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# The spatiality of Irish manufacturing linkages in the 'Celtic Tiger' era

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Manufacturing investment from abroad has been of immense importance to Ireland's economic development in recent decades. In particular, high levels of foreign investment in manufacturing were the main contributor to the unprecedented economic growth rates from the early 1990s which led to Ireland's economy being compared with the Asian 'Tigers'. Clearly it is desirable from a national economic point of view that the current base of foreign manufacturing firms should remain as embedded as possible. In this respect, the low level of local linkages developed by foreign firms has been a constant concern for policy-makers. A number of studies have been conducted on the nature of linkages developed within the Irish economy by foreign-owned manufacturing plants in terms of the nature of these linkages and their potential for further development. However, there has been little research on the spatial patterns of external linkages of the plants in question. Based on a survey of 91 firms in four key manufacturing sectors, this paper examines the spatial configuration of the material input linkages of Irish manufacturing industry. The findings show that major sectoral variations exist in the spatiality of the linkage structures of Irish manufacturing industry. The paper concludes with a discussion of the possible implications of these variations for the future stability and embeddedness of manufacturing firms in the Irish economy.

**Keywords:** spatial linkages; Ireland; 'Celtic Tiger'; manufacturing industry

## Introduction

The 1950s saw the emergence of 'new spatial divisions of labour' within large industrial corporations based in the advanced western economies. A key element of this was the relocation of routine, labour-intensive, production activities in response to measures being implemented by governments to attract industrial development to other countries and regions. Over time, the resultant 'branch plant industrialisation' became the subject of growing criticism relating, among other things, to the quality of the jobs created, the very limited extent of their 'knock-on' effects within the local economies in which they were located and the instability of industrial plants set up through this form of industrial development. Branch plants were seen as 'snatchers' rather than 'stickers' which were happy to take whatever benefits were available (cheap labour, grants and subsidies, tax incentives) but that corporations had no compunctions about pulling out when unfavourable conditions presented themselves or where superior alternatives became available elsewhere (Dicken *et al.* 1994).

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While this image was no doubt exaggerated, it did lead to an increasing concern among policymakers of developing ways which would 'embed' branch plants more deeply in their host economies, thereby reducing their likelihood of leaving as a result of changed circumstances. Such embedding could take various forms, such as a switch from outside to local management or the local provision of specialised skills or other resources with particular attractions for established branch plants. However, the most favoured embedding mechanism was the development by branch plants of local linkages whereby other locally based firms provided them with inputs of materials, services and/or equipment. Not only would this (it was hoped) increase the commitment of branch plants to the locality, but it would have the added benefits of generating further employment in those firms acting as suppliers to branch plants and, possibly, of facilitating the transfer of technological know-how from branch plant to supplier (Turok 1993).

One effect of this emerging policy focus was the stimulation of a wave of 'linkage studies' around the world – for example in the USA (Heron and Schmidt 1976, Le Heron and Schmidt 1976, Schmennor 1982, Glasmeier and McCluskey 1987, Clarke 1994) and the UK (Lever 1972, Hoare 1978, Turok 1993) – investigating the level of local linkage developed by foreign firms and their implications for economic development. Such studies tended to focus on the nature, extent and local impact of existing linkages, obstacles to further linkage development and formulating measures to promote linkage formation. To the extent that such studies have extended their horizons beyond the local level, it has generally been to examine the relationship of branch plants to broader corporate frameworks of which they are part, and in particular the relationship with the parent company's head office. This is because the potential development of local linkages by branch plants is crucially related to overall company policy and strategy relating to subsidiary activities, including the independence of action conferred upon branch plants (Dicken *et al.* 1994, Birkinshaw and Hood 1998).

However, rarely have linkage studies examined the broader production systems within which corporate branch plants are embedded, including linkages beyond the framework of the parent corporation. In particular, there has been a dearth of research on the spatial configuration of the overseas linkages of branch plants and the possible bearing these might have on the stability and embeddedness of the branch plants in question. Among the key questions to be asked in this respect are: Can recognisable patterns be identified in the spatial configuration of these overseas linkages? If so, what are the underlying processes which give rise to these patterns? What, if any, are the implications of these patterns and processes for the nature and stability of branch plant industrialisation in particular territories?

The present paper addresses these questions in the context of overseas manufacturing branch plants operating in Ireland. The next section of the paper provides a background context to the foreign manufacturing sector in Ireland in terms of its evolution and structure, including the extent and nature of local linkage as identified by previous linkage studies and current documentary sources. This is followed by a brief account of a survey conducted among 91 Irish-based manufacturing plants which examined, inter alia, the spatial configuration of their backward (i.e. supply) linkages. The paper then examines in some detail the findings which emerged from this survey before concluding with some comments on the

implications of the findings for the future development of Ireland's branch plant sector.

**Foreign investment and industrial linkage in Irish manufacturing industry**

The Republic of Ireland (henceforth 'Ireland') has a long history of attracting foreign investment. The failure of an earlier policy of industrialisation via protectionism led to the adoption, in the 1950s, of an alternative approach which envisaged inward investment as the main engine of economic growth and employment creation. Consequently, a number of measures and incentives designed to attract foreign investment were introduced, including generous capital grants, labour training grants and an initial period of complete tax relief from profits derived from exports (this was replaced in 1980 by a flat tax rate of 10% on all manufacturing profits). A government agency – the Industrial Development Authority (IDA) – was also established to promote industrial development. The IDA was given responsibility for securing investment in Ireland by foreign firms and quickly gained a reputation as a very effective investment promotion agency (Breathnach 1998a). Another important attraction for foreign firms at this time was the availability of a large reservoir of labour which, although lacking technical skills, possessed a good standard of education. Furthermore, they were willing to accept wage levels significantly below the norm in both the UK and the more advanced economies of continental Europe.

Growth in manufacturing employment accelerated from less than 2% during the 1950s to 20% in the 1960s (Breathanch 2007). By 1973, employment in foreign-owned firms had increased to 22% of total manufacturing employment and was mainly made up of British (43%) and American (27%) firms (Ó Súilleabháin 1982). Although new foreign firms were involved in a wide range of activities and sectors, the dominant sector at this time was the metals and engineering sector with a new growth sub-sector in electronics assembly, reflecting the parallel growth of this sector in the USA. In 1973, Ireland experienced a major surge of new inward investment principally triggered by entry to the European Economic Community. As a result, there was a further influx of manufacturing branch plants attracted by access to the EEC market. These branch plants imported the majority of their inputs and their output was almost entirely exported. By 1981, employment in foreign manufacturing firms had risen to 35% of all manufacturing employment, with US firms accounting for 42% of employment in the foreign sector (Breathnach 1998b, p. 1). As Breathnach (2007, 11) has pointed out, Ireland at this time was seen as being 'particularly attractive to US firms seeking a production location inside the EEC's Common External Tariff, especially as Ireland was English-speaking, had strong cultural links with the USA, was strongly pro-American attitudinally, had familiar legal and financial systems and politically was both stable and conservative'.

Throughout the 1980s, the severe international recession resulted in a significant decrease in the rate of new foreign investment. However in the early 1990s, there was a rapid turn-around with unprecedented growth rates jump-starting the so-called 'Celtic Tiger' era. Between 1993–2000, total employment in foreign-owned manufacturing plants grew by over one-third. More importantly, from a broader economic viewpoint, the output of these plants almost trebled in real terms in the same period. By the year 2000, the foreign sector accounted for 49% of all manufacturing employment (Forfás 2003). Most of the inward investment in the 1990s came from

the USA, so that by the mid-1990s Ireland was attracting one quarter of all US investment into the EU, just behind the UK as the most favoured European destination for US firms. Furthermore, the nature of inward investment was also changing, with an increasing emphasis on export services and high-tech manufacturing (electronics, pharmaceuticals, medical devices) compared with the routine, labour-intensive plants which had characterised inward investment in the 1960s and 1970s.

Despite this change in the type of inward investment coming to Ireland, the level of local linkage developed by foreign firms and indeed indigenous firms has remained very low. Numerous studies have been completed on the linkages and embeddedness of foreign and indigenous firms in the Irish economy over the years (Stewart 1976, McAleese and McDonald 1978, O'Farrell and O'Loughlin 1980, Kennedy 1991, Ruane and Gorg 1997). These studies found that backward material input linkages were generally limited in all sectors (both foreign and indigenous firms) with the exception of the Food, Drink and Tobacco and the Non-Metallic Mineral Product sectors. They also found that backward material input linkages were significantly lower in foreign firms than indigenous firms. Linkages did tend to develop with time but only minimally and unevenly. The Irish economy expenditure survey for 2003 compiled by Forfás, the Irish government's policy advisory body for enterprise and science, shows that the proportion of inputs purchased in Ireland by the most important sectors was as low as 16% for the electronics sector and 19% for the pharmaceuticals and medical device sectors (Brennan 2006).

While it has been established that both foreign and indigenous manufacturing firms purchase a low level of their inputs within Ireland, little is known about the origins of those inputs which are not sourced in Ireland. The only studies which have examined the spatial configuration of Irish manufacturing industry to date were those by Heanue and Jacobson (2008) (whose case study of two furniture-making firms and two engineering firms found that the furniture firms sourced the majority of their inputs from the Far East with the engineering firms mainly sourcing their supplies locally) and Van Egeraat (2002) (whose study of five large microcomputer firms found that the great majority of components were sourced in regions outside Ireland and Britain, mainly the Far East and, to a lesser extent, the USA). The current paper explores the spatial configuration of material input linkages of a much larger number and broader range of Irish manufacturing industry. It also explores the implications of these linkage structures for the future sustainability and development of the Irish manufacturing sector. The next section outlines the methodology utilised in achieving this.

## Methodology

The findings presented in this paper are based on empirical research which was conducted for a doctoral thesis (Brennan 2006). Using a survey methodology, a detailed postal/online questionnaire was sent to a sample of Irish-based[1] manufacturing firms. This survey focused on four sectors, each of which accounted for at least 5% of total manufacturing employment or gross output in 2001 and sourced the majority of its inputs from overseas.[2] These were: pharmaceuticals (NACE Code

2442);[3] basic metals & engineering (27–28); electronics (30-32)[4] and medical devices (33).[5] According to the Census of Industrial Production, these sectors, between them, accounted for 77.6% of total manufacturing gross output and 35.3% of total manufacturing employment in 2001. Further details on these sectors are provided in Table 1.

Within these sectors all indigenous firms employing at least 50 people and foreign firms employing at least 100 were targeted for inclusion. The difference in threshold size was due to the desire to obtain a usable sample of indigenous firms for comparison with their foreign counterparts, given the generally smaller size profile of indigenous firms. In order to establish the spatial configuration of the linkage structures of the survey firms, information was sought on the main categories of material inputs used by the firms and the proportion of total expenditure on materials devoted to each. In addition, for the two most important suppliers of each input category, the following information was sought:

- the proportion of the input supplied by each supplier;
- the location and nationality of the supplier;
- the reason for not using an Irish supplier (where the supplier was non-Irish);
- whether the supplier actually produced the input (and, if not, where the input was sourced); how long the survey firm had been using that supplier; and
- whether the supplier was an affiliate of the survey firm (i.e. both were jointly owned by a common parent company).

Overall, 234 manufacturing firms were selected for inclusion in the survey. The survey questionnaire was first sent to these firms in May 2003 with follow-up reminders being sent until the end of October 2003. Usable responses were obtained from a total of 91 firms in these sectors making the effective response rate 38.8%. As only pharmaceutical firms (NACE Code 244) responded to the survey from the chemicals and pharmaceuticals sector, this became a sector of its own. Table 2 shows the response rate for the four sectors, distinguishing between indigenous and foreign firms. While the response rate varied intersectorally, the overall response rate (38.9%) compares well with Cantwell and Mudambi's (1998, p. 15) 33% response from a survey of foreign engineering firms in the British midlands and Birkinshaw *et al.*'s (1998) 34% response for a survey of TNC subsidiaries in Canada, Sweden and Scotland. At the same time, the response rate does not permit reliable comparisons

Table 1. Profile of survey sectors, 2001.

| | Gross output €M | Net output €m | Empl. | % foreign firms | Gross output/ worker € | Net output/ worker € | % materials imported |
|---|---|---|---|---|---|---|---|
| Pharmaceuticals | 3978.2 | 2670.5 | 8135 | 85.5 | 489022 | 328273 | 90.4 |
| Medical devices | 4659.1 | 2534.0 | 19792 | 87.1 | 235403 | 128032 | 81.0 |
| Engineering | 1906.0 | 880.4 | 15355 | 22.9 | 124129 | 57336 | 58.6 |
| Electronics | 26964.9 | 10039.3 | 45196 | 82.2 | 596621 | 222128 | 83.7 |

Source: Census of Industrial Production

Table 2. Survey response rates by sector.

| | Firms targeted | Actual returns | Response rate% |
|---|---|---|---|
| Pharmaceuticals | | | |
| Indigenous | 11 | 2 | 18.2 |
| Foreign | 34 | 11 | 32.4 |
| Total | 45 | 13 | 28.9 |
| Medical devices | | | |
| Indigenous | 13 | 6 | 46.2 |
| Foreign | 42 | 18 | 42.9 |
| Total | 55 | 24 | 43.6 |
| Engineering | | | |
| Indigenous | 37 | 14 | 37.8 |
| Foreign | 10 | 4 | 40.0 |
| Total | 47 | 18 | 38.3 |
| Electronics | | | |
| Indigenous | 20 | 11 | 55.0 |
| Foreign | 67 | 25 | 37.3 |
| Total | 87 | 36 | 41.3 |
| Overall | | | |
| Indigenous | 81 | 33 | 40.7 |
| Foreign | 153 | 58 | 37.9 |
| Total | 234 | 91 | 38.9 |

to be made between indigenous and foreign respondents at the individual sectoral level.

### *Survey firm characteristics*

Of the 91 firms who responded, the majority of them were of either US (44.0%) or Irish (36.3%) headquartered. Of the remaining 18 firms, 13 were drawn from five different European countries, four were of Asian origin and one was of joint UK/USA origin. The prominence of US-owned firms in the survey reflects the dominance of US foreign investment in the Irish manufacturing sector generally. There was little variation in nationality profile between sectors, with all sectors except the engineering sector being dominated by US-owned firms followed by Irish-owned firms. The engineering sector was dominated by Irish-owned firms. The majority (60%) of respondent firms were branch plants, while 30% were stand-alone firms and 10% were parent firms with branches elsewhere. Branch plants dominated each sector with the exception (again) of the engineering sector which was dominated mainly by stand-alone (Irish-owned) firms. Generally, stand-alone firms tended to be Irish-owned firms.

The number of people employed varied from 50 to 3500 with an overall average of 356. Table 3 shows that over half the firms employed 200+people, indicating quite a large size profile. Employment levels in foreign firms generally were higher than in indigenous firms with the exception of the engineering sector. Some firms in the foreign-owned electronics, medical devices and pharmaceutical sectors were particularly large, employing 1000+people.

Table 3. Survey firms by employment size.

| | 50 <100 | 100 <200 | 200 <500 | 500+ |
|---|---|---|---|---|
| Pharmaceuticals | 1 | 2 | 8 | 2 |
| Medical devices | 6 | 4 | 8 | 6 |
| Engineering | 8 | 5 | 4 | 1 |
| Electronics | 9 | 7 | 13 | 7 |
| Total | 24 | 18 | 33 | 16 |

**Spatial configuration of supply structures**

While respondent firms provided information on the proportion of total inputs accounted for by different input types and suppliers, information was not sought on the actual quantities involved as it was thought that seeking such potentially sensitive information might compromise the survey response rate. However, it is possible to estimate the overall value of input purchases for each of the respondent firms by multiplying the number of employees by the average expenditure on materials per employee for the relevant sector which can be calculated from the Census of Industrial Production for 2003, the year in which the survey was conducted. Scale effects are catered for to an extent by the fact that materials expenditure can be calculated for different firm size categories, the level of breakdown by size varies between sectors. This approach can be further justified by the fact that the survey firms themselves account for a very large proportion of materials purchases in their respective sectors (Table 4).

By allocating the estimated total materials expenditure for each firm to the proportions accounted for by different inputs and the sources reported for the main suppliers of these inputs, a picture can be built up of the geographical configuration of the supply sources for the different survey sectors. This is not a complete picture, since the two main suppliers for each input for which information was sought do not necessarily account for all supplies of that input; in addition, not all responses gave usable information on the sources used by the main suppliers.[6] Nevertheless, the proportion of estimated total inputs for which sources could be identified was quite high, averaging out at 68.6% across the four survey sectors (Table 5).

***Irish economy linkages***

Only 12.7% of the material input requirements of the respondent firms were sourced in Ireland. This compares with a figure of 14.8% for the corresponding sectors in the 2003 Census of Industrial Production (CIP). As Table 6 shows, the proportions of inputs sourced in Ireland by pharmaceuticals and electronics firms were also slightly

Table 4. Estimated material input expenditures of survey firms as percentage of total sectoral materials expenditure (Census of Industrial Production 2003).

| | |
|---|---|
| Pharmaceuticals | 56.8 |
| Medical devices | 55.6 |
| Engineering | 28.9 |
| Electronics | 30.5 |
| All sectors | 36.2 |

Table 5. Proportion of estimated material input expenditures for which source information was available (%).

| | |
|---|---|
| Pharmaceuticals | 66.9 |
| Medical devices | 73.3 |
| Engineering | 78.7 |
| Electronics | 67.4 |
| All sectors | 68.6 |

below the corresponding CIP figures. This presumably reflects the bias in the survey towards larger firms which have a higher tendency to source overseas. At the same time, the proportion of Irish-sourced materials for the medical devices firms was significantly above the CIP figure. However, the biggest discrepancy by far applied to the engineering sector, where the surveyed firms sourced only 5% of their inputs in Ireland compared with 46.8% for the sector at large. A significant factor in explaining this discrepancy is the large number of small firms ( $<$50 workers) in this sector; in 2003, such firms accounted for over 90% of all firms in the sector and 44% of total sectoral expenditure on material inputs. Furthermore, the firms included in the survey were mainly involved in basic metal manufacture, requiring inputs (sheet metal, metal ingots, etc.) which are, for the most part, not produced in Ireland.

### *International linkages*

The 87.3% of respondent firms' traceable material inputs which were sourced from abroad were drawn from 29 separate named countries in addition to broader regions (Europe, Far East/Asia/East Asia/South Asia, Abroad/Worldwide/Global). Apart from the USA and Mexico, all of these countries are located either in Europe or Asia. Table 7 shows the distribution of material inputs, by sector, between four broad regions: Europe, USA, Asia and Other/Unstated. Overall, all three named regions are strongly represented; this contrasts with Hewitt-Dundas *et al.*'s (2005) survey of 61 TNCs based in the Republic of Ireland which showed a much stronger orientation towards Europe and a much weaker representation of the Far East. However, the present survey has a different sectoral configuration and includes a number of indigenous firms.

The aggregate data conceal major intersectoral variations in the regional distribution of supply sources. Europe is by far the main supply source for pharmaceuticals and (particularly) engineering and is significantly under-represented

Table 6. Irish economy linkage by sector.

| Sector | % Material inputs sourced in Ireland by survey firms | % material inputs sourced in Ireland in respective sector, Census of Industrial Production 2003 |
|---|---|---|
| Pharmaceuticals | 9.8 | 11.6 |
| Medical Devices | 23.6 | 15.0 |
| Engineering | 5.0 | 46.8 |
| Electronics | 10.0 | 12.9 |
| Overall | 12.7 | 14.8 |

Table 7. Foreign input sources by region and sector.

| Sector | Europe | USA | Asia | Other/ Unstated | Total traceable overseas expenditure €M (2003) | No. of firms |
|---|---|---|---|---|---|---|
| Pharmaceuticals | 61.6 | 4.2 | 26.1 | 8.1 | 510.5 | 13 |
| Medical devices | 30.9 | 64.7 | 4.4 | - | 676.5 | 23 |
| Engineering | 96.7 | 0.7 | 2.6 | - | 177.3 | 17 |
| Electronics | 22.2 | 20.2 | 55.0 | 2.6 | 2184.5 | 31 |
| Overall | 33.2 | 25.8 | 38.3 | 2.7 | 3548.7 | 84 |

as a source of electronics inputs. The USA is by far the main source of inputs for the medical devices sector with very little involvement in engineering and pharmaceuticals (despite the prominence of American firms in the latter industry in Ireland). Asia (including the Far East) is, predictably, strongly over-represented in electronics with very little presence in engineering and medical devices. There is clear evidence here of a high level of both global reach and regional specialisation in the supply of materials to Irish industry.

There is a good degree of correspondence between the regional distribution shown in Table 7 and that of imports in general for the respective sectors as tabulated for 2003 by the Central Statistics Office, although the national import figures include final products as well as intermediate goods. Thus, 58.0% of imports of medical and pharmaceutical products (SITC51) were derived from the EU in that year, compared with 61.6% (for Europe) for the survey respondents in this sector. However, the USA was much more prominent, and Asia much less prominent, as a source of overall sectoral imports compared with the survey firms. Imports of Professional, Scientific and Controlling Apparatus (SITC87), which includes medical devices, were divided 51.3% and 34.8%, respectively, between the USA and EU compared with 64.7% and 30.9% (Europe) for survey firms in this category. Of Metal Manufacturing imports (SITC69), 77.7% were sourced in the EU compared with 96.7% of engineering survey firms. Finally, 57.0% of imports of Office and Data Processing Machinery (SITC75) emanated from Asia compared with 55.0% for survey firms in electronics. Otherwise, the EU is over-represented, and the USA under-represented, among the survey firms compared with overall imports for the sector.

Apart from regional specialisation at the global level, there is also a high degree of international specialisation within regions at a sectoral level (Table 8). In pharmaceuticals, Denmark is by far the most important European materials source (as it is for national imports in the corresponding category), followed by Germany and Italy, with the UK and Switzerland also having a significant presence. Almost all of Asian pharmaceuticals inputs came from Japan (as is also the case for national imports in this sector), with India and Singapore accounting for very small amounts. For medical devices material inputs, the UK is easily the leading European source (corresponding to the national trend for imports in this sector), with Germany, the Netherlands and Switzerland also significant players. There was a considerable amount of vagueness relating to European supplies of engineering inputs, with over one-third of supplies being attributed to the broad 'Europe' category. As regards named countries, the UK was by far the most important (as with national imports of

Table 8. National sources of inputs within regions by sector (%).

| (a) Pharmaceuticals: Europe | |
|---|---|
| Denmark | 52.1 |
| Germany | 16.8 |
| Italy | 12.8 |
| UK | 6.8 |
| Switzerland | 4.9 |
| Other* | 6.5 |

* France, Finland, Norway, Belgium

| (b) Medical devices: Europe | |
|---|---|
| UK | 43.7 |
| Germany | 10.3 |
| Netherlands | 8.0 |
| Switzerland | 5.7 |
| Other* | 16.5 |
| Europe | 15.8 |

*Italy, Denmark, Poland, France, Luxembourg, Norway, Sweden, Belgium

| (c) Engineering: Europe | |
|---|---|
| UK | 45.8 |
| Germany | 9.2 |
| France | 5.2 |
| Italy | 4.5 |
| Other* | 0.8 |
| Europe | 34.5 |

* Spain, Netherlands, Denmark

| (d) Electronics | |
|---|---|
| **Asia** | |
| China | 34.3 |
| Singapore | 22.9 |
| Thailand | 14.2 |
| Hong Kong | 6.8 |
| Japan | 4.7 |
| Malaysia | 4.2 |
| Other* | 0.4 |
| Asia/Far East | 12.5 |
| * Philippines, Taiwan | |
| **Europe** | |
| UK | 48.8 |
| Germany | 30.9 |
| Italy | 4.5 |
| Other* | 4.9 |
| Europe | 10.9 |

* Sweden, Portugal, France, Netherlands, Czech Republic, Spain, Slovenia

machinery manufactures), with Germany, France and Italy also figuring prominently. China and Singapore were the most important Asian sources of electronics inputs (as they were for national imports in the corresponding sector), with Thailand, Hong Kong, Japan and Malaysia also of significance. European-sourced electronic inputs were primarily supplied by the UK and Germany, with Italy also having a minor presence (for national imports in the sector, the UK was also the clear leader, with France pushing Germany into third place).

Table 9 combines all four survey sectors in order to get an overall idea of the role of different European countries as suppliers of inputs to Irish manufacturing industry. The UK is the clear leader, followed by Germany and (perhaps surprisingly) Denmark. Italy also has a prominent presence with France, Switzerland and the Netherlands the only other countries with at least a 1% share. Ten other countries share the remaining 3.7% after allowing for the catch-all 'Europe' category.

Electronics was the only sector which offered a sufficient number and spread of firm sizes and a sufficient spread of input sources between the three major world regions to make it worthwhile attempting to identify whether firm size impacted on input sourcing patterns – and indeed this turned out to be the case (Table 10). Thus, smaller firms (one half of which were Irish-owned) were more inclined to source inputs in Ireland and Europe and correspondingly less inclined to source in Asia. The opposite was the case for the largest firm category with the intermediate size category in between. This clearly shows the importance of scale in facilitating global search and worldwide sourcing in this industry.

Overall, 34.5% of the surveyed foreign firms used affiliate firms as a source for some material inputs; however, only 10.1% of inputs for which this information was available were sourced from affiliates. This contrasts with McAleese's (1977) earlier finding that 29% of imported materials used by foreign companies in Ireland were sourced from affiliates and this lends support to the widely held view that large corporations are reducing their level of vertical integration and resorting instead to the outsourcing of non-core functions to independent suppliers (Rubery *et al.* 1987). Indeed, in response to a specific question on this topic, almost one half (48.6%) of respondent firms reported that they had outsourced, at least to some extent, over the previous five years (Brennan 2006). Again, significant sectoral variations were apparent in the use of affiliates, with the medical devices sector making the greatest use of affiliates and engineering firms making the least use of them (Table 11). The medical devices figure is inflated by a high level of sourcing from affiliates by one large firm in this sector; eliminating this firm reduces the proportion for the sector to

Table 9. European sources of material inputs: all sectors (%).

| | |
|---|---|
| UK | 36.2 |
| Germany | 20.5 |
| Denmark | 14.6 |
| Italy | 6.7 |
| France | 2.3 |
| Switzerland | 2.3 |
| Netherlands | 1.6 |
| Other | 3.7 |
| Europe | 12.3 |

Table 10. Input source region by firm size (electronics sector).

| | | % of total inputs | % of inputs sourced overseas | | | |
|---|---|---|---|---|---|---|
| Firm employment size | n | sourced in Ireland | Europe | USA | Asia | Other/unstated |
| <200 | 13 | 16.7 | 45.1 | 18.0 | 21.0 | 15.9 |
| 200 <500 | 11 | 10.5 | 39.5 | 19.4 | 31.5 | 9.6 |
| 500+ | 7 | 9.6 | 20.5 | 21.6 | 56.6 | 1.3 |

just 6.1% and the overall figure for all sectors to 6.6%. While over one-third of electronics firms made use of affiliates, the proportion of inputs supplied by these affiliates was quite low (5.7%).

## Conclusions

The key findings to emerge from this analysis are the very low levels of linkage with the Irish economy portrayed by the survey firms (with the partial exception of the engineering sector), the very distinctive regional patterns of overseas supply to these firms and the sharp interrsectoral differences apparent in these patterns. Thus, engineering and pharmaceuticals both rely heavily on Europe as a supply source; the USA fulfils the same role with respect to medical devices, while electronics are mainly focused on suppliers located in Asia. Within regions, particular countries also stand out as supply sources: Denmark is the leading source of pharmaceuticals inputs in Europe, with the UK playing this role with respect to the other three sectors, while China and Singapore predominate in the supply of electronics inputs from Asia. Another significant finding is that affiliates play only a minor role as suppliers to the survey firms.

The findings present implications for the embeddedness and future sustainability and development of the Irish manufacturing sector. Of the four sectors surveyed, only one – electronics – has developed a strong dependence on low-cost suppliers in Asia (and, to a small extent, Mexico). The emergence of this region as a reliable source of cheap supplies has encouraged very stiff competition, particularly at the high-volume consumer end of electronics markets. The resultant driving down of profit levels has meant that Ireland's low-tax regime is no longer as attractive to this industry as it once was. This, in turn, has been reflected in a recent wave of disinvestment from the industry in Ireland (see Table 12), including the computer

Table 11. Sourcing from affiliate suppliers by foreign-owned firms.

| Sector | No. of foreign firms in survey | No. of foreign firms which used an affiliate as a source for material inputs | % of total Imports sourced from affiliates by foreign firms |
|---|---|---|---|
| Pharmaceuticals | 11 | 2 | 11.3 |
| Medical devices | 18 | 8 | 22.4 |
| Engineering | 4 | 1 | 4.2 |
| Electronics | 25 | 9 | 5.7 |
| Overall | 58 | 20 (34.5%) | 10.1 |

Table 12. Sectoral trends in employment and gross output 2001–2006.

| Sector | Empl 2001 | Empl 2006 | Change 2001–06 (%) | Gross Output 2001 €M | Gross Output 2006 €M | Change 2001–06 (%) |
|---|---|---|---|---|---|---|
| Pharmaceuticals | 9863 | 12303 | +24.7 | 4594 | 7101 | +54.6 |
| Medical Devices | 19792 | 25568 | +29.2 | 4659 | 5742 | +23.2 |
| Engineering | 15355 | 15674 | +2.1 | 1906 | 2330 | +22.2 |
| Electronics | 45196 | 29190 | −35.4 | 26965 | 25419 | −5.7 |

Source: Census of Industrial Production

maker Dell's announcement in 2009 that it will cease manufacturing at its Limerick plant.

On the other hand, the fact that most suppliers to the other three survey sectors are located in high-cost countries suggests that costs are much less important as a locational consideration in these sectors. This is partly related to the very highly specified and high-tech nature of many inputs in these industries; at the same time clearly another reason why cost considerations appear to be less important in these industries – and why Ireland continues to be an attractive location for them, despite rising costs – is the very high level of profitability in the Pharmateuticals and Medical Devices industries (Angell 2004). In the engineering industry, the localised nature of the supply system is undoubtedly a function of the small size of firms in a mature medium-tech industry in which proprietary technology is uncommon.

These different characteristics are reflected in the performance of the four sectors in the first half of the 2000s (Table 12). Thus, there has been a calamitous decline in electronics employment (but not so much in output) whereas both pharmaceuticals and medical devices experienced strong growth in employment and output (particularly pharmaceuticals). In between, the engineering sector experienced marginal employment growth but strong output growth, indicating a substantial gain in average productivity. One can see here a direct link between the geography of supply linkages to Irish manufacturing firms and the recent economic performance of these firms. The trends apparent in Table 12 parallel recent trends in US FDI in manufacturing overseas, which shows that US investment in Europe (including Ireland) grew very strongly in the early 2000s in the chemicals/pharmaceuticals and 'other manufacturing' (which includes Medical Devices) sectors, whereas the computers/electronics sector has been performing very poorly since 2000 (Koudal 2005).

Much of the decline in electronics employment in Ireland has involved the relocation of production to Asia. The finding, reported earlier, that large electronics firms make the most use of Asian suppliers therefore has a certain irony in that, while large employers at first glance should be of particular attraction to the Irish government, it is these firms which are most globalised, most aware of variations in costs and operating conditions between world regions, and therefore the most likely to engage in relocation. It may be preferable, therefore, for the Irish government to target small or medium-sized electronics firms in terms of maximising the stability of employment created.

The evidence, presented here, that costs are not a leading location factor for the pharmaceuticals and medical devices sectors has important implications for Ireland

given that the US firms which dominate these sectors in Ireland are mainly reliant on European (in the case of pharmaceuticals) and American (in the case of medical devices) suppliers, as this gives Ireland an advantage in terms of proximity, and accessibility, to these suppliers. The trend towards increasing outsourcing reported by the survey firms is also potentially significant in that it can be argued that, where Irish plants source a large proportion of inputs from affiliates, this would make their Irish locations more vulnerable, as it suggests that, no matter where in the world the plants were located, they would still be getting their main inputs from affiliates, i.e. proximity would not be a factor in terms of customer/supplier linkages.

The trend towards outsourcing could also contribute to the stability of Irish branch plants in another way in that outsourcing may mean that branch plants are being given increasing autonomy in terms of sourcing inputs (which previously had to be sourced from affiliate plants). Phelps (1993) in particular has argued that this increases the likelihood that branch plants will develop linkages with local suppliers in the countries in which they are located.

A final point about the linkage structures of Irish branch plants which could work in Ireland's favour relates to the development of long-term relations with suppliers. Research by Morris and Imrie (1993) has shown that firms in the post-Fordist era are engaging in longer-term relationships with a smaller number of preferred suppliers. Thus, instead of having numerous competing suppliers for particular inputs, firms are increasingly focusing on building long-term, cooperative relationships with one or two suppliers for each key input with a growing emphasis on quality rather than price. Again, the current survey found evidence of such a trend, in that some 80% of the suppliers to the survey firms had been acting in that capacity for at least five years and that over half have been suppliers for over ten years. Long-term relationships were particularly marked in the pharmaceuticals sector. This is important in that frequent changes of suppliers would indicate an unstable supply system which would be conducive to locational volatility. A stable supplier system, by contrast, increases the likelihood that the focal firms themselves will be locationally stable.

To conclude, the findings presented in this paper demonstrate that exploring the spatial configuration of linkages can provide useful information on the embeddedness of firms in its local economy. In the Irish case the research has shown that, whilst the pharmaceuticals and medical devices sectors in particular have developed a very low level of local linkage, exploring other aspects of the linkage structures of these firms, and particularly their spatial configuration, has unearthed additional dimensions which could act to enhance the stability and embeddedness of firms in these sectors in the Irish economy.

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## Notes

1. Irish-based firms are firms that are located in Ireland and can be Irish- or foreign-owned.
2. The foreign and indigenous Food, Drink and Tobacco sectors and the indigenous-owned Non-Metallic Mineral Products sector, which source most of their inputs from within the Irish economy, were excluded on this basis.

3. It was originally intended to include the entire chemicals & pharmaceuticals sector (NACE Code 24) but due to a very low response from chemicals firms, the analysis was confined to pharmaceuticals.
4. Most of the electronics firms surveyed were from NACE codes 30 (Office Machinery & Computers) and 32 (Electronic Valves, Tubes and Components), but some were drawn from code 31 (Electrical Machinery & Apparatus). Accordingly, data for codes 30–32 combined are furnished below.
5. Medical devices refer to NACE code 3310 (Medical & Surgical Equipment and Orthopaedic Appliances). However, as this accounts for the great bulk of output and employment in code 33, and as some Census of Industrial Production is not given for code 3310, data are given for the entire sector below.
6. In order to make optimal use of the available information, some assumptions were applied in cases of unclear information: for example, where dual sources were reported for a particular input, the supply of that input was divided equally between these sources, and where two suppliers were reported for an input, but the proportion supplied by each was not given, the average proportion of that input supplied by first and second suppliers reported by the other firms in the sector was applied. Further information on these assumptions is available from the authors.

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