Explanatory Hypotheses for Irish Trade in Manufactured Goods in the Mid-Nineteen Sixties

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FOR the last twenty years, the literature on international trade has contained numerous discussions of the Heckscher-Ohlin hypothesis. In a world where all economies use similar technologies and have identical homogeneous production functions of the first degree, and similar demand patterns, where factor reversibility does not exist, where factors are immobile as between economies and where transport costs and government policy do not impede trade, it was presumed that an economy would export commodities in which its most abundant factors of production were incorporated.[1]

The so-called Leontief paradox pushed the profession into a wave of empirical research by suggesting that the Heckscher-Ohlin doctrine did not apply to the US case.[2] The original Leontief procedure, making use of input-output data, used the two factor case (capital and labour) to show that US exports seemed to be less capital intensive than US imports (i.e. import substitutes). Both Leontief and others proceeded to publish a series of studies to explain the paradox. Some questioned the basic procedures used by Leontief.[3] Others moved to refine the Leontief procedures and to reformulate the crude form of the Heckscher-Ohlin hypothesis laid out by Leontief.[4]

Within the last 18 months, McGilvray and Simpson have submitted Irish trade data to a battery of tests mainly in the tradition of the recent literature.[5] Among

*My thanks are due to the following: Miss Renita Esayian who acted as a research assistant during an important stage of the project; Professor Helen Manning Hunter and Mr. John Blackwell who gave valuable advice and assistance; the Haverford Computer Centre which permitted me to use their facilities; Dr. E. Henry who provided necessary data; Dr. Dermot McAleese and the referee who provided invaluable comment on an earlier draft.

1. R. E. Baldwin [2], J. Bhagwati [5].
2. W. Leontief [27, 28].
3. See, as examples, R. E. Baldwin [2], P. Bardhan [4], I. Kravis [25], R. W. Jones [20].
4. R. E. Baldwin [2], P. Bardhan [4], I. Kravis [25], R. W. Jones [20].
5. J. McGilvray & D. Simpson [33, 34].

their findings, they discovered that on the basis of the application of a refined version of the Leontief procedures to Irish input-output data, Irish merchandise exports tended to be more labour intensive and more skill intensive than Irish imports. When they dropped the natural resource sector from their computations, Ireland no longer tended to be a clear-cut net exporter of labour intensive commodities.[6] Again without the inclusion of the natural resource sectors, they observed direct skill ratios and found that Ireland tended to be a net importer of skills through the process of merchandise trade. Finally, they noted that part of the explanation for their results was that the method of classification of skills in agriculture imposed a bias on their results, that agriculture was labour intensive and that Irish industry purchased complementary capital intensive and resource specific imports.

The orientation of this paper is essentially complementary to that of McGilvray and Simpson. The predominant interest is in assessing the appropriateness of applying Leontief procedures to an analysis of the character of Irish manufacturing exports and imports. The Leontief procedures are adapted to an examination of the total manufacturing sector and trade in manufactured goods is examined for its capital, labour, and skill content. Emphasis is also put on the role of female labour in the international trade in manufactured goods. The results are then assessed and some possible objections to the character of the procedures used are examined. As an extension of the discussion, analyses are undertaken of the character of Irish manufacturing industries, and of the impact of the nature of complementary imports and of the grant-aided industries on the factor content of Irish manufactured goods. Finally, on the basis of the results, further insight is sought from the works of Keesing, Gruber, Mehta and Vernon into the determinants of trade in manufactured goods.[7]

REFINED LEONTIEF PROCEDURES APPLIED TO THE MANUFACTURING SECTOR

In recent years, a good deal of attention has been given to Ireland's export drive in manufactured goods. To further understanding of the role of the manufacturing sector, it seems important to assess the basis of the manufacturing sector's contact with the international market for goods.

As a first step then, procedures were set up to pull the manufacturing industries (sectors 18 through 59 in the Irish input-output table)[8] out of the 92 sector input-output table for 1964 and to derive capital, labour, skill and female labour coefficients for Irish manufactured exports and imports.

The statistical work proceeded through the following stages:

6. For the purposes of this paper "net exporter" of (say) labour intensive commodities means that the labour content of £1,000 of exports exceeds the labour content of £1,000 of imports.

7. W. Gruber, D. Mehta and R. Vernon, [11], D. Keesing, [23], R. Vernon, [41].

8. Ireland [15].

(*a*) The original transaction matrix of 92 sectors was reduced to 42 with processing sectors for manufacturers (18 through 59) included in the revised table.[9] Intermediate similar good imports and intermediate complementary good imports were dropped as were intermediate good purchases from non-manufacturing sectors. Thus the output total for each sector reflected solely the value added generated within manufacturing industries, and the intermediate purchases and sales between manufacturing groupings excluded transactions involving intermediate similar imports.

(*b*) The total and composition of exports and final similar imports were adjusted also for the revisions undertaken under (*a*).

(*c*) On the basis of the data and computational requirements, the 42 sectors were then compressed into 27 manufacturing groupings.

(*d*) The inverse of the 27 sector table was then found.

(*e*) On the basis of data originally provided by Dr. Eamon Henry,[10] a replacement cost fixed capital-in-use series was compiled for each sector in 1964 and direct capital coefficients were found for the 27 sectors.[11] Using Henry data, direct labour coefficients were also derived.[12]

(*f*) Assuming exports and final similar imports each equal to £1,000, the distributions of exports and final similar imports were found. Following the Leontief procedures, the direct and indirect labour requirements per £1,000 of exports were found. The labour requirements per £1,000 of imports were also found as were the capital requirements for exports and final similar imports.

(*g*) Making use of Census of Population data,[13] the total female and skill requirements of exports and imports were also derived. To develop the total skill requirements for Irish trade, the labour force in each of the 27 groupings was classified in the following way:

I — Professional and technical
II — Managers, directors, and company secretaries
III — Electricians, electrical workers, machinists and fitters
IV — Semi-skilled labourers and operatives
V — Others including labourers, clerks and typists, transport, communication and sales workers

(*h*) The procedures have been applied to merchandise manufactured good exports, excluding sectors using significant amounts of domestic natural resource

9. For further details of the classification scheme of the revised table, see the appendix.

10. The data provided by Henry are unpublished and unofficial. In more aggregated form, some of his findings have been published in: E. Henry [13], The method of compiling the capital-in-use series has been described in: Noel J. J. Farley [10].

11. For each of the 27 sectors the direct capital coefficient is the quantity of capital, measured in market prices, needed to produce a unit of output.

12. The direct labour coefficient for each of the 27 sectors is the amount of labour, measured in man-years, needed to produce a unit of output.

13. Ireland [18].

products (sectors 18 through 32 of the 92 sector input-output table) and final similar manufactured good imports (first including and then excluding sectors 18 through 32). The published input-output table also shows total exports by each manufacturing sector. Definitionally, total manufactured good exports is the sum of merchandise and invisible manufactured good exports. The major invisible export is tourist expenditures. Total labour, capital and skill requirements for total manufactured good exports are also computed.

(*i*) Procedures were also constructed to divide the 27 manufacturing groupings into intermediate and final manufactured good output and it was then possible to determine the total (direct and indirect) capital, skill and female components of each of the classifications of merchandise manufactured good exports.

The procedures used to classify manufactured good output into intermediate and final items is a refined version of the analysis of Chenery and Watanable.[14] The input-output statistics for Irish manufacturers were again divided into 27 groupings. For each grouping the "total flow for the domestic market" was measured as:

$$T_{di} = T_i - E_i - M_i \qquad (1)$$

where T_{di} is the "total flow for the domestic market," T_i is the total flow, E_i is the value of exports and M_i is the value of total imports. Subscript i refers to the grouping in question such that $i = i(1, 2, 3 \ldots 27)$.

Inter-industry sales of the product group i was measured as:

$$T_{mi} = T_{ti} - M_{mi} \qquad (2)$$

where T_{mi} is the value of domestic output sold in inter-industry transactions, M_{mi} is the total of intermediate similar imports of the type produced in group i and T_{ti} is the total-inter-industry purchases of the product types produced in group i.

Then,

$$W = T_{mi}/T_{di} \qquad (3)$$

where W is the percentage of the total flow for the domestic market sold in intermediate good transactions. It was then possible to compare W values by sector with the value of W for the whole of manufatcuring industries. Thus:

$$W^a = \sum_{i=1}^{27} T_{mi} / \sum_{i=1}^{27} T_{di} \qquad (4)$$

where W^a is the value of W for the total manufacturing sector.

W values by grouping which were greater than W^a permitted us to view those groupings as producers of intermediate products. Groupings producing final goods had W values less than W^a.

14. H. Chenery and T. Watanable [8].

TABLE 1

	Female Coefficient	*Total Capital Coefficient*	*Total Labour Coefficient*	*Skill I Coefficient*	*Skill II Coefficient*	*Skill III Coefficient*	*Skill IV Coefficient*	*Skill V Coefficient*
Merchandise Manufactured Good Exports	·2907	1·5462	1·2187	·0191	·0435	·0981	·4260	·4133
Similar Manufactured Good Imports	·2902	1·3147	1·0959	·0224	·0406	·1255	·4841	·3274
Merchandise Manufactured Good Exports excluding Natural Resource Based Industries	·3145	1·5065	1·2169	·0198	·0350	·1256	·5341	·3255
Similar Manufactured Good Imports excluding Natural Resource Based Industries	·2902	1·3686	1·0785	·0212	·0394	·1383	·5191	·2820
Similar Intermediate Imports	·2510	1·4318	1·1885	·0180	·0375	·1392	·4420	·3633
Total Exports	·3018	1·4805	1·1849	·0180	·0435	·0876	·4412	·4097

TABLE 2

	Female Coefficient	*Capital Coefficient*	*Labour Coefficient*	*Capital/ Labour*	*Skill I Coefficient*	*Skill II Coefficient*	*Skill III Coefficient*	*Skill IV Coefficient*	*Skill V Coefficient*
Merchandise Manufactured Good Exports/Merchandise Manufactured Good Imports	1·002	1·176	1·119	1·051	·853	1·071	·782	·889	1·262
Merchandise Manufactured Good Exports/Merchandise Manufactured Good Imports (excluding Natural Resource Based Industries)	1·083	1·101	1·128	·976	·934	·888	·908	1·029	1·154
Total Manufactured Good Exports/ Total Manufactured Good Imports	1·039	1·126	1·081	1·042	·804	1·071	·714	·911	1·251

Sources: Ireland [15]
Ireland [18].
Data for intermediate similar imports provided by Dr. E. Henry. These statistics are unpublished and unofficial.
Capital and labour series provided by Dr. E. Henry. These statistics are also unpublished and unofficial.

TABLE 3: *Other Characteristics of Merchandise Manufactured Good Exports*

(*a*) W^a for the manufactured good sector			·4323
Percentage of Merchandise Manufactured Good Exports made up of Intermediate Goods		28·3	(38·1[1])
Percentage of Merchandise Manufactured Good Exports made up of Final Goods		71·7	(61·9[1])
(*b*) *Coefficients for Merchandise Manufactured Good Exports*	*Intermediate[2] Goods*	*Final[3] Goods*	*All*
Labour	1·2018	1·2289	1·2187
Capital	1·5990	1·5130	1·5462
Female	·2742	·3008	·2907
Skill-Class I	·0228	·0168	·0191
Skill-Class II	·0347	·0488	·0435
Skill-Class III	·1782	·0488	·0981
Skill-Class IV	·3981	·4714	·4260

1. The figures in brackets are based on export values which, in turn, are based on value added in the manufacturing sector alone. These figures are the basis for the coefficients which are included in (*b*). The alternative values are based on export values which include intermediate inputs from both inside and outside the manufacturing sector.

2. Intermediate goods-input-output groupings numbers 4, 7, 8, 9, 11, 12, 14, 17, 19, 20, 24, 25, 26, 27 (For definitions see the Appendix).

3. Final goods—1, 2, 3, 5, 6, 10, 13, 15, 16, 18, 21, 22, 23.

The results of the statistical procedures are included in Tables 1, 2, and 3. The highlights of these results are:

(*a*) With regard to the total (direct and indirect) labour coefficients, the merchandise manufactured good export/manufactured good import ratio is 1.119. When natural resource based industries are excluded from the computations, the ratio rises to 1.128. When both merchandise and invisible exports and imports are included, the ratio is 1.081.

(*b*) The results for the total capital coefficients also show the export/import ratio to be greater than one in all three cases. The highest ratio is achieved for merchandise manufactured good trade and the high capital requirements of the natural resource based industries is indicated by the fall in the ratio when natural resource based industries are excluded from the statistics for manufactured good trade.

(*c*) The results for the capital to labour ratios of exports and imports indicate that the export/import ratio is greater than one in two of the three cases. The exception is merchandise manufactured good trade excluding natural resource based industries, which suggests that sectors using domestic natural resource inputs tended to be capital intensive. None of these results, however, deviate substantially from 1.

(*d*) The examination of the export/import ratios for the five classifications of skill suggests that Ireland was unequivocally a net importer of skill classes I and III and a net exporter of skill class V. The results show Ireland as an exporter of goods dependent on unskilled labour and an importer of goods which incorporate various kinds of skilled labour. Of great significance for its stage of economic development, was the net import status of Ireland in professional, technical, electrical and mechanical skills.

(*e*) The results for the female coefficients are generally inconclusive. Only in the case of the ratio for merchandise manufactured good trade excluding natural resource based industries is the result substantially different from one and suggests that Ireland was a net exporter of female labour.

(*f*) An examination of the various coefficients for intermediate similar imports suggests that in contrast to the results for total manufactured good exports, similar intermediate imports tended marginally to be more labour and less capital intensive and to be goods which involved more class III skills (electricians, machinists and fitters). In contrast to merchandise manufactured good exports, however, intermediate similar imports tended to be mildly more capital intensive.

(*g*) The value of W^a was ·4323. 71·7 per cent of merchandise manufactured good exports are classified as final goods, 28·3 per cent as intermediate goods. Looking at the breakdown of these results, we discovered that:

1. Final manufactured food, drink and tobacco exports were about one half of total merchandise manufactured good exports;
2. The final good category was more female intensive and labour intensive than the intermediate good category. It also put somewhat less emphasis on Class I skills and much less emphasis on Class III skills.

ASSESSMENT OF THE RESULTS

These results are of great interest in the light of the findings of McGilvray and Simpson.[15] In Table 3.1 of their paper, they found that the total capital-labour ratio requirements, for merchandise exports/merchandise imports all deviated substantially from one, suggesting that Ireland is a net exporter of labour intensive commodities. Probably the closest point of contact with this paper in terms of

15. J. McGilvray and D. Simpson [34, p.5].

methodological procedures is when they examined the direct capital/labour ratio requirements for merchandise exports/merchandise imports (excluding in each case the influence of the primary sector).[16] In these cases their ratios came close to one and show the same lack of conclusiveness as the results seen here.

One note of difference in the results must be noted, however. While the two sets of results for merchandise trade in manufactured goods are close to 1, the McGilvray and Simpson findings suggest that Ireland was mildly a net exporter of labour intensive commodities and the results here suggest that Ireland was slightly a net exporter of capital intensive commodities. This difference in the results can be explained by variations in methodological procedures. The McGilvray and Simpson result is based on *direct* coefficients. The result here is based on *total* coefficients derived from an examination of value added within the manufacturing sector alone.

The fact that this study examined value added within the manufacturing sector alone, while the McGilvray and Simpson study examined value added in the total economy, provides a further insight into the McGilvray and Simpson findings. Commenting on the differences in their results when they use direct and total coefficients, they note:

> Statistically, this difference may be wholly or partly explained by the fact that, while the direct contribution of natural resource sectors to exports are excluded (in tests 3 and 4), these sectors—in particular agriculture—are important indirect exporters. Since agriculture is highly labour intensive, this reduces the capital/labour ratio of exports when indirect factor requirements are included.[17]

The results of this study, based on direct and indirect coefficients for the manufacturing sector alone adds weight to this contention. If McGilvray and Simpson are correct, the results of this study for merchandise manufactured good trade should show some greater capital intensity than their results using direct coefficients. The findings meet this condition although the differences between them are small.

We have also concluded that intermediate similar imports are slightly more capital intensive than merchandise manufactured good exports and marginally more labour intensive than total manufactured good exports. These conclusions contrast with McGilvray and Simpson's emphasis on the role of intermediate similar imports as capital intensive inputs to be associated in production with the abundant supply (relative to capital) of unskilled labour.[18] Differences in methodological procedures as between the two studies are again responsible for these varying results.

Of great interest in the findings of Table 2 is that Ireland appeared to be a net

16. The exclusions are: agriculture, forestry, fishing, coal, peat and other mining.
17. J. McGilvray and D. Simpson [34, p. 6].
18. J. McGilvray and D. Simpson [33, p. 5].

exporter of both labour and capital in its merchandise manufactured good trade. This result was initially baffling. After much experimentation within the framework of these procedures, it became clear that the results are related to the fact that the level of technical efficiency or the character of technical methods varied significantly as between Irish manufacturing industries.

In compiling direct labour and capital coefficients for each of the 27 manufacturing groupings, we have been assuming that the manufactured good sector has been operating with fixed input coefficients. These two direct input coefficients for each industry seemed to vary somewhat across the 27 groupings. Thus the rank correlation coefficient was sought using the direct labour coefficient as the dependent variable and the direct capital coefficient as the independent variable. Kendall's Tau came out to be ·473 and was significant at the 1 per cent level.

The difference in technical sophistication[19] as between industrial groupings which this finding implies is consistent with *a priori* preconceptions about the evolution of the manufacturing sector. McAleese[20] stated that he perceived Irish manufacturing activities as divided into two categories: those industries which emerged after 1931 operating behind a protective wall to cater to the domestic market and those industries which have appeared since 1958 and cater to the export market.[21]

What is further implied by the nature of the results is that the technically most sophisticated industries were not necessarily the major exporters, and imports did compete with the products of the more technically efficient industries.[22] This suggests further that the basis of the manufacturing sector's exports may be explained less by factor proportions and technical methods within the manufacturing sector and more by the nature and quantity of natural resources available outside the manufacturing sector, the nature of tax and trade policies[23] of the Irish and other governments, and the character of product differentiation in the manufacturing sector.

The results for the skill classifications also provide a series of interesting implications. First, Ireland's net import status for skill classifications I and III indicate a relative shortage of technical and scientific skills as well as the limited emphasis on mechanical and electrical skills. There are strong suggestions of a high investment in managerial skills as the basis of the manufacturing sector's export drive and of the important role of service-type labour apart from the production line and of unskilled labour in facilitating the export endeavour. This last point highlights the role of managerial organisation in bringing about exports and suggests that exports occur as a result of major selling and distribution

19. Another way of putting this is that the net productivity of labour and capital together will be greater, the higher the level of technical sophistication.

20. D. McAleese [31].

21. For an analysis of the evolution of Irish industry see: K. Kennedy [24].

22. For more on this see: J. McGilvray and D. Simpson [34].

23. In mind here particularly but not exclusively is the role of tariff policy in influencing the character of imports.

efforts. The total input coefficients for similar intermediate imports tend to reinforce the overall results presented here.[24]

In an international framework, the results are of particular interest with regard to class I skills. Baldwin had found that professional and technical skills represented 6·7 per cent of the labour input in US exports.[25] Keesing's equivalent statistic for direct professional and technical skills in manufactured good exports was 10·63 per cent with percentages of approximately 8 per cent for the UK, Switzerland, and the Netherlands.[26] Ireland's percentages—2·28 per cent for intermediate manufactured goods, 1·68 per cent for final manufactured goods and 1·91 per cent for all merchandise manufactured good exports—seem small beside these statistics and suggest an emphasis on either the production of commodities with simple standardised rather than technically sophisticated methods.[27]

Finally the results for female labour suggest that Ireland is a net exporter of female labour when we observe the export/import ratio for merchandise manufacturing trade excluding natural resource based manufactures. The effort to tally these results with those for categories of skills did not produce significant rank correlation results. One suspects, however, that cost considerations encouraged Irish manufacturing exporters to make use of cheap female labour. Nevertheless, an effort was made to understand further the nature of industries making use of female labour.

The procedure was to rank the 27 groupings according to the *direct* percentage of female labour participating in the labour force of each grouping. Thus number 1 was the most female-intensive and number 27 the least female intensive grouping. The groupings were then broken down into three sub-groupings, numbers 1–9 representing the female intensive grouping, 10–18 the medium female-intensive grouping and 19–27 the least female intensive grouping. The percentage of total manufacturing exports coming from each sub-grouping was then computed. The capital, labour, capital/labour input rankings were then derived and statistics were compiled to show the relationship between the degree of participation of women and the use of capital and labour in various industries. These computations are contained in Table 4.

The results indicate that 29·1 per cent of manufacturing good exports came from the female intensive industries. In addition, there was a tendency for the least female-intensive grouping to be the most technically sophisticated (see the frequency of rankings between 19 and 27) though there appears to be little evidence in this grouping for the prevalence of higher capital to labour ratios than in the other groupings. Thus there may be a tendency for female labour to

24. Similar intermediate imports are less female intensive than exports or other categories of imports. They are also less labour intensive and more capital intensive than similar final imports. They are more skill III intensive than similar final imports. See Table 1. J. McGilvray and D. Simpson [34] also examine the skill content of trade but while there is no apparent contradiction the two sets of results, direct comparisons are difficult because of differences in the basis of measurement.

25. R. E. Baldwin [2]. 26. D. Keesing [22]. 27. See tables 1, 2, 3.

be associated with the less technically sophisticated industries and with production processes with relatively high requirements of capital per unit of labour.

ASSESSMENT OF THE APPROPRIATENESS OF THE REFINED LEONTIEF PROCEDURES

A number of objections to the procedures used must now be subjected to scrutiny. These possible objections can be divided into two groupings:

(*a*) Is the assumption of a common technology within and across economics a valid one? Is it acceptable to assume the same homogeneous production function of degree is for firms within an industry and for industries across countries at a moment of time? Two aspects of these questions will be examined here. First the traditional test of factor reversibility will be examined between Ireland and the UK to determine whether it is appropriate to use Irish capital and labour coefficients to examine the factor content of Irish manufactured good exports and import replacements. Secondly, Irish industrial groupings will be examined to determine whether different technologies and factor proportions are used in export-oriented as contrasted with import-replacement establishments.

(*b*) Is it adequate to examine the factor content of manufactured good trade by using Leontief procedures which focus on exports and import replacements above? Do complementary imports play an important role in determining the factor content of imports? As a result of these questions an effort will be made to give separate treatment to the factor content of similar and complementary imports.

(*1*) *The Question of Factor Reversibility*

The Heckscher-Ohlin conclusions about the basis of trade are applicable unambiguously only in the case where factor reversibility does not exist. Empirical tests for factor reversibility have been discussed by such economists as Minhas, Ball, Travis as well as in the Irish case by McGilvray and Simpson.[28] The Irish findings as well as the predominance of the other evidence suggests that while there is not a perfect rank correlation between the rankings of industries in different economies by the degree of capital intensity, the rank correlations are high enough to be significant.

The McGilvray and Simpson tests used Lary's value added per employee as a proxy for the degree of capital intensity.[29] As such, their definitions of capital include both physical and human elements. In the light of the crudeness of the value added concept, an effort was made to compute capital to labour ratios for individual British and Irish industries. On the basis of the available data, this was possible for 17 of the 27 groupings included in our revised input-output table.

28. B. Minhas [35, ch. 4], D. S. Ball [3], W. Travis [39, pp. 91–94].
29. H. B. Lary [26].

Rank correlation analysis was applied to the results and Kendall's Tau was ·566 which was significant at the 1 per cent level.[30] The assumption of no factor reversibility seemed then to be an acceptable approximation of the reality.

TABLE 4: *Female Intensive Grouping*

	Ranking			*Percentage of Manufactured Exports*
	1–9	*10–18*	*19–27*	
Coefficient for:				
Direct Capital Input	4	3	2	
Direct Labour Input	3	5	1	
Capital/Labour Ratio	2	5	2	
Percentage of Manufactured Exports				29·1
MEDIUM FEMALE INTENSIVE GROUPING				
Coefficient for:				
Direct Capital Input	4	3	2	
Direct Labour Input	4	3	2	
Capital/Labour Ratio	4	3	2	
Percentage of Manufactured Exports				30·9
LEAST FEMALE INTENSIVE GROUPING				
Coefficient for:				
Direct Capital Input	1	3	5	
Direct Labour Input	2	1	6	
Capital/Labour Ratio	3	1	5	
Percentage of Manufactured Exports				40·0

Sources: Ireland [15], Ireland [18].

(2) *Technology and Factor Propositions within Irish Industrial Groupings*

A more serious problem arises with the original 92 sector input-output table. The method of classification of production sectors proceeded in the conventional way and thus failed to distinguish between the operations of grant-aided and other establishments within each classification. This would appear to have important implications in the light of the substantial changes in the performance of the manufacturing sector caused by the growing significance of the grant-aided industries.[31]

On the basis of available data, it can be seen that between 1960 and 1966, grant-aided industries were responsible for 28·3 per cent of the increase in output and 87·3 per cent of the increase in exports from mining and manufacturing industries.[32] By 1966, grant-aided industries accounted for 42 per cent of the

30. Data for British Manufacturing are taken from T. Barna [1].

31. Ireland [19, p. 22].

32. Ireland [19, p. 22]. McAleese [31, p. 29] suggests that excluding the Shannon area, grant-aided industries were responsible for 60 per cent of the increase in manufactured good exports, and 26 per cent of the increase in the output of transportable goods output.

exports of mining and manufacturing industries.[33] This would be the cause of little concern if grant-aided manufacturing industries used similar technical methods and factor proportions as other manufacturing industries in the economy.

The available data are few in number but enough information is available to produce striking results. In Table 5 data are assembled to show the net output per worker in grant-aided manufacturing industries as a ratio of net output per worker in both grant-aided and non-grant aided manufacturing establishments. Table 6 shows the percentage of the labour force which is female for each grouping.

A number of conclusions then follow. First, with the exception of other manufacturing, output per worker is from 18 to 303 per cent higher in grant-aided industries than in all manufacturing industries. Secondly, it is also apparent that grant-aided industries are more significant users of female labour. This may indicate either a preference for industries (within the broad definitions of Table 6) which are traditionally female intensive and/or a willingness to make greater use of female labour in individual industries.

It seems clear that the grant-aided industries use different production methods and factor proportions than other manufacturing industries. Nevertheless, the data at hand do not permit us to conclude that grant-aided industries are more capital intensive than others, though there is some reason to presume that newer processes have been more capital intensive than the old.[34] The data do confirm, however, the importance of the supply of female labour in encouraging the emergence and growth of grant-aided industries catering to the export market.

These findings do influence the character of our previous results based on the 27 × 27 revised input-output table. First, while exact quantification is not possible, it would appear that the results for females contained in Table 2 showing an export/import ratio greater than one only for merchandise manufactured trade excluding natural resource based industries significantly underestimated the role of women in Ireland's exports of manufactured goods. The grant-aided industries were oriented primarily to exports[35] and thus the female component in exports but not in imports was thereby too low. It seems reasonable to conclude that Ireland was a significant net exporter of manufactured goods from female intensive industries.[36] Secondly, the conclusion from Table 1 that Ireland was a net exporter of both labour and capital through its trade in manufactured goods must also be put into question. The examination of data for grant-aided industries suggests

33. Ireland [19, p. 22].

34. As indicated later, there is evidence to suggest that capital to labour ratios have been rising in Irish manufacturing over the period 1953–1967. Grant-aided firms which have grown in importance since 1958, are thus probably more capital intensive than the overall manufacturing sector. See: Noel J. J. Farley [10].

35. Ireland [19, ch. 2].

36. When account is taken of invisible exports and particularly of tourism, the significant role of women in bringing about exports becomes even more apparent. Three key non-manufacturing sectors from the point of view of tourism have the following female participation in their labour forces: retail trade 51·0 per cent, air transport 31·4 per cent, catering and hotels 66·1 per cent. See Ireland [18].

higher labour productivity levels of sufficient magnitude to ensure that Ireland was a net importer of labour through its trade in manufactured goods. If we also judge with some reason that the grant-aided industries were more capital intensive than the manufactured sector in toto, then we end up with the conclusion that the manufacturing sector's trade in exports and imports made Ireland a net exporter of capital intensive goods in 1964.

(3) *The coverage of the Manufactured Good Import Statistics*

What we have been analysing with our refined version of the Leontief procedures is the factor content of manufactured good exports and similar manufactured good imports. Excluded from the analysis is complementary good imports, in fact, intermediate complementary imports to the manufacturing sector were 2.1 times the size of final similar manufactured good imports. To leave these imports out of the analysis of the factor content of trade, then, is to provide a potentially distorted view of the basis of Ireland's international trade, especially when the factor content of these imports deviates significantly from the pattern applicable to the trade included in the revised Leontief procedures.

THE OPERATIONS OF THE IRISH MANUFACTURING SECTOR

(a) *The Character of Irish Industry*

In order to examine complementary manufactured good imports, it is necessary to seek some perspective, within an international framework, on the degree of capital intensity of Irish manufacturing industries.

The degree of capital intensity of Irish manufacturing industries is a function of two variables:

1. the degree of capital intensity accepted in the choice of techniques within individual industries;
2. the degree of capital intensity achieved as a result of the choice of industries.

On the first score, there seems little doubt about the growing capital intensity of the manufacturing sector over the period 1953–1967. In a previous study, this author found rising capital to labour ratios in 42 out of 44 manufacturing industries over the period.[37] This should provide no surprise. Many articles have appeared on the manufacturing sector's difficulty in raising employment as well as output in the developing countries. Modern technologies embodied in imported capital equipment tend to be capital intensive. Ireland, as an importer of much capital equipment, tended, according to Leser's findings,[38] not to produce manufactured goods with labour intensive methods. The capital grants policy,

37. Noel J. J. Farley [10].
38. C. Leser [29, p. 6].

the nature of exchange rate and tariff policies,[39] Government programmes of credit for manufacturing expansion, all tended to pull in the same direction.

TABLE 5: *Net Output per Worker in Grant-Aided Industries as a Ratio of Net Output per Worker in All Manufacturing Industries in 1966*

Food	1·38
Drink and Tobacco	—
Textiles	1·18
Clothing	1·35
Wood and Furniture	1·39
Paper and Printing	1·30
Chemicals	4·02
Clay products and Cement	1·23
Metal products	1·27
Other Manufacturing	1·02

Sources: Ireland [17], Ireland [19, pp. 46, 49, 50].

TABLE 6: *Percentage of Females in Each Industrial Grouping*

	Grant-Aided Industries	*All Manufactured Industries*
Food	47·7	27·8
Drink and Tobacco	38·5	20·8
Textiles	59·1	51·6
Clothing and footwear	82·6	71·2
Wood, wood products, furniture	10·6	8·3
Paper and printing	48·6	33·8
Chemicals	31·9	27·8
Clay, cement	28·3	11·9
Metals, engineering	27·8	15·5
Other manufactures	33·1	31·6

Sources: Ireland [18], Ireland [19, p. 43].
Note: The grant-aided industry statistics are employment estimates based on full capacity use within establishments.

Some of these measures tended to counteract market imperfections, pulling production in the labour intensive direction,[40] but the preponderance of the

39. Low, or no tariffs on imports of capital goods, and tariffs on consumer good imports can produce the effect of producing higher capital to labour ratios than would exist in a world of no tariffs and an exchange rate adjusted for the elimination of tariffs. An analysis can be developed showing that exchange rate and tariff policies raise the price of labour relative to the price of capital as compared with the situation of free trade with adjustment of the exchange rate.

40. McAleese [32] makes reference to the complications created by these market imperfections.

evidence would tend to suggest that there were strong forces pulling production techniques in the capital intensive direction.

An examination of the character of Irish manufacturing industry, however, can say much about the overall capital intensity of that sector. For comparative purposes, Table 7 has been compiled from Hufbauer.[41] It shows the 1963 dollar value of capital per man and the ranking of industries according to degree of capital intensity. Assuming limited factor reversibility as between economies in the production of individual goods, this table should provide a yardstick against which to examine the degree of capital intensity of Irish industry in 1964.

Table 7 strikingly shows the capital intensity of the basic metal industries producing intermediate goods for use in other branches of industry. It also highlights the high capital requirements of the basic chemical industry also producing intermediate products. The high ranking of "paper and paper products" is caused by the category "paper and paperboard", another category of intermediate goods. If final products alone were included in paper and paper products its ranking would fall to the bottom half of the table.

It is also noticeable that the labour intensive industries include clothing, shoes, wood and cork products, furniture, final metal products and machinery. With some exceptions, the commodity groupings in the bottom half of the table are for final goods.

With these findings in mind, it is of some interest to examine the distribution of value added by manufacturing sectors in 1964.[42] As in Table 7, the food, drink and tobacco industries are omitted from the initial discussion. The examination of the annual figures by industry as published in the Irish Statistical Bulletin shows:

(1) The output of the chemical industry predominantly excluded basic chemical products (51, 52 in Table 7).

(2) The paper and paper product industry also excluded from its output, basic paper and paperboard products. Thus this industry tended to be labour intensive according to the rankings in Table 7.

(3) Ireland lacked a basic iron and steel industry and the metal industry was engaged in the production and fabrication of basic metals and purchases semi-processed metal goods.

(4) Ireland's industry also lacked a non-ferrous metals industry of any substantial dimension.

If we define all industries that follow transport equipment in Table 7 as well as paper and paper products as labour intensive, then 75·3 per cent of value added in the manufacturing sector was labour intensive and 24·7 per cent was capital

41. G. C. Hufbauer [14, p. 220].
42. Ireland [17] various issues.

TABLE 7

SITC 2 Digit Classification for US Manufactures		*Capital per man in 1963 Dollars*	*Ranking according to capital to labour ratio in the US*
51	Chemical elements and components	36,213	1
58	Plastic materials	24,788	2
52	Mineral tar and crude materials	24,188	3
64	Paper and paper products	23,383	4
67	Iron and steel	22,547	5
68	Non-ferrous metals	20,915	6
55	Essential oils, perfume materials, toilet and cleaning goods	19,506	7
59	Chemical materials and products	19,489	8
56	Fertilisers	17,103	9
66	Non-metallic mineral products	14,561	10
54	Medicines	13,646	11
53	Dyeing, tanning, colouring materials	13,395	12
81	Sanitary, plumbing, heating and lighting fixtures	9,593	13
62	Rubber manufactures	9,361	14
73	Transport equipment	9,328	15
57	Explosives	7,703	16
71	Non-electrical equipment	7,595	17
69	Metals	6,974	18
86	Scientific instruments, photo goods, watches	6,619	19
65	Textiles	6,437	20
72	Electrical machinery	5,627	21
61	Leather, leather goods, dressed fur	5,195	22
89	Miscellaneous goods	4,841	23
63	Wood and cork products	4,086	24
82	Furniture	3,470	25
85	Shoes	1,443	26
84	Clothing	1,329	27
83	Travel goods	1,217	28

Source: G. C. Hufbauer [14, pp. 212–220].

Note: Using Barna's data for capital per man in UK manufacturing industries, an effort was also made to rank these industries according to the SITC classification. Barna's classification scheme was different to the SITC and the task was a difficult one. Nevertheless, in a rough way, it appears that using rank 14 as a dividing line, the UK rankings are similar except that SITC numbers 55, 66, 53 and 81 go below the line and 69, 65, 73 and 89 go above the line.

Source: Barna [1, pp. 16–17].

intensive. Using Barna's capital per man statistics for the UK economy as an indicator of capital intensity, the breakdown was 60·1 per cent labour intensive and 39·9 per cent capital intensive. The relative unimportance of basic industries intermediate goods was responsible for the fundamental labour intensive character of Irish industry.

The inclusion of the food, drink and tobacco industries changes the picture somewhat. Such industries as sugar refining, margarine, drink and tobacco and

grain-milling all tended to be capital intensive[43] and this was confirmed by the findings in Tables 1 and 2. Nevertheless, the labour intensive character of Irish manufactures seems established by the yardstick of comparative data for the US and the UK.[44]

(b) The Character of Complementary Imports

The input-output table for 1964 divides complementary imports into intermediate and final categories and intermediate complementary imports are allocated as inputs among the productive sectors. Intermediate imports complementary to the manufacturing sector were valued at £90·8 millions. Picking from this cluster complementary import inputs into the chemical, metal, petroleum and paper sectors, this grouping accounted for 74 per cent of total intermediate complementary imports to the manufacturing sector. These statistics, however, include both natural resource and manufactured products and do not include final complementary imports. Fortunately, it is possible to examine the character of both final and intermediate complementary good imports in 1964.[45] Table 8 summarises the picture for intermediate complementary imports entering the manufacturing sector, the final complementary imports which were absorbed by gross fixed capital formation and total complementary imports.

Among the intermediate complementary imports, it is striking the degree to which Ireland's manufacturing sector was dependent on mineral-based products. These accounted for 58·1 per cent of these intermediate complementary imports. Turning to final complementary imports destined for gross fixed capital formation, mineral-based products accounted for 93·2 per cent an overwhelming percentage of the total. To put this last figure into perspective, gross fixed capital formation, excluding construction, added up to £73·7 millions in 1964. Of this total, £35·6 millions or 48·3 per cent was accounted for by similar and complementary imports. The direct import content of the remaining £38·1 millions was £16·6 millions, leaving £21·5 or 29 per cent to be accounted for by domestic value added and imports of mineral and non-mineral goods and services needed in the domestic production of capital goods.[46] Finally, turning to the composition of total complementary imports, regardless of sectoral destination or use, 41·6 per cent was made up of mineral-based products. Putting together all of these results, the striking result is the degree to which complementary imports took the form of mineral-based products in 1964.[47]

The second important question regarding these imports was their factor content. Due to the aggregate nature of the statistics at hand for complementary imports,

43. See: G. C. Hufbauer [14, p. 220].

44. The structure of Irish industry also has implications for scale economies which will be discussed later in the paper.

45. The complementary good import data were compiled by Dr. E. Henry of the CSO during the preparation of the 1964 input-output table. The data are unpublished and unofficial.

46. Ireland [17] and input-output data.

47. J. McGilvray and D. Simpson also make reference to this [33].

a decision was made to use the statistics for total trade. SITC classifications 5 through 8 were used to determine the character of manufactured good exports and imports. Food manufactures were excluded from these statistics under examination.

These export and import data include both complementary and similar trade and both intermediate and final goods. Hufbauer's estimates for capital per man and the percentage of the labour force accounted for by professional, technical and scientific personnel have been used to classify manufactured food trades. Exports and imports have been classified at the three digit level for capital per man and at the two digit level for the skill index. To supplement these findings,

TABLE 8: *Intermediate Complementary Imports Destined for the Manufacturing Sector, Final Complementary Imports destined for Gross Fixed Capital Formation and all Complementary Imports in Ireland 1964. (Percentages are in brackets)*

	Intermediate Complementary Imports for the Manufacturing Sector	*Final Complementary Imports for Gross Fixed Capital Formation*	*Total Final Complementary Imports*
Food, wine, raw tobacco, oilseeds, rubber, pulp, textile fibres, petroleum	36,214,000 (28·9)		58,940,000 (26.3)
Chemicals	9,979,000 (8·0)		13,212,000 (5·7)
Rubber goods, wood products, paper	1,532,000 (1·4)	200,000 (·6)	2,935,000 (1·2)
Textile products	669,000 (·8)	303.000 (·9)	2,397,000 (1·0)
Non-metallic minerals, rough metals and metal hardware	11,965,000 (10·8)	1,558,000 (4·6)	20,978,000 (8·7)
Electrical and non-electrical machinery	7,897,000 (27·0)	25,843,000 (75·6)	48,875,000 (21·2)
Vehicles	20,995,000 (20·3)	4,453,000 (13·0)	27,014,000 (11·7)
Others including invisibles	1,565,000 (2·8)	1,827,000 (5·3)	55,785,000 (24·2)
Total	90,816,000 (100·0)	34,184,000 (100·0)	230,136,000 (100·0)

Source: Data compiled by Dr. E. Henry. The statistics are unpublished and unofficial

Barna's capital to labour ratios for the UK have also been used to classify Irish manufactured good trade. In this analysis, trade is viewed as capital intensive if the commodity grouping falls within the first 14 rankings, and labour intensive if it falls in the second half of Table 7. The rankings, it must be remembered, are based on the factor content at the last point where value-added occurs before goods enter the avenues of international trade. The results are contained in Table 9.

In contrast to manufactured good exports, the results demonstrate that manufactured good imports were capital and class I skill intensive and suggest that the inclusion of complementary imports in the statistical procedures reverses the earlier conclusions about the labour and capital content of trade.

There are two other notes of interest from this analysis. First, international statistics suggest that scale economies have significance in basic metals, chemicals and petroleum, paper, printing and some metal goods, and also in rubber products, textiles and non-metallic minerals.[48] Many of these products predominate among complementary imports and this suggests that scale economies were determinants of the pattern of manufactured good trade. Secondly, the production of complementary mineral-based imports depended significantly on the use of class III skills. In the earlier examination of manufactured good exports and import replacements, it was shown that Ireland was a net importer of class III skills. The pattern of complementary good imports now suggests that this finding is applicable to the total trade in manufactured goods.

TECHNOLOGY AND INTERNATIONAL TRADE

The analysis to this stage has left many questions aside which are fundamental to an analysis of Irish manufactured good trade. By examining the applicability of the Heckscher-Ohlin doctrine using Leontief procedures, we have been using a

TABLE 9: *Manufactured Goods (SITC 5–8) Trade in 1964. (Percentage of trade which is capital-intensive, labour-intensive and skill I intensive)*

	Exports	*Imports*
Capital Intensive		
Estimate based on Hufbauer-Rankings	25·1	34·1
Estimate based on Barna Rankings	40·8	65·2
Labour Intensive		
Estimate based on Hufbauer Rankings	74·9	65·9
Estimate based on Barna Rankings	59·2	34·8
Skill Intensive		
8 per cent or more	31·2	62·2
Less than 8 per cent	68·8	37·8

Note: Skill Index—professional, scientific and technical labour as a percentage of the labour force. These statistics are based on Hufbauer's estimates of class I skill content by industrial grouping The statistics for exports are included for comparative purposes. The differences in the finding is based on Hufbauer's data and those based on Barna's data can be explained by the differences in the rankings derived from the two sets of data. Note has been made of this at the end of Table 7.

Sources: T. Barna [1], G. C. Hufbauer [14, pp. 212–220] UN [40].

framework with a number of important assumptions. Specifically, for present purposes, we have been assuming that production and trade have been undertaken within competitive markets, technological knowledge is a free good and common

48. See: H. Chenery [6] H. Chenery and L. Taylor [7] J. Haldi and D.Whitcomb [12].

technologies are applied in the production processes of all producers. Some questions have already been raised about this last assumption.

In recent years, R. Vernon has developed the product cycle theory to explain the pattern of US trade in manufactured goods and the character of direct US foreign investments.[49] The pattern of US manufactured good trade is explained, according to Vernon, by the differences in technical sophistication between US producers and those in other countries. At the industry level, he distinguishes between new products which are unstandardised in terms of inputs, processing and final specification, mature products and standardised products. During the life cycle of a product, the US as a technological leader, tends to export a commodity when it is a new product, and to engage in direct foreign investment and production of the product abroad when the product becomes mature and standardised. The framework is an imperfectly competitive one and explains the pattern of exports during the "new product" stage in terms of a monoply position and the pattern of direct foreign investment during the mature and standardised stages in terms of fear of competition from foreign producers in international markets. The keys to this framework, therefore, are the imperfectly competitive markets for manufactured good products, the availability of different technological knowledge to producers across and between economies and the different rates of introduction of new products and new processes across national economics. Studies of US exports by Keesing and Mehta, Gruber and Vernon have added weight to this analysis by showing that R & D expenditures are prime determinants of US exports of manufactured goods.[50] Within this framework, it is of particular significance that Ireland is placed geographically between the UK and the US, invites their capital into Ireland and also trades significantly with them.

Northcott's comments are of great interest in this regard. Observing new plants established in Ireland since the war, he noted:

> They have mostly been of two kinds; plants making relatively simple products, where all or most of the processes can be done conveniently in a single plant of only moderate size: and plants doing relatively straightforward processes in the construction of a somewhat more complicated product, either assembling a final product, the most difficult components of which have been made elsewhere or making components for assembling into final products elsewhere.[51]

McAleese has indicated also the limited links between grant-aided industries and the rest of the economy.[52]

From the point of view of trade in manufactured goods, data have been assembled to examine many of these contentions. In the first stage of the analysis, the sources of intermediate inputs for the production of manufactured good

49. R. Vernon [41].
50. D. Keesing [23], Gruber, Mehta, Vernon [11].
51. J. Northcott [37, p. 185].
52. D. McAleese [32].

exports are examined. Using the classification of goods into intermediate and final items contained in Table 3, it was possible to examine the sources of intermediate inputs for various groupings of manufactured good exports. The results are recorded in Table 10.

An examination of Table 10 shows that 38·5 per cent of a unit of merchandise manufactured good exports came from value added within the manufacturing sector. Another 39·6 per cent was provided by other domestic intermediate non-manufacturing inputs and 21·9 per cent came from imports.
Among the detailed results were:

(*a*) For final manufactured food, drink and tobacco exports, the manufactured value added component was exceedingly small and there was little reliance on imported inputs.

(*b*) Leaving aside the food, drink and tobacco industries, all other manufactured good exports were heavily dependent on imported inputs, relied little on the non-manufacturing sector for inputs, produced about 50 per cent of their exports in the form of value added within each manufacturing grouping. Within final manufactured good exports, inter-sectoral purchases of manufactured good inputs were responsible for only 7·4 per cent of output. The equivalent statistic for intermediate manufactured good exports was 8·6 per cent or about 25 per cent of imported inputs. It should be noted also that the import content of the output of grant-aided industries was 32 per cent and if the food industries are excluded from the statistics, this percentage rises to 40 per cent.[53] The equivalent statistics for the exports of all manufacturing industries were 21·9 per cent and 35 per cent respectively. Thus grant-aided industries particularly would appear to have been in the business of processing imported materials as the basis for the expansion of their exports.

Nevertheless, these estimates certainly underestimate the degree of backward and forward linkages between Irish manufacturing industries and economic enterprises abroad. In a recent study Ó hUiginn has examined linkages between foreign subsidiaries in Ireland and firms abroad. His data indicate that 55 per cent of the grant-aided establishments were subsidiaries of parent companies, and that many functions were undertaken for these establishments by parent companies or other firms abroad.[54] Among the backward linkages to firms abroad were purchasing and producing functions and forward linkages took the form of further manufacturing and selling functions. Parent companies also undertook supervision and direction of managerial and financial functions as well as R & D activities. Not all of these firms had come into existence in the mid-1960s but enough of them had to suggest that our results derived from input-ouptut data underestimated the links between foreign and domestic firms.

53. Ireland [19, p. 46].
54. P. Ó hUiginn [36, p. 18].

TABLE 10: *Manufactured Good Exports (Including Inputs from outside the Manufacturing Sector)*

	Percentage of Exports	*Value added in the manufacturing sector per unit of exports*[2]	*Intersectoral purchases of manufactured good inputs per unit of exports*	*Non-manufacturing inputs per unit of exports*	*Intermediate imports per unit of exports*	*Intermediate non-manufacturing inputs per unit of exports*
Final	71·7	·3342	·0744	·6658	·1690	·4968
(*a*) Final-Food, Drink and Tobacco[1]	52·2	·2544	·0458	·7456	·1065	·6391
(*b*) Final-Other	19·5	·5477	·1513	·4523	·3364	·1159
Intermediate	28·3	·5142	·0862	·4858	·3469	·1389
(*a*) Intermediate-Food, Drink and Tobacco	·9	·4778	·0333	·5222	·1555	·3667
(*b*) Intermediate-Other	27·4	·5153	·0879	·4847	·3532	·1315
Total	100·0	·3851	·0788	·6149	·2194	·3955

1. Food, Drink and Tobacco—sectors 18 through 32 of the 92×92 input-output table.
2. All of these coefficients are direct rather than total coefficients.
Sources: Ireland [15]. Unpublished and unofficial statistics provided by Dr. E. Henry.

Ó hUiginn's findings suggested that 78·3 per cent of the grant-aided subsidiaries relied on the parent company for R & D backing. As Daly[55] suggests, many firms, including grant-aided ones, undertook technology transfers from abroad and also engaged in indigenous R & D activities. In most of these cases, however, the purpose of R & D spending was to adapt foreign technology to the local scene.

Within the framework of the total manufacturing sector, in the mid-1960s, it is necessary to determine the degree to which indigeneous R & D activities were undertaken. Table 11 contains statistics showing the percentages of R & D expenditures in Gross Output for the year 1963.

The statistics in Table 11 show the very limited commitment of the Irish manufacturing sector to R & D activities. They are miniscule in contrast to US statistics. Taking R & D as a percentage of sales in 1960, Keesing found that among 16 manufacturing groupings, the percentage was above 4 per cent in seven cases. The lowest percentage was 0·6 per cent and only in four cases was the percentage less than 1 per cent.[56] Even when federally financed R & D spending is left out of the US statistics, the Irish manufacturing R & D effort still looks exceedingly small beside the US findings. Irish payments abroad for the use of patents, know-how etc.[57] and the high percentage of machinery and equipment and intermediate inputs purchased elsewhere[58] gives a strong indication of the source of development of many products and of techniques of production in use in Ireland during this period.

TABLE 11: *R & D Expenditures as a Percentage of Gross Output for Various Irish Manufacturing Grouping in 1963*

Food, Drink and Tobacco	0·3
Metals and Engineering	0·3
Other Manufacturing	0·2
Chemicals	0·2
Clay, Glass, Cement	0·2
Clothing and Footwear	0·1
Textiles	0·1
Paper and Printing	0·1
Wood and Furniture	Less than 0·1
Total Manufacturing	0·2

Note: The R & D Expenditures cover both those financed by extra and intra mural sources.
Sources: Ireland [18], Ireland [16, Vol. II, p. 83].

55. Patrick J. Daly [9, pp. 10–11].
56. D. Keesing [23, p. 41].
57. Patrick J. Daly [9, p. 9].
58. This has been discussed earlier in the paper.

INTERPRETATION OF THE FINDINGS

We are now in a position to weave together the findings in the light of this analysis. The important conclusions are the following;

(1) Manufactured good exports from the food, drink and tobacco industries were a significant part of total manufactured good exports. Only limited processing took place in this grouping and the main source of materials was the agricultural sector.

(2) For the remainder of manufactured good exports, there was very limited reliance on the rest of the economy for intermediate purchases. The avenue of purchase abroad was largely used as a substitute.

(3) The manufacturing sector engaged in very limited indigenous R & D activities. The payments made abroad for the use of patents etc., and the importance of the imports of machines and equipment, and intermediate goods indicates that Irish manufacturing industries largely got their inspiration for the production of new[59] products and new[59] methods from R & D efforts undertaken elsewhere.

(4) In contrast to manufactured good exports, similar manufactured good imports were more class skill I and class skill III intensive and were apparently labour intensive. That last result clashed with the *a priori* notions of the writer and the original findings of McGilvray and Simpson.

Much of this fits the product cycle hypothesis laid out by Vernon. It is clear that Irish manufactured good exports in the mid-1960s were mature and largely standardised commodities. The limited extent of indigenous R & D spending and the way in which technical knowledge was imported through the avenues of trade points in this direction. The importance of food, drink and tobacco in manufactured good exports also gives the first suggestion of relatively simple production processes but the positions of class I and class III skills in the findings also point more comprehensively in the direction of relatively standardised rather than new and complicated methods of production. Finally, the findings on capital intensity which were less clear-cut than this writer had expected, can also be partially explained in terms of the Vernon framework. Given the stage of mature and standardised commodities, parent companies do bring capital intensive methods into their subsidiaries in labour abundant economies for both market reasons and also to minimise labour costs in the face of emerging competition. But, in addition, it must be noted that the importance of imports to domestic investment spending also means that Irish firms were purchasing machines and equipment which were developed for less labour abundant economies. The large part played by the food, drink, and tobacco industries in contributing to Irish manufactured good exports also meant that a high percentage of the

59. New, that is, to the Irish scene.

production effort for manufactured good exports was being undertaken with capital intensive techniques.

Vernon's analysis was constructed to explain US trade and investment and is applicable to other developed economies such as West Germany and the UK. The analysis here has turned over the coin. Many of the suggestive findings fit the pattern to be expected from a Vernon analysis of the structure of manufactured good trade for a small semi-industrial economy whose major trading activities have been undertaken with countries in the developed world.

No effort has been made to explore fully the pattern of direct foreign investments in the Irish economy, but it should be noted that the majority of these investments in the manufacturing sector are not of American origin. Clearly, also some direct foreign investors came to Ireland to minimise labour costs but others came to take advantage of government policies which opened market opportunities and cut other costs below levels that would exist without government action.[60] But these are not the prime issues here and what has been sought is some indication of the character of technology, production methods and markets involved in manufactured good trade. The implications of Vernon's analysis as well as the findings on the R & D basis of US manufactured good exports has given important insight into the character of Ireland's trade in manufactured goods.

CONCLUSIONS

In terms of the methodology of empirical research, it has become clear that the Heckscher-Ohlin hypothesis has some, but limited, explanatory power in examining the character of Irish manufactured good trade. The original Leontief procedures have had to be refined and supplemented in a number of ways:

(1) The expansion of variables beyond the two factor Leontief case to include skill indices added to our understanding of the basis of trade.

(2) The Leontief procedures can also be refined to examine intermediate and final good components in total exports. Such a division adds much to the understanding of the basis of trade especially when the factor content and technical methods of each component are different from the other. This was so in the Irish case.

(3) The Leontief procedures were also importantly supplemented to account for the "dualism" of the manufacturing sector. The character of the data at hand did not permit a precise statistical analysis of the impact of grant-aided industries but it became clear that when dualism caused by different market orientations and by different production methods and factor proportions does exist, careful refinements of the analysis must be undertaken.

(4) It became clear that the Leontief procedures must also be supplemented when complementary imports take an important part of total imports. The

60. Ireland [19, ch. 3].

original Heckscher-Ohlin hypothesis presumed that all economies are engaged in the production of the same range of commodities and similar production functions exist for individual economies. When the range of commodities produced by the small economy excludes many commodity types which are imported, the Leontief procedures simply look at the factor content of goods which are or could easily be produced in the economy. Once account is taken of this, the examination of complementary imports becomes an important part of understanding the basis of trade as Kravis originally suggested.

Of greatest concern for future research into industrial and trade patterns is the existence of dualism in the Irish economy. It indicates the need for more emphasis on micro approaches to the understanding of Ireland's trade and industrial development.

Finally, the conclusion that Irish manufactured good exports are not class I and class III skills intensive and that export commodities are relatively simply processed and standardised items, is not meant to suggest that Ireland should abandon the training of professional personnel and R&D activities. Nevertheless, the understanding of where Ireland is in the process of development should help to determine the appropriate priorities of a science policy and prevent unrealistic expectations about the impact of science policies on the character of Irish manufactured good exports in the immediate future.

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APPENDIX

Manufacturing sectors of the 92 sector Input-Output Table have been amalgamated to produce the following 27 sector classifications:

1.	Shoes, Leather Goods	(40)★
2.	Vehicles	(56, 57, 58)
3.	Pig Slaughtering	(22)
4.	Animal Feed	(26)
5.	Hosiery, Knitting	(39)
6.	Clothing	(41)
7.	Fertilisers	(47)
8.	Glass, Pottery	(50)
9.	Clay Products, Cement	(51)
10.	Drink, Tobacco	(31, 32)
11.	Ropes, Mats, Sacks	(37)
12.	Printing, Publishing	(45)
13.	Non-electrical Machinery	(53)
14.	Electrical Machinery	(54, 55)
15.	Animal Slaughter	(18, 19, 20, 21, 23)
16.	Margarine, Processing of Fruit etc.	(30)
17.	Fellmongery, Tanning	(46)

★These numbers are the sector numbers in the original 92 sector input-output table.

18.	Flour, Bread, Biscuits	(25, 27)
19.	Wool	(33, 34)
20.	Paper and Products	(44)
21.	Medicine, Soaps etc.	(49)
22.	Milk Products, Sugar Refining, Chocolates, Sweets	(24, 28, 29)
23.	Lumber, Wood, Wood Products	(42, 43)
24.	Metal Products	(52)
25.	Cotton, Linen, etc.	(35, 36, 38)
26.	Paints, etc.	(48)
27.	Petroleum, etc.	(59)

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