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A note on transfer pricing and the R&D intensity of Irish manufacturing

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**A Note on Transfer Pricing and the R&D Intensity of
Irish Manufacturing**

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**DEPARTMENT OF ECONOMICS
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A Note on Transfer Pricing and the R&D Intensity of Irish Manufacturing

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November 2002

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Abstract

Ireland's low corporation tax regime has proved especially attractive to foreign multinational companies operating in high-tech sectors. Ireland's increasing concentration in such sectors has facilitated the country's rise in the international R&D rankings. On a sector by sector basis however, R&D expenditures in Ireland remain low by international standards. This has led to questions about whether the health of the country's R&D environment matches the technological orientation of its industry, and about the commitment of the foreign sector to R&D activities in host economies such as Ireland. The present note focuses on the transfer pricing behaviour that tends to arise in a low corporation tax regime, and shows that a simple correction for transfer pricing reveals Ireland to be less of an outlier in terms of sectoral R&D expenditures than the conventional measures suggest.

Keywords: Transfer pricing, Multinational Corporations, R&D Intensity.

Introduction

Most studies reveal Ireland to have the lowest effective rate of corporation tax in the EU. This is arguably the principal reason why it has proved so successful in attracting foreign direct investment. Table 1 presents a measure of the effective rate of corporation tax levied on US companies in various EU jurisdictions (derived from US Treasury Department corporate tax return files) alongside one measure of a country's ranking in the FDI stakes, i.e. the share of foreign companies in overall manufacturing employment.¹ Ireland emerges as an outlier along both dimensions.

Table 1

The foreign manufacturing companies operating in Ireland are predominantly located in what the OECD defines as high-technology sectors, while indigenous companies are clustered in low-tech sectors. The high output levels of the foreign companies dominate however, so that Ireland overall, in production terms, appears by international standards to be highly specialised in high-tech industry. Table 2 illustrates the 1994 production shares of domestically-owned firms in Ireland alongside the production shares for all manufacturing firms for Sweden, Finland, Denmark, Spain and Ireland.² The Nordic countries are chosen for comparison as equivalently small high-tech economies, while Spain is included as another historically less-well-off peripheral EU economy.

Table 2

Because the R&D intensity of the high-tech sectors (however measured) is higher than that of other sectors, the increased FDI inflows of the 1990s in these sectors facilitated Ireland's convergence on average OECD R&D intensity over this period; Table 3.

¹ The rate levied on US companies is particularly important in the Irish case given that (on the basis of 1999 data) 42 percent of foreign manufacturing companies in Ireland are US-owned, and these account for 61 percent of employment in foreign-owned companies.

² We choose 1994 as the mid-year point of the period 1991-97 for which the OECD provides cross-country R&D-intensity data.

Table 3

On a sector by sector basis however, Ireland's R&D intensity remains low by international standards, as illustrated in Table 4. This has raised questions about the state of health of the country's R&D environment. Forfás (2002, page 11), the Irish national policy and advisory board for enterprise, trade, science, technology and innovation, points out that "increasing these levels remains a key objective for national industrial policy".

Table 4

Even more surprisingly, the R&D intensity of domestic firms appears higher than that of foreign firms in each sector, though with foreign firms more concentrated in the high-tech sectors, the overall R&D intensity of the foreign sector is slightly higher; Table 5.

Table 5

Both of these findings have raised questions about the commitment of the foreign sector to engage in R&D in host economies like Ireland. Thus Forfás (2002, page 4) asserts that "the indigenous sector consistently outperforms foreign-owned firms in terms of research intensity... In the key sectors of Electrical and Electronic Equipment and of Instruments the indigenous firms are investing on a much more significant scale in R&D.. Clearly foreign-owned firms are still dependent for their innovation performance on R&D performed in their home countries". These and other data on patenting activities lead O'Sullivan (2000) to conclude that "the evidence on the behaviour of foreign-owned enterprises in Ireland does not provide support for strong positive statements about the viability of FDI as a basis for long term industrial development".

The conjecture of this note is that Ireland's weak position in the sectoral rankings, and the low R&D intensity of foreign firms relative to indigenous ones, are due in part at least to the transfer pricing behaviour of the multinational corporations which locate in Ireland.

Transfer Pricing and the Multinational Sector

A low corporation tax regime offers multinational companies an incentive to engage in transfer pricing. This practice entails the invoicing of a company's purchases from other branches of the parent company at prices lower than would arise in the case of arm's-length trades, and the invoicing of its sales to other branches of the parent company at prices higher than would otherwise arise. In this way a higher proportion of the firm's profits are made to appear to derive from activities carried out in the low tax environment.³

A low corporation tax environment is of particular value then to firms in sectors in which equivalent arm's-length prices are difficult for the home-country tax authorities to establish. This will be the case in sectors in which advertising and R&D expenditures are crucial, since it is difficult under these circumstances to locate the precise stages of production at which value is added. Both of the world's major soft drinks companies, for example, produce their very valuable cola concentrates to secret recipes in Ireland, presumably from quite basic ingredients, and a similar procedure is followed in the pharmaceuticals sector, in which Ireland plays host to nine of the world's ten largest corporations.

Thus, in Ireland, 86 percent of foreign-company employment is in NACE 3-digit advertising-intensive and/or R&D-intensive sectors, according to the classification developed by Davies and Lyons (1996), compared to a figure of only 28 percent for indigenous industry.⁴

³ See Hines and Rice (1994) and Clausing (2001) for further discussion and empirical analysis of the practice of transfer pricing.

⁴ A sector is classified as advertising-intensive if advertising expenditures in the UK exceed 1 percent of national consumption of the product. (The UK is used as it is the only EU country with appropriately comprehensive advertising-intensity data by sector). Of the roughly 100 NACE 3-digit sectors Davies and Lyons classify 13 as of this type. R&D data from both Italy and the UK are used in the determination of R&D-intensive sectors. Relatively high R&D expenditures are required in both countries if a sector is to be classified as such. 22 of the NACE 3-digit sectors are classified as of this type, and 9 as intensive along both dimensions. Of foreign employment in Ireland in 1999, 8 percent is in advertising-intensive sectors, 44 percent in R&D-intensive sectors and 34 percent in sectors which are both advertising- and R&D-intensive.

Some indication of the possible extent of transfer pricing in the Irish case is presented in Table 6 which shows net output per worker in certain of the foreign-dominated sectors in Ireland alongside average EU net output per worker in these sectors. For the cola concentrates sector, for example, net output stands at over one and a quarter million euro per employee in Ireland, compared to a mere 114,000 euro across the rest of the EU. The differences across the other sectors are less stark but are nevertheless substantial.

Table 6

Transfer pricing profits are thought to represent a substantial proportion of the profits recorded by multinational corporations. Multinational profits in Ireland are by far the largest component in the 15 percent wedge between GDP (which includes these profits) and GNP (which excludes them). Because transfer pricing is thought to be so pervasive in the Irish case, Irish economists tend to eschew the use of production and value added statistics in favour of employment statistics in analysing the activities of the foreign sector (though transfer pricing does result in substantial gains to the Irish Exchequer).⁵

This is the insight that the present paper brings to the analysis of the R&D intensity measures shown in Tables 4 and 5 above.

Correcting R&D Intensity for Transfer Pricing

It has been argued above that production measures tend to be polluted by transfer pricing in the Irish case. The conventional measure of R&D intensity in sector i can be written as $R\&D_i/Y_i$, where $R\&D_i$ represents R&D expenditure in sector i and Y_i measures gross output in the sector. Because measured Y_i is likely to be overstated in Ireland, for the foreign-dominated high-tech sectors at least, we propose to correct for this by evaluating

⁵ For the same reason, GNP is preferred to GDP as a measure of national income. Measuring business enterprise R&D as a proportion of GNP rather than GDP for the four years shown in Table 3 yields figures of 0.54, 0.6, 0.89 and 1.03 respectively, which depicts stronger convergence on the OECD average. The data that would allow an equivalent analysis to be carried out on a sector by sector basis are unfortunately not available.

intensity per worker instead; i.e. as $R\&D_i/L_i$. This entails multiplying $R\&D_i/Y_i$ by Y_i/L_i in each case.⁶

Table 7 shows sectoral employment shares in each of the countries under consideration. Comparing these to the sectoral production shares shown in Table 2 we see that the only country for which the shares are substantially different for the high-tech sectors is Ireland, where high-tech industry accounts for 23 percent of gross production and only 17 percent of employment, a difference of 6 percentage points. The difference in the case of each of the other countries is less than one percentage point. The corresponding slack in the Irish case is taken up by medium-to-low tech industry.

Table 7

In the case of each of the other countries the most substantial differences arise in the low-tech and medium-to-high tech sectors. These arguably reflect differences in factor intensities, with the Coke, Refined Petroleum and Nuclear Fuel sector recording by far the highest gross output per worker, presumably reflecting its very high capital-labour ratio. This provides further confirmation that Ireland's outlier status is driven by transfer pricing rather than by differing sectoral factor intensities across countries.

Table 8 performs the calculation of our preferred measure of R&D intensity, which is R&D expenditure per employee, for indigenous and foreign firms in Ireland. Comparing the results in this table to those in Table 5 above, we see that the R&D intensity of foreign firms now surpasses that of indigenous firms in 7 of the 14 sectors, and primarily in higher-technology sectors. Hence we see that the overall R&D intensity of the foreign sector gains substantially on that of domestically-owned industry. The R&D intensity of

⁶ Because of problems of data availability I use the values of Y_i/L_i for 1994, the mid-year point of the OECD period 1991 to 1997. Gross output is evaluated in millions of 1995 ECUs. These data come from the Eurostat database, DAISIE.

the foreign sector is now more than two and a half times that of indigenous industry, rather than being just slightly higher as the conventional measure suggests.⁷

Table 8

Table 9 performs the calculation of our preferred measure of R&D intensity for all the countries under consideration. The left-hand side of the table reports R&D intensities relative to Ireland using the conventional OECD measure, while the right-hand side reports the equivalent data based on our preferred measure.

Table 9

Here Ireland is seen to converge substantially on Denmark and Sweden on a sector-by-sector basis, to diverge slightly from Finland, and to pull even further ahead of Spain; Table 10.

Table 10

In terms of the overall R&D intensity of manufacturing industry, which depends on the sectoral structure of industry as well as the R&D intensity of each sector, R&D expenditures per worker are as shown in Table 11. Thus Sweden, Finland and Denmark continue to dominate Ireland, but by factors of 3.3, 1.8 and 1.3 rather than the factors of 3.7, 1.9 and 1.6 that the conventional measures suggest. Rather than dominating Spain by a factor of 1.6 as the conventional analysis suggests, Ireland is now seen to dominate Spain by a factor of 2.8.

⁷ Note that Tables 8 and 9 are not directly comparable. Not only do some of the sectoral categories differ but the output, employment and R&D data in the two tables come from different sources: those in Table 8 from Irish national data sources (Forfás and the Irish Census of Industrial Production) and those in Table 10 from internally-consistent international data sets (OECD and DAISIE).

Table 11

The changes in relative sectoral R&D rankings by country are also interesting. These are marked in bold print in Table 9. Spain overtakes Ireland in the R&D intensity of the motor vehicles sector, which is not surprising given that the bulk of Spanish production and employment in the sector is in Motor Vehicle construction while that for Ireland is in parts and accessories. Ireland falls behind both Denmark and Finland in the R&D intensity of ship and boat construction and repair, a substantial activity in these two Nordic countries and a very small-scale activity in Ireland. Interestingly, Ireland overtakes Denmark (as well as Sweden) in the R&D intensity of the very substantial Food, Drink and Tobacco sectors, aided, as Table 8 shows, by the R&D activities of foreign firms in Ireland.

Conclusions

Policy needs to be guided by accurate data. It is widely recognised that Irish output figures are distorted by the transfer pricing behaviour of multinational companies operating in the economy. This distorts also the standard measures of sectoral and overall R&D intensities. When R&D intensity is recalculated as expenditure per employee Ireland's foreign sector pulls further ahead of indigenous industry, and overtakes it in all but one of the high-tech sectors.

Some anomalies remain however, and these warrant further investigation, at the level of the individual firm if possible. Alone amongst the high-tech sectors, for example, Instrument Engineering records a higher R&D-intensity for domestic firms (using our preferred measure) than for foreign firms. It would be of interest to establish whether this arises between of interrelationships such as sub-supply linkages between the two sets of firms in the sector.

Our preferred measure shows that Ireland does not lag as far behind the Nordic countries as the conventional measure suggests, while it gains even further on Spain. The gap with

the Nordic countries remains significant however, and the reasons for this also warrant further analysis.

It will be clear that the Nordic countries represent home rather than host locations for many of the high-tech firms located there, and it is certainly reasonable to imagine that firms will carry out a substantial proportion of their total R&D activities in their home locations. Thus Blomström et al. (1997) find that an increase in a firm's overseas production tends to be associated with an expansion of headquarters services and high-skill employment in the firm's home location. The tendency to concentrate R&D expenditures at home will undoubtedly form part of the explanation as to why Ireland lags behind the Nordic countries. Further work is required to determine if the entire gap can be explained in this way however.

This line of reasoning may suggest that the strong growth in outward FDI from Ireland over the course of the 1990s, documented by Barry, Görg and McDowell (2002), will raise the R&D-intensity of domestic industry as the country hosts a growing number of Irish-owned multinational companies. It is not clear that this will necessarily be the case though. Barry et al. (2002) find that Irish-owned multinationals are disproportionately located in non-traded sectors such as Construction and Paper and Packaging and do not exhibit the "created asset" intensity derived from research and development activities and strong product differentiation that Dunning, Kim and Lin (2001) find for countries such as Korea and Taiwan. Irish indigenous overseas M&A activities in the high-tech area, furthermore, are concentrated on the US and tend to be directed toward "technology sourcing", which, according to Blomström and Kokko (2000), can lead to a downsizing of domestic R&D facilities and a reduction in high-skill employment in the home economy.⁸ Dunning et al. (2001) do suggest however that FDI outflows and indigenous exports will gradually reorient towards "created asset"-intensive sectors as technological progress and human resource development in the home economy proceeds.

⁸ Technology sourcing may also generate positive externalities however, as Globerman et al. (2000) argue.

The analysis therefore suggests a number of research areas for those interested in the developing Irish economy. The main issue highlighted, however – that of transfer pricing and its impact on the measurement of R&D-intensity levels – is of broader international interest. A number of Central and Eastern European countries, in preparing for EU accession, have studied carefully the reasons for Ireland's recent economic success and have begun to emulate some of the policies adopted there.⁹ Of particular interest in this regard is the low corporation tax strategy that Ireland has followed. As of 2003 the nominal corporation tax rate in Ireland will be set at 12.5 percent across all sectors. This compares to an EU average of 35 percent. Estonia has recently set its corporation tax at zero, Hungary has instituted a rate of 18 percent, Poland's is set to fall to 22 percent by 2004, and the rate for Slovenia and Latvia stands at 25 percent; Barry (2002). These rates will offer opportunities for multinational companies to engage in transfer pricing in the CEE countries also, so the corrections necessary in the case of the Irish data are likely to become of wider significance in the near future.

⁹ For a discussion of the Irish policy environment, with CEE countries in mind, see Barry (2000).

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Table 1: Effective corporation tax rates and shares of foreign affiliates in manufacturing employment

	Average effective tax rate on US MNCs (1992)	Share of foreign affiliates in manufacturing employment (1998)
Ireland	5.8	47.5
France	22.8	27.8
Sweden	16.7	21.1
Netherlands	17.9	19.7
Austria	32.6	18.6
Belgium	25.9	18
UK	19.3	17.8
Finland	15.8	15.9
Italy	32.6	11.5
Portugal	25.3	7.3
Germany	28.9	6
Spain	25.3	n.a.
Greece	33.4	n.a.
Denmark	31	n.a.

Notes: Effective tax rates from Altshuler et al. (2001); share of affiliates in manufacturing employment from OECD (2001) Science, Technology and Industry Scoreboard, tables C.4.1 and C.4.2.1. Note that these two OECD tables, derived from different databases, give substantially different results for some countries, such as France and Norway; results reported here are those most consistent with OECD (1999).

Table 2: Production Shares, 1994

	NACE codes	Yi/Y					
		Swe	Fin	Denm	Spn	Irl	Irl (domestic)
<u>High technology</u>							
Aircraft		1.0	0.4	0.0	0.4	0.0	0
Pharmaceuticals	244	3.4	0.8	4.6	2.4	4.3	0.6
Office and Data Processing Equip.	30	0.7	1.5	0.4	0.8	11.3	1.1
Radio, TV and Telecomm Equip.	32	5.5	4.9	2.2	1.5	3.5	0.4
Medical and optical Equip.	33	2.0	1.2	2.6	0.7	3.4	0.7
	Sub-total	12.6	8.7	9.9	5.8	22.5	2.8
<u>Medium-to-high tech</u>							
Electrical Machinery	31	2.4	3.1	2.4	2.9	2.5	1.5
Motor Vehicles	34	11.4	1.0	1.3	10.6	0.9	1.0
Chemicals less Pharmac.	24 less 244	4.5	5.7	4.1	8.2	12.7	3.9
Transport nec		0.6	0.4	0.2	0.5	0.0	0
Machinery and Equip. nec	29	11.3	9.5	12.2	4.7	3.4	3.2
	Sub-total	30.2	19.7	20.2	26.9	19.5	9.6
<u>Medium-to-low tech</u>							
Coke, refined and nuclear		2.1	3.5	0.9	3.1	0.0	
Rubber and Plastics	25	2.5	2.4	3.9	3.7	2.5	2.5
Other Non-Metallic Materials	26	1.8	2.2	3.7	5.7	2.2	5.5
Ships and boats: construction and repair	351	0.4	2.0	2.5	0.7	0.1	0.2
Basic metals	27	8.3	8.8	2.7	5.4	0.8	5.0*
Fabricated metal prods.	28	5.0	3.7	5.2	6.0	2.3	
	Sub-total	20.2	22.6	18.7	24.7	7.9	13.2
<u>Low-tech sectors</u>							
Manufacturing nec	36	1.8	1.7	5.4	3.0	2.1	4.7
Wood, Paper and Printing	20-22	22.3	31.6	9.4	9.9	9.7	11.5
Food, Beverages and Tobacco	15-16	11.7	13.5	32.7	22.4	35.1	54.5
Textiles, clothing and footwear	17-19	1.1	2.2	3.8	7.4	3.1	3.9
	Sub-total	37.0	48.9	51.2	42.6	50.0	74.6
Total Manufacturing		100	100	100	100	100	100

Note: *: includes fabricated metal products.

Source: DAISIE for national production shares; Irish Census of Industrial Production for production shares in domestic firms.

Table 3: Business Expenditure on R&D as a percentage of GDP, various years

	1986	1990	1993	1999
OECD average	1.56	1.64	1.44	1.54
Ireland: percent of GDP	0.48	0.53	0.79	0.88

Source: Forfás (1997, 2002).

Table 4: R&D Intensities as a proportion of gross output, average 1991-97.

	Sweden	Finland	Denmark	Spain	Ireland
Aircraft	15.3	0.9		16	
Pharmac	21.5	14	14.8	3.1	5.2
ODP	12	3.1	5.4	2.6	0.6
R,TV,Comm	17.8	11.4	7.7	6.3	8.6
Medical and opt.	8.2	7	6.1	2.1	2
Elec mach	2.6	4.5	1.5	0.9	1.7
Motors	6.1	1.8		0.8	1.2
Chemicals less Pharmac	2.2	2.8	1.7	0.6	0.4
Transport nec	2.5	9.4	0.3	1.2	0
Machinery nec	4	2.4	32	1	1.1
Coke etc.	0.4	0.8		0.4	
Rubber etc.	1.5	1.7	0.8	0.5	0.8
Other NMM	0.9	1.4	0.4	0.2	0.9
Ships and boats	2	0.7	0.8	1.5	1.2
Basic metals	0.8	0.7	0.6	0.2	0.4
Fabr. metals	0.8	1.1	0.2	0.2	0.9
Manuf nec	0.3	0.7	2.3	0.2	0.4
Paper and print	0.7	0.5	0.1	0.1	0.2
Food etc.	0.4	0.6	0.4	0.1	0.4
Textiles etc.	0.5	0.6	0.1	0.1	1
Total Manufac.	3.7	1.9	1.6	0.6	1

Source: OECD (2001)

Table 5: R&D Intensity of Domestic and Foreign-Owned Industry in Ireland, 1995

	NACE	Ri/Yi (%) Domestic industry	Ri/Yi (%) Foreign- owned industry
Pharmaceuticals	244	4.8	4.6
Electrical and electronic	30-32	5	1.2
Instruments	33	4.4	1.7
Chemicals less Pharm	24-244	0.5	0.4
Transport Equipment	34-35	0.8	2.7
Machinery and Eq	29	2.7	1
Rubber and Plastics	25	2	0.8
Non-Metallic Mins.	26	1	1.9
Basic and Fab metals	27-28	1.4	0.4
Wood Products	20	0.4	1.1
Paper, print and publishing	21-22	0.3	0
Food,drink and tobacco	15-16	0.3	0.4
Textiles, clothing, leather.	17-19	1.9	1.2
Other manufacturing	36-37	0.7	0.1
Total Manufacturing		0.9	1.1

Source: Forfás (2002, page 12)

Table 6: Indications of possible transfer pricing in Irish manufacturing:
Net output per worker, 1999, millions of euro.

Industry	NACE codes	EU average	Ireland
Computers	30	132	214
Electronic components	32.10	132	291
Organic and basic chemicals	24.14, 24.4	206	1073
Software reproduction	22.3	81	922
Cola concentrates	15.85, 15.88, 15.89	114	1285

Source: Honohan and Walsh (2002)

Table 7: Sectoral Employment Shares

		Sweden	Finland	Denmark	Spain	Ireland
Aircraft		1.90	0.87	0.00	0.49	0.00
Pharmac		2.09	1.13	3.79	1.76	2.69
ODP		1.02	0.96	0.55	0.37	5.21
RTVC		5.36	4.49	2.66	1.34	3.53
Med and opt		2.88	1.67	3.74	1.01	5.27
	sub-total	13.25	9.13	10.74	4.97	16.71
Elec mach		3.07	3.92	2.68	3.41	5.00
Motor V		10.78	1.86	1.71	6.27	1.59
Chems less Pharm		3.23	4.01	3.09	4.39	5.82
Transport nec		0.81	0.92	0.23	0.52	0.00
Mach and Eq nec		15.30	12.83	17.09	6.38	6.71
	sub-total	33.19	23.53	24.81	20.97	19.12
Coke etc.		0.42	0.94	0.52	0.34	0.00
Rubber and Plas		3.27	3.42	4.51	4.30	4.39
Other NMM		2.70	3.42	4.40	7.03	4.28
Ships and boats		0.59	2.73	3.23	1.29	0.24
Basic metals		4.91	4.59	2.53	3.34	1.14
Fab metal		7.25	5.33	7.31	10.06	5.00
	sub-total	19.14	20.42	22.50	26.36	15.04
Manuf nec		2.75	3.45	7.06	6.23	4.08
Paper and print		19.60	26.44	10.38	11.27	11.17
Food BT		10.25	12.10	20.08	17.24	22.84
Text,cloth and foot		1.81	4.93	4.43	12.97	11.05
	sub-total	34.42	46.93	41.96	47.71	49.14
Total		100	100	100	100	100

Source: DAISIE

Table 8: R&D Intensity of Domestic and Foreign-Owned Industry in Ireland, 1995:
Preferred Measure

	Sector's share in total employment in domestic firms	Sector's share in total employment in foreign firms	Ri/Li (£1995) Domestic industry	Ri/Li (£1995) Foreign- owned industry
Pharmac	1	5	2996	11900
Electrical	6	27	2835	3390
Instruments	1	10	2585	1500
Chem less Pharm	2	9	835	1536
Transport Eq	6	2	356	2358
Mach and Eq	6	7	1428	966
Rubb and Plas	4	5	1343	690
NMM	7	1	751	1518
Basic and Fab metals	8	3	873	488
Wood	3	1	236	1657
Paper print	12	5	213	0
Food etc	28	12	568	1129
Text etc.	10	8	719	568
Other manuf	5	4	683	77
Total Manuf	100	100	901	2321

Source: Forfás (2002); Irish Census of Industrial Production (1995); own calculations.

Table 9: R&D Intensities as a proportion of gross output and per employee, average 1991-97.

	R&D/Yi (conventional measure)				R&D/Li (preferred measure)			
	Denm/lrl	Esp/lrl	Fin/lrl	Swe/lrl	Denm/lrl	Esp/lrl	Fin/lrl	Swe/lrl
High-tech								
Pharmac	2.85	0.60	2.69	4.13	1.73	0.30	1.07	3.60
ODP	9.00	4.33	5.17	20.00	2.70	2.39	3.48	5.40
R, TV, Comm	0.90	0.73	1.33	2.07	0.61	0.48	1.36	1.88
Medical and opt	3.05	1.05	3.50	4.10	2.70	0.70	3.79	3.95
Medium-high								
Elec. Mach.	0.88	0.53	2.65	1.53	1.28	0.53	4.06	2.15
Motor Vehicles	0.00	0.67	1.50	5.08	0.00	1.23	1.44	8.71
Chemicals less Pharmac.	4.25	1.50	7.00	5.50	2.09	0.75	4.29	3.08
Machinery nec	2.91	0.91	2.18	3.64	3.29	0.79	3.01	4.65
Medium-low								
Rubber etc.	1.00	0.63	2.13	1.88	1.20	0.54	2.45	2.21
Other NMM	0.44	0.22	1.56	1.00	0.58	0.21	1.87	1.14
Ships and boats	0.67	1.25	0.58	1.67	1.19	1.10	1.18	2.54
Basic metals	1.50	0.50	1.75	2.00	1.78	0.67	4.41	4.12
Fabr. Metals	0.22	0.22	1.22	0.89	0.27	0.17	1.73	1.17
Low-tech								
Manuf nec	5.75	0.50	1.75	0.75	6.70	0.27	1.52	0.82
Paper and print	0.50	0.50	2.50	3.50	0.42	0.30	3.25	4.01
Food etc.	1.00	0.25	1.50	1.00	0.85	0.12	1.03	0.65
Textiles etc.	0.10	0.10	0.60	0.50	0.24	0.12	0.91	0.94
Total Manufacturing*	1.6	0.6	1.9	3.7	1.32	0.36	1.78	3.26

Note: Ireland has no presence in two sectors: Aircraft and Spacecraft, and Coke etc., and relative R&D intensities are not therefore reported for these sectors. The recalculated R&D intensity of these sectors for the other countries for which data are reported is of course taken into account in calculating the level for the overall R&D intensity of manufacturing.

Source: OECD (2001), DAISIE, own calculations.

Table 10: R&D intensities relative to Ireland;

Unweighted sectoral averages: standard and preferred measures

	Denmark	Spain	Finland	Sweden
standard measure	2.06	0.85	2.33	3.48
preferred measure	1.63	0.63	2.40	3.00

Table 11: R&D expenditures per worker, average 1991-97, in 1995 ecu.

	Total Manufacturing
Sweden	5610
Finland	3058
Denmark	2267
Spain	621
Ireland	1719