cent)							
		Prices of goods for other sheltered industries	Consumer price level	Domestic allocation of total goods and services	Total factor income	Total wages and salaries exc. agriculture and fishing	Agricultural income	Fishing income	Profits			
									Other sheltered industries	Import-competing manufactures	Other export-oriented industries	Shipping
Increase of 1 per cent in:												
Wages and salaries per man-year (all industries) .....	W	0,68	0,46	0,46	0,55	1,00	-0,48	-0,44	1,00	-2,80	-1,03	-2,84
Agricultural prices .....	P <sub>1</sub>	0,03	0,08	0,05	0,08	..	..,61	-0,01	..	-0,05	-0,05	-0,03
Fish prices .....	P <sub>4</sub>	0,01	0,01	0,01	0,02	..	-0,04	1,72	..	-0,01	-0,09	-0,01
Productivity in:												
Agriculture .....	Z <sub>1</sub>	..	..	..	0,03	..	0,55	..	..	..	..	..
Other sheltered industries...	Z <sub>2</sub>	-0,68	-0,46	-0,46	0,09	..	0,48	0,44	..	0,43	0,50	0,51
Import-competing manufacturers .....	Z <sub>3</sub>	..	..	..	0,12	..	..	..	..	2,87	..	..
Shipping .....	Z <sub>5</sub>	..	..	..	-0,06	..	..	..	..	..	..	3,25
Other export-oriented industries (excluding fisheries) .	Z <sub>6</sub>	..	..	..	0,11	..	..	..	..	..	2,12	..
Import prices:												
Raw materials for:												
Sheltered industries .....	Q <sub>2</sub>	0,08	0,05	0,05	-0,01	..	-0,05	-0,04	..	-0,05	-0,05	-0,05
Import-competing manufacturers .....	Q <sub>3</sub>	..	..	..	-0,06	..	..	..	..	-1,46	..	..
Shipping .....	Q <sub>5</sub>	..	..	..	-0,07	..	..	..	..	..	..	-3,43
Other export-oriented industries (excluding fisheries) .	Q <sub>6</sub>	..	..	..	-0,06	..	..	..	..	..	-1,23	..
Competing imports <sup>1)</sup> .....	P <sub>3</sub>	0,04	0,13	0,14	0,23	..	-0,04	-0,07	..	5,78	-0,13	-0,11
Consumer goods <sup>2)</sup> .....	P <sub>7</sub>	..	0,13	0,07	..	..	..	..	..	..	..	..
Capital goods <sup>3)</sup> .....	P <sub>10</sub>	0,05	0,03	x	-0,04	..	-0,16	-0,03	..	-0,03	-0,48	-0,53
Export prices:												
Shipping .....	P <sub>5</sub>	0,01	0,01	0,01	0,22	..	-	-	..	-0,01	-	11,44
Other export-oriented industries (excluding fisheries) .	P <sub>6</sub>	0,05	0,06	0,06	0,22	..	-0,18	-0,03	..	-0,40	4,79	-0,11
Percentage point change in share of entrepreneurial income in other sheltered industries <sup>4)</sup> .....	r <sub>3</sub>	1,00	0,67	0,67	0,80	..	-0,70	-0,65	4,65	-0,64	-0,72	-0,74

Symbols. - = negligible effect. .. = no effect. x = not calculated.

1) The price of imported goods which compete on the Norwegian market with products from "import-competing manufacturers". 2) Imports direct for consumption. 3) Increase in the price of imported capital goods (leads to an increase in depreciation calculated in current prices and reduces the entrepreneurial income in all industries except the sheltered ones which raise prices accordingly. 4) The share of profits in sheltered industries (exc. agriculture) in 1965 was 31.2 per cent. The figures here show what the effects would have been if this share, ceteris paribus, rose by 1 percentage point, i.e. to 32.2.

prices by 1 per cent may be expected, ceteris paribus, to raise the level of consumers' prices by  $.05 + .13 + .13 + .03 = .34$  per cent (column 2). In this manner the table can help in providing quick estimates of the indirect effects to be expected on consumers' prices and incomes of any event or action whose direct impact on the exogenous variables of the model can be foreseen. For instance, an estimate of the effects of a possible devaluation could be worked out by guessing how the devaluation would affect foreign price variables of the model, reading off from the table the corresponding effects on prices and incomes, and adding up.

20. The model, or alternatively the "table of effects" computed from it, may be used equally well for historical analysis. We must start, in this case, from observed changes of the exogenous variables in a period of the past. With these changes given, the effects of each variable on prices and income distribution may be calculated by means of the "table of effects". Thus, we will be able to tell how much each exogenous variable has contributed, in some sense, to observed changes in prices and income distribution. If the total of the calculated effects equal the observed changes we will be able to claim that the actual movements of prices and incomes are "explained" as being generated by changes in wages, productivities etc. through a mechanism as described by the model. Alternatively, if there are discrepancies between calculated and observed values of the endogenous variables, the size of the discrepancies will indicate the extent to which the model fails in describing reality accurately.

#### V. Comments on the assumptions of the model

21. The assumptions underlying the model, or the economic theory inherent in it, cannot be expected to hold true in all circumstance. Some discussion of the realism of the model is, therefore, called for.

22. One set of assumptions amounts to postulating that changes in volume flows are determined by changes in employment and productivity only, and that they are not influenced - neither through changes in demand nor otherwise - by changes in wages and prices. These are obvious, simplifying assumptions to make in a model designed primarily for the study of prices rather than quantities. Yet they must reduce the confidence which we should have in conclusions derived from the model:

- (i) It is assumed that there is sufficient demand for the products of each individual sector of production and, furthermore, that employment in

each sector in the short run will be uninfluenced by changes in other exogenous variables. This reduces the usefulness of the model in situations where wages and prices develop in such a way that the competitiveness of the export industries is threatened, and therefore their levels of output and employment.

(ii) It is assumed that productivity in the individual sectors of production is independent of changes in other exogenous variables. This cannot be expected to hold true if the changes in exogenous variables are big enough to cause considerable changes in market conditions.

(iii) It is assumed that input-output coefficients are stable in volume terms, even though labour productivities and relative prices change. This is a standard assumption in input-output analysis. Yet it may be doubted whether the coefficients are sufficiently stable for conclusions derived from the model to be reliable in all circumstances.

23. The really crucial assumptions of the model, however, is the group of assumptions relating to the "price behaviour" (the price generating process) of the individual sectors.

24. In the case of agriculture the model assumes that output prices are fixed by a price settlement between government and farmers independently of supply and demand. This assumption is realistic, under Norwegian conditions, for grains and for most animal products. It is unrealistic, however, for fruits and vegetables where prices are usually left free to be determined by market forces. It is known, for instance, that a bad harvest will raise prices of fruits and vegetables considerably and cause an increase in consumers' prices which the model can not account for.

25. In the case of the exposed industries the model assumes that output prices are determined by export and import prices and following the pattern of these. For the export-oriented industries (fishing, shipping and "other export-oriented industries") this must hold true in most cases. For import-competing manufacturers the assumption is much more questionable. (For evidence, see section VI).

26. In the case of sheltered industries excluding farming the model assumes that output prices are adjusted in such a manner that the relationship between profits and wages in this group conforms with a certain trend value. This is an assumption which has important consequences for the conclusions reached by the model. The empirical basis for the assumption is annual data from the national accounts reproduced in row 1 of table 3. These data show that profits computed as a share of factor income in the sheltered industries excluding

agriculture has moved close to a trend dropping from around 35 per cent in 1953 till around 31.5 per cent in 1965.<sup>1)</sup> Deviations from this trend have been relatively small except for years when production, and therefore profits, were unfavourably influenced by the business cycle (1958, 1959, 1962 and partly 1963). This is in marked contrast to the strong fluctuation of the corresponding share in the exposed industries (table 3, row 2). The assumption that the ratio between

Table 3. Share of profits in factor income. Sheltered and exposed industries.

	1953	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965
Sheltered industries <sup>1)</sup>	34.7	36.0	34.5	33.2	33.7	(31.3)	(31.0)	32.7	32.8	(31.0)	32.2	31.9	31.6
Exposed industries	44.3	43.9	45.1	49.9	47.3	37.6	33.5	34.3	34.7	32.1	31.6	37.9	41.1

1) Excluding agriculture.

profits and wages in the group of sheltered industries excluding agriculture will follow the trend value may be useful, therefore, as long as the conditions of demand in these industries are "normal". A possible theoretical basis for the assumption could be that most firms within the group calculate their selling prices on a "cost plus" principle, that is, by adding to direct costs of labour and materials a certain percentage for overheads and profits. If this pricing principle was in general use, and if the percentage was chosen so as to give the firm "normal" profits in years with "normal" output, we would expect to observe profits to move in a steady ratio to wages in "normal" years but to fall short of this value when production was less than "normal", and vice versa. This is precisely what our data show for the group as a whole.<sup>2)</sup>

1) Here and elsewhere in this paper factor income is defined, in any industry as value added at factor cost (i.e. net of indirect taxes less subsidies) of that industry. Profits of an industry is defined, as in the SNA revised, as factor income less wages and salaries.

2) However, when it comes to individual industries within the group the relationships no longer holds. Instead, national accounts data show considerable erratic movements of the relationship between profits and wages for most industries. In light of this the remarkable stability of the relationship for the group of sheltered industries as a whole is difficult to explain. It may be that (i) fluctuations in output caused by the trade cycle, which cause profits to deviate from the trend are not synchronized as between industries, and that (ii) though most firms apply some variant of the "cost plus" pricing principle, selling prices are not continuously corrected as direct costs change but rather are adjusted at long intervals and with random lags. (There is reluctance to change selling prices too frequently; it takes time for the firm even to realize that costs have changed; sometimes a small increase in costs may be used as an excuse for a long contemplated and considerable increase in prices, etc.) Such a mechanism of randomness would explain our observations in the past but would not guarantee the stability of the profit-wage ratio of the group of sheltered industries as a whole to hold indefinitely in the future. Clearly more research into the actual price behaviour of firms is needed to bring this part of the model on a firmer footing.

## VI. Empirical tests of the model

26. The realism of the model may be tested by studying its ability to explain changes in prices and incomes during a past period. In light of the discussion in section V the weakest parts of the model appear to be the assumptions made with respect to (i) the stability of volume flows, or the supposed independence of quantities on prices and incomes, (ii) the tendency for output prices of import-competing manufacturers to follow prices of competing imports, (iii) the price behaviour of sheltered industries excluding agriculture.

27 In one test correct historical values were fed into the model for the years 1961-1967 for changes in (i) all exogenous variables, (ii) output prices of "import-competing manufacturers", and (iii) the coefficient of income distribution within "other sheltered industries". On this basis, corresponding hypothetical values for changes in the remaining endogenous variables were estimated by the model on a year-to-year basis. These hypothetical changes were then compared with actual changes. The results of the test are summarized in table 4. As will be seen, the discrepancies between hypothetical and historical values of the changes were moderate in all cases. The impression left by the test is that, in spite of its simplicity, the model possesses considerable ability to forecast correctly granted (i) that correct guesses of the exogenous variables are available, (ii) that the value of the coefficient of income distribution within "other sheltered industries" is correctly foreseen, (iii) that output prices of "import-competing manufacturers" do in fact follow prices of competing imports.<sup>1)</sup>

28. The latter assumption may be tested directly by confronting the two price indices. The assumption does not stand up well, as the following show:

	1961	1962	1963	1964	1965	1966	1967
Output prices, import-competing manufacturers	100	102.7	104.8	107.0	110.4	113,1	116,7
Prices of competitive imports	100	96.8	94.0	93.8	95.9	97,4	101,0

It appears that import-competing manufacturers have had a much larger scope for price increases than might have been expected in light of the price development

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1) In the test just described historical values were used for changes in output prices of "import-competing industries". However, in the model as set out in the appendix these prices are considered an endogenous variable which is assumed to follow exogenously given prices of competing imports (equation 58).



Table 4. Actually observed changes (a) and estimated changes<sup>1)</sup> (b) of selected endogenous variables of the model. Per cent

	1961-1962		1962-1963		1963-1964		1964-1965		1965-1966		1966-1967	
	a	b	a	b	a	b	a	b	a	b	a	b
Consumers prices	4.5	4.1	2.7	2.6	5.2	4.4	3.9	4.2	3.2	3.5	4.4	3.8
Deflated incomes:												
Total factor income .....	3.2	3.8	6.2	6.2	4.7	5.4	6.7	6.2	3.8	3.2	4.1	4.2
Wages per man year .....	6.3	6.5	3.1	3.1	1.9	2.6	4.3	3.9	6.0	5.7	6.4	7.0
Income from agriculture <sup>1)</sup> ..	-7.3	-4.3	5.6	4.3	1.2	2.5	7.8	3.5	0	-2.9	6.5	2.0
Income from fishing <sup>1)</sup> ..	-8.6	-11.0	8.2	7.7	19.9	18.1	58.6	55.1	23.3	22.3	-28.8	-29.8
Profits (excluding agriculture and fishing), total.	-2.3	-1.6	9.5	9.7	7.8	8.5	7.0	6.7	-3.2	-3.9	-1.8	-2.2
Of which:												
Sheltered industries .....	-	0.3	11.4	11.4	2.1	2.9	5.0	4.5	0.1	-0.4	1.1	1.5
Exposed industries .....	-7.4	-5.7	5.4	5.6	22.1	22.6	11.2	11.3	-9.7	-10.8	-8.2	-10.1
Import - competing ...	2.8	5.0	6.0	4.3	4.8	3.8	2.3	0.5	-0.6	-4.5	-2.4	-5.7
Shipping .....	-4.5	-13.4	42.7	42.8	58.0	57.1	-2.1	-4.2	-22.6	-22.3	-10.8	-12.6
Other export-competing ...	-14.1	-10.7	-3.3	-1.5	24.2	26.5	22.6	25.0	-10.6	-10.6	-11.3	-12.2

1) Estimated by the model, using historical values for all exogenous variables etc.  
See the text (paragraph 27).

2) Per man year.

of what has been termed here "competitive imports". (However, import competing manufacturers have raised prices much less than manufacturers within the sheltered industries.) The explanation presumably is that the classification of industries into "sheltered" and "exposed" used in the model is not fine enough and that many firms which are classified as exposed do not, in fact, feel foreign competition much. This suggests that the model could be improved by a more detailed and careful classification of industries<sup>1)</sup>.

29. As it is, however, we must conclude that a systematic error is contained in the model in that it systematically underestimates the ability of "import-competing manufacturers" to compensate for cost increases. It therefore underestimates the effects of a rapidly rising national cost level on consumers' prices and overestimates the depressing effects/<sup>of rising costs</sup> on profits within import-competing manufacturers. The magnitude of the discrepancies can be gauged by repeating the test computations in table 4 but replacing actual prices of output of import-competing manufacturers by actual prices of competing imports (table 5). The discrepancies between the two sets of estimates of profits within import-competing manufacturers are seen to be considerable.

30. The model assumes that the coefficient of income distribution in "other sheltered industries" will follow a given trend value. The extent to which deviations from the trend may cause errors in the forecast has been studied by comparing the results of the estimates derived on the basis of actual values for this variable with the results of another set of estimates where trend values were used rather than actual values. The test showed the discrepancies between the two sets of estimates to be comparatively small for all endogenous variables. The discrepancies were not systematic in one direction. The results are reproduced in table 6 for two of the endogenous variables with the biggest discrepancies.

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1) The classification of industries into "sheltered" and "exposed" in the model was based on published national accounts data in which only 20 manufacturing industries were distinguished. Consequently the whole of, e.g., the metal manufacturing industry had to be classified as "import-competing" though many enterprises within this industry (e.g. repair shops) undoubtedly feel no foreign competition. A better classification could be made starting from unpublished national accounts data where some 130 industries are specified but this would have made the practical use of the model more cumbersome.

Table 5. Test of the assumption made with respect to output prices of "import-competing manufacturers".<sup>1)</sup>

	1961- 1962	1962- 1963	1963- 1964	1964- 1965	1965- 1966	1966- 1967
<u>Changes in consumers prices. Per cent</u>						
Actual <sup>1)</sup> .....	4.5	2.7	5.2	3.9	3.2	4.4
Estimated I <sup>2)</sup> .....	4.1	2.6	4.4	4.2	3.5	3.8
II <sup>3)</sup> .....	3.2	1.9	4.0	4.1 <sup>4)</sup>	3.4 <sup>4)</sup>	3.9 <sup>4)</sup>
<u>Changes in profits of import-competing manufacturers. Per cent</u>						
Actual <sup>1)</sup> .....	2.8	6.0	4.8	2.3	-0.6	-2.4
Estimated I <sup>2)</sup> .....	5.0	4.3	3.8	0.5	-4.5	-5.7
II <sup>3)</sup> .....	-38.7	-33.0	-13.6ca.	-5.5 <sup>4)</sup> ca.	-8.0 <sup>4)</sup> ca.	-3 <sup>4)</sup>

1) As (a) in table 4. 2) As (b) in table 4. 3) As (b) in table 4 except that actual historical values of output prices of import-competing manufacturers were replaced by actual historical values of prices of competing imports.

4) Rough estimate calculated by means of the table of effects.

Table 6. Test of the assumption made with respect to ratio of profits to wages in sheltered industries excluding agriculture.

	1961- 1962	1962- 1963	1963- 1964	1964- 1965	1965- 1966	1966- 1967
<u>Changes in consumers prices. Per cent</u>						
Actual <sup>1)</sup> .....	4.5	2.7	5.2	3.9	3.2	4.4
Estimated I <sup>2)</sup> .....	4.1	2.6	4.4	4.2	3.5	3.8
II <sup>3)</sup> .....	4.4	2.1	4.0	4.2 <sup>4)</sup>	2.7 <sup>4)</sup>	4.5 <sup>4)</sup>
<u>Profits in sheltered industries excluding agriculture. Per cent</u>						
Actual <sup>1)</sup> .....	-	11.4	2.1	5.0	0.1	1.1
Estimated I <sup>2)</sup> .....	.3	11.4	2.9	4.5	-0.4	1.5
II <sup>3)</sup> .....	2.3	8.0	3.2ca.	4.5 <sup>4)</sup> ca.	4.5 <sup>4)</sup> ca.	6.5 <sup>4)</sup> ca.

1) As (a) in table 4. 2) As (b) in table 4. 3) As (b) in table 4 except that trend values of the coefficient of income distribution in "other sheltered industries" were used rather than historical values. 4) Rough estimate calculated by means of "the table of effects".

31. We may conclude: The tests leave the impression that the model gives a realistic description of the price and income distribution mechanism of the Norwegian economy. Granted that the future values of exogenous variables can be correctly foreseen, the model may be expected to produce forecasts which are sufficiently accurate to be of practical use. The forecasts are not completely unbiased, however: The assumption that output prices of "import-competing manufacturers" must follow prices of competing imports is not entirely realistic; for this reason the model tends to underestimate the price increasing effect to be expected from rising costs while profits in "import-competing manufacturers" are underestimated and other incomes (deflated) correspondingly overestimated. It is possible that this shortcoming of the model may be overcome through a more careful classification of industries into "sheltered" and "exposed".

#### VII. Implications for an incomes policy

32. Granted that our model gives a reasonably accurate description of the price and income distribution mechanism of an economy, certain interesting propositions follow. Some are worth noting because they are of relevance for an incomes policy.

33. For one thing, we shall have to give up the popular belief that the struggle over income shares may be viewed mainly as a confrontation of wage-earners and employers. Instead, it has been argued here that wage-earners and owners of enterprises in the sheltered industries have a common interest in rising wages since, according to the model, a rise in wages will lead automatically, via price adjustments, to a proportionate increase in profits of the sheltered industries. Of course, any gain in real income obtained by these groups will be at the expense of other groups (farmers, and owners of enterprises in the exposed industries). The parties confronting each other in the struggle over income shares, therefore, may be said to be (i) the farmers, (ii) the owners of enterprises in the sheltered industries and the wage-earners, (iii) owners of enterprises in the exposed industries. (We are leaving aside here the factors determining the absolute level of real income, which in any case cannot be studied by means of the present model).

34. Farmers can work actively to increase their share of the national income through demanding higher prices for agricultural output. Wage-earners and owners of enterprises in the sheltered industries can work actively to increase their share of the national income through demanding, respectively allowing, higher

wages. Owners of enterprises in the exposed industries, on the other hand, can work actively to increase their share of the national income through opposing the price and wage claims of the other groups. Therefore the whole burden of avoiding cost-push inflation appears to rest with a small group of entrepreneurs in the exposed industries. This group of people is bound to be a minority in any society; no wonder that the modern society seems to have a strong tendency for inflation under conditions of full employment.

35. The national price level is determined, according to the model, through simultaneous developments in wages, agricultural prices, indirect taxes and subsidies, prices of exports and imports, and productivities. Since this is so, no simple formula can be laid down which will serve as a guide-post, once and for ever, for an incomes policy aiming at stable prices. The assertion often heard, for instance, that a necessary and sufficient condition for price stability is that wages should rise in step with average productivity, is a false statement: An incomes policy adhering strictly to this principle might lead to a falling, stable or increasing national price level depending on what happens simultaneously to the other exogenous variables of the model.

36. According to the model, the national price level and the distribution of the national income are determined through the same set of exogenous variables. But the ways in which the price level and the individual income shares are affected by the exogenous variables are not identical (see the "reduced form" formulas of the appendix, or the entries in the columns of table 2). It is conceivable, therefore, that no set of values for the exogenous variables can be found which will result at the same time in a desired development of prices and a desired distribution of incomes: Only by accident will world market prices and productivities (which society does not control) change in such a way that an incomes policy can be designed which will ensure stable prices without having undesired effects for the distribution of income, or maintain the established distribution of income without allowing unwanted changes in the price level. In other words, society's targets for prices and for income distribution may be in conflict.

37. That this may be a serious conflict is illustrated by post-war Norwegian data: During the period 1951-1965 productivity increased by 2 - 2.5 per cent per year on the average in agriculture and other sheltered industries but by 4.5 - 5.5 per cent on the average in the exposed industries while export and import prices, by and large, remained stable. With import prices stable, wages would have had to follow (roughly) the weak productivity increase of the sheltered industries of 2 - 2.5 per cent a year if an increase in the national

price level were to have been avoided. This would have resulted in a steadily increasing share of national income going to profits in the exposed industries. Conversely: If the share of profits were ~~to have been~~ kept constant, wages would have had to follow (roughly) the much stronger productivity increase of the exposed industries of 4.5 - 5.5 per cent a year. This would have been incompatible with a stable national price level. The figures quoted makes it very improbable that it would have been possible, or even wise, for Norway, to achieve price stability over the period in question, when a policy of stable ratios of foreign exchanges was maintained.<sup>1)</sup>

### VIII. Concluding remarks

38. The realization that prices and income distribution targets may conflict, the discovery that productivities may develop very differently in the sheltered and in the exposed industries, and the understanding that this may cause the national price level to move differently from prices on the world market, are conclusions which invite further research. In particular they may serve as a starting point for an extension of the ideas set out in this paper into a theory which will explain the behaviour of prices and incomes not only in the short run, but in the long run as well.

39. In such a theory wages can no longer be treated as an exogenous variable. The long-run trend of wages must be explained by the theory. In recent Norwegian research it has been assumed that, with constant exchange rates, wage adjustments must leave the exposed industries "reasonably competitive". By assuming the existence of mechanisms which ensures this (in these mechanisms forces of supply and demand play important parts), models can be set up in which the long-term trend of wages in an open economy will depend ultimately on world market prices and productivity trends in the exposed industries, while the trend of the national price level is determined by the same variables and by productivity trends in the sheltered industries.<sup>2)</sup>

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1) What happened in actual practice was that wages went up by no less than 7 per cent a year on the average during the 15-year period. - This resulted in an average annual increase in consumers' prices of 3.2 per cent and a steady decrease in the share of profits in the exposed industries from 21.9 per cent of national income in 1951 (when profits were exceptionally high due to the Korean war) to 12.8 per cent in 1965.

2) A model along this line was the main content of the second report of "The Reporting Committee for the Income Settlement in 1966", referred to in the footnote to paragraph 2.

Appendix:

MATHEMATICAL FORMULATION OF THE MODEL

1. Classification of industries

- |                                     |   |                      |
|-------------------------------------|---|----------------------|
| 1. Agriculture (including dairies)  | } | sheltered industries |
| 2. Other sheltered industries       |   |                      |
| 3. Import-competing manufacturers   | } | exposed industries   |
| 4. Fisheries                        |   |                      |
| 5. Shipping                         |   |                      |
| 6. Other export-oriented industries |   |                      |

2. Endogenous variables

Number

- |          |  |      |
|----------|--|------|
| $Y_j$    | = Total delivery from sector j, measured in current prices.<br>(j = 1,2...6)   | (6)  |
| $Y_{ij}$ | = Sector j's use of intermediate products from sector i,<br>measured in current prices.<br>(i = 1,2...6, j=1,2...6, i ≠ j) | (30) |
| $B_j$    | = Sector j's use of imported intermediate products,<br>measured in current prices.<br>(j = 1,2...6)                        | (6)  |
| $E_j$    | = Profits in sector j.<br>(j = 2,3,5,6)  | (4)  |
| $J_1$    | = Sum of wages and profits in agriculture  | (1)  |
| $J_4$    | = Sum of wages and profits in fishing  | (1)  |
| $P_2$    | = Price index of products from sector 2  | (1)  |
| $P_3$    | = Price index of products from sector 3  | (1)  |
| $P_9$    | = Consumer price index   | (1)  |
| $T_2$    | = Net indirect taxes paid by sector 2  | (1)  |
| $T_3$    | = Net indirect taxes paid by sector 3  | (1)  |
| $S_j$    | = Price index of depreciation in sector j.<br>(j = 1,2,3,4,6)  | (5)  |

Total endogenous variables

58

3. Exogenous variables

- |                |  |
|----------------|--|
| $T_j$          | = Net indirect taxes paid by sector j. (j = 1,4,5,6)                                     |
| $m_j$<br>$n_j$ | } = Tax rates for sector j. (j = 2,3)  |
| $L_j$          |  |
| $N_j$          | = Number of wage and salary earners in sector j. (j = 2,3,5,6).<br>Measured as an index. |
| $N_j$          | = Total employment in sector j. (j = 1,2...6).<br>Measured as an index,                  |

- $Z_j$  = Index of productivity for sector  $j$ . ( $j = 1, 2, \dots, 6$ )  
 $P_1$  = Index of agricultural prices. The index is assumed to be determined by an income settlement.  
 $P_j$  = Price index of products from sector  $j$ . ( $j = 4, 5, 6$ ).  
 The index is assumed to be determined by prices obtained on the world market.  
 $P_7$  = Price index of imported consumer goods.  
 $P_8$  = Price index of competitive imports, that is, of imported goods comparable with products from the sector "import-competing manufacturers".  
 $P_{10}$  = Price index of imported capital goods.  
 $W_j$  = Index of the wage and salary level in sector  $j$ . Changes in  $W_j$  will partly be due to changes in wage agreements and partly to an exogenous wage drift. ( $j = 2, 3, 5, 6$ ).  
 $Q_j$  = Price of imported intermediate goods sector  $j$ . ( $j = 1, 2, \dots, 6$ ).  
 $S_5$  = Price index of depreciation in shipping. The price index is assumed to be determined on the world market by prices of newly built ships.  
 $D_j$  = Volume of depreciation in sector  $j$ . ( $j = 1, 2, \dots, 6$ ).

#### 4. Structural coefficients, or parameters

- $b_{ij}$  = Input-output coefficients that show the amount of the  $i$ -th input required for each unit of the  $j$ -th output. ( $i, j = 1, 2, 3, 4, 5, 6$   $i \neq j$ ).  
 $b_{7j}$  = Input-output coefficients that show the amount of imported input required for each unit of the  $j$ -th output. ( $j = 1, 2, \dots, 6$ ).  
 $r_2$  = Profits as a share of factor income (wages + profits) in sector 2.  
 $\left. \begin{matrix} d_{2j} \\ d_{7j} \end{matrix} \right\}$  = Weights in the price index of depreciation in sector  $j$ . ( $j = 1, 2, \dots, 6$ ).  
 $a_j$  = Weights in the consumer price index. ( $j = 1, 2, \dots, 7$ )  
 $h_j$  = Total nominal wages in the base year in sector  $j$ . ( $j = 2, 3, 5, 6$ ).  
 $c_j$  = Total production in the base year in sector  $j$ . ( $j = 1, 2, \dots, 6$ ).  
 $\left. \begin{matrix} m_2 \\ n_2 \\ m_3 \\ n_3 \end{matrix} \right\}$  = Coefficients in the tax-equations.



## 5. Equations

Definitional equations ((1) - (14)):

$$(1) Y_1 = \sum_{i=1}^6 Y_{i1} + B_1 + T_1 + J_1 + D_1 \cdot S_1$$

$$(2) Y_4 = \sum_{i=1}^6 Y_{i4} + B_4 + T_4 + J_4 + D_4 \cdot S_4$$

$$(3)-(6) Y_j = \sum_{i=1}^6 Y_{ij} + B_j + L_j W_j h_j + T_j + E_j + D_j \cdot S_j \quad (j = 2, 3, 5, 6)$$

Each of the equations (1)-(6) gives, for a sector, a definitional relationship which shows that costs + profits equal the payments for the sector's deliveries. The h coefficients in equations (3)-(6) are those which must be introduced in order to coordinate the criteria chosen for wage levels, employment and wage costs. (Scale coefficients.)  $Y_{ij}$  is fixed by definition equal to 0 when  $j = i$ . The h coefficients must be estimated.

$$(7) P_9 = \sum_{j=1}^7 a_j P_j$$

Equation (7) defines a consumer price index as weighted average of the price indices  $P_1 \dots P_7$ .

The weights  $a_1 \dots a_7$  are assumed to be known figures.

$$(8)-(12) S_j = d_{7j} P_{10} + d_{2j} P_2 \quad (j = 1, 2, 3, 4, 6)$$

Equations (8)-(12) define the price indices for depreciation as weighted averages of the price index of imported capital goods and the price of capital goods produced in sector 2. The weights  $d_{7j}$  and  $d_{2j}$  ( $j = 1, 2, 3, 4, 6$ ) are assumed to be known.

$$(13) T_2 = m_2 Y_2 + n_2 \frac{Y_2}{P_2}$$

$$(14) T_3 = m_3 Y_3 + n_3 \frac{Y_3}{P_3}$$

Equation (13) expresses that the indirect taxes paid by sector 2 consist of one component which is proportional to the value of the sector's total deliveries and another component which is proportional to the volume of the sector's total deliveries. Equation (14) expresses a comparable situation for sector 3.  $m_2, n_2, m_3, n_3$  must be estimated.

Input-output relationships ((15) - (50)):

$$(15)-(44) \quad \frac{Y_{ij}}{P_i} = b_{ij} \cdot \frac{Y_j}{P_j} \quad (i = 1, 2 \dots 6)$$

$$(j = 1, 2 \dots 6) \\ (i \neq j)$$

$$(45)-(50) \quad \frac{B_j}{Q_j} = b_{7j} \cdot \frac{Y_j}{P_j} \quad (j = 1, 2 \dots 6)$$

Equations (15) - (50) indicate that the quantity a sector consumes of a certain type of intermediate goods is proportional to the magnitude of the sector's delivery measured in volume. (The figures for quantity are expressed by dividing the figures for value by prices.) The b coefficients must be estimated.

Production functions((51) - (56)):

$$(51)-(56) \quad \frac{Y_j}{P_j} = c_j Z_j N_j \quad (j = 1, 2 \dots 6)$$

Equations (51) - (56) express the volume of the total delivery from a sector as a function of the product of employment in the sector and index of productivity for the sector. The c coefficients must be estimated.

Price behaviour equations ((57)-(58)):

$$(57) \quad \frac{E_2}{E_2 + W_2 L_2 h_2} = r_2$$

Equation (57) expresses the thought that enterprises in sector 2 (other sheltered industries) adjust their output prices ( $P_2$ ) in such a way that the ratio of profits to factor income in sector 2 (the left-hand side of the equation) assumes a pre-determined value expressed by the coefficient  $r_2$ . The coefficient  $r_2$ , in normal years, is supposed to follow a given trend.

$$(58) \quad P_3 = P_8$$

Equation (58) expresses the thought that enterprises in sector 3 (import-competing manufacturers) adjust their output prices in such a way that an index of these prices follow an index of prices of comparable imported products.

## 6. The reduced form of the model

The easiest way of solving the system is first to find the solution for  $P_2$ . We can then use this result to find the solution for the other endogenous variables.

Below we have listed the results for the endogenous variables of main interest.

$$P_2 = \frac{1}{1 - m_2 - d_{22} \frac{D_2}{c_2 N_2 Z_2}} \left[ b_{12} P_1 + b_{32} P_8 + b_{42} P_4 + b_{52} P_5 + b_{62} P_6 + b_{72} Q_2 + n_2 \right. \\ \left. + d_{72} \frac{D_2}{c_2 N_2 Z_2} P_{10} + \frac{1}{1 - r_2} \cdot \frac{h_2 L_2 W_2}{c_2 N_2 Z_2} \right]$$

$$P_9 = a_1 P_1 + a_2 P_2 + a_3 P_8 + a_4 P_4 + a_5 P_5 + a_6 P_6 + a_7 P_7$$

$$E_2 = \frac{r_2}{1 - r_2} h_2 L_2 W_2$$

$$E_3 = c_3 N_3 Z_3 \left[ P_8 - b_{13} P_1 - b_{23} P_2 - b_{43} P_4 - b_{53} P_5 - b_{63} P_6 - b_{73} Q_3 - n_3 - m_3 P_8 \right] \\ - \left[ d_{23} P_2 + d_{73} P_{10} \right] D_3 - h_3 L_3 W_3$$

$$E_5 = c_5 N_5 Z_5 \left[ P_5 - b_{15} P_1 - b_{25} P_2 - b_{35} P_8 - b_{45} P_4 - b_{65} P_6 - b_{75} Q_5 \right] \\ - S_5 D_5 - T_5 - h_5 L_5 W_5$$

$$E_6 = c_6 N_6 Z_6 \left[ P_6 - b_{16} P_1 - b_{26} P_2 - b_{36} P_8 - b_{46} P_4 - b_{56} P_5 - b_{76} Q_6 \right] \\ - \left[ d_{26} P_2 + d_{76} P_{10} \right] D_6 - T_6 - h_6 L_6 W_6$$

$$J_1 = c_1 N_1 Z_1 \left[ P_1 - b_{21} P_2 - b_{31} P_8 - b_{41} P_4 - b_{51} P_5 - b_{61} P_6 - b_{71} Q_1 \right] \\ - \left[ d_{21} P_2 + d_{71} P_{10} \right] D_1 - T_1$$

$$J_4 = c_4 N_4 Z_4 \left[ P_4 - b_{14} P_1 + b_{24} P_2 - b_{34} P_8 - b_{54} P_5 - b_{64} P_6 - b_{74} Q_4 \right] \\ - \left[ d_{24} P_2 + d_{74} P_{10} \right] D_4 - T_4$$