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An Input-Output Analysis of the Agricultural Sector of the Irish Economy in 1964

by

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Contents

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SUMMARY

This paper is divided into two main sections as follows:

(1) Input-Output Model of the Agricultural Sector.
(2) Input-Output relationships between and among the various sectors included in the model.

In addition there are three appendices. The main input-output tables are given in Appendix A. Appendix B describes how the various feed items were distributed among the different livestock enterprises, while a note on the problems associated with secondary and joint products is given in Appendix C.

Input-Output Model of the Agricultural Sector

In preparing an agricultural input-output model the definition of the sector presents many problems.

In national income accounting the farm gate is a convenient and well defined boundary for the agricultural sector. In the context of an agricultural input-output model on the other hand the farm gate is not a particularly realistic boundary and the selection of such a cut-off point presents problems in the specification of final demand for the products of various agricultural sub-sectors. Large quantities of farm produce go to other industries for processing and if these industries are not included in the model their agricultural inputs will have to appear in a column headed "other industries" in the final demand section of the input-output table. This is not very enlightening and for that reason in a study of this kind it is best to go beyond the boundaries of the farm gate and include in the model industries which are mainly dependent on farm produce for their raw materials. This has been done in preparing the model under review, for which 1964 was selected as the base year. The model prepared included 16 purely farming sub-sectors and 12 industrial sub-sectors. This model has been used in making various analyses of the economy but for reasons explained in the text it has not been published. Instead a more aggregated model which includes 11 purely farming sub-sectors and 4 non-farming sub-sectors is presented in Appendix A. These sub-sectors are referred to as sectors in the text.

An adjusted version of the smaller model is also presented, in which are included three artificial sectors for the disposal of the joint products of other sectors. The entries are explained in the text. The methods of dealing with subsidies in the context of an Irish agricultural input-output model are also discussed in this section.

Income Arising as a Proportion of Output

Among the livestock sectors income arising as a percentage of output in 1964 was 42 per cent. for cattle, 67 per cent. for dairying, 71 per cent. for sheep and wool, 27 per cent. for pigs, 49 per cent. for poultry and 63 per cent. for horses. For most crops it was about 50 per cent.

In interpreting these percentages it should be kept in mind that income arising has been defined to include the amount remaining to remunerate all labour and management and to pay interest on own and borrowed capital.

Among the non-farming industries included in the model income arising as a proportion of output was 9 per cent. for animal slaughtering and milk processing, 12 per cent. for grain milling and 31 per cent. for other intermediate industries. The definition of income arising in these sectors is similar to that for the purely farming sectors. The small technical co-efficients for income arising in the food industries do not mean of course that these industries are unprofitable. With relatively rapid turn-overs food processors can afford to take low average returns. Farmers on the other hand because of slow turn-overs must obtain high average returns.

"Income Multipliers"

The "income multiplier" of a sector is the amount by which the total income of an economy is increased as a result of a one unit increase in the final demand for the products of that sector. The model shows that dairying and sheep had higher "income multipliers" than any of the other sectors in the model. An increase of £1 in the final demand for milk processing and other slaughtering (mainly sheep slaughter) was responsible for an increase of over £1 in the overall income of the country. The "income multipliers" of most other sectors were in the region of £0·5 with that of fellmongery and tanning being lowest at £0·24.

Import Content of Different Sectors

Figures for the direct and indirect import requirements of £1 final demand for the products of different sectors were calculated and show that the farming sectors requiring the highest proportion of imports were: wheat, horses and feed grains. £1 final demand for the products of these sectors required, on average, about £0·4 of both direct and indirect imports. Farming sectors requiring the lowest proportion of imports were: potatoes, dairying and sugar beet—about £0·1 for each £1 of final demand.

Relationship between Unitary Increases in Final Demands and Non-Capital Subsidies

In 1964 every £1 of final demand (i.e. home consumption or exports) for the products of the milk processing industry required on average £0·24 in non-capital subsidies. This level of support was higher than that for any other sector. The figures for beef and pig products which are next highest on the list were £0·1 and £0·08 respectively. The subsidy per unit of live cattle exports was 0·035 units. When the cattle and milk processing sectors are combined it is found that a unit increase in the final demand for the products of these sectors requires non-capital subsidies to the extent of 0·106 units.

Price Effects

The analysis shows that if there were no change in the quantity or pattern of production and no change in input prices (other than feeds and seeds) an increase of about 8 per cent. in the agricultural price index would bring about a rise of 10 per cent. in farmers' incomes. This income increase would raise the wholesale price of all foods by about 7 per cent.

AN INPUT-OUTPUT MODEL OF THE IRISH AGRICULTURAL SECTOR

Purpose of the Study

The purpose of the exercise under review is to quantify the inter-relationships between the various farming enterprises of the Irish economy and certain industries which are directly or indirectly dependent on farming.* A knowledge of these relationships is important in determining how one farm enterprise might be affected by changes in other such enterprises or in non-agricultural industries. It is hoped that this knowledge may be of use to those who are engaged in economic planning particularly in relation to agriculture.

In order to study the various inter-relationships an input-output model has been constructed for what might loosely be described as the agricultural sector of the economy. The definitions used are described below. Some of the more important inter-relationships between different sectors are also examined but the model has not been used for planning the economy.

Selecting a Base Date

At the time of the commencement of this study, 1964 was the latest year for which information was available on a number of the manufacturing industries included in the model. Consequently 1964 was selected as the base year for the study. This year might be considered as somewhat "abnormal" in terms of recent trends in agricultural output. Both volume and price of agricultural production increased sharply in 1964 and while prices have continued to rise slowly in subsequent years the volume of net output has declined somewhat since then. It is impossible, however, to define precisely a "normal year" particularly in relation to agricultural output and consequently 1964 is probably as good a base year as any other which might be chosen.

Commodity Groups Within the Model

In preparing the national accounts the agricultural sector is defined to include only the purely farming enterprises. It does not include industries which are closely related to farming such as meat, milk and vegetable processing, grain milling, etc. Economists have often questioned this definition on the ground that it is too narrow but there is little justification for such strictures in the context of national accounting. The farm gate is a well defined boundary for the

*When discussing the input-output tables these enterprises and industries are referred to as sectors.

farming sector and if the statistician wishes to extend this boundary he has no clear-cut guide as to where he should stop.

In the context of an agricultural input-output model on the other hand the farm gate is not a particularly realistic boundary and the selection of such a cut-off point creates problems in the specification of final demands for the outputs of the various agricultural sub-sectors. Large quantities of farm produce go to other industries for processing and if these industries are not included in the model their agricultural inputs must appear as part of final demand for the various agricultural sub-sectors. Therefore if the agricultural sector is rigidly defined to include only the purely farming enterprises a high proportion of its output will appear in a column headed "other industries" in the final demand section of the table. This is not very enlightening and for that reason it is best in a study of this kind to go beyond the boundaries of the farm gate and include in the inter-industry quadrant certain industries which are mainly dependent on farm produce for their raw materials.

How far one should go in this direction is a matter for debate. Some argue that the table should embrace all economic activity within the state with the agricultural sub-sectors being given in a good deal of detail and the others in more highly aggregated form. This in effect means preparing an input-output model for the whole economy which is a very formidable undertaking. The writers considered that it was not necessary to do this in the present instance particularly since a large multisectoral model was in the course of preparation in the CSO at the same time. It was felt that a less ambitious model which included some but not all the non-farming sectors would prove useful and could be prepared in a relatively short time. The selection of industrial enterprises to be included in the model presented a difficult problem however. Originally it was intended that the industries to be included would be those which depended directly on farming for their raw materials. Secondary type industries like bread and biscuits, boots and shoes, cocoa, chocolate, etc. were therefore omitted from the first table prepared. When this model was examined it was found that a large volume of processed and semi-processed commodities such as flour, leather, sugar, etc., appeared in the "other industries" column in Final Demand. This was considered undesirable and accordingly a number of secondary and even tertiary industries such as those mentioned above were included so as to reduce as low as possible the entries in the "other industries" column.

The final model which was used to make various analyses of the economy contained 16 purely farming sub-sectors and 12 industrial sub-sectors. These, in addition to four artificial sub-sectors for such items as skim milk, wool, hides, fats and offals gave a transactions table, having 33 inter-industry sub-sectors.

In preparing such a detailed model many very subjective decisions had to be made regarding the distribution of inputs between different sub-sectors. Therefore the structures of some of the sub-sectors defined, while adequate for input-output purposes are very arbitrary and for that reason it is not proposed to publish the detailed tables described above. Instead a more aggregated model is given which, though having a number of very subjective entries, has not the same degree of "arbitrariness" as the other. Though more limited in its application than the larger one, this model can be used for most normal analyses and has the great advantage of not being over-unwieldy.

Table A1 is the basic transactions table for the aggregated model. As can be seen it contains 15 interindustry sub-sectors (referred to subsequently as sectors). The entries in this table, which are in value terms (£000), are outlined below.

Quadrant I—Interindustry Flows

Quadrant 1 consists of 15 rows and a similar number of columns, plus a column for totals—column (16). Within this quadrant 11 purely farming sectors have been defined, these are:

(1) Cattle, which includes cows suckling calves.
(2) Dairying.
(3) Sheep and wool.
(4) Pigs.
(5) Poultry and eggs.
(6) Horses.
(7) Grain crops (i.e. wheat, oats, malting and feeding barley, maize and milo).
(8) Root and Green crops (sugar beet, potatoes, turnips, mangels and fodder beet).
(9) Conserved Grass (hay and silage).
(10) Pasture, including rough grazing.
(11) Other crops—rye, beans and peas, kale and field cabbage, other root and green crops, fruit and horticulture, rye grass for seed, and root crop seeds. Farmer's peat is included here also.

This classification corresponds closely with that used by the CSO in preparing the national estimates of agricultural output. Certain differences, however, between the outputs in the model and in the official tables require mention. These differences occur because of different accounting procedures. In preparing the national estimates of agricultural output all agricultural holdings in the State are considered as being a single national farm and the official output of any commodity is the amount sold off this farm to non-farming sectors of the economy,

exported, or consumed by persons in farm households. It does not include amounts used in further production on the farms where produced or sold by one farmer to another. These amounts are netted out in making the calculations.

In preparing an input-output table on the other hand inter-sectoral transactions are not netted out. These flows are a fundamental feature of the model and accordingly must be recorded. Hence the output of a commodity in the national accounts and in an input-output table is not necessarily the same though the two figures may be reconciled by making adjustments for the internal flows.

The cattle and dairying sectors in the model provide a good illustration of the above differences. In preparing the official output estimates, account is taken only of the final demands for cattle and milk. Internal sales and transfers of these items are ignored. In preparing the input-output model on the other hand separate cattle and dairying sectors are defined and sales or transfers from one of these sectors to the other are included in the table. The output of the dairying sector consists of (*a*) milk fed to animals, consumed by persons and used for processing; (*b*) dropped calves other than stock bull replacements transferred to the cattle sector and (*c*) cull cows and bulls sold for slaughter and export. The inputs of this sector include heifers in calf and imported dairy cows purchased from the cattle sector. It is assumed that the dairy calves are transferred to the cattle sector at birth and that milk fed to these animals is also transferred to the cattle sector. Cull cows and bulls are assumed to be first transferred to the cattle sector, and from this sector sold for slaughter or export. Imported dairy cows are assumed to be imported by the cattle sector and then transferred to the dairying sector. Heifers in calf enter the dairying sector when they calve. These assumptions with slight modifications are those commonly made by farm accountants in farm business analysis.[1]

The output of the cattle sector which includes cows suckling calves, consists of all cattle sold for slaughter and live export together with heifers in calf and imported dairy cows transferred to the dairying sector. Inputs to the cattle sector from the dairying sector are (*a*) calves, (*b*) cull cows and bulls and (*c*) milk fed to calves.

One sector appearing in the model which requires some mention is the Pasture sector. Pasture is used entirely for further production on the national farm and hence does not appear as a commodity in the national output tables. It is included, however, in the input-output tables because it provides a very substantial portion of the national livestock feed. Numerous hazards are involved in valuing pasture and in allocating it to the different sectors and because of these the figures for this crop must be taken with a good deal of caution. The methods of valuing and allocating pasture to the different sectors are described in Appendix B.

Industrial Sectors

The industrial sectors included in the model are:

(12) Animal slaughtering—cattle (including slaughtering by butchers), pigs (including slaughtering by pork butchers but excluding farm slaughtering) and other animal slaughter (mainly sheep, lambs and horses).

(13) Milk processing (excluding milk purchased by processing plants for sale for liquid consumption).

(14) Flour Milling and Animal Feed.

(15) Other Intermediate—includes sugar refining, brewing, malting and distilling, food processing, fellmongery and tanning.

The classification of the industrial sectors is based on the Census of Industrial Production conducted annually by the CSO.

Quadrant II—Final Demand Sectors

The sectors included in the final demand quadrant of Table A1 are:

(17) Other Industries: This is a residual column into which was put primary or secondary agricultural produce used in industries other than those listed above and for which inputs were not defined.

The largest single entry in this column is that of 974* for home produced wool going to the wool and worsted industry which is not defined separately. The figure of 198 in row (6) of this column represents the net value of horses sold for non-agricultural purposes within the state. Net in this context means sales less purchases. The entry of 215 in row (9) and most of the 440 in row (7) represents the consumption of conserved grass and oats by non-agricultural horses.

(18) Personal consumption: The entries in this column relate to the value of processed and unprocessed agricultural commodities consumed by persons within the state.

(19) Exports: These consist of live animals and crops exported as such, dead meat and other processed commodities such as dairy products, sugar, chocolate crumb, leather footwear, beer, spirits, etc.

[1]See for example "Farm Records and Accounts", p. 38, prepared by the agricultural advisory service, Department of Agriculture and Fisheries, Dublin.

*In this and subsequent examples in the text the figures are given as they appear in the Transactions Table, i.e. rounded to the nearest £1,000.

(20) Stock changes: These include the value of livestock changes on farms as published in the national accounts together with changes in inventories of crops held by merchants and millers, manufactured products and industrial raw materials. No information was available for stocks of crops on farms, hence all unsold crops were assumed to be consumed in the year of production.

(21) Total Final Demand: This is the sum of columns (17), (18), (19) and (20).

Remaining Columns of Table AI

The remaining columns of the table are:

(22) *Total Commodity Flow:* The figures in this column were obtained by adding together columns (16) and (21).

(23) *Imports:* In this study most imports were taken as being competitive and were entered in a special column. Imports such as fertilisers, fuel oils, cocoa, salt, etc. which were considered as being definitely non-competitive were entered as expenses in the primary input quadrant and are not shown separately though estimates of them have been made.

(24) *Total Domestic Flow:* The entries in this column were obtained by deducting the entries in column (23) from those in column (22). For the purpose of input-output analysis Total Domestic Flow is equivalent to total output and the entries in the first 15 rows of this column are equal to the corresponding entries in the first 15 columns of the "Total Inputs" row (row (21)).

(25) *Transfer Adjustment:* In preparing the purely farming sector entries in Table A1 a number of intra- and inter-farm transactions were included which are not included in preparing the official agricultural output statistics (see p. 4 above). For this reason the entries in the Total Domestic Flow column (column (24)) are generally greater than the corresponding official outputs for the commodities concerned. In order to reconcile these two items (domestic flow and official output) it was necessary to include a further column which has been headed "Transfer Adjustment". The figures in this column represent the difference between the total domestic flows and the official outputs of the purely farming sectors. For example the total domestic flow of cattle in col. (24) is 88,109. The official output of cattle including the value of cattle casualty hides and stock changes of cattle but excluding the value of changes in dairy cow stocks is 73,601. The difference of 14,508 which is the transfer adjustment also occurs in col. (2) and represents the value of heifers in calf and imported breeding stock transferred from the cattle to the dairying sector. Similarly, the figure of 30,513 appearing as a transfer adjustment in row (2) is the sum of the three figures in cols. (1), (4) and (5) of this row (i.e. 29,343 +1,064+106). The figure of 29,343 represents the value of calves, old cows and bulls transferred from the dairy herd to the cattle herd and the value of milk, whole and skim, fed to calves, while the figures 1,064 and 106 represent the values of skim milk fed to pigs and poultry respectively. The figure of 12,633 appearing as a transfer adjustment in row (10) is the value of pasture fed to grazing livestock. Since the official output of pasture is nil the transfer adjustment is exactly the same as the total domestic flow of pasture in col. (24).

In the case of root and green crops the transfer adjustment is the sum of the entries in cols (1) to (8), less the entry of 15 in col (23). The latter figure relates to imported seed potatoes which are included with home grown seeds in col (8). The transfer adjustment for grain crops cannot be determined directly from Table A1 since sold and unsold grains are included in most of columns in the row. It is a pure coincidence that the entry of 3,150 for other intermediate in the grain crop row is the same as the transfer adjustment for grains. There is no connection between these two figures.

Transfer adjustments are included for the purely farming enterprises only. No such adjustments are made for the non-farming industrial enterprises. The total value of the transfer adjustment is 75,576.

(26) *Official Agricultural Output:* The figures in this column are the official outputs of the various farming enterprises and their sum is equal to the official gross agricultural output (including livestock changes) in the State for 1964 (i.e. 240,156).

Pricing System Used

Items sold and those used unsold for household consumption were valued at producers' prices, i.e. at the prices which it is estimated the producers received for them. These correspond to the output prices given in official publications and include

subsidies. The entries in the export column are therefore not the same as those appearing for corresponding items in the foreign trade statistics. The latter are, of course, valued at f.o.b. prices which in some cases, because of subsidies, are lower than producer prices. The entries in the import column are, however, valued at import (c.i.f.) prices. Inter-sectoral flows of livestock are valued at average 1964 prices for the corresponding items but unsold produce and crops fed to livestock and used for seed are valued at approximate cost of production prices. The reason for this is as follows:

Normally the entries in a transactions table are valued at producers' prices and these prices are also suitable for valuing household consumption of unsold produce. For produce fed to animals, however, which does not come on to the market, the use of producer market prices is not entirely realistic.[2] For example, only about one-third of the Irish potato crop is sold, the remainder being fed to farm animals on the farms where produced, or going to waste. All the potatoes in the state could not be sold at the average market price ruling in any year and indeed, if farmers were to value potatoes fed to animals at market prices, the animals fed would likely show a substantial loss. Accordingly, products of this kind are best valued at cost of production prices and this has been done for all unsold produce fed to animals in preparing Table A1. The method of calculating these costs is explained in Appendix B.

Quadrants III and IV—Primary Inputs

Entries for primary inputs are given in rows (16) to (20). The method of distributing these inputs between the different sectors is explained in Appendix B also.

Row (16) *Fertilisers and Lime*

In this row is given the value of fertilisers and lime applied to the different crops in 1964. The value entered for fertilisers is the amount paid by farmers plus the subsidy received by the manufacturers. The subsidy element is, however, distributed with negative signs to the different crops in the subsidy row. The net effect is therefore the same as if the subsidised values were entered for fertilisers and the subsidies ignored. The amount of the fertiliser subsidy in 1964 was 3,816.

In the case of lime the state payments are regarded as a transport subsidy. Hence lime is entered in row (16) at the prices actually paid by farmers while the subsidy is distributed with positive signs to the different crops in the "Other Expenses" row and with negative signs in the subsidy row. The lime (transport) subsidy was 717, in 1964. The distribution of fertilisers and lime subsidies as between the different crops is shown in Table 1 together with trade and transport margins on seeds (described later).

Row (17) *Rates*

Actual rates paid by farmers are distributed to the different crops and livestock enterprises along row (17). In accordance with the procedure adopted in preparing the national accounts the subsidy element in farmers' rates has been ignored. Total rates paid by farmers in 1964 were 7,188. Separate figures for rates were not available for the non-farming enterprises, hence for these sectors rates are included in the "Other Expenses".

Row (18) *Other Expenses*

For the purely farming sectors the following items are included in "Other Expenses":

(1) Veterinary expenses
(2) Repairs to machinery, fuel oil, etc.
(3) Farm share of family car and electricity
(4) Depreciation of machinery
(5) Transport marketing and other costs.

[2]Carter H. O. and Heady, E. O. An Input-Output Analysis emphasising Regional and Commodity Sectors of Agriculture. *Research Bul. 469*, Iowa State University, Ames, Iowa. September 1959.

TABLE 1: DISTRIBUTION AMONG THE DIFFERENT CROPS OF FERTILISER AND LIME SUBSIDIES, TOGETHER WITH TRADE AND TRANSPORT MARGINS ON SEEDS,

Item	Total	Grain crops	Root and Green crops	Conserved grass	Pasture	Other crops
	£000					
Fertilisers and lime at prices paid by farmers	11,930·0	2,069·9	2,206·8	1,708·4	5,668·5	276·4
Fertiliser subsidy	3,816·0	569·9	701·2	587·2	1,886·0	71·7
Total fertilisers and lime in Table A1	15,746·0	2,639·8	2,908·0	2,295·6	7,554·5	348·1
Lime subsidy included in "Other Expenses"	717·0	114·1	52·1	48·0	496·8	6·0
Trade and transport margins on seeds	1,911·0	935·0	345·0	176·0	303·0	152·0

These items are all taken from official statistics,[3] and are distributed to the different sectors as explained in Appendix B. Some of the items contain non-competitive imports such as fuel oil, medicines, etc. which are not shown separately. The entries in this row also contain the lime subsidy which as explained above is taken as a transport subsidy. In addition to the above items the entries in row (18) include trade and transport margins which are the differences between what producing sectors obtained for produce sold and what the consuming sectors paid for these items. Trade and transport margins for seeds are given in Table 1 and for livestock feed in Table B2 of the Appendix.

Row (19) *Subsidies*

The entries in this row include (*a*) subsidies paid directly to farmers such as the calved heifer subsidy and some of the bovine tuberculosis eradication scheme payments; (*b*) subsidies used to reduce the cost of inputs such as the fertiliser and lime subsidy and (*c*) subsidies used to increase the prices of commodities sold by farmers. In 1964 the value of subsidies paid directly was 2,285. This is the sum of the figures in cols. (1) and (2) of this row.

The entries in the various crop columns are the fertiliser and lime subsidies and the subsidies under the Land Acts. The total value of these cost-reducing subsidies was 5,328 in 1964. The entry of 1,970 in the animal slaughtering column relates to cattle slaughtering—it is the amount of subsidy paid to the meat factories for fat cattle slaughtered under the BTE scheme. Under this scheme the factories purchased cattle at a relatively high price and exported the meat at a relatively low price, the apparent loss being recouped from the Government by way of subsidy which amounted to 1,970 in 1964. There is no subsidy relating to pig-slaughtering in this column even though the government subsidises pig production by guaranteeing prices for certain grades of pigs sold to factories. The home market for pig meat is protected so that prices on this market are related directly to those paid by the factory for pigs. There is therefore no state subsidy on home-consumed pig meat. Pig meat in excess of home requirements is taken up by the Pigs and Bacon Commission at a price related also to the guaranteed price for pigs. This meat is exported usually at a lower price than was paid for it by the Commission, the government paying the difference by way of an export subsidy. In preparing the input-output table, pig meat exported is entered in the export column at the prices which the factories received from the Pigs and Bacon Commission (i.e. producers' prices) while the subsidy is entered with a negative sign in the subsidy row of this column.

The entry of 5,815 in the milk processing column requires some explanation since the mechanics of the milk subsidy payments are somewhat complicated. Briefly the position is as follows:

Registered milk processors have what in effect is a guaranteed price for all milk products manufactured. This occurs because the home market is protected and Bord Bainne agrees to take up at a guaranteed price and export all butter and cheese offered to them. The price offered by Bord Bainne for these products does not enable the factories to pay what is considered a sufficiently high price for milk and so the Government pays the factories a production allowance on a per gallon basis for the purpose of further increasing the price to farmers. In 1964 the net value (value paid by the state less certain deductions) of this production allowance was 5,815, and this is the amount entered in column (13) of the subsidy row.

The amounts the factories received for products sold on the home market and from Bord Bainne and other sources for products exported are the amounts entered in the household consumption and export columns respectively of the milk processing row. Bord Bainne, however, does not receive on the export market the amount it pays the creameries for products exported. It suffers a loss on the transaction which is recouped by a further government subsidy. The amount of this subsidy in 1964 was 2,401, and this figure is included along with a bacon export subsidy of 1,950 in the export column of the subsidies row.

The one remaining entry in the subsidy row which requires explanation is the figure of 127 in the grain milling and animal feed column. This is a subsidy paid to animal feed millers to enable them to pay a guaranteed price to farmers for unmillable wheat.

As can be seen from column (22) the total value of production and price support subsidies paid by the state for agricultural produce in 1964 was 19,876. This does not represent the total state payments in relation to agriculture as published by the Government. As stated above, the subsidy on rates is not included. Neither are capital grants such as those paid for animal housing, land rehabilitation, etc.

Row (20) *Income Arising*

In general it can be said that the entries in this row are residuals representing the differences between total outputs and total inputs. The sum of the entries for the purely farming sectors, however (i.e. 161,159) is the same, except for a slight rounding error, as the official figure for Income Arising in Agriculture as given in Table 9 on p. 74 of the

[3]Irish Statistical Bulletin, June 1967, p. 74, Table 9.

June 1967 issue of the Irish Statistical Bulletin. "Income Arising in Agriculture" includes:

(*a*) Income from self employment and other trading income.

(*b*) Wages and salaries of hired workers and,

(*c*) the rent element in the land annuities including the subsidy under the land acts.

All the income arising in the pasture sector, most of that arising in the conserved grass sector and some of that arising in all the crop sectors relates to item (*c*) above.

Row (21) *Total Inputs*

In accordance with input-output methodology the entries in columns (1) to (15) of this row are the same as the figures in the corresponding rows of column (24). This means that what is here termed the total domestic flow of a sector is equal to the total inputs of that sector. Though totals for the different quadrants are not shown in the table, it should be noted that the total of all entries in Quadrant III, i.e. the algebraic sum of rows (16) to (20) in column (16), is the same as the sum of all the entries in Quadrant II, i.e. the sum of the first 15 rows of column (21) less the sum of the corresponding rows of column (23). This equality is also in accordance with input-output definitions.[4]

Adjusted Transactions Table

It is explained in Appendix C how secondary and joint products cause difficulties in input-output analysis and how these problems can be overcome by means of artificial transfers. The more detailed the tables, the greater the need for such adjustments and in preparing the large model mentioned above a number of such transfers were made. On the other hand, for a fairly aggregated model such as that presented here there is not a great deal of justification for the inclusion of artificial transfers since most rows contain a rather heterogeneous collection of products in any case.

However, it was felt that the structure of the model could be improved by making certain transfers and accordingly Table A2 has been prepared by making some adjustments to Table A1. In making the adjustments it was assumed that all the joint products concerned varied in proportion to the producing rather than the consuming sectors, hence in all cases the products were entered with positive signs in the diagonal cells of the producing sectors and with negative signs in the corresponding columns of the rows to which they were transferred.* They were then distributed along these rows by means of positive entries in the consuming columns. It was possible to transfer some of the products to existing sectors so that artificial rows and columns had only to be included for a few items. These are:

(i) Calves/cows/skim milk,

(ii) Wool,

(iii) Hides and skins, fats and offals.

The adjustments carried out in making the transfers are described below.

Cattle—casualty hides

These are joint products of the cattle sector which are shown in Table A1 as being sold directly to fellmongery and tanning (included in "other intermediate" in the tables). In Table A2 their value, 35, is entered with a positive sign in the diagonal cell of the cattle sector and with a negative sign in the cattle column of the artificial hides and skins, fats and offals [row (15)]. They are distributed along this row together with other hides, skins, fats and offals to the "other intermediate" column.

Calves/cows/skim milk/casualty cow hides

These joint products of dairying, instead of being sold directly to the using sectors as in Table A1, are transferred to artificial rows in Table A2. Their total value, 32,934, is entered with a positive sign in the diagonal cell of the dairying sector and with negative signs in the dairying column of rows (3) and (15). The entry of 20 in row (15) is the value of cow casualty hides which is sold along this row to "other intermediate". The entry of 32,914 in row (3) is the value of the remaining items which is transferred along this row to the various using sectors. The purpose of this transfer is to distribute whole milk along the dairying row and other products of dairying along the artificial rows. The output of the dairying sector is therefore a homogeneous product.

Shorn Wool

Shorn wool (valued at 4,096 in 1964) is a joint product of sheep-raising, and is shown in Table A1 as going directly with live sheep to final demand. In Table A2 the value of shorn wool is entered with a positive sign in the diagonal cell of the sheep and wool sector and with a negative sign in the sheep and wool column of the artificial wool row [row (5)]. It is then distributed along this row to final demand. The output of the sheep and wool sector is therefore a fairly homogeneous product, i.e. sheep and lambs.

Slaughtered Hides and Skins

These were transferred from the animal slaughtering row to the artificial hides and skins, fats and

*See under Artificial entries Appendix C.

[4]Problems of Input-Output Tables and Analysis, p. 6. Studies in Method, Series F, No. 14. United Nations, New York, 1966.

offals row and distributed along this row to the Other Intermediate sector.

Fats and Offals

These were considered to be sufficiently different from meat to warrant distribution along a separate row and so they were distributed along the artificial row for hides, skins, fats and offals.

Malt Combings and Wet Grains

In Table A1, wet grains are sold directly from other intermediate industries to the dairying sector and dried grains to the grain milling and animal feed sector. In Table A2 both are transferred to the grain crops row by means of a negative entry in the other intermediate column of that row. The negative entry is not apparent in this cell, however, since it is more than offset by the sum of other positive entries.

Sugar Beet Pulp

This was considered to be comparable with root and green crops and was transferred to the latter row from the other intermediate industries sector for distribution to the consuming sectors.

Technical Coefficients

Two sets of technical coefficients are given corresponding to the entries in Tables A1 and A2. Those in Table A3 are based on the unadjusted transactions in Table A1 and provide a clear picture of the proportions of the different output items going to various uses. The figures in Table A4 which are based on the adjusted transactions in Table A2 do not (because of the artificial entries) give such a clear picture of the proportionate flows. Despite this drawback, however, the latter figures are better suited than those of Table A3 for the derivation of interdependence coefficients.

The technical coefficients in both those tables are obtained by dividing each entry in Quadrants I and III of tables A1 and A2 by the total of the column in which the entry is recorded. For example every entry in the cattle columns of table A3 or A4 is obtained by dividing the entries in Tables A1 and A2 respectively by 88,109 which is the total domestic flow (and input) of cattle. The entries in the other columns are obtained in a similar manner. Some of the more important technical relationships which can be derived from Table A3 are summarised below.

Distribution of Inputs to the Dfferent Sectors

The distribution of the different inputs to the livestock sectors are shown in Table 2.

Cattle

Reference to the first column of Table 2 shows that 19 per cent. of the total inputs to the cattle sector consisted of unpurchased feed from the other farming sectors. The biggest single item of this feed was pasture which accounted for about 8 per cent. of total inputs followed closely by conserved grass accounting for about 6 per cent. and skim and whole milk for 4 per cent. of inputs. The value of all kinds of feed per £100 cattle inputs was £22.

Every £100 of cattle output required other inter-industry inputs of £29, made up of calves valued at £19 and old cows valued at £10. Rates and other cattle expenses accounted for 7 per cent. of inputs leaving 42 per cent. available for the remuneration of labour, capital and management (income arising).

Dairying

The second column of Table 2 shows that the inputs to the dairying sector were distributed as follows:

Ten per cent. came from the crop sectors in the form of unpurchased feed, pasture and hay being the biggest single items at 4 and 3 per cent. of total inputs respectively. Three per cent. of inputs went for purchased feed and 16 per cent. went to the cattle sector for the purchase of heifers in calf. Rates and other expenses accounted for 5 per cent. leaving 67 per cent. available for the remuneration of labour, management and interest on capital.

TABLE 2: DISTRIBUTION OF INPUTS TO THE LIVESTOCK AND LIVESTOCK PRODUCTS SECTORS

Item	Cattle	Dairying	Sheep and Wool	Pigs	Poultry and Eggs	Horses*
	Per cent. of total inputs					
Unpurchased feed ..	19	10	20	9	13	23
Purchased feed	3	3	†	55	32	4
Other inter-industry ..	29	16	—	—	1	—
Rates and other expenses	7	5	8	9	5	10
Income arising	42	67	71	27	49	63
Total Inputs=Output ..	100	100	100	100	100	100

*Agricultural horses only.
†Less than 0·5 per cent.

TABLE 3: DISTRIBUTION OF DIFFERENT CROP INPUTS

Item	Grain crops	Root and green crops	Conserved grass	Pasture	Other crops†
	Percent of total inputs				
Seeds	8	5	4	3	2
Fertilisers and Lime*	10	11	20	45	2
Rates and Other Expenses	32	35	69	39	5
Income arising	50	49	7	13	91
Total input=output	100·0	100·0	100·0	100·0	100·0

*Net of subsidies.
†Including peat produced by farmers.

Other Livestock Sectors

The figures for the other livestock sectors have similar meanings. As a general point it should be noted that income arising as a proportion of total output is lowest for pigs and highest for sheep and wool. Feed as a proportion of total inputs is highest for pigs and lowest for dairying.

Crops

The distribution of the crop inputs is shown in Table 3. Some of the figures in this table tend to be confusing unless certain points are kept in mind. As stated above, the pasture sector is completely artificial and for this reason the figures for distribution of pasture inputs must be taken with caution. The high figure for expenditure on fertiliser does not mean that each acre of pasture received more fertiliser than each crop acre, which it did not. It means that fertiliser was the main item of expenditure on pasture, accounting for 45 per cent. of the total. Actually the average expenditure on fertilisers and lime for pasture in 1964 is estimated at only about £0·7 per acre. This includes the value of fertiliser applied to pasture from which silage was taken. Of the other pasture inputs, rates and other expenses accounted for about 40 per cent. of the total, seeds for about 3 per cent. and income arising for the remaining 13 per cent. As explained previously the latter item is the rent element in the land annuities allocated to pasture. The figures for conserved grass should be interpreted in the same way as those for pasture. The high figure for income arising in the "other crop" sector is due to the inclusion here of turf (peat) for which expenses other than labour are very low.

Industrial Sectors

The proportional distribution of inputs to the industrial sectors are summarised in Table 4. As can be seen from the first column, cattle accounted for 35 per cent, sheep for 14 per cent. and pigs for 31 per cent. of the inputs to the animal slaughtering industry. Other expenses accounted for 11 per cent. of inputs, income arising making up to 9 per cent. of the total. Subsidies accounted for 2 per cent. of the inputs to animal slaughtering. As explained above these were not the total subsidies paid on cattle and pigs. Other subsidies were paid directly to farmers (i.e. those under the BTE scheme) while others were paid to the Pigs and Bacon Commission for the purpose of subsidising bacon exports.

Seventy-nine per cent. of the total inputs to the milk processing sector came from dairying. Other expenses accounted for 18 per cent., income arising made up 9 per cent. while production subsidies paid to creameries accounted for 13 per cent. of inputs.

Of the inputs to the grain milling and animal feeding stuffs industry 64 per cent consisted of grain crops over $\frac{1}{3}$ of which were imported. Other expenses made up 20 per cent. and income arising 12 per cent. of inputs. Of the inputs to the other intermediate industries, other expenses and income arising accounted for about $\frac{1}{3}$ each while about $\frac{1}{10}$ came from crops and $\frac{1}{4}$ from inter-industry sales.

TABLE 4: DISTRIBUTION OF INPUTS TO INDUSTRIAL SECTORS

	Animal Slaughtering	Milk Processing	Grain Milling	Other Intermediate
	per cent. of total inputs			
Cattle	35	—	—	—
Dairying	—	79	—	—
Sheep and Wool	14	—	—	—
Pigs	31	—	—	—
Other livestock	1	—	—	1
Crops	—	*	64	9
Other Intermediate	—	8	4	24
Other Expenses	11	18	20	34
Subsidies	−2	−13	*	—
Income Arising	9	9	12	31
Total Inputs = Output	100·0	100·0	100·0	100·0

*Less than 0·5 per cent.

(I—A) Matrix

The (I — A) matrix is obtained from the matrix of technical co-efficients by subtracting the diagonal elements of the latter from 1·0 and multiplying all the other elements by —1·0. Since the (I — A) matrix is not of any great interest in itself it is not shown in this paper.

Interdependence Co-efficients—$(I—A)^{-1}$ Matrix

The interdependence coefficients are shown in Table A5. These have been calculated from the adjusted technical co-efficients in Table A4 by first constructing an (I — A) matrix from the latter table and then inverting this matrix on a computer.* Table A5 allows many interpretations which are valuable for policies and decisions relating to Irish agriculture but in a single publication of this kind it is impossible to discuss all of them. Here we will concern ourselves with a few of the more important interpretations which can be made.

*This inversion was made on the computer in An Foras Talúntais with the kind permission of the Director.

INPUT-OUTPUT RELATIONSHIPS BETWEEN AND AMONG THE VARIOUS SECTORS INCLUDED IN THE MODEL

"Income Multipliers"

The "income multiplier" of a sector is the amount by which the income of an economy is increased as a result of a one unit increase in the final demand for the products of that sector with no increase in the final demand for the products of any other sector. The latter assumption is rather stringent because all sectors are not completely independent and it is unrealistic to have an increase in the demand for the products of some sectors without at the same time increasing the demand for those of others. However, where a marginal change in the final demand for a sector is involved the specification of zero increase in the final demands of other sectors is not invalidating if it is kept in mind that the "income multiplier" resulting from a marginal change may not be valid for substantial changes.

"Income multipliers" for a number of sectors resulting from marginal increases in final demands are given in Table 5. These results have been derived from the larger model discussed above.

Taking first the sector concerned, it can be seen from Table 5 that dairying and sheep give producers the highest income increases per unit of final demand while the lowest income increases come from unitary changes in the milk processing and animal slaughtering sectors.

A one unit increase in the final demand for liquid milk increases the income of dairy farmers by 1·078 while a similar rise in the exports of sheep and wool increases the income of that sector by 0·943 units. On the other hand, a unit increase in the final demand for milk processing only increases the income accruing to this sector by 0·088 units. This low return is to be expected since most of the milk processing is done by the co-operative creameries which by definition are non-profit making. The low return to the animal slaughtering sectors is not so easily explained but the technical co-efficients for the large model show that income arising forms a rather low proportion of output in all the industrial food sectors. The small technical coefficients for income arising in the food industries do not mean, of course, that these industries are unprofitable. Although these processors obtain low average returns per unit of output they probably make reasonable profits because of relatively rapid turnovers. On the other hand, though most of the purely farming sectors have high technical co-efficients for income arising, the absolute level of income of many producers is low because they have little produce to sell.

TABLE 5: INCOME EFFECTS OF UNIT INCREASES IN FINAL DEMANDS FOR THE PRODUCTS OF CERTAIN SECTORS WITH NO INCREASE IN THOSE OF OTHER SECTORS

Sector	Increase in Income of		
	Sector Concerned	All Farming Sectors	All Sectors in Model
Cattle	0·423	0·488	0·492
Dairying	1·078	1·248	1·254
Sheep and Wool	0·943	0·990	0·990
Pigs	0·271	0·526	0·593
Poultry and Eggs	0·497	0·692	0·731
Wheat	0·667	0·646	0·646
Oats	0·394	0·394	0·394
Barley and Other	0·527	0·527	0·527
Potatoes	0·601	0·601	0·601
Sugar Beet	0·607	0·620	0·620
Cattle Slaughtering	0·103	0·464	0·570
Pig Slaughtering	0·100	0·429	0·585
Other Slaughtering	0·093	1·043	1·136
Milk Processing	0·088	1·008	1·119
Flour Milling	0·136	0·396	0·514
Animal Feed	0·115	0·419	0·542
Sugar Refining	0·195	0·366	0·561
Brewing Malt etc.	0·525	0·072	0·598
Food Processing	0·253	0·155	0·459
Fellmongery and Tanning	0·237	0·000	0·237

Though the return to milk processors for a unit increase in the final demand for milk products is low the return to all the farming sectors from such an increase is high, i.e. 1·008. This return is, of course, highly influenced by state policy in relation to milk production. In 1964 the average price received by farmers for manufacturing milk (with skim returned) was 22·12d. per gallon, the total exchequer payment on this being about £8 million[5] or 5·1d. per gallon. Hence if the milk subsidy were removed with other things remaining constant the income of dairy farmers would be reduced considerably. Even at unsubsidised prices, however, milk production in 1964 would on average be more profitable to farmers than unsubsidised cattle rearing.

The benefit to the country from home slaughtering of cattle, sheep and pigs as compared with live exports can be determined from Table 5 also. As can be seen a unit increase in final demand for the products of the cattle sector (i.e. live exports) increases the income of all sectors in the model by 0·492 units. A unit increase in cattle slaughter on the other hand increases the income arising in all sectors by 0·570. There is, therefore, some gain to the economy from home slaughtering compared with live exports of cattle though not as much as might be expected.

Looking at the sheep sector we see that a unit increase in the final demand for sheep and wool (i.e. exports of live sheep and wool) increases the income of all sectors in the model by 0·990 units. On the other hand, a unit increase in sheep slaughtering (i.e. other slaughter) increases the income of all sectors in the model by about 1·136 units and indicates a fairly reasonable gain from home slaughter of sheep as compared with live exports.

In the case of pigs it would appear that live exports are superior to home slaughter but this is not necessarily so for any substantial numbers. Live pig exports form a very tiny fraction of total production so that no firm conclusion can be drawn from the "income multiplier" of the pig sector.

Import Content of Different Sectors

The import requirements of £1 final demand for the products of different sectors are shown in Table 6. These are the total requirements and include indirect as well as direct imports. Thus the figure for the cattle sector includes not only the live cattle imports but also the imported fertiliser used in producing home grown cattle feed and so on. The figures in Table 6 were prepared from the large model (unadjusted for joint products) as follows:

The competitive imports of all sectors were transferred to the inter-industry quadrant and each expressed as a fraction of its own sectoral output. An inverse matrix was then developed which incorporated these import co-efficients in the diagonal elements. All imports for each sector (i.e. competitive and non-competitive) were then totalled and each total expressed as a fraction of its own sectoral output also. These fractions were then multiplied by the corresponding column of the adjusted inverse matrix to obtain the required results.

TABLE 6: IMPORT AND NON-CAPITAL SUBSIDY REQUIREMENTS PER £1 FINAL DEMAND FOR THE PRODUCTS OF DIFFERENT SECTORS

Sector	Import requirements	Non-Capital subsidies
Farming Sectors		
Cattle	0·144	0·035
Dairying	0·104	0·064
Sheep and Wool	0·182	0·047
Pigs	0·275	0·029
Poultry and Eggs	0·196	0·020
Horses	0·406	0·032
Wheat	0·447	0·026
Oats	0·271	0·062
Barley and other Feed grains	0·338	0·044
Sugar beet	0·116	0·045
Potatoes	0·079	0·021
All farming sectors	0·149	0·039
Industrial Sectors		
Cattle slaughter	0·148	0·097
Pig slaughter	0·235	0·083*
Other slaughter	0·184	0·050
Milk processing	0·117	0·241*
Flour milling	0·272	0·012
Animal Feed	0·435	0·048
Sugar refining	0·265	0·017
Brewing, malting, distilling	0·207	0·006
Food processing	0·363	0·013
Fellmongery and Tanning	0·291	—
Leather footwear	0·204	—
All industrial sectors	0·231	0·076
All sectors in model	0·205	0·064

*Includes Export Subsidy.

As can be seen from Table 6 the farming sectors requiring the highest proportion of imports were wheat, horses, barley and other feed grains. The high figure for wheat occurs because in preparing the model, imports of bread wheat were included in the wheat rather than in the flour milling row. The farming sectors requiring the lowest proportion of imports were potatoes, dairying and sugar beet. The import requirements for these crops were mainly fertilisers and fuel oil. Those for dairying were mainly imported feeds together with the import requirements of home grown feed consumed by cows. As might be expected the industrial sectors which rely heavily on home produced raw materials have similar import patterns to the supplying sectors. The industrial sectors requiring the highest level of imports were animal feed, food processing, fellmongery and tanning and flour milling. Those having the lowest import requirements are milk processing, cattle slaughter and other slaughter.

[5]Report of the two-tier milk price study group. Pr. 9639. P. 57. Stationery Office, Dublin, January, 1967.

The Relationship between Unitary Increases in Final Demands and Non-Capital Subsidies

The cost to the state in non-capital subsidies for each one unit increase in the final demand for the products of the different farming sectors is shown in Table 6 also. These subsidies include price supports, fertiliser and lime subsidies, T.B. eradication and calved-heifer subsidy and the subsidy under the land acts. Export subsidies on dairy products and pig meat are also included.

As can be seen from Table 6 subsidy elements appear in all the sectors shown even though most of the sectors do not receive any direct subsidy. These results are due to indirect effects. For example, the subsidy element in the horses sector is made up of the fertiliser and land act subsidy elements in the home grown feed consumed by horses. The subsidy element in the root crop sectors is also the fertiliser and land act subsidies distributed to these crops, and so on for all sectors using home grown crops.

The subsidy element appearing in the milk processing sectors requires some explanation also. In 1964, this sector received a subsidy of £0·241 for every £1 of final demand for milk products, whereas the dairying sector received only £0·064 for every £1 of final demand for its products. This apparent anomaly arises because of the way in which the various subsidies were treated in preparing the model. The subsidy in the milk processing sector includes most of the milk price subsidy which has been adjusted to include the export subsidy paid to Bord Bainne. The subsidy element appearing in the dairying sector includes only a small proportion of the milk price subsidy. The main items in this sector are the shares of the calved heifer subsidy, and the BTE payments on reactor cows together with the proportions of the fertiliser, lime and land act subsidies in the feed consumed by dairy cows.

The subsidy payment on pigs and pig slaughtering can be interpreted in a similar manner. That appearing in the pig slaughtering sector includes most of the subsidy payment on bacon exports whereas none of the latter item is included directly in the subsidy element appearing in the pig sector. The main items included in the latter are the fertiliser, lime and land act subsidy on home grown feed consumed by pigs exported alive or going into stocks.

The subsidy elements on both the cattle and cattle slaughtering sectors at £0·035 and £0·097 are relatively low compared with those in the milk processing sector where £1 final demand for milk products requires a subsidy of about £0·24. These figures would seem to indicate that we could save some of the exchequer payments by concentrating on cattle rather than on milk production. This, of course, would only be true if farmers were prepared to produce beef by single or multiple suckling. As matters stand, however, they are unwilling to do this on any large scale. As practised in Ireland cattle production and dairying are complementary enterprises. Any increase in the production of cattle requires extra cows and these produce extra milk which must be sold at subsidised prices. For this reason it is interesting to estimate the subsidy requirements of a unit increase in the final demand for cattle and dairying combined. This in effect tells us the subsidy requirements of a unit increase in the exports of these products since the home market can absorb very little extra in the way of dairy products or beef.

To determine the consequential increase in milk processing for some given increase in live cattle exports with no change in the final demands for sectors other than live cattle or milk processing we turn to the table of interdependence co-efficients (Table A5) and derive the following equations from rows 1 and 2:

$$(1)\qquad \begin{aligned} 1{\cdot}0066Y_1 + 0{\cdot}2074Y_{16} &= X_1 \\ 0{\cdot}0373Y_1 + 1{\cdot}2659Y_{16} &= X_2 \end{aligned}$$

where Y_1 = the net increase in live cattle exports (i.e. exports less imports)

Y_{16} = the consequential increase in final demand for milk processing

and X_1 and X_2 are the increases in outputs of cattle and dairying respectively.

Taking the technical co-efficients in row 3 of Table A4 and assuming that an increase in the demand for cattle and milk has no effect on the output of pigs, poultry and other intermediate industries we derive the following additional relationship:

$$(2)\qquad 0{\cdot}3103X_1 - 0{\cdot}3708X_2 \geqq 0$$

The relationship derives from the fact that row 3 of Table A4 represents an artificial sector whose output is zero. Changing the approximate sign in (2) into a sign of equality and solving the system we obtain the following result:

$$(3)\qquad Y_{16} = 0{\cdot}735Y_1$$

which means that if the demand for other sectors remains constant each unit increase in the final demand for live cattle is associated with an increase of approximately 0·735 units in the final demand for milk products. From this, together with the relevant figures in Table 6, it is readily calculated that a unit increase in the final demand for live cattle and dairy products combined requires non-capital subsidies to the extent of 0·106 units, i.e.,

$$\left[\frac{(0{\cdot}735 \times 0{\cdot}241) + 0.035}{2}\right] = 0{\cdot}106$$

The position in this respect has altered considerably since 1964. The milk subsidy per gallon almost doubled between 1964 and 1967 and there have also been increases in the subsidy on beef exports. Hence in order to make up-to-date assessments of the present subsidy position it would be necessary to alter the technical co-efficients to allow for the recent changes.

Price Increases Required to bring about a Given Change in the Income Arising in Different Sectors

The producer price increases required to bring about a 10 per cent increase in the income arising in all the sectors of the model (with no change in production or technology) are shown in Table 7. The figures in this table were calculated using the method suggested by Geary and Pratschke.[6]

This table shows that if farmers' incomes were to increase by 10 per cent with no change in the quantity or pattern of production, milk prices would need to increase by 12·7 per cent, those of sheep and wool by 10·3 per cent, those of other crops by 9·2 per cent, those for poultry, eggs and horses by about 7 per cent while those for the other farm products would need to rise by between 5 and 6 per cent. The average increase for all the farming sectors would be 7·7 per cent, which figure is obtained by weighting the various farm price increases by the corresponding values of sales (commodity flows) of the different farming sectors and averaging the results. The average figure for all farming sectors indicates that with no change in production patterns or import prices an increase of about 8 per cent in the agricultural price index would be necessary to bring about an increase of 10 per cent in farmers' incomes. This income increase would raise the wholesale price of all foods by 7 per cent as indicated by the figure opposite "all sectors in the model" in Table 7. The weights used in obtaining the latter average were the values for personal consumption in the model.

TABLE 7: PRODUCER PRICE CHANGES REQUIRED TO BRING ABOUT A 10 PER CENT INCREASE IN THE INCOME ARISING IN DIFFERENT SECTORS

Sector	Price Increase
Farming Sectors	%
Cattle	5·45
Dairying	12·7
Sheep and Wool	10·3
Pigs	5·8
Poultry and Eggs	7·3
Horses	7·2
Grain Crops	5·5
Roots and Green Crops	5·2
Other Crops	9·2
All Farming Sectors	7·7
Industrial Sectors	
Animal Slaughtering	6·7
Milk Processing	11·3
Flour Milling and Animal Feed	5·1
Other Intermediate	4·8
All Industrial Sectors	6·4
All sectors in Model	7·0

[6]Geary, R. C. and Pratschke, J. L.—Some Aspects of Price Inflation in Ireland—ESRI Paper No. 40, pp. 23-27, Jan. 1968.

Appendices

APPENDIX B

Allocation of inputs among the different farming sectors

The problems which arise in allocating inputs among different industrial sectors are well known to students of "input-output" and it is not proposed to deal with them here. Those which arise in allocating inputs among the purely farming sectors are, however, not so well known and it is proposed to describe in this Appendix the procedure adopted by the authors. No claim is made that this was the best method of approach.

Allocation of feed among the different livestock sectors

The allocation of feed among the different livestock sectors is probably the most difficult and time-consuming operation in preparing an agricultural input-output table and many of the divisions are of necessity arbitrary. Consequently other workers could obtain substantially different results. In preparing the figures under review the different classes of cattle, sheep and horses in June 1964 were listed and assumptions were made as to the quantities of feed which each of these categories of animal consumed during the seven months, April to October inclusive. These amounts, which are based on technical data from various sources, are given in Table B1.[7] In specifying the livestock categories it

[7]See in particular Sheehy, E. J. Animal Nutritions. Macmillan. London 1955.

TABLE B1: FEED UTILISATION (1964) (BARLEY EQUIVALENT)

Item	On farms June 1964	Summer Feed April-Oct		On farms January 1964–65	Winter Feed Nov-March		Total Feed
		Per head	Total (*a*)		Per head	Total (*a*)	
	000	tons	000 tons	000	tons	000 tons	000 tons
Dairying (cows and bulls) ..	1,291	1·61	2,076·9	1,221	0·90	1,106·1	3,183·0
Cattle:							
Cows and bulls ..	129	1·49	191·8	136	0·76	103·2	295·0
Heifers in calf ..	202	1·49	301·0	294	0·76	223·7	524·7
3 years and over ..	201	1·49	299·5	} 2,793	0·59	1,637·1	4,809·3
2—3 years	792	1·49	1,180·0				
1—2 years	1,120	1·06	1,187·2				
0—1 years	1,233	0·41	505·5				
Total Cattle	3,677	—	3,665·0	3,223	—	1,964·0	5,629·0
Sheep:							
Ewes	2,200	0·26	571·3	2,295	0·18	408·4	979·7
Lambs	2,206	0·09	207·6	—	—	—	207·6
Other Sheep ..	544	0·25	136·1	1,126	0·18	201·0	337·1
Total Sheep	4,949	—	915·0	3,421	—	609·4	1,524·4
Horses	180	1·02	184·2	180(*b*)	0·68	121·8	306·0
Total Grazing Livestock	—	—	6,841·1	—	—	3,801·3	10,642·4
Pigs:							
Output 1964 ..	1,692	0·40	—	—	—	—	677·0
Stock Changes ..	145	0·21	—	—	—	—	30·0
Total Pigs	—	—	—	—	—	—	707·0
Total Poultry (June) ..	11,626	0·03	—	—	—	—	334·0
Total all stock	—	—	—	—	—	—	11,683·4

(*a*) Because of rounding errors totals do not always check with numbers of animals and amounts consumed.
(*b*) Number of horses in January estimated.

was decided that cows suckling calves and a corresponding proportion of the bulls should be included in the cattle sector, the remainder of the cows and bulls being included in the dairying sector. In order to determine the amount of feed consumed for the months of November to March averages of the number of the different classes of grazing livestock in the State in January 1964 and 1965 were averaged and assumptions were made as to the amount of feed consumed by each of these classes in this period.

Feed consumption by dairy cows formed the basis for the average consumption by different classes of other grazing stock. It was assumed that each dairy cow in June required about 10 lb. of barley equivalent (B.E.) per day for maintenance and 4 lb. for each gallon of milk. On the basis of creamery statistics and other returns it was estimated that about 73 per cent of the total milk supply other than milk suckled (641·2 m. gals.) was produced in the April to October period by the June cows, the remaining 27 per cent being produced in the November to March period by the January cows. On the basis of these figures it was estimated that each dairy cow in June consumed 1·61 tons of B.E. and that each January cow consumed 0·90 tons. All bulls were taken to consume the same amounts of feed as dairy cows. The total consumption by dairy cows and bulls as shown in Table B1 was 3,183 thousand tons B.E.

Cows suckling calves were assumed to consume somewhat less feed during the summer than dairy cows. The 1·49 tons allocated to them for the summer period was sufficient for the production of 300 gals. per cow leaving 11 lb. of B.E. per day for maintenance and a slight weight gain. These cows were allocated 0·76 tons of B.E. for the winter period which was also sufficient for maintenance and a very slight weight gain. All other cattle 2 years old and over were assumed to consume the same amounts of feed as cows suckling calves. Cattle 1–2 years and 0–1 years were assumed to consume about $\frac{3}{4}$ and $\frac{1}{2}$ of this amount respectively. These proportions are based on conventional figures for livestock unit equivalents.

The feed requirements for sheep are based on data compiled by the writer in connection with another study,[8] with adjustments made for mountain sheep on the basis of figures for breeds of ewes collected at the 1964 enumeration of crops and livestock. In estimating the feed requirements for horses it was assumed that consumption by full sized horses was similar to that for cows suckling calves. This consumption was adjusted downwards to take account of estimated numbers of ponies and young horses on the basis of the proportion of these animals in the State as determined at the June enumerations in past years.

Feed consumption by pigs is based on the output of pigs in 1964 allowing about 8·0 cwt. of B.E. per pig. This includes a share for the sow's and boar's feed. There was an increase of 145,000 in pig stocks between January 1964 and January 1965 and an allowance of 4 cwt. of B.E. per pig has been included for these. The allowance made for poultry has been built up using rather arbitrary figures for consumption by the different classes of fowl on farms in June and by the 6·5 million broilers produced during the year. An average of about 11 lb. of feed per broiler was allowed.

Allocation of the various feeds to the different sectors

Having determined the overall feed requirements of each sector the next exercise was to allocate the different available feeds to these sectors. Figures for the availability of all feeds in the State other than pasture are compiled annually in the Central Statistics Office. The basic data used in preparing these availabilities were kindly made available by the Director of that office. Estimates are made annually in the Department of Agriculture and Fisheries of the amounts of the different cereals fed to various classes of stock and these data were kindly made available also. The above information together with published and unpublished data kindly supplied by An Foras Talúntais enabled what appeared to be a reasonable allocation of the different feeds other than pasture. The latter was included as a residual item for the grazing stock. Figures for the allocations are given in Table B2. As can be seen the total feed supplied by pasture, hay and silage was 9,469,000 tons B.E. It was estimated on the basis of feed requirements by mountain sheep that some 242,000 tons of B.E. were produced on the 3,000,000 acres of rough grazing in the State hence 9,227,000 tons of B.E. were produced from the 10·079 million acres of hay and pasture or an average of 18·3 cwts. of B.E. per acre. This compares with a figure of 19·4 (i.e. 14 cwts. of S.E.) prepared by OEEC for the year 1951–52 and which has been quoted widely.[9],[10] No indication is given as to how the latter figure was arrived at and so there is no way of checking it out. As a matter of interest, however, the writers, using exactly the same conventions as for 1964, have estimated that the output per acre from grassland was 16·5 cwts. of B.E. (11·9 cwts. S.E.) in 1952. Though the absolute level of this figure and also of

[8]O'Connor, R. Economic Utilisation of Grassland—Journal of the Statistical and Social Inquiry Society of Ireland. Vol. XX, Part III, 1959/60.

[9]Economic Development, p. 62. Pr. 4803, Stationery Office, Dublin. November 1958.

[10]Neenan, M. et. al. The Output of Irish Pastures. Journal British Grassland Society, Vol. XIV, No. 2, 1959.

TABLE B2: ALLOCATION OF FEED TO DIFFERENT ENTERPRISES (1964)

Item	Unit	Price	Cattle	Dairying	Sheep	Pigs	Poultry	Horses	Total	Cattle	Dairying	Sheep	Pigs	Poultry	Horses	Total
			Quantity (000 tons)							Value (£000)						
Unsold Feed:																
Wheat	as such	12·05	6·4			8·0	7·0		21·4	77·1			96·4	84·4		257·9
Oats	,,	6·73	24·2	45·0	12·0		96·0	39·7	216·9	162·9	302·9	80·8		646·1	267·2	1,459·9
Barley	,,	10·43	41·0	37·0	4·0	12·0	28·0		122·0	427·6	385·9	41·7	125·2	292·0		1,272·4
Whole Milk o/t suckled ..	BE	17·73	113·0						113·0	2,003·3						2,003·3
Skim Milk	,,	17·73	96·0			60·0	6·0		162·0	1,701·9			1,063·7	106·4		2,872·0
Potatoes	,,	14·96	5·0	3·2		70·0	53·8		132·0	74·8	47·9		1,047·2	804·8		1,974·7
Feed Roots	,,	7·62	54·7	162·0	100·2	41·8		4·0	362·7	407·4	1,272·7	748·0	305·5		30·0	2,763·6
Sugar Beet Tops (*a*) ..	,,	6·58	11·0	23·0	11·0				45·0	72·4	151·3	72·4				296·1
Other Crops (*b*)	,,	—	27·4	56·1	5·0			3·0	91·5	154·6	387·6	37·1			26·2	605·5
Conserved Grass	,,	5·40	935·0	507·0	23·0			44·0	1,509·0	5,056·9	2,741·5	123·1			235·4	8,156·9
Pasture	,,	1·59	4,191·1	2,223·9	1,353·8			176·0	7,944·8	6,695·3	3,552·6	2,100·5			284·3	12,632·7
Total Unsold Feed ..			5,504·8	3,057·2	1,509·0	191·8	190·8	266·7	10,720·3	16,834·2	8,842·4	3,203·6	2,638·0	1,933·7	843·1	34,295·0
Purchased Feed:																
Oats	as such	21·2561						20·3	20·3						431·5	431·5
Conserved Grass	BE	14·36						15·0	15·0						214·7	214·7
Oats, Ground and Crushed	as such	26·92	6·6						6·6	177·6						177·6
Barley	,,	27·62	14·0	13·0	1·0	10·0	9·0		47·0	386·7	359·1	27·6	276·0	246·0		1,295·4
Maize Meal	,,	31·58	5·7	10·0		12·0	14·0	2·0	43·7	180·0	316·0		379·0	442·0	63·1	1,380·1
Compounds—Pig	,,	30·8291	5·0			454·5	5·0		464·5	154·0			13,998·6	154·0		14,306·6
—Poultry ..	,,	34·92					105·2		105·2					3,673·6		3,673·6
—Cattle ..	,,	32·64	24·0	29·4					53·4	783·4	959·6					1,743·0
—Other ..	,,	32·64					0·7		0·7					22·9		22·9
Maize Meal Mixture ..	,,	29·8	3·3			14·0	3·3		20·6	98·3			416·5	98·3		613·1
Bran and Pollard	,,	21·661	14·9	21·4		19·7	6·0		62·0	322·7	463·5		426·8	130·0		1,343·0
Beet Pulp (wet and dry) ..	BE	14·77	43·8	27·0	14·0	5·0			89·8	637·0	388·0	221·0	80·0			1,326·0
Other Concentrates ..	as such		1·0						1·0	66·7	28·4	14·7	4·2		3·2	117·2
Oil Seed Cakes	,,	37·34	5·9	6·0				2·0	13·9	220·3	224·0				74·7	519·0
Malt Grains	BE	9·14		19·0					19·0		173·6					173·6
Total Purchased Feed ..			124·2	125·8	15·0	515·2	143·2	39·3	962·7	3,026·7	2,912·2	263·3	15,581·1	4,766·8	787·2	27,337·3
Total All Feed			5,629·0	3,183·0	1,524·0	707·0	334·0	306·0	11,683·0	19,860·9	11,754·6	3,466·9	18,219·1	6,700·5	1,630·3	61,632·3
Purchased Feed at Retail Prices										3,605·5	3,400·0	382·2	16,586·7	5,008·8	760·6	29,789·3
Trade and Transport Margin										578·8	487·8	118·9	1,005·6	242·0	18·9	2,452·0

BE — Barley Equivalent.
(*a*) Sugar beet tops valued at same price per unit BE as fodder beet. (*b*) Includes straw. Prices not uniform for each crop.

the corresponding figure for 1964 may be in considerable error the trend should be reasonably correct indicating very little increase in total grassland production over the years despite increased fertiliser use. The only rational explanation of this is that while much of our grassland is now producing more than it was in 1952 a considerable portion is producing much less. This is not an unreasonable conclusion since in certain parts of the country large tracts of land which in the early post-war years were reasonably well grazed are now almost derelict. The results of the 1965 Census of Agriculture showed that in that year only about one quarter of the total hay and pasture in the State received fertilisers. A Foras Talúntais survey in 1964[11] showed a somewhat higher proportion of the grassland being fertilised but as there was an upward bias in the sample studied the figure of one quarter may not be too far out.

Valuation of livestock feed

Having determined the amounts of the various feeds consumed by different classes of livestock the next exercise was to value this feed. The principles of valuation adopted were as follows:

(*a*) Imported items going directly to farms without processing were valued at import (c.i.f.) prices. There was very little of such feed used since practically all imported feed goes through some form of processing before being sold to farmers. It was possible to isolate the small amounts involved from CSO records.

(*b*) Purchased home-grown feed which does not go through any form of processing was valued at agricultural output prices. The amount of this feed was small also and could be estimated from CSO data.

(*c*) Purchased feed whether home-grown or imported which went through some form of processing was valued at prices received by the millers or manufacturers. The amounts and values of such feed were also available in the CSO.

(*d*) Home-grown unsold feed was valued at cost of production prices. The amount of this feed was estimated as a residual by deducting purchased home-grown feed from estimated total supplies.

The method of determining the cost of production of the different feeds is shown in Table B3. In preparing this table the various agricultural expenses published in the June 1967 issue of the Irish Statistical Bulletin were first allocated as between all livestock and all crop sectors. The separate allocations were then broken down as between the different crops and livestock enterprises. The allocation of expenses as between livestock and crops was fairly arbitrary though all available information from Irish farm surveys and from the British Ministry of Agriculture farm management bulletins was used.[12], [13], [14] These sources were also used in allocating expenses as between the different crops and livestock. Some idea of the way in which the expenses were allocated is given below. The allocation of the livestock expenses is shown in Table B4.

Rates

Separate estimates are available in the CSO for the gross rates assessed on land and on farm buildings. After making allowance for the agricultural grant all the rates on buildings were charged to livestock and those on land were allocated to crops and grass on an acreage basis. The rates on buildings were allocated among the cattle, horses, pigs and poultry on a livestock unit basis. None were charged to sheep.

Land Annuities

All land annuities were charged to land—none to buildings—and were distributed to the different crops on the basis of acreage.

Machinery Expenses

These expenses which include repairs, fuel oil and depreciation were arbitrarily allocated between crops and livestock with the major proportion going to crops. The crop expenses were allocated as between the different crops on the basis of British figures[15] for per acre tractor requirements.

Transport and Marketing

These expenses were allocated to the different crops and livestock in proportion to the value of the gross output of each sector sold. As transport and marketing expenses do not enter into the cost of unsold feed these expenses were omitted in calculating the unit costs of the latter. They have, however, been included in Table B3 as they are one of the elements of total expenses in the main Transactions Table.

Other Expenses

These include veterinary expenses, farm share of family car, farm share of electricity, small tools, etc. Veterinary expenses and farm share of electricity were allocated entirely to livestock as was most of

[11]Murphy, W. E. and Attwood, E. A. Fertiliser Use Survey, An Foras Talúntais, June 1966.

[12]National Farm Survey 1955–58. Final Report. Pr. 6180. Stationery Office, Dublin, 1961.

[13]An Foras Talúntais—Farm Survey Results—Unpublished.

[14]The Farm as a Business, HMSO London, 1958.

[15]*ibid.*

TABLE B3: ALLOCATION OF OTHER EXPENSES OF AGRICULTURE AMONG THE DIFFERENT CROP ENTERPRISES AND ESTIMATION OF PRODUCTION COSTS (1964)

(£000)

Item	Total	Wheat	Oats	Barley	Sugar Beet	Potatoes	Feed Roots	Conserved Grass	Pasture	Other Crops inc. peat	Total Crops	Total Livestock
Rates	7,188	112·3	151·1	237·2	41·8	95·4	79·1	1,028·3	4,476·9	45·9	6,268·0	920·0
Land Annuities	2,250	40·3	54·2	85·1	15·0	34·2	28·3	369·2	1,607·3	16·4	2,250·0	—
Total Rates and Land Annuities	9,438	152·6	205·3	322·3	56·8	129·6	107·4	1,397·5	6,084·2	62·3	8,518·0	920·0
Repairs to Machinery, Spare parts, etc.	2,718	194·7	125·8	407·6	203·0	463·7	350·6	769·0	29·4	84·2	2,628·0	90·0
Petrol, Oil, Fuel	6,516	343·4	225·2	721·7	354·1	817·7	571·0	1,163·6	51·2	148·1	4,396·0	2,120·0
Depreciation of Machinery	8,840	600·0	419·9	1,285·6	587·9	1,427·7	1,033·0	2,698·5	83·1	262·3	8,398·0	442·0
Transport and Marketing	3,795	123·0	25·8	174·2	550·0	108·6	0·4	1·6	—	12·4	996·0	2,799·0
Other	7,515	133·7	26·2	168·7	135·5	64·1	1·2	6·4	54·0	48·3	638·1	6,876·9
Total other than Rates and Annuities	29,384	1,394·8	822·9	2,757·8	1,830·5	2,881·8	1,956·2	4,639·1	217·7	555·3	17,056·1	12,327·9
Seeds:												
Purchased	4,724	919·5	489·9	1,045·5	169·3	487·4	129·4	471·0	662·3	349·7	4,724·0	—
Unsold	744·2	—	72·3	30·1	—	628·4	—	12·9	—	0·5	744·2	—
Total Seeds	5,468·2	919·5	562·2	1,075·6	169·3	1,115·8	129·4	483·9	662·3	350·2	5,468·2	—
Fertilisers and Lime	11,930	554·6	406·6	1,108·7	951·4	653·5	601·9	1,708·4	5,668·5	276·4	11,930·0	—
Total Costs	56,220·2	3,021·5	1,997·0	5,264·4	3,008·0	4,780·7	2,794·9	8,228·9	12,632·7	12,44·2	42,972·3	13,247·9
Total costs less Transport and Marketing	—	2,898·5	1,971·2	5,090·9	—	4,672·1	2,794·5	8,227·3	12,632·7	—	—	—
Production less Waste (000 tons—BE)	—	240·6	292·7	487·9	879·0	312·3	366·7	1,524·0	7,944·8	—	—	—
Cost of Production less Transport and Marketing per ton £	—	12·05	6·73	10·43	—	14·96	7·62	5·40	1·59	—	—	—

TABLE B4: ALLOCATION OF "OTHER EXPENSES" AND FEED COSTS AMONG DIFFERENT LIVESTOCK ENTERPRISES (1964)

(£000)

Item	Total	Cattle	Dairying	Sheep and Wool	Pigs	Poultry	Horses
Rates	920·0	392·2	386·3	—	51·8	35·2	54·5
Land Annuities	—	—	—	—	—	—	—
Repairs to Machinery	90·0	45·0	25·0	—	15·0	5·0	—
Petrol, Fuel, Oil	2,120·0	1,025·6	564·4	240·8	168·8	68·8	51·6
Depreciation of Machinery	442·0	221·0	123·7	—	75·2	22·1	—
Transport and Marketing	2,799·0	1,044·3	848·0	269·2	433·9	144·5	59·1
Other	6,876·9	2,921·8	2,009·7	724·8	714·1	331·4	175·1
Total other Expenses	12,327·9	5,257·7	3,570·8	1,234·8	1,407·0	571·8	285·8
Unsold Feed	34,295·0	16,834·2	8,842·4	3,203·6	2,638·0	1,933·7	843·1
Purchased feed at Output Prices ..	27,337·3	3,026·7	2,912·2	263·3	15,581·1	4,766·8	787·2
Trade and Transport Margins on Purchased Feed	2,452·0	578·8	487·8	118·9	1,005·6	242·0	18·9
Purchased Feed at Retail Prices ..	29,789·3	3,605·5	3,400·0	382·2	16,586·7	5,008·8	806·1
Other Expenses plus T. &. T.M. ..	14,779·9	5,836·5	4,058·6	1,353·7	2,412·6	813·8	304·7
Total all Expenses	77,332·2	26,089·6	16,199·5	4,820·6	20,683·5	7,549·5	1,989·5

the farm share of family car. They were allocated among the different livestock on the basis of livestock units on farms in June. The remaining items were allocated to crops in an arbitrary manner depending on the items involved.

Seeds

In order to determine the input of seeds, the different crops in the state were listed and the amount of seed required for each was estimated. The seed comes from three sources (*a*) from imports, (*b*) from sales of home grown seeds by assemblers and merchants and (*c*) from unsold farm seeds. Figures for the quantity and value at retail prices of items (*a*) and (*b*) are calculated each year in the Central Statistics Office and the aggregate values are published annually in the Irish Statistical Bulletin. These values for the different crops in 1964 are given opposite purchased seeds in Table B3.

The amounts of unsold seeds were obtained by deducting purchased seeds from total requirements for each crop. These amounts were valued at estimated cost of production prices. The estimation of cost of production of seeds involves "circularity" since the cost of the unsold seeds is an element of the cost of the crop concerned. The costing had therefore to be done by successive approximations as follows. The costs other than those of unsold seeds and of transport and marketing expenses for each crop were first listed and an approximate value entered for unsold seeds. These costs were then totalled and the result divided by the total production less waste of the crop concerned to obtain the first estimate of the cost of production per unit. The unsold seed was then valued at this first estimate of cost and the value obtained entered in the second approximation and so on until a cost per unit of seed was obtained which was the same as that of the crop concerned. It was assumed that the cost per unit of producing the unsold seed was the same as that of producing the remainder of the crop.

The method of carrying out the successive approximations is explained algebraically below where:

Y = Total production less waste of crop concerned
Q = Quantity of unsold seed used
a = Total cost of producing the crop other than cost of unsold seed
C_1 = 1st arbitrary estimate of cost of production per unit
C_2 = 2nd derived estimate of cost per unit and
C_n = Final estimate of cost per unit.

Cost of production per unit

$$\text{1st approximation} = \frac{C_1Q + a}{Y} = C_2$$

$$\text{2nd approximation} = \frac{C_2Q + a}{Y} = C_3$$

$$n\text{th approximation} = \frac{C_nQ + a}{Y} = C_{n+1}$$

The desired result is obtained when C_n is approximately equal to C_{n+1}. If the first estimate of C is not

too wide of the mark a sufficiently good result is obtained after two or three approximations.

Cost of production per ton of unsold feed

The cost of production per ton of each unsold item of feed other than milk was obtained as shown in Table B3 by dividing total cost less transport and marketing expenses by the total production less waste of the crop concerned. These costs which are entered in the top section of the price column of Table B2 were used to value the unsold feeds in Table B2. Quantities and production costs for each item included in "other crops" were estimated and distributed separately to the different classes of livestock. Consequently an average figure for the combined cost of all these items is not given.

The cost of production of milk fed to farm animals was calculated in a similar manner to that for seeds. In making this calculation the total costs of the dairying sector (i.e. cost of purchased feed at retail prices, cost of unsold feed at cost of production prices and other expenses of dairying) were first apportioned between milk and cattle from the dairy herd on the basis of the output values of these items. The output value of the milk included the value of whole and skim milk fed to animals so that "circularity" was involved which necessitated successive approximations. After each iteration the cost attributed to the milk was divided by the barley equivalent of the total whole milk produced to obtain the cost of production per ton of B.E. This cost was then applied to the B.E. of whole and skim milk fed to obtain the total cost or output value of these and this value was used in the next iteration and so on until a final figure was obtained.

Fertilisers and Lime

The distribution of these to the different crops was based on the results of a fertiliser-use survey carried out by An Foras Talùntais in 1964.[16]

Trade and Transport Margins

As indicated above, purchased feeds in Table B2 were valued at output or import (cif) prices. These feeds were, however, purchased by farmers at higher retail prices. The retail values of purchased feed used by the different sectors are given in the second last row of Table B2. The total of this row except for rounding errors is the same as the 1964 figure for animal feed in Table 4 of the Agricultural Output Article in the June 1967 issue of the Irish Statistical Bulletin. When the values of feed at output prices used by the different sectors are deducted from those at retail prices the trade and transport margins shown in the last line of the table are obtained. Trade and transport margins for the different crop sectors were obtained in a similar manner by deducting the output values of home-grown seeds sold from the retail values which purchasers of such seeds paid to merchants. As indicated in the text these values were added on to other expenses so as to obtain the correct values for income arising in the different sectors.

[16]See footnote 11.

APPENDIX C

Secondary and Joint Products

The establishment or firm is the basic unit in the industrial statistics of most countries but, as is well known, many establishments produce more than one product. Usually one of the products is of primary importance and the others are secondary. For example cattle slaughtering plants produce beef, hides, fats and offals, beef being the primary product and the others being of secondary importance. Similarly, flour millers produce flour, bran, pollard and compound feeding-stuffs for animals, flour being primary and the others secondary.

Several classes of secondary products can be distinguished but strictly speaking only those classes of secondary products whose production is independent of the primary product should be referred to as secondary. Products which are the output of a single technical process fall into the category of joint products. Examples of secondary products are compound feeds produced by flour millers, grass meal produced by the sugar company, potato crisps produced by a tobacco company and so on. These products have separate input structures and the derivation of independent cost figures for them presents no conceptual difficulties. Examples of joint products are flour and bran, beef and hides, mutton and wool, malt and combings, etc. The general characteristics of these products is that they are the output of one production process and so share a common input structure. Consequently, they cannot be costed separately. Also the supply of one cannot usually be increased without a corresponding increase in the other. Hence they are produced in strict proportion.

Both secondary and joint products give rise to considerable difficulties in input-output analysis. The main problem is that the allocation to one sector of an establishment having several products impairs the principles of sector homogeneity and gives rise to misleading results when the table is used for analytic purposes. For example, since the cattle slaughtering industry produces beef and hides in more or less fixed proportions an increase in the consumption or exports of beef will lead to an increase in production and slaughtering of cattle and to the production of hides. An increase in the consumption of hides on the other hand does not automatically lead to an increase in the production of cattle or the consumption and export of beef, though this is what a conventional input-output table would show. Such a table would also show that if final demand for leather was postulated to increase by some given amount while that of meat was assumed to remain constant a certain quantity of meat would be routed to the tanning industry to supply the demand for hides. A similar thing could happen with mutton and wool or indeed with any other secondary or joint product.

A number of methods are available for dealing with problems of this kind depending on the nature of the products concerned. The most satisfactory solution which applies to all classes of secondary products (other than joint products) is to separate the inputs used in the production of the secondary products from those used in the production of the primary products and to rearrange in one sector all products of a given type regardless of where they have been produced. This procedure is known as redefinition and is always employed to a greater or lesser extent in preparing transactions tables. As indicated above, redefinition cannot be carried out in a satisfactory manner for joint products and for these other techniques have to be employed for separating them from one another. Such techniques can also be used for secondary products if sufficient data to enable redefinition are not available.

Artificial entries

If joint products are distributed to consuming sectors along the same row they are implicitly assumed to be the same product and in subsequent manipulations of the table they are treated as such, often with misleading consequences. If, however, they are distributed along different rows to the consuming sectors they will be treated as separate products in subsequent operations. Distribution along separate rows can be performed by the introduction of artificial entries to the original table as follows:

I. If the secondary or joint product is a commodity for which there is already a sector in the table in which it can be entered, the product is first sold to this sector and from there distributed to the sectors using it. Two methods of doing this are available.

(*a*) When the output of the secondary or joint

product varies in proportion to the output of the producing sector (which is what usually happens in practice), the secondary product is transferred from the producing sector A to an appropriate sector B and distributed to the consuming sector C along the B row as shown in the following example.

Suppose we have three sectors in a transactions table, i.e. brewing, animal feed, and livestock. Suppose also that the brewing industry produces malt combings to the value of £170 thousand which are sold directly to farmers for livestock feeding. In the initial construction of a transactions table we would show the figure of 170 in the livestock column of the brewing row as follows:

TABLE C1

	Brewing	Animal Feed	Live-stock	Total
	A	B	C	
Brewing A ..	—	—	170	170
Animal feed B ..	—	—	—	—
Livestock C ..	—	—	—	—
Total ..	—	—	170	170

If, however, we decide on the more sophisticated procedure the table would be adjusted as follows:

TABLE C2

	Brewing	Animal Feed	Live-stock	Total
	A	B	C	
Brewing A ..	170	—	—	170
Animal Feed B ..	−170		170	—
Livestock C ..	—	—	—	—
Total ..	—	—	170	170

In the first case the malt combings are sold directly to the livestock sector. In the second case they are shown first as being used in the brewing sector by means of the positive entry in the brewing row and column. They are then shown as being sold to the animal feed sector (by means of the negative entry in the brewing column of the animal feed row) from which they are distributed along this row to the livestock column. As can be seen the procedure leaves unchanged the row and column totals. In both cases the total of the brewing row and the livestock column is 170.

(*b*) When the output of the secondary product varies with the output of the sector to which it is to be transferred a somewhat different procedure is adopted which is explained in the example given below. Cases such as this do not arise with joint products (only with secondary products) but if we assume for expository purposes that in the above example the output of malt combings varied in proportion to the animal feed industry, the adjusted table would appear as follows:

TABLE C3

	Brewing	Animal Feed	Live-stock	Total
	A	B	C	
Brewing A ..	—	170	—	170
Animal Feed B ..	—	−170	170	—
Livestock C ..	—	—	—	—
Total ..	—	—	170	170

As can be seen from Table C3 the malt combings in this case are sold directly to the animal feed industry by means of a positive entry in the animal feed column of the brewing row. They are then transferred to the animal feed row by means of an offsetting negative entry in the diagonal cell of the animal feed sector, from whence they are distributed along this row to the livestock column. As in the previous case the procedure leaves the row and column totals the same as they were in the original table (Table C1).

II. If the secondary or joint product is one which cannot be entered in any of the sectors of the table and if it cannot be classified into a sector of its own because separate input data for it are not available or cannot be defined, the practice is to enter it in an artificial sector which represents no real production but merely permits distribution to consuming sectors. The method of doing this is as follows:

The value of the joint product should be entered with a positive sign in the diagonal cell of the producing sector and with a negative sign in the producing sector column of a new artificial row. In this way, the joint product is transferred to the artificial row along which it is distributed to the consuming sectors. An artificial column is also introduced so that the matrix will have the same number of rows as columns. The column, however, is left blank. An example using beef and hides will explain the method clearly.

Because beef and hides have a common input structure the allocation of separate costs to one product or the other is not feasible, hence redefinition is impossible. A real sector for hides cannot

therefore be defined and so an artificial sector must be introduced. Let us assume, for expository purposes, that the value of beef output from cattle slaughter is £30 million and that of hides is £2 million. We assume also that all of the beef goes to final demand while all the hides go to the tanning industry.

Table C4 shows the relevant section of the transactions table as it would appear if no adjustment for joint products were made.

TABLE C4

	Cattle Slaughter	Tanning	Final Demand	Total Output
Cattle Slaughter	—	2	30	32
Tanning	—	—	3	3
Primary inputs ..	32	1		
Total inputs ...	32	3		

The adjustment is made by including an artificial row and column for hides as shown in Table C5.

TABLE C5

	Cattle Slaughter	Hides	Tanning	Final demand	Total output
Cattle slaughter	2	—	—	30	32
Hides ..	−2	—	2	—	—
Tanning ..	—	—	—	3	3
Primary inputs ..	32	—	1		
Total inputs	32	—	3		

In Table C4 the hides are sold directly to the tanning industry while in Table C5 they are shown as being first used in the cattle slaughter industry by means of the positive entry in the diagonal cell of that sector. They are then shown as being sold to the artificial hides sector by means of the negative entry in the cattle slaughter column of the hides row, from whence they are distributed to the tanning column. As can be seen the procedure leaves unchanged the row and column totals. The artificial hides sector has counter-balancing entries of −2 and +2 in the row giving zero for the row total. The hides column has blanks in all cells.

Let us now examine (using both Tables C4 and C5) the effects of an increase in the demand for leather (i.e. the product of the tanning industry), keeping in mind that due to technical factors the output of beef and hides from cattle slaughtering must remain in the same proportion as they were in the base year (i.e. in the ratio of 30/2 = 15/1). Because there are very few figures in the tables concerned this examination can be done without calculating technical or interdependence coefficients. In order to understand the discussion, however, the following points should be kept in mind:

(1) A change in the final demand for the products of a sector, directly affects the inputs of that sector, i.e. the sector's column entries. Each non-zero entry in this column will undergo a change proportional to the change in output which has taken place as a result of the change in final demand. Zero column entries will, of course, be unaffected.

(2) A change in final demand for the products of a sector does not directly affect any of the sector's other row entries, with the exception of the diagonal entry (if non-zero) and the total output. The diagonal element is affected because it is a column as well as a row entry. Total output is affected because it is the row total.

(3) Since the column entries of any sector are elements in the rows of other sectors, changes in the entries of any column affect the total outputs of the relevant *real* rows. Other entries in these rows, however, will not be affected. We explain later what happens to artificial rows in such cases.

Effects of change in final demand for leather

Suppose the final demand for leather increases by say 3 units (£3 million) with no change in final demand for beef. Reference to the tanning row of Table C4 shows that this change will increase final demand for tanning to 6 units but since there is no entry in the diagonal cell of the tanning sector there will be no further increase in the output of tanning so that the revised tanning output will also be 6 units.

Reference to the tanning column of Table C4 shows that for every three units of total output of tanning 2 units of cattle slaughter and 1 unit of primary inputs are required. Therefore, six units of tanning output require 4 units of cattle slaughter and 2 units of primary inputs. The sum of these two figures brings the total inputs to 6 which is the same as the total output of the tanning sector. (See Table C6.)

Now the two extra units of cattle slaughter required by tanning will increase the output of cattle slaughter by 2 units to 34 units but since the output of cattle slaughter and hides must be in the proportion of 15/1 the amounts of these products in the new 34 units of output is 31·875 of beef and 2·125 of hides. Since, however, only 30 units of beef are required for final demand the remaining 1·875 units must have gone to the tanning industry to

supply a demand for hides. This, of course, does not make sense. Table C6 which is based on the classification in Table C4 shows the position after the change in the tanning sector.

TABLE C6

	Cattle slaughter	Tanning	Final Demand	Total Output
Cattle slaughter	—	4{1.875B, 2.125H	30B	34{31.875B, 2.125H
Tanning ..	—	—	6{1.875B, 2.125H, 2.00V.A	6
Primary inputs ..	34	2		
Total inputs	34	6		

B=Beef; H=Hides; V.A.=Value added.

Let us now use Table C5 to see what happens when final demand for leather is assumed to increase by 3 units and final demand for beef remains constant. As in the previous case the output of tanning will increase from three to six units, and so every entry in the tanning column of the table will be doubled, i.e. total inputs will increase to 6, primary inputs to 2 and the input of hides to 4. Since there is no entry in the cattle slaughter row of this column, cattle slaughtering will not be affected by the increased demand for hides. Hence, output and inputs of this sector remain constant. The extra hides required, therefore, cannot come from domestic cattle slaughter. They must come from some other source and of course the only other source of hides is imports. To show how imports can supply hides a competitive imports column is needed in the table. Such a column is included in Table C7 which is based on Table C5 and shows the position after the change in the tanning sector. As can be seen the import column of this Table has an entry of −2 in the hides row. This counterbalances the extra two units of hides going to tanning and preserves the zero total for the artificial hides row.

The Specification of Final Demands for the Products of Artifical Sectors with Blank Columns

In planning an economy using the input-output system, realistic and consistent final demands have to be specified for the different sectors. In the case of an artificial sector with a blank column the row total (i.e. the total output) must always be zero, and the problem arises as to how the final demand for such a sector can be specified to give this result. A little reflection shows that this specification presents no real problems. An artificial sector with a blank column does not interact with any other sector and so we can specify in advance any level of final demand we wish and determine the required level later as shown below.

We explain the procedure using as an example the artificial hides sector discussed previously. To do this technical and interdependence co-efficients are calculated from the data in Table C5. These are given in Table C8 and C9 respectively.

TABLE C8

TECHNICAL CO-EFFICIENTS BASED ON TABLE C5

	Cattle Slaughter x_1	Hides x_2	Tanning x_3
Cattle Slaughter ..	1/16	o/o	o
Hides	−1/16	o/o	$\frac{2}{3}$
Tanning	o	o/o	o
Primary Inputs ..	1·0	o	$\frac{1}{3}$

TABLE C9

INTERDEPENDENCE CO-EFFICIENTS BASED ON TABLE C8

	Cattle Slaughter x_1	Hides x_2	Tanning x_3
Cattle Slaughter ..	16/15	o	o
Hides	−1/15	1	2/3
Tanning ..	o	o	1

Example I

Suppose as in a previous example we wish to increase the final demand for leather from the 3 units

TABLE C7

	Cattle Slaughter	Hides	Tanning	Final Demand	Total Domestic	Imports	Total Output
Cattle Slaughter.. ..	2	—	—	30	32	—	32
Hides	−2	—	4	—	2	−2	—
Tanning	—	—	—	6	6	—	6
Primary Inputs	32	—	2	—	—	—	—
Total Inputs	32	—	6	—	—	—	—

in Table C5 to 6 units with no change in the final demand (of 30 units) for beef. By assuming that under those conditions final demand for hides is Y_2 the outputs of the different sectors are obtained as follows:

$$(1)\quad \begin{matrix}(I-A)^{-1}\\ \begin{bmatrix} \frac{16}{15} & 0 & 0 \\ -\frac{1}{15} & 1 & \frac{2}{3} \\ 0 & 0 & 1 \end{bmatrix}\end{matrix} \quad \begin{matrix}Y\\ \begin{bmatrix} 30 \\ Y_2 \\ 6 \end{bmatrix}\end{matrix} = \begin{matrix}X\\ \begin{bmatrix} 32 \\ Y_2+2 \\ 6 \end{bmatrix}\end{matrix} = \begin{matrix}X\\ \begin{bmatrix} 32 \\ 0 \\ 6 \end{bmatrix}\end{matrix}$$

Here $(I-A)^{-1}$ is the matrix of interdependence coefficients which is multiplied by Y the vector of final demands to give X which is the vector of outputs. Each element of X is obtained by multiplying the elements of the corresponding row of the $(I-A)^{-1}$ matrix by the corresponding elements of the Y vector and totalling the results. Thus:

$$\begin{aligned} X_1 &= (\tfrac{16}{15}\times 30)+(0\times Y_2)+(0\times 6) = 32 \\ (2)\quad X_2 &= (-\tfrac{1}{15}\times 30)+(1\times Y_2)+(\tfrac{2}{3}\times 6) = Y_2+2 \\ X_3 &= (0\times 30)+(0\times Y_2)+(1\times 6) = 6. \end{aligned}$$

As can be seen the output of the hides sector X_2 is Y_2+2 but since the output of this sector must be zero, $Y_2+2=0$, and so $Y_2=-2$. Hence in order to satisfy our conditions, final demand for hides must be -2 units which, in fact, means an import of 2 units of hides. This level of final demand, however, need not be specified in advance. It can be determined from the exercise by including a symbolic value for it.

Example 2

Suppose the final demand for beef is specified to increase from 30 to 34 units with no change in the final demand for leather which is 3 units. What level of final demand for hides will leave the output of the hides sector zero?

Proceeding as in Example 1 and letting final demand for hides be Y_2 units we obtain:

$$(3)\quad \begin{matrix}(I-A)^{-1}\\ \begin{bmatrix} \frac{15}{16} & 0 & 0 \\ -\frac{1}{15} & 1 & \frac{2}{3} \\ 0 & 0 & 1 \end{bmatrix}\end{matrix} \quad \begin{matrix}Y\\ \begin{bmatrix} 34 \\ Y_2 \\ 3 \end{bmatrix}\end{matrix} = \begin{matrix}X\\ \begin{bmatrix} 36\frac{4}{15} \\ Y_2-\frac{4}{15} \\ 3 \end{bmatrix}\end{matrix} = \begin{matrix}X\\ \begin{bmatrix} 36\frac{4}{15} \\ 0 \\ 3 \end{bmatrix}\end{matrix}$$

In this case the output of hides is $Y_2-\frac{4}{15}$ but since this output must be zero $Y_2=\frac{4}{15}$. Hence in order to satisfy our conditions the final demand (i.e. exports or stock changes) for hides must be $\frac{4}{15}$ units.

As in the previous case this level of final demand need not be specified in advance. It can also be determined from the exercise by including a symbolic value for it.

In practical work the procedure adopted is to enter zero values for the final demands of all artificial sectors which have blank columns and determine the real values by solution of the matrix equation:

$$(I-A)^{-1}(Y-M) = X$$

where $(I-A)^{-1}$ is the inverse matrix,
Y is a column vector of final demands,
M is a column vector of competitive imports,
and X is the column vector of outputs.

Having completed the calculations the outputs of the artificial sectors are examined when it will be found that they are either positive, negative or zero. These, of course, are not real outputs since the output of these sectors must be zero. They are in fact final demands with signs changed. Hence, a zero output for an artificial sector indicates that final demand for the product of such a sector is zero also. A positive output indicates an import of the same numerical magnitude, while a negative output indicates an export or home consumption of this magnitude.

APPENDIX A

TABLE A1: AGRICULTURAL INPUT-OUTPUT TRANSACTIONS TABLE (Unadjusted) 1964 (£000)

	Consuming Industries / Industries of Origin	1 Cattle	2 Dairying	3 Sheep and Wool	4 Pigs	5 Poultry and Eggs	6 Horses	7 Grain Crops	8 Root and Green Crops	9 Conserved Grass	10 Pasture	11 Other Crops including Peat	12 Animal Slaughtering	13 Milk Processing	14 Grain Milling and Animal Feed	15 Other Intermediate	16 Total Intermediate	17 Other Industries	18 Personal Consumption	19 Exports	20 Stock Changes	21 Total	22 Total Commodity Flow	23 Imports	24 Total Domestic Flow	25 Transfer Adjustment	26 Official Agricultural Output	Consuming Industries / Industries of Origin
		Interindustry																Final Demand										
1	Cattle		14,508										29,368			35	43,911			49,282	3,564	52,846	96,757	−8,648	88,109	14,508	73,601	1
2	Dairying	29,343			1,064	106							12,060	34,303		104	64,920	70	19,341	173	4,250	23,834	88,754		88,754	30,513	58,241	2
3	Sheep and Wool								883				26,574				26,574	974		4,224	1,101	6,299	18,359	−1,499	16,860		16,860	3
4	Pigs														724	613	711		724	57	1,376	2,157	28,731	−397	28,334		28,334	4
5	Poultry and Eggs					98									14,134		14,134		14,134	596	−36	14,694	15,405	−306	15,099	98	15,001	5
6	Horses												652				652	198		4,700		4,898	5,550	−1,968	3,582		3,582	6
7	Grain crops	668	689	123	221	1,022	267	1,622						90	23,511	3,150	31,363	440		26	−2,303	−1,837	29,526	−9,164	20,362	3,150	17,212	7
8	Root and Green Crops	555	1,472	820	1,353	805	30		883							7,306	13,224	98	6,318	932		7,348	20,572	−15	20,557	5,903	14,654	8
9	Conserved Grass	5,057	2,741	123			235										8,156	215		63		278	8,434		8,434	8,156	278	9
10	Pasture	6,696	3,553	2,100			284										12,633						12,633		12,633	12,633	Nil	10
11	Other Crops incl. Peat	155	388	37			26		186	278	359	199				782	2,410	51	10,569	691	25	11,336	13,746	−738	13,008	615	12,393	11
12	Animal Slaughtering												418		537	3,790	4,745	722	44,829	35,740	−435	80,856	85,601	−1,142	84,459			12
13	Milk Processing														1,012	1,327	2,339	115	20,436	20,826	−170	41,207	43,546	−95	43,451			13
14	Grain Milling and Animal Feed	2,390	2,350	42	15,501	4,767	141									8,280	33,471	638	6,883	1,014	414	8,949	42,420	−5,359	37,061			14
15	Other Intermediate	637	562	221	80					30			311	3,401	347	8,890	14,479	1,537	75,195	21,287	−1,493	96,526	111,005	−11,133	99,872			15
16	Fertilisers and Lime							2,642	2,907	2,294	7,555	348					15,746						15,746		15,746			16
17	Rates	392	386		52	35	55	500	217	1,028	4,477	46					7,188						7,188		7,188			17
18	Other Expenses	5,837	4,059	1,354	2,413	814	305	6,024	7,066	4,863	1,018	712	9,527	7,683	7,471	34,431	93,577						93,577		93,577			18
19	Subsidies	−646	−1,639					−747	−781	−766	−2,951	−83	−1,970	−5,815	−127		−15,525			−4,351		−4,351	−19,876		−19,876			19
20	Income Arising	37,025	59,685	12,040	7,650	7,452	2,239	10,321	10,079	707	2,175	11,786	7,519	3,789	4,310	31,164	207,941						207,941		207,941			20
21	Total Inputs*	88,109	88,754	16,860	28,334	15,099	3,582	20,362	20,557	8,434	12,633	13,008	84,459	43,451	37,061	99,872	580,575	5,058	198,429	135,260	6,293	345,040	925,615	−40,464	885,151	75,576	240,156	Total Inputs* 21

*Total inputs for each interindustry sector equals total domestic flow for each of these sectors

TABLE A2: ADJUSTED AGRICULTURAL INPUT-OUTPUT TRANSACTIONS TABLE 1964 (£000)

	Consuming Industries / Industries of Origin	1 Cattle	2 Dairying	3 Calves/ Cows/ Skim	4 Sheep and Wool	5 Wool	6 Pigs	7 Poultry and Eggs	8 Horses	9 Grain Crops	10 Root and Green Crops	11 Conserved Grass	12 Pasture	13 Other Crops (including Peat)	14 Animal slaughtering	15 Hides and Skins Fats and Offals	16 Milk Processing	17 Flour Milling and Animal Feed	18 Other Intermediate	19 Total Intermediate	20 Other Industries	21 Personal Consumption	22 Exports	23 Stock Changes	24 Total	25 Total Commodity Flow	26 Imports	27 Total Domestic Flow	28 Transfer Adjustment	29 Official Agricultural Output	Consuming Industries / Industries of Origin
		Interindustry															Final Demand														
1	Cattle	35	14,508												29,368					43,911			49,282	3,564	52,846	96,757	−8,648	88,109	14,508	73,601	1
2	Dairying	2,003	32,934				1,064	106									34,303			69,240	70	19,341	173	4,250	23,834	88,754		88,754	30,513	58,241	2
3	Calves/Cows/Skim	27,340	−32,914																84	−4,320				4,320						3
4	Sheep and Wool				4,096										12,060					16,156			1,624	579	2,203	18,359	−1,499	16,860		16,860	4
5	Wool				−4,096															−4,096	974		2,600	522	4,096						5
6	Pigs														26,574					26,574		724	57	1,376	2,157	28,731	−397	28,334		28,334	6
7	Poultry and Eggs							98								613				711		14,134	596	−36	14,694	15,405	−306	15,099	98	15,001	7
8	Horses														652					652	198		4,700		4,898	5,550	−1,968	3,582		3,582	8
9	Grain Crops	668	863		123		221	1,022	267	1,622							90	23,858	2,629	31,363	440		26	−2,303	−1,837	29,526	−9,164	20,362	3,150	17,212	9
10	Root and Green Crops	1,192	1,860		1,041		1,433	805	30		883	30							5,950	13,224	98	6,318	932		7,348	20,572	−15	20,557	5,903	14,654	10
11	Conserved Grass	5,057	2,741		123				235											8,156	215		63		278	8,434		8,434	8,156	278	11
12	Pasture	6,696	3,553		2,100				284											12,633						12,633		12,633			12
13	Other Crops (incl. Peat)	155	388		37				26		186	278	359	199					782	2,410	51	10,569	691	25	11,336	13,746	−738	13,008	615	12,393	13
14	Animal Slaughtering														8,956			388	436	9,780		42,506	32,250	162	74,018	84,698	−239	84,459			14
15	Hides and Skins, Fats and Offals	−35	−20												−8,538			149	3,409	−5,035	722	2,303	3,490	−597	5,938	903	−903				15
16	Milk Processing																	1,012	1,327	2,339	115	20,476	20,826	−170	41,207	43,546	−95	43,451			16
17	Flour Milling and Animal Feed	2,390	2,350		42		15,501	4,767	141										8,280	33,471	638	6,813	1,014	414	8,949	42,420	−5,359	37,061			17
18	Other Intermediate														311		3,401		10,767	14,479	1,537	75,195	21,287	−1,493	96,526	111,005	−11,133	99,872			18
19	Fertilisers and Lime								2,642	2,907	2,294	7,555	348							15,746						15,746		15,746			19
20	Rates	392	386				52	35	55	500	217	1,028	4,477	46						7,188						7,188		7,188			20
21	Other Expenses	5,837	4,059		1,354		2,413	814	305	6,024	7,066	4,863	1,018	712	9,527		7,683	7,471	34,431	93,577						93,577		93,577			21
22	Subsidies	−646	−1,639							−747	−781	−766	−2,951	−83	−1,970		−5,815	−127		−15,525			−4,351		−4,351	−19,876		−19,876			22
23	Income Arising	37,025	59,685		12,040		7,650	7,452	2,239	10,321	10,079	707	2,175	11,786	7,519		3,789	4,310	31,164	207,941						207,941		207,941			23
24	Total Inputs*	88,109	88,754		16,860		28,334	15,099	3,582	20,362	20,557	8,434	12,633	13,008	84,459		43,451	37,061	99,872	580,575	5,058	198,429	135,260	6,293	345,040	925,615	−40,464	885,151	75,576	240,156	Total Inputs* 24

*Total inputs for each interindustry sector equals total domestic flow for each of these sectors

TABLE A3: TECHNICAL CO-EFFICIENTS FOR UNADJUSTED TRANSACTIONS TABLE

	Consuming Industries / Industries of Origin	1 Cattle	2 Dairying	3 Sheep and Wool	4 Pigs	5 Poultry and Eggs	6 Horses	7 Grain Crops	8 Root and Green Crops	9 Conserved Grass	10 Pasture	11 Other Crops	12 Animal Slaughtering	13 Milk Processing	14 Grain Milling and Animal Feed	15 Other Intermediate	Consuming Industries / Industries of Origin
1	Cattle		0·1635										0·3477			0·0004	Cattle 1
2	Dairying	0·3330			0·0376	0·0070								0·7895		0·0010	Dairying 2
3	Sheep and Wool												0·1428				Sheep and Wool 3
4	Pigs												0·3146				Pigs 4
5	Poultry and Eggs					0·0065										0·0061	Poultry and Eggs 5
6	Horses												0·0077				Horses 6
7	Grain Crops	0·0076	0·0078	0·0073	0·0078	0·0677	0·0745	0·0797						0·0021	0·6344	0·0315	Grain Crops 7
8	Root and Green Crops	0·0063	0·0166	0·0486	0·0478	0·0533	0·0084		0·0430							0·0732	Root and Green Crops 8
9	Conserved Grass	0·0574	0·0309	0·0073			0·0656										Conserved Grass 9
10	Pasture	0·0760	0·0400	0·1246			0·0793										Pasture 10
11	Other Crops incl. Peat	0·0018	0·0044	0·0022			0·0073		0·0090	0·0330	0·0284	0·0153				0·0078	Other Crops incl. Peat 11
12	Animal Slaughtering												0·0049		0·0145	0·0379	Animal Slaughtering 12
13	Milk Processing														0·0273	0·0133	Milk Processing 13
14	Grain Milling and Animal Feed	0·0271	0·0265	0·0025	0·5471	0·3157	0·0394									0·0829	Grain Milling and Animal Feed 14
15	Other Intermediate	0·0072	0·0063	0·0131	0·0028					0·0036			0·0037	0·0783	0·0094	0·0890	Other Intermediate 15
16	Fertilisers and Lime							0·1298	0·1414	0·2720	0·5980	0·0268					Fertilisers and Lime 16
17	Rates	0·0044	0·0043		0·0018	0·0023	0·0154	0·0246	0·0106	0·1219	0·3544	0·0035					Rates 17
18	Other Expenses	0·0662	0·0457	0·0803	0·0852	0·0539	0·0851	0·2958	0·3437	0·5766	0·0806	0·0547	0·1128	0·1768	0·2016	0·3448	Other Expenses 18
19	Subsidies	−0·0073	−0·0185					−0·0367	−0·0380	−0·0908	−0·2336	−0·0064	−0·0233	−0·1338	−0·0034		Subsidies 19
20	Income Arising	0·4202	0·6725	0·7141	0·2700	0·4935	0·6251	0·5069	0·4903	0·0838	0·1722	0·9061	0·0890	0·0872	0·1163	0·3120	Income Arising 20
21	Total	0·9999	1·0000	1·0000	1·0001	0·9999	1·0001	1·0001	1·0000	1·0001	1·0000	1·0000	0·9999	1·0001	1·0001	0·9999	Total 21

TABLE A4: TECHNICAL CO-EFFICIENTS FOR ADJUSTED TRANSACTIONS TABLE

	Consuming Industries / Industries of Origin	1 Cattle	2 Dairying	3 Cattle/ Cows/ Skim Milk	4 Sheep and Wool	5 Wool	6 Pigs	7 Poultry and Eggs	8 Horses	9 Grain Crops	10 Root and Green Crops	11 Conserved Grass	12 Pasture	13 Other Crops (including Peat)	14 Animal Slaughtering	15 Hides and Skins, etc.	16 Milk Processing	17 Flour Milling and Animal Feed	18 Other Intermediate	Consuming Industries / Industries of Origin
		Calves	Dairying																	
1	Cattle	0·0004	0·1635												0·3477					Cattle 1
2	Dairying	0·0227	0·3711														0·7895			Dairying 2
3	Calves/Cows/Skim	0·3103	−0·3708				0·0376	0·0070											0·0008	Calves/Cows/Skim 3
4	Sheep and Wool				0·2429										0·1428					Sheep and Wool 4
5	Wool				−0·2429															Wool 5
6	Pigs														0·3146					Pigs 6
7	Poultry and Eggs							0·0065											0·0061	Poultry and Eggs 7
8	Horses														0·0077					Horses 8
9	Grain Crops	0·0076	0·0097		0·0073		0·0078	0·0677	0·0745	0·0797							0·0021	0·6437	0·0263	Grain Crops 9
10	Root and Green Crops	0·0135	0·0210		0·0617		0·0506	0·0533	0·0084		0·0430	0·0036							0·0596	Root and Green Crops 10
11	Conserved Grass	0·0574	0·0309		0·0073				0·0656											Conserved Grass 11
12	Pasture	0·0760	0·0400		0·1246				0·0793											Pasture 12
13	Other Crops (Peat included)	0·0018	0·0044		0·0022				0·0073		0·0090	0·0330	0·0284	0·0153					0·0078	Other Crops (Peat included) 13
14	Animal Slaughtering														0·1060			0·0105	0·0044	Animal Slaughtering 14
15	Hides and Skins, Fats and Offals	−0·0004	−0·0002												−0·1011			0·0040	0·0341	Hides and Skins, Fats and Offals 15
16	Milk Processing																	0·0273	0·0133	Milk Processing 16
17	Flour Milling and Animal Feed	0·0271	0·0265		0·0025		0·5471	0·3157	0·0394										0·0829	Flour Milling and Animal Feed 17
18	Other Intermediate														0·0037		0·0783		0·1078	Other Intermediate 18
19	Fertilisers and Lime									0·1298	0·1414	0·2720	0·5980	0·0268						Fertilisers and Lime 19
20	Rates	0·0044	0·0043				0·0018	0·0023	0·0154	0·0246	0·0106	0·1219	0·3544	0·0035						Rates 20
21	Other Expenses	0·0662	0·0457		0·0803		0·0852	0·0539	0·0851	0·2958	0·3437	0·5766	0·0806	0·0547	0·1128		0·1768	0·2016	0·3448	Other Expenses 21
22	Subsidies	−0·0073	−0·0185							−0·0367	−0·0380	−0·0908	−0·2336	−0·0064	−0·0233		−0·1338	−0·0034		Subsidies 22
23	Income arising	0·4202	0·6725		0·7141		0·2700	0·4935	0·6251	0·5069	0·4903	0·0838	0·1722	0·9061	0·0890		0·0872	0·1163	0·3120	Income Arising 23
24	Total	0·9999	1·0001		1·0000		1·0001	0·9999	1·0001	1·0001	1·0000	1·0001	1·0000	1·0000	0·9999		1·0001	1·0001	0·9999	Total 24

TABLE A5: INTERDEPENDENCE CO-EFFICIENTS FOR ADJUSTED MODEL

	Industries of Origin / Consuming Industries	1 Cattle	2 Dairying	3 Calves/ Cows/ Skim	4 Sheep and Wool	5 Wool	6 Pigs	7 Poultry and Eggs	8 Horses	9 Grain Crops	10 Root and Green Crops	11 Conserved Grass	12 Pasture	13 Other Crops including Peat	14 Animal Slaughtering	15 Hides and Skins, Fats and Offals	16 Milk Processing	17 Flour Milling and Animal Food	18 Other Intermediate	Industries of Origin / Consuming Industries
1	Cattle	1·0066	0·2621				0·0054	0·0031	0·0004						0·3934		0·2074	0·0098	0·0060	Cattle 1
2	Dairying	0·0373	1·6012		0·0001		0·0190	0·0111	0·0014						0·0213		1·2659	0·0348	0·0222	Dairying 2
3	Calves/Cows/Skim	0·2985	−0·5124	1·0000			0·0323	0·0040	−0·0004						0·1274		−0·4050	−0·0097	−0·0054	Calves/Cows/Skim 3
4	Sheep and Wool	0·0001	0·0001		1·3208		0·0012	0·0007	0·0001						0·2114		0·0002	0·0022	0·0013	Sheep and Wool 4
5	Wool				−0·3208	1·0000	−0·0003	−0·0002							−0·0514			−0·0005	−0·0003	Wool 5
6	Pigs	0·0001	0·0002				1·0020	0·0012	0·0001						0·3527		0·0003	0·0037	0·0021	Pigs 6
7	Poultry and Eggs							1·0065									0·0005		0·0069	Poultry and Eggs 7
8	Horses								1·0000						0·0086			0·0001	0·0001	Horses 8
9	Grain Crops	0·0285	0·0538		0·0128		0·3928	0·2973	0·1086	1·0866					0·1527		0·0526	0·7025	0·1009	Grain Crops 9
10	Root and Green Crops	0·0152	0·0391		0·0852		0·0536	0·0565	0·0091		1·0449	0·0038			0·0388		0·0364	0·0014	0·0711	Root and Green Crops 10
11	Conserved Grass	0·0589	0·0645		0·0096		0·0009	0·0065	0·0657			1·0000			0·0254		0·0510	0·0017	0·0010	Conserved Grass 11
12	Pasture	0·0780	0·0840		0·1646		0·0013	0·0008	0·0794				1·0000		0·0578		0·0664	0·0024	0·0015	Pasture 12
13	Other Crops incl. Peat	0·0064	0·0126		0·0088		0·0007	0·0006	0·0120		0·0096	0·0335	0·0288	1·0155	0·0043		0·0107	0·0003	0·0097	Other Crops incl. Peat 13
14	Animal Slaughtering	0·0003	0·0006				0·0005	0·0037	0·0005						1·1210		0·0010	0·0118	0·0067	Animal Slaughtering 14
15	Hides and Skins, Fats and Offals	−0·0003	−0·0003				0·0016	0·0009	0·0001						−0·1125	1·0000	0·0028	0·0029	0·0380	Hides and Skins, Fats and Offals 15
16	Milk Processing	0·0008	0·0014		0·0001		0·0150	0·0087	0·0011						0·0057		1·0024	0·0274	0·0176	Milk Processing 16
17	Flour Milling and Animal Feed	0·0283	0·0496		0·0033		0·5490	0·3189	0·0395						0·2055		0·0468	1·0034	0·0971	Flour Milling and Animal Feed 17
18	Other Intermediate	0·0001	0·0001				0·0013	0·0008	0·0001						0·0051		0·0880	0·0025	1·1224	Other Intermediate 18

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