TECHNOLOGY AND FOREIGN DIRECT INVESTMENT IN IRELAND

Trinity Economic Paper Series
Technical Paper No. 98/10
JEL Classification: F23, O39

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Abstract

Two routes by which foreign multinational enterprises (MNEs) may transfer technology - direct R&D undertaken in Ireland or through the transfer of the fruits of R&D work undertaken by the parent firm - are examined. Direct R&D undertaken by MNEs in Ireland now accounts for two-thirds of all R&D in Ireland but does not appear to differ significantly, in terms of application or orientation, from the R&D work undertaken by Irish-owned industry. Using US tax rules on the allocation of parent firm R&D expenditures between the parent firm and the host firm, technology transfer from US parent firms is estimated. It is found that incorporating technology transfer from parent firms doubles the level of R&D expenditure attributable to US firms for use in Ireland.

Acknowledgements

An earlier draft of this paper was presented to the IEA Conference 1995 and is drawn from Meyler (1995). The author is grateful to his thesis supervisor Frances Ruane. Thanks are also due to Eric Strobl for his generous reading of an earlier draft. A debt of gratitude is also due to Denis Slater and Marcus Breathnach, Forfás for their generous provision of data. All errors and omissions remain the responsibility of the author.

I. Introduction

The central role of foreign direct investment (FDI) in Irish industrial policy since the 1950s has been well documented.[1] Industrial policy, for many years, concentrated on attracting FDI to the modern sectors and maintaining Irish-owned industry in the traditional or natural resource sectors. While the relative success of foreign-owned industry and the poor performance of Irish-owned industry has been thoroughly researched, most of the studies have focused on variables such as employment, output and exports. This paper examines, for the first time, the impact of FDI on the technological landscape of industry in Ireland.

First, we present a brief overview of industry in Ireland, illustrating clearly the dual (Irish vs. foreign) nature of the Irish economy. Section III examines technology transfer into Ireland through FDI via R&D undertaken within Ireland. Section IV explores a method for estimating the level of technology transfer arising from R&D work undertaken by the parent firm, and applies this methodology to US FDI in Ireland. Section V concludes.

This paper investigates both the direct contribution of foreign-owned industry in Ireland to the overall level of technology of Irish industry and the contribution through the transfer of the fruits of research and development undertaken elsewhere. The international empirical literature on this topic has been predominately from a source-country viewpoint, in particular, on the effect of technology diffusion on source-country competitiveness. In contrast, this paper is unambiguously from a host-country viewpoint.

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[1] For a recent exposition see, for example, Ruane and Görg (1997)

II. Industry in Ireland: A Background

Since 1958, the attraction of FDI into Ireland has played a central role in Irish industrial policy. Indeed, Ireland has been very successful relative to other EU countries in attracting FDI projects. Over the period, 1982 to 1994, US FDI into Ireland has accounted for over 3.3% of all additional US FDI into the European Union.[2] This compares to a share of the EU population of approximately 1%. Ireland has been even more successful in the chemical, machinery and electronics areas, attracting 5.6, 5.9 and 8.7% in each sector respectively. This policy significantly changed the structure of industry in Ireland. First, the share of FDI firms in total employment in Ireland has risen substantially. Employment by foreign-owned firms in Ireland has increased from 37.6% (93,300) of all manufacturing and internationally-traded services employment in 1979 to 46.3% (109,500) in 1995.[3] This compares with a decrease in Irish-owned manufacturing employment from 154,900 in 1979 to 127,100 in 1995.[4] Second, there have been significant shifts in the composition of manufacturing industry. The breakdown of manufacturing employment by industry in Ireland over the period 1979-1995 is illustrated in Fig. 1. Employment in the modern sector has risen from 47,700 in 1979 to 88,100 in 1995 (19.2% to 37.2%), while employment in both the traditional and natural resource sectors has fallen since 1979.[5] This trend has been driven primarily by

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[2] Own calculations from US Department of Commerce (various years) data.

3 Barry and Hannan (1995) argue that it is possible for employment by foreign-owned firms to have crowded out Irish-owned employment. The structural breakdown of R&D expenditures by Irish-owned firms is very different to that of foreign-owned companies. However, this probably owes more to the different structure of Irish-owned industry generally than any possible 'crowding-out' of Irish R&D in certain sectors. See Section III for a sectoral breakdown of R&D activity within Ireland.

[4] The year 1979 is chosen as a starting point in order to ensure comparability with data on R&D expenditures presented below.

[5] Overall industry is broken down into three categories for the purposes of analysing the employment data. These are: Modern (Chemicals, Man-Made Fibres, Mechanical Engineering, Data Processing, Electrical Engineering, Instrument Engineering, and Non-Manufacturing Grant Aided); Traditional (Metal Processing, Metal Articles, Motor Vehicles, Other Transport Equipment, Textiles, Clothing, Footwear and Leather,

FDI. Table 1 shows the breakdown of Irish-owned and foreign-owned employment across three broad sectoral classifications over the period 1979 to 1995. Irish-owned employment in the modern sector has increased by 7,700 (50%) and foreign-owned employment in this sector has increased by 32,700 (100%). Most of the increase is accounted for by US-owned companies.[6] Employment in the traditional and natural resource sectors has declined across nearly all nationalities. The largest percentage decreases have been amongst non-US foreign-owned enterprises in the traditional and natural resource sectors (40%).

Recent discussion has focused on the level of linkages between foreign industry in Ireland and Irish-owned industry. Data from the Forfás Irish Economy Expenditures Survey allow us to examine the level of expenditure linkages between foreign-owned and Irish-owned industry. In 1995, Irish-economy expenditures by foreign-owned firms amounted to 34% of sales; this compares to 78% of sales for Irish-owned firms. The pattern of linkages differs considerably across industry sector. Expenditure linkages are weakest in the more modern (metals and engineering, and chemical) sectors. Table 2 presents the breakdown of Irish-economy expenditures across sectors by nationality. As can be seen, the ratio of Irish-economy expenditures is higher for Irish-owned firms in all sectors.

Timber and Furniture, Paper and Printing, and Miscellaneous Industries); and, Natural Resource (Non-Metallic Minerals, Food, Drink and Tobacco, and Mining, Quarrying and Peat).

[6] Most of the decline in non-US foreign-owned employment is accounted for by UK companies. This has occurred due to two factors. First, many UK firms located in Ireland in the 1930s and were located in un-competitive, high labour-input sectors and suffered as these sectors faced increasing competition from lower labour cost regions. Second, some of the apparent decline could be due to the take-over of UK firms by Irish management and their subsequent reclassification as Irish-owned (Ruane and McGibney, 1991).

Thus, despite the success in attracting foreign industry to establish in Ireland, concern has been expressed about the level of linkages with Irish-owned firms. It is often argued that multinationals are merely profiting from the generous tax system and grants regime without contributing significant 'value-added' to the economy. NESC (1990, p.13) argues that "the type of foreign firms which should be attracted to Ireland are those which will locate functions in Ireland which are the key to the competitive success of the company". Critics of industrial policy cite the lack of R&D facilities of multinationals as evidence of the superficial nature of FDI in Ireland.

III. Direct R&D Contribution

One of the benefits of FDI may be additional R&D undertaken within the host country. Many studies within the US and other source countries have highlighted the concern expressed by commentators that FDI may lead to the transfer of research facilities to the host country. Fors and Svensson (1994) report that the level of research undertaken abroad by Swedish multinational enterprises (MNEs) has risen from 7% in 1965 to 18% in 1990. On the other hand, host country commentators frequently lament the level of R&D work carried out abroad by MNEs and question the level of sophistication of any R&D work undertaken.

Table 3 illustrates the sectoral breakdown of firms undertaking R&D on a continuous basis.[7] At first glance it would appear that the R&D effort of foreign multinationals in Ireland is poor. Only 13.6% of foreign-owned firms surveyed

[7] Surprisingly, the percentage of Irish-owned enterprises undertaking R&D on a continuous basis was relatively similar at 11.7%. In the R&D survey, firms are asked whether they undertake R&D on a 'continuous' basis, on an 'occasional' basis or not at all.

undertake R&D on a continuous basis.[8] The number of firms undertaking R&D on a continuous basis is highest in the Chemicals, Pharmaceuticals and Rubber & Plastic, and Machinery Equipment, Electronics, Instruments and Software Sectors, but not significantly so.

Fig. 2 decomposes overall intramural business R&D expenditures into those undertaken by Irish-owned firms and those undertaken by foreign-owned firms operating in Ireland.[9] In 1979 actual R&D expenditures by Irish-owned firms outweighed those of foreign-owned firms.[10] Since 1982 this situation had been reversed, and in 1995 business R&D expenditures by foreign-owned firms were over twice those of Irish-owned firms.[11] Foreign-owned enterprises operating in Ireland accounted for 64% of business R&D undertaken within Ireland in 1995, which is significantly larger than their share of industrial employment and indicates the importance of the R&D work carried out by foreign-owned enterprises in Ireland despite the small number undertaking R&D on a continuous basis.[12] This share has remained relatively constant since 1986.[13]

In parallel to employment trends these overall figures mask considerable differences in trends across sectors. Table 4 illustrates the breakdown of R&D expenditures between Irish-owned and foreign-owned firms across each industry. It can be seen that, despite a decreasing overall share of R&D expenditures,

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[8] An additional 12.3% undertook on an occasional basis.

[9] Intramural R&D expenditures refer to R&D expenditures undertaken 'in-house' and not contracted to an outside agent (related or unrelated). Only intramural R&D expenditures are examined as a consistent time series is not available for extramural R&D payments since 1979. Extramural R&D payments have tended to account for approximately 5% of intramural R&D expenditures.

[10] Data broken down by nationality of ownership are only available since 1979.

[11] Setting 1979 as a base equal to 100 for both categories, Irish-owned R&D expenditures rose to 490 by 1995, whereas foreign-owned R&D rose to 1015.

[12] In 1995 foreign firms accounted for 46% of the employment and 75% of the net output of manufacturing industry in Ireland.

R&D activity in some industry groups is still almost entirely accounted for by Irish-owned firms. This is particularly true in the Food, Drink and Tobacco, and Paper and Printing groups. R&D activity in the Chemical and Drugs, and the Electrical and Electronics groups are accounted for mainly by foreign-owned firms. US-owned firms are the largest investors in R&D, accounting for 38% of all R&D investment. Overall, Irish-owned firms account for 36% of R&D investment.[14]

The data in Table 4 are also aggregated into three major sub-sectors (modern, traditional and natural resource) to afford a clearer view of the pattern revealed in sectoral data. Irish-owned industry accounts for 75% of R&D expenditures in the natural resource sector and 68% of R&D expenditures in the traditional sector. In contrast, foreign-owned industry accounts for 79% of R&D in the modern sector.

Table 5 decomposes 1995 R&D expenditures by broad sub-sector. Comparing the breakdown in 1995 with that in 1963 it is evident that a large sectoral shift has taken place over this period from the natural resource sector to the modern sector. The extent of shift in R&D activity to the modern sector is even larger than that noted earlier for employment. Part of this shift may be attributable to the modernisation of Irish-owned industry but is primarily due to the scale of FDI in the modern sector. R&D expenditures by Irish-owned firms in the modern sector account for 40% of all R&D expenditure by Irish-owned firms. UK and US firms offer the most striking comparison by sectoral breakdown. A significant amount of R&D undertaken by UK firms is located in

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[13] The fact that Irish-owned industry has maintained its share of overall R&D expenditure is encouraging, especially given the large increase in R&D expenditures in recent years.

[14] Irish-owned industry accounted for 54% of industrial employment in 1995.

the natural resource sector (primarily within the food, drink and tobacco industry). R&D undertaken by US industry is almost totally within the modern sector (primarily the chemical and drugs, the electrical and electronic, and the paper and printing industries). Thus, one can conclude that US-owned industry has contributed significantly to the modernisation of Irish industry and to the shift in concentration of R&D activities in Ireland from the natural resource to the modern sector.

Quality of Direct R&D Contribution

It is often suggested that the R&D work undertaken away from 'home' by multinationals is of an 'inferior' quality to that undertaken at 'home'. The 'R&D' undertaken might be the adaptation of products or processes to suit local market conditions. An example of this activity might be the adaptation of a product to meet local safety regulations.[15] The level of spillover is likely to be low from this type of R&D. To study this issue, overall R&D expenditures in 1993 are disaggregated into three components in Fig. 3: Basic, Applied and Development.[16] *A priori*, one should expect to see a higher proportion of R&D expenditures accounted for by development R&D if the R&D is of the adaptive type. According to Fig. 3, there is relatively little difference between Irish-owned and foreign-owned enterprises. Irish-owned enterprises spend marginally more on basic/applied research than foreign enterprises, although the difference in breakdown is too small to be considered significant.

Comparing the breakdown of US-owned affiliates operating in Ireland with that of firms located in the US also yields surprising results. OECD (1993)

[15] Local, in the Irish example, could refer to the EU market.

figures for all US firms indicate a basic/applied to development R&D ratio of 27:73. This compares to a ratio of 32:68 for US-owned industry in Ireland. Hence, R&D by US-owned industry in Ireland does not appear to be significantly biased towards development research. However, this may reflect the sectoral composition of US investment in Ireland.[17]

An alternative method of analysing the quality of R&D undertaken is to decompose R&D expenditures by research objective (i.e., product development/improvement or process development/improvement). There are two possible interpretations of the data. First, a larger proportion of foreign-owned R&D expenditures being devoted to product development/improvement may indicate that the R&D work of foreign-owned firms is undertaken to adapt technology developed by the parent firm in the source-country. For example, manufacturers of durable consumer goods may need to adapt an existing product, developed in the source-country, to meet local safety regulations or to satisfy local market conditions. In this case, the R&D work undertaken is likely to be company-specific and that the potential level of spillover to other firms to be low. Second, a larger proportion of R&D expenditures by foreign-owned firms being devoted to process development/improvement may indicate that the R&D work of foreign-owned firms is undertaken to adapt the production process for products developed in the source-country, taking maximum advantage of local factor market conditions.[18] In this instance the firm may have already successfully developed and marketed its product in the source-country and may

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[16] See Appendix 1 for a definition of these terms. This breakdown is not available for 1995 data.

[17] Mansfield (1969, 1988) produces data for US firms in high-technology industries that indicate a much higher basic/applied to development ratio than the OECD figures for all US firms. As firms in high-technology industries are more likely to be significant direct investors abroad, comparing foreign industry in Ireland with all US firms is perhaps not the correct comparison. However, data by R&D type are not available for US parent firms investing abroad.

[18] The author is grateful to Frances Ruane for this interpretation.

be availing of a cheap factor of production in the host-country (labour, for example) and must alter its production technology to do so.

Fig. 4 illustrates the breakdown of R&D expenditures by objective across nationality. It can be seen that foreign-owned firms spend relatively more on product development/improvement than Irish-owned firms but only marginally so. This may be seen as confirmation of the results obtained above for R&D applicability in that the R&D work of foreign-owned companies in Ireland is only slightly biased towards transforming the technological capability developed by the parent company to suit local market conditions.

IV. Technology Transfer[19]

Whilst foreign-owned firms may contribute significantly to the R&D effort in Ireland, they may also contribute significantly to the technological capacity of industry in Ireland through technology transfer. Technology transfer from the parent firm represents an additional benefit to the host-economy as well as the generation of additional output and employment. To understand the role of technology transfer in the behaviour of MNEs, it is first necessary to consider briefly the theory of the MNE. A recurrent theme in this literature is the role of firm-specific assets (FSAs), such as technological knowledge.[20] It is argued that investment in R&D gives rise to a technological asset with semi-public good characteristics (i.e., technological knowledge). The parent firm may use this asset in other countries at little or no extra cost and without diminishing the amount available for use in the source-country. It is this fact combined with issues in the market for technological knowledge that underpins Dunning's

[19] This section examines technology transfer by US multinationals only due to data availability.

Ownership Location Internalisation (OLI) paradigm. Dunning's OLI paradigm states:[21]

- First, that locational forces must exist to require foreign production abroad by the multinational, such as availability of cheap factors of production or a large market combined with high transport costs;
- Second, that the multinational enterprise must possess ownership advantages, such as technological knowledge, that allow it to produce more efficiently than firms in the host-country;
- Third, that due to failures in the market for FSAs, it is more efficient to internalise the transfer within one firm than to license the FSA to a firm in the host-country.

US tax authorities recognise than when a parent firm undertakes R&D at 'home' some of the benefit from this R&D will be used abroad.[22] Under US tax laws there exists an incentive to incur expenses in the United States where tax rates are high and to earn income where tax rates are lower (e.g., Ireland). This may be achieved through transfer pricing although the US tax authorities seek to prevent this through arms-length pricing rules. Another means by which this may be accomplished is by undertaking R&D in the United States and utilising some of the output of this research in a lower tax country, such as Ireland.[23] The US tax authorities have sought to reflect accurately the impact of R&D expenditures undertaken within the United States. Under their system of allocating parent-firm R&D expenditure, a US multinational incurring R&D expenditures in the US

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[20] See, for example, Caves (1996), Dunning (1988), and Horstmann and Markusen (1987)
[21] For a fuller exposition, see, for example, Chapter 1, Dunning (1988).
[22] This was first codified by the US tax authorities in 1977 (US Treasury Regulation §1.861-8).
[23] There are other reasons why a US multinational may wish to concentrate R&D in the parent firm such as to benefit from spillover from other R&D projects and closeness to the market where the output might be exploited first.

may only allocate a part of the expenditures against US-source income with the remainder being allocated against foreign-source income.[24] The apportionment between source-country and host-country income is determined on the basis of sales.[25] Currently, 50% of expenditures are automatically allocated against source-country income with the remaining 50% being allocated on the basis of sales in the source-country and the host countries.[26] Table 6 outlines the formula used in apportioning R&D expenditures.

For example, assume 80% of the multinational's total sales are attributable to the US parent firm and 20% to foreign affiliates. This would result in 90% (i.e., 0.5 + [0.5 * 0.80]) of the US parent firm's R&D expenditures (R) being allocated to US-source income, the remaining 10% being allocated to foreign-source income. Although this measure is somewhat arbitrary, it has developed from the experience of the US tax authorities and serves to yield a rough indication of the possible scale of technology transfer from US parent firms to affiliates.[27] A more robust measurement would require a micro-level study of each firm. The estimates presented in this paper are based on this allocation rule and hence should be regarded solely as indicators of the possible scale of benefit to Ireland of investment by US multinationals in the technological capability of their affiliates via technology transfer.

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[24] Hines (1994) discusses the implications of this method of apportionment for the undertaking of R&D in the source-country or the host-country. This paper is only concerned with using this method to ascertain the scale of technology transfer.

[25] In certain instances R&D expenditures may be allocated on the basis of income in the source-country and the host-country, although restrictions apply. See Hines (1994) for a more detailed discussion. Given the incentive to allocate R&D expenditures in the higher-tax country, US firms in Ireland will always use the sales apportionment method since the income share of Irish subsidiaries is higher than their sales share.

[26] The precise allocation formula has varied since 1977. For a period following the Economic Recovery Act (ERTA 1981) 100 per cent allocation against US-source income was permitted. Otherwise the proportion allocable against US-source income has varied between 30 per cent and 64 per cent.

[27] This simple model assumes that technology transfer is relatively homogenous across firms and economies. In practice, it appears that the level of technology transfer across economies is positively related to factors such

Data available from the US Department of Commerce surveys of US MNEs allow estimation of the amount of R&D undertaken in the United States allocable to their affiliates in Ireland.[28] The US Department of Commerce surveys gather data on the activities of affiliates of US multinationals and their parents. Data available include: R&D expenditures of the parent firm across industry, operating statistics (i.e., sales, income, taxes, assets, employment, employee compensation and exports) of the parent firms across industry and the operating statistics of their affiliates across industry and country. Unfortunately the data are disaggregated across different sectors to those used earlier; hence only the aggregate total may be compared to the overall level of R&D undertaken within Ireland. Furthermore, data are only available from 1989.[29]

Table 7 shows the results for the estimated level of technology transfer from US parent companies to their affiliates in Ireland for the period 1989-1994 using the methodology outlined above. Following real growth of 7.6% from 1989 to 1990, the level of R&D expenditures allocable to Irish affiliates stagnated until 1992 due to the stagnation in R&D expenditures of their parent companies during the US recession. Allocable R&D expenditures rose significantly in 1993, primarily in the chemical sector. A large increase in R&D by US parent companies is not reflected in the 1994 data, as the increase occurred mainly in sectors in which Ireland is not strongly represented. It is likely that future data will reflect the record amounts of FDI currently entering

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as, *inter alia*, the host country's level of development, education system and host country technology transfer requirements. See Blomström (1991) for a further discussion.

[28] Only non-bank majority-owned foreign affiliates of non-bank US parents are included. The US Department of Commerce (1994, p. ix) defines a majority-owned foreign affiliate as a "foreign-affiliate in which the combined direct and indirect ownership interest of all US parents exceeds 50 per cent".

[29] This is due to widespread data suppression by the US Department of Commerce to ensure confidentiality of respondents prior to 1989.

Ireland, particularly in the high technology sectors. Approximately 85% of expenditures are currently accounted for by firms in the hi-tech chemical, machinery and electrical sectors.

Using these results, one can also compare the level of technology transfer from US parent firms to the level of R&D undertaken within Ireland. Using the R&D expenditure apportionment method, R&D undertaken by US parent firms for use by their affiliates appears to be more significant than the level of R&D actually undertaken by their affiliates in Ireland. In 1993, the affiliates of US multinationals operating in Ireland invested £111 million in R&D. Technology transfer was estimated to be £144 million.[30]

Fig. 5 shows the breakdown of all investment in R&D for use by industry in Ireland for 1993. The scale of technology transferred from US parent firms is 30% larger than the level of R&D undertaken by US affiliates in Ireland. In other words, technology transfer by US multinationals more than doubles the level of R&D made available for use in Ireland by their affiliates. However, the economic benefit derived from technology transferred by the parent firm is likely to be less than that derived from an equivalent amount of R&D investment by the affiliate in Ireland, as the level of spillover from technology transfer is certain to be smaller than for that from R&D undertaken in Ireland.[31]

Fig. 5 emphasises the significant role played by multinationals in augmenting the technological capacity of industry in Ireland. Even though the

[30] This refers to technology transfer by US multinationals only. Sufficient data are not available to estimate the scale of technology transfer from other countries. US FDI accounts for the largest proportion of overall FDI into Ireland (55% of foreign employment and 70% of net foreign output in 1995).

[31] There is likely to be a degree of spillover if personnel within foreign affiliates are mobile and move to Irish-owned enterprises or establish enterprises themselves.

analysis excludes technology transfer from non-US-owned multinationals, only 22% of R&D investment is accounted for by Irish-owned firms. In 1993, 62% of R&D investment was accounted for by R&D undertaken within Ireland by affiliates of US multinationals or by technology transfer by US parent firms to their affiliates in Ireland. The results presented above may help explain, in part, why industry in Ireland, although apparently under-investing in R&D, is export-intensive in goods that embody a high degree of technological knowledge.

The results outlined above coincide with those obtained by Fors (1996) who examined the level of technology transfer from Swedish multinationals. Fors estimated that one-fifth of the gain in value-added attributable to parent-firm R&D accrued to subsidiaries. These subsidiaries accounted for one-third of all output from Swedish multinationals. Thus Fors (1996) finds results very similar to those that would be obtained using the US R&D expenditure allocation rule. He also finds that there is little benefit to the parent firm arising from the direct R&D expenditure of subsidiaries. This would indicate that the R&D activity of subsidiaries tends to be developmental in nature, as described above.

V. Conclusions

This paper has outlined the possible effects of multinationals on Ireland's technological capital stock, in addition to the effects on employment creation and output usually measured. This contribution manifests itself in two forms. First, foreign firms may undertake R&D within Ireland. It was shown that, despite the relatively small numbers of foreign-owned firms undertaking R&D on a regular basis, R&D by foreign-owned firms has accounted for an increasing share of overall R&D expenditures within Ireland. The current industrial policy aimed at attracting 'back-office' activities into Ireland and encouraging domestic

management within foreign-owned firms to increase their level of embededness is likely to increase further the level of R&D undertaken by foreign-owned firms in Ireland.

Foreign multinationals may also transfer the benefits of R&D work undertaken elsewhere. Whilst the level of spillover is likely to be lower from technology transfer than from direct R&D, technology transfer represents a significant additional benefit arising from FDI. Thus, to maximise the benefit from these transfers to the economy, industrial policy should also aim to foster the linkages between Irish-owned firms and the subsidiaries of foreign multinationals.[32]

32 Blomström and Kokko (1993) suggest that to maximise technology transfer and spillover, government should utilise policy tools such as increasing competition in the local market and improving the learning capability of the host-country workforce.

Table 1 - Employment by Nationality and Sector

	Irish-Owned		Foreign-Owned		US-Owned		Non-US Foreign-Owned	
	1979	**1995**	**1979**	**1995**	**1979**	**1995**	**1979**	**1995**
Modern	16,129	23,827	31,577	64,302	16,390	42,401	15,187	21,901
Traditional	60,932	47,681	33,599	27,124	9,656	13,070	23,943	14,054
Natural Resource	77,846	55,565	28,111	18,089	4,730	4,254	23,381	13,835
Total	**154,907**	**127,073**	**93,287**	**109,515**	**30,776**	**59,725**	**62,511**	**49,790**

Source: Data provided by Forfás Employment Surveys

Table 2 - Irish Economy Expenditures 1995

	Irish-Owned			Foreign-Owned		
	Sales	**Irish-Economy Expenditure**	**%**	**Sales**	**Irish-Economy Expenditure**	**%**
Chemicals	346	260	75%	3769	982	26%
Metals & Engineering	1,211	693	57%	8638	2,704	31%
Textiles	136	68	50%	312	132	42%
Miscellaneous	328	208	63%	388	166	43%
Clothing, Footwear & Leather	196	112	57%	121	65	54%
Paper & Printing	742	468	63%	165	92	56%
Drink & Tobacco	196	147	75%	978	578	59%
Timber	333	228	68%	78	47	60%
Non-Metallic Minerals	403	322	80%	194	82	42%
Food	5,188	4,583	88%	2046	752	37%
Total	**9,079**	**7,088**	**78%**	**16,689**	**5,599**	**34%**

Source: Forfás, 1995 Irish Economy Expenditure Survey (unpublished data)

Table 3 - Foreign-Owned Firms Undertaking R&D on a Continuous Basis by Sector - 1995

	Number of Performing R&D On a Continuous Basis	Number of Foreign-Owned Firms Surveyed	% Performing R&D on a Continuous Basis
Machinery Equipment, Electronics, Instruments & Software	49	302	**16.2%**
Chemicals, Pharmaceuticals & Rubber & Plastic	24	154	**15.6%**
Miscellaneous	25	195	**12.8%**
Textiles, Clothing & Footwear	7	59	**11.9%**
Non-metallic mineral products, Basic Metals & Fabricated Metal Products	7	71	**9.9%**
Food/Drink/Tobacco	6	73	**8.2%**
Wood, Paper & Printing	2	31	**6.4%**
Total	**120**	**885**	**13.6%**
Modern	77	511	**15.1%**
Traditional	36	281	**12.8%**
Natural Resource	7	93	**7.5%**

Source: Figures compiled from the Forfás R&D Survey 1995

Table 4 - Share of Intramural Business R&D Expenditures by Nationality Across Sector, 1995

	Irish-owned Industry	Foreign-owned Industry	of which			Total Industry
	%	Total %	UK %	US %	Other %	
Chemicals & Drugs	16	84	4	58	22	100
Electrical & Electronic	23	77	1	46	30	100
Textiles, Clothing & Leather	55	45	3	28	15	100
Miscellaneous	59	41	2	31	7	100
Food, Drink & Tobacco	74	26	14	4	8	100
Non-Metallic Minerals & Fabricated Metal Products	86	17	7	5	4	100
Paper & Printing	92	8	1	6	1	100
Overall	**36**	**64**	**4**	**38**	**22**	**100**
Modern	21	79	2	49	28	100
Traditional	68	32	2	21	8	100
Natural Resource	75	25	14	4	7	100

Source: *Derived from data from 1995 Forfás R&D Survey*

Note: *Modern denotes Chemicals, Pharmaceuticals, Rubber and Plastics, Machinery nec, Computer and Office, Electrical Machinery, Electronics, Instruments, Financial Services, and Software. Traditional denotes Textiles, Clothing, Leather/Footwear, Wood/Wood Products, Paper/Paper Products, Printing and Publishing, Motor Vehicles, Other Transport, Furniture and Other Manufacturing, and Other. Natural Resource denotes Food, Drink and Tobacco, and Non-Metallic Minerals.*

Table 5 - Share of Intramural Business R&D Expenditures by Sector

	1963	1995			
	Total	Irish-owned	UK	US	Total
Modern	26	40	39	89	70
Traditional	9	31	9	9	16
Natural Resource	65	29	52	2	14
Total	**100**	**100**	**100**	**100**	**100**

Source: *Derived from Forfás 1995 R&D Survey and other data provided by Forfás*

Table 6 - Allocating R&D Expenditures Against US-Source and Foreign-Source Income

	US-Source Income	**Foreign-Source Income**
Fixed Allocation	0.5 * R	0
Allocation on the Basis of Sales	0.5 * R * ($Sales_U/Sales_T$)	0.5 * R * ($Sales_F/Sales_T$)
Total Allocation	**[0.5 * R] + [0.5 * R * ($Sales_U/Sales_T$)]**	**[0.5 * R * ($Sales_F/Sales_T$)]**

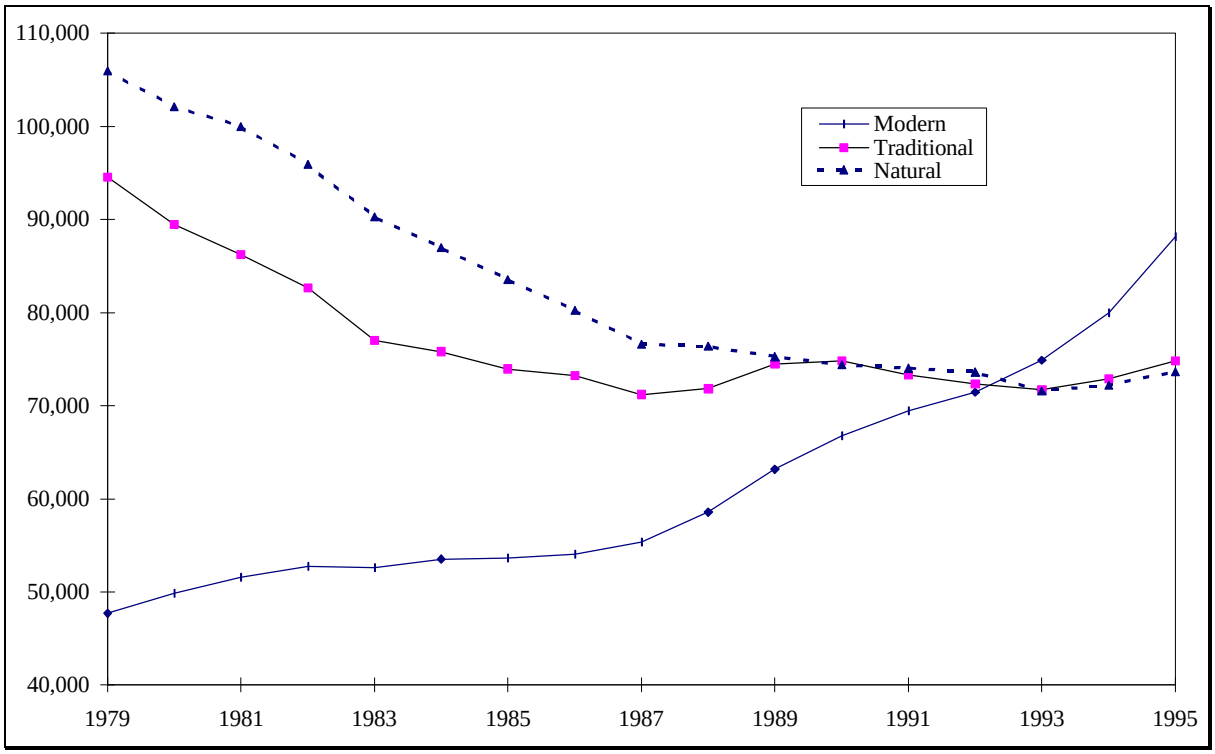
Note: R denotes the amount of R&D expenditures undertaken in the US to be allocated
F denotes foreign-source, U denotes US-source, T denotes total (U + F)

Table 7 - US Parent Firm R&D Expenditures Allocable to Irish Industry, 1989-1994

	1989 £M	**1990 £M**	**1991 £M**	**1992 £M**	**1993 £M**	**1994 £M**
Chemical	24.4	27.7	35.3	43.1	60.1	50.9
Machinery	57.0	59.0	57.2	51.2	54.9	40.1
Miscellaneous Manufacturing	8.6	10.1	12.0	12.0	14.0	15.4
Electrical	8.3	11.4	7.2	9.0	9.8	26.1
Food	1.6	1.4	1.7	2.1	1.9	2.0
Other	1.3	1.3	1.5	1.5	1.9	3.4
Transport	1.0	1.2	1.0	1.1	1.1	1.8
Fabricated Metal Products	0.6	1.1	0.7	0.7	0.6	0.6
Total	**102.7**	**113.3**	**116.5**	**120.6**	**144.3**	**140.2**
Total (constant 1990 prices)	***105.3***	***113.3***	***113.1***	***113.6***	***129.9***	***123.0***

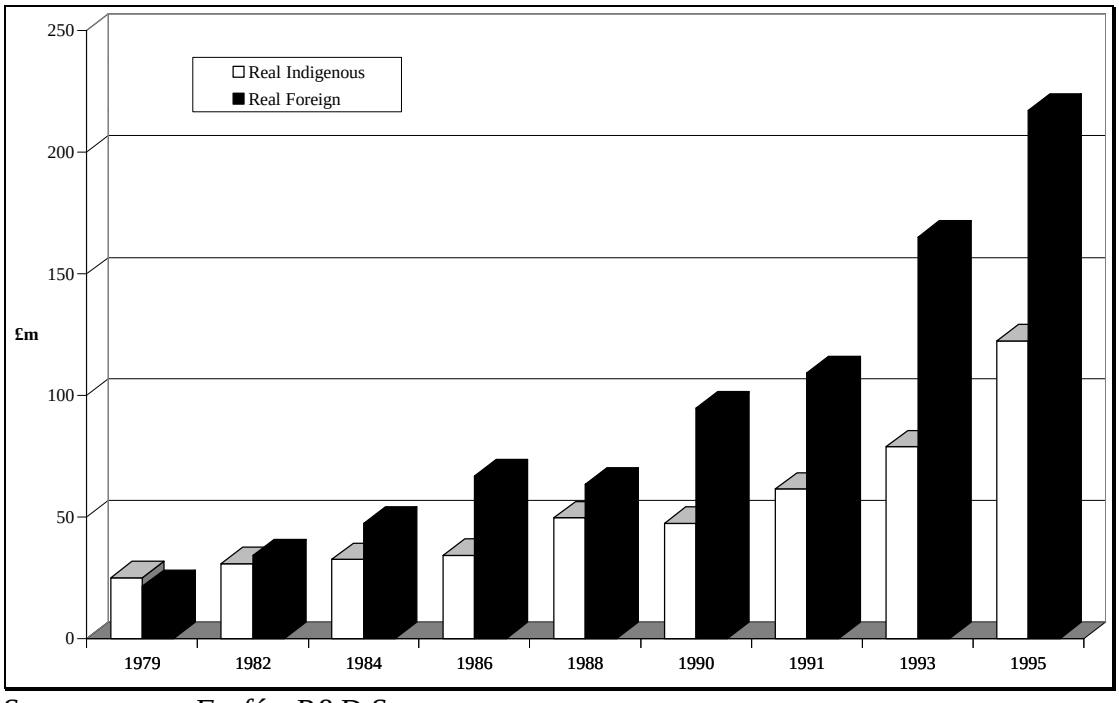
Source: Author's calculations

Fig. 1 - Manufacturing Employment by Broad Sector, 1979-1995



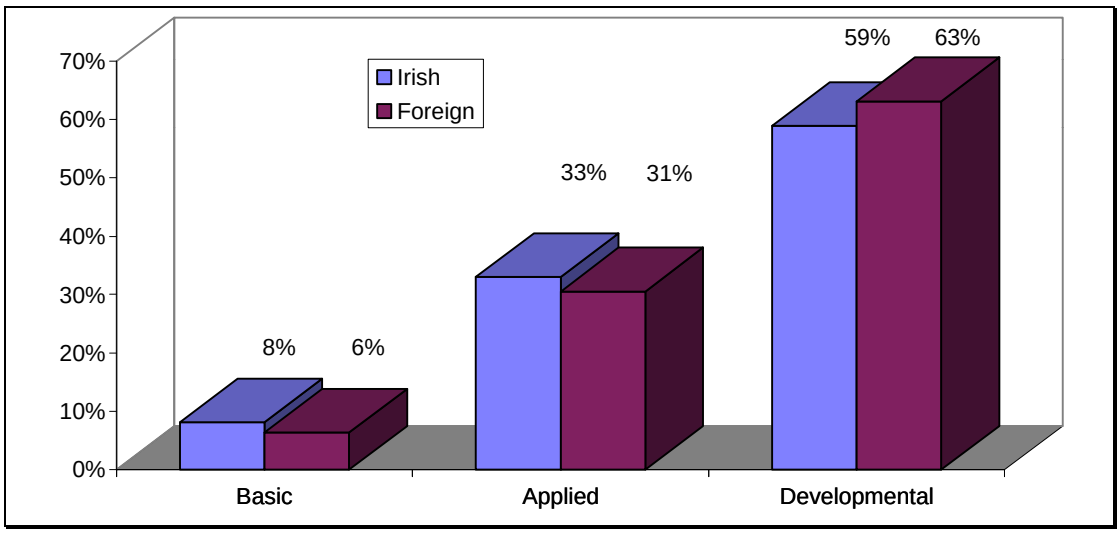
Source: *Data provided by Forfás Employment Surveys*

Fig. 2 - Breakdown of Intramural R&D Expenditures (1990 Prices) by Nationality, 1979-1995



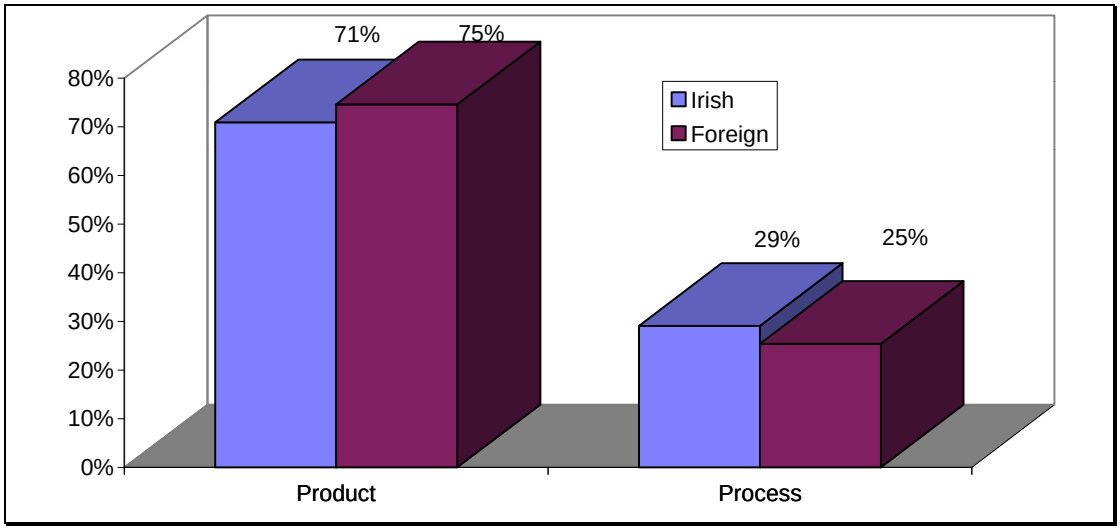
Source: *Forfás, R&D Surveys*

Fig. 3 - Share of Domestic Intramural Business R&D Expenditures by Application and Nationality, 1993



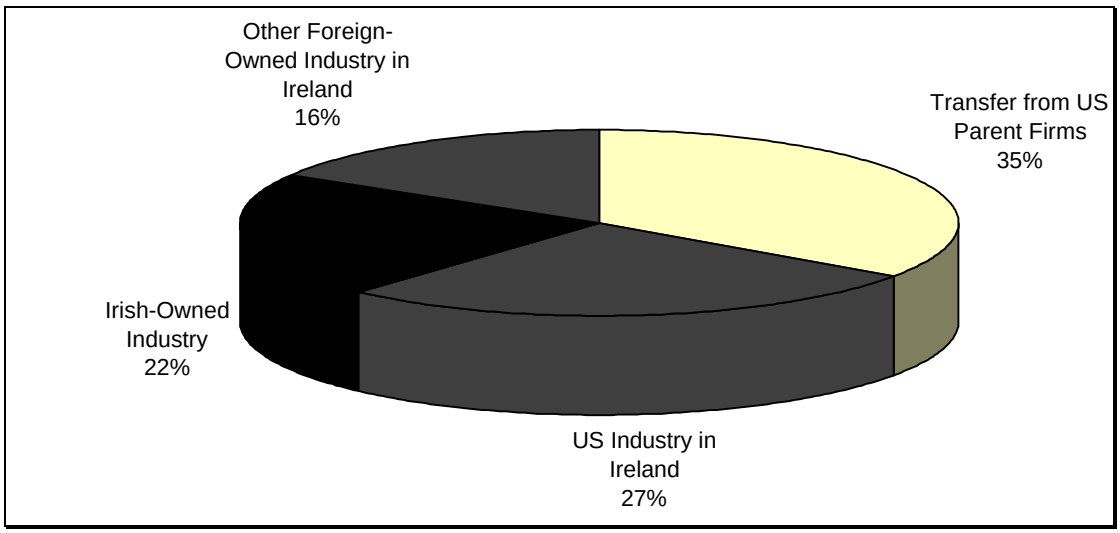
Source: *Derived from Forfás 1993 R&D Survey*

Fig. 4 - Share of Domestic Intramural Business R&D Expenditures by Objective and Nationality, 1993



Source: *Data derived from Forfás 1993 R&D Survey*

Fig. 5 - Overall Investment in R&D For Use by Industry in Ireland by Source, 1993



Appendix 1 -
Definition of Basic, Applied & Development R&D

The OECD (1981, pp. 54-55) distinguishes between three types of R&D activity:

(1) Basic Research:

".. is experimental research or theoretical work undertaken primarily to acquire new knowledge of the underlying foundation of phenomenon and observable facts, without any particular application or use in mind."

(2) Applied Research:

".. is also original investigation undertaken in order to acquire new knowledge. It is, however, directed primarily towards a specific practical aim or objective."

(3) Development Research:

".. is systematic work, drawing on existing knowledge gained from research and practical experience, that is directed to producing new materials, products and devices, to installing new processes, systems and services, and to improving substantially those already produced or installed."

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