THE
ECONOMIC & SOCIAL
RESEARCH INSTITUTE

Irish Full Employment Structures, 1968 and 1975

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MAY, 1974

PAPER No. 74

THE ECONOMIC AND SOCIAL RESEARCH INSTITUTE
COUNCIL 1973-74

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ISBN 0 901809 75 6

CONTENTS

LIST OF TABLES

Tables included in the Appendices

ACKNOWLEDGEMENTS

While responsibility for the content of the paper is entirely his own, the author wishes to thank Dr K. A. Kennedy, Dr R. C. Geary and especially Professor R. O'Connor of The Economic and Social Research Institute for valuable comments and suggestions on the draft report at all stages of its preparation.

The opinions expressed in the paper, the analysis of results and the methods of treating imports are not necessarily those of ESRI nor of the Central Statistics Office. The author alone is answerable for any errors or omissions which the paper contains.

Irish Full Employment Structures 1968 and 1975

SUMMARY

THIS paper contains an introduction followed by four main sections which are as follows:

(1) Detailed discussion of the model used.
(2) The 1968 experiments.
(3) The 1975 experiments.
(4) Conclusions.

It is explained in the introduction that the paper is a suitable illustration of how an input-output table can be used with linear programming (LP) techniques so as to measure the economic structure required to give full employment of a specified labour force and simultaneously to maximise household expenditure for a given import surplus. The emphasis is on methodology and illustration rather than on precise estimation of economic structure. The intention is to stimulate discussion. The previous input-output models of Geary and Simpson are described briefly. There is a short account of how the 1968 full-employment economic structure is approached via LP techniques.

Section 1 has a description of non-mathematical aspects of the model used in the LP experiments. There is an outline of the techniques used, a discussion of upper and lower bounds, of the labour and capital stock resources and of the limitations of the present treatment of capital stock. The treatment of labour and employment and the underlying assumptions and limitations of the model are discussed. Brief comments are also made on the constant-price assumptions, on the usefulness of sub-optimal results and on the loss of precision through having possibly too few agricultural and industrial sectors in the model.

In Section 2 the system of constraints for the 1968 experiments (1) and (2) is described, with experiment (1) having no capital stock or borrowing from abroad incorporated in its structure, whereas experiment (2) takes account of this aspect of economic expansion. The results show that full employment is possible under the conditions specified for both experiments, but that under the more realistic experiment (2) conditions, an increase of only 4·1 per cent in household expenditure is achieved, about the 1968 base level, some £51 million of borrowed investment funds is needed by industry and the patterns of industrial outputs and exports differ significantly from those of the 1968 base.

In Section 3 the results of the 1975 experiments (3) and (4) show that full employment is possible for the conditions specified in both experiments. Experiment (3) is more realistic than experiment (4), because the latter shows excessive agricultural and industrial exports, balanced by corresponding excessive similar imports, although other items appear to have reasonable values for the solution of that experiment. Among the results for experiment (3), household expenditure is 40 per cent above that of the 1968 base and some £226 million of preparatory loans from abroad is required for industrial sectors. Major expansions of sector outputs and of exports (58 per cent for exports of agriculture etc., mining and manufacturing in aggregate) above their 1968 base levels are required. There is considerable stability in the pattern of exports minus similar imports for experiments (3) and (4). The latter experiment is of interest, in showing an increase of only £22 million (1·8 per cent) in household expenditure above that of experiment (3), £1,246 million, in spite of remarkably high levels of exports and of similar imports. At the level of three major sub-sectors of all economic activity, the 1975 experiment (3) shares of total employment and of GDP are close to these average shares for four small European countries circa 1967.

A slightly sub-optimal experiment (3) result shows a possibly more acceptable disposal of livestock output than the disposal given by the fully optimal experiment (3) outcome. The sub-optimal disposal has a direct export of 17 per cent of livestock, the same percentage as obtained for the 1968 base structure, with the rest of livestock output being absorbed by food manufacturing, of which 37 per cent is exported, as compared with 34 per cent for the 1968 base structure. The sub-optimal value of household expenditure is only £2·4 million below that of the experiment (3) optimal value.

In Section 4 there are nine conclusions set out and considered. Major increases in employment are possible if good export markets for specified commodities can be realised and if loans from abroad can be obtained to provide the necessary expansion of the capital stock. For 1975 experiment (3) conditions versus those of the 1968 base, some 132,000 man-years of new employment (including a 46,000 loss of employment in agriculture since 1968) are absorbed in roughly equal amounts of some 33,000 by (*a*) manufacturing, (*b*) construction, (*c*) government services, and (*d*) other services. It would appear that the government has a crucial role to play in securing full employment by a choice of expenditure patterns. The 1975 supposed economic conditions show significant improvement over those of 1968, since there is an increase of 30 per cent in household expenditure per man-year. Exports minus similar imports, rather than exports alone, are of importance for increasing economic efficiency. The optimal economic profile provides a benchmark against which other results can be measured. Sub-optimal results may, how-

ever, be more acceptable than those of an optimal outcome which has question able disposal of livestock or other commodities. The shadow prices are valuable indicators of which structural changes are relatively efficient for increasing the objective function. The experiments are to be regarded as pointing the way to right development policy rather than as furnishing actual targets. An encouraging feature of the 1975 optimal structure is that it shows, at the level of three sub-sectors of all economic activity, employment and GDP shares of the totals which closely match those of the average structure of four other small western European countries circa 1967.

The final conclusion considers important aspects of a policy directed towards an optimum. There must be government involvement and consistent planning. There may be a conflict between increased productivity and the target of enlarged employment. The public services and education, as absorbers of the labour force, may have upper limits above which their employment becomes less and less meaningful. There are some open questions as to how the employment problem will be solved in the future.

Introduction

THE advent of Irish entry to membership of the Common Market has now become history and the prospects of improved export markets for at least agricultural livestock and the livestock products appear to be realistic. The unemployment situation has in recent times been worsened by the effects of redundancy and the apparent reduction in the level of net emigration. The question arises as to how full employment of a specified labour force might be achieved in 1968 pre-EEC economic conditions and in 1975 likely economic conditions of EEC membership.

The existence of input-output results [2] for 1968 was one reason for choosing that year. Another important reason was that 1968 was chosen as the base year for the Third Programme of Economic and Social Development [4] and had subsequently been used as base for Central Statistics Office national accounting and other economic time series. It so happened that the year 1968 had an unusually high annual rate of growth of real GNP, namely 7·9 per cent [1, p. 9]. Thus one would surmise relatively intense use of available capital stock and relatively high output per man-year, in general. The year 1968 would therefore appear to be appropriate, both for investigations into unemployment then existing and as a base for projections to 1975.

This report describes four experiments in which input-output (1—0) has been combined with linear programming (LP) so as to measure the economic structures required to achieve the 1968 and 1975 targets of full employment and the largest possible household expenditure for a given import surplus. Price levels in general are taken to be those of 1968 and thus the results are given in 1968 volume units. In the report the emphasis is on methodology rather than numerical precision, but at the same time an effort has been made to achieve fairly realistic numerical results. These results however are not to be taken as precise because the number of productive sectors used below is small and because some of the limits and constants used in the experiments are subjective and would probably require amendment through hindsight and informed comment. It is hoped that this report will stimulate discussion of what is involved in any real-life approach towards full employment and help to show how such a worthy objective might be attempted.

Previous Input-Output Models

The model used for the 1968 and 1975 experiments has drawn heavily on the techniques and ideas contained in the pioneering models of Geary [5] and

Simpson [6]. This author acknowledges his debt to these two model-builders. A brief description of relevant aspects of the models in question occupies the following two paragraphs, to put the present essay in clearer perspective by indicating what approaches were used in the recent past to problems which are similar to those discussed in this essay.

R. C. Geary's Decision Model [5] was published in 1964 and was the first example of medium-term economic projection in an input-output setting, for the Irish economy. Although not formally an LP model, the Geary model selected from some 50 trials the solution for 1970 deemed to be optimal in terms of sector outputs and balance of payments results. By varying the parameters, simulation of economic behaviour under different conditions was achieved. The core of the Geary model was the input-output and national accounting identities, including the crucial savings-investment equality. "The model is primarily designed to show, in fairly considerable industrial detail, the economic pattern in some future year of reference, on the assumption of different rates of increase of GNP. However detailed, the pattern must be consistent in all its parts." [5, p. 82].

David Simpson's Medium-Term Planning Model [6] was published in 1968. Linear programming techniques were used to maximise household consumption, the objective function, subject to constraints on labour, capital and the balance of payments, as well as constraints given by the input-output inter-relations between economic activities. The numerical results gave an optimal economic structure for 1964. This model illustrated the improvements in productivity and income which might be possible in Ireland if, over a period, efforts were made to redistribute labour and capital between different parts of the economy in the most efficient way possible. Two assumptions were particularly important: that export demand for the output of each sector is perfectly price-elastic, and that employment is proportional to output in each sector (except agriculture). This model had two categories of labour, namely—(*a*) skilled and (*b*) unskilled. Each category was treated as having an available supply for 1964 not exceeding a specified amount in man-years.

Method used in this Study

The method used to find the highest possible level of household expenditure for full employment in 1968 can in essence be described as follows. *A specified volume of employment, larger than that observed for 1968 actual conditions, is forced into the economic structure.* This means expansion of economic activity beyond that observed for 1968. Some of the resulting extra output will be purchased directly and indirectly by the increased spending power arising from the extra employment. The rest of the extra output must be exports, at supposed average

observed 1968 export prices. Both industry and households will purchase extra imports.

The expansion of economic activity implies a prior build-up of capital stock, probably in excess of observed rates of domestic savings available for such purposes and of observed inflows of private investment funds. The extra investment funds required to permit the necessary extra capital stock are supposed to have been borrowed from foreign sources and invested in Ireland during some years before 1968 and are being repaid (principal plus interest) during 1968 at a rate of 17 per cent of the total amount borrowed. There is no borrowing during 1968.

For the expanded economic activity the cost structure of each of 33 productive sectors, as given in Table 3.2 of [2], is assumed to apply, as well as the 1968 basic employment and capital stock coefficients per unit of gross output of each productive sector. Likewise the average observed expenditure patterns per unit level of personal and government expenditure and of capital formation are taken as applicable. Since all price levels are taken as those of 1968, the possibility of inflation arising from conditions of full or near-full employment [13] is ignored. The government instruments of taxation, subsidies and transfer payments as observed for 1968 are assumed to be unchanged in intensity. This treatment of current transfer payments implies that what had been unemployment benefits now, in full employment conditions, take a different form, but still continue to enlarge the purchasing power of poorer members of the community. The domestic savings behaviour for 1968 actual conditions is taken as still valid.

A further important condition is that the outputs of the domestic productive sectors and the import excess should lie within a plausible range of levels known as upper and lower bounds. If one supposes that the planning of the situation of full employment began in 1963, then the sector outputs should be not less than those observed in 1963 (because capital stocks then in existence for use in specific industries are not to be wasted by scrapping or abandonment) and they should not be unrealistically large either, because of the supposition of export sales at average 1968 prices.

For such economic conditions, what is the maximum 1968 household expenditure possible? The answer depends on a complicated set of interacting economic activities and on the form and number of constraints applied. The first question however is whether any meaningful mathematical answer exists to the problem, i.e. does the problem have a "feasible" solution? If we permit sector outputs to expand sufficiently to absorb the 1968 unemployed labour force, the answer is yes. We can visualise the 1968 structure scaled up by 6 per cent to absorb an extra 6 per cent of employment.

The possibility of choice may also be considered. If we still have scope to

change sector outputs, within the upper and lower bounds specified, we can enlarge the household expenditure by choosing the more remunerative activities. This change also involves changes in exports and in similar imports, since the supply of a commodity for the domestic market is given by domestic production plus similar imports less exports. The combined labour inputs to all domestic outputs must still, of course, employ the full labour force.

We next consider the import excess upper bound. This constraint will force a new set of output and export levels to operate and its effect will be to reduce the maximum household expenditure possible without such a constraint. It is a general principle in LP that each additional constraint which is fully effective reduces the maximum achievable without it. A further reduction to the possible maximum will be caused by making extra exports cover the repayment of funds which were borrowed for capital investment. The nature of the compromise optimal level of household expenditure should now be clear. It should also be apparent that a feasible solution is both possible and likely, provided we do not significantly distort the proportions inherent in the input-output transactions structure, as observed for 1968. The linear programming solution for each of the four experiments described below gives the maximum household expenditure possible. It also provides the values of interrelated sector outputs, sectoral employment, exports and imports, capital stock requirements, borrowing and repayments and national accounts. Shadow price results (given in Appendix 8) can be used to indicate which changes and constraints offer the best scope for economic expansion.

Section 1: Detailed Discussion of the Model Used

Outline of the Technique Used

In Appendix 10 the model used for the 1968 and 1975 experiments is described in mathematical terms and in technical detail. For those not wishing to study the technique in full detail, it may be stated that the essence of the LP approach is to maximise the value of one variable, referred to as the objective function, subject to conditions, referred to as constraints. These are expressed by "linear inequalities", each of which means a weighted sum of the values of a set of variables being specified less than or equal to a known constant value, positive or negative.

The method by which the LP process obtains the maximum is described in textbooks on Linear Programming. It suffices here to state that the number of constraints is always less than the number of variables. The LP process selects a number of variables equal to the number of constraints and gives zero values to all the other variables. It then treats the system of constraints as a system of non-homogeneous simultaneous linear equations having the number of selected variables equal to the number of equations. The system is solved for the selected variables.

In the experiments described below the selected variables include values of sector outputs, of selected exports, selected similar imports, income tax, savings, etc. Personal expenditure, which is identical with the objective function, is also one of the selected variables and includes tourist expenditure. The latter is taken to be 7·9 per cent of personal expenditure for 1968, the same percentage as that relating to Table 3.1 of [2] and 5 per cent for 1975.

In applying the model the 33-sector 1968 I—O transactions table and derived technical (or direct input) coefficients shown in Appendix Tables 3.1 and 3.2 of [2] are used. Each of the 33 rows of technical coefficients forms an individual constraint, which equates the supply for the row with corresponding demands. For 15 of the first 16 rows, similar imports are permitted to increase the supply available from domestic outputs of the sectors, if the LP process requires such imports.

In order to state the employment constraint, there is a row of employment coefficients, in man-years per £1 domestic gross output of each of the 33 productive sectors. The employment constraint is an equation, in which each

employment coefficient is multiplied by the gross output of its sector and the aggregate of these products equated with the specified labour force, expressed in man-years.

A row of capital stock coefficient for industrial sectors is used in the same way as the employment coefficients, in order to take account of capital stock requirements by industry, thus stating the capital stock constraint.

There are also four behaviour relations and five national accounting identities included in the model, as further constraint rows. These give, as part of each set of solutions, a consistent set of national accounts, both from the income and expenditure side. The three important behaviour relations have estimation formulae for (*a*) domestic savings, (*b*) income tax, (*c*) government current transfers. The behaviour relations and the national accounting identities impose on the model the constraints which apply in the actual compilation and balancing procedures used to prepare annual national accounts.

The core of the model therefore consists of 47 rows of constraints, which can be summarised as follows. Rows (1) to (33) equate the supply of each of the 33 productive sectors with domestic plus export demand, less similar imports, the latter relevant for 15 of the first 16 rows. Row (34) accounts for indirect taxes and row (35) for subsidies. Row (36) measures depreciation allowance, while row (37) calculates the national income (wages, pensions, profits, inflows or emigrants' remittances, etc. less such outflows). Rows (38) to (41) have the four behaviour relations: income tax, net government investment and trading income, government current transfer payments, personal and corporate savings. Rows (42) to (44) cater for national accounting entities: government income, government savings, import surplus. Row (45) accounts for complimentary imports. Row (46) equates the aggregate inputs of labour with a specified labour force. Row (47) equates savings from all sources (including import surplus) with gross physical capital formation. The core of the model (apart from the labour constraint) has been described in a recently published paper [17] by the author.

Upper and Lower Bounds

Because the algebraic form is linear, the optimum solution tends to channel all resources into a few outlets and thus give unacceptable results in the form of huge outputs for a few sectors, with small or zero outputs for many other sectors. To avoid the latter outcome, upper and lower bounds must be specified for sectors which have exports and similar imports at possible non-zero levels in their rows. Each upper bound is stated as a constraint row and each lower bound likewise forms a further constraint row.

It is necessary to include bounds because it is not realistic to allow certain domestic outputs to vanish. In any real life context one starts with observed

outputs for an historic economic structure and moves forward in time towards enlarged GNP, etc. The plant, machinery and employment existing in some productive sector during a certain year cannot be supposed to be drastically changeable in the short-term, but rather to be used, renewed, and gradually modified, over a period of years. Similarly, several arguments favour upper bounds on sector gross outputs. Sectors such as agricultural livestock have a fairly definite maximum rate of annual increase determined by biological factors. Huge growth of output means huge extra exports, and these might not be marketable at any prices higher than dumping prices. The investment funds might not be available for the huge increment of capital stock required to give the increase in output capacity.

The model has upper and lower bounds on the gross output of livestock and crops and on each of the ten manufacturing sectors, as well as output bounds for a few other sectors. It is assumed that the exports can be sold at economic f.o.b. values unless otherwise indicated. Because the upper bounds placed on sector outputs are to some extent arbitrary, the meaning of the numerical solutions is thereby limited. *What is significant in these optimal solutions is the selection of sectors which are at their upper bounds, and of those which are at their lower bounds.*

The model also has upper bounds on similar imports, which may occur in 15 of the first 16 rows of the 33 productive sectors. The LP process will set the gross output of a domestic industry at zero level, where better optimisation is obtained by substituting similar imports, unless the similar import amount for that row has an upper bound. The possibility of substitution between similar imports and domestic outputs may be a useful aspect of the model. Foreseen or possible future replacement by domestic (new) commodities is thus intended to be catered for. Similar imports cover a wider range of commodities than do competing imports and might be described as commodities which could be substituted for fairly quickly by domestic items in an emergency. A discussion of systems of classifying imports is contained in [2].

It should be noted that excessive use of bounds can predetermine the results within narrow limits and thus severely curtail insight into how the value of the objective function changes, for changes in the bounds. It is necessary, therefore, to devote considerable thought to the constant values specified for the bounds and it is also necessary to run a number of experiments with the minimum of bounds so as to determine the sectors which would grow and contract in the absence of such constraints. In other words the technique is a kind of learning process, in which repeated trials are made with modified or additional bounds on sector outputs.

In some of the first computer runs the author obtained huge outputs of sectors such as drink, etc. and chemicals, with the outputs of livestock and of

crops far below those actually obtained for 1968. Full employment conditions as well as those of the specified import surplus were satisfied, but the sector output levels were unacceptable. In subsequent runs arbitrary though not unreasonable upper and lower bounds were added for these sectors, which consequently had output values of fairly acceptable size. Four of these latter runs are described below as experiments (1) to (4), two of them relating to 1968 and two to 1975.

Treatment of Labour and Employment

It is likely that a considerable proportion of those who were unemployed in 1968 would work, if suitable employment opportunities were available. There is little doubt (for 1968 conditions at least) that the income from employment was generally well above that obtainable from unemployment benefits. The design of the present model specifies that for full-employment conditions the same proportion of government income is allocated to households, in the form of transfer payments, as applied for 1968 actual conditions. Thus, in terms of human economic welfare, being employed means having more purchasing power than for being unemployed.

Simpson's 1964 results [6] indicated that for a reallocation of 1964 available resources of labour and capital, so as to maximise household expenditure, there would be full employment of the skilled labour force, matched by considerable unemployment of unskilled labour. Table 3.6 of [6] shows 108·6 thousand units of unemployment, for the Simpson "Model A" (actual pool of 1964 skilled labour assumed available), out of 1,036·1 thousand units in the labour force, i.e. Model A gives 10·5 per cent unemployed for the optimal structure. The Simpson "Model B" (20,000 more units of skilled labour, than actually applied for 1964, assumed available) gives 33·9 thousand units of unemployment, i.e. 3·3 per cent unemployed.

The present model has a different approach to employment of labour. Let the full labour force (to be interpreted as all those who would be willing to work) be employed, under the economic conditions simulated by the model. Then see how the shadow price (marginal product) of labour emerges in the results. It is necessary here to quote results of experiments (1) to (4), by way of explanation of the outcome of this trial. In all four experimental results the shadow price of labour is *positive*, which means that the household expenditure maximum, as obtained, would be enlarged further, for a small increase in the supply of labour. The shadow price emerges on average at about £760 per man-year, in a range of £610 to £780 per man-year, for all four experiments. The average level, roughly £15 per week per worker, is at 1968 prices and relates to personal expenditure, after all deductions such as income tax, and after all receipts from current transfer payments. Thus there is a positive

contribution to the objective function, of the order of £760 per extra man-year of labour.

Simpson has commented that the distinction between skilled and unskilled labour, although used consistently in deriving the labour coefficients, is unsatisfactory. The present model does not treat skilled labour as a distinct resource but takes total labour input only. One can project the total labour input coefficient, subject to suitable production functions being available, in conjunction with increasing productive capital stock. These projections are carried out for 1975, being based on production functions described in the author's paper [8], and will be discussed as part of the 1975 experiments. The total use of the full labour supply is one equation of the model.

What would be the outcome if the present model specified skilled and unskilled 1968 categories of labour separately, each not to exceed a specified amount? (It would probably not be feasible to specify both as simultaneously fully absorbed, because of inconsistency in the model specifications, set out thus.) It is likely that the skilled labour would be all used, with some 10 per cent of the full labour-force being unemployed unskilled workers, i.e. the Simpson 1964 Model A results would be repeated for 1968. A larger maximum 1968 personal expenditure would be obtained than that for experiments (1) and (2), because the constraint of full employment of all available labour would not be effective. (Each fully effective constraint reduces the possible maximum, as stated in the previous sub-section.) This higher personal expenditure would undoubtedly benefit those who were employed, but at the human cost of much higher unemployment than that actually occurring in 1968. What the full employment condition means, therefore, is a distribution of labour (among the various productive sectors) different from that of the Simpson Model. More people would have to be put to work in the less remunerative sectors and a more equitable social distribution of the product would result. It is advisable, however, to realise that the maximum value obtained for personal consumption, with its associated set of sector outputs, national accounts, etc. is a mathematical construction and not necessarily a feasible blueprint for an economic annual plan.

With the estimated 1968 employment quoted on page 30 of [1] as being 1,067,000 persons for a labour force 1,128,000 persons, the estimated level of unemployment for 1968 amounted to 61,000 persons, which is 5·4 per cent of the labour force. Section 2 following describes how the full 1968 labour force could be "usefully employed", given the 1968 import surplus of £22·3 million and the 1968 economic structure inherent in Tables 3.1 and 3.2 of [2]. In this context being "usefully employed" means producing for a likely home demand and for selected export markets. Section 3 deals with full employment of a supposed 1975 labour force of 1,155,000 persons, which is the author's com-

promise between some three fairly close projections based on unofficial Central Statistics Office (CSO) estimates. The labour coefficients used in 1968 and 1975 and the employment for the LP results are shown in Appendix 2.

The economic problem of emigration has been bypassed in the experiments, by using supposed levels of the labour force for 1968 and 1975. That significant reduction in Irish unemployment expressed as a percentage of persons employed relative to the corresponding percentage for the United Kingdom can cause significant reduction in net emigration has been shown by B. M. Walsh in [14]. A further factor determining net emigration is the differential between Irish and UK wage rates. This means that the number of people looking for employment in Ireland expands with increases in Irish employment opportunities and improved wage rates, so that either measured or real unemployment is a variable depending on UK and Irish economic conditions present and prospective. Thus the experiments might make better sense if their results were interpreted as showing the possibilities of large increases in employment for a year such as 1975, rather than full employment of some absolute labour force.

Labour is measured in man-years, and the number of man-years required by each sector in the optimal solutions is presumed to be available. Retraining of labour is assumed to have occurred without interfering with the demands on the labour supply by the optimal sector outputs. The differences between the pattern of 1968 actual labour inputs to the sectors and the pattern of each optimal solution are assumed possible. It is supposed that there are no problems of reallocation, for the necessarily large work-force engaged in the construction and assembly of the fixed capital formation covered by loans from abroad, supposedly over a period of years before 1968 and again before 1975. It is also supposed that the full quoted labour force is employable, even though some argument can be made for a maximum of 96 per cent, because of seasonal effects, changing from one job to another, young people coming into the labour supply and so on.

Using the same average remuneration per man-year for each input-output sector as obtains for the 1968 Table 3.1 of [2] implies that the same average mixture of various skilled and unskilled labour categories still holds within each sector (or industry) for full-employment conditions. For an employed work-force 6 per cent larger than that of 1968, this might mean some prior training of labour so as to extend the supply of skilled labour by 6 per cent. There might also be some necessary movement from one industry to another, but the present model ignores the many real-life problems underlying retraining and mobility of labour, by assuming that the required mixture of labour is available.

Capital Stock

In the present model the treatment of capital stock is as follows. Explicit

measures are confined to fifteen of the thirty-three productive sectors, because of data deficiencies. It is admitted that ignoring the capital stock requirements for agriculture, trade, transport and communications (and possibly for some other sectors) may be a serious defect in the model solutions obtained below, since some notable differences in results were obtained for exclusion versus inclusion of capital costs for 15 sectors, as will be described for experiments (1) and (2) respectively. The 15 sectors considered are: solid fuel; stone/ores, etc.; the ten manufacturing sectors; the two construction sectors; electricity/gas/water. The required amount of mid-year capital stock at 1968 prices is obtained as the sum of the products of each sector's gross output by its capital coefficient, the latter including vehicles, plant, buildings, land and other capital assets. The existing amount of capital stock for all 15 sectors combined is taken to be the estimated mid-year "Equivalent—New" level for 1968, as described in [9], but for the gross outputs of the I—O structure rather than those of the Census of Industrial Production. For 1975 the corresponding "expected" level is obtained on the assumption of 1968–1971 observed trends in gross output levels continuing to 1975 and these expected gross outputs having the observed 1968 equivalent—new capital stock coefficients. The difference between the required and the existing or expected is supposed to be loan capital, borrowed from abroad, some 17 per cent of it being repaid in 1968 or 1975 and covered by a corresponding amount of exports, to keep the import surplus unaffected by such repayments.

The rationale of the above treatment requires some further comment. For the 1968 full-employment situation a further £100 million of borrowed capital, for expansions of sectors other than the 15 listed, is forced into the picture. For 1975 a corresponding £300 million for the other sectors is permitted. The 17 per cent is based on a ten-year repayment of the total loan, having 10 per cent of the total loan as repayment of principal, and some 7 per cent of the total loan in the form of interest on the outstanding principal. It is assumed that the amounts of loan capital have been obtained and used for gross domestic fixed capital formation during a period of 5 or 6 years before 1968 and before 1975, i.e. the capital stock is available for use in 1968 and 1975. A further assumption is that the gross physical capital formation in 1968 and 1975 is normally behaved, as per observations of level and content in the national accounts 1966–1971. The savings behaviour and normal growth rate of the domestic economy are assumed capable of renewals and replacements of expected capital stock over the period 1968–1975. The 1975 expected level is intended to be conservative, via use of the 1968 capital stock coefficients, whereas the 1975 capital stock coefficients used to obtain the required amount are generally significantly larger than those of 1968.

A more serious attack on the problem of capital stock requirements for full

employment would require a year-by-year LP solution, starting with 1968 actual employment and stepping up the employment each year so as to equate with the full labour force of 1975. Renewal and replacement would be distinguished from net additions. Allowance would need to be made for increases in the capital stock per man-year. Some fraction of the net additions would be available as usable stock during the year in question, perhaps 50 or 75 per cent. Capital formation in housing, roads, schools, hospitals, etc. would be specified for each year. The agricultural sectors, as well as trade, transport and communications, would need to be considered. The savings from domestic sources could then be compared with the aggregate gross physical capital formation required and the loan capital from abroad would be the residue. The repayments of principal and interest for this amount, as well as for amounts from earlier years, would be included in invisible imports and the model LP solution would have exporting levels sufficient to give a specified import surplus. Such a simulation of an economic programme for the approach towards full employment over a number of years involves dynamic I—O models and is a research topic beyond the scope of this essay.

Sub-Optimal Results Obtainable from LP Solutions

The repayment of principal and interest on loans from abroad, as given by the LP results, can be modified without the necessity of a completely new LP calculation. Both on the income and expenditure side of the national accounts, an enlargement of the repayment reduces GNP by a corresponding amount and vice versa, since the repayment is an invisible import. One will still obtain a balanced set of national accounts, although admittedly any such change in the repayment level given by the LP solution will give a sub-optimal economic structure. The departure from optimality, for moderate changes in the level of the repayment, is unlikely to be serious. It is suggested here that there might be some flexibility in the treatment and interpretation of the repayment. If the loan is to be confined to the requirements of sectors (5) to (19), which alone have explicit capital coefficients, then the loan capital amount, as computed by the LP solution, should be reduced by £100 million for 1968 and £300 million for 1975. It has been implied above that these amounts were in fact subtracted from the existing or expected capital stock for sectors (5) to (19), thus forcing the loan to exceed the needs of sectors (5) to (19), by the amounts deducted. Next, a supposed scheme of repayment is chosen, and the LP calculated repayment adjusted accordingly, as well as the national accounts, to give a revised, sub-optimal solution.

Further Underlying Assumptions and Limitations of the Model Used

(*a*) *Prices*

All prices remain constant, or increase at a constant rate, thus there is no

tendency to change the pattern of household expenditure (or of any other expenditure) in response to relative changes in price movements. This implies a wage and price freeze, these being necessary to prevent the inflation usually inherent in conditions of full or near-full employment.

Although constant (1968) prices have been used in general for the LP experiments, the 1975 profits coefficient for livestock is increased to take some account of EEC improvements in livestock prices. This beneficial effect is so important that failure to make allowance for it would seriously impair the credibility of the 1975 experimental results for agriculture and associated sectors. One or two other related changes are also incorporated in the 1975 I—O structures, thus breaking the letter of the law for strict 1968 pricing. The results should be more realistic, especially in the LP evaluation of the economic efficiency of livestock.

(*b*) *Household Expenditure*

The average 1968 actual pattern of household expenditure still applies for the larger working population. It is difficult to make precise suggestions as to what a realistic pattern for the new situation might be, but a relative increase in consumer non-durables matched by a relative decrease in durable goods is likely. The extra spending-power of the poorer members of the community comes from two sources (*a*) payment for being employed, (*b*) current transfer payments in larger amounts than those of 1968 actual conditions.

(*c*) *Commodity-Mix of Productive Sectors*

The same output mix and input structure of each productive sector, as applied for 1968, applies also to the optimal situation. Thus there is no change in the technical coefficients. This rigidity of structure is an intrinsic property of the model used and will apply to an I—O model of this kind, regardless of how many productive sectors are specified. The absence of flexibility of structure is not a fault of the LP process as such, but is worthy of mention, since it limits the precision with which sectoral outputs can be predicted for models having a small number of sectors, compared with aggregated results for models having sectors in more detail.

The numerical results are of interest, although the model has rather a small number of sectors. Possibly 60 productive sectors would be adequate instead of 33. For example, agricultural livestock might preferably be split into (1) cattle, (2) dairying, (3) pigs, (4) sheep, (5) other livestock. Food manufacturing might be broken down into five activities such as three kinds of animal slaughter, milk products, other food. Likewise, for some others of the 33 sectors used. The results of the experiments are acceptable on the assumption that the product-mix within sectors is in the same proportions as for 1968 actual conditions, i.e.

the I—O technical coefficients, as used, are valid for 1968 and 1975 specified conditions.

(*d*) *Planned Levels of Outputs, of Exports and of Similar Imports*

In order to achieve the consumption and employment targets shown by the 1968 optimal structure, it is necessary to provide the sector outputs and export levels included in that structure and to import the exact optimally specified amounts of each kind of similar imports. All this means prior planning and current quota control of similar imports. Perfect prior knowledge is assumed, as well as full realisation of the planned volume of exports, in sectoral detail and at average 1968 prices. The preparatory build-up of capital stock, to permit the sectoral outputs, also means planning, during some years before 1968. The availability of investment funds, to provide the expansion envisaged for productive capacity, means some prior inflow of such funds from abroad. Thus the optimal structure, in summary, requires (1) a fully worked-out plan, (2) strict control of amounts and kinds of similar imports, (3) international co-operation, to provide investment funds, to sell imports and to purchase the planned menu of exports, (4) domestic co-operation, in every way one can think of.

(*e*) *Active Sectors versus Passive Sectors*

In the LP model, as designed, we visualise certain sectors as active or exposed. These include the agricultural and industrial sectors (excluding construction and electricity, etc.) and the transport sector, which have actual or possible significant exports and some of which have significant competition on the home market from similar imports. The passive or sheltered sectors, by contrast, neither export nor have to compete with similar imports on the home market. These latter sectors include new and repair construction, electricity, etc. and the service sectors generally, including government services, but excluding transport.

Within the framework and design of the model, the active sectors determine the level of real GNP, because their impact on the export markets, modified by the counteracting effects of similar imports, significantly affects their output levels. All other sectors have a significant direct and indirect response to the demands created by these output levels. There is of course interaction on the home market between all sectors, with government income and spending treated as behaviouristic. Government spending depends upon government income and a fixed pattern, based on observed behaviour, is built into the model both for income and spending of government. Thus the model in effect makes the scale of GNP depend significantly upon the scale of net impact upon the world markets as given by exports less similar imports.

What the optimal structure implies is that the government and other passive sectors will keep their input or expenditure patterns in strict proportion to those observed for 1968 actual conditions, with proportionate changes in employment at average 1968 wage rates.

(*f*) *The Real-Life Situation versus the Ideal*

It should by now be obvious that the above assumptions (*a*) to (*b*) concern an ideal which is not practicable. There is less than perfect mobility of labour and on that account alone full employment is not possible. A wage and price freeze is hardly practicable. Perfect planning is not a part of the human condition as we know it, and neither is perfect co-operation, even in Ireland. It is unlikely that the service sectors (or any other sectors) would increase their employment in strict proportion to receipts for sales of goods and services even at constant wage-rates. There is no point in prolonging the discussion as to how and why the mathematical optimum is not realistic. Enough has been said already.

What then of the LP optimal structure and its practical use as a guide to enlarged personal expenditure? This much at least is clear, more for 1975 than for 1968, that large structural changes have significance. Sectors which reach their upper permitted bounds are worthy of development, by contrast with those which the optimal sets at or near their lower bounds. The same criterion applies to exports. Those much larger than for the same sector under 1968 actual conditions are the exports to be marketed. The exports set at zero level in the optimal structure are not profitable to the economy. The similar imports can be useful or destructive, depending upon how the LP optimal treats them, by comparison with 1968 observed levels. Further useful indicators, of expansion or contraction recommended for the bounds on outputs and the constraint constants, are the so-called "Shadow Prices", listed in Appendix 8. These give the marginal products of the constraints in question. In view of the discussion given below on the numerical results of the four experiments, no more will be said here about shadow prices. The general conclusion appropriate at this point is that while large changes from the 1968 observed structure deserve notice, in review of the optimal results, small changes have no significance. The shadow prices are useful indicators of the direction of change of constraint constants which will increase the objective function. The maximum is unlikely to be achieved, in practice, because even a fully worked-out plan is subject to uncertainty of achievement.

Finally, it should be said that the results obtained are strongly influenced by the methodology adopted. In the experiments described below the objective function to be maximised is personal expenditure, but different solutions would be obtained if some other objective function were used. The results

would obviously be different for 1975, if estimated at current prices rather than at 1968 prices. Indeed, a variety of alternative methods could be used, all of which would influence the results differently. Thus the numerical solutions given below should be regarded in proper perspective and the reader should be content to look at large or significant features and to treat the lesser detail with reserve.

Section 2: The 1968 Experiments

Since considerable detail of the background material for the four experiments as well as of their results is contained in Appendices 1 to 9 below, only the main features of 1968 experiments (1) and (2) are considered in this section.

The System of Constraints

In addition to the 47 rows considered to be the core of the model, experiments (1) and (2) had 15 upper bounds on sector outputs, 13 lower bounds on sector outputs and 13 upper bounds on similar imports. There were also lower bounds on government current expenditure and gross domestic physical capital formation. Experiments (2) had an extra row for capital stock required. There were, therefore, 90 rows of constraints for experiment (1) and 91 for experiment (2).

Upper Bounds on Sector Outputs and Similar Imports

All ten manufacturing sectors had upper bounds of 150 per cent of their 1968 I—O levels given in Appendix 3.1 of [2]. The five sectors—livestock, crops, fishing, stone/ores, etc. and transport each had upper bounds 110 per cent of the 1968 I—O output level. The rationale of the upper bounds chosen was that since the manufacturing industries have in fact doubled their merchandise exports between 1964 and 1968 [2, p.17], this area of economic activity seemed the right place to concentrate the search for full employment. The five sectors having upper bounds set at 110 per cent were considered to be unsuitable for major expansions beyond observed 1968 output levels, for various reasons.

Thirteen constraint rows were added, to regulate the behaviour of similar imports. These were not to exceed a certain fraction of the domestic flow to domestic purchasers, for each of the 13 rows containing a similar import variable.

The fractions were calculated from the entries in the 1968 I—O Table 3.1 of [2]. It is assumed that the combined effects of political motivation, import quotas and customs duties have set upper limits on the similar imports in the form specified but that a situation of purely domestic supply is possible, i.e. it is possible to have no similar imports for any of the 13 rows considered, if the optimisation process seeks this form of solution.

Lower Bounds on Sector Outputs, Government Current Expenditure and Capital Formation

For the 13 sectors having similar imports as a possible substitute in the LP formation, lower bounds were set, to prevent possible complete replacement by similar imports. For livestock and crops the 1968 actual I—O sector outputs were chosen, on the grounds that full use should be made of agricultural land, to avoid possible unrealistic LP solutions. Solid fuel had its lower bound set at 50 per cent of its 1968 I—O output, to allow possible replacement of peat by imported coal, etc. The ten manufacturing sectors had lower bounds set at 80 per cent of their 1964 I—O sector outputs. These lower bounds convey a rough picture of the output levels of 1962–63, since which time the really spectacular increases in output have occurred. Thus for solid fuel and manufacturing, the interesting question being raised is how should growth have occurred since 1962–63 so as to give 1968 full employment?

Government current expenditure was constrained not to fall below its 1968 I—O table 3.1 level of £168·83 million. Gross physical capital formation had its lower bound set at 90 per cent of the 1968 I—O Table 3.1 value of £269·07 million, i.e. the lower bound was £242·17 million.

Other Features of the Models

Experiment (2) had a row for capital stock, whereby the capital stock required by outputs of sectors (5) to (19) was accounted for by investment borrowed from abroad, as well as from domestic sources. Some allowance was also made for loan capital in other sectors.

The 1968 average pattern was used for each of personal expenditure, government current expenditure and gross physical capital formation. These patterns were obtained as three columns of coefficients adding to unity, by using the final demand entries in the 1968 I—O Table 3.1, together with their column aggregates.

There were 14 exporting activities entered explicitly as variables—livestock, fishing, stone/ores, etc., transport and the 10 kinds of manufacturing.

Results of 1968 *LP Experiments* (1) *and* (2)

In both cases a feasible optimal solution was obtained. For full employment of the labour force of 1,128,000 man-years and an import surplus of £22·3 million (the specified maximum), experiment (1) gave £955·1 million for household expenditure and experiment (2) £924·1 million as well as £25·6 million for 17 per cent repayment of foreign loan capital. (See Table 5). These maximum values of household expenditure, compared with £887·8 million for the 1968 I—O structure used as base, show increases of 7·6 per cent

for experiment (1) and 4·1 per cent for experiment (2). The loan repayment for the latter experiment accounts roughly for its household expenditure being some £31 million below that of experiment (1). The loan capital required was £50·8 million for sectors (5) to (19), apart from a further £100 million postulated to be needed for other productive sectors or for social capital. This £50·8 million loan for experiment (2) is explained in Appendix 3. Fairly concise comment on some five aspects of the solutions is given below.

Sector Outputs

The full detail of sector outputs is shown in Appendix 1.1 while results for the 16 sectors having upper and/or lower bounds specified are given in Table 1.

TABLE 1: *Sector outputs for Experiments* (1) *and* (2) *compared with* 1968 *I—O Base Data*

Sector		*Lower Bound*	1968 *Base*	*Experiment* (1) 1968	*Experiment* (2) 1968	*Upper Bound*	*Percentage of Output Exported*	
		£ million at 1968 *prices*					1968 *Base* ‡	*Experiment* (2) ‡
Agricultural Livestock	(1)	324·24	324·24	324·24†	324·24†	356·66	17	34
Agricultural Crops (excluding peat)	(2)	94·43	94·43	94·43†	94·43†	103·88	2	2
Fishing	(4)	None	4·20	2·82	2·72	4·61	31	Nil
Solid fuel	(5)	6·22	15·11	16·36	15·96	None	5	4
Stone/ores, etc.	(6)	None	19·37	21·30*	21·30*	21·30	48	53
Food	(7)	196·32	332·31	257·93	210·45	498·47	34	Nil
Drink/tobacco	(8)	29·87	50·19	75·29*	75·29*	75·29	24	45
Textiles (excluding hosiery)	(9)	32·28	51·72	32·28†	32·28†	77·58	34	16
Clothing, etc.	(10)	43·79	72·87	45·17	43·79†	109·30	40	0
Wood/furniture	(11)	12·50	20·76	19·75	20·37	31·14	15	10
Paper/printing	(12)	26·00	45·17	67·80*	67·80*	67·80	16	35
Chemicals	(13)	20·91	51·64	77·46*	77·46*	77·46	26	45
Clay, etc.	(14)	14·68	30·27	45·41*	23·86	45·41	21	Nil
Metal, etc.	(15)	84·57	152·66	228·99*	228·99*	228·99	26	46
Other manufacturing	(16)	24·63	70·62	105·94*	105·94*	105·94	56	67
Transport	(21)	None	89·39	98·33*	98·33*	98·33	40	42

‡Excluding Tourist expenditure
*at upper bound
†at lower bound

The latter table shows the bounds and the outputs, including those of the 1968 base structure. Although experiment (1) results are given in Table 1, the discussion here will focus mainly on those of experiment (2). As can be seen from the table, agricultural livestock and crops both stay at their lower bounds, and

so have been found to be relatively unprofitable for increasing household expenditure. Fishing emerges as inefficient for exporting, whereas solid fuel and stone/ores, etc. have been found to be efficient, the first for the home market in competition with possible similar imports and the latter for exporting. Transport likewise is good for invisible exports.

Of the ten manufacturing sectors, five reach the upper bounds specified, these sectors being (8) drink, etc., (12) paper, etc., (13) chemicals, etc., (15) metal, etc. and (16) other manufacturing. Three sectors show slight or major decreases below their 1968 base levels, namely wood etc., (11), food (7) and clay, etc. (14). Wood, etc. is slightly below the 1968 base level of output, but both food and clay, etc. are set at two-thirds of the level they reached in the 1968 I—O base structure. These three sectors, however, lie above the lower bounds specified for them, but below their upper bounds. They have zero-level shadow prices (see Appendix 8 below) for both kinds of bounds and moderate changes in the outputs of these sectors have a neutral effect upon the objective function. By reference to experiment (1), both sectors (7) and (4) show reduced output through capital stock effects.

The remaining two sectors, namely, (9) textiles and (10) clothing etc. are definitely inefficient, being set at their lower bounds, with major replacement by similar imports. Since these sectors show correspondingly low levels for experiment (1), the capital stock condition is not responsible for their inefficiency.

The main lesson to be learnt from Table 1 is that seven sectors are relatively efficient in 1968 specified conditions, both with and without capital stock considerations. These sectors are numbered (6), (8), (12), (13), (15), (16) and (21) and show the best potential for increasing household expenditure.

Distribution of Sector Outputs Between Home and Export Markets

The export percentages for the 1968 base and for experiment (2) appear in the last two columns of Table 1, while Appendix 1.2 shows the distribution of gross outputs of 16 sectors between home markets and export markets, for the 1968 base and for experiments (2) and (3). The distribution in question excludes similar imports other than negligible amounts of re-exports.

Table 1 shows that for experiment (2) versus the 1968 base, the proportion of domestic output exported is roughly doubled for livestock*, drink etc., paper etc., chemicals and metal etc. Of these 5 sectors, 4 are at their upper bounds (Table 1). A further 6 sectors show experiment (2) exports forming roughly the same percentage of domestic gross outputs as for the 1968 base, namely,

*In other words the highly subsidised exports of milk products and meat were found to be inefficient for increasing household consumption.

crops, solid fuel, stone/ores etc., wood etc., other manufacturing and transport. Of the remaining 5 sectors, 4 show reduction of exports to zero level—fishing, food, clothing etc., and clay etc., while the textile sector has the experiment (2) export proportion at about half the 1968 base level. All these 5 sectors have outputs far below those of the 1968 base, partly as a result of having been rejected for exporting.

TABLE 2: *Employment for Experiments* (1) *and* (2) *compared with* 1968 *Base Data*

Sector or sector-group		*Thousand man-years*			*Percentage Distribution*		
		1968 *Base*	*Experiment* (1)	*Experiment* (2)	1968 *Base*	*Experiment* (1)	*Experiment* (2)
Agriculture, forestry, fishing	(1)	308·79	308·00	307·79	28·9	27·3	27·3
Stone/ores and solid fuel	(2)	15·41	16·76	16·46	1·4	1·5	1·5
Food, drink and tobacco	(3)	56·62	51·45	44·85	5·3	4·6	4·0
Textiles and clothing	(4)	49·07	30·48	29·86	4·6	2·7	2·6
Wood, paper and chemicals	(5)	31·24	42·40	42·64	2·9	3·8	3·8
Clay, metal, other manufacturing	(6)	54·96	82·44	76·29	5·1	7·3	6·8
Total Manufacturing (3)+(4)+(5)+(6)		191·89	206·77	193·64	17·9	18·3	17·2
New and repair construction	(7)	91·44	105·37	95·51	8·6	93	8·5
Electricity/gas/water	(8)	10·96	11·96	11·53	1·0	11	1·0
Total Industry (2)+(3)+(4)+(5)+(6)+(7)+(8)		309·70	340·86	317·14	29·0	30·2	28·1
Trade and transport	(9)	173·09	186·80	181·27	16·2	16·6	16·1
Other services, except government	(10)	214·93	228·67	238·26	20·1	20·3	21·1
Government services	(11)	62·90	63·67	83·55	5·9	5·6	7·4
Total Services (9)+(10)+(11)		450·92	479·14	503·08	42·2	42·5	44·6
Total, All Sectors		1,069·40	1,128·00	1,128·00	100—	100—	100—
Within Manufacturing							
Food		46·24	35·89	29·29	24·1	17·4	15·1
Drink/tobacco		10·38	15·56	15·56	5·4	7·5	8·0
Textiles (excluding hosiery)		16·04	10·01	10·01	8·4	4·8	5·2
Clothing etc.		33·03	20·47	19·85	17·2	9·9	10·3
Wood/furniture		8·15	7·75	7·99	4·2	3·7	4·1
Paper/printing		15·64	23·48	23·48	8·2	11 4	12·1
Chemicals		7·45	11·17	11·17	3·9	5·4	5·8
Clay etc.		8·64	12·96	6·81	4·5	6·3	3·5
Metal etc.		38·52	57·78	57·78	20·1	27·9	29·8
Other manufacturing		7·80	11·70	11·70	4·1	5·7	6·0
Total Manufacturing		191·89	206·77	193·64	100—	100—	100—

Employment

Selected figures for actual and percentage distributions of employment are given in Table 2. The remarks following will be confined to comparisons between experiment (2) results and the 1968 base.

Employment in agriculture, forestry, fishing and in total manufacturing shows practically no change from the 1968 base level. The absorption of the 59,000 man-years of 1968 base unemployment to give 1968 full employment takes the form of an extra 52,000 in total services, with some 5,000 of the rest appearing in construction and electricity etc. Government services take 21,000 of the extra employment, 23,000 go to other services while trade and transport take the remaining 8,000. Thus the apparent solution of the unemployment problem, as found by experiment (2), is an expansion of employment, by some 16 per cent, in government and other services, except trade and transport. This means that the percentage of total employment occurring in sectors (10) to (11) of Table 2 is increased from 26·0 for the 1968 base to 28·5 for experiment (2).

It may be pointed out that the experiment (2) employment has 1968 average wage-levels, due to the fixed ratio between the wage coefficient and the man-year coefficient for each sector being that of the 1968 base, apart from minor adjustments of the latter, detailed in Appendix 2. With government current expenditure some 38 per cent higher for experiment (2) than for the 1968 base, it follows that expenditure on government services and on education (the two largest fixed proportions of government current expenditure) is up by 38 per cent, with corresponding effects upon employment. This explains not merely the extra 21,000 man-years in government services, but also some 11,000 in education. The increased government income which permits this extra expenditure is consistent with the 1968 structure of the model, as used by the LP optimisation process and is the result of the optimum levels of sector outputs, exports, similar imports and so on.

In order to see whether the increased employment in the services sectors is reasonable, a comparison of experiment (2) employment percentage distribution with that of a few of the smaller European countries can be made for the year 1967 and for the aggregate denoted "public services". The nearest Irish equivalent consists of communications, education and government services, the latter including local authority medical services, the defence and police forces and the general civil service. Experiment (2) shows 145,000 man-years for the aggregate of sectors (24), (26) and (32), which together account for some 13 per cent of total employment. Table 3.27 of [16] shows 14·1 per cent for Belgium (although these figures exclude all public hospitals), 15·4 per cent for The Netherlands (although health services are privately organised), and 13·3 per cent for Norway. It therefore appears that the experiment (2) percentage is

in no way excessive by comparison with 1967 percentages in the three countries considered.

Table 3.32 of [16] can be used to give further employment data, with Denmark taken into account as well (except for public services for which Danish data are missing). The average employment pattern for the four European countries (Belgium, The Netherlands, Norway and Denmark) circa 1967 can be compared with that of experiment (2), for four major sub-sectors of economic activity. Results are as follows:

	Experiment (2)	*European Average*
	Percentage of Total Employment	
Agriculture etc.	27·3	12·1
Manufacturing	17·2	30·1
Public Service	13·0	14·3
All other activities	42·5	43·5
Total	100·0	100·0

For agriculture combined with manufacturing, the European average is 42·2, compared with 44·5 for experiment (2) and the other two percentages also show close correspondence. It therefore appears that there is nothing wrong with the distribution of employment among the four sub-sectors listed, as given by experiment (2), in comparison with the European average described above.

The changes in employment within manufacturing (as shown in Table 2) are derived from changes in sector outputs considered above. In percentages of total employment in manufacturing sectors, the 24·1 per cent share for food, for the 1968 base, is reduced to 15·1 per cent for experiment (2). The latter reduces the base share of 25·6 per cent held by textiles plus clothing to 15·5 per cent. The 19 per cent reduction in these three sectors is balanced by increases of almost 10 per cent for metal etc., almost 3 per cent for drink etc., and almost 4 per cent for paper etc., with some 2 per cent for chemicals and for other manufacturing. As can be seen the experiment (2) optimal employment pattern within manufacturing differs considerably from that of the 1968 base.

Capital Stock

The ten manufacturing sectors are examined in Table 3, which indicates that experiment (2) requires only some £31 million more of capital stock than the output levels of the 1968 base, whereas experiment (1) would need £77 million extra. The advantage of optimising the use of the stock, as is done by experiment (2), is evident. A fairly full discussion appears in Appendix 3.

TABLE 3: *Capital stock of manufacturing for Experiments (1) and (2), compared with 1968 Base Data*

		Estimated mid-year levels corresponding to I–O sector outputs					
		1968 *Base*	*Experiment* (1)	*Experiment* (2)	1968 *Base*	*Experiment* (1)	*Experiment* (2)
		£ million at 1968 prices			*Percentage Distribution*		
Food	(7)	137·11	106·42	86·83	28·3	19·0	16·8
Drink/tobacco	(8)	53·47	80·21	80·21	11·0	14·3	15·6
Textiles (excluding hosiery)	(9)	34·66	21·63	21·63	7·2	3·9	4·2
Clothing etc.	(10)	33·58	20·80	20·17	6·9	3·7	3·9
Wood/furniture	(11)	11·77	11·19	11·55	2·4	2·0	2·2
Paper/printing	(12)	34·14	51·24	51·24	7·0	9·1	9·9
Chemicals	(13)	37·14	55·71	55·71	7·7	9·9	10·8
Clay etc.	(14)	36·19	54·28	28·52	7·5	9·7	5·5
Metal etc.	(15)	73·00	109·50	109·50	15·1	19·5	21·2
Other manufacturing	(16)	33·40	50·10	50·10	6·9	8·9	9·7
TOTAL		484·46	561·08	515·46	100—	100—	100—

Following the changes in the pattern of the distribution of labour within total manufacturing, described above, one is not surprised to see the experiment (2) distribution of £515·5 million of capital stock different from that of the £484·5 million corresponding to the 1968 base sector outputs. In percentages of the total cost, the main reduction is for food, being 11·5, with 6·0 per cent reduction for textiles plus clothing and 2·0 per cent for clay etc. The largest increase in the share of the total is 6·1 per cent for metal etc. and other increases include 4·6 for drink etc., 3·1 for chemicals, 2·9 for paper etc., and 2·8 per cent for other manufacturing.

It might be well to state here that the changes under discussion arise from a supposed build-up of capital stock in each of the various sectors over a period of years since roughly 1963. Thus the experiment (2) optimal outcome for a sector may be higher or lower than that of the 1968 base, depending on how the sector supposedly changed since 1963 in reaching its 1968 optimal capital stock requirement.

Exports and Similar Imports

Table 4 shows export and similar import results for sectors (1) to (16), where significant changes, between the optimal experiment (2) pattern and the 1968 base pattern, occur. The export figures exclude tourist expenditure within the country.

Major export increases, of a size once or twice the value of the base exports,

are found for livestock*, drink etc., paper etc., chemicals, metal etc., and other manufacturing, i.e. for 6 sectors of the 15 listed. Major decreases are apparent for food, textiles, clothing, etc. and clay etc., i.e. for further 4 sectors. The aggregate experiment (2) increase, therefore, emerges as a modest £52 million for sectors (1) to (16), some 15 per cent of the 1968 base level.

The only dramatic change in the similar import pattern is a decrease of £13 million for experiment (2) agricultural crops. The direct input coefficient for crops to food manufacturing is 0·1231 and a decrease of £122 million in the output of the latter causes a decrease of £15 million in the demand for crops. Since the output of the crops' sector was given a lower bound identical with

TABLE 4: *Exports and similar imports for Sectors (1) to (16) of Experiment (2) compared with 1968 Base Data*

Sector		1968 *Base*			1968 *Experiment* (2)			*Percentage Distribution of net Exports*	
		Exports except tourist (1)	*Similar Imports* (2)	*Net Exports:* (1) *less* (2) (3)	*Exports except tourist* (4)	*Similar Imports* (5)	*Net Exports:* (4) *less* (5) (6)	1968 *Base*	*Experiment* (2)
		£ million			*£ million*				
Agricultural livestock	(1)	54·97	18·82	36·15	110·07	14·97	95·10	66·6	83·8
Agricultural crops (excluding peat)	(2)	1·76	17·49	—15·73	1·76	4·77	—3·01	—29·0	—2·7
Fishing	(4)	1·32	0·24	1·08	nil	0·24	—0·24	2·0	—0·2
Solid fuel	(5)	0·71	1·09	—0·38	0·71	1·16	—0·45	—0·7	—0·4
Stone/ores etc.	(6)	9·27	0·46	8·81	11·38	0·46	10·92	16·2	9·6
Food	(7)	113·98	17·78	96·20	nil	17·11	—17·11	177·1	—15·1
Drink/tobacco	(8)	12·16	4·05	8·11	34·17	4·38	29·79	14·9	26·3
Textiles (excluding hosiery)	(9)	17·64	35·53	—17·89	5·17	28·26	—23·09	—32·9	—20·4
Clothing	(10)	28·79	16·33	12·46	0·13	16·07	—15·94	22·9	—14·1
Wood/furniture	(11)	3·04	14·29	—11·25	2·04	14·78	—12·74	—20·7	—11·2
Paper/printing	(12)	7·39	24·46	—17·07	23·47	28·62	—5·15	—31·4	—4·5
Chemicals	(13)	13·61	26·40	—12·79	34·85	29·58	5·27	—23·5	4·6
Clay etc.	(14)	6·39	5·15	1·24	nil	5·15	—5·15	2·3	—4·5
Metal etc.	(15)	39·19	82·25	—43·06	106·20	89·01	17·19	—79·3	15·2
Other manufacturing	(16)	39·45	31·02	8·43	71·46	33·44	38·02	15·5	33·5
Total		349·67	295·35	54·32	401·41	287·98	113·43	100—	100—

*The realism of exporting some 34 per cent of 1968 agricultural livestock at average 1968 base prices (per experiment (2)) may be questioned. The need for subdivision of both livestock production and food manufacturing into five or more sectors is apparent. Such figures would give separate detail for cattle, dairying, pigs and so on within agriculture and for beef, bacon, other meat, milk products, milling and so on within food manufactures. It will appear below, in discussing the 1975 results shown in Table 13, that livestock exports can be forced through sector (7), food manufacturing, for no change in livestock output and for negligible reduction of household expenditure. This alternative method of disposal of livestock output may be more realistic than that of directly exporting it.

the 1968 I–O base sector output, the only way to cut back on crops is by reducing similar imports. The shadow prices in Appendix 8 indicate a very small but positive profitability for extending the upper bounds on twelve of the thirteen similar imports treated as variables, the exception being crops. Apart from the latter, all similar imports are at their upper bounds.

It appears that both exports and similar imports for a row can increase together, their difference, however, remaining relatively invariant. It is instructive to compare the pattern of net exports (exports less similar imports) for experiment (2) with that of the base, as percentages of aggregate net exports. In experiment (2) results, six sectors are chosen as significant net exporters (having a sizeable positive net export percentage) and these are livestock, stone/ores etc., drink etc., chemicals, metal etc. and other manufacturing, the latter four being four of the five sectors of manufacturing found efficient for employment and capital stock reallocations. With food output cut back for experiment (2) whereas livestock has been held at its 1968 base level, the only outlet for livestock output in excess of home demand is through direct exports. The paper etc. sector has a negative net export percentage (meaning net imports) for experiment (2), although selected as efficient for employment and capital stock reallocations. This negative percentage is numerically much smaller than that of the base (—31·4) so the movement has been towards less net imports. The other five sectors chosen for net importing by experiment (2) are food, textiles, clothing etc., wood etc., and clay etc. and these have been found inefficient on other grounds, as shown in previous discussion.

It is the opinion of the author that an important outcome of the experiments is the recognition of net exports or net imports having economic significance for the efficient performance of a sector, rather than gross exports alone. A fairly obvious difficulty, in practical planning applications, may be how to predict or specify the similar import value for a row, since a postulated net export value requires the import part to be specified before the gross export can be stated for export planning. Conversely, a realistic upper limit for the gross exports of a sector, in the present discussion, requires a corresponding upper limit on similar imports of such commodities, to achieve the optimal net export level. The question of how to control similar imports, in conditions of free trade, may be worth mentioning, even if no answers are offered to it here.

National Accounts

Table 5 shows the LP national accounts results, with 1968 base figures for comparison. The numbering of rows down to (47) corresponds to that given for the constraints, in Appendix 7.

It might be well to first of all see the main differences between experiments (2) and (1), arising solely from the capital stock condition being omitted from

TABLE 5: *National accounts results for Experiments (1) and (2) compared with 1968 Base Data*

Item		1968 *Base*	*Experiment* (1)	*Experiment* (2)
			£ million	
Indirect taxes	(34)	237·42	258·33	250·42
Subsidies	(35)	59·51	45·68	39·88
Wages, profits etc. before loan repayment	(36)(a)	1,034·41	1,107·94	1,118·27
Less loan repayment	(36)(b)	nil	nil	—25·64
Depreciation	(37)	91·11	99·38	97·90
Income tax	(38)	122·80	134·19	151·74
Savings (persons and corporations)	(39)	139·22	143·71	145·46
Net government investment and trading income	(40)	29·00	30·40	30·61
Government current transfers	(41)	144·40	155·48	159·28
Government income [(34)+(38)+(40)]	(42)	389·22	422·92	432·78
Government savings [(42)—(51)]	(43)	16·48	52·93	nil
Import surplus [(60)—(57)]	(44)	22·26	22·25	22·26
Complementary imports	(45)	273·32	343·61	329·68
Gross domestic physical capital formation	(47)(a)	269·07	318·27	265·61
Total savings available for [(37)+(39)+(43)+(44)]	(47)(b)	269·07	318·27	265·61
Household expenditure	(48)	887·78	955·12	924·10
Net government current expenditure	(49)	168·83	168·83	233·62
GNP arising [(34)—(35)+(36)(a)—(36)(b)+(37)]	(50)(a)	1,303·42	1,419·96	1,401·07
GNP expenditure [(47)(a)+(48)+(49)—(44)]	(50)(b)	1,303·42	1,419·96	1,401·07
Government outgoings on current account [(35)+(41)+(49)]	(51)	372·74	369·99	432·78
Variable exports, at producer's prices	(52)	377·06	426·21	433·72
Margin on merchandise exports (except subsidy)	(53)(a)	16·96	19.28	19·58
Subsidy margin on food exports	(53)(b)	—12·26	—2.08	nil
Tourist expenditure	(54)	75·70	81.44	78·80
Constant exports	(55)	30·96	30·96	30·96
Wages, profits etc. net inflow	(56)	58·00	58.00	58·00
Total Exports [(52)+(53)(a)+(53)(b)+(54)+(55)+(56)]	(57)	546·42	613·81	621·05
Variable similar imports	(58)	294·65	291·75	287·28
Complementary imports	(45)	273·32	343·61	329·68
Constant imports	(59)	0·70	0·70	0·70
Loan repayment	(36)(b)	nil	nil	25·64
Total Imports [(58)+(45)+(59)+(36)(b)]	(60)	568.68	636.06	643·30

(1), since there are no other differences in conditions. The experiment (1) household expenditure, at £955 million, is £51 million higher than that of (2), which has an apparent extra cost of £25·6 million repayment of loan from abroad, covered by extra exports less imports. Experiment (2) finds the extra £25·6 million in the form of £7·2 million extra exports of various kinds, £4·5 million less of similar imports and £13·9 million less of complementary imports. The latter reduction partly causes (2) to have £53 million less of capital formation than experiment (1), but the capital stock required by construction and metal sectors must also have a reducing effect on the level of capital formation in (2). The lower capital formation in (2) pushes government savings to zero level (compared with £53 million in (1)).

Government current expenditure in (2) is accordingly some £65 million higher than in (1). Indirect taxes for (2) are some £8 million less than those of (1) and subsidies some £6 million less, mainly because of lower output of the food sector and of food exports. Income tax in (2) is £18 million higher than in (1) because of direct and indirect results of the £65 million higher government current expenditure generating considerably higher sector outputs in education (£12 million extra) and government services (£40 million extra), both of which sectors are wage-intensive. The conclusion reached is that omission of some capital stock constraint can give a less realistic solution for many of the national accounting variables.

For experiment (2) compared with the 1968 base structure, the extra 4·1 per cent of household expenditure for the extra 59,000 man-years of employment (5·5 per cent of the base level) shows a slight reduction in household expenditure per man-year, which is about £819 for experiment (2). The national accounts variables for (2) are generally larger than those of (1), with total exports and total imports £75 million higher, to preserve the same import surplus of £22·3 million.

The subsidies for experiment (2) are £20 million less than those of the 1968 base, because of a £12 million saving on food exports (set at zero for (2)) and roughly £8 million through a cut-back* of £122 million in the output of the food sector, having a subsidy coefficient of 0·0664. Capital formation for experiment (2) is some £3·5 million below that of the 1968 base, but still well above the lower bound of £242·17 million mentioned above.

The reader can find further detail in Table 5. Of the £98 million extra GNP arising in experiment (2) results, versus the 1968 base levels, £36 million went to household expenditure and £65 million to government current expenditure,

*The reduction in the output of the food manufacturing sector has caused an increase in the direct exports of agricultural livestock. The output of livestock is still the same as it was for the 1968 base. A slightly sub-optimal approach, which routes livestock exports through the food sector, is discussed below for results shown in Table 13.

for a reduction of £3 million in capital formation. That the capital stock coefficients are mainly responsible for this distribution of the extra GNP becomes apparent by reference to experiment (1), which keeps government current expenditure at its base level (coinciding with the specified lower bound) and distributes the extra GNP in the form of £67 million extra to household and £49 million to capital formation. The two major components of government current expenditure are government services (63 per cent) and education (20 per cent) and both of these have zero capital stock coefficients for experiment (2). Household expenditure and capital formation, by contrast, make direct demands on the required level of capital stock, involving loan capital and repayment.

TABLE 6: *Wages, profits and depreciation for* 1968 *Experiment* (2) *compared with* 1968 *Base Data*

Sector or sector-group		1968 *Base*				1968 *Experiment* (2)			
		Wages etc.	*Profits*	*Depreciation*	*Total*	*Wages etc.*	*Profits*	*Depreciation*	*Total*
		£ million				*£ million*			
Agriculture, forestry, fishing	(1)	21·1	170·4	13·0	204·5	21·1	169·5	12·8	203·7
Stone/ores and solid fuel	(2)	9·8	12·1	2·7	24·6	10·5	13·0	2·9	26·4
Food, drink and tobacco	(3)	49·4	16·0	7·3	72·7	43·3	14·4	6·5	64·2
Textiles and clothing	(4)	31·5	8·2	3·6	43·3	19·2	5·0	2·2	26·4
Wood, paper and chemicals	(5)	28·0	9·9	4·3	42·2	38·9	14·1	6·2	59·2
Clay, metal, other manufacturing	(6)	48·5	16·6	7·5	72·6	66·7	22·6	9·9	99·2
Total Manufacturing (3)+(4)+(5)+(6)		157·4	50·7	22·7	230·8	168·1	56·1	24·8	249·0
New and repair construction	(7)	74·1	9·2	2·3	85·6	77·4	9·4	2·4	89·2
Electricity/gas/water	(8)	12·3	9·0	5·8	27·1	13·0	9·5	6·1	28·6
Total Industry (2)+(3)+(4)+(5)+(6)+(7)+(8)		253·6	81·0	33·5	368·1	269·0	88·0	36·2	393·2
Trade and transport	(9)	103·5	42·6	14·2	160·3	109·4	44·6	15·2	169·2
Other services, except government	(10)	156·8	83·1	24·9	264·8	176·5	96·2	27·0	299·7
Government services	(11)	80·6			80·6	110·9			110·9
Total services (9)+(10)+(11)		340·9	125·7	39·1	505·7	396·8	140·8	42·2	579·8
Total all sectors		615·6	377·1	85·6	1,078·3	687·2	398·3	91·2	1,176·7

TABLE 6:—*continued.*

Sector or sector-group		1968 *Base*				1968 *Experiment* (2)			
		Wages etc.	*Profits*	*Depreciation*	*Total*	*Wages etc.*	*Profits*	*Depreciation*	*Total*
		£ million				*£ million*			
		Percentage Distribution				*Percentage Distribution*			
Agriculture, forestry, fishing	(1)	3·4	45·2	15·2	19·0	3·1	42·5	14·0	17·3
Stone/ores and solid fuel	(2)	1·6	3·2	3·2	2·3	1·5	3·3	3·2	2·2
Food, drink and tobacco	(3)	8·0	4·2	8·5	6·7	6·3	3·6	7·1	5·5
Textiles and clothing	(4)	5·1	2·2	4·2	4·0	2·8	1·3	2·4	2·2
Wood, paper and chemicals	(5)	4·5	2·6	5·0	3·9	5·7	3·5	6·8	5·0
Clay, metal, other manufacturing	(6)	7·9	4·4	8·8	6·7	9·7	5·7	10·9	8·4
Total Manufacturing (3)+(4)+(5)+(6)		25·6	13·4	26·5	21·4	24·5	14·1	27·2	21·2
New and repair construction	(7)	12·0	2·4	2·7	7·9	11·3	2·4	2·6	7·6
Electricity/gas/water	(8)	2·0	2·4	6·8	2·5	1·9	2·4	6·7	2·4
Total Industry (2)+(3)+(4)+(5)+(6)+(7)+(8)		41·2	21·5	39·1	34·1	39·1	22·1	39·7	33·4
Trade and transport	(9)	16·8	11·3	16·6	14·9	15·9	11·2	16·7	14·4
Other services, except government	(10)	25·5	22·0	29·1	24·6	25·7	24·2	29·6	25·5
Government services	(11)	13·1			7·5	16·1			9·4
Total Services (9)+(10)+(11)		55·4	33·3	45·7	46·9	57·7	35·4	46·3	49·3
Total, All Sectors		100—	100—	100—	100—	100—	100—	100—	100—

Gross Domestic Product at Factor Cost by Sector of Origin

Table 6 shows the distribution of wages, profits and depreciation, as well as their sum (which is gross domestic product (GDP) at factor cost), among eleven sub-sectors, for the 1968 base and for experiment (2). The lower half of Table 6 contains the derived percentages.

In value terms, there is virtually no change in GDP for agriculture etc., some £18 million extra for experiment (2) manufacturing and some £74 million extra for experiment (2) total services, the latter increase showing the effects of absorbing an extra 52,000 man-years.

In percentage terms, experiment (2) shows 17·3 per cent of total GDP originating in agriculture etc., versus 19·0 per cent for the 1968 base, both

manufacturing and industry virtually unchanged, and 49·3 per cent for services compared with 46·9 for the base. Thus experiment (2) has reduced the agricultural share of GDP and increased the services share.

Comparison with European data can be made via Table 3.27 (for 1967) and Table 3.31 (1965–1967) of [16]. The average percentage level for the four continental countries listed above in the discussion of employment may be compared with the percentage relating to the 1968 experiment (2), for each of the four major components of GDP corresponding to the major subdivisions of employment. Results are as follows:

	Experiment (2)	*European average*
	Percentage of total GDP	
Agriculture etc.	17·3	8·4
Manufacturing	21·2	30·2
Public Service	16·0	12·8
All other activities	45·5	48·6
Total	100·0	100·0

It therefore emerges that the experiment (2) combined shares of agriculture etc. and manufacturing, at 38·5 per cent of GDP, almost equal the European 4-country average level of 38·6 per cent and likewise for all the rest of economic activity. On this score, at least, the GDP results for experiment (2) appear to be credible.

Section 3: The 1975 Experiments

THE details of the preparations for the 1975 experiments (3) and (4) appear in Appendix 9. There are some four significant differences from 1968 conditions or constraints. (1) Output per man-year is increased, for 1975. (2) Significantly larger profits per unit of agricultural livestock apply. (3) There are no subsidies of any kind related to raw or manufactured agricultural commodities. (4) Incremental personal expenditure is used as objective function, with 1968 actual personal expenditure being part of the row constants.

For both experiments a feasible optimal solution was obtained. For full employment of the labour force of 1,155,000 man-years and an import surplus of the specified maximum (£65 million), experiment (3) has a 1975 maximum household expenditure of £1,246 million, which is 40·3 per cent above the 1968 base level of £887·8 million. (See Table 11). The experiment (4) level of household maximum expenditure is £1,268 million, which is 42·8 per cent higher than the 1968 base level. The repayments of foreign loan capital (at 17 per cent of amounts borrowed before 1975), are £69·3 million for experiment (3) and £57·6 million for experiment (4), as shown in Table 11. Further details, of the loans and related capital stock, can be found in Appendix 3.

The results of experiment (3) are more realistic than those of experiment (4), because the latter has an extreme degree of substitution for domestic products by similar imports, matched by extreme levels of domestic exports, with a net export value for most of the sectors close to that of experiment (3). Tables 4.2 and 4.3 of Appendix 4 show these details, for exports and similar imports, and their difference. The experiment (4) results (including those of the Table 11 national accounts) are of interest, being for many items very close to those of experiment (3) and thereby showing relatively small economic gains (in the objective function and elsewhere) obtained through the freeing of similar import behaviour without permitting reductions in sector outputs below specified limits, these being the same for both experiments. The discussion below will, therefore, refer mainly to experiment (3).

Sector Outputs

The outputs of sectors (1) to (16), except (3), appear in Table 7. Five of the 15 sectors have experiment (3) outputs at the upper bounds—livestock, stone/ores etc., chemicals, metal etc., and other manufacturing. This profitable

TABLE 7: *Sector outputs for Experiments* (3) *and* (4) *compared with* 1968 *I-O Base Data*

Sector		*Base*	*Lower Bound*	*Experiment (3)*	*Experiment (4)*	*Upper Bound*	*Percentage of output exported* χ	
		1968		1975			1968 *Base*	*Experiment (3)* 1975
		£ million at 1968 *prices*						
Agricultural livestock	(1)	324·24	376·12	437·72*	437·72*	437·72	17	23
Agricultural crops (excluding peat)	(2)	94·43	113·32	115·56	113·32†	134·10	2	3
Fishing	(4)	4·20	none	2·64	2·74	8·39	31	nil
Solid fuel	(5)	15·11	15·11	22·34	15·11†	none	5	14
Stone/ores etc.	(6)	19·37	none	38·73*	38·73*	38·73	48	59
Food	(7)	332·31	385·48	385·48†	385·48†	505·11	34	29
Drink/tobacco	(8)	50·19	62·24	62·24†	62·24†	90·35	24	20
Textiles (excluding hosiery)	(9)	51·72	65·16	65·16†	65·16†	93·09	34	24
Clothing etc.	(10)	72·87	94·73	123·66	94·73†	145·74	40	38
Wood/furniture	(11)	20·76	28·03	30·21	28·03†	41·52	15	nil
Paper/printing	(12)	45·17	54·21	54·21†	54·21†	90·35	16	3
Chemicals	(13)	51·64	67·14	103·28*	87·58	103·28	26	48
Clay etc.	(14)	30·27	45·41	45·41†	45·41†	78·68	21	18
Metal etc.	(15)	152·66	167·93	228·99*	197·11	228·99	26	19
Other manufacturing	(16)	70·62	103·82	176·56*	176·56*	176·56	56	74
Transport	(21)	89·39	none	169·47	190·83	none	40	50

χexcluding tourist expenditure
*at upper bound
†at lower bound

outcome for livestock* is very satisfactory because it is in harmony with great expectations for Irish agriculture in EEC conditions, especially livestock. Less satisfactory is the result that six of the ten manufacturing sectors have outputs at or slightly above their lower bounds (meaning expected 1973 output levels)—food, drink etc., textiles, wood etc., paper etc., and clay etc. By comparison with the 1968 experiment (2), two sectors of manufacturing have shown themselves inefficient or unprofitable, by moving from 1968 upper bounds to 1975 lower bounds or nearby—drink etc., and paper etc. On the other hand, clothing etc. in 1975 has moved well up from its lower bound, where it was located in the 1968 experiment (2). The three sectors of manufacturing appearing relatively worthwhile for further expansion are chemicals, metal etc. and other manufacturing and are in this respect consistent with 1968 results.

*The practicality of this livestock result depends on the reality of meaningful exports of 23 per cent of the sector's output, compared with an actual 17 per cent for the 1968 base year, as shown in the last two columns of Table 7. A slightly sub-optimal approach, which routes livestock exports through the food sector, is discussed below for results shown in Table 13.

Distribution of Sector Outputs Between Home and Export Markets

The export percentages for the 1968 base and for experiment (3) appear in the last two columns of Table 7. For experiment (3) versus the 1968 base, the proportion of domestic output exported is significantly higher for livestock, solid fuel, stone/ores etc., chemicals, other manufacturing and transport (the latter having a specified constant 1975 export value), i.e. the optimisation procedure has increased the proportionate export share of the first 5 sectors listed and 4 of these are at their upper bounds (livestock, stone/ores, chemicals and other manufacturing, per Table 7). A further 5 sectors show experiment (3) exports forming roughly the same share of domestic gross outputs as for the 1968 base—crops, food, drink/tobacco, clothing etc., clay etc. Of the remaining 5 sectors, three show reduction of export percentage to zero or near-zero levels—fishing, wood etc. and paper etc. The other two sectors, textiles etc. and metal etc. have noticeable reductions in the export share. Three of these 5 sectors have domestic outputs at their specified lower bounds. Fishing is well below its 1968 base level and metal etc. although at its upper bound is evidently efficient for domestic markets and, hence, is less available for exporting than in 1968 base conditions.

Employment

Table 8 gives the employment results, including those of the 1968 base and also those of experiment (2). For the 1975 experiment (3) compared with 1968 base, agriculture etc. has a decrease of 46,000 man-years, industry an increase of 70,000 and services an increase of 62,000. Thus even for the maximum expansion permitted, agriculture etc. cannot keep employment at the 1968 level. This probably results from the 8 per cent per annum increase in productivity. Of the 70,000 increase in industry, some 34,000 is in manufacturing and 33,000 in new and repair construction, with stone/ores etc. and solid fuel absorbing the other 3,000 man-years. The 62,000 increase in services is shared by government services (34,000) and other services (26,000), with trade and transport having a mere 2,000 increase. In percentage terms, experiment (3) agriculture etc. has 22·7 per cent of total employment versus 28·9 for the 1968 base, industry has 32·9 per cent versus 29·0 and services 44·4 versus 42·2. It was seen above that experiment (2) for 1968 absorbed almost all the unemployment by expansion of services. These 1975 results show expansion of industry as well as services to absorb the reduction in agricultural employment and thus are in contrast to results of experiment (2).

Within manufacturing, major increases are shown for clothing etc. (9,000), chemicals (5,000), metal etc. (12,000), and other manufacturing (8,000) for experiments (3) versus the 1968 base, with the biggest decrease being 2,000 for textiles.

TABLE 8: *Employment for* 1975 *Experiments* (3) *and* (4) *compared with* 1968 *Base Data and* 1968 *Experiment* (2)

Sector or sector-group		*Thousand man-years*				*Percentage distribution*			
		1968 *Base*	1968 *Experiment* (2)	1975 *Experiment* (3)	1975 *Experiment* (4)	1968 *Base*	1968 *Experiment* (2)	1975 *Experiment* (3)	1975 *Experiment* (4)
Agriculture, forestry, fishing	(1)	308·79	307·79	262·63	261·64	28·9	27·3	22·7	22·7
Stone/ores and solid fuel	(2)	15·41	16·46	18·79	14·82	1·4	1·5	1·6	1·3
Food, drink and tobacco	(3)	56·62	44·85	56·84	56·84	5·3	4·0	4·9	4·9
Textiles and clothing	(4)	49·07	29·86	55·12	45·55	4·6	2·6	4·8	3·9
Wood, paper, chemicals	(5)	31·24	42·64	36·47	34·01	2·9	3·8	3·2	2·9
Clay, metal, other manufacturing	(6)	54·96	76·29	77·02	69·96	5·1	6·8	6·7	6·1
Total Manufacturing (3)+(4)+(5)+(6)		191·89	193·64	225·45	206·36	17·9	17·2	19·5	17·9
New and repair construction	(7)	91·44	95·51	124·02	125·15	8·6	8·5	10·7	10·8
Electricity/gas/water	(8)	10·96	11·53	11·24	11·23	1·0	1·0	1·0	1·0
Total Industry (2)+(3)+(4)+(5)+(6)+(7)+(8)		309·70	317·14	379·50	357·56	29·0	28·1	32·9	31·0
Trade and transport	(9)	173·09	181·27	174·70	182·33	16·2	16·1	15·1	15·8
Other services, excluding government	(10)	214·93	238·26	241·25	254·23	20·1	21·1	20·9	22·0
Government services	(11)	62·90	83·55	96·94	99·26	5·9	7·4	8·4	8·6
Total Services (9)+(10)+(11)		450·92	503·08	512·89	535·82	42·2	44·6	44·4	46·4
Total, All Sectors		1,069·40	1,128·00	1,155·00	1,155·00	100—	100—	100—	100—
Within Manufacturing									
Food		46·24	29·29	47·06	47·06	24·1	15·1	20·9	22·8
Drink/tobacco		10·38	15·56	9·78	9·78	5·4	8·0	4·3	4·7
Textiles (excluding hosiery)		16·04	10·01	14·23	14·23	8·4	5·2	6·3	6·9
Clothing etc.		33·03	19·85	40·89	31·32	17·2	10·3	18·1	15·2
Wood/furniture		8·15	7·99	8·35	7·75	4·2	4·1	3·7	3·8
Paper/printing		15·64	23·48	15·88	15·88	8·2	12·1	7·0	7·7
Chemicals		7·45	11·17	12·24	10·38	3·9	5·8	5·4	5·0
Clay etc.		8·64	6·81	10·29	10·29	4·5	3·5	4·6	5·0
Metal etc.		38·52	57·78	50·73	43·67	20·1	29·8	22·5	21·2
Other manufacturing		7·80	11·70	16·00	16·00	4·1	6·0	7·1	7·8
Total Manufacturing		191·89	193·64	225·45	206·36	100—	100—	100—	100—

In the discussion of the results of experiment (2) above reference was made to the European countries Belgium, Denmark, Netherlands and Norway. Combination of the employment data for these countries appearing in Tables 3.27 and 3.32 of [16] and relating to 1967 or 1965–1967 can be used for comparison with 1975 experiment (3) employment results as follows:

	Experiment (3)	*European Average*
	Percentage of Total Employment	
Agriculture etc.	22·7	12·1
Manufacturing	19·5	30·1
Public Service	14·9	14·3
All other activities	42·9	43·5
Total	100·0	100·0

If agriculture etc. and manufacturing be taken together there is almost perfect concordance of experiment (3) results with the average percentage levels of the four small continental countries considered. One may conclude that the 1975 experiment (3) figures appear to be a realistic picture of the average employment structure in these four countries circa 1967, at the level of three major subsectors.

TABLE 9: *Capital Stock for Experiments* (3) *and* (4) *Manufacturing compared with* 1968 *Base Data and Experiment* (2)

Sector		*Estimated mid-year levels corresponding to I-O Sector Outputs*							
		1968		1975		1968		1975	
		Base	*Experiment (2)*	*Experiment (3)*	*Experiment (4)*	*Base*	*Experiment (2)*	*Experiment (3)*	*Experiment (4)*
		£ million at 1968 prices				*Percentage Distribution*			
Food	(7)	137·11	86·83	178·86	178·85	28·3	16·8	18·9	20·0
Drink/tobacco	(8)	53·47	80·21	124·48	124·48	11·0	15·6	13·1	14·0
Textiles (excluding hosiery)	(9)	34·66	21·63	70·12	70·12	7·2	4·2	7·4	7·9
Clothing etc.	(10)	33·58	20·17	73·21	56·08	6·9	3·9	7·7	6·3
Wood/furniture	(11)	11·77	11·55	28·85	26·76	2·4	2·2	3·0	3·0
Paper/printing	(12)	34·14	51·24	53·56	53·56	7·0	9·9	5·7	6·0
Chemicals	(13)	37·14	55·71	97·50	82·68	7·7	10·8	10·3	9·3
Clay etc.	(14)	36·19	28·52	68·75	68·75	7·5	5·5	7·3	7·7
Metal etc.	(15)	73·00	109·50	148·60	127·91	15·1	21·2	15·7	14·3
Other manufacturing	(16)	33·40	50·10	102·76	102·76	6·9	9·7	10·9	11·5
Total		484·46	515·46	946·69	891·95	100—	100—	100—	100—

Capital Stock

The capital stock results for 1975 manufacturing appear in Table 9, with extra detail in Appendix 3. Experiment (3) requirements are almost double those of the 1968 base, at £947 million versus £484 million and for the 33,560 man-years increase in employment costing a marginal £13,800 per man-year. The optimal distribution of stock for 1975 shows a big reduction in the relative amount for food (18·9 per cent versus 28·3 for the 1968 base) and noticeable increases for drink etc., chemicals and other manufacturing.

Exports and Similar Imports

Table 10 compares 1968 and 1975 experimental results for these two items. The export figures exclude tourist expenditure within the country. Only the net export pattern for experiment (4) is shown in Table 10, as of more interest than the gross figures. It has been argued above in the corresponding section for experiments (1) and (2) that the net exports (exports less similar imports) are of more significance than either exports or similar imports, treated separately. As can be seen experiment (4) net exports correspond fairly closely in sign and magnitude with those of experiment (3) in 12 sectors out of 15.

TABLE 10: *Exports and Similar Imports for Sectors* (1) *to* (16). *Experiments* (3) *and* (4) *compared with* 1968 *Experiment* (2)

Sector		1968 Experiment (2)			1975 Experiment (3)			1975 Experiment
		Exports except tourist	Similar imports	Net Exports: (1) less (2)	Exports except tourist	Similar imports	Net Exports: (4) less (5)	Net Exports (4)
		(1)	(2)	(3)	(4)	(5)	(6)	(7)
		£ million			£ million			£ million
Agricultural livestock	(1)	110·07	14·97	95·10	100·58	23·58	77·00	76.02
Agricultural crops (excluding peat)	(2)	1·76	4·77	—3·01	3·55	nil	3·55	1.17
Fishing	(4)	nil	0·24	—0·24	nil	2·00	—2·00	—2.00
Solid fuel	(5)	0·71	1·16	—0·45	3·10	1·47	1·63	—5.76
Stone/ores etc.	(6)	11·38	0·46	10·92	22·84	0·75	22·09	22.07
Food	(7)	nil	17·11	—17·11	112·64	22·21	90·43	88.59
Drink/tobacco	(8)	34·17	4·38	29·79	12·34	5·34	7·00	6.17
Textiles (excluding hosiery)	(9)	5·17	28·26	—23·09	15·92	51·34	—35·42	—27.09
Clothing etc.	(10)	0·13	16·07	—15·94	46·74	28·34	18·40	—10.27
Wood/furniture	(11)	2·04	14·78	—12·74	nil	24·37	—24·37	—25.98
Paper/printing	(12)	23·47	28·62	—5·15	1·66	34·06	—32·40	—35.32
Chemicals	(13)	34·85	29·58	5·27	49·12	37·60	11·52	—0.70
Clay etc.	(14)	nil	5·15	—5·15	8·39	7·99	0·40	0.67
Metal etc.	(15)	106·20	89·01	17·19	44·28	134·33	—90·05	—118.87
Other manufacturing	(16)	71·46	33·44	38·02	130·56	44·82	85·74	88 26
Total		401·41	287·98	113·43	551·72	418·20	133·52	56.96

The freeing of similar import behaviour for experiment (4) was used by the LP process to meet all domestic demand by similar imports, for livestock and each of the ten manufacturing sectors, and to dispose of total domestic output by way of exports.

The two 1975 experiments and the 1968 experiment (2) show a consistently large positive export surplus for the 4 sectors: livestock, stone/ores etc., drink etc., and other manufacturing and a large import surplus (negative export surplus) for the 3 sectors: textiles, wood etc., paper etc. Further consistency, but confined to 1975, appears for crops, fishing, food, clay etc. and metal etc., i.e. for a further 5 sectors. The 3 sectors: solid fuel, clothing etc. and chemicals, have a positive export surplus for experiment (3) but some negative export surplus for experiment (4), with the former results to be preferred to those of experiment (4).

Thus, for the 15 sectors being considered, 7 show consistency for all three experiments and a further 5 are consistent for the two 1975 experiments. The remaining 3 have a positive export surplus for 1975 experiment (3) but negative results for experiment (4). It therefore appears that for 1975 postulated conditions, the optimal net export or net import level for 12 of the 15 sectors is fairly stable, regardless of the permitted behaviour of similar imports, and that the maximum attainable level of household expenditure is fairly well-defined, ranging from £1,246 million for experiment (3) to £1,268 million for experiment (4), the latter having the maximum possible substitution by similar imports.

National Accounts

The LP results appear in Table 11 as well as the 1968 base figures. The GNP for experiment (3) shows an increase of 55 per cent above that of 1968, for 40 per cent increase in household expenditure, 56 per cent increase in variable exports and 41 per cent increase in variable similar imports (chosen at non-zero levels by the LP process). The national accounts entries generally for experiment (3) are from about 1·5 to 2·0 times those of the 1968 base, but subsidies are about half, which might be expected for conditions of 1975 unsubsidised food production and exports. Total exports are up by 62 per cent and total imports by 67 per cent. Capital formation is at its specified lower bound of £486 million and government savings, at £1·6 million, are well below their upper bound (5 per cent of government income), some £32 million for experiment (3). Thus a linear growth rate of slightly below 6 per cent per annum for household expenditure is given by experiment (3), matched by a linear growth rate of 1·1 per cent in employment, over the years 1969–1975. The reader can make further comparisons from the figures shown in Table 11 and in the appendices.

TABLE 11: *National Accounts Results for Experiments* (3) *and* (4) *compared with* 1968 *Base Data. (All values are at* 1968 *Prices.)*

Item			1968 *Base*	*Experiment* (3) 1975	*Experiment* (4) 1975
				£ *million*	
Indirect taxes	(34)		237·42	373·36	379·14
Subsidies	(35)		59·51	30·90	30·73
Wages, profits etc. before loan repayment	(36)	(a)	1,034·41	1,571·88	1,584·12
Less loan repayment	(36)	(b)	nil	−69·31	−57·55
Depreciation	(37)		91·11	177·98	178·91
Income tax	(38)		122·80	224·95	230·68
Savings (persons and corporations)	(39)		139·22	241·34	242·09
Net government investment and trading income	(40)		29·00	44·58	44·99
Government current transfers	(41)		144·40	254·17	258·94
Government income [(34)+(38)+(40)]	(42)		389·22	642·89	654·81
Government savings [(42)−(51)]	(43)		16·48	1·68	nil
Import surplus [(60)−(57)]	(44)		22·26	65·00	65·00
Complementary imports	(45)		273·32	462·61	453·60
Gross domestic physical capital form.	(47)	(a)	269·07	486·00	486·00
Total savings available for (47)(a) [(37)+(39)+(43)+(44)]	(47)	(b)	269·07	486·00	486·00
Household expenditure	(48)		887·78	1,245·87	1,267·75
Net government current expenditure	(49)		168·83	356·14	365·14
GNP arising [(34)−(35)+(36)(a) −(36)(b) +(37)]	(50)	(a)	1,303·42	2,023·01	2,053·89
GNP expenditure [(47)(a)+(48)+(49)−(44)]	(50)	(b)	1,303·42	2,023·01	2,053·89
Government outgoings on current account [(35)+(41)+(49)]	(51)		372·74	641·21	654·81
Variable exports, at producers' prices	(52)		347·21	543·22	1,657·05*
Margin on merchandise exports (except subsidy)	(53)	(a)	16·96	26·66	81·32*
Subsidy margin on food exports	(53)	(b)	−12·26	nil	nil
Tourist expenditure	(54)		75·70	65·57	66·72
Constant exports (including invisible transport)	(55)		60·81	179·66	179·66
Wages, profits etc. net inflow	(56)		58·00	70·00	70·00
Total exports [(52)+(53)(a) +(53)(b) +(54)+(55)+(56)]	(57)		546·42	885·11	2,054·74*
Variable similar imports	(58)		294·65	415·43	1,605·84*
Complementary imports	(45)		273·32	462·61	453·60
Constant imports	(59)		0·70	2·75	2·75
Loan repayment	(36)	(b)	nil	69·31	57·55
Total Imports [(58)+(59)+(36)(b) +(45)]	(60)		568·68	950·11	2,119·74*

*These experiment (4) results are unrealistic, but all the other results of that experiment appear to be acceptable.

GDP at Factor Cost by Sector of Origin

The distribution of GDP at factor cost is shown in Table 12 for eleven sub-sectors of the economy, together with derived percentages. Results of the 1975 experiment (3) are compared with the 1968 base. The wages, profits and depreciation for the 33 productive sectors were obtained by multiplying the sector gross outputs by the relevant coefficients, which appear in Appendix

TABLE 12: *Wages, profits, and depreciation for 1975 Experiment (3) compared with 1968 Base Data*

Sector or sector-group	1968 *Base*				1975 *Experiment (3)*			
	Wages etc.	*Profits*	*Depreciation*	*Total*	*Wages etc.*	*Profits*	*Depreciation*	*Total*
	£ million				*£ million*			
Agriculture, forestry fishing (1)	21·1	170·4	13·0	204·5	16·1	265·3	17·0	298·4
Stone/ores and solid fuel (2)	9·8	12·1	2·7	24·6	12·9	24·3	5·6	42·8
Food, drink, tobacco (3)	49·4	16·0	7·3	72·7	42·3	22·2	10·1	74·6
Textiles and clothing (4)	31·5	8·2	3·6	43·3	35·0	21·8	9·5	66·3
Wood, paper and chemicals (5)	28·0	9·9	4·3	42·2	33·1	21·9	9·6	64·6
Clay, metal, other manufacturing (6)	48·5	16·6	7·5	72·6	67·9	37·9	17·0	122·8
Total Manufacturing (3)+(4)+(5)+(6)	157·4	50·7	22·7	230·8	178·3	103·8	46·2	328·3
New and repair construction (7)	74·1	9·2	2·3	85·6	100·5	38·1	9·7	148·3
Electricity/gas/water (8)	12·3	9·0	5·8	27·1	12·6	14·0	8·9	35·5
Total Industry (2)+(3)+(4)+(5)+(6)+(7)+(8)	253·6	81·0	33·5	368·1	304·3	180·2	70·4	554·9
Trade and transport (9)	103·5	42·6	14·2	160·3	110·5	101·9	38·7	251·1
Other services, except government (10)	156·8	83·1	24·9	264·8	182·9	172·9	40·0	395·8
Government services (11)	80·6			80·6	167·8			167·8
Total Services (9)+(10)+(11)	340·9	125·7	39·1	505·7	461·2	274·8	78·7	814·7
Total, All Sectors	615·6	377·1	85·6	1,078·3	781·6	720·3	166·1	1,668·0
	Percentage Distribution				*Percentage Distribution*			
Agriculture, forestry, fishing (1)	3·4	45·2	15·2	19·9	2·1	36·8	10·2	17·9
Stone/ores and solid fuel (2)	1·6	3·2	3·2	2·3	1·7	3·4	3·4	2·6
Food, drink, tobacco (3)	8·0	4·2	8·5	6·7	5·4	3·1	6·1	4·5
Textiles and clothing (4)	5·1	2·2	4·2	4·0	4·5	3·0	5·7	4·0
Wood, paper and chemicals (5)	4·5	2·6	5·0	3·9	4·2	3·0	5·8	3·9
Clay, metal, other manufacturing (6)	7·9	4·4	8·8	6·7	8·7	5·3	10·2	7·4
Total Manufacturing (3)+(4)+(5)+(6)	25·6	13·4	26·5	21·4	22·8	14·4	27·8	19·7
New and repair construction (7)	12·0	2·4	2·7	7·9	12·9	5·3	5·8	8·9
Electricity/gas/water (8)	2·0	2·4	6·8	2·5	1·6	1·9	5·4	2·1
Total Industry (2)+(3)+(4)+(5)+(6)+(7)+(8)	41·2	21·5	39·1	34·1	38·9	25·0	42·4	33·3
Trade and transport (9)	16·8	11·3	16·6	14·9	14·1	14·1	23·3	15·1
Other services, except government (10)	25·5	22·0	29·1	24·6	23·4	24·0	24·1	23·7
Government services (11)	13·1			7·5	21·5			10·1
Total Services (9)+(10)+(11)	55·4	33·3	45·7	46·9	59·0	38·2	47·4	48·8
Total, All Sectors	100—	100—	100—	100—	100—	100—	100—	100—

3.2 of [2] for the 1968 base and in Appendix Table 7.2 below for 1975. The 33-sector detailed figures were then aggregated into eleven sub-totals, as shown in Table 12.

The value figures for GDP show an increase of £94 million for agriculture etc. above its 1968 base level, with increases of £97 million for manufacturing, £187 million for industry and £309 million for services.

In percentages of total GDP, experiment (3) had 17·9 for agriculture etc., compared with 19·0 for 1968, 19·7 for manufacturing versus 21·4 for 1968, 33·3 for industry versus 34·1 for 1968 and 48·8 for services versus 46·9 for 1968. The experiment (3) agriculture, manufacturing and industry, therefore, all show decreases in relative importance, as compared with 1968, whereas the services for 1975 take about 2 per cent more of GDP than they did in 1968.

Comparison of the 1975 experiment (3) shares of GDP with the average shares for the four small European countries referred to above in discussing employment is as follows, the European data being for about 1967:

	Experiment (3)	*European Average*
	Percentage of GDP	
Agriculture etc.	17·9	8·4
Manufacturing	19·7	30·2
Public Service	17·2	12·8
All other activities	45·2	48·6
Total	100·0	100·0

For agriculture and manufacturing combined, experiment (3) has 37·6 per cent of GDP, which agrees closely with the European average of 38·6. It follows that all other activities have 62·4 per cent for experiment (3) and that this European average is 61·4 per cent of GDP.

Another kind of comparison can be made for experiment (3) results, namely the percentage share of employment versus the percentage of GDP, for experiment (3) itself, without reference to the European countries. For agriculture etc. the pair of percentages are 22·7 and 17·9; for manufacturing 19·5 and 19·7; for public services 14·9 and 17·2; for all other activities 42·9 and 45·2. It may be pointed out that in ascertaining disposable personal income by sector of origin the initial advantage in GDP share which the latter three sectors hold over agriculture etc. will be reduced by income tax deductions, which in experiment (3) conditions leave agricultural GDP virtually unaltered.

The experiment (3) results, therefore, appear to be quite respectable on two counts. For agriculture and manufacturing combined, they closely match the corresponding average share of GDP for four European countries, with equally close concordance for all other activities combined. With due allowance for

income tax effects, the GDP available for disposable personal income appears to be fairly equitably distributed among four major sub-sectors of the economy according to the distribution of employment.

Sub-Optimal Results, via the 1975 Experiment (3)

The results which follow in Table 13 illustrate how a slight, almost negligible, reduction in the objective function permits an economic profile possibly more realistic and supposedly more socially acceptable than the profile related to the experiment (3) maximum value of household expenditure.

Let us suppose that two aspects of the 1975 experiment (3) as shown in Table 7 are undesirable, as follows:

(*a*) The 23 per cent export of the output of livestock, sector (1), is questionable because of the physical make-up of the product mix forming that output. Fresh milk as such is not exportable, neither are live pigs and certain cattle, at least under current export conditions. All of these need processing by sector (7), food manufacturing, in order to become suitable for exporting.

(*b*) It is government policy to encourage the activity of sector (7) as an obvious way of giving some employment, via processing of agricultural commodities, even if these are for export. Such employment would be lost if the livestock and crops were directly exported, without prior processing by sector (7). This government policy might also include the retention or expansion of sugar beet refining, fruit and vegetable processing etc. Thus the experiment (3) result which sets food manufacturing at the level of its lower bound is undesirable and maybe unacceptable. We want sector (7) to have a larger output.

For 1968 I-O base conditions, the output of sector (7) was 79·4 per cent of the combined outputs of sectors (1) and (2), agricultural livestock and crops. We therefore specify that the 1975 output of sector (7) should be not less than 79·4 per cent of the combined outputs of sectors (1) and (2). Thus the lower bound for sector (7) is revised upwards, but otherwise there is no change in 1975 experiment (3) conditions. We expect that this revision will give a sub-optimal result (i.e. reduce the value of household expenditure) because experiment (3) has set sector (7) output at its lower bound (£385·48 million) with the related shadow price indicating that further lowering of that bound would increase the value of the objective function and vice versa.

The 1975 experiment (3), with revised lower bound for sector (7), food manufacturing, has been re-submitted to the LP optimisation process and the computed results appear in Table 13 and are denoted "Revised (sub-optimal)." The national accounts' section of that table shows a reduction of only £2·4 million in household expenditure, for the sub-optimal experiment. The loan repayment is £1·7 million more for the sub-optimal profile, due to an extra

TABLE 13: *Sub-optimal results for 1975 Experiment (3) compared with optimal results shown in Tables 7 to 12 above. (Apart from National Accounts items, only those showing noticeable differences are recorded below).*

Item	1975 *original (optimal) Experiment (3)* (*a*)	*Revised (sub-optimal) Experiment (3)* (*b*)	*Difference (a) less (b)* (*c*)
	£ million		
Sector Outputs:			
Agricultural crops (2)	115·56	120·05	—4·49
Food manufactures (7)	385·48	442·72	—57·24
Clothing, hosiery, shoes etc. (10)	123·66	94·73	28·93
Exports (except Tourist):			
Agricultural livestock	100·58	72·59	27·99
Food manufactures	112·64	165·15	—52·51
Textiles (except hosiery)	15·92	20·14	—4·22
Clothing, hosiery, shoes etc.	46·74	20·14	26·60
Total exports, as listed	275·88	278·02	—2·14
Similar Imports:			
Agricultural livestock	23·58	25·53	—1·95
Textiles (except hosiery)	51·34	46·94	4·40
Total similar imports, as listed	74·92	72·47	2·45
Exports less similar imports, as listed	200·96	205·55	—4·59
National Accounts:			
Indirect taxes	373·36	373·54	—0·18
Less subsidies	—30·90	—31·26	0·36
Wages, profits etc.	1,571·88	1,571·39	0·49
Less loan repayment	—69·31	—70·97	1·66
Depreciation	177·98	178·04	—0·06
Total GNP by sector of origin	2,023·01	2,020·74	2·27
Household expenditure	1,245·87	1,243·51	2·36
Net government current expenditure	356·14	356·22	—0·08
Gross domestic physical capital formation	486·00	486·00	0·00
(Loan capital from abroad)	(407·73)	(417·47)	(—9·74)

£9·7 million of prior capital borrowing being necessary. The optimal total GNP is reduced by only £2·3 million via the sub-optimal economic profile and such a reduction is negligible.

The rest of Table 13 shows only items for which noticeable changes occurred, between their optimal and sub-optimal values. The two similar import items, livestock and textiles, have relatively minor changes, amounting to only £2·5 million in aggregate, a reduction.

The sector outputs have two dramatic changes. The sub-optimal food output is £442·7 million, £57·2 million greater than that of the original experiment (3), but yet again at its revised lower bound, given by 79·4 per cent of the output of sectors (1) and (2) combined (437·72 +115·56). Thus the output of food is higher than that of the original experiment (3) and this increase causes an increase of £4·5 million in the output of crops, via the input of crops to food manufacturing. The second dramatic change in output relates to sector (10), clothing etc., a reduction of £28·9 million occurring for the sub-optimal profile, this reduction causing reduced inputs of textiles to clothing etc. Thus the sub-optimal profile has re-allocated output, employment and prior capital investment from the optimal profile sector (10), clothing etc., to its own sector (7), food manufacturing.

The sector exports show four noticeable changes, of which three are large, with a relatively minor change occurring for textiles, namely an increase of £4·2 million for the sub-optimal exports. This increase in textiles' exports is due to reduced inputs to clothing etc., for the same output of textiles as occurred in the optimal experiment (3) solution. Agricultural livestock has a reduction of £28·0 million for the sub-optimal export of its output, as might be expected, for the same output as occurred in the original experiment (3) results but for a much larger input to food manufacturing. The latter exports are higher than those of the original optimal structure by £52·5 million and absorb most of the output increase of £57·2 million for sector (7), mentioned above. Thus if food manufacturing increases for the sub-optimal structure it absorbs more livestock, which thereby is available in lesser amounts for direct export. But the extra food manufactures must be exported as the home market cannot take them.

The sub-optimal exports of clothing etc., are £26·6 million less than those of the optimal structure. This export reduction accords with the £28·9 million reduction in sector (10) clothing etc., output, already mentioned above. It evidently occurs because employment etc., has been switched to food manufactures. The aggregate exports for the four sectors listed in Table 13 show a change of only £2·1 million between the optimal and sub-optimal profiles of the 1975 experiment (3). In percentages, the situation can be set out as follows:

		Exports, except tourist, as percentage of sector output		
		1975 *original (optimal) Experiment* (3)	*Revised (sub-optimal) Experiment* (3)	1968 Base
Agricultural livestock	(1)	23·0	16·6	17·0
Food manufacturing	(7)	29·2	37·3	34·3
Textiles (excluding hosiery)	(9)	24·4	30·9	34·1
Clothing etc.	(10)	37·8	21·3	39·5

If we compare the sub-optimal and the optimal percentages with those of 1968, the sub-optimal percentage for output exported is indeed closer to that of the 1968 base, for three sectors out of four, the exception being clothing etc. For livestock, the figure 16·6 for the percentage exported by the sub-optimal is almost the same as that of the 1968 base, 17·0, and this result might be more acceptable than the 23 percent export level specified by the optimal.

Some five important aspects of the comparison of the experiment (3) optimal and sub-optimal solutions are as follows:

(1) Agricultural livestock is at its upper bound for both solutions, because this sector is efficient in increasing household expenditure. The livestock output in excess of full home demands, for controlled similar imports, must be exported either directly or via the food manufacturing sector.

(2) The nature of the livestock commodities and the effects of government policy may influence the proportions of livestock exports going directly or through the food sector.

(3) There is some flexibility in the allocation of labour and other resources between the food and clothing etc. sectors. Their output levels will determine how much of either is available for export, after satisfying home demand, subject to a specified limitation of similar imports of these commodities.

(4) The combined exports of livestock, food, textiles and clothing etc., stay fairly constant for the optimal and sub-optimal solutions being considered.

(5) The maximum level of household expenditure is almost completely unaffected by the changes in outputs and exports, as described. Thus there is considerable scope for varying the outputs and exports which showed the changes recorded in Table 13, without serious reduction of

household expenditure. But precise calculation is needed, for any such variations, to ensure consistent and reliable solutions. Because the model has fairly complicated interactions, the change in a single constraint (i.e. the lower bound of sector (7)) produces noticeable changes in the levels of three outputs, four exports and two similar imports.

Section 4: Conclusions

THE author will venture some nine conclusions on the results of the experiments. The reader may draw further conclusions from the text and tables and from the appendices.

(1) Full employment of the specified labour force has been found feasible for both 1968 and 1975 economic conditions as outlined, including the stated upper limits on the import surplus.

In catering for the 59,000 unemployed man-years in 1968, experiment (2) has an optimal structure which takes 52,000 extra man-years into the service sectors. Government services take 21,000 of this extra employment, 23,000 go to other services, including 11,000 to education, while trade and transport take the remaining 8,000. For government current expenditure (38 per cent higher for experiment (2) than for the 1968 level) the model specified that government services increase employment by 33 per cent. It is this 38 per cent increase in government current expenditure which brings up the employment in education. Thus the government instruments of taxation procure enough extra government income to directly cover the cost of an extra 32,000 man-years, in the optimal solution, at supposed 1968 prices.

For 1975 optimal conditions, experiment (3) fulfils the full-employment condition by postulating 34,000 extra man-years in manufacturing, 33,000 in construction, 34,000 in government services and 31,000 mainly in other services (of which 22,000 relate to education). These increases are offset by a decline of 46,000 man-years in agriculture to give the required increase of 86,000 man-years. Experiment (3) sets government current expenditure at 211 per cent of its 1968 base level and thus directly covers the cost of some 54 per cent extra employment in government services and 66 per cent in education, at supposed 1968 prices.

These increases in public services may appear very large but it has been shown in Section 3 above that the four small European countries used for comparison provided employment for a similar proportion of the labour force, in "Public Services". It would seem therefore that if full employment is to be obtained in this country in future years the public service will have to play a crucial role in this policy. In other words government income must be sufficient to provide these extra 56,000 jobs in the public service. The money for these must come, through the 1968 taxation instruments, from the increased economic activities generated.

(2) The attainment of full employment can only be achieved at a price, namely, extra outputs and exports and extra capital stock, with the latter requiring loans from abroad during some years of a preparatory period.

For 1968 experiment (2) conditions, major expansions of 50 per cent beyond their 1968 levels are required for the outputs of five manufacturing sectors—drink/tobacco, paper/printing, chemicals, metal etc. and other manufacturing. The major export increases occur for six sectors—livestock, drink etc., paper etc., chemicals, metal etc. and other manufacturing. There are, however, major decreases shown for food, textiles, clothing etc., and clay etc., so that the export effort of the 1968 base structure needs to be re-directed. Exports of livestock and food, however, are best regarded as compensatory, as emerged from the sub-optimal experiment (3) trial. The total amount of investment funds needed from abroad is £151 million, of which £50·8 million is needed for mining, manufacturing, construction and electricity etc., and a supposed £100 million for agriculture and services. The annual repayment of principal plus interest, at 17 per cent of the total loan, is £25·6 million, which is covered by part of the extra exports.

Indications are that between 1968 and 1972 investment ratios and the capital costs of providing employment may have risen. Consequently, figures given here represent lower bounds.

For the 1975 experiment (3), major expansions beyond their 1968 levels are shown by six sectors—livestock, stone/ores etc., chemicals, metal etc., other manufacturing and transport—the latter pre-determined by a higher specified export level. Major export increases appear for livestock, stone/ores, etc., clothing etc., chemicals, other manufacturing and transport, and the only noticeable decrease is for paper etc. Here also the exports of livestock and food make better sense as a combination rather than individually, with mild sub-optimisation routing some 17 per cent of livestock output directly to exports and the remainder indirectly through food manufacturing, as explained at the end of Section 3. The aggregate 1975 export value for sectors (1) to (16) is £552 million, which is some £202 million or 58 per cent higher than the 1968 base level of £350 million. Under one assumption the total investment borrowing from abroad amounts to £408 million, of which £226 million is needed by mining, manufacturing, construction and electricity, etc., and £182 million is allowed for investment in agriculture and elsewhere. Under a different assumption of available domestic investment funds, £108 million is borrowed from abroad for mining, manufacturing, construction and electricity, with £300 million from abroad allowed for investment in agriculture and elsewhere. Annual repayments amount to £69·3 million, under either assumption.

(3) The domestic economy is not capable of providing the investment required for optimal industrial expansion, on recent observed saving behaviour, without a major cutback on social investment, and this latter method has been considered too unrealistic to be applied in the experiments. Short of a policy of enforced saving by means of increased taxation there appears to be no alternative to borrowing from abroad. The loan repayments are incorporated in the 1975 optimal solutions, as described in point (2) above, and would not appear to create any special difficulties.

(4) The 1975 economic conditions give significant improvement on those of 1968. The attainment of 1968 full employment caused a slight reduction (below the base level) in household expenditure per man-year, whereas the 1975 experiment (3) not only provides 86,000 extra jobs but also gives (at 1968 prices) £1,079 per man-year versus a 1968 base level of £830, i.e. the 1975 ratio is 30 per cent above that of the 1968 base. Some of the credit for this increase goes to the beneficial effects of EEC agricultural policy, but increases in productivity combined with assumed markets for specified exports, at average 1968 prices, play a large part in the process of improvement.

(5) That the optimal pattern of exports minus similar imports, rather than of exports alone, is of significance in increasing economic efficiency, is considered to have been demonstrated by the experiments. In view of the discussion above and Appendices 4 and 5 no more will be said on this point.

(6) As has been pointed out near the end of Section 1 of the paper, sub-optimal patterns of outputs etc., may have values of the objective function quite near the computed maximum, but be more socially acceptable. For example, if a reduction in the food sector is not socially feasible, to maintain the output of this sector at 79 per cent of the output of livestock and crops combined would not reduce GNP substantially, as shown in Table 13. Once the maximum value of the objective function is known, it provides a bench-mark against which other values of the objective function, calculated from changed conditions or based on practical considerations, may be measured. Without knowing the maximum, proper evaluation of the loss entailed by sub-optimal solutions is not possible.

(7) As the shadow prices of the constraint rows are discussed above and listed in Appendix (8) only a few practical quotations will be made here, for the 1975 experiment (3). The six largest positive shadow prices occur for subsidies (0·94), government current transfer payments (0·92), savings/investment (0·92), labour (0·74), import surplus (0·39) and capital stock (0·22). Whatever economic or other conditions permit positive increases in the

constants for these rows (as given in Appendix 7) are of most value in any policy designed to increase household expenditure. Some of the largest negative shadow prices occur for complementary imports (−1·31), depreciation (−0·94), various kinds of savings (−0·92), indirect taxes (−0·56), and income tax (−0·54). Any changes in policy or behaviour, which cause an algebraic decrease in the constants for these rows, will also produce relatively large increases in household expenditure.

(8) The results are true only to the extent that the basic data are fair and accurate, and are to be regarded as pointing the way to right policy rather than furnishing actual targets—they are a first step in any planning process. The 1975 experiment (3) has shown that the agriculture etc., plus manufacturing combined aggregate has almost the same share of total employment and of total GDP as these average shares for four small European countries circa 1967. Bright prospects for the Irish economy are indicated by these results, under the assumption and implications of a policy directed towards the optimum and accepted as such by all those whose co-operation is necessary.

(9) Some of the more important aspects of a policy directed towards an optimum, under the assumptions of the goodwill and co-operation of government, business and the general public, are as follows. In planning the government must play an active part by expanding its own employment and the taxation instruments must be adjusted to obtain the funds for this. In experiments (2) and (3) conditions it certainly has had the money to do so, via its 1968 taxation instruments operating on the economic system.

There must be planning for exports and outputs, with investment funds from abroad possibly included in the plan, even if such plans are never fully realised. How to procure the optimal profile of similar imports will not be suggested here, but some such profile must be incorporated in the plan and implemented during the practical execution of the plan. The magnitude of the likely markets for various kinds of exports must be considered, and special attention given to promoting sales of commodities which are most profitable, in shadow price terms. As a small but useful part of any serious planning exercises, LP models of many more sectors than that used in experiments (1) to (4) could provide theoretical optimal economic profiles, by being applied to various menus of exports etc. These results, of course, require interpretation, as was pointed out in Section 1 above in discussion of interpretation and of how the results are influenced by the methods used. The choice of the pattern of investment and of its allocation between social and productive purposes needs analysis in depth, although this aspect has been by-passed in the paper.

There is, finally, the possibility of a conflict between increased gross output per man-year (denoted increased productivity in what follows) and the target of enlarged employment. Let us compare results of experiments (2) and (3), the latter having a much higher productivity. The experiment (3) results, as percentages of the corresponding results of experiment (2), were as follows: total employment 102·4, employment in government services and education 119·3, total exports 142·5, and household expenditure 134·8. It should be noted that the extra total employment is only 2·4 per cent for a 34·8 per cent increase in household expenditure, which means some 32 per cent increase in household expenditure per man-year. This is achieved by increased productivity, whereby exports increase by 42·5 per cent and household expenditure by 34·8 per cent. Employment in government services and education has increased by 19·3 per cent, which is far higher than average rate of increase. The extra government income to pay for this results directly and indirectly from expansion of outputs and exports.

It is at least suggested by the form of economic development between the experiment (2) structure and that of experiment (3) that failure of exports could directly cause unemployment in exporting industries and indirectly in government etc., through reduction of taxes. There is also the suggestion that growth of productivity means growth of exports and a higher rate of growth of employment in government services and education. These two services may have an upper bound, as a proportion of total employment, beyond which such employment is more and more meaningless, as a necessary factor in full employment of the labour force. Thus there may be two barriers to full employment, for increasing productivity, (*a*) a failure of exports and output to expand sufficiently in line with increasing productivity, causing direct and indirect unemployment, (*b*) a limit on meaningful employment in government and education services, the cost of which comes from taxation of all employment. All that is intended is to draw attention to possible difficulties in the years lying ahead, problems which might be avoided by having in general a less passive and more inquiring attitude towards higher productivity and some of its less pleasant implications.

REFERENCES

[1] Department of Finance et al.—*Review of* 1970 *and Outlook for* 1971. Stationery Office, Dublin, 1971. (Prl. 1788).

[2] Henry, E. W.—*Irish Input-Output Structures* 1964 *and* 1968. Paper No. 66, The Economic and Social Research Institute, Dublin, November, 1972.

[3] Baker, T. J. and Neary, P.—*Quarterly Economic Commentary,* October 1972, The Economic and Social Research Institute, Dublin.

[4] "Third Programme: Economic and Social Development 1969-72." (Prl. 431), Stationery Office, Dublin.

[5] Geary, R. C.—"Towards an Input-Output Decision Model for Ireland". *Journal of the Statistical and Social Inquiry Society of Ireland,* Volume XXI, Part II, 1963-64.

[6] Simpson, David—*A Medium-Term Planning Model for Ireland.* Paper No. 41, The Economic and Social Research Institute, Dublin, August 1968.

[7] Central Statistics Office—*National Income and Expenditure* 1971. Stationery Office, Dublin, November, 1972. (Prl. 2779).

[8] Henry, E. W.—"Production Functions for 14 Sub-sectors of Irish Industry, 1960-1968, for the purpose of Estimating Employment". *The Economic and Social Review,* Dublin, Volume 3, Number 2, January 1972.

[9] Henry, E. W.—"Estimation of Capital Stock in Irish Industry", *Journal of the Statistical and Social Inquiry Society of Ireland,* Volume XXII, Part IV, Dublin, 1971-72.

[10] Geary, R. C.—"Relative efficiency of count of sign changes for assessing residual autoregression in least squares regression". *Biometrica* (1970), 57, 1, p. 123.

[11] Henry, E. W.—*Input-Output Studies of the Irish Economy and their Application to Model-Building, Medium-Term.* Unpublished Ph.D. Dissertation, submitted to National University of Ireland (UCD), November, 1971.

[12] Bridge, J. L.—*Applied Econometrics.* North-Holland Publishing Company, 1971.

[13] Mulvey, E. and Trevithick, J.—"The expectations hypothesis and the theory of inflation: an appraisal". *The Economic and Social Review,* Volume 3, No. 2, January, 1972.

[14] Walsh, B. M.—*Some Irish Population Problems Reconsidered.* Paper No. 42, The Economic and Social Research Institute, Dublin, November, 1968.

[15] Geary, R. C. and Scott, S.—*Actual and Shadow Prices in Linear Programming.* Memorandum Series, No. 74, The Economic and Social Research Institute, Dublin, May 1972.

[16] United Nations—*Economic Survey of Europe in* 1969, *Part* 1. New York, 1970.

[17] Henry, E. W.—"An Input-Output Model of the Irish Economy". *Long Range Planning,* Volume 6, Number 3, September 1973. (The Journal of the Society for Long Range Planning, London.)

Appendix 1.1: *Sector Gross Outputs at 1968 Prices*

Input-Output Sector		1968 *Base*	1968 *Experiment* (1)	1968 *Experiment* (2)	1975 *Experiment* (3)	1975 *Experiment* (4)
			£ million			
Agricultural livestock	(1)	324·24	324·24	324·24	437·72	437·72
Agricultural crops (excluding peat)	(2)	94·43	94·43	94·43	115·56	113·32
Forestry	(3)	2·94	3·45	3·39	5·68	5·72
Fishing	(4)	4·20	2·82	2·72	2·64	2·74
Solid fuel	(5)	15·11	16·36	15·96	22·34	15·11
Stone/ores etc.	(6)	19·37	21·30	21·30	38·73	38·73
Food	(7)	332·31	257·93	210·45	385·48	385·48
Drink/tobacco	(8)	50·19	75·29	75·29	62·24	62·24
Textiles (excluding hosiery)	(9)	51·72	32·28	32·28	65·16	65·16
Clothing etc.	(10)	72·87	45·17	43·79	123·66	94·73
Wood/furniture	(11)	20·76	19·75	20·37	30·21	28·03
Paper/printing	(12)	45·17	67·80	67·80	54·21	54·21
Chemicals	(13)	51·64	77·46	77·46	103·28	87·58
Clay etc.	(14)	30·27	45·41	23·86	45·41	45·41
Metal etc.	(15)	152·66	228·99	228·99	228·99	197·11
Other manufacturing	(16)	70·62	105·94	105·94	176·56	176·56
New construction	(17)	143·58	169·83	141·73	241·59	241·59
Repair construction	(18)	58·31	64·47	66·02	105·73	108·01
Electricity/gas/water	(19)	42·30	46·19	44·53	55·53	55·50
Trade margin	(20)	180·07	194·02	186·69	257·85	260·22
Transport	(21)	89·39	98·33	98·33	169·47	190·83
Banking etc.	(22)	51·54	56·37	54·65	77·13	76·62
Other finance	(23)	73·88	79·29	81·32	113·27	153·09
Communication	(24)	31·19	33·58	33·67	49·56	52·60
Medical services, private	(25)	25·31	26·62	29·11	40·87	41·68
Education	(26)	40·96	41·70	54·07	84·90	86·77
Rent of dwellings	(27)	69·85	75·19	72·82	89·84	91·02
Personal services	(28)	22·93	24·64	23·95	25·95	26·15
Hotel/catering	(29)	17·91	19·06	19·49	25·02	25·48
Sport	(30)	23·97	25·27	24·72	33·76	34·15
Domestic services etc.	(31)	26·48	28·48	27·56	27·78	27·87
Government services	(32)	127·11	128·68	168·85	264·48	270·81
Artificial sectors, n.e.s.	(33)	169·45	188·28	181·17	267·05	257·60

Appendix 1.2: *Distribution of outputs of 16 sectors between home markets and exports, 1968 and 1975*

Sector		1968 *Base*			1968 *Experiment* (2)			1975 *Experiment* (3)		
		Home Sales	*Exports except tourist*	*Gross output of productive sector*	*Home Sales*	*Exports except tourist*	*Gross output of productive sector*	*Home Sales*	*Exports except tourist*	*Gross output of productive sector*
					£ million					
Agricultural livestock	(1)	269·27	54·97	324·24	214·17	110·07	324·24	337·14	100·58	437·72
Agricultural crops (excluding peat)	(2)	92·67	1·76	94·43	92·67	1·76	94·43	112·01	3·55	115·56

APPENDIX 1.2—*continued.*

Sector		1968 *Base*			1968 *Experiment* (2)			1975 *Experiment* (3)		
		Home Sales	*Exports except tourist*	*Gross output of productive sector*	*Home Sales*	*Exports except tourist*	*Gross output of productive sector*	*Home Sales*	*Exports except tourist*	*Gross output of productive sector*
		£ million								
Fishing	(4)	2·88	1·32	4·20	2·72	nil	2·72	2·64	nil	2·64
Solid fuel	(5)	14·40	0·71	15·11	15·25	0·71	15·96	19·24	3·10	22·34
Stone/ores etc.	(6)	10·10	9·27	19·37	9·92	11·38	21·30	15·89	22·84	38·73
Food	(7)	218·33	113·98	332·31	210·45	nil	210·45	272·84	112·64	385·48
Drink/ tobacco	(8)	38·03	12·16	50·19	41·12	34·17	75·29	49·90	12·34	62·24
Textiles (excluding hosiery)	(9)	34·08	17·64	51·72	27·11	5·17	32·28	49·24	15·92	65·16
Clothing etc.	(10)	44·08	28·79	72·87	43·66	0·13	43·79	76·92	46·74	123·66
Wood/ furniture	(11)	17·72	3·04	20·76	18·33	2·04	20·37	30·21	nil	30·21
Paper/ printing	(12)	37·78	7·39	45·17	44·33	23·47	67·80	52·55	1·66	54·21
Chemicals	(13)	38·03	13·61	51·64	42·61	34·85	77·46	54·16	49·12	103·28
Clay etc.	(14)	23·88	6·39	30·27	23·86	nil	23·86	37·02	8·39	45·41
Metal etc.	(15)	113·47	39·19	152·66	122·79	106·20	228·99	184·71	44·28	228·99
Other manufacturing	(16)	31·17	39·45	70·62	34·48	71·46	105·94	46·00	130·56	176·56
Transport	(21)	53·54	35·85	89·39	56·64	41·69	98·33	85·04	84·43	169·47
		Per Cent								
Agricultural livestock	(1)	83	17	100	66	34	100	77	23	100
Agricultural crops (excluding peat)	(2)	98	2	100	98	2	100	97	3	100
Fishing	(4)	69	31	100	100	nil	100	100	nil	100
Solid fuel	(5)	95	5	100	96	4	100	86	14	100
Stone/ores etc.	(6)	52	48	100	47	53	100	41	59	100
Food	(7)	66	34	100	100	nil	100	71	29	100
Drink/ tobacco	(8)	76	24	100	55	45	100	80	20	100
Textiles (excluding hosiery)	(9)	66	34	100	84	16	100	76	24	100
Clothing etc.	(10)	60	40	100	100	0	100	62	38	100
Wood/ furniture	(11)	85	15	100	90	10	100	100	nil	100
Paper/ printing	(12)	84	16	100	65	35	100	97	3	100
Chemicals	(13)	74	26	100	55	45	100	52	48	100
Clay etc.	(14)	79	21	100	100	nil	100	82	18	100
Metal etc.	(15)	74	26	100	54	46	100	81	19	100
Other manufacturing	(16)	44	56	100	33	67	100	26	74	100
Transport	(21)	60	40	100	58	42	100	50	50	100

Appendix 2: *The Labour Coefficients Used and the Employment for the LP Results*

Column (6) of Table 2.1 gives the labour coefficients chosen for use in the 1968 LP experiments. The aggregate employment for the 1968 33-sector I-O actual sector outputs, via the column (6) labour coefficients is about 1,069,400 man-years. This figure is some 2,000 units larger than the 1,067,000 referred to above (page 30 of [1]) as persons employed, and appears in column (7) of Table 2.1, as well as the employment estimates for individual sectors. It will be seen that these employment estimates in column (7) match closely the estimated actual employment figures for 1968 given in column (2) of Table 2.1 for sectors (4) to (19), but differ by up to 3,000 units in a few of the other sectors.

The 1968 domestic gross outputs of the 33 productive sectors are shown in column (1) of Table 2.1 matched by the corresponding estimated numbers of persons employed, column (2), and the derived labour coefficients per £1,000 of output, in column (3). The entries in column (2) are taken from chapter 15 of [11]. The figures being rounded to hundreds for sectors (1) to (4), (17) and (18), (20) to (32), indicate the uncertainty involved in making the estimates. The total for column (2) is some 4,000–5,000 higher than the 1,067,000 persons at work, quoted on page 30 of [1]. The author considers this discrepancy not serious in aggregate, in view of the possible difference between "persons at work" and "man-years" and the reallocation of Census of Population data necessary to match the activities included in each of the 33 I-O sectors. The man-year figures are intended to mean full employment for one year for the average worker.

Columns (4) and (5) give estimated "Normal" and "High" labour coefficients. The so-called normal coefficient relates to gross output per worker for fairly average conditions. The coefficients denoted high, by contrast, relate to relatively high gross output per worker, and are consequently numerically smaller than those referred to as normal. The labour coefficients of column (6), to be used in the experiments, are taken from column (5) for sectors (5) to (19) and from column (4) for all other sectors. Their sources and description are given in [8] and in chapters (13) and (14) of [11].

The column (6) coefficients are considered to be somewhat better estimators of the true picture than those of column (3). The 1968 full employment level will be taken to be 1,128,000 persons at work during the year, i.e. 1,128,000 man-years, without standardisation for age, sex, or number of hours worked.

Table 2.2 shows the labour coefficients used for 1975, as well as those used

for 1968. The resulting sectoral employment, via the product of the labour coefficient and the sector gross output, is shown for all four experiments and for 1968 actual gross outputs. The labour force of 1,155,000 man-years for 1975 was chosen by the writer as a compromise between three fairly close estimates derived from CSO unofficial projections. In all four experiments the employment constraint equated the aggregate employment required by the sectors with the total labour force specified.

Table 2.1: 1968 *Sector Gross Outputs, Employment in Man-Years and Labour Coefficients, for 33-sector Structure*

Sector		1968 *Output* £000	*Estimated Employment in Nos. of Persons*	*Labour Coefficient* (2) ÷ (1)	*"Normal" Labour Coefficient*	*"High" Labour Coefficient*	*Labour Coefficient used in Experiments* (1) *and* (2)	*Employment via* (6) × (1), *man-years*
		(1)	(2)	(3)	(4)	(5)	(6)	(7)
Agricultural livestock	(1)	324,240	223,500	0·68930	0·69818	0·63131	0·69818	226,378
Agricultural crops (excluding peat)	(2)	94,434	72,800	0·77091	0·77101	0·70621	0·77101	72,810
Forestry	(3)	2,938	4,700	1·59973	1·60000	1·52439	1·60000	4,701
Fishing	(4)	4,195	4,900	1·16806	1·16822	1·11235	1·16822	4,901
Solid fuel	(5)	15,107	11,376	0·75303	0·83963	0·75301	0·75301	11,376
Stone/ores/gravel	(6)	19,365	4,034	0·20831	0·25900	0·20833	0·20833	4,034
Food	(7)	332,312	46,963	0·14132	0·14259	0·13916	0·13916	46,245
Drink/tobacco	(8)	50,193	10,373	0·20666	0·22381	0·20670	0·20670	10,375
Textiles (excluding hosiery)	(9)	51,717	16,038	0·31011	0·32499	0·31008	0·31008	16,036
Clothing/hosiery/shoes/leather	(10)	72,870	33,014	0·45305	0·46664	0·45331	0·45331	33,033
Wood/furniture	(11)	20,759	8,146	0·39241	0·40306	0·39246	0·39246	8,147
Paper/printing	(12)	45,173	15,646	0·34636	0·36483	0·34626	0·34626	15,642
Chemicals	(13)	51,642	7,539	0·14599	0·14767	0·14418	0·14418	7,446
Clay/cement/glass	(14)	30,272	8,663	0·28617	0·29560	0·28531	0·28531	8,637
Metal/engineering/vehicles	(15)	152,660	38,512	0·25227	0·26178	0·25233	0·25233	38,521
Other manufacturing	(16)	70,624	8,000	0·11328	0·11701	0·11049	0·11049	7,803
New construction	(17)	143,582	55,200	0·38445	0·39635	0·38462	0·38462	55,225
Repair construction	(18)	58,310	36,200	0·62082	0·64020	0·62112	0·62112	36,218
Electricity/gas/water	(19)	42,298	10,971	0·25937	0·26874	0·25900	0·25900	10,955
Trade margin	(20)	180,069	135,900	0·75471	0·75472	0·71891	0·75472	136,388
Transport	(21)	89,394	36,700	0·41054	0·41051	0·39093	0·41051	36,697
Banking/insurance	(22)	51,542	14,500	0·28132	0·28129	0·26788	0·28129	14,498
Other financial and business services	(23)	73,875	25,900	0·35059	0·35063	0·33389	0·35063	25,903
Communications	(24)	31,188	16,700	0·53546	0·53533	0·50994	0·53533	16,696
Medical services, private	(25)	25,310	16,200	0·64006	0·64020	0·60976	0·64020	16,203
Education	(26)	40,958	33,200	0·81059	0·81037	0·77160	0·81037	33,191
Rent of dwellings	(27)	69,850	nil	nil	nil	nil	nil	nil
Personal services	(28)	22,931	31,100	1·35624	1·29534	1·23305	1·29534	29,703
Hotel/catering margin	(29)	17,908	24,200	1·35135	1·17786	1·12233	1·17786	21,093
Sport	(30)	23,974	8,800	0·36706	0·36711	0·34965	0·36711	8,801
Domestic service/handicrafts	(31)	26,476	49,000	1·85073	1·84502	1·75747	1·84502	48,848
Government services	(32)	127,112	62,900	0·49484	0·49480	0·47125	0·49480	62,895
Artificial sectors, n.e.s.	(33)	169,448	nil	nil	nil	nil	nil	nil
Total			1,071,675					1,069,399

The 1975 labour coefficients for sectors (5) to (16) were derived as follows. By means of the CSO quarterly volume indices of industrial production for 1971 and corresponding employment figures, the change in real gross output per man-year between 1968 and 1971 was obtained, and the annual percentage change derived. The percentage change over the seven years 1968–1975 was thus estimated and compared with results from projections of real gross output per man-year 1968 to 1972 described in [8]. A reasonable compromise for the seven-year increase was made and the 1968 labour coefficient reduced accordingly.

For livestock and crops the 3-year change 1968 to 1971 was derived from the CSO agricultural output volume indices and numbers of males engaged in

Table 2.2 *Employment for L P results compared with* 1968 *Base*

Input-Output Sector	*Labour Coefficients used for* 1968	*Labour Coefficients used for* 1975	*Estimated Employment* (000 *man-years*)				
			1968 *Base*	1968 *Experiment* (1)	1968 *Experiment* (2)	1975 *Experiment* (3)	1975 *Experiment* (4)
(1)	0·69818	0·44957	226·38	226·38	226·38	196·79	196·79
(2)	0·77101	0·49647	72·81	72·81	72·81	57·37	56·26
(3)	1·60000	1·12676	4·70	5·52	5·42	6·40	6·44
(4)	1·16822	0·78404	4·90	3·29	3·18	2·07	2·15
(5)	0·75301	0·54924	11·38	12·32	12·02	12·27	8·30
(6)	0·20833	0·16828	4·03	4·44	4·44	6·52	6·52
(7)	0·13916	0·12207	46·24	35·89	29·29	47·06	47·06
(8)	0·20670	0·15719	10·38	15·56	15·56	9·78	9·78
(9)	0·31008	0·21837	16·04	10·01	10·01	14·23	14·23
(10)	0·45331	0·33064	33·03	20·47	19·85	40·89	31·32
(11)	0·39246	0·27638	8·15	7·75	7·99	8·35	7·75
(12)	0·34626	0·29294	15·64	23·48	23·48	15·88	15·88
(13)	0·14418	0·11847	7·45	11·17	11·17	12·24	10·38
(14)	0·28531	0·22662	8·64	12·96	6·81	10·29	10·29
(15)	0·25233	0·22154	38·52	57·78	57·78	50·73	43·67
(16)	0·11049	0·09064	7·80	11·70	11·70	16·00	16·00
(17)	0·38462	0·29586	55·22	65·32	54·51	71·48	71·48
(18)	0·62112	0·49690	36·22	40·05	41·00	52·54	53·67
(19)	0·25900	0·20234	10·96	11·96	11·53	11·24	11·23
(20)	0·75472	0·47767	136·39	146·43	140·90	123·17	124·30
(21)	0·41051	0·30408	36·70	40·37	40·37	51·53	58·03
(22)	0·28129	0·18753	14·50	15·86	15·37	14·46	14·37
(23)	0·35063	0·23375	25·90	27·80	28·51	26·48	35·79
(24)	0·53533	0·41179	16·70	17·98	18·03	20·41	21·66
(25)	0·64020	0·49246	16·20	17·04	18·63	20·13	20·52
(26)	0·81037	0·64830	33·19	38·79	43·82	55·04	56·25
(28)	1·29534	1·07053	29·70	31·92	31·03	27·78	27·99
(29)	1·17786	0·97344	21·09	22·45	22·95	24·35	24·80
(30)	0·36711	0·30340	8·80	9·28	9·07	10·24	10·36
(31)	1·84502	1·52481	48·85	52·55	50·85	42·36	42·49
(32)	0·49480	0·36652	62·90	63·67	83·55	96·94	99·26
Total			1,069·40	1,128·00	1,128·00	1,155·00	1,155·00

farm work in June, via the June and September 1972 issues of the Irish Statistical Bulletin. This annual rate of change (7·9 per cent) was used for 1968–1975. For construction sectors and electricity etc. the annual change was taken from results for 1968–1972 in [8]. For the other sectors the annual rate of change in real gross output per man-year is based on estimated changes between 1964 and 1968 discussed in [11].

In each sector, if the selected annual rate of change of gross output per man-year is x per cent, and l_{1968} is the 1968 labour coefficient in man-years per £1,000 gross output at 1968 prices, then

$$l_{1975} = (100\ l_{1968})/[100 + 7x]. \tag{A2.1}$$

For each sector the seven-year change used is directly obtainable from Table 2.2 by dividing the 1975 labour coefficient into that given for 1968.

Appendix 3: *Capital Stock Estimates*

TABLE 3.1 gives the capital stock coefficients used for 1968 and 1975, as well as the levels of the stock required, via the products of the coefficients and the sector gross outputs. All figures are at 1968 prices. Coefficients for work-vehicles plus plant are shown separately. Stock levels for 1968 actual gross outputs and for 1975 "expected" gross outputs are also shown. These 1975 stock figures were obtained by applying the 1968 capital stock coefficients to 1975 gross outputs at 1968 prices, where the 1975 outputs are estimated projections of 1968–1971 increases to 1975. The CSO 1971 quarterly volume indices of industrial production provided the growth rates in the period 1968–1971. The discussion of the rationale of this method of obtaining 1975 "expected" capital stock levels appears in Section 1 above.

Because reasonably reliable data were available only for industrial sectors, as described in [9], no attempt was made to estimate capital stock coefficients for agriculture, trade, transport and the other services. The capital stock levels are defined as "equivalent-new" and are intended to measure the amount of stock required to permit the gross outputs in question, at full cost of completely new vehicles, plant, buildings etc.

The method of obtaining the 1975 capital coefficients can be summarised as follows. The 1975 gross output per man-year, as described in Appendix 2, was taken as a datum. In terms of 1958 prices, the production functions described in [8] were used to derive 1975 levels of work-vehicles and plant per man-year. Thus the 1975 cost of work-vehicles and plant per unit gross output was available, first at 1958 prices and then at 1968 prices. The 1968 capital stock coefficients, per unit gross output, for the rest of the stock (passenger vehicles, buildings, land, other kinds) were assumed to apply for 1975 and the sum of the two 1975 coefficients for each sector was used and is denoted "aggregate of all kinds" in Table 3.1.

Before discussion of LP results three comments need to be made. (*1*) The 1975 aggregate coefficient for (8) drink/tobacco is an estimate, since the level given by the production function appeared to be excessive. (*2*) A single coefficient is used for new and repair construction (sectors (17) and (18)) because separate coefficients were not available. (*3*) The 1975 aggregate coefficient for electricity etc., 4·797, is less than that for 1968, 6·315 and in this way is exceptional. The capital stock/gross output coefficient for this sector, at 1958 prices, decreased steadily from 6·014 for 1963 to 4·943 for 1968, via the results given in [11], so that further reduction over the years to 1975, as given by the production function for work-vehicles plus plant and the 1968 level for

Table 3.1: *Capital Stock for* 1968 *and* 1975, *all entries being at* 1968 *prices*

Input-Output Sector	1968 *mid-year equivalent—new capital stock per £1 gross output*		*Aggregate* 1968 *estimated mid-year capital stock corresponding to I–O sector gross outputs*		
	Work vehicles and plant	*Aggregate of all kinds*	1968 *Base*	*Experiment* (1)	*Experiment* (2)
				£ million	
(5)	0·8951	2·0111	*20·39	*22·91	*22·10
(6)	0·7665	1·2587	24·37	26·81	26·81
(7)	0·2141	0·4126	137·11	106·42	86·83
(8)	0·5344	1·0653	53·47	80·21	80·21
(9)	0·4182	0·6702	34·66	21·63	21·63
(10)	0·2311	0·4605	33·58	20·80	20·17
(11)	0·2539	0·5668	11·77	11·19	11·55
(12)	0·4544	0·7558	34·14	51·24	51·24
(13)	0·4130	0·7192	37·14	55·71	55·71
(14)	0·7439	1·1954	36·19	54·28	28·52
(15)	0·2585	0·4782	73·00	109·50	109·50
(16)	0·2794	0·4729	33·40	50·10	50·10
(17)} (18)}	0·1626	0·2677	54·05	62·72	55·61
(19)	4·0577	6·3150	267·11	291·72	281·20
Total			850·36	965·24	901·18

Input-Output Sector	1975 *mid-year equivalent—new capital stock per £1 gross output*		*Aggregate* 1975 *estimated mid-year capital stock corresponding to I–O sector gross outputs*		
	Work vehicles and plant	*Aggregate of all kinds*	1975 "*Expected*"	*Experiment* (3)	*Experiment* (4)
				£ million	
(5)	0·865	2·081	24·30*	36·14*	21·10*
(6)	0·829	1·321	45·09	51·16	51·16
(7)	0·265	0·464	172·76	178·86	178·85
(8)	1·469	2·000	74·32	124·48	124·48
(9)	0·824	1·076	48·53	70·12	70·12
(10)	0·363	0·592	50·00	73·21	56·08
(11)	0·642	0·955	18·59	28·85	26·76
(12)	0·687	0·988	45·07	53·56	53·56
(13)	0·638	0·944	54·23	97·50	82·68
(14)	1·062	1·514	65·86	68·75	68·75
(15)	0·429	0·649	80·30	148·60	127·91
(16)	0·388	0·582	58·45	102·76	102·76
(17)} (18)}	0·233	0·338	81·07	117·38	118·17
(19)	2·540	4·797	491·49†	266·40	266·20
Total			1,310·04	1,417·77	1,348·58

*Excluding farmers' peat, for which 1968 sales value was £4·968 million, this same value being assumed also for 1975.

†At 1975 capital/output ratio of 4·797 this aggregate would be £373·34 million for 1975 electricity etc.

other capital stock, is to be expected. Use of the 1975 predicted coefficient instead of the 1968 specified coefficient would reduce the "expected" capital stock of electricity etc. for 1975 by £118·15 million and the Table 3.1 "expected" total for sectors (5) to (19), £1,310·04 million, by the same amount. On this account the £1,310·04 million supposed to apply for 1975 may be an over-estimate.

The extra stock required as loans abroad before 1968 is, for sectors (5) to (19) £114·9 million for experiment (1) and £50·8 million for experiment (2). Since experiment (1) did not take account of such extra stock requirements, an annual repayment level of 17 per cent would increase the import surplus by a further £19·5 million, apart from any effects of extra stock requirements by sectors other than (5) to (19). In experiment (2), however, the annual repayment outflow of £25·6 million is balanced by extra exports, so that the 1968 specified import surplus of £22·3 million still applies. It might be noted that the experiment (2) extra stock, as calculated for the LP results, includes £100 million forced into the scheme for sectors other than (5) to (19), for which the extra stock needed is £50·82 million, as can be found from Table 3.1 results. Thus experiment (2) gives a total need of £150·82 million borrowed abroad before 1968, to permit the experiment (2) sector outputs.

For the 1975 experiments (3) and (4), sectors (5) to (19) require as loan capital, in £ million, 107·7 and 38·5, respectively, for a 1975 "expected" capital stock of 1,310·0, which includes results for the 1968 relatively large electricity etc. capital coefficient. If the projected 1975 smaller electricity etc. coefficient be used, then the 1975 "expected" capital stock is 118·15 smaller than 1,310·0 and consequently the amounts required by sectors (5) to (19) in the form of loan capital from abroad are 225·9 for experiment (3) and 156·7 for experiment (4). The LP results give, as loans from abroad having repayments of 17 per cent covered by corresponding extra exports, 407·73 for experiment (3) and 338·54 for experiment (4). These figures come from an allowance of 300 for sectors other than (5) to (19) and 107·7 (38·5) for experiment (3), (4) sectors (5) to (19). If the "expected" 1975 capital stock level for sectors (5) to (19) is 118·15 too large, then the supposed loan of 300 for other sectors should be reduced by 118·15, so as to allow 182 instead of 300 for build-up of capital stock, other than that of sectors (5) to (19), during the years before 1975.

Appendix 4: *The Treatment of Exports*

APART from the valuation of exports for balance of payments purposes, which is discussed in Appendix 6, the following describes briefly how exports were treated in the experiments and what export results emerged. The choice of certain exports as constant may be subjective, but some of the reasons for the constants will appear below.

Variable and Constant Exports and Re-Exports

Tourist expenditure is an invisible export and combined with household expenditure in personal expenditure, of which it is taken to be 7·86 per cent for 1968 and 5 per cent for 1975, the latter an extrapolation of the percentage which steadily decreased between 1967 and 1971. It is conceded that the 5 per cent level chosen for 1975 may be pessimistic and that a level such as 7 or 8 per cent might be more likely. Invisible exports of transport are entered as a variable in row (21), transport output, for 1968 experiments (1) and (2), but set at a predicted constant level of £75 million for 1975. This 1975 level is based on a 12 per cent annual growth rate from 1971, for which the level was £50·8 million, some 36 per cent higher than that of 1968. The source of this

Table 4.1: *Exports/Re-Exports held Constant for the LP Experiments*

Export/Re-Export		*Value* £000		*Export/Re-Export*		*Value* £000	
		1968	1975			1968	1975
Agricultural livestock	(1)		150	Banking etc.	(22)	50	100
Agricultural crops (excluding peat)	(2)	1,761	3,550	Other financial	(23)	300	600
Solid fuel	(5)	708	3,100	Communications	(24)	278	356
Food	(7)		300	Medical services, private	(25)		200
Drink/tobacco	(8)		300	Personal services	(28)	100	100
Clothing etc.	(10)		100	Hotel/catering	(29)	300	400
Paper/printing	(12)		200	Sport	(30)	6,830	12,300
Metal etc.	(15)		600	Government services	(32)	2,377	5,000
Other manufacturing	(16)		200	Artificial sectors, n.e.s.	(33)	14,491	25,000
Electricity/gas/water	(19)	50	100	Indirect taxes		1,330	38,400
Trade margin	(20)	100	200	Complementary imports		2,282	13,400
Transport	(21)		75,000	Wages, profits, pensions etc., net inflow		57,997	70,000

information is the balance of payments statement in the September 1972 issue of the Irish Statistical Bulletin. The 1975 level chosen may be on the high side, both on account of 1971 being chosen as base year of projection and because the figures are in fact at 1971 prices. Possibly £65 million would be a better estimate. The setting of this export at some specified level for 1975 is based on supposed continued growth of foreign demand for the service, which includes freight transport as well as passengers.

Thirteen further exporting activities have been chosen as variables for all four experiments and include small amounts of re-exports. They are: agricultural livestock, fishing, stone/ores etc., which is a proxy for ores and the ten manufacturing activities.

The items listed in Table 4.1 were treated as constants and amount to £88·954 million for 1968 and £249·656 million for 1975.

Table 4.2: *Exports and Re-Exports for the LP Solutions*

Description		1968			1975	
		Base	*Experiment* (1)	*Experiment* (2)	*Experiment* (3)	*Experiment* (4)
				£000		
Agricultural livestock	(1)	54,966	86,183	110,071	100,579	437,874*
Agricultural crops (excluding peat)	(2)	1,761	1,761	1,761	3,550	3,550
Fishing	(4)	1,323	nil	nil	nil	nil
Solid fuel	(5)	708	708	708	3,100	3,100
Stone/ores etc.	(6)	9,270	8,985	11,383	22,840	22,816
Food	(7)	113,976	19,290	nil	112,643	385,782*
Drink/tobacco	(8)	12,162	32,852	34,167	12,338	62,539*
Textiles (excluding hosiery)	(9)	17,644	4,239	5,174	15,924	65,163*
Clothing etc.	(10)	28,792	nil	131	46,739	94,831*
Wood/furniture	(11)	3,045	nil	2,042	nil	28,025*
Paper/printing	(12)	7,390	22,716	23,469	1,656	54,408*
Chemicals	(13)	13,611	34,815	34,848	49,116	87,580*
Clay etc.	(14)	6,390	16,908	nil	8,391	45,408*
Metal etc.	(15)	39,187	96,902	106,201	44,279	197,709*
Other manufacturing	(16)	39,454	69,972	71,462	130,564	176,760*
Electricity/gas/water	(19)	50	50	50	100	100
Trade margin	(20)	100	100	100	200	200
Transport	(21)	35,853	40,172	41,693	84,428†	103,760†
Banking etc.	(22)	50	50	50	100	100
Other financial etc.	(23)	11,265	12,761	12,954	17,830	53,158
	(24) to (29)	678	678	678	1,056	1,056
Sport	(30)	6,830	6,830	6,830	12,300	12,300
Government services	(32)	2,377	2,377	2,377	5,000	5,000
Artificial sectors, n.e.s.	(33)	14,491	14,491	14,491	25,000	25,000
Complementary imports		2,282	2,282	2,282	13,400	13,400
Indirect taxes		1,330	1,330	1,330	38,400	38,400
Less subsidies		—12,262	—2,081	nil	nil	nil
Wages, profits etc. net inflow		57,997	57,997	57,997	70,000	70,000
Tourist expenditure		75,700	81,443	78,798	65,572‡	66,723‡
Total		546,420	613,811	621,047	885,105	2,054,742

*The full domestic output is being exported. This has been permitted by massive import substitution and the results are not to be taken seriously.

†May be some £10 million over-optimistic.

‡May be pessimistic estimates, at 5 per cent of personal expenditure.

Table 4.3: *Exports and Similar Imports for Experiments* (3) *and* (4)

Export Sector		*Experiment (3)*			*Experiment (4)**		
		Exports (a)	*Similar Imports (b)*	*Difference (a) less (b)*	*Exports (a)*	*Similar Imports (b)*	*Difference (a) less (b)*
		£ million			*£ million*		
Agricultural livestock	(1)	100·58	23·58	77·00	437·87	361·85	76·02
Agricultural crops (excluding peat)	(2)	3·55	nil	3·55	3·55	2·38	1·17
Fishing	(4)	nil	2·00	—2·00	nil	2·00	—2·00
Solid fuel	(5)	3·10	1·47	1·63	3·10	8·86	—5·76
Stone/ores etc.	(6)	22·84	0·75	22·09	22·82	0·75	22·07
Food	(7)	112·64	22·21	90·43	385·78	297·19	88·59
Drink/tobacco	(8)	12·34	5·34	7·00	62·54	56·37	6·17
Textiles (excluding hosiery)	(9)	15·92	51·34	—35·42	65·16	92·25	—27·09
Clothing etc.	(10)	46·74	28·34	18·40	94·83	105·10	—10·27
Wood/furniture	(11)	nil	24·37	—24·37	28·02	54·00	—25·98
Paper/printing	(12)	1·66	34·06	—32·40	54·41	89·73	—35·32
Chemicals	(13)	49·12	37·60	11·52	87·58	88·28	—0·70
Clay etc.	(14)	8·39	7·99	0·40	45·41	44·74	0·67
Metal etc.	(15)	44·28	134·33	—90·05	197·71	316·58	—118·87
Other manufacturing	(16)	130·56	44·82	85·74	176·76	88·50	88·26
Total		551·72	418·20	133·52	1,665·54	1,608·58	56·96

*Only the Difference Column requires serious consideration.

Appendix 5: *The Treatment of Imports*

THE following describes briefly how imports are treated in the experiments and what import results emerged. Appendix 6 describes the valuation of imports for balance of payments purposes.

The imports are included in the LP model as either being similar or complementary. Similar imports are treated like negative exports. Complementary imports generally are estimated by a row of coefficients, each coefficient being applied to a level of output of a productive sector or of a final demand. Re-exports of complementary imports are treated as a constant, and their description included in Appendix 4. A special kind of similar import, treated as a variable in the experiments, is the repayment on loan capital borrowed from abroad, set at 17 per cent of the full capital amount borrowed during some years before 1968 or again before 1975.

Table 5.1: *Imports for the LP Solutions*

Description		1968			1972	
		Actual	*Experiment* (1)	*Experiment* (2)	*Experiment* (3)	*Experiment* (4)*
		£000				
Similar Imports						
Agricultural livestock	(1)	18,823	16,640	14,970	23,577	361,851
Agricultural crops (excluding peat)	(2)	17,488	12,132	4,766	nil	2,383
Fishing	(4)	242	242	242	2,000	2,000
Solid fuel	(5)	1,091	1,186	1,156	1,467	8,859
Stone/ores etc.	(6)	460	460	460	750	750
Food	(7)	17,777	nil	17,110	22,206	297,188
Drink/tobacco	(8)	4,046	4,515	4,375	5,341	56,366
Textiles (excluding hosiery)	(9)	35,526	29,231	28,256	51,336	92,246
Clothing etc.	(10)	16,332	16,621	16,066	28,344	105,103
Wood/furniture	(11)	14,288	15,931	14,783	24,366	53,996
Paper/printing	(12)	24,458	29,103	28,617	34,057	89,728
Chemicals	(13)	26,396	29,602	29,579	37,598	88,273
Clay etc.	(14)	5,153	6,150	5,149	7,988	44,766
Metal etc.	(15)	82,251	95,751	89,010	134,332	316,584
Other manufacturing	(16)	31,023	34,889	33,443	44,815	88,498
Total similar imports		295,354	292,453	287,982	418,177	1,608,591
Complementary imports		273,324	343,612	329,682	462,614	453,600
Repayment on loan		nil	nil	25,639	69,314	57,552
Total imports		568,678	636,065	643,303	950,105	2,119,743

*The first 16 rows are only meaningful as used with exports in Table 4.3 above.

Variable and Constant Similar Imports

Apart from the loan repayment just mentioned, thirteen similar import activities have been chosen as variables. These are: livestock, crops, solid fuel and the ten manufacturing activities. Two import items are held constant: fishing at 242 and 2,000, stone/ores etc. at 460 and 750, in £000 for 1968 and 1975 respectively.

Import Results for the LP Experiments

Table 5.1 has the experimental results as well as the 1968 I–O results, for comparison. The similar import figures for 1975 experiments (3) and (4) have been considered in Appendix 4, in conjunction with corresponding domestic exports.

The pattern for experiment (1) is quite close to that of 1968 actual, except for a zero import of food and a sizeable increase in metals etc. Experiment (2) has close concordance with 1968 similar imports, apart from a large reduction in crops' imports and a fairly large reduction in textiles. Experiments (1) and (2) both show large increases in complementary imports, above their 1968 actual level. The loan repayment was not a feature of experiment (1) constraints.

Appendix 6: *Valuation of Exports and Imports for Balance of Payments Purposes*

Exports and Re-Exports

THE f.o.b. value of each merchandise export is its value to the national economy for balance of payments accounts.

For invisible exports of transport, the value equivalent to the f.o.b. pricing of merchandise is identical with the output value at producers' prices, i.e., the row relating to inequality (A10.15) (ii) of Appendix 10 has a coefficient e_j of unity for transport. Tourist expenditure, also an invisible export, is entered in this row as a fixed fraction of personal expenditure, 7·86 per cent for 1968 and 5·0 per cent for 1975.

For merchandise exports other than 1968 food, the f.o.b. value per unit of gross output at producers' prices is made up of three components: the unit producers' value, a transport margin (sector (21)), and a margin for other financial and business services (sector (23)). The e_j is equal to $(1+a_{21\,\mathrm{E}j}+a_{23\,\mathrm{E}j})$. The numerical value of e_j for these activities is 1·049074, in the LP experiments.

For 1968 merchandise exports of food there is a further negative coefficient, $-q_{\mathrm{E}_1}$, relating to the subsidy required to reduce the production and delivery price per unit to the actual obtainable f.o.b. price per unit. Thus e_j for food 1968 exports is given by $(1+a_{21\,\mathrm{E}_1}+a_{23\,\mathrm{E}_1}-q_{\mathrm{E}_1})$. The 1968 numerical value of e_j for food is 0·941206.

Each coefficient forming a component of e_j appears separately in its own constraint row. Food involves five coefficients, the 1·0 in row (7), the a's in rows (21) and (23), the e_1 in row (44) corresponding to inequality (A10.15) (ii) and the subsidy coefficient in row (35). The other variable exporting activities, except transport and tourist expenditure, are like the food activity, but without a subsidy component. The invisible exporting activity of transport (experiments (1) and (2)) requires only two coefficients, a unit in row (21) and a unit in row (44).

It is to be noted that if the savings-investment equality (A10.16) includes F in terms of inequality (A10.15) (i), then the e_j coefficients, (and unit coefficients for importing activities) will also appear in row (47) corresponding to equality (A10.16). This is the case in the experiments.

The data on the transport and other financial etc. margins on merchandise exports are of doubtful reliability. It was decided to spread these margins evenly over the variable exporting activities for merchandise and to ignore

them for the relatively trivial invisible exports shown in the 13 rows in question in Table 3.1 of [2] and for the constant exports listed in Appendix 4. The numerical entries in Table 3.1 give £6·000 million for transport margin and £10·965 million for other financial etc. margin on all merchandise exports, £351·531 million at producers' prices. These numerical entries are now taken as the margins on £345·701 million, which is the producers' value of the merchandise exports and re-exports from the 13 exporting activities in question in Table 3.1. The derived coefficients per £1 of exports at producers' prices are 0·017356 for the sector (21) margin and 0·031718 for the sector (23) margin.

The subsidy margin of £12·262 million on £113·676 million of food merchandise exports and re-exports at producers' prices, also shown in Table 3.1 of [1], gives a subsidy coefficient 0·107868, to have opposite sign to the other coefficients of 1968 food exports, referred to above.

It is assumed that these coefficients for margins are applicable to the experiments. The subsidy coefficient for food is important. It is reliable for the 1968 food export product-mix amounting to the £113·676 million shown in Table 3.1. For the other coefficients, their aggregate effect may give transport and other financial etc. margins, on aggregate merchandise exports, of the right order of magnitude.

The design of the 33-sector structure used in the experiments does not distinguish exports from re-exports, since 15 of the first 16 rows distribute domestic and similar import commodities together to all uses, including exporting and re-exporting. It permits substitution between the domestic and imported items in the form of a one-to-one value exchange. In the 1968 actual Table 3.1 situation, the re-exports from the 13 sectors, having the £345·701 million mentioned above as the value of combined exports and re-exports, amounted to £9·785 million, i.e. re-exports formed only 2·83 per cent of the total value.

Thus re-exporting for 1968 was of trivial importance for the 13 exporting/re-exporting activities in question. It was also trivial, amounting to only £27,000, for agricultural crops and solid fuel, the two I–O merchandise exporting activities treated as constants in the experiments.

It therefore seems reasonable to take re-exports as being at zero level and the 13 variable merchandise exporting activities to mean domestic exports only, in the LP results, unless otherwise indicated.

Imports

All imports are valued at c.i.f. import prices in the balance of payments accounts. Thus for row (44), corresponding to inequality (A10.15) (ii), each similar import activity column has a coefficient of value unity, likewise the column for complementary imports.

Appendix 7.1: *Non-zero constants for the first 47 rows of the LP Experiments*

Row		Value of Constant	
		1968	1975
		£000	
Agricultural livestock	(1)		35,878
Agricultural crops (excluding peat)	(2)	1,761	18,822
Fishing	(4)	−242	−85
Solid fuel	(5)	708	8,803
Stone/ores etc.	(6)	−460	−750
Food	(7)		147,513
Drink/tobacco	(8)		37,341
Textiles (excluding hosiery)	(9)		18,376
Clothing etc.	(10)		51,298
Wood/furniture	(11)		7,806
Paper/printing	(12)		13,204
Chemicals	(13)		13,388
Clay etc.	(14)		4,798
Metal etc.	(15)		43,441
Other manufacturing	(16)		13,315
Electricity/gas/water	(19)	50	25,408
Trade margin	(20)	100	125,811
Transport	(21)		94,869
Banking etc.	(22)	50	12,935
Other financial etc.	(23)	300	5,840
Communications	(24)	278	10,556
Medical services, private	(25)		15,903
Education	(26)		3,906
Rent of dwellings	(27)		68,100
Personal services	(28)	100	21,593
Hotel/catering	(29)	300	14,876
Sport	(30)	6,830	28,409
Domestic services etc.	(31)		26,364
Government services	(32)	2,377	18,115
Artificial sectors, n.e.s.	(33)	14,491	25,811
Indirect taxes	(34)	1,330	180,037
Subsidies	(35)		13,260
Wages plus profits	(37)	57,997	70,000
Income tax	(38)	−59,920	−137,100
Savings of persons etc.	(39)	−55,050	−47,050
Net government investment and trading income	(40)	687	687
Government current transfers	(41)	1,034	6,600
Import surplus	(44)	110,510	360,000
Complementary imports	(45)	2,282	61,961
Labour	(46)	†1,128,000	†1,155,000
Savings=capital	(47)	88,252	295,080

†Man-years.

Appendix 7.2: *Selected coefficients for* 1975 *differing from those of* 1968

Sector	*Agricultural Livestock* (1)	*Food* (7)	*Incremental Personal Expenditure*	*Gross Physical Capital Formation*	*Wages etc.*	*Profits*	*Depreciation*
	Columns				*Rows*		
(1)	·2475	·5166	·0214	·0143	·02230	·50200	·00150
(2)	·0934	·0993	·0071	·0070	·02932	·37911	·13009
(3)				·0074	·52349	·10000	·11987
(4)		·0022	·0036		nil	·45292	·23838
(5)		·0010	·0050	·0009	·26574	·45858	·07266
(6)		·0001		·0006	·17932	·36428	·10231
(7)	·0862	·1183	·1369	·0059	·07580	·03440	·01600
(8)		·0008	·0357	·0008	·20952	·14285	·06245
(9)			·0164	·0102	·15635	·11008	·04813
(10)			·1141	·0016	·20071	·11807	·05162
(11)			·0214	·0138	·19845	·12174	·05319
(12)			·0107	·0025	·27439	·10756	·04703
(13)	·0038	·0063	·0107	·0029	·11865	·11965	·05233
(14)			·0036	·0035	·21956	·14812	·08306
(15)	·0012		·0321	·2208	·19033	·07410	·03048
(16)	·0013	·0036	·0071	·0115	·08133	·08039	·03514
(17)				·4971	·23663	·10459	·02679
(18)					·40999	·12106	·03066
(19)	·0028	·0049	·0143		·22768	·25222	·16088
(20)	·0128	·0042	·1427	·0240	·24561	·32439	·06242
(21)	·0035		·0285	·0225	·27822	·10759	·13317
(22)	·0035		·0128		·25715	·44421	·01349
(23)	·0113	·0056	·0036		·23818	·28580	·02418
(24)	·0009		·0185		·37132	·17312	·15656
(25)			·0143		·32401	·33853	nil
(26)			·0143		·63941	·36059	nil
(27)			·0542		nil	·33787	·22763
(28)			·0071		·61089	·15674	·09060
(29)			·0107		·32217	·20465	·06002
(30)			·0107		·20580	·25205	·03918
(31)			·0036		·69534	·18860	·11606
(32)			·0392		·63432	nil	nil
(33)	·0001	·0834		—·0224	nil	nil	nil
Complt. imports		·0257	·0428	·1505			
Indirect taxes	·0097	·0018	·1640	·0246			
Less subsidies	—·0038		—·0071				
Wages etc.	·0223	·0758					
Profits	·5020	·0344					
Depreciation	·0015	·0160					
Total	1·0000	1·0000	1·0000	1·0000			

Appendix 8.1 : *Shadow prices for constraint rows used in the LP experiments*

Row		*Experiment* (1)	*Experiment* (2)	*Experiment* (3)	*Experiment* (4)
Agricultural livestock	(1)	−1·16	−1·26	−1·33	−1·27
Agricultural crops	(2)	−1·15	−1·25	−1·25	−1·27
Forestry	(3)	−2·18	−1·79	−1·63	−1·73
Fishing	(4)	−1·87	−1·59	−1·41	−1·50
Solid fuel	(5)	−1·16	−1·38	−1·39	−1·27
Stone/ores	(6)	−1·16	−1·26	−1·33	−1·29
Food	(7)	−1·15	−1·29	−1·33	−1·27
Drink/tobacco	(8)	−1·16	−1·26	−1·33	−1·27
Textiles	(9)	−1·16	−1·25	−1·32	−1·27
Clothing	(10)	−1·23	−1·26	−1·32	−1·27
Wood etc.	(11)	−1·18	−1·25	−1·35	−1·27
Paper etc.	(12)	−1·16	−1·25	−1·32	−1·27
Chemicals	(13)	−1·16	−1·25	−1·32	−1·27
Clay etc.	(14)	−1·16	−1·28	−1·33	−1·27
Metal etc.	(15)	−1·16	−1·25	−1·32	−1·27
Other manufacturing	(16)	−1·16	−1·25	−1·32	−1·27
New construction	(17)	−1·20	−1·16	−1·21	−1·23
Repair construction	(18)	−1·23	−1·13	−1·19	−1·22
Electricity etc.	(19)	−0·93	−2·25	−1·99	−1·98
Trade	(20)	−1·24	−1·03	−0·95	−1·01
Transport	(21)	−1·15	−1·25	−1·04	−1·07
Banking	(22)	−0·75	−0·65	−0·64	−0·68
Other financial, etc.	(23)	−0·94	−0·83	−0·82	−0·85
Communications	(24)	−1·11	−0·96	−0·98	−1·03
Medical services, private	(25)	−1·17	−0·98	−0·98	−1·03
Education	(26)	−1·03	−0·79	−0·82	−0·89
Rent	(27)	−0·70	−0·68	−0·66	−0·69
Personal services	(28)	−1·59	−1·24	−1·30	−1·40
Hotel	(29)	−1·68	−1·36	−1·39	−1·48
Sport	(30)	−0·98	−0·88	−0·90	−0·93
Domestic service	(31)	−1·98	−1·47	−1·53	−1·67
Government services	(32)	−1·06	−0·91	−0·91	−0·95
Artificial sectors, n.e.s.	(33)	−1·04	−1·02	−1·03	−1·03
Indirect taxes	(34)	−0·66	−0·57	−0·56	−0·59
Subsidies	(35)	1·07	0·93	0·94	0·99
Depreciation	(36)	−1·07	−1·11	−0·94	−0·99
Wage+profit	(37)	−0·32	−0·29	−0·34	−0·36
Income tax	(38)	−0·63	−0·55	−0·54	−0·57
Savings, personal	(39)	−1·05	−1·09	−0·92	−0·97
Government i. and t. income	(40)	−1·05	−0·91	−0·92	−0·97
Current transfers	(41)	1·05	0·91	0·92	0·97
Government income	(42)	−1·05	−0·91	−0·92	−0·97
Government saving	(43)	−1·05	−0·91	−0·92	−0·97
Import surplus	(44)	0·11	0·16	0·39	0·30

APPENDIX 8.1:—*continued.*

Row		*Experiment* (1)	*Experiment* (2)	*Experiment* (3)	*Experiment* (4)
Complementary imports	(45)	−1·15	−1·25	−1·31	−1·27
Labour	(46)	0·87	0·61	0·74	0·81
Savings/investment	(47)	1·05	1·09	0·92	0·97
Upper Limits:					
Livestock	(48)	0·00	0·00	0·09	0·02
Agricultural crops	(49)	0·00	0·00	0·00	0·00
Fishing	(50)	0·00	0·00	0·00	0·00
Stone/ores	(51)	0·33	0·18	0·21	0·16
Food	(52)	0·00	0·00	0·00	0·00
Drink/tobacco	(53)	0·17	0·07	0·00	0·00
Textiles etc.	(54)	0·00	0·00	0·00	0·00
Clothing	(55)	0·00	0·00	0·00	0·00
Wood etc.	(56)	0·00	0·00	0·00	0·00
Paper etc.	(57)	0·05	0·04	0·00	0·00
Chemicals	(58)	0·12	0·06	0·03	0·00
Clay etc.	(59)	0·12	0·00	0·00	0·00
Metal etc.	(60)	0·05	0·07	0·04	0·00
Other manufacturing	(61)	0·07	0·03	0·02	0·00
Transport	(62)	0·05	0·24	*	*
Government savings	(63)	*	*	0·00	0·00
Lower Limits:					
Livestock	(64)	−0·37	−0·14	0·00	0·00
Agricultural crops	(65)	−0·42	−0·16	0·00	−0·02
Solid fuel	(66)	0·00	0·00	0·00	−0·17
Food	(67)	0·00	0·00	−0·04	−0·06
Drink/tobacco	(68)	0·00	0·00	−0·12	−0·15
Textiles	(69)	−0·01	−0·02	−0·08	−0·11
Clothing	(70)	0·00	−0·01	0·00	−0·05
Wood etc.	(71)	0·00	0·00	0·00	−0·09
Paper etc.	(72)	0·00	0·00	−0·00	−0·05
Chemicals	(73)	0·00	0·00	0·00	0·00
Clay etc.	(74)	0·00	0·00	−0·07	−0·11
Metal etc.	(75)	0·00	0·00	0·00	0·00
Other manufacturing	(76)	0·00	0·00	0·00	0·00
Government current expenditure	(77)	−0·02	0·00	*	*
Capital formation	(78)	0·00	0·00	−0·08	−0·01
Upper Limits on Similar Imports or Exports†					
Livestock	(79)	0·01	0·01	0·02	0·02
Crops	(80)	0·00	0·00	0·00	*
Fishing	(81)	*	*	*	0·00

APPENDIX 8.1—*continued.*

Row		*Experiment* (1)	*Experiment* (2)	*Experiment* (3)	*Experiment* (4)
Solid fuel	(82)	0·01	0·13	0·08	*
Stone/ores	(83)	*	*	*	0·00
Food	(84)	0·00	0·04	0·02	0·02
Drink/tobacco	(85)	0·01	0·01	0·02	0·02
Textiles	(86)	0·00	0·01	0·01	0·02
Clothing	(87)	0·07	0·01	0·01	0·02
Wood etc.	(88)	0·02	0·01	0·04	0·02
Paper etc.	(89)	0·00	0·01	0·01	0·02
Chemicals	(90)	0·00	0·01	0·01	0·02
Clay etc.	(91)	0·01	0·04	0·02	0·02
Metal etc.	(92)	0·00	0·01	0·01	0·02
Other manufacturing	(93)	0·00	0·01	0·01	0·02
Equality:					
Capital stock	(94)	*	0·21	0·22	0·22

*The constraint in question does not apply.

†On similar imports for experiments (1), (2) and (3), on exports for experiment (4).

Appendix 9: *Preparations for the 1975 Experiments (3) and (4)*

THE main preparations for the 1975 experiments (3) and (4) are considered in this section. Further detail appears in Appendices 1 to 7. The present discussion is as concise as possible. In particular, Appendix 7.2 has the main 1975 coefficients differing from those of 1968.

The System of Constraints

There were 90 rows of constraints for both experiments. Besides the 47 rows forming the core of the model there were 14 upper bounds and 13 lower bounds on sector outputs, 13 upper bounds on similar imports (experiment (3)) or on exports of domestic outputs (experiment (4)), as well as an upper bound on government savings, a lower bound on capital formation, and an equality for capital stock.

Upper Bounds on Sector Outputs and on Similar Imports or on Exports

For agricultural livestock and crops, as well as for stone/ores etc. and for each of the ten manufacturing sectors, growth rates between 1968 and 1971 were taken from data in publications such as the Irish Statistical Bulletin. These rates, in annual terms, were doubled, multiplied by 7, and applied to the 1968 I–O base-level sector outputs. In summary, the observed annual growth rate from a 1968 base was doubled and applied to the same 1968 base, over the 7-year period 1969–1975, to give feasible maximum 1975 sector outputs. The 1975 upper bound for fishing was taken to be twice the 1968 base output.

For experiment (3) exactly the same kind of upper limits were imposed on similar imports as those described above in Section 2. For experiment (4), however, variable exports were constrained not to exceed domestic outputs, as follows:

$$E_i \leqslant X_i \text{ for } i = 1, 4, 6, 7, \ldots 15, 16. \tag{A.9.1}$$

This means that each of the 13 exporting activities treated as variable by the LP process is not to exceed the domestic output of the sector to which it relates. Thus re-exporting of similar imports is not permitted, even though these items may completely replace domestic items on the home market. The similar import behaviour for experiment (4) is much less constrained than for experiment (3).

Lower Bounds on Sector Outputs

The same 13 sectors as for experiments (1) and (2) had lower bounds specified, to prevent a take-over by similar imports. For livestock, crops, and the ten manufacturing sectors, the observed 1968–1971 growth was projected to 1972 and applied to the 1968 base. This means lower bounds roughly in line with 1972 expected sector outputs. Solid fuel was set at its 1968 base level, although it declined to some 88 per cent of the base level, for 1971.

Other Bounds

Government savings were constrained not to exceed 5 per cent of government income, in accordance with observed ratios for recent years. Gross physical capital formation was taken at 1·77 times the 1968 base level, i.e. a linear growth rate of 11 per cent per annum was assumed. The capital stock required by the outputs of sectors (5) to (19) was set equal to an "expected" 1975 level plus a residue covered by loans from abroad. Appendix 3 describes the methods used.

Changes in Input Coefficients of Livestock and Food

A price differential of 30 per cent for 1975 livestock (including milk) output and livestock input is postulated, on the basis of observed changes between 1968 and 1972. The increase in the sale price of 1975 livestock output and in the purchase price of livestock input is thus assumed to be 30 per cent higher than the price increases of all the other inputs, relative to 1968 unit price levels. The livestock 1968 input coefficients were accordingly adjusted, with the effect that livestock to livestock remained unchanged, the profits coefficient increased from 0·411 to 0·502 and the other coefficients were reduced, so that the sum of the input coefficients was still unity. This means an increase of about one-fifth in livestock profits per £1 of output and is an attempt to take account of 1975 livestock profits per £1 unit of output being, undoubtedly, higher than those of 1968.

What this adjustment implies is that purchasers of livestock output in 1975 are getting less livestock physical amount per £1 of expenditure (at 1968 prices of items in general) than they in fact got in 1968. If all inputs per £1 spent on the purchase of output, except the inputs of livestock and the surplus or profit, are valued at 1968 prices and these inputs are less than those of 1968 for the livestock columns, then the physical inputs per £1 of output are less than those of 1968 and consequently the physical output obtained for £1 is less than that available for £1 at 1968 original input costs, including those for livestock and for the profit.

The adjustment to the food input coefficients took account of removal of

subsidies on livestock inputs (which include milk), a price differential of 30 per cent for livestock inputs and a resulting higher relative cost for food inputs to food. The general result was a somewhat larger 1975 input coefficient for livestock, a zero subsidy coefficient and all other coefficients somewhat smaller than those of 1968, but with the new coefficients adding to a total input of unity. As in the case of livestock, there is in effect some reduction in the purchasing power of £1 spent on food, at 1968 general price levels.

Productivity Changes Between 1968 and 1975

For livestock and crops and the industrial sectors (5) to (16), data on volume of gross output and employment for 1971 compared with 1968, mainly from the Irish Statistical Bulletin, but also from other sources, were used to give annual rates of change in gross output per man-year. These rates were used linearly to project gross output per man-year to 1975, and corresponding reductions made in the labour coefficients used for 1968 experiments (1) and (2). For other sectors annual rates of change, either for 1968 to 1972 or 1964 to 1968, were used to adjust the labour coefficient. The reader can find a fuller explanation in Appendix 2.

The wages etc. coefficients in general were adjusted in the same way as those for labour. These reductions in the wages etc. coefficients were absorbed by increases in the profits and depreciation coefficients, so that those for 1975 are larger than those of 1968, but in the same proportions as the latter. The sum of these three new coefficients is identical with the sum of the corresponding three 1968 coefficients, so there is no change in the aggregate primary input coefficient for each sector and thus no source of price changes from the 1968 base levels.

This means that in general the wage level per man-year is the same as that of the 1968 base, the exceptions being agricultural livestock and food manufacturing. Since most farm workers are self-employed the profits coefficient rather than the wage coefficient is of relevance for the livestock sector and the combined wages plus profits coefficient per man-year is about 75 per cent higher for 1975 than for 1968. The increase is due to the combined effects of 56 per cent increase in productivity and some 20 per cent increase in profits, as described above. In the food sector the double effect of subsidy loss plus increased costs of livestock inputs has outweighed the increase in productivity, with the result that the wage level per man-year in 1975 emerges some 20 per cent below that of 1968 as compared with a 2 per cent increase in the profits coefficient per £1 of gross output. These results for food are not satisfactory, even though they are consistent with the assumptions and methods described above. The problem of constant prices for most coefficients in a column, versus changed prices for a few coefficients presents difficulties not easily overcome.

It is necessary to be honest about the shortcomings of the food input coefficients but to avoid obsession with one sector out of 33.

Patterns Used for Final Demands

A study of patterns of government current expenditure given in [7] indicated considerable stability for some years around 1968 and the pattern derived from the 1968 I–O base table has been used for 1975.

For gross physical capital formation, the proportions for three main components appearing in A13 of [7] for 1971 capital formation at 1968 prices, were used. New construction was one component, changes in stocks was the second and all the rest formed the third. The "apparent surplus/deficit" column appearing in the 1968 I–O Table 3.1 was ignored and the "adjustment for stock appreciation" was spread over the other entries in the stock change column of that table, before scaling up to form the 1971 column used for proportionality. The gross fixed capital formation column of Table 3.1, with new construction omitted, was also scaled up to the 1971 level required, before adding new construction and the appropriate stock change column.

For personal expenditure, the 1968 vector of values appearing in Table 3.1 of [2] was used as a column of constants and data from [2] and [7] used to estimate a vector of coefficients for incremental personal expenditure. This method is along the lines of the Stone-Geary Linear Expenditure System, as described on page 88 of [12].

Terms of Trade for 1975 Assumed to be at Unit Levels

Exports are supposed to be sold at average prices ruling in 1968, and with no export subsidies for 1975. Possible improvements in the terms of trade for 1975 are ignored, although on page 20 of [3] and in the September 1972 issue of the Irish Statistical Bulletin (page 153) it appears that for the few years following 1968 the implied price index of exports exceeds that of imports, both indices being based on unity for 1968. Thus the import surplus of £65 million for 1975, as used by the model in the LP results, may contain a safety factor, by overestimating the import surplus which would emerge if all figures were transformed into values at 1975 prices. The writer takes the view that any possible error is in the right direction—it seems less wrong to overestimate the cost of imports than to underestimate it in looking at the future.

Present Government Policy Assumed Unchanged for 1975

It is assumed that the instruments of government policy incorporated in the model continue to operate according to their observed behaviour in recent years. No attempt is made to predict changes between 1966–1971 average behaviour and that of 1975, for income tax, government transfer payments, and

net government investment and trading income. The assumption of government current transfer payments continuing to take the same share of government income as has been observed for recent years implies that payments to the unemployed would in conditions of full employment take a different form and would continue to enlarge the purchasing power of the poorer members of the community. The 1968 I–O indirect tax coefficients are used for 1975, without modification. The set of eleven items of government current expenditure, extracted from Table A23 of [7], is interpreted as showing strong stability of expenditure pattern over the period 1965–1970, and the 1968 I–O final demand vector in question is used to give input coefficients, adding to unity, for 1975.

Other Feature of the 1975 Experiments (3) and (4)

Invisible exports of transport are treated as a constant at £75 million and tourist expenditure set at 5 per cent of personal expenditure. Price levels in general are those of 1968, except for livestock and food, as explained above in the discussion of changes in the input coefficients of these sectors. The objective function is incremental personal expenditure, as measured by the increase above the 1968 I–O base level of £963·48 million.

Appendix 10

The Model: Variables, Objective Function, Constraints, Behaviour Relations

THE variables are first listed, then the constants and then the coefficients and parameters. The set of inequalities which define the constraints on the economic system are next formulated, with the objective function appearing as statement number (A10.0). The variables have unknown values, to be found by the LP optimisation process.

VARIABLES

X_i Gross output of domestic productive sector i.

M Complementary imports, which are imports not classified as being similar.

$\mathcal{N}_i$ The variable part of similar imports of type i, distributed along the same row i as gross output of domestic sector i. It exists only for some values of i.

E_i The variable part of exports and re-exports of type i, from domestic output i and similar imports i. It exists only for some values of i.

$\mathcal{J}$ Indirect taxes, also called taxes on expenditure.

Q Subsidies.

W National income, consisting of wages, salaries, pensions, profits.

W_{AFF} The part of W arising in agriculture, forestry and fishing.

D Depreciation allowance.

C Personal expenditure on goods and services.

E_T Tourist expenditure, taken to be a fixed fraction, k_t, of C.

H Household expenditure, taken to be $(1-k_t)\ C$.

T Income tax as for the national accounts, with taxes on capital excluded.

T_g Net government investment and trading income.

P Government current transfer payments, as for the national accounts.

S Personal and corporate savings, net of income tax and net of depreciation allowance, but including the value of physical changes in stocks.

S_g Government savings.

Z Government income, excluding taxes on capital.

V Gross national product (GNP) at market prices.

F Foreign capital inflow, or import surplus.

G Net government central and local current expenditure, as for the national accounts.

I Investment in gross domestic physical capital formation. This includes fixed capital, the values of physical changes in stocks as for the national accounts, and the changes in stocks denoted "apparent surplus/deficit". The latter appears as a column of final demand in the transactions Table 3.1 of [2] and has a column aggregate equal to zero.

I_{AFF} The part of I relating to agriculture, forestry and fishing. For revised formulae (A10.7) to (A10.10) it is confined to value of changes in livestock on farms plus agricultural machinery.

I_L Loan capital from abroad, to permit capital investment required for full employment.

CONSTANTS

The asterisk following a symbol denotes a constant value and will be included below with the symbol, in the system of constraints.

S_O^* Constant in the personal and corporate savings behaviour equality.

T_O* Constant in the income tax behaviour equality.

P_O* Constant in the government current transfer payment behaviour equality.

T_{gO}* Constant in the net government investment etc. income behaviour equality.

L_O* Constant labour supply, the 1968 available labour force in man-years.

W_E* Inflows from abroad, of wages, salaries, pensions, profits, emigrants' remittances, all being invisible exports.

W_N* Outflows to abroad, of wages, salaries, pensions, profits etc., all being invisible imports, but excluding repayments arising from loan capital, namely $f_L I_L$.

M_E* Re-exports of complementary imports.

$\mathcal{J}_E$* Indirect taxes such as harbour dues paid by foreign shipping, being part of invisible exports, but excluding indirect taxes included in tourist expenditure.

$\mathcal{N}_i$* The constant part of similar imports of type i. It exists only for some values of i.

E_i* The constant part of exports and re-exports of type i. It exists only for some values of i.

F_O* A specified constant value, the 1968 actual import surplus.

$X^U{}_i$* Upper bound specified for output $X^U{}_i$.

$X^L{}_i$* Lower bound specified for output X_i.

K_O* Capital stock specified as already existing, for some or for all productive sectors, before or after reduction by a specified amount.

PARAMETERS AND COEFFICIENTS
(for n productive sectors)

a_{ij} Inter-industry technical coefficient for input of row i to column j, including similar import flow.

a_{iC}, a_{iG}, a_{iI} Coefficient for input of row i per unit of expenditure of C, G and I, respectively.

a_{kEj} Margin of type k on merchandise exports of type j, per unit of E_j the unit being £1 at producers' prices. (Of relevance only for $k=21$ and $k=23$ in the 33-sector I–O framework).

$m_1, m_2, \ldots m_n$
m_c, m_g, m_I } Complementary import coefficients.

$j_1, j_2, \ldots j_n, j_C, j_G, j_I$ Indirect tax coefficients.

$q_1, q_2, \ldots q_n, q_C$ Subsidy coefficients, giving the amount of subsidy on inputs to produce a unit of output, or per unit of personal expenditure.

q_{E1} Subsidy per unit of food exports, the unit being £1 at producers' prices.

$w_1, w_2, \ldots w_n, w_I$ Wages plus profits coefficients.

$d_1, d_2, \ldots d_n, d_G$ Depreciation coefficients.

e_j Value of export of type j, for balance of payment purposes, per £1 of output at producers' prices. The coefficient is unity for exports of transport classified as invisible exports in the national accounts. For merchandise exports it is the f.o.b. value, being

$(1+a_{21\,Ej}+a_{23\,Ej})$ for exports other than food and

$(1+a_{21\,Ej}+a_{23\,Ej}-q_{E1})$ for food, which has an export subsidy reducing the unsubsidised f.o.b. value.

l_j Labour coefficient, in man-years, per £1 per unit of gross output of sector j.

s_j Coefficient of explanatory variable j in the personal and corporate savings behaviour equality.

t_j Coefficient of explanatory variable j in the income tax behaviour equality.

p_j Coefficient of explanatory variable j in the government current transfer payments behaviour equality.

g_j Coefficient of explanatory variable j in the net government investment etc. income behaviour equality.

k_t The proportion of personal expenditure taken to be tourist expenditure.

$\lambda\triangle$ The percentage of gross domestic physical capital formation which consists of the value of physical changes in stocks.

$\lambda\triangle_{AFF}$ For agriculture, forestry and fishing, the percentage of gross physical capital formation which consists of the value of changes in numbers of livestock on farms.

k_j Capital stock per £1 of gross output of productive sector j.

f_L The proportion of I_L which is the outflow of principal and interest.

PREFERENCE FUNCTION AND CONSTRAINTS

Objective Function

Personal consumption, denoted C above, is to be maximised.

(A10.0) $$1{\cdot}0\ C = \max.$$

Constraints

The constraints consist of linear equalities (equations) and inequalities. The linear equalities are of four kinds. The first kind, numbered (A10.1) to (A10.7) below, are input-output transactions. Their coefficient are the I—O 1968 technical coefficients given in Table 3.2 of [2], or coefficients derived from Table 3.1 final demands. The second kind, numbered (A10.8) to (A10.11)

are behaviouristic and their coefficients were derived by Ordinary Least Squares regressions applied to data for the eleven years 1958–1968, tested and modified via 1969–71 data. The third kind of equations, namely, (A10.12) to (A10.16), are national accounting identities. The fourth kind, number (A10.17) and (A10.18), set required capital stock equal to a specified amount plus loan capital from abroad and the labour required by the productive sectors equal to the constant labour supply. The inequalities will be commented on below, within their own sub-section. The number of productive sectors, n, is set at a value of 33 in what follows.

Equalities

Commodity Flows

$$(A10.1) \quad X_i = \sum_{j=1}^{33} a_{ij}X_j + a_{ic}C + a_{iG}G + a_{iI}I + E_i + E_i^* - N_i - N_i^*$$

for $i \neq k$, where $i = 1, 2, \ldots 20, 22, 24, 25, \ldots 33$ and $k = 21, 23$.

The E_i, E_i^*, N_i and N_i^* exist only for some rows i.

$$(A10.2) \quad X_k = \sum_{j=1}^{33} a_{kj}X_j + a_{kc}C + a_{kG}G + a_{kI}I + \sum_s (a_{kEs})E_s + E_k + E_k^*$$

for $k = 21, 23$, s relating to variable merchandise exports and E_k existing only for $k = 21$ (invisible exports of transport).

Complementary Imports

$$(A10.3) \quad M = \sum_{j=1}^{33} m_j X_j + m_c C + m_G G + m_I I + M_E^*$$

Indirect Taxes

$$(A10.4) \quad \mathcal{J} = \sum_{j=1}^{33} j_j X_j + j_c C + j_G G + j_I I + \mathcal{J}_E^*$$

Subsidies

$$(A10.5) \quad Q = \sum_{j=1}^{33} q_j X_j + q_c C + q_{E1} E_1$$

Depreciation

$$(A10.6) \qquad D = \sum_{j=1}^{33} d_j X_j + d_G G$$

National Income (Wages etc. plus Profits)

$$(A10.7) \qquad W = \sum_{j=1}^{33} w_j X_j + w_I I + W_E^* - W_N^* - f_L I_L$$

where $w_I I$ is the adjustment for stock appreciation, affecting profits of business.

Income Tax

$$(A10.8) \qquad T = T_0^* + t_1[W - I - (W_{AFF} - I_{AFF})]$$

Net Government Investment and Trading Income

$$(A10.9) \qquad T_g = T_{g0}^* + g_1(W + D + \mathcal{J} - Q - \lambda_A I)$$

Government Current Transfer Payments

$$(A10.10) \qquad P = P_0^* + p_1(T + \mathcal{J})$$

Personal and Corporate Savings

$$(A10.11) \qquad S = S_0^* + s_1(W_{AFF} - \lambda_A I_{AFF}) + s_2[W - \lambda_A I - (W_{AFF} - \lambda_A I_{AFF})]$$

Government Income

$$(A10.12) \qquad \mathcal{Z} = T + \mathcal{J} + T_g$$

Government Savings

$$(A10.13) \qquad S_g = \mathcal{Z} - G - Q - P$$

Expenditure on the GNP at Market Prices

$$(A10.14)\quad V=H+G+I+\sum_j e_j E_j+\sum_j e_j E_j^*+W_E^*+E_T$$
$$+M_E^*+\mathcal{J}_E^*-\sum_j N_j-\sum_j N_j^*-W_N^*-M-f_L I_L$$

where $H=(I-k_t)C$ and $E_T=k_t C$

Equality (A10.14) was not used in the LP computations as such, but only after computer results became available. It is given here as fitting into the system of national accounting identities.

Import Surplus (Foreign Capital Inflow)

$$(A10.15)\quad \text{(i)}\quad F=M+W_n^*+\sum_j N_j+\sum_j N_j^*-\sum_j e_j E_j$$
$$-\sum_j e_j E_j^*-W_E^*-\mathcal{J}_E^*-M_E^*-E_T+f_L I_L$$

$$\text{(ii)}\quad F\leqslant F_O^*$$

The inequality (ii) is included here because it was used for the import surplus, in the experiments, with F replaced by the right-hand-side of (A10.15) (i).

Savings Equated with Investment

$$(A10.16)\quad S+S_G+D+F=I$$

The first three entries on the left give domestic savings from all sources. The variable F, if positive, means funds from abroad to purchase domestic capital formation. F negative means an outflow of domestic savings (in the form of an export surplus) for investment abroad. With F replaced by the right-hand-side of (A10.15) (i) above, and all the latter variables positive or zero in the LP solution, a negative value of F can emerge. Such a negative value would not be feasible for F used as a single variable in the LP model.

Required Capital Stock

$$(A10.17)\quad \sum_{j=5}^{19} k_j X_j=K_O^*+I_L$$

Labour Supply and Demand

(A10.18) $\sum_{i=1}^{33} l_j X_j = L_O^*$

Inequalities

The inequality (A10.15) (ii) above constrains the import surplus to be not greater than F_O^*, a constant. The other inequalities are simple upper and lower bounds for outputs of productive sectors, exports, similar imports, government current expenditure, gross physical capital formation.

Following are the constraints on outputs for all experiments. Extra constraints have been described in sections of the report and in other appendices.

Upper Bounds on Outputs of Productive Sectors

(A10.19) $X_i \leqslant X_i^{U*}$
for $i = 1, 2, 4, 6, 7, \ldots 15, 16$.

Lower Bounds on Outputs of Productive Sectors

(A10.20) $X_i \geqslant X_i^{L*}$
for $i = 1, 2, 5, 7, 8, \ldots 15, 16$.
Each domestic productive sector having similar imports in its row is thus not permitted to be completely replaced by similar imports.

THE FOUR BEHAVIOUR RELATIONS

In order to use the above model it is necessary to find numerical values for the coefficients and constants of equalities (A10.8) to (A10.11). From various regression experiments using OLS on data at current prices for the eleven years 1958–1968, four formulae were selected, as follows. The units are in £ million. These formulae were tested on 1969–71 data and three of them revised to fit the period 1966–1971.

Income Tax (T)

(A10.8′) $T = -59{\cdot}920 + 0{\cdot}30628\ [W - I - (W_{AFF} - I_{AFF})]$
(46.87)
$R = 0{\cdot}998$; $F = 2197$; $\tau = 4$; s.e. $= 2{\cdot}055$.

Revised $T = -137{\cdot}1 + 0{\cdot}43796\ [W - I - (W_{AFF} - I_{AFF})]$ with I_{AFF} confined to livestock changes and farm machinery.

Net Government Investment and Trading Income (T_g)

(A10.9′) $T_g = 0{\cdot}687 + 0{\cdot}02122\ (W + D + \mathcal{J} - Q - \lambda\triangle I)$
(15·68)
$R = 0{\cdot}982$; $F = 246$; $\tau = 4$; s.e. $= 0{\cdot}971$.

There was no apparent need to revise this formula.

Government Current Transfer Payments (P)

(A10.10′) $P = 1{\cdot}034 + 0{\cdot}39348\ (T + \mathcal{J})$
(99·45)
$R = 0{\cdot}9995$; $F = 9889$; $\tau = 5$; s.e. $= 0{\cdot}977$.
Revised $P = 6{\cdot}6 + 0{\cdot}41379\ (T + \mathcal{J})$

Personal and Corporate Savings (S)

(A10.11′) $S \neq -55{\cdot}050 - 0{\cdot}60301\ (W_{AFF} - \lambda\triangle_{AFF} I_{AFF})$
(2·17)
$+ 0{\cdot}09646\ [W - \lambda\triangle I - (W_{AFF} - \lambda\triangle_{AFF} I_{AFF})]$
(2·47)
$R = 0{\cdot}978$; $F = 75{\cdot}6$; $\tau = 6$; s.e. $= 6{\cdot}47$.

Revised The constant, $-55{\cdot}05$, is revised, to be $-47{\cdot}05$. Otherwise there is no change.

The t-level of each coefficient is shown directly below it, in parentheses.

R is the coefficient of multiple correlation. F is the Fisher variance ratio, uncorrected. τ is the Geary parameter for number of sign-changes of residuals [10]. The letters s.e. mean standard error of the estimate.

Only one coefficient, marked with a $\neq$ symbol in equality (A10.11′) is not significant at the 5 per cent level. All four values of τ indicate that auto-correlation of residuals is not significant.

The income tax equation omits income arising in agriculture, forestry and fishing, as might be expected. The saving equation shows markedly different rates for agriculture etc. and non-agriculture, and former activity showing 60 per cent saving of an incremental unit of income arising less stock increases, as against a 10 per cent saving propensity for the latter. Equality (A10.11′) is not nearly so precise as the other three, as is apparent from its relatively large

standard error of estimate. It is however the best savings formula available for use in the model structure.

A testing of the four formulae (A10.8′) to (A10.11′) for 1969–71 showed a major revision necessary only for (A10.8′), income tax. The formula (A10.9′) required no alteration, while (A10.10′) and (A10.11′) effectively needed only revision of their constant term. The amended formulae are based on data at current prices for the six years 1966–1971, and are more appropriate to the short-term relationships than the old formulae, for 1958–1968. Because linear formulae are needed for the LP procedures, whereas some of the relationships in the long-term are curvilinear, the only possible compromise is to use the apparent linear relationship for the recent past unless better information, regarding future changes in the present relationship, becomes available.

Printed by Cahill & Co. Limited, Dublin 3

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