Arbeidsnotater

STATISTISK SENTRALBYRÅ

Dronningensgt. 16, Oslo-Dep., Oslo 1. Tlf. 41 38 20, 41 36 60

WORKING PAPERS FROM THE CENTRAL BUREAU OF STATISTICS OF NORWAY

IO 74/12

27. februar 1974

STUDIES IN THE STABILITY OF INPUT-OUTPUT RELATIONSHIPS. SLACK IN INPUT-OUTPUT MODELS

by

Per Sevaldson

Contents

SLACK IN INPUT-OUTPUT MODELS

I Introduction

In studies of input-output relationships it has been found that there are considerable variations in the coefficients from year to year even when the basic input-output data are given in constant price values.[1] Apparently, only a minor fraction of the variations may be explained by gradual technological change. There are a number of possible explanations for the remaining variability: random changes in product mix within the sectors, changes in market shares for establishments with different techniques, random variations in quality and utilisation of raw materials and errors in statistical measurement as well as purposeful adjustments of the production techniques or product mix within sectors, e.g. in response to changing relative prices. Whereas random variations in the coefficients will lead to random errors in the analytical results of input-output computations, and thus are of importance for precision, they do not (necessarily) introduce systematic biases. This is different with coefficient variations caused by systematic adjustments to relative prices. Such adjustments will introduce systematic errors in the results of an analysis.

Assume e.g. that a change in final demand is considered, which, with base year coefficients, will increase the demand for labour by 10 per cent. Let us further assume that the needed 10 per cent extra labour is not available. The conclusion from an ordinary input-output analysis must be that the change in final demand cannot be realized, unless the extra labour can somehow be supplied. On the other hand, we may reason that what actually will happen if the change in final demand is put into effect, will be that a scarcity of labour is felt, and, possibly, wages and the prices of labour intensive products will rise. Even if this fails to increase the supply of labour, entrepreneurs may be able to, and induced to, change their techniques in such ways that they use less direct and indirect labour, and the changed final demand may be satisfied with the new techniques, without over-exhausting the available supply of labour. In this case the use of input-output analysis will be of very limited value.

---

1) See Per Sevaldson: "The Stability of Input-Output Coefficients" in "Applications of Input-Output Analysis" Eds. A.P. Carter and A. Brody Amsterdam/London 1969. Also as "Artikler" No. 32 from the Central Bureau of Statistics of Norway.

We have outlined two extreme possibilities. Reality is probably somewhere in between, and it is important to know as much as possible about where.

Empirical studies of the errors committed by using fixed coefficient input-output matrices to compute production and input levels for historical years can tell something about the scope of errors, but they cannot in themselves indicate whether the errors are systematic or random.

In the present study we go another way in trying to evaluate the importance of variability in input-output proportions: We start with the table of empirical input-output cofficients for a given base year. Then we assume that some of the coefficients in this input-output coefficient table can be systematically changed from their base year values. We suppose that entrepreneurs are induced to reduce their labour costs, and for that purpose change the input-output coefficients in such a way as to achieve the maximum possible saving in direct and indirect labour at the cost of increased requirements for other primary inputs. (The cause of the change may be a relative increase in the price of labour compared to prices for other resources.) A saving in direct labour can be achieved, if the coefficient for direct labour input can be reduced at the cost of compensating increases in other inputs. A saving in indirect labour input can be achieved if the coefficients for the most labour intensive inputs in a sector can be reduced at the cost of compensating increases in some of the less labour intensive inputs. We want then to investigate the changes in requirements for direct and indirect input, both of labour and other means of production, which are associated with alternative assumptions about variability in input-output proportions. In stipulating the rules for systematic changes in input-output proportions we take account of the variability actually observed in annual Norwegian input-output tables in fixed prices for the periode 1949-1960.

If we assume that some of our alternatives are to some extent representative of the scope for systematic variations in input-output proportions in reality, then we may draw conclusions about the margins of error which may occur in various types of estimates made on the basis of an input-output model. By comparing hypothetical errors with observed errors in estimates we may even get some indication about the extent to which the observed changes in coefficients are due to systematic cost adjustments or are of a more random nature.

One could say that the purpose of this test was threefold:

a) To obtain some indication whether the observed variability in input-output coefficients was mainly the result of systematic adjustments to changing relative prices, or if they could be ascribed to random or temporal changes.

b) To obtain indications of the margins of error which must be taken into account for the results of input-output estimates, if systematic changes in accordance with some of our alternative assumptions must be counted on.

c) To get an impression of the pattern of changes in intermediate deliveries from domestic sectors which we might obtain if systematic changes must be assumed.

II The data

The basis for our study was the input-output table for the Norwegian economy for the year 1959 in 1955-producers' prices[1]. The table had 92 production sectors, and 5 final delivery columns for exports, government consumption, private consumption, gross fixed asset formation and inventories. There was also a column for total final deliveries, which had no entries from indivudual production sectors, but received its input from exports, government consumption, private consumption, gross fixed asset formation and inventories. Each of these was entered with its column sum on a separate row as a delivery to total final deliveries.

The table also had a row for total imports into each sector (of production or final delivery) and rows for gross national product, wages, depreciation charges and owner income.[2] (See Diagram 1.)

The table could be looked upon as a 98 sector input-output table and direct coefficients and the Leontief inverse could be computed for the entire matrix.[3]

---

1) Figures in 1955-prices were chosen in order to maintain comparability with measurements of coefficient variability over the period 1949-1960. See below and also Sevaldson: Op.cit. 1969.

2) Indirect taxes and subsidies were not specified so that there was not a complete specification of the components of value added.

3) Let us write A for the 92 by 92 matrix of production sectors in the base year, B for the 92 by 5 matrix of "final delivery proportions" i.e. the fractions of the total of each of the 5 final delivery categories originating in each production sector in the base year, and finally, C for the 5 by 1 vector of total deliveries to each of

Note 3) page 4 (cont.)

the 5 final delivery categories as fractions of the total of all final deliveries in the base year. The comprehensive matrix corresponding to the A-matrix in diagram 1 is then

$$G = \begin{pmatrix} A & B & 0 \\ 0 & 0 & C \\ 0 & 0 & 0 \end{pmatrix}$$

and

$$(I-G) = \begin{pmatrix} (I-A) & -B & 0 \\ 0 & I & -C \\ 0 & 0 & I \end{pmatrix}$$

The Leontief inverse of this is:

$$(I-G)^{-1} = \begin{pmatrix} (I-A)^{-1} & (I-A)^{-1}B & (I-A)^{-1}BC \\ 0 & I & C \\ 0 & 0 & I \end{pmatrix}$$

where I are unit matrices and 0 zero-matrices of appropriate dimensions. The effects of partial changes in total final deliveries from any one of the 92 production sectors is now given by $(I-A)^{-1}$ (assuming A constant B changed and no assumption about C compared to base year proportions). The effects of partial changes in total deliveries to one of the final delivery categories, when the change is distributed on delivering sectors in the same proportions as deliveries in the base year, is given by $(I-A)^{-1}B$ (assuming A and B constant and C changed from the base year). The effects of a change in total final deliveries, when this change is distributed on final delivery categories in the same proportions as deliveries in the base year, and changes in deliveries to each of the final delivery categories are distributed on delivering sectors in the same proportions as base year deliveries, is given by $(I-A)^{-1}BC$ (assuming A, B and C unchanged from the base year).
Denoting now by V the 5 by 92 matrix of imports, gross product and the three specified elements, wages, depreciation and owner incomes, all per unit of output in the respective production sectors, and by W the corresponding 5 by 98 matrix obtained by supplementing the V matrix by a matrix, U, of dimension 5x5, with imports as fractions of each final delivery category in the first line and zeros elsewhere, and a zero matrix of dimension 5x1:
W= (V, U, 0), then we also find the effects on gross product and its elements as
$W (I-G)^{-1} = (V(I-A)^{-1}, V(I-A)^{-1}B + U, V(I-A)^{-1}BC + UC)$.

Diagram 1. Outline of the basic data-table

	From \ To	G-matrix: Production sectors 1 2 92	G-matrix: Exports 93	G-matrix: Gvt. consumption 94	G-matrix: Pvt. consumption 95	G-matrix: Fixed assets 96	G-matrix: Inventories 97	Total final delivery 98	Row sums
A-matrix	Production sectors 1 2 92	X			X			0	X
A-matrix	Final delivery sectors: Exports 93; Gvt. consumption 94; Pvt. consumption 95; Fixed assets 96; Inventories 97	0			0			X	X
A-matrix	Total final delivery 98	0			0			0	0
		W-matrix							
B-matrix	Total import	X			X			0	X
B-matrix	Gross product of this: wages, depreciation, owner incomes	X			0			0	X
	Column sums	X			X			X	X

Areas marked X have figures, areas marked 0 are empty.

The inverse table could give the following information:

Effects on production in Norwegian sectors, on sum imports, gross national product, total wages, depreciation and owner income of

a) 1 unit increase in total final deliveries distributed over exports, government consumption, private consumption, gross fixed asset formation, and inventories in the same proportions as actual deliveries in the base year. $((I-A)^{-1}BC$ and $V(I-A)^{-1}BC + UC)$

b) 1 unit increase in any one of the separate categories of final deliveries distributed over Norwegian production sectors and imports in the same proportions as actual deliveries in the base year. $((I-A)^{-1}B$ and $V(I-A)^{-1}B + U)$

c) 1 unit increase in final deliveries from any one production sector. $((I-A)^{-1}$ and $V(I-A)^{-1})$

III The test computations

The purpose of the experiment was to find the effects of systematic changes in the coefficients on the essential characteristics of the Leontief inverse described above. It was assumed that a relative increase occured in labour costs compared to other costs of primary inputs. It was further assumed that this relative cost increase affected the prices for outputs of production sectors in proportion to their total (direct plus indirect) content of wages, as computed from the basic input-output table. Accordingly, output from sectors with higher than average total wage input per unit of output increased in price compared to outputs from sectors with lower than average wage input per unit of output. It was then assumed that producers adjusted to this change in relative prices by changing their input proportions in such a way as to achieve a maximum saving of wages.

The changes in input proportions were restricted by a specification of which types of input-output coefficients could be changed, by how much each coefficient could be changed, and by certain rules applying to the changes in sums of coefficients.

There were four alternative specifications of which types of input-output coefficients could be changed:[1)]

1) The computations were actually carried out with alternatives 1) to 3) and an additional alternative 4), which was equal to alternative 2, with the modification that all coefficients for inputs into a given sector from Norwegian production sectors must be changed in the same proportion and in the same direction. Alternative 0) was formed by taking the difference between alternatives 2) and 4). As a consequence, the "basic table" for alternative 0 is not the original 1959 table, but the table corresponding to the coefficients after the changes under alternative 4 have been put into effect.

Alternative 0). Only the coefficients for input into a sector from Norwegian production sectors can be changed (decreased or increased)

Alternative 1). Only the coefficients for imports and for inputs from production sectors can be changed.

Alternative 2). The coefficient for direct labour input (wages) can be changed in addition to the coefficients for imports and inputs from production sectors.

Alternative 3). The above coefficients can be changed, and also the coefficient for owner income.

The first of these alternatives (0) corresponds to a very restrictive assumption about the scope for changes. Only the coefficients inside the square matrix of intersector deliveries can be adjusted. In alternative 1 we allow substitution between all intermediate inputs, including substitution between domestic products and inputs, but no substitution between intermediate and primary inputs. This is a production model which may be reasonably realistic when the sector specification is relatively detailed, and when the dividing live between intermediate and primary products is consistently drawn. The latter condition means that essentially the same types of inputs should not be treated partly as primary inputs (say wages and salaries, use of real capital) and partly as intermediate inputs in the form of payments for semiprocessed raw materials, for "consultations" from the service sectors and rentals for the use of real capital). In alternative 2 we allow substitution between intermediate inputs and direct labour input. Apart from the cases of an unclear dividing live between intermediate and primary inputs, this simple type of interchangeability between primary inputs and labour inputs does not seem to be realistic. While it seems reasonable to assume that changes in labour input and intermediate input proportions may be made in order to reduce costs, it seems unlikely that they should be of the simple nature assumed here: i.e. that the coefficients of direct labour input are reduced, and to some extent also the coefficients for inputs with high indirect labour content, while there are compensating increases in the coefficients for inputs with low or zero indirect labour content. (See below). Since the assumptions used here give the maximum reduction in labour inputs possible, with the given limitations on variability, they may be considered as upwards limit values for the possible changes with these limitations. In alternative 3 we also allow changes in the

owner income coefficients, assuming such changes to reflect the exchange of work by owners and owners' family members for other inputs, particularly for hired labour.

The restrictions on the extent of changes in the coefficients were, apart from what follows from the general description above, the same for all alternatives. They were specified in the following way:

1) The column sum of coefficients changes for each sector must be zero. (The balance requirement).
2) For each type of coefficient, and for the sum coefficient for inputs to a production sector from all production sectors, there was given a maximum numerical change, depending on the size of the coefficient.
3) No coefficient could be more than doubled or reduced to less than zero.

The limits set are shown in table 1. Roughly they correspond to twice the standard deviation about the trend for the corresponding types of coefficients observed over the period 1949-1960[1)].

Since the balancing requirements generally prevented the changing of all coefficients up to the given maxima, certain priorities had to be established. Since the purpose of the adjustments was to save labour inputs, this also gave the basis for the priorities which were established:

a) The highest priority was given to reducing the direct labour coefficient with as near to its maximum change as possible. (Alternatives 2, 3 and 4).

b) If there was still room inside the balance requirement, the next priority was to reduce the sum coefficient for inputs from production, thus saving in indirect labour. (Alternatives 1, 2, 3 and 4).

c) The coefficient of owner income was never reduced, but was, when it could be changed (Alternative 3), left unchanged unless the permitted increase in the import coefficient was not sufficient to compensate for the maximum reductions in the direct labour coefficient and in the sum coefficient for inputs from production. In that case the coefficient for owner income was increased in order to allow for the biggest possible savings in direct labour and intermediate input.

d) Increase in the import coefficient was the preferred compensation for reductions in other coefficients.

e) If maximum reduction in the direct labour coefficient more than offset the sum of maximum allowable increases in import and owner income coefficients, as much of the remainder of the allowable maximum reduction in the labour coefficient as possible was realized against a compensating

---

1) See Sevaldson, Op.cit. 1969.

increase in the sum coefficient for inputs from production up to the maximum change for this sum coefficient. This sum coefficient could thus either decrease or increase. (Compare b) above.)

f) Within the limits set by the required change in the sum coefficient for inputs from production according to b) or e) above, the individual coefficient for inputs from production to a sector were changed in such a way that inputs with a high indirect labour content in the base year were reduced and inputs with a low indirect labour content were increased.

Table 1. Limits for changes in coefficients compared to observed standard deviations in coefficients 1949-1960.[1)]

	If the original coefficient was						
	0.0200 and less	0.0201-0.0500	0.0501-0.1000	0.1001-0.2500	0.2501-0.5000	0.5001 and above	
the change in coefficients for inputs from individual production sectors, labour (wages) and owner income must not exceed	0.0120	0.0140	0.0240	0.041	0.0860	0.0880	
the change in coefficients for imports and sum of inputs from production sectors must not exceed ...	0.0120	0.0180	0.0280	0.0440	0.0620	0.1220	
Standard deviation about trend according to observations 1949-1960 was[1)]							
for intermediate input coefficients .	0.006	0.007	0.012	0.021	0.043	0.044	
for total import coefficients	0.006	0.009	0.014	0.022	0.031	0.061	
for gross value added coefficients .	..	..	0.033	0.048	0.036	0.016	

1) See Per Sevaldson, Op. cit. 1969.

The fact that some coefficients could not be changed under some of the alternatives should not complicate the interpretation of this procedure.

On the basis of the given rules, four alternative labour saving coefficient matrices could be derived from the given base year coefficient matrix.

The following procedures were used for changing the input coefficients for each sector in turn:

1. Under alternatives 2 and 3 the coefficient for labour was reduced as much as possible, the limitations given by the limits according to table 1 or by the balance requirement.
2. Under alternatives 1,2 and 3 the coefficient for imports was increased as much as possible, the limitations given by the limits according to table 1 or by the balance requirement.
3. Under alternative 3 the coefficient for owner income was increased as much as possible, the limitations given by the limits according to table 1 or by the balance requirements.
4. When steps 1, 2 and 3 had been carried out, the sum coefficient for intermediate inputs would have to be::

a) unchanged (always for alternative 0)

b) reduced, when the maximum allowable increase in the import coefficient and the owner income coefficient together exceeded the maximum allowable reduction in the labour coefficient.

c) increased, when the maximum allowable reduction in the labour coefficient exceeded the maximum allowable increase in the import coefficient and the owner income coefficient.

5. The individual coefficients of inputs from production sectors were then changed in the following way:

a) All production sectors were ranked according to the size of the coefficient for total (direct plus indirect) labour input, as found from the Leontief inverse of the base year matrix.

b) All coefficients for inputs from production into a sector were ordered in accordance with the above ranking of the sectors of origin. Coefficients for inputs from the sectors with the lowest total labour input coefficients were increased as much as possible according to the established limits (from table 1), and those for inputs from the sectors with the highest total labour input coefficients were reduced as much as possible. The dividing line between those coefficients which were increased and those which were decreased in a given sector was drawn in such a way that

the sum of all the changes equalled the already prescribed (positive, negative or zero) change in the sum of the coefficients for inputs from production. In order to secure equality, one of the coefficients might not get the full change stipulated by the limit.

As an illustration, appendix table 1 gives basic and adjusted coefficient vectors for a sector where the sum coefficient of inputs from production is reduced for some alternatives (1 and 3) and increased for others (2 and 4).[1)]

It is now a fundamental question if, and in what ways our alternatives reflect the empirically observed variability in coefficients. We have no empirical observations of variations in coefficients for labour input and owner incomes, or other elements of value added. We have given them the same variability as individual input coefficients.

But our empirical observations give more or less continuous distributions of coefficients about their averages. How can we make deductions about the maximal adjustability from these observations? We have no basis for assuming that all coefficients in a given size group are equally adjustable. We would like to find an estimate of the typical, or representative, adjustability. Thus the maximum of observed changes is almost certainly not representative of the changes that producers can systematically undertake from one year to the next, but would exaggerate the flexibility in the system. Since it may be reasonably maintained that there is no reason to believe that all coefficients are changed maximally between all years, an average, like the root-mean-square may be assumed to underestimates the possibilities for changes.

It must be admitted that the choice of twice the observed root-mean-square standard deviation from trend as the limit is a rather arbitrary compromise, and all our results must be evaluated in the light of this arbitrary basic choice.

The limitation that no coefficient can be reduced below zero seems quite obvious, whereas the corresponding rule that no coefficient can be more than doubled has nothing except symmetry to speak for it. Probably this particular restriction, which only is effective for small coefficients does not have important consequences for our results. The crucial assumption seems to be the choice of twice the standard deviation as the numerical limit to coefficient changes. It seems to be a fair guess that the choice of other multipla of the standard deviation would have changed our results close to proportionately, but this has not been tested.

---

1) See footnote 1) p. 7.

IV The results

The effects of the alternative changes in coefficients can now be studied on the basis of the Leontief inverses of the adjusted coefficient matrices, compared to the original Leontief inverse for the base year.

From our Leontief inverses we get coefficients which may be interpreted in the following ways:

- for each domestic production sector we find total, direct plus indirect, production in each of 92 domestic production sectors associated with each unit of final delivery from the given production sector.
- for each domestic production sector we also find total, direct plus indirect (in the given and all other sectors) imports, gross product, wages, depreciation and owner income associated with each unit of production in the given sector.
- for each category of final deliveries: exports, government consumption, private consumption, fixed asset formation and inventory changes, we find total, direct plus indirect production in each of 92 domestic production sectors associated with each unit of final delivery of the given category, when this unit is assumed to consist of base year proportions of direct deliveries from domestic production sectors and imports.
- for each of the same categories of final deliveries we also find total, direct plus indirect imports and gross product, wages, depreciation and owner income associated with each unit of final delivery of the given category, again assuming base year proportions.
- for total final deliveries we find total, direct plus indirect production in each of 92 domestic production sectors associated with each unit of total final delivery, when this unit is assumed to consist of base year proportions of direct deliveries from domestic production sectors and imports.
- for total final deliveries we also find total, direct plus indirect imports and gross product, wages, depreciation and owner income associated with each unit of delivery, again assuming base year proportions.

The units of measurement will be in constant price value units, and when we consider value units in kroner, here per unit figures are most conveniently given as percentages, i.e. per 100 kroner. When we consider changes in such per unit of final delivery figures, we may then either consider the absolute changes in kroner per 100 kroner of final deliveries, or we may consider the changes in per cent of the per unit figures of a basis

table, i.e. the per cent saving or dissaving in the production in a given supporting sector, or in the use of imports, in gross product, wages, depreciation or owner income implied by the change in coefficients.

In most of the following analysis we look at both these measures of changes in inverse coefficients.

a. Total labour saving.

The assumed purpose of the coefficient adjustments was to save labour, and our assumptions turn out to give scope for sizeable labour saving.

With a composition of final deliveries corresponding to total final deliveries in the base year (1959) a reduction of the labour input by 1.4 kroner per 100 kroner final deliveries (table 2) or 4.6 per cent of total labour input (table 3) is possible with adjustments only in the coefficients for domestic intermediate inputs. The labour saving is increased by more than one krone per 100 kroner final deliveries, to 2.46, when also import coefficients are adjusted as substitutions for reductions in domestic inputs. This gives 8 per cent saving in labour. If we allow also the coefficient for direct labour inputs to be adjusted, the saving is drastically increased, to 6.6 kroner per 100 kroner final delivery, or a saving of 21.4 per cent of the labour input required according to the basis matrix. This is an increase of 4.1 kroner per 100 kroner final delivery or an increase by 13.4 per cent of the required labour input. It is possible to compute the total labour saving that would have resulted if direct labour coefficients could have been reduced without any compensating increases in the coefficient sums for inputs from production. Such reductions would have given a saving in total labour input of 5.4 kroner per 100 kroner final delivery, or 17.9 per cent of labour input requirements. This is more than the increase in labour saving from alternative 1 to alternative 2. The difference is explained by the increase in indirect labour requirements caused by the increases in the sum coefficients for inputs from production, which were necessary in order to compensate for the reduced direct labour input coefficients. These increases were in total 1.4 kroner per 100 kroner total final delivery or 4.5 per cent of labour input requirements according to the basis matrix.

Table 2. Effects of changes in input-output coefficients on direct plus indirect coefficients for total final deliveries (1959-composition). Kroner per 100 kroner total final delivery

	Basic coefficients			Possible changes[1]			
	Direct	Indirect	Total	Alternative 0 Changes only in coefficients for inputs from production	Alternative 1 Changes also in import coefficients	Alternative 2 Changes also in direct labour coefficients	Alternative 3 Changes also in owner income coefficients
Effects on Production in							
1. Agriculture, foresty, hunting and fishing .	3.52	9.47	12.99	+1.94	+1.07	+2.10	+ .91
2. Extraction and production of mineral and metal goods	11.02	5.60	16.62	- .73	- .86	- .11	- .73
3. Production of food and beverages, oils, fats and chemicals ..	11.25	5.09	16.34	+ .58	- .21	+ .56	- .28
4. Products of wood, pulp and paper, printing, textiles, clothing, leather and rubber products	8.33	6.67	15.00	- .41	-1.93	+ .14	- .97
5. Construction	11.40	.01	11.41	- .01	- .01	- .01	- .01
6. Trade and transportation	26.78	7.68	34.46	-1.48	-2.12	- .72	-1.51
7. All other activities (services)	14.49	6.29	20.78	-1.01	-2.10	- .32	-1.80
Sum domestic deliveries	86.79	40.81	127.60	-1.12	-6.16	+1.64	-4.39
Imports	13.32	16.89	30.21	+ .16	+2.66	+4.38	+3.47
Gross national product ..	-	69.48	69.48	- .07	-2.54	-4.30	-3.36
of this:							
Wages (labour input)	-	30.77	30.77	-1.40	-2.46	-6.57	-7.77
Owner income	-	17.18	17.18	+ .95	- .03	+1.35	+3.64
Depreciation	-	15.20	15.20	+ .14	- .11	+ .41	- .04

1) Changes from basis for each alternative.

Table 3. Effects of changes in input-output coefficients on direct plus indirect coefficients for total final deliveries (1959-composition. Changes in per cent of basic total coefficients.

	Possible changes[1]			
	Alternative 0 Changes only in coefficients for inputs from production	Alternative 1 Changes also in import coefficients	Alternative 2 Changes aslo in direct labour coefficients	Alternative 3 Changes also in owner income coefficients
Effects on				
Production in				
1. Agriculture, foresty, hunting and fishing	+14.9	+ 8.2	+16.2	+ 7.0
2. Extraction and production of mineral and metal goods	- 4.4	- 5.2	- .7	- 4.4
3. Production of food and beverages, oils, fats and chemicals	+ 3.5	- 1.3	+ 3.4	- 1.7
4. Products of wood, pulp and paper, printing, textiles, clothing, leather and rubber products	- 2.7	-12.9	+ .9	- 6.5
5. Construction	- .1	- .1	- .1	- .1
6. Trade and transportation	- 4.3	- 6.2	- 2.1	- 4.4
7. All other activities (services) ..	- 4.9	-10.1	- 1.5	- 8.7
Sum domestic deliveries	- .9	- 4.8	+ 1.3	- 3.4
Import	+ .5	+ 8.8	+14.5	+11.5
Gross national product	- .1	- 3.7	- 6.2	- 4.8
of this:				
Wages (labour input)	- 4.6	- 8.0	-21.4	-25.3
Owner income	+ 5.5	- .2	+ 7.9	+21.2
Depreciation	+ .9	- .7	+ 2.7	- .3

1) Per cent changes from basis for each alternative

We can make the following summary:

	Labour savings	
	Kroner per 100 kroner final deliveries	Per cent of basis labour inputs
Total saving under alternative 2	6,6	21,4
Total saving under alternative 1	2,5	8,0
Increase in saving as a net effect of letting labour coefficients change (Alt. 2 - Alt. 1)	4.1	13.4
Of this due to:		
Reductions in direct labour coefficients	5,4	17.9
Compensating increases in intermediate inputs	-1.4	-4.5

If we now allow even the coefficients for owner income to be adjusted, it turns out that this gives scope for some additional reductions in the direct labour coefficients, but only to the extent of an additional ½ krone saving, i.e. 6 kroner per 100 kroner final delivery or 19.6 per cent labour saving altogether through reductions in direct labour coefficients. The greater part of the additional slack is taken up by additional saving on indirect labour - since the saving in direct labour now can be compensated by increases in owner income coefficients instead of in intermediate inputs - and this gives a labour saving which amounts to 1 3/4 kroner per 100 kroner final delivery, so that total labour saving under this alternative is as high as 7.77 kroner per 100 kroner final delivery or 25.3 per cent of the labour input implied by the base year coefficients.

It is of some interest to know to what extent the potential labour saving is dependent on the specific composition of final deliveries in the base year. In addition to the possible labour saving with a final delivery composition corresponding to the total in the base year, we have also computed the possible saving when the final delivery composition corresponds to respectively deliveries to private consumption, to government consumption, to gross fixed asset formation, to exports and to inventory changes. (The latter is, of course, somewhat peculiar, since it consists of positive and negative items, and it will not be commented on.) (Tables 4 and 5). Generally, the composition of final deliveries to gross fixed asset formation gives the greatest scope for labour saving on a given amount of final deliveries, for most alternatives 30-50 per cent more than the others (ignoring inventory changes). The differences between the other final delivery compositions are quite small for all alternatives, except in the case where

only coefficients for domestic intermediate deliveries are adjusted (alternative 0). Here Government consumption gives scope for the greatest labour saving, and even greater than gross fixed asset formation.

Table 4. Labour savings from changes in input-output coefficients for different compositions of final deliveries. Kroner per 100 kroner final deliveries of each category

		Possible changes			
	Basic coefficients. Indirect= Total	Alternative 0 Changes only in coefficients for inputs from production	Alternative 1 Changes also in import coefficients	Alternative 2 Changes also in direct labour coefficients	Alternative 3 Changes also in owner income coefficients
Final delivery composition:					
Total final delivery 1959	30.77	-1.40	-2.46	-6.57	-7.77
Private consumption 1959	25.75	-1.37	-2.28	-5.68	-7.05
Government consumption 1959 ..	54.78	-1.87	-2.45	-5.76	-7.37
Gross fixed asset formation 1959	31.08	-1.80	-3.14	-8.55	-9.72
Exports 1959	22.60	- .85	-2.10	-6.26	-7.13
Inventory changes[1]	28.34	.13	-1.18	-3.12	-7.16

1) Total inventory change was small and negative, but was a sum of negative and positive figures. The results for inventories are consequently not very interesting.

Exports gives room for very limited savings compared to the others for this alternative. The total labour content in each of the final delivery categories vary from 22.6 to 54.8 per cent according to the basic coefficients, but there does not appear to be any close connection between labour content and potentialities for labour saving, so labour input saved under each alternative tend to vary much more between the final demand categories when taken as percentages of basic labour inputs (table 5) than when the savings are measured in kroner per 100 kroner of final deliveries.

We must conclude that our assumptions, which might be considered to set relatively liberal limits for coefficient adjustments, give scope for relatively sizeable changes in labour input through substitutions of

intermediate inputs alone (including imports) under the alternative (Alternative 1) which gives the maximum saving of this type, namely 8 per cent, but with considerably lower figures for the remaining alternative. But when labour can be saved through reductions in direct labour input coefficients in the production sectors, the potential savings are at once impressive. This is, however, only a reflection of the adjustments that we have directly allowed through our hypotheses and, as already mentioned, these potential savings should be considered as an upward limit, rather than as estimates according to a plausible model. The compensating increases in requirements for intermediate inputs when direct labour inputs are reduced counteract the effects of substitution among such inputs on the need for labour, so that when direct labour inputs can be adjusted, the net effect of compensating increases in intermediate input sums and of substitutions among intermediate inputs is comparatively small.

Table 5. Labour savings from changes in input-output coefficients for different compositions of final deliveries. Percentages of basic (indirect) labour coefficient

	Possible changes			
	Alternative 0 Changes only in coefficients for inputs from production	Alternative 1 Changes also in import coefficients	Alternative 2 Changes also in direct labour coefficients	Alternative 3 Changes also in owner income coefficients
Final delivery composition:				
Total final delivery 1959	-4.6	-8.0	-21.4	-25.3
Private consumption 1959	-5.3	-8.9	-22.0	-27.4
Government consumption 1959	-3.4	-4.5	-10.5	-13.5
Gross fixed asset formation 1959 ..	-6.0	-10.1	-27.5	-31.2
Exports 1959	-3.8	-9.7	-29.0	-33.0
Inventory changes[1)]	.5	-4.1	-11.0	-25.4

1) See note 1) table 4.

b. Labour saving for individual sectors.

From the basic matrix and its Leontief inverse we obtain the direct and total, direct plus indirect, labour content per unit of final

Table 6. Labour coefficients and possible changes for individual sectors, grouped according to the size of indirect and direct labour coefficients. Kroner per 100 kroner final deliveries

	Sectors	Basic coefficients			Possible changes							
					Alternative 0 Changes only in coefficients for inputs from production	Alternative 1 Changes also in import coefficients	Alternative 2 Changes also in direct labour coefficients			Alternative 3 Changes also in owner income coefficients		
		Direct	Indirect	Total			Direct change	Indirect change	Total change	Direct change	Indirect change	Total change
High direct labour coefficient (25.0 and above)												
High indirect labour coefficient (10.0 and above)												
40	Publishing etc.	27.7	34.6	62.3	1.9	3.3	(8.6)	(3.7)	12.3	(8.6)	(7.6)	16.2
60	Construction	27.4	20.7	48.1	3.1	5.1	(8.6)	(5.0)	13.6	(8.6)	(6.9)	15.5
80	Services related to transport and storage	47.3	17.6	64.9	3.3	4.5	(8.6	(1.5)	10.1	(8.6)	(5.7)	14.3
41	Printing, bookbinding etc.	39.2	16.1	55.3	1.8	3.0	(8.0)	(3.0)	11.0	(8.6)	(4.5)	13.1
20	Canning of fish and meat	26.2	15.1	41.3	3.0	5.1	(8.6)	(5.7)	14.3	(8.6)	(6.6)	15.2
35	Other wood and cork products	26.7	14.0	40.7	1.8	3.7	(8.6)	(2.4)	11.0	(8.6)	(4.6)	13.2
74	Coastal water transport	38.4	13.4	51.8	1.9	3.7	(8.6)	(2.0)	10.6	(8.6)	(3.8)	12.4
58	Shipbuilding industries	36.7	12.4	49.1	1.8	3.9	(8.6)	(2.8)	11.4	(8.6)	(4.6)	13.2
32	Footwear and repair, fur goods etc.	25.4	12.4	37.8	1.6	3.5	(8.6)	(2.7)	11.3	(8.6)	(3.8)	12.4
49	Non-metallic mineral products	29.1	11.9	41.0	1.2	2.5	(8.6)	(1.6)	10.2	(8.6)	(3.7)	12.3
67	Commercial, savings banks etc.	47.3	10.3	57.6	2.7	2.7	(4.4)	(2.0)	6.4	(8.6)	(3.9)	12.5
68	Life insurance	42.9	10.2	53.1	2.0	2.7	(6.2)	(1.6)	7.8	(8.6)	(4.1)	12.7
57	Electrical machinery, apparatus, appliances etc.	26.1	10.2	36.3	1.5	3.4	(8.6)	(2.4)	11.0	(8.6)	(3.4)	12.0
56	Iron and metal products	32.3	10.0	42.3	1.5	3.3	(8.6)	(2.2)	10.8	(8.6)	(3.3)	11.9
	Average	33.8	14.9	48.7	2.1	3.6	(8.1)	(2.8)	10.8	(8.6)	(4.8)	13.4
Medium direct labour coefficient (10.0 - 24.9)												
High indirect labour coefficient (10.0 and above)												
34	Sawmills, planing mills etc.	21.7	26.1	47.8	1.2	1.6	(4.1)	(2.0)	6.1	(4.1)	(6.5)	10.6
36	Wood pulp	12.2	19.3	31.5	1.2	1.8	(4.1)	(1.9)	6.0	(4.1)	(5.2)	9.3
37	Paper, paperboard and cardboard	15.1	18.5	33.6	1.2	3.0	(4.1)	(4.2)	8.3	(4.1)	(6.3)	10.4
40	Herring oil and fish meal	13.0	17.5	30.5	2.1	3.7	(4.1)	(5.7)	9.8	(4.1)	(7.3)	11.4
39	Paper and paperboard products	16.0	17.1	33.1	1.1	2.8	(4.1)	(4.1)	8.2	(4.1)	(6.1)	10.2
21	Fish processing	13.3	14.6	27.9	1.8	2.9	(4.1)	(4.7)	8.8	(4.1)	(6.3)	10.4
25	Other food preparations	15.8	14.4	30.2	3.6	5.8	(4.1)	(6.9)	11.0	(4.1)	(8.1)	12.2
51	Iron and steel works and rolling	19.7	11.7	31.4	1.5	2.7	(4.1)	(3.0)	7.1	(4.1)	(4.7)	8.8
38	Wallboards etc.	20.4	10.7	31.1	1.0	1.9	(4.1)	(1.7)	5.8	(4.1)	(4.0)	8.1
45	Chemicals and products of chemicals .	18.4	10.7	29.1	2.0	3.9	(4.1)	(4.2)	8.3	(4.1)	(5.5)	9.6
64	Trade	22.8	10.5	33.3	2.7	2.8	(4.1)	(3.3)	7.4	(4.1)	(4.9)	9.0
30	Knitting mills	22.0	10.5	32.5	.9	3.3	(4.1)	(3.5)	7.6	(4.1)	(4.7)	8.8
33	Clothing	21.9	10.4	32.3	.8	2.7	(4.1)	(2.9)	7.0	(4.1)	(4.1)	8.2
	Average	17.9	14.8	32.6	1.6	3.0	(4.1)	(3.7)	7.8	(4.1)	(5.6)	9.7

Table 6 (cont.). Labour coefficients and possible changes for individual sectors, grouped according to the size of indirect and direct labour coefficients. Kroner per 100 kroner final deliveries

	Sectors	Basic coefficients			Possible changes							
		Direct	Indirect	Total	Alternative 0 Changes only in coefficients for inputs from production	Alternative 1 Changes also in import coefficients	Alternative 2 Changes also in direct labour coefficients			Alternative 3 Changes also in owner income coefficients		
							Direct change	Indirect change	Total change	Direct change	Indirect change	Total change
	Low direct labour coefficient (9.9 and below) High indirect labour coefficient (10.0 and above)											
4	Unspecified transport .	-	44.7	44.7	7.4	8.1	(-)	(13.3)	13.3	(-)	(15.3)	15.3
3	Unspecified services .	-	42.3	42.3	5.5	8.7	(-)	(11.2)	11.2	(-)	(14.3)	14.3
1	Unspecified office supplies	-	41.4	41.4	4.2	7.7	(-)	(13.1)	13.1	(-)	(15.1)	15.1
48	Other oil refineries ..	6.3	20.2	26.5	1.8	4.7	(2.4)	(7.3)	9.7	(2.4)	(8.2)	10.6
19	Margarine	7.2	18.5	25.7	2.4	4.8	(2.4)	(7.9)	10.3	(2.4)	(8.8)	11.2
18	Dairy products	8.0	18.2	26.2	5.1	6.9	(2.4)	(10.0)	12.4	(2.4)	(10.9)	13.3
2	Unspecified energy supplies	-	11.5	11.5	1.1	3.1	(-)	(4.6)	4.6	(-)	(5.0)	5.0
17	Slaughtering and preparation of meat	6.5	10.5	17.0	3.2	4.2	(2.4)	(6.3)	8.7	(2.4)	(6.8)	9.2
	Average	3.5	25.9	29.4	3.8	6.0	(1.2)	(9.2)	10.4	(1.2)	(10.6)	11.8
	High direct labour coefficient (25.0 and above) Medium indirect labour coefficient (4.1 - 9.9)											
65	Bank of Norway	57.3	8.6	65.9	1.4	2.1	(4.4)	(1.6)	6.0	(8.8)	(3.4)	12.2
66	State banks and loan associations	64.1	8.5	72.6	1.6	2.5	(6.2)	(1.2)	7.4	(8.8)	(3.7)	12.5
62	Gas supply	35.5	7.8	43.3	1.6	2.7	(8.6)	(1.5)	10.1	(8.6)	(2.8)	11.4
43	Rubber products	26.0	7.3	33.3	.9	2.5	(8.6)	(1.7)	10.3	(8.6)	(2.6)	11.2
55	Non-ferrous metal foundries	25.8	6.5	32.3	1.1	2.8	(8.6)	(2.2)	10.8	(8.6)	(3.2)	11.8
81	Communications	70.5	6.4	76.9	2.1	2.7	(6.2)	(1.2)	7.4	(8.8)	(2.1)	10.9
52	Iron and steel foundries	38.7	6.1	44.8	1.3	2.9	(8.6)	(1.3)	9.9	(8.6)	(2.6)	11.2
75	Services related to water transport	44.0	5.4	49.4	1.2	2.4	(6.2)	(.8)	7.0	(8.6)	(1.7)	10.3
85	Medical and veterinary services	55.0	5.1	60.1	1.5	1.9	(4.4)	(1.2)	5.6	(8.8)	(2.5)	11.3
69	Non-life insurance	31.2	4.4	35.6	.9	2.2	(8.6)	(.2)	8.8	(8.6)	(2.6)	11.2
87	Non-business organisations and institutions .	125.3	4.3	129.6	.9	1.6	(4.5)	(.7)	5.2	(6.9)	(1.0)	7.9
92	Laundry, cleaning and other personal services	45.3	4.2	49.5	1.0	2.2	(6.2)	(1.0)	7.2	(8.6)	(2.8)	11.4
78	Land transport n.e.c. .	26.7	4.2	30.9	.9	2.2	(8.6)	(.5)	9.1	(8.6)	(2.6)	11.2
	Average	49.6	6.1	55.7	1.3	2.3	(6.9)	(1.2)	8.1	(8.5)	(2.6)	11.1

Table 6 (cont.). Labour coefficients and possible changes for individual sectors, grouped according to the size of indirect and direct labour coefficients. Kroner per 100 kroner final deliveries

Sectors	Basic coefficients			Possible changes							
				Alternative 0 Changes only in coefficients for inputs from production	Alternative 1 Changes also in import coefficients	Alternative 2 Changes also in direct labour coefficients			Alternative 3 Changes also in owner income coefficients		
	Direct	Indirect	Total			Direct change	Indirect change	Total change	Direct change	Indirect change	Total change
Medium direct labour coefficient (10.0 - 24.9)											
Medium indirect labour coefficient (4.1 - 9.9)											
42 Leather and leather products	21.5	9.6	31.1	2.2	4.1	(4.1)	(4.2)	8.3	(4.1)	(5.1)	9.2
44 Distilling, rectifying and blending of spirits	18.5	9.3	27.8	1.1	2.7	(4.1)	(2.9)	7.0	(4.1)	(4.2)	8.3
89 Recreation services	22.3	8.8	31.1	1.6	3.1	(4.1)	(2.6)	6.7	(4.1)	(4.2)	8.3
23 Bakery products	21.7	8.4	30.1	2.1	3.7	(4.1)	(4.1)	8.2	(4.1)	(4.9)	9.0
59 Other manufacturing	24.6	8.2	32.8	1.2	3.0	(4.1)	(2.8)	6.9	(4.1)	(4.1)	8.2
29 Spinning and weaving	21.5	8.1	29.6	1.4	3.5	(4.1)	(3.5)	7.6	(4.1)	(4.2)	8.3
31 Cordage rope and twine	19.4	7.8	27.2	.8	2.5	(4.1)	(2.8)	6.9	(4.1)	(3.5)	7.6
50 Ferro-alloys	15.8	6.2	22.0	1.0	2.5	(4.1)	(2.7)	6.8	(4.1)	(3.4)	7.5
61 Electricity supply	16.6	5.8	22.4	.5	.8	(4.1)	(.8)	4.9	(4.1)	(2.0)	6.1
27 Breweries and soft drink production	15.1	4.4	19.5	.8	1.8	(4.1)	(1.1)	5.2	(4.1)	(2.4)	6.5
Average	19.7	7.7	27.4	1.3	2.8	(4.1)	(2.8)	6.9	(4.1)	(3.8)	7.9
Low direct labour coefficient (9.9 and below)											
Medium indirect labour coefficient (4.1 - 9.9)											
54 Other non-ferrous metals	7.8	6.3	14.1	1.0	2.4	(2.4)	(3.1)	5.5	(2.4)	(3.3)	5.7
22 Grain mill products and livestock feed	5.0	6.2	11.2	1.7	3.0	(1.4)	(4.0)	5.4	(1.4)	(4.2)	5.6
7 Agriculture	3.8	6.2	10.0	2.5	3.3	(1.4)	(4.3)	5.7	(1.4)	(4.7)	6.1
24 Cocoa, chocolate and sugar confectionary	9.6	5.4	15.0	1.2	3.0	(2.4)	(2.9)	5.3	(2.4)	(3.5)	5.9
26 Distilling, rectifying and blending of spirits	1.3	4.6	5.9	1.7	2.7	(1.2)	(3.3)	4.5	(1.2)	(3.5)	4.7
28 Tobacco	6.7	4.1	10.8	.4	2.0	(2.4)	(1.7)	4.1	(2.4)	(2.2)	4.6
Average	5.7	5.5	11.2	1.4	2.7	(1.9)	(3.2)	5.1	(1.9)	(3.5)	5.4
High direct labour coefficient (25.0 and above)											
Low indirect labour coefficient (4.0 and below)											
77 Tramways and suburban railway transport	64.8	4.0	68.8	.7	1.1	(4.6)	(.4)	5.0	(8.7)	(.6)	9.3
14 Coal mining	80.2	3.9	84.1	.9	1.6	(4.6)	(.1)	4.7	(7.0)	(.3)	7.3
76 Railway transport	77.0	3.6	80.6	.8	1.5	(4.6)	(.5)	5.1	(8.8)	(1.9)	10.7
91 Hotel and restaurant services	52.3	3.5	55.8	1.5	2.4	(4.4)	(1.4)	5.8	(8.5	(1.7)	10.2
15 Metal mining	31.8	2.9	34.7	.4	1.1	(4.6)	(.3)	4.9	(8.6)	(.5)	9.1
9 Forestry	35.1	2.8	37.9	.2	.6	(2.9)	(-.1)	2.8	(8.6)	(1.2)	9.8
16 Quarrying and mining n.e.c.	29.4	2.8	32.2	.5	1.1	(4.6)	(.2)	4.8	(8.6)	(1.5)	10.1
13 Whaling	34.5	2.5	37.0	.5	1.5	(7.2)	(.1)	7.3	(8.6)	(.3)	8.9
88 Legal, technical and business services	34.7	2.0	36.7	.8	1.3	(1.9)	(.9)	2.8	(8.6)	(1.5)	10.1
86 Religious and wellfare activities	102.3	1.0	103.3	.5	.8	(2.8)	(.5)	3.3	(3.9)	(.6)	4.5
84 Educational services	103.8	.1	103.9	.1	.1	(.8)	(-)	.8	(2.2)	(-)	2.2

Table 6 (cont.). Labour coefficients and possible changes for individual sectors, grouped according to the size of indirect and direct labour coefficients. Kroner per 100 kroner final deliveries

Sectors	Basic coefficients			Possible changes							
				Alternative 0 Changes only in coefficients for inputs from production	Alternative 1 Changes also in import coefficients	Alternative 2 Changes also in direct labour coefficients			Alternative 3 Changes also in owner income coefficients		
	Direct	Indirect	Total			Direct change	Indirect change	Total change	Direct change	Indirect change	Total change
High direct labour coefficient (25.0 and above) (cont.)											
Low indirect labour coefficient (4.0 and below) (cont.)											
70 Social insurance	120.8	-	120.8	-	-	(-)	(-)	-	(-)	(-)	-
82 Government administration	117.0	-	117.0	-	-	(-)	(-)	-	(-)	(-)	-
63 Water supply	113.1	-	113.1	-	-	(-)	(-)	-	(4.1)	(-)	4.1
83 Military defence services	103.8	-	103.8	-	-	(-)	(-)	-	(-)	(-)	-
90 Domestic services	101.1	-	101.1	-	-	(-)	(-)	-	(-)	(-)	-
Average	75.1	1.8	76.9	.4	.8	(2.7)	(.3)	3.0	(5.4)	(.6)	6.0
Medium direct labour coefficient (10.0 - 24.9)											
Low indirect labour coefficient (4.0 and below)											
47 Vegetable oil mills ..	10.8	3.9	14.7	.7	2.2	(4.1)	(2.5)	6.6	(4.1)	(2.6)	6.7
79 Air transport	15.7	3.4	19.1	.4	1.5	(4.1)	(1.6)	5.7	(4.1)	(1.9)	6.0
12 Fishing	14.3	3.4	17.7	.6	1.7	(4.1)	(.9)	5.0	(4.1)	(2.4)	6.5
53 Refining of aluminium	15.8	3.2	19.0	.4	1.6	(4.1)	(1.5)	5.6	(4.1)	(2.0)	6.1
73 Ocean water transport	15.7	2.0	17.7	.3	1.4	(4.1)	(1.3)	5.4	(4.1)	(1.5)	5.6
Average	14.5	3.2	17.7	.5	1.7	(4.1)	(1.6)	5.7	(4.1)	(2.1)	6.2
Low direct labour coefficient (9.9 and below)											
Low indirect labour coefficient (4.0 and below)											
72 Dwellings	.8	1.2	2.0	.4	.4	(.8)	(.3)	1.1	(.8)	(1.1)	1.9
71 Commercial buildings .	.8	1.1	1.9	.2	.2	(.8)	(.2)	1.0	(.8)	(.9)	1.7
11 Hunting etc.	-	1.1	1.1	.1	.8	(-)	(.9)	.9	(-)	(.9)	.9
8 Agricultural capital formation	-	-	-	-	-	(-)	(-)	-	(-)	(-)	-
10 Standing forests	-	-	-	-	-	(-)	(-)	-	(-)	(-)	-
5 Central government capital consumption ..	-	-	-	-	-	(-)	(-)	-	(-)	(-)	-
6 Local government capital consumption ..	-	-	-	-	-	(-)	(-)	-	(-)	(-)	-
Average	.2	.5	.7	.1	.2	(.2)	(.2)	.4	(.2)	(.4)	.6

Table 7. Possible changes in labour inputs for individual sectors. Characteristics of the distributions. Kroner per 100 kroner final deliveries

	Alterna-tive 0	Alterna-tive 1	Alternative 2			Alternative 3		
			Direct changes	Indirect changes	Total changes	Direct changes	Indirect changes	Total changes
Highest possible change (for 92 sectors)	7.4	8.7	(8.6)	(13.3)	14.3	(8.8)	(15.3)	16.2
83 items are below (first decile).	2.8	4.6	(8.7)	(5.8)	11.1	(8.7)	(7.0)	13.3
69 items are below (first quartile)	1.9	3.4	(6.3)	(3.4)	9.8	(8.7)	(4.8)	11.5
46 items are below (median)	1.3	2.6	(4.2)	(1.8)	7.0	(4.2)	(3.5)	9.3
23 items are below (third quartile)	.6	1.6	(2.5)	(.8)	5.0	(2.5)	(1.6)	6.2
9 items are below (ninth decile).	.1	.1	(.1)	(.1)	.1	(.1)	(.1)	1.0
Number of zero items	9	10	(14)	(11)	9	(13)	(11)	8
Average	1.40	2.56	(4.16)	(2.56)	6.73	(4.94)	(3.71)	8.64
Standard deviation	1.24	1.74	(2.78)	(2.70)	3.61	(3.24)	(3.09)	4.15
Coefficient of correlation between direct and indirect changes			-.36			-.45		
Possible change in labour input in total final delivery (from table 4)	1.40	2.46			6.57			7.77

delivery (or production) for each production sector. Correspondingly, we have computed the potential savings in direct and indirect labour inputs per unit of final delivery from each sector under our alternative assumptions about coefficient adjustments. The results for individual sectors are given in table 6, and the frequency distributions of potential changes are given in table 7.

The averages over all sectors of possible changes under the various alternatives (table 7) correspond quite well tc the potential changes in labour input into total final deliveries under the corresponding alternatives. However the variations in possible changes between the sectors are quite wide. When labour input coefficients can be changed, there is a slight tendency for large potential changes in direct labour coefficients to be offset by a more limited scope for savings in indirect labour inputs.

In table 6 the sectors have been grouped according to the size of indirect and direct labour input. There are marked differences between the nine groups. These differences can be studied in table 8, where the averages for the groups are given.

There are greater possibilities for labour saving on deliveries from sectors with high than from sectors with low indirect labour coefficient, and also greater potentiality for labour saving on deliveries from sectors with high than from sectors with low direct labour input coefficient when the direct labour coefficient can be changed (Alternative 2 and 3). However, our basic assumptions about coefficient adjustments imply that when direct labour is the only or almost the only input, and the direct coefficient is close to or above 100, there is no possibility for labour saving. The size of the direct labour input coefficient is, in accordance with our basic assumptions, decisive for the potential savings in direct labour input. However, since big direct labour saving generally has to be offset through reduced indirect labour saving, the result is that it is the size of the indirect labour input coefficient which is the dominating determinant of the total potential for labour saving for most of the sectors under all our alternatives.

It is of interest to know to what extent the differences between the groups of sectors in regard to the average of possible changes in labour inputs for each alternative may be taken to be systematic or the results of random causes. In order to investigate this we have computed the standard deviation for each group average of changes under each alternative under the assumption that the sector observations in each group is a random sample of the 92 sector observations in table 6. Then the difference between the average for the group and the corresponding average for all the 92 sectors is measured in terms of this standard deviation.[1] The results are given in table 9. When we consider only the marginal distributions, i.e. either according to the size of the direct labour coefficient alone or according to the size of the indirect labour coefficient alone, we find that only the size of the indirect coefficient appears to be important for the possibilities for change in total labour input to a sector. The distribution according to the size of the direct labour input coefficient give small differences between the various group averages and the overall average for all sectors, when these differences are measured in terms of the computed standard deviations for the group averages.

---

1) If A is the average and σ the standard deviation about the average for all 92 sectors for a given alternative and further, if A_i is the average and n_i the number of sectors for group no. i, then the figures in table 9 give $\sqrt{n_i}\,(A_i-A)/\sigma$.

Table 8. Averages of labour coefficients and possible changes for groups of sectors classified according to the size of indirect and direct labour coefficients. Kroner per 100 kroner final deliveries

Sector groups	Number of sectors	Basic coefficients			Possible changes							
		Direct	Indirect	Total	Alternative 0 Changes only in coefficients for inputs from production	Alternative 1 Changes also in import coefficients	Alternative 2 Changes also in direct labour coefficients			Alternative 3 Changes also in owner income coefficients		
							Direct change	Indirect change	Total change	Direct change	Indirect change	Total change
High indirect labour coefficient (10.0 and above)												
High direct labour coefficient (25.0 and above)	14	33.8	14.9	48.7	2.1	3.6	(8.1)	(2.8)	10.8	(8.6)	(4.8)	13.4
Medium direct labour coefficient (10.0 -24.9) ...	13	17.9	14.8	32.6	1.6	3.0	(4.1)	(3.7)	7.8	(4.1)	(5.6)	9.7
Low direct labour coefficient (9.9 and below)	8	3.5	25.9	29.4	3.8	6.0	(1.2)	(9.2)	10.4	(1.2)	(10.6)	11.8
Total, high indirect	35	20.9	17.4	38.3	2.3	3.9	(5.0)	(4.6)	9.6	(5.2)	(6.4)	11.7
Medium indirect labour coefficient (4.1 - 9.9)												
High direct labour coefficient (25.0 and above)	13	49.6	6.1	55.7	1.3	2.3	(6.9)	(1.2)	8.1	(8.5)	(2.6)	11.1
Medium direct labour coefficient (10.0 - 24.9) ..	10	19.7	7.7	27.4	1.3	2.8	(4.1)	(2.8)	6.9	(4.1)	(3.8)	7.9
Low direct labour coefficient (9.9 and below)	6	5.7	5.5	11.2	1.4	2.7	(1.9)	(3.2)	5.1	(1.9)	(3.5)	5.4
Total, medium indirect	29	30.2	6.5	36.7	1.3	2.6	(4.9)	(2.1)	7.0	(5.6)	(3.2)	8.8
Low indirect labour coefficient (4.0 and below).	16	75.1	1.8	76.9	.4	.8	(2.7)	(.3)	3.0	(5.4)	(.6)	6.0
Medium direct labour coefficient (10.0 - 24.9) ..	5	14.5	3.2	17.6	.5	1.7	(4.1)	(1.6)	5.7	(4.1)	(2.1)	6.2
Low direct labour coefficient (9.9 and below)	7	.2	.5	.7	.1	.2	(.2)	(.2)	.4	(.2)	(.4)	.6
Total, low indirect	28	45.6	1.7	47.3	.3	.8	(2.3)	(.5)	2.8	(3.9)	(.8)	4.7
Total, high direct labour coefficient	43	53.9	7.4	61.3	1.2	2.2	(5.7)	(1.3)	7.1	(7.4)	(2.6)	9.9
Total, medium direct labour coefficient	28	17.9	10.2	28.1	1.3	2.7	(4.1)	(3.0)	7.1	(4.1)	(4.4)	8.5
Total, low direct labour coefficient	21	3.0	11.6	14.6	1.9	3.1	(1.1)	(4.5)	5.6	(1.1)	(5.2)	6.2
All sectors	92	31.4	9.2	40.5	1.4	2.6	(4.2)	(2.6)	6.7	(4.9)	(3.7)	8.6
Standard deviations					1.2	1.7	(2.8)	(2.7)	3.6	(3.2)	(3.1)	4.1

Table 9. Deviations of group averages of possible changes in labour coefficients from over all averages. Measurements in terms of standard deviations for group averages computed on the basis of standard deviations for total distributions.[1)]

Sector groups	Number of sectors	Possible changes: Alternative 0 Changes only in coefficients for inputs from production	Alternative 1 Changes also in import coefficients	Alternative 2 Changes also in direct labour coefficients: Direct change	Alternative 2: Indirect change	Alternative 2: Total change	Alternative 3 Changes also in owner income coefficients: Direct change	Alternative 3: Indirect change	Alternative 3: Total change
High indirect labour coefficient (10.0 and above)									
High direct labour coefficient (25.0 and above)	14	2.11	2.15	(5.25)	(.28)	4.25	(4.27)	(1.33)	4.33
Medium direct labour coefficient (10.0 - 24.9)	13	.58	.83	(-.13)	(1.47)	1.10	(-.89)	(2.22)	.96
Low direct labour coefficient (9.9 and below)	8	5.47	5.53	(-3.05)	(6.91)	2.90	(-3.23)	(6.32)	3.08
Total, high indirect coefficient	35	4.29	4.42	(1.70)	(4.38)	4.75	(.55)	(5.17)	4.42
Medium indirect labour coefficient (4.1 - 9.9)									
High direct labour coefficient (25.0 and above)	13	-.29	-.62	(3.50)	(-1.87)	1.40	(4.01)	(-1.28)	2.17
Medium direct labour coefficient (10.0 - 24.9)	10	-.26	.36	(-.11)	(.23)	.18	(-.78)	(.10)	-.53
Low direct labour coefficient (9.9 and below)	6	-	.14	(-2.03)	(.54)	-1.09	(-2.27)	(-.16)	-1.89
Total, medium indirect coefficient	29	-.43	-	(1.36)	(-1.00)	.45	(1.16)	(-.87)	.26
Low indirect labour coefficient (4.0 and below)									
High direct labour coefficient (25.0 and above)	16	-3.23	-4.14	(-2.16)	(-3.41)	-4.10	(.62)	(-4.01)	-2.51
Medium direct labour coefficient (10.0 - 24.9)	5	-1.62	-1.16	(-.08)	(-.83)	-.62	(-.55)	(-1.16)	-1.29
Low direct labour coefficient (9.9 and below)	7	-2.77	-3.19	(-3.81)	(-2.35)	-4.62	(-3.83)	(-2.83)	-5.10
Total, low indirect coefficient	28	-4.69	-5.47	(-5.52)	(-4.12)	-5.72	(-1.63)	(-4.97)	-4.97
Total, high direct labour coefficient	43	-1.06	-1.51	(3.54)	(-3.16)	.73	(5.06)	(-2.33)	2.05
Total, medium direct labour coefficient	28	-.43	.30	(-.19)	(-.78)	.59	(-1.31)	(1.20)	-.13
Total, low direct labour coefficient	21	1.91	1.32	(-5.11)	(3.22)	-1.40	(-5.37)	(2.22)	-2.65

1) See footnote p. 25.

When the simultaneous classification according to size both of direct and of indirect labour coefficient is considered we get a more varied picture. Still the indirect coefficient appears to be decisive for the direction and signifiance of the deviation, but for all the classes with medium direct coefficient the deviations from the average are less than for other classes. But the general conclusion must be that the possibilities for labour saving through changes in coefficients are largest on final deliveries from sectors with a relatively high content of indirect labour, whereas the direct labour content of the delivering sector is not that important.

c. Changes in total intermediate deliveries, in imports and in owner incomes.

The way our experiments have been designed, any saving in labour inputs must be compensated by corresponding net increases in other elements of value added and imports.[1] In all our alternatives at least part of these changes are brought about by changes caused by substitutions between intermediate delivery inputs in the production sectors. In alternative 0 this is the only source of changes. The substitutions between intermediate deliveries may lead to more or less circuitous production patterns, and thus inflate or deflate the total of intermediate deliveries. When products with low total labour content are substituted for products with high labour content, these former products will by implication have higher direct plus indirect content of other components of value added and/or imports, but whether their total requirements for intermediate deliveries are greater or smaller than the requirements of the products that they replace is undetermined. In our alternative 0, where substitutions of intermediate goods are the only possible adjustments, the total of intermediate deliveries is reduced by 1.12 kroner per 100 kroner total final deliveries (table 2). For the various categories of final deliveries there are reductions from .97 kroner per 100 kroner for exports to 2.12 kroner per 100 kroner for gross fixed capital formation (table 10). Thus, for all the final delivery compositions, this type of substitutions tend to make the economy slightly less "circuitous", i.e. to reduce the number of processing sectors through which the primary inputs have to pass before they emerge as final deliveries from the production system.

1) In our data value added entails a little more than gross national product, since we have treated as primary inputs some transfer items and repair work etc. by own workers. We will ignore this in the sequel, but it should be noted that these items account for fractional discrepancies in our tables.

Table 10. Effects of changes in input-output coefficients on coefficients for total intermediate deliveries, imports and owner incomes

	Basic coefficients			Possible changes			
	Direct	Indirect	Total	Alternative 0 Changes only in inputs from production	Alternative 1 Changes also in import coefficients	Alternative 2 Changes also in labour coefficients	Alternative 3 Changes also in owner income coefficients
Kroner per 100 kroner final deliveries to private consumption							
Sum deliveries from Norwegian production sectors	82.96	52.96	135.92	-1.05	-6.73	1.11	-7.27
Imports	17.67	13.68	31.35	- .03	2.31	3.62	2.21
Owner incomes	-	25.42	25.42	1.23	.34	1.54	4.71
Depreciation	-	14.95	14.95	.34	.01	.59	- .09
Other items	- .61	3.14	2.53	- .21	- .36	- .04	.24
Sum imports and value added ex wages	17.06	57.19	74.25	1.33	2.30	5.71	7.07
Wages (labour input)	-	25.75	25.75	-1.37	-2.28	-5.68	-7.05
Kroner per 100 kroner final deliveries to government consumption							
Sum deliveries from Norwegian production sectors	105.29	29.70	134.99	-1.21	-4.56	3.26	-3.35
Imports	2.10	5.11	7.21	.23	1.51	2.67	1.69
Owner incomes	-	16.41	16.41	1.36	.67	1.99	4.99
Depreciation	-	15.12	15.12	- .17	- .04	.40	.05
Other items	-7.38	13.86	6.48	.35	.32	.71	.65
Sum imports and value added ex wages	-5.28	50.50	45.22	1.77	2.46	5.77	7.38
Wages (labour input)	-	54.78	54.78	-1.87	-2.45	-5.76	-7.37
Kroner per 100 kroner final deliveries to gross fixed asset formation							
Sum deliveries from Norwegian production sectors	67.82	45.41	113.23	-2.12	-6.81	4.82	- .60
Imports	33.39	14.61	48.00	.35	3.18	4.84	4.05
Owner incomes	-	14.14	14.14	1.09	- .11	2.09	4.07
Depreciation	-	5.07	5.07	- .14	- .30	.34	-
Other items	-1.21	2.92	1.71	.48	.35	1.27	1.58
Sum imports and value added ex wages	32.18	46.74	68.92	1.78	3.12	8.54	9.70
Wages (labour input)	-	31.08	31.08	-1.80	-3.14	-8.55	-9.72
Kroner per 100 kroner final deliveries to exports							
Sum deliveries from Norwegian production sectors	94.63	31.28	125.91	- .97	-6.38	-1.63	-5.39
Imports	.21	27.80	28.01	.16	3.18	5.61	5.15
Owner incomes	-	11.94	11.94	.30	- .70	.22	1.39
Depreciation	-	22.93	22.93	.31	- .12	.30	- .05
Other items	5.12	9.40	14.52	.05	- .22	.18	.68
Sum imports and value added ex wages	5.33	72.07	77.40	.82	2.04	6.31	7.17
Wages (labour input)	-	22.60	22.60	- .85	-2.10	-6.26	-7.13

Table 10 (cont.). Effects of changes in input-output coefficients on coefficients for total intermediate deliveries, imports and owner incomes

	Direct	In-direct	Total	Alter-native 0 Changes only in inputs from produc-tion	Alter-native 1 Changes also in import coeffi-cients	Alter-native 2 Changes also in labour coeffi-cients	Alter-native 3 Changes also in owner income coeffi-cients
Kroner per 100 kroner final deliveries to inventory changes[1]							
Sum deliveries from Norwegian production sectors	54.09	6.97	61.06	-1.13	-6.64	-1.46	-2.39
Imports	45.91	4.15	50.06	.29	.18	.77	.98
Owner incomes	-	19.10	19.10	- .85	-1.21	- .41	-7.05
Depreciation	-	-2.91	-2.91	- .33	- .73	- .64	- .45
Other items	-	5.41	5.41	.76	2.95	3.41	13.70
Sum imports and value added ex wages	45.91	25.75	71.66	- .13	1.19	3.13	7.18
Wages (labour input)	-	28.34	28.34	.13	-1.18	-3.12	-7.16

1) Figures for inventory changes are percentages of a small negative net sum, and should not be taken too seriously.

Under alternative 1, when imports may be substituted for domestic inputs, the substitutions naturally lead to reduction in the total use of domestically produced intermediate products. The reduction is as much as 6.16 kroner per 100 kroner of total final deliveries or 15.1 per cent of total intermediate deliveries. (Table 2.). For the various categories of final deliveries, the reduction is only 4.56 kroner per 100 kroner total final deliveries to government consumption, but between 6.38 and 6.81 kroner per 100 kroner for the other categories. (Table 10).

When we pass from alternative 1 to alternative 2, we allow direct labour input coefficients in the production sectors to be reduced, provided that the reduction can be compensated by increases in coefficients for imports and domestic intermediate products. Since most of the allowed slack in import coefficients has been utilized under alternative 1, the reduction in labour coefficients must in general be compensated by increases in the coefficients for domestic inputs, and we end up with a small net increase in intermediate deliveries, when compared to the basic accounts. The increase is 1.64 kroner per 100 kroner total final deliveries, (Table 2) but the

effects vary a good deal between the final delivery categories, (Table 10) 4.82 kroner per 100 kroner increase for gross fixed investment, 3.62 kroner per 100 kroner for government consumption, 1.11 kroner per 100 kroner for private consumption and 1.63 kroner per 100 kroner reduction for exports. The variation is a reflection of the two opposite effects of substitution of imports for domestic inputs and substitution of domestic inputs for direct labour inputs.

When we finally pass to alternative 3 and allow coefficients of owner income to be increased, this will give room for some additional saving in direct labour, in sectors where the combined slack in import and domestic input coefficients are smaller than the slack in the labour coefficient. But the major part of the new flexibility will be utilized to saving labour through substitution of owner income for intermediate inputs, and thus, under this alternative, we get again a reduction in total intermediate deliveries, compared with the basis situation. The reduction is less than under alternative 1 for the total, (Table 2) with 4.39 kroner per 100 kroner final deliveries, and for all the individual categories of final deliveries except private consumption, where the reduction under this alternative is as much as 7.27 kroner per 100 kroner final deliveries. (Table 10).

In input-output analysis the identity: Final deliveries equals imports plus value added will be preserved. Since we do not alter column sums of coefficients in our adjustments, but compensate all reductions in coefficients by corresponding increases in other coefficients in the same column, the sum of changes in total direct plus indirect coefficients for imports and value added in kroner per 100 kroner final deliveries must be zero in all our alternatives, i.e. reductions in the total (direct plus indirect) labour coefficients must be equal to net increases in the sums of total coefficients for imports and other value added elements. The distribution of the compensating increases on imports and the value added elements owner incomes, depreciation charges and other will depend on the assumptions about changes in coefficients and the consequent changes in relative production levels for the sectors of production. In our alternative 0, where no changes are allowed in direct import and value added coefficients, all changes must be caused by changes in intermediate deliveries, and thus in the activity levels of the production sectors. In this alternative, the main compensation for the reduction in labour input is an increase in owner income (Table 2). In the computations for total final deliveries we find that imports, depreciation and other

elements of value added are not much affected. The main reason appears to be that the sectors with the lowest labour coefficients (like Agriculture and Fisheries), which are expanding, also have high owner income coefficients. When we look at the individual final delivery categories (table 10) there is a reservation to this general conclusion for deliveries to exports, where depreciation and owner income get about the same increase.

In alternative 1, when import coefficients are adjusted, increases in imports naturally form the main offsetting compensation to reductions in labour inputs.

Under alternative 2, when direct reductions in labour input coefficients are allowed, both imports and owner incomes take up the additional slack and under alternative 3, when direct owner income coefficients may be increased, the increase in owner incomes both compensates for the additional labour saving, and allows the increase in imports to be somewhat less than under alternative 2. This latter effect occurs in spite of the fact that we do not use the slack in direct owner income coefficients to reduce the change in direct import coefficients, so that direct import coefficients are the same in alternatives 2 and 3.

d. Effects on production by sector

The effects on the activity levels in production sectors are of particular interest, since estimates of the production levels are the immediate products of input-output analysis. Conclusions about the robustness of the theory must be directly dependent on conclusions about the predictive power for production levels.

In relation to the present experiment, where we study the effects of systematic adjustments within limits related to empirically computed variations, we may pose questions like the following:

a) What will be the typical pattern of labour saving adjustments in the Norwegian economy under our assumptions?
b) How large are the error margins in input-output estimates if the variability in coefficients is as assumed in our various alternatives, and if the adjustments are systematic?
c) Is there any relationship between the possible adjustments in deliveries from a sector under our assumptions and the empirical standard error of input-output estimates of deliveries from the same sector?[1)]

1) See: Per Sevaldson, "Studies in the Stability of Input-Output Relations. Effects of Aggregation and Changes in Coefficients on the Results of Input-Output Analysis". Working Paper IO 72/6 from the Central Bureau of Statistics. 23. March 1972. Mimeographed.

The base year proportions are given in table 11, which again emphasises the difference in basis between alternative 0 and the other alternatives.

Table 11. Deliveries for final and intermediate use from imports and Norwegian production sectors in 1959 in kroner per 100 kroner of total final deliveries

	Final deliveries	Intermediate deliveries	Total deliveries
Alternatives 1, 2 and 3			
From imports	13.3	16.9	30.2
From 92 Norwegian production sectors	86.8	40.8	127.6
per sector	.943	.444	1.387
Alternative 0			
From imports	13.3	21.1	34.4
From 92 Norwegian production sectors	86.8	43.7	130.5
per sector	.943	.475	1.418

Summary figures for the possible changes are given in table 12.

By the measurements in table 12 the 4 alternatives give very similar results, and they all indicate quite radical changes in intermediate deliveries as consequences of the adjustments which we assume. However, since intermediate deliveries make up, on the average, less than one third of total production, the production pattern is considerably more stable than the pattern of intermediate deliveries.

If we take the standard deviation about zero as the best measure of distortion, we find that this is close to two thirds of average intermediate deliveries for the three first alternatives and well over half for the last alternative. Seen in another way, the root of the mean of the squared changes is nearly one third of the root of the average of the squared basic intermediate deliveries.

A visual picture of the possible changes under alternative 1 is given in diagram 2 for the 53 sectors with indirect deliveries above 0.9 kroner per 100 kroner total deliveries in 1964. The other alternatives will not be materially different.

We may also compare the possible changes in intermediate deliveries, as measured by the standard deviations of the changes under our various alternatives with the empirical standard errors of input-output estimates of intermediate deliveries in the period 1949-1960.[1)]

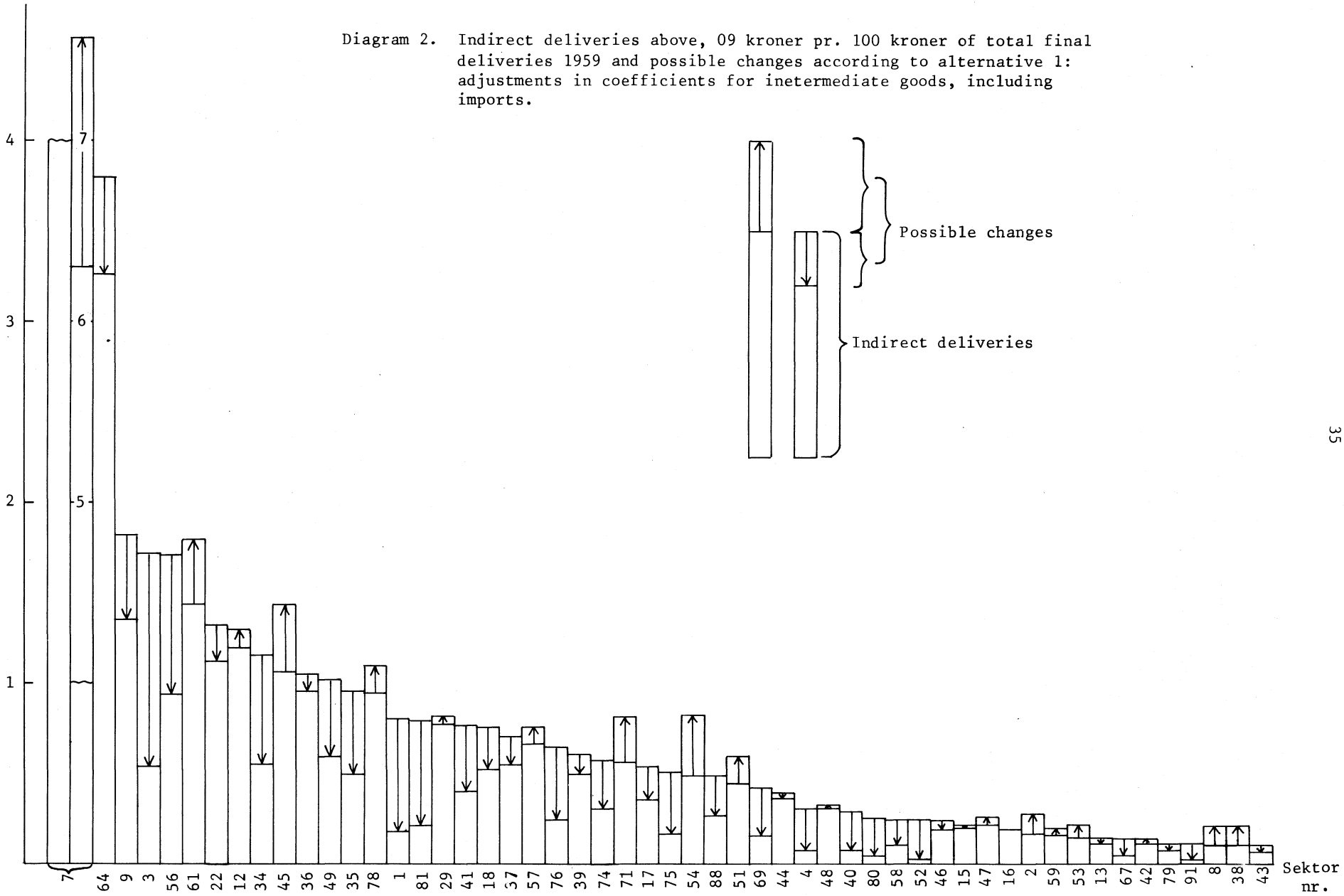
1) Per Sevaldson 1972 op.cit.

Table 12. Possible changes in intermediate deliveries, summary figures

	Alternative 0 Changes only in coefficients for inputs from production	Alternative 1 Changes also in import coefficients	Alternative 2 Changes also in labour coefficients	Alternative 3 Changes also in owner income coefficients
Intermediate deliveries from 92 sectors in basis, kroner per 100 kroner total F.D. 1)	43.7	40.8	40.8	40.8
Average per sector, kroner per 100 kroner of total F.D.	.475	.444	.444	.444
Standard deviation about average, kroner per 100 kroner total F.D.	2) ..	.830	.830	.830
Possible changes:				
Increases, kroner per 100 kroner total F.D.	5.85	3.95	7.15	3.84
Number of sectors	37	25	38	27
per sector, kroner per 100 kroner total F.D.	.158	.158	.188	.142
Decreases, kroner per 100 kroner total F.D.	-6.97	-10.11	-5.51	-8.21
Number of sectors	33	46	34	44
per sector, kroner per 100 kroner total F.D.	-.211	-.220	-.162	-.187
Numerical sum of changes, Kroner per 100 kroner total F.D.	12.82	14.06	12.66	12.05
per sector, 92 sectors, kroner per 100 kroner total F.D.	.139	.153	.138	.131
per cent of average intermediate delivery	29.26	34.46	31.08	29.50
Net change, 92 sectors, kroner per 100 kroner total F.D.	-1.12	-6.16	1.64	-4.37
per sector, kroner per 100 kroner total F.D.	-.012	-.067	.018	-.048
Standard deviation of changes about zero[3] 92 sectors, kroner per 100 kroner total F.D.	.299	.285	.279	.242
per cent of average intermediate delivery	62.95	64.19	62.84	54.50

1) F.D. = final deliveries.
2) Has not been computed.
3) Computed as $(1/92\ \Sigma, X^2)^{\frac{1}{2}}$, when the X; are the 92 observations of change under one of the alternatives.

Diagram 2. Indirect deliveries above, 09 kroner pr. 100 kroner of total final deliveries 1959 and possible changes according to alternative 1: adjustments in coefficients for inetermediate goods, including imports.



The observed standard errors of estimates of intermediate deliveries from each of the 92 production sectors, estimated by a 92 sector input-output table for 1960, declined from 36 per cent of the average intermediate delivery in 1949 to 11 per cent in 1959, with an average of 22.4 per cent over 11 years. These observed errors are thus of the order of 1/3 to 1/2 of the possible errors according to our hypothesis. Considering that we have allowed the coefficients to be adjusted by changes of the order of two times standard deviations about their averages computed over the period 1949-1960, there must be some dependence between the observed standard errors and the changes which are possible according to our assumptions, and it is difficult to draw strong conclusions from these overall comparisons. However, it is important to notice that irrespective of which of our 4 alternatives is chosen a systematic utilization of coefficient adjustability amounting to twice the observed standard deviation of coefficients over the period 1949-1960, might have given prediction errors of 2 to 3 times the errors found in the prediction simulations[1)].

In table 13 we have listed all the 92 sectors, ordered according to the size of their total (direct plus indirect) coefficient of labour (wage) input. For eaah sector we have listed final and intermediate deliveries in kroner per 100 kroner total final deliveries in 1964 and we have given the possible changes under our four alternatives as percentages of intermediate deliveries. Finally, for the purpose of comparison, the tables also gives for each sector the observed standard error of estimates of intermediate deliveries in the period 1949-1959 on the basis of the 92 sector input-output matrix for 1960. The standard errors are given as percentages of average intermediate deliveries from the sector, measured in constant (1955) kroner over the period 1949-1960.

Table 13 shows clearly that for the majority of sectors possible changes in intermediate deliveries are very nearly the same for the same sector under all our alternatives. Of the 73 sectors with non-zeroe possible changes under the four alternatives only 11 have both positive and negative possible changes under the four alternatives.

All sectors with above 41 per cent direct plus indirect labour input (wages) get reduced (or, for two items, unchanged) intermediate deliveries under all alternatives (excluding sectors without intermediate deliveries), and reductions are predominant down to 36.5 per cent total labour coefficient for alternatives 0 and 2, and down to 33 per cent for

---

1) Per Sevaldson 1972 op.cit.

Table 13. Total (direct plus indirect) wage coefficient, final and intermediate deliveries and possible changes in per cent of intermediate deliveries 1959. Standard error of input-output estimates 1949-1960 in per cent of average intermediate deliveries

Sector		Total (direct plus indirect) wage coefficient 1959	Production 1959 in kroner per 100 kroner total final deliveries			Possible changes in per cent of intermediate deliveries				Standard error 1949-1960 in per cent of average intermediate delivery
			Final	Intermediate	Total	Alternative 0 Changes only in inputs from production[1]	Alternative 1 Changes also in import coefficient	Alternative 2 Changes also in labour coefficient	Alternative 3 Changes also in owner income coefficient	
Non-business org. and institutions	87	129.62	.31	.04	.35	-80.0	-75.0	-75.0	-75.0	18.4
Social insurance[2]	70	120.81	.09	-	.09	.	.	.	.	-
Government administration.	82	117.01	1.18	-	1.18	.				-
Water supply	63	113.06	.07	-	.07	.	.	.	.	-
Educational services	84	103.90	1.40	-	1.40	.	.	.	.	-
Military defence services.	83	103.83	1.16	-	1.16	.	.	.	.	-
Religious and welfare activities	86	103.26	.30	-	.30	.	.	.	.	-
Domestic services	90	101.12	.45	-	.45	.	.	.	.	-
Coal mining	14	84.11	.03	.02	.05	-100.0	-100.0	-100.0	-100.0	75.0
Railway transport	76	80.64	.40	.64	1.04	-63.0	-62.5	-57.8	-60.9	10.6
Communications	81	76.93	.32	.78	1.10	-65.5	-73.2	-62.9	-71.9	8.7
State banks and loan associations	66	72.62	.04	-	.04	.	.	.	.	-
Tramways and surburban railway transp.	77	68.76	.12	.01	.13	-100.0	-100.0	-100.0	-100.0	28.6
Bank of Norway	65	65.94	.05	.01	.06	-100.0	-100.0	-100.0	-100.0	64.2
Services related to transport and storage	80	64.88	.01	.25	.26	-86.2	-84.0	-84.0	-84.0	5.1
Publishing etc.	40	62.26	.58	.28	.86	-44.8	-75.0	-42.8	-71.5	44.9
Medical and veterinary services	85	60.10	1.49	.02	1.51	-100.0	-100.0	-100.0	-100.0	17.1
Other banks etc.	67	57.61	.72	.13	.85	-64.3	-69.2	-61.5	-69.2	27.1
Hotel and restaurant services	91	55.84	.67	.11	.78	-75.0	-81.9	-72.8	-81.9	4.0
Printing, bookbinding etc.	41	55.29	.13	.76	.89	-30.6	-48.7	-22.4	-42.1	3.8
Life insurance	68	53.07	.16	-	.16	.	.	.	.	-
Coastal water transport	74	51.82	.16	.57	.73	-47.7	-47.7	-40.4	-45.6	7.5
Laundry, cleaning, other personal services	92	49.51	.35	.05	.40	-	-40.0	-	-20.0	9.4
Services related to water transport	75	49.37	.22	.50	.72	-49.1	-68.0	-64.0	-68.0	11.7
Shipbuilding industries	58	49.08	2.11	.24	2.35	-63.0	-58.3	-58.3	-58.3	25.9
Construction	60	48.05	11.40	.01	11.41	-100.0	-100.0	-100.0	-100.0	21.7
Sawmills, planing mills etc.	34	47.75	.04	1.15	1.19	-53.8	-53.1	-47.8	-13.1	20.6
Iron and steel foundries	52	44.78	.10	.24	.34	-92.7	-91.8	-91.8	-91.8	15.4
Unspecified transport	4	44.71	-	.30	.30	-40.0	-76.6	-63.3	-73.3	37.0
Gas supply	62	43.25	.01	.03	.04	-50.0	-66.7	-66.7	-66.7	32.3
Unspecified services	3	42.32	.36	1.72	2.08	-55.1	-69.3	-48.3	-65.7	19.0
Iron and metal products	56	42.26	3.31	1.69	5.00	-43.4	-45.0	-36.7	-44.4	6.8
Unspecified, office supplies	1	41.35	.20	.80	1.00	-30.8	-78.8	-21.2	-70.0	4.9
Canning of fish and meat	20	41.32	.53	-	.53	-	-	-	-	122.2
Non-metallic mineral products	49	41.02	.21	1.02	1.23	-25.2	-43.1	-15.7	-43.1	25.0
Other wood and cork products	35	40.69	.76	.95	1.71	14.1	-48.5	27.4	4.2	14.5
Foresty	9	37.90	.01	1.82	1.83	-10.4	-25.8	3.8	-5.5	17.6
Footwear and repair, fur goods, etc.	32	37.79	.61	.01	.62	-100.0	-100.0	-100.0	-100.0	100.0
Whaling	13	37.04	.48	.14	.62	-15.4	-21.4	-21.4	-21.4	45.7
Legal, technical and business services	88	36.70	.14	.48	.62	-17.3	-45.9	-10.4	-25.0	10.6
Electrical machinery etc.	57	36.33	.91	.66	1.57	23.0	13.6	37.9	25.8	22.3
Non-life insurance	69	35.56	.13	.42	.55	2.4	-64.3	2.4	-76.2	5.3
Metal mining	15	34.67	.35	.21	.56	-9.5	-9.5	-9.5	-9.5	19.4
Paper, paperboard and cardboard	37	33.57	1.38	.70	2.08	2.5	-22.8	17.2	-8.6	5.3

1) Per cent of intermediate deliveries under the basis alternative 0.
2) Dots (.) indicate that no figures are possible.

Table 13 (cont.). Total (direct plus indirect) wage coefficient, final and intermediate deliveries and possible changes in per cent of intermediate deliveries 1959. Standard error of input-output estimates 1949-1960 in per cent of average intermediate deliveries

Sector		Total (direct plus indirect) wage coefficient 1959	Production 1959 in kroner per 100 kroner total final deliveries			Possible changes in per cent of intermediate deliveries				Standard error 1949-1960 in per cent of average intermediate delivery
			Final	Intermediate	Total	Alternative 0 Changes only in inputs from production	Alternative 1 Changes also in import coefficient	Alternative 2 Changes also in labour coefficient	Alternative 3 Changes also in owner income coefficient	
Trade	64	33.30	10.20	3.80	14.00	4.3	-14.2	14.8	-5.3	3.6
Rubber products	43	33.30	.27	.10	.37	36.3	-40.0	50.0	20.0	17.3
Paper and paperboard products	39	33.13	.12	.60	.72	-	-18.4	5.0	-6.7	13.0
Other manufacturing	59	32.82	.50	.15	.65	50.0	26.7	60.0	40.0	59.0
Knitting mills	30	32.45	.48	-	.48	-	-	-	-	52.3
Clothing	33	32.30	1.79	.06	1.85	-	-33.3	-16.7	-33.3	27.8
Non-ferrous metal foundries	55	32.28	.01	.03	.04	66.7	66.7	66.7	66.7	15.8
Quarrying and mining n.e.c.	16	32.23	.08	.18	.26	19.1	-	38.9	-	8.8
Wood pulp	36	31.53	1.34	1.05	2.39	13.6	-9.5	19.1	-	4.3
Wallboards etc.	38	31.53	.08	.10	.18	90.8	100.0	110.0	110.0	16.0
Iron and steel works and rolling	51	31.43	.35	.44	.79	19.2	34.1	40.9	36.4	20.8
Recreation services	89	31.12	.51	.02	.53	50.0	-	50.0	-	11.1
Leather and leather products	42	31.06	.14	.11	.25	25.0	18.2	36.3	18.2	37.9
Land transport n.e.c.	78	30.94	.79	.94	1.73	20.4	26.6	38.3	31.9	4.8
Herring oil and fish meal.	46	30.45	.25	.23	.48	-	-21.7	-4.3	-13.0	42.6
Other food preparations	25	30.20	.26	.08	.34	-	37.5	-	-37.5	35.0
Bakery products	23	30.13	.81	-	.81	.	.	.	.	-
Chemicals and products of chemicals	45	29.05	.86	1.06	1.92	48.2	34.9	56.6	40.6	22.6
Fish processing	21	27.93	1.23	.05	1.28	40.0	-	40.0	-40.0	194.5
Fertilizers etc.	44	27.78	.98	.38	1.36	2.7	-5.3	-	-7.9	27.1
Cordage, rope and twine	31	27.23	.19	.01	.20	100.0	100.0	100.0	100.0	37.5
Other oil refineries, etc.	48	26.46	.39	.30	.69	16.7	6.7	16.7	6.7	192.0
Dairy products	18	26.20	1.57	.75	2.32	-17.4	-30.7	-17.4	-26.7	11.6
Margarine	19	25.67	.42	.04	.46	50.0	-	50.0	-	21.1
Electricity supply	61	22.44	.83	1.43	2.26	33.5	25.2	47.6	29.4	12.1
Ferro alloys	50	22.00	.68	.08	.76	37.5	37.5	37.5	37.5	21.8
Breweries and soft drink production	27	19.47	.66	.02	.68	-	-	-	-	21.3
Air transport	79	19.08	.58	.11	.69	-38.5	-36.4	-27.3	-36.4	58.8
Refining of aluminium	53	19.01	.95	.14	1.09	61.6	50.0	50.0	50.0	23.5
Ocean water transport	73	17.74	14.00	.06	14.06	33.3	16.7	33.3	33.3	26.9
Fishing etc.	12	17.65	.38	1.19	1.57	13.9	7.2	14.4	7.9	5.3
Slaughtering and preparation of meat	17	17.04	1.48	.53	2.01	-25.9	-34.0	-24.5	-34.0	15.8
Cocoa, chocolate and sugar confectionary	24	14.96	.59	-	.59	-	-	-	-	183.3
Vegetable oil mills	47	14.74	.03	.21	.24	35.0	19.1	28.6	19.1	10.1
Other non-ferrous metals	54	14.13	1.45	.48	1.93	61.6	70.8	75.0	72.9	5.4
Unspecified, energy supply	2	11.49	-	.16	.16	100.0	68.8	87.5	75.0	13.4
Grain mill products and livestock feed	22	11.18	.20	1.32	1.52	5.5	-13.6	1.5	-24.3	40.1
Spinning and weaving	29	10.77	.44	.77	1.21	26.3	5.2	24.7	7.8	8.4
Tobacco	28	10.77	.83	.01	.84	100.0	-	-	-	120.0
Agriculture	7	10.03	2.27	6.21	8.48	31.6	21.9	28.2	13.2	4.2
Distilling, rectifying and blending of spirits	26	5.85	.19	.08	.27	75.0	62.5	75.0	50.0	8.8
Dwellings	72	1.95	2.61	-	2.61	.	.	.	.	-
Commercial buildings	71	1.87	.08	.56	.64	29.4	44.7	57.2	50.0	9.5
Hunting etc.	11	1.07	.07	-	.07	-	-	-	-	66.7
Agricultural capital formation	8	-	.20	.10	.30	81.7	100.0	100.0	100.0	39.5
Local government consumption capital	6	-	.74	-	.74	.	.	.	.	-
Central government consumption capital	5	-	.45	-	.45	.	.	.	.	-
Standing forests	10	-	.12	-	.12	.	.	.	.	-

alternatives 1 and 3. For sectors with lower total labour coefficient positive changes dominate, but there are sectors with as low coefficients as 17 per cent for alternatives 0 and 2 and 11 per cent for alternatives 1 and 3 which have their intermediate deliveries reduced. There appears to be no association between the numerical values of possible changes and the size of the empirical standard error in input-output estimates 1949-1959.[1] From this fact we may venture the conclusion that the changes in input-output coefficients in the period 1949-1960 do not seem to be caused primarily by adaptations to changes in relative labour costs, provided, however, that our assumptions roughly resemble conditions in the economy. If, for instance, not all coefficients of the same size are in general equally adjustable, or if prices on all products are not affected at least roughly in proportion to their total labour content, our conclusion is shaken.

Roughly, the size of the possible changes, in kroner per 100 kroner total final deliveries follow the size of intermediate deliveries, when these are also measured in kroner per 100 kroner of total final deliveries. Consequently, there is no association between the size of intermediate deliveries and the sizes of possible changes, taken as percentages of intermediate deliveries.[2]

Let us now consider the picture for the more aggregate sector specifications. Our 92 sectors can be aggregated to 33 sectors. By such an aggregation the value of intermediate deliveries per sector will increase from .44 (.48 for alternative 0) kroner per 100 kroner total final deliveries to 1.24 (1.32 for alternative 0) kroner per 100 kroner. Table 14.

The possible changes per sector will also increase, but not quite in the same proportions, since some increases will be offset by decreases within the same aggregate sector. Thus the average numerical value of the possible changes are reduced from between 29.3 and 34.5 per cent of average intermediate deliveries to between 24.9 and 30.4 per cent of intermediate deliveries. The standard deviation about zero is reduced from between 54.5 and 64.2 per cent of average intermediate deliveries to between 38.8 and 46.0 per cent.

This can be compared to the reduction in the standard error of input-output estimates based on the 92 sector input-output matrix for 1960 when the results are aggregated from the 92 sector specification

---

1) Correlation coefficient -.05.
2) Correlation coefficient -.04.

Table 14. Possible changes in intermediate deliveries, 33 sectors. Summary figures

	Alternative 0 Changes only in coefficients for inputs from production	Alternative 1 Changes also in import coefficients	Alternative 2 Changes also in labour coefficients	Alternative 3 Changes also in owner income coefficients
Intermediate deliveries from 33 sectors in basis, per sector, kroner per 100 kroner total F.D.[1]	1.323	1.237	1.237	1.237
Standard deviation about average, kroner per 100 kroner total F.D ..	1.351	1.307	1.307	1.307
Possible changes:				
Increases, number of sectors	14	12	16	13
per sector, kroner per 100 kroner total F.D.	.349	.257	.372	.224
Decreases, number of sectors	16	20	16	19
per sector, kroner per 100 kroner total F.D.	- .375	- .462	- .270	- .385
Numerical sum of changes, kroner per 100 kroner of total F.D.	10.88	12.40	10.27	10.22
per sector, 33 sectors, kroner per 100 kroner total F.D.	.330	.376	.311	.310
per cent of average intermediate delivery	24.94	30.40	25.14	25.06
Net change, 33 sectors, kroner per 100 kroner total F.D. .	- .034	- .187	.050	-.133
Standard deviation of changes about zero				
33 sectors, kroner per 100 kroner total F.D.	.528	.569	.482	.480
per cent of average intermediate delivery	39.91	46.00	38.97	38.80

1) F.D. = final deliveries.

to the 33 sector specification.[1] By this aggregation the standard error in per cent of average intermediate delivery is reduced to figures between 61 and 74 per cent of the standard error in the 92 sector specification for the individual years, with an average of 69 per cent. The coresponding reduction in standard deviation for our four alternatives are to between 62 and 72 per cent. There is thus a very close correspondence in reductions. A line of reasoning could be: Since the aggregation process

1) Sevaldson: Op.cit. 1972 table 5a,b.

tends to group together similar sectors, and if the similarities also apply to total wage coefficients, we might expect that detailed sectors going into the same aggregate sector should be changed in the same direction by our adjustment procedure, and thus that we would not get so much offsetting effects between increases and reductions in the adjustment experiment. If, on the other hand, the errors in the 1949-1960 computations were due to random causes, we might expect more extensive offsetting effects, and thus a greater reduction in the observed standard error. Since this was not the case, we might be tempted to take it as an indication that the errors in the 1949-60 computations were not predominantly random. There are, however, very strong qualifications to such a conclusion: If we consider the figures for sectors belonging to the same two digit groups in table 13, we will find that although the majority of detailed sectors belonging to the same aggregate will in general have the changes in intermediate deliveries in the same direction or no change at all, nearly half of the aggregate sectors consisting of two or more detailed sectors have at least one sector with a change in the opposite direction from the others. There are also reasons why errors for related sectors might tend to go in the same direction in the empirical studies, even if they are not the results of systematic coefficient adjustments. Still, the evidence seems to be worth noticing.

Figures for all the 33 sectors, with possible changes under the four alternatives in percent of intermediate deliveries are given in table 15. The table also gives standard errors for the 1949-1959 estimates based on aggregates of the results obtained with the 92-sector matrix for 1960. Again there is no tendency to covariation between the numerical values of possible changes and the size of the standard error. We notice the tendency to increases in deliveries from manufacturing sectors and decreases for labour intensive service producing sectors.

At our highest aggregation level, with only 7 production sectors, intersector differences are to a large extent evened out. Particularly, if we look at the numerical averages of possible changes, or standard deviations of possible changes about zero, both expressed in per cent of average intermediate deliveries per sector, the figures for the 7 sector aggregation (table 16) are considerably reduced compared to the 33-sector (table 14) and 92-sector (table 12) figures.

Figures for each of the seven sectors are given in tables 2 and 17.

Table 15. Final and intermediate deliveries and possible changes in per cent of intermediate deliveries 1959. Standard error of input-output estimates 1949-1960 in per cent of average intermediate deliveries. 33 sector specification.

Sector	Production 1959 in kroner per 100 kroner total final deliveries			Possible changes in per cent of intermediate deliveries				Standard error 1949-60 in per cent of average intermediate delivery
	Final	Indirect	Total	Alternative 0 Changes only in inputs from production	Alternative 1 Changes also in import coefficients	Alternative 2 Changes also in labour coefficients	Alternative 3 Changes also in owner income coefficients	
11 Agriculture	2.53	6.32	8.85	32.6	23.2	29.4	14.7	3.3
12 Foresty	.13	1.82	1.95	-10.4	-25.9	3.9	-5.5	17.6
13 Fishing, whaling	.86	1.33	2.19	11.1	5.3	12.8	6.0	9.7
21 Mining	.45	.42	.87	-	-9.5	7.2	-9.5	19.0
22 Non-metallic mineral products	.21	1.02	1.23	-25.2	-43.2	-15.7	-43.2	25.0
23 Basic metal industries ..	3.54	1.41	4.95	19.4	27.7	31.2	29.1	6.3
24/25/26 Iron and metal products	3.31	1.69	5.00	-43.5	-45.0	-36.7	-44.4	6.8
27 Shipbuilding industries .	2.10	.25	2.35	-60.7	-56.0	-56.0	-56.0	25.9
28 Electrical machinery etc.	.91	.66	1.57	23.0	13.6	37.9	25.8	22.3
29 Other manufacturing	.50	.15	.65	50.0	26.7	60.0	40.0	59.0
31 Food industries	7.07	2.79	9.86	-5.8	-22.2	-7.2	-26.9	30.2
32 Tobacco and beverages ...	1.68	.11	1.79	70.0	45.4	54.5	36.3	5.3
33 Products of oils and fats	.67	.74	1.41	16.7	1.4	13.5	4.1	15.4
34/39/49 Chemicals	2.10	1.55	3.65	36.7	20.0	41.9	27.1	24.1
41 Textiles	1.10	.79	1.89	25.7	5.1	24.1	7.6	8.4
42 Clothing	1.79	.06	1.85	-	-33.3	-16.7	-33.3	27.8
43 Footwear, leather, fur ..	.75	.12	.87	15.4	8.4	25.0	8.4	36.7
44 Wood and cork etc.	.80	2.10	2.90	-23.3	-51.0	-13.8	-25.2	7.1
45 Pulp, paper and paper products	2.91	2.46	5.37	10.2	-11.0	18.7	.4	5.0
46 Printing and publishing .	.71	1.04	1.75	-34.2	-55.8	-27.9	-50.0	10.3
50 Construction	11.40	.01	11.41	-100.0	-100.0	-100.0	-100.0	21.7
61 Wholesale and retail trade	10.19	3.81	14.00	4.3	- 14.2	14.7	- .5	3.6
62 Water transport	14.39	1.12	15.51	-48.6	-53.6	-47.3	-52.7	7.8
63 Land and air transport ..	1.88	1.97	3.85	-24.3	-20.8	-13.2	-17.8	2.7
64 Communications	.32	.78	1.10	-65.5	-73.1	-62.8	-71.8	8.7
71 Electricity, gas and water	.91	1.46	2.37	32.3	24.0	45.9	28.1	11.2
72 Banking and insurance ...	1.19	.56	1.75	-19.3	-67.8	-17.9	-76.8	11.6
73 Business buildings, dwellings	2.69	.56	3.25	29.4	44.6	57.1	50.0	7.8
74 Government, defence	2.34	-	2.34	.	.	.	.	..
75 Educational, health services	2.89	.02	2.91	-100.0	-100.0	-100.0	-100.0	16.3
76 Personal services	1.47	.16	1.63	-52.9	-68.7	-50.0	-62.5	4.5
77 Other services	2.45	.54	2.99	-20.4	-46.3	-13.0	-27.8	8.0
78 Unspecified	.55	2.99	3.54	-40.7	-64.9	-35.1	-59.9	12.1
Total (numerical)	86.79	40.81	127.60	1051.6	1207.7	1091.1	1141.4	481.2
Numerical averages	2.63	1.24	3.87	31.87	36.60	33.06	34.59	14.58

Table 16. Possible changes in intermediate deliveries, 7 sectors. Summary figures

	Alternative 0 Changes only in coefficients for inputs from production	Alternative 1 Changes also in import coefficients	Alternative 2 Changes also in labour coefficients	Alternative 3 Changes also in owner income coefficients
Intermediate deliveries from 7 sectors in basis, per sector, kroner per 100 kroner of total F.D.[1]	6.24	5.83	5.83	5.83
Standard deviation about average, kroner per 100 kroner of total F.D.	2.88	2.73	2.73	2.73
Possible changes				
Increases, kroner per 100 kroner of total F.D.	2.52	1.07	2.80	.91
number of sectors	2	1	3	1
per sector, kroner per 100 kroner of total F.D.	1.26	1.07	.93	.91
Decreases, kroner per 100 kroner of total F.D.	-3.64	-7.23	-1.16	-5.30
number of sectors	5	6	4	6
per sector, kroner per 100 kroner of total F.D.	-.73	-1.21	-.29	-.88
Numerical sum of changes, kroner per 100 kroner of total F.D.	6.16	8.30	3.96	6.21
per sector, 7 sectors, kroner per 100 kroner of total F.D. .	.88	1.19	.57	.89
per cent of average intermediate delivery	14.10	20.41	9.78	15.27
Net change per sector, 7 sectors, kroner per 100 kroner of total F.D. ...	-.16	-.88	.23	-.63
Standard deviation of changes about zero 7 sectors, kroner per 100 kroner of total F.D.	1.07	1.44	.87	1.06
per cent of average intermediate delivery	17.15	24.70	14.92	18.18

1) Final deliveries.

Table 17. Final and intermediate deliveries and possible changes in per cent of intermediate deliveries 1959. Standard error of input-output estimates 1949-1960 in per cent of average intermediate deliveries, 7 sector specification

	Production in kroner per 100 kroner of total final deliveries			Possible changes in per cent of intermediate deliveries				Standard error 1949-1960 in per cent of average intermediate delivery
	Final	Indirect	Total	Alternative 0 Changes only in inputs from production	Alternative 1 Changes also in import coefficients	Alternative 2 Changes also in labour coefficients	Alternative 3 Changes also in owner income coefficients	
1. Agriculture, foresty, hunting and fishing .	3.52	9.47	12.99	20.1	11.3	22.2	9.6	3.5
2. Extraction and production of mineral and metal products ..	11.02	5.60	16.62	-11.7	-15.4	- .2	-13.0	11.0
3. Production of food and beverages, oils, fats and chemicals ..	11.25	5.09	16.34	11.4	-4.1	11.0	-5.5	20.4
4. Products of wood, pulp and paper, printing, textiles, clothing, leather ...	8.33	6.67	15.00	-5.7	-28.9	2.1	-14.5	2.6
5. Construction	11.40	.01	11.41	-100.0	-100.0	-100.0	-100.0	21.7
6. Trade and transportation	26.78	7.68	34.46	-17.5	-27.6	-9.4	-19.7	3.0
7. All other activities (services)	14.49	6.29	20.78	-14.3	-33.4	-5.1	-28.6	7.0
Numerical averages	12.40	5.33	18.23	25.8	31.5	21.4	27.3	9.88

V Summary and conclusions

The problem we posed for this study was to find what the effects of coefficient variability would be on the precision in estimates based on the input-output model, when the variability was in some way related to observed coefficient variability in the period 1949 to 1960, and when the variability was utilized in systematic adjustments, whereas the model estimates were assumed to be made on the basis of unadjusted coefficients. We made four alternative sets of assumptions, which are progressively more relaxed compared to a hypothesis of fixed coefficients. In all the alternatives we set limits to the possible changes in individual input-output coefficients and in the sums of coefficients. Generally a coefficient could be adjusted by up to the minimum of a) its own value and b) two times the standard deviation of coefficients of the same order of magnitude in the period 1949-1960.

However, total input-output balances must be preserved.

In alternative 0 only substitutions between inputs from domestic production sectors were allowed. In alternative 1, also imported inputs might be substituted for domestic. In alternative 2 the substitutions under alternative 1 might be made, but in addition also direct labour input coefficients might be adjusted and in alternative 3, finally, even the coefficients for owner income might be adjusted. All the adjustments were made so as to reduce direct and indirect labour inputs, (e.g. on the assumption that an increase had occured in the relative price of labour).

It turns out that, under our assumptions, the reshuffling of domestic inputs under alternative 0, makes possible a saving of nearly 5 per cent (4.6) in labour input. An additional 3.5 per cent (total 8 per cent) saving is achieved by allowing imports to substitute for domestic inputs (alternative 1). The biggest saving is obtained when direct labour input coefficients can be reduced. This alone gives a saving of 13.5 per cent, or a total saving of more than one fifth (21.4 per cent) of the basis figure under alternative 2. Again, allowing owner income to substitute for other inputs gives an additional 4 per cent labour saving, giving a total saving of 1/4 of the basis labour input under alternative 3.

The effects on the precision in our labour input estimates under alternatives 0 and 1 are "unsavoury", but we might be able to live with them. But the effects of alternatives 2 and 3 are really damaging. It should, however, be taken into consideration that our assumptions for alternatives 2 and 3 imply that there exists a general substitutability in such a way that input-output coefficients in each sector can be freely and independently changed within the given limits, subject only to a balance requirement. We feel that it would be more realistic to assume that there exist more strict interdependencies between changes in the labour coefficient and in other coefficients for a given sector. Such interdependencies might be expected to restrict the potentialities for labour saving, but it would not be a straightforward task to formulate numerical hypotheses about their nature. If the coefficients are really subject to systematic variations to the extent assumed under alternatives 2 and 3, it must be admitted that input-output analysis has little to contribute in the analysis of labour input in production. Since the errors in labour inputs must be matched by compensating errors in imports and other elements of value added, the same conclusions must be valid for them. The hope for input-output analysis rests on the possibility that our assumptions about variability are too liberal, or that our assumptions

about systematic adjustments to changes in relative prices are wrong, so that the variations observed in the coefficients are predominantly random or caused by systematic changes over time. The differences in composition of sector deliveries between the 5 categories of final deliveries considered in our computations do not imply very big differences in the results.

Thus, referring back to the three problems stated in the introduction we may conclude.

a. Our results do not throw much light on the question whether the observed variability of input-output coefficients was the result of systematic substitutions in order to minimize input cost per unit of output, or of more random variations. If relative price changes over the period 1949-1960 were dominated by changes in direct and indirect labour costs, then the fact that the estimated adjustments in intermediate deliveries according to our tests were uncorrelated with standard errors of prediction of intermediate deliveries for the period 1949-1960 indicates that the variations were not mainly of the systematic type corresponding to the present experiment. We have also given some logical arguments against the most extreme alternatives in regard to systematic adjustability of coefficients. However, considerations of the effects of aggregation on the results of the present computations and on the predictions for the period 1949-1960 indicate that the errors in the latter may not be entirely random.

b) We have computed the margins of errors associated with our alternative basic assumptions. The results are strongly conditioned by our general and arbitrary choice of twice the observed standard deviation 1949-1960 as the limit for coefficient adjustments. For the two most restrictive alternatives, which we also consider most realistic, the margins of error are considerable but not unocceptable for the estimates of labour input requirements. The more permissive alternatives give unocceptable margins of error for estimates of labour input requirements. The alternatives are not markedly different in the errors for estimates of intermediate input requirements. They would all make possible margins of error in the prediction of intermediate deliveries of an order two to three times those, not inconsiderable errors, we found in a simulation experiment in another study.

c. In regard to the changes in the pattern of total primary and intermediate inputs to the production system, our alternative 0, where only coefficients for inputs from domestic production sectors can be changed, stands apart. Under this alternative /~~total~~ the amount of intermediate domestic deliveries

is increased by the labour saving adjustments of the input-output coefficients and the main compensation for reductions in labour input is provided by increased owner incomes, i.e. increases in the output from sectors with relatively high owner incomes compensate reduction in output from sectors with relatively high labour input. For the three other alternatives labour saving is accompanied by a reduction in total domestic intermediate deliveries. For these alternatives import is a dominating overall substitute for labour. Only when the direct owner income coefficient can be adjusted is this an equally important substitute. Depreciation of fixed capital is not of significant importance as substitute for labour in any of our alternatives.

When we look at the effects of our assumed adjustments on the estimates of intermediate product deliveries from individual domestic production sectors, the effects are percentagewise considerable already under alternative 0, and the increases in magnitudes up to the higher numbered alternatives are not very big. The average percentage changes in intermediate deliveries from individual production sectors is somewhere between $1\frac{1}{2}$ and $2\frac{1}{2}$ times the average empirical standard error in per cent for estimates over the period 1949-1960, which is probably a reflection of our basic assumptions. However, there is no correlation between the numerical changes under our alternatives and the size of the standard error of estimates 1949-1960 for the same sector.

This may be taken as an indication that the observed standard errors were of a more random type than the systematic adjustments assumed in our test. But it is only an indication, since adjustments to other systematic factors than a change in the relative price of labour, might have given changes in other sectors in our test. As might be expected, intermediate deliveries tend to be reduced from sectors with high total (direct plus indirect) labour content per unit of output, and to be increased from sectors with low labour content.

Appendix table 1. Basic and adjusted input-output coefficients for the sector Fish processing.[1)]

	Direct + indirect wage content of delivering sector in base year	Basic coefficients	Adjusted coefficients: Alternative 1 Changes in inputs from production and imports	Alternativ 2 Changes also in direct labour coefficients	Alternative 3 Changes also in owner income coefficients	Alternative 4 As alternative 2, but with proportional changes in inputs from production
Direct inputs						
7 Agriculture	10.03	.84	1.68	1.68	1.68	.86
47 Vegetable oil mills	14.74	.02	.04	.04	.04	.02
12 Fishing	17.65	57.64	62.72	66.44	62.72	59.54
61 Electricity supply	22.44	.52	-	.38	-	.54
19 Margarine	25.67	.07	-	-	-	.07
18 Dairy products	26.20	.43	-	-	-	.44
21 Fish processing	27.93	.09	-	-	-	.09
45 Chemicals and products of chemicals	29.05	.07	-	-	-	.07
25 Other food preparations	30.20	.32	-	-	-	.33
39 Paper and paperboard products	33.13	2.05	.65	.65	.65	2.11
64 Trade	33.30	5.84	3.44	3.44	3.44	6.03
35 Other wood and cork products	40.69	1.96	.76	.76	.76	2.02
01 Unspecified office supplies	41.35	.71	-	-	-	.73
56 Iron and metal products	42.26	.06	-	-	-	.06
03 Unspecified services	42.32	.43	-	-	-	.44
41 Printing, bookbinding etc.	55.29	.04	-	-	-	.04
Total	..	71.09	69.29	73.39	69.29	73.39
Import	..	3.08	4.88	4.88	4.88	4.88
Gross product	..	25.82	25.82	21.72	25.82	21.72
Labour (wages)	..	13.33	13.33	9.23	9.23	9.23
Depreciation	..	3.92	3.92	3.92	3.92	3.92
Owner income	..	10.68	10.68	10.68	14.78	10.68
Computed direct plus indirect inputs						
Total input from production		89.69	78.81	88.49	76.82	94.65
Imports		10.32	13.21	14.22	13.04	15.04
Gross product		89.53	86.77	85.75	86.94	84.78
Labour (wages)		27.93	25.00	19.07	17.52	20.88
Depreciation		25.35	26.29	28.08	25.99	26.27
Owner income		38.46	39.03	41.58	46.83	39.67

1) See footnote 1) p. 7 for an explanation of the relationship between alternative 0 and alternative 4.