

Closing the Knowledge Gap in Irish Manufacturing – A North-South Comparison

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Abstract

For regions or nations which historically have had low levels of domestic R&D investment, such as Ireland, North and South, inward investment represents a potentially of inward knowledge transfer. Using data from large multi-national plants throughout Ireland this paper examines the geography of knowledge within Irish manufacturing focussing particularly on knowledge gaps and knowledge transfer activity.

The analysis suggests four main empirical results. First, no significant knowledge gaps exist between the Irish plants of multinational companies and international best practice. Secondly, larger knowledge gaps exist between MNE plants and their best local suppliers suggesting the potential for local learning in the supply chain. Average knowledge gaps to suppliers also tend to be larger in the North. Third, there is no clear evidence that knowledge transfer activity is more intensive where knowledge gaps are widest. In particular, developmental interaction between MNE plants and suppliers tends to be more common in the South. Fourth, MNE plants indicated they had a larger impact on their suppliers in the South. Our results suggest the potential benefit of policy measures both to increase knowledge transfer activity along the supply chain but also between companies which are not trading partners.

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Closing the Knowledge Gap in Irish Manufacturing – A North-South Comparison

“Knowledge spillovers tend to be spatially restricted.... The increased importance of innovative activity in the leading developed countries has triggered a re-surgence in the importance of local regions as a key source of comparative advantage.... a new policy approach is emerging, focusing on enabling the creation and commercialisation of knowledge...encouraging R&D, venture capital and new-firm start ups.” Audretsch, (1998, p 26)

1 Introduction

For regions or nations which historically have had low levels of domestic R&D investment, such as Ireland, North and South, inward investment represents a potentially of inward knowledge transfer (e.g. Young and Lan, 1997). The economic value to the host country of such knowledge is not intrinsic, however, but depends instead on its diffusion and application to generate innovation or 'the transformation of knowledge into novel wealth creating technologies, products and services' (Porter and Stern, 1999, p. 13). How are these knowledge transfers mediated, however? There is now some US evidence, for example, in the knowledge production function literature which has often been interpreted as evidence of 'pure' knowledge spillovers from academic R&D (e.g. Jaffe, 1989; Acs et al, 1992, 1994; Audretsch and Feldman, 1996; Anselin et al, 2000)¹. In each case the evidence is positive suggesting the existence of positive localised pure knowledge spillovers. Evidence from European studies is more tentative, although comparison with the more extensive US evidence is complicated by differences in approach and geographical scale². Increasingly,

¹The distinction between 'rent' and 'pure' knowledge spillovers is due to Griliches (1979, 1992). 'Rent spillovers arise when quality improvements by a supplier are not fully translated into higher prices for the buyer(s). Productivity gains are then recorded in a different firm or industry than the one that generated the productivity gains in the first place. Rent spillovers occur in input-output relations. Pure knowledge spillovers refer to the impact of the discovered ideas or compounds on the productivity of the research endeavours of others. Pure knowledge spillovers are benefits of innovative activities of one firm that accrue to another without following market transactions'. (Beugelsdijk and Cornet, 2001, p. 3).

² For example, Beugelsdijk and Cornet (2001) apply the knowledge production function concept to an analysis of Dutch manufacturing firms, relating the innovative output (i.e. share of new products as a proportion of turnover) of each firm to its own

however, attention is focussing on the importance of ‘rent’ rather than ‘pure’ knowledge spillovers, i.e. on knowledge transfers mediated through market transactions (e.g. supply-chains), networks or direct contractual relationships between firms or firms and other knowledge generating organisations (e.g. universities, research laboratories).

Developing such boundary-spanning knowledge transfers and co-ordination routines allow those within the alliance to internalise sources of internally-generated uncertainty and to respond more effectively to externally-generated uncertainty (e.g. Mowery et al., 1996). Boundary-spanning knowledge transfers may, for example, be important in reducing primary uncertainty (i.e. volatility due to exogenous shocks), particularly where the behaviour of one partner was previously a major source of uncertainty for the other partner. Other advantages may arise from the development by partner organisations of routines designed to reduce secondary uncertainty, i.e. the risk that managers within the partner organisations will not co-ordinate knowledge in the optimum fashion (Koopmans, 1957; Buckley and Carter, 1999).

One area where such boundary-spanning knowledge transfers have achieved increasing prominence in recent years has been in the supply chain. Phelps (1996) comments, for example:

‘There is now a growing literature suggestive of the renaissance of inter-firm linkages as mechanisms of technology transfer ... collaboration as part of normal trading relationships between firms may prove the most important means of technology transfer.’ (Phelps, 1996, p. 395).

innovation expenditure, the innovation expenditure of firms within 1,2, and 3-digit postcode of the firm, and the location within a 2-digit postcode of a technical university. They find no evidence that innovation expenditures by nearby firms have a greater effect on a firm’s innovative performance than expenditure by firms located further away. They do, however, find some evidence of positive spillovers from local technological universities. The difference between this result and the American studies may in part be due to differences in variable definitions, but the authors suggest it is more likely to be due to differences in geographical scale. “This study thus suggests that the Netherlands is too small a country to have proximity play the leading role in facilitating knowledge spillovers. This conclusion might a fortiori hold for other regions of similar size.” (Beugelsdijck and Cornet, 2001, p. 17).

Empirical analyses of dynamic clusters (e.g. Turok, 1993), leader firms (e.g. Albio et al., 1999), supplier partnering (Beecham and Cordey-Hayes, 1998) and Japanese and Korean industrial conglomerates (e.g. Best, 1991; Lincoln et al., 1998) have emphasised the contribution of various organisational forms to boundary-spanning knowledge co-ordination within the supply chain and its contribution to sustaining competitive advantage. Underlying each organisational form is recognition of firms' mutual inter-dependence, and that increasingly:

'Companies compete as members of networked groups of companies and the diffusion of new practices and principles across networked groups is critical to making the transition to more advanced technology management capabilities' (Best, 2000, p. 70).

Knowledge transfer and co-ordination through established supply-chain relationships may therefore have a dual benefit. First, like any knowledge transfer they may contribute to the competitiveness of individual recipient companies to an extent dependent on their absorptive capacity (Young and Lan, 1997). Second, they may also contribute to the competitiveness of the supply chain itself both through enriching partners' knowledge base but also by enhancing the effective application and co-ordination of knowledge between partners.

But, what is the source of this knowledge? For some economies (e.g. Finland, Israel) with high levels of domestic R&D spending much of the 'new' knowledge driving local business competitiveness is created domestically. For Ireland, both North and South, however, historically low levels of domestic R&D spending mean that inward technology transfer - primarily associated with inward investment - has been crucial to recent economic development (e.g. Roper and Frenkel, 2000). This suggests two main questions. First, how does the knowledge transferred to Ireland, through international inward investment compare to international best practice? And, second,

to what extent does this knowledge then diffuse to other Irish manufacturing businesses³?

These questions are, of course, not new. In Section 2 we therefore review briefly the evidence from some previous studies of knowledge transfers from inward investors to their host region. We focus in particular on the mechanisms through which such knowledge transfers can take place ranging from formal joint-venture agreements to informal and unstructured learning resulting from social contacts. Section 3 describes our data on MNE plants in Ireland and identifies some of the key differences in the population of MNE plants, North and South. Section 4 outlines our empirical approach focussing on the identification of knowledge gaps between international best practice, Irish MNE plants and their suppliers and on MNE plants' involvement in knowledge transfer activity. Subsequent sections report our empirical results focussing on whether Irish MNE plants are world-class, the potential for local learning, the extent of knowledge transfer activity and the impact of MNE plants on their local suppliers. Section 9 summarises the key points and discusses some of the strategic and policy implications.

2 Knowledge Transfers from Inward Investors - Literature Review and Hypotheses

A number of studies have considered the impact of inward investment on their host economy in conceptual terms and through empirical analyses of specific regions or sub-regions⁴. A persistent theme in these studies has been the potential for MNE plants to influence their host region through knowledge transfers. Young, Hood and Hamill (1988), for example, observe that the establishment of an MNE plant on a greenfield site necessarily involves the physical relocation of technologies embodied

³ A third, and related, question concerns the contrasting experiences of Ireland, North and South, particularly given the very different history of inward investment in the two areas (e.g. Roper and Love, 2001).

⁴ The effects of foreign multinationals on specific UK regions and localities are considered by the following: Smith and Stone (1989) on the Northern region; Hill and Munday (1991) on Wales; Collis and Roberts (1992) on the West Midlands; and Gripaios and Gripaios (1993) on Plymouth.

in capital goods (e.g. machinery) and a number of forms of disembodied technology, including industrial property rights, un-patented know-how, and managerial and organisational expertise. They also suggest, however, that, once established, there are three other ways in which an MNE plant may contribute to local technological development: by undertaking local research and development, through supply-chain linkages or supplier development activities, and through a “demonstration effect” on local firms. As Morgan (1995) has observed, each of these impacts is likely to be positive: 'to the extent that technology transfer occurs within the region, FDI certainly has the potential to stimulate growth through its impact on the competitiveness of domestic firms.' (Morgan, 1995, p. 1-2).

The realisation of these potential knowledge transfers, however, will depend directly on ‘the extent to which the technology (possessed by the MNE plant) is made available to potential users outside the firm either directly, through linkages with indigenous firms, or indirectly via the “demonstration effect”’ (Dicken, 1992, p. 392). In other words, the mere presence of MNE plants within an economy does not guarantee technology/knowledge spill-overs to the wider economy. Rather, ‘beneficial spin-off effects will occur only if the foreign affiliates of TNCs do become linked to local firms. Where TNCs do not create such linkages they remain essentially as foreign enclaves within a host economy contributing little other than some direct employment’ (Dicken, 1992, p. 395-6). Even where MNE plants do become linked to local firms, it is by no means certain that significant knowledge transfers will take place. Dunning (1993) suggests that deliberate knowledge transfers will only occur where MNE plants perceive there to be a direct benefit (e.g. improved input quality, reduced cost, or improved service): i.e. ‘Where the improvement of local supply capability is critical to the competitiveness of the purchasing company ... then it may pay the company to invest resources in upgrading the efficiency of its suppliers’ (Dunning, 1993, p. 456).

From the local supplier’s point of view, knowledge transfers may contribute to the development of their relationship with their MNE customer. They may also contribute, however, to more general improvements in competitiveness, i.e. ‘the experience gained in new technologies by local firms may enable them to compete

more effectively in broader markets, provided, of course, that they are not tied exclusively to a specific customer.’ (Dicken, 1992, p. 395)

Underpinning these arguments about the potential benefits of inward investment to supplier companies however, is the assumption that within the multi-national knowledge management or co-ordination is effective and that the MNE plant being established will represent international best practice. This suggests hypothesis 1.

Hypothesis 1: Because of effective intra-group knowledge management, the utilisation of management and control techniques by Irish MNE plants will be similar to group best practice, i.e. any knowledge gaps between Irish MNE plants and group best practice are likely to be small

The difficulties and barriers to knowledge transfers in the supply chain emphasised by Dicken and Dunning, however, also suggest

Hypothesis 2: Limited flows of knowledge across company boundaries are likely to mean that significant knowledge gaps will exist between MNE plants and their suppliers. This suggests the potential for local learning in the supply chain.

Unfortunately, the current empirical evidence on the significance and nature of any such effects in Ireland is indirect and relatively limited. At a general level, Kearns and Ruane (2001) do demonstrate that R&D-active multinational plants in the South have greater longevity and that these plants create a higher quantity and quality of employment, relative to non-R&D active plants. Similarly, Görg and Strobl (2000) conclude that, controlling for firm and sector-specific effects, spill-over effects from the externally-owned sector have the effect of extending the longevity of indigenously-owned firms operating in high-tech sectors. Both results on plant longevity are important in themselves, however, their significance is increased by the evidence of Görg and Ruane (2000) who demonstrate that in the Southern electronics sector, at least, backward linkages - and therefore the potential for knowledge transfers - become stronger as plant vintage increases.

Relatively little evidence is also available on 'how' knowledge transfers take place in Ireland although this has been the focus of studies elsewhere. Tan (1989), for example, focused on the relationships between OEMs and their local suppliers in Singapore, and examined whether these relationships were conducive to improvements in supplier performance. Using a postal survey, he asked 74 OEMs about the quality of their relationships with suppliers, the development of their supplier relationships, the provision of assistance to suppliers and their evaluation of supplier performance. Tan found that as part of their efforts to develop their suppliers: 93 per cent of OEMs regularly reviewed supplier performance, 86 per cent had provided technical support, 70 per cent had provided raw materials, 62 per cent of the OEMs had visited suppliers but only 20 per cent of OEMs provided any sort of financial assistance. In the majority (76 per cent) of cases these contacts were leading to longer-term supplier relationships and larger orders.

A second Singaporean study, by Wong (1992), focused on the contribution of local sourcing by Singapore-based MNE plants to the technological development of local suppliers. In general terms, Wong (1992) concluded that:

- MNE plants that are committed to long-term subcontracting relationships with their suppliers are more likely to induce technological developments among those suppliers.
- Technological developments are more likely to be induced in suppliers where there is a degree of overlap between the areas of technical competence of the MNE plants and their suppliers.
- Technological developments are also more likely to be induced in sub-contractors supplying specialised rather than standardised inputs.

To examine how such technological developments came about, Wong identified a list of twenty-one "technology development inducement processes". Wong concluded that the dominant type of knowledge transferred through these mechanisms was process-

related, relating especially to quality assurance. Wong also found evidence of ‘significant learning of generalised management know-how in the form of good manufacturing practice’, including operations management, systems and procedures, good housekeeping practices, organisational and management control methods and corporate cultures. Interestingly, however, Wong found very little evidence of the acquisition by suppliers of product design know-how.

A third study, by PACEC (1995), set out to assess the wider effects of manufacturing FDI ‘..on other UK firms, especially the impact on their management and operational practices and their business performance’ (p. 1). The study was based on an analysis of the impact of 30 large foreign-owned manufacturing plants located throughout the UK, of which 60 per cent had explicit strategies for developing their UK supply base. Moreover, because of the competitive strength of the inward investors, PACEC detected substantial potential for knowledge transfers to suppliers. PACEC also concluded that the attitude of inward investors was generally conducive to such transfers occurring: ‘Most firms took a positive stance on the transmission of their practices to suppliers. This helped them to ensure that their specifications were met at the right cost and within the desired timescale. They actively encouraged suppliers to introduce, and improve, quality management and delivery systems in combination with improvements to their production processes and cost control methods’ (p. v). A key question, however is whether the extent of such knowledge transfer activity is related to knowledge gaps. More specifically we might suggest that:

Hypothesis 3: Knowledge transfer activity is likely to be more intensive where knowledge gaps between MNE plants and their suppliers are widest.

The key mechanisms used by inward investors for the transmission of such operating practices were contractual arrangements on product specifications (67 per cent of investors) and on quality assurance methods (47 per cent), and visits to suppliers to discuss technical aspects of production or to carry out quality audits (60 per cent). Informal liaison was also important (50 per cent of investors). The majority of inward investors provided technical assistance to their suppliers to help them improve their

production and quality assurance methods (60 per cent), knowledge of market trends (40 per cent), and approach to management and organisational issues (27 per cent).

UK inward investors felt their major impacts on suppliers were related to production processes, especially quality assurance (which 83 per cent said their suppliers had improved), delivery methods (70 per cent), and product development (60 per cent). Forty per cent of inward investors also said that their suppliers had re-organised their production processes as a result of their advice or assistance.

3. Data Sources

To address our hypotheses, data was collected through face-to-face interviews with senior managers of large (i.e. those with 200 or more employees), externally-owned, MNE plants throughout Ireland⁵. A plant was said to belong to an externally-owned MNE if its parent company owned manufacturing plants in more than one country. In the South, this population includes plants owned by Dell Computers (Ireland), Ballet International 2000 Ltd, Data Packaging Ireland Ltd and H J Heinz Co (Ireland) Ltd. In addition, plants previously owned by Irish companies but now externally-owned, such as Irish Distillers, are also included in the population. In the North, the population of MNE plants includes externally-owned companies such as Bombardier-Shorts, Visteon, AVX and Seagate and the Northern Ireland plants of UK-owned multinationals⁶.

Using data provided by the development agencies, North and South, and commercial company databases (e.g. Kompass, Dun and Bradstreet) we initially compiled a listing of the target population of large manufacturing sites in Ireland. For the North this exercise was undertaken in early 1998 and identified 95 such sites. In the South, 195 such sites were identified in early 2000. Of these large manufacturing sites 132 (68

⁵ Our rationale for focusing on externally-owned MNE plans is that it is these multinationals which are generally perceived to be “leaders” in technology and hence in a position to introduce new technologies into Ireland. We focus on large MNE plants because we believe these larger plants are likely to have the greatest influence on the Irish economy.

⁶ We excluded, however, Southern-owned firms whose operations are limited to the island of Ireland.

per cent) were controlled by externally- owned multinationals in the South and 61 (60 per cent) in the North. North American multinationals predominate, controlling 55 per cent of externally-owned MNE plants in the Republic of Ireland and 37 per cent of such plants in Northern Ireland (Table 1). The composition of the target group by industrial sector is also of interest and largely reflects inward investment patterns (e.g. Crone, 1998; Görg and Ruane, 2000). For example, 54 per cent of large MNE plants in the South are in the chemicals and electronics & electrical engineering sectors. In the North, by contrast, the four largest sectors – accounting for 80 per cent of large MNE plants – are textiles & clothing (25 per cent), electronics & electrical engineering (21 per cent); food, drink & tobacco (15 per cent) and metals & mechanical engineering (19 per cent). Overall, therefore Northern Ireland's MNE sector is dominated by more mature industries, although recent inward investments in electronics, data processing equipment and vehicle components have reduced this dependency (e.g. Crone, 2000).

All plants in the target population of large MNE plants were contacted by letter and then telephone and invited to participate in the study. Face-to-face interviews were then conducted with senior managers in each MNE plant, and where possible interviews were recorded and later transcribed. Interviews were based on a semi-structured questionnaire. In the North, interviews were conducted in Spring and Summer 1998 and involved senior managers in 33 of the 52 target plans (63 per cent). In the South, interviews were conducted between October and December 2000 and involved 61 plants, 46 per cent of the target group. The relatively high response rates achieved, and the lack of any statistically significant difference between the ownership and industrial composition of the final sample and the target group, suggests that the final sample is likely to provide representative results for each area (Table 1).

In addition to differences in sectoral structure, marked differences are also evident between the Northern and Southern populations of MNE plants in terms of their level of local sourcing and their strategic and functional orientation (Table 2). In terms of the average *percentage* of material inputs, by value, obtained from suppliers in the

local economy (the “percentage local”) purchases of material inputs⁷, for example, in the South (21 per cent) was significantly higher than that in the North (11 per cent)⁸. It is important to emphasise, however, that this average data hides very considerable variation within the sample in terms of percentage local. Another important difference between the purchasing patterns of MNE plants in the two areas is the proportion of total material inputs that is sourced from the UK. MNE plants in the North sourced 49 per cent of their material inputs from within the UK compared to only 18 per cent of those in the South (Table 3). Southern MNE plants were instead sourcing a higher proportion of their material inputs from North America (19 per cent) than MNE plants in the North (4 per cent). This is likely to reflect the much stronger US presence, particularly in the high-tech sectors, in the South⁹.

Other differences between the population of MNE plants, North and South, reflects strategic and functional ‘quality’ of the MNE plants themselves¹⁰. For example, significant differences exist in terms of the marketing responsibility of Southern and Northern MNE plants: more Southern plants (39.3 per cent) sell all of their output to other group plants than in the North (30 per cent); while more Northern MNE plants have full responsibility for sales and marketing activities (39 per cent) than in the South (18 per cent). In terms of R&D, our data also suggests that R&D departments

⁷ That is, we focus on MNE plants’ purchases of raw materials, part-processed goods, components, and sub-contracted products but exclude purchases of equipment, utilities, services, and labour.

⁸ Hewitt-Dundas et al (2002) use a Tobit model to decompose the difference in percentage local, North and South, into its ‘structural’ and ‘locational’ components. They find that structural factors (including plant age, sector, size and ownership) were reducing percentage local by 2.0 pp compared to the South with a more significant 6.5 pp locational effect. In other words only around a quarter of the difference in percentage local between North and South could be explained by the structural characteristics of plants in the two regions; the remaining differential is due to other locational factors.

⁹ In terms of cross-border sourcing, significant differences between Southern and Northern MNE plants are also evident: Northern MNE plants buy 11 per cent of their material inputs from the South, the same proportion they buy locally. Southern MNE plants, however, only source one per cent of their materials from the North.

¹⁰ Another possible influence on the level of knowledge transfers is plants’ degree of local decision making autonomy. Hewitt-Dundas et al. (2002) report an autonomy index based on plants’ decision making autonomy in twelve key managerial decisions. While values for individual plants varied widely, no significant difference was evident between the overall degree of decision making autonomy, North and South.

were more common among Southern MNE plants (53 per cent) than in the North (39 per cent), although this difference was not statistically significant (Table 2). Significant differences were evident in the *type* of R&D activity being undertaken, however (Table 2). A higher proportion of Southern plants (23.3 per cent) was involved in pure research on new product technologies than in the North (6.0 per cent). Further, while half of all Southern MNE plants were also involved in the design and/or development of new products, this was true of only 27 per cent of Northern plants. Despite these differences in the types of R&D being undertaken, the average contribution of products newly introduced in the 3 years prior to the interview as a proportion of total sales was only slightly and insignificantly lower among Northern MNE plants (Table 2).

4. Empirical Approach

Knowledge 'gaps' (after Young and Lan, 1997) or 'lags' (after Mansfield and Romero, 1980) between plants are then measured by examining differences in the level of utilisation of these systems. To be more concrete, we measure knowledge gaps in terms of the number of months that it would take for one plant, say the supplier, to match the current level of utilisation of each system by, say, the MNE plant. If knowledge gaps are substantial, and if MNE plants have more 'knowledge', then knowledge diffusion to other plants in the host economy may take place. The presence of knowledge gaps is therefore indicative of the potential for knowledge transfers through inter-firm linkages.

Our first hypothesis concerns how the knowledge implemented in MNE plants in Ireland compares to international best practice. Our empirical approach draws on literature on economic literature on technological diffusion and measures the stock of knowledge in each MNE plant in terms of its utilisation of different management and control systems (e.g. ROPER and HEWITT-DUNDAS, 1998). Knowledge 'gaps' (after Young and Lan, 1997) or 'lags' (after Mansfield and Romero, 1980) between international best practice and Irish MNE plants can then be quantified by measuring

differences in the level of utilisation of various management and control systems¹¹. We focus in particular on plants' utilisation of eight management and control systems including process technologies (i.e. CAD, CAM, shop-floor data collection, CIM and statistical process control), managerial and organisational techniques (JIT, TQM) and E-business (EDI). Managers in the MNE plants were then asked to consider how many months it would be before the level of utilisation of each particular technique at their MNE plant was on a par with group best practice. In essence, managers were being asked to estimate how many years 'ahead' or 'behind' group best practice they were in the utilisation of each management and control system. To address Hypothesis 2, a similar approach was also used to identify the 'knowledge gaps' between MNE plants and their best local suppliers¹².

Our third hypothesis focuses on knowledge transfers between MNE plants and local suppliers. It is, however, difficult to conceive of a method by which actual flows of knowledge could themselves be measured, particularly by a survey conducted at a single point in time. Also, it is doubtful whether MNE plant managers would be able to give a reliable account of the sorts of knowledge that had been transferred to suppliers in recent years, especially when not all knowledge transfers are explicit or even intentional. To overcome these problems, our approach follows previous studies and focuses instead on the 'activities' (or 'mechanisms') through which transfers of knowledge between MNE plants and their suppliers might take place (e.g. Wong 1992; PACEC 1995). For example, product related knowledge might be transferred through joint product development activities or joint ventures, while process specific knowledge may be transferred if an MNE plant assists its suppliers with the implementation of quality control systems. In this latter case, it is the clear intention

¹¹ One shortcoming of this approach is that it measures only certain types of knowledge and does not take account of product-embodied knowledge or 'tacit' knowledge. From a methodological point of view these other forms of knowledge are more difficult to measure.

¹² This rather complex exercise was aided by the use of a diagram, which showed a 'timeline' ranging from "five years behind" through to "five years ahead" for each management and control technique. Thus, for example, if the manager of an MNE plant thought that it would take its best local supplier two years to match its own current level of utilisation of Total Quality Management, this would amount to a two year 'lag' or 'knowledge gap'.

of the MNE plant to transfer knowledge so as to enable the supplier to improve its competencies and capabilities. In other situations, however, knowledge transfer may be incidental to efforts to improve the quality of product, delivery performance, and level of service provided by the suppliers (e.g. discussion of technical issues, notification of production forecasts).

This suggests a distinction between the repeated contacts between MNE plants and their suppliers which might be part of a normal trading relationship, and more irregular or infrequent collaborations which might be more developmental. We consider two indicators which might suggest the intensity of MNE-supplier contact (and therefore knowledge transfer) as part of normal trading relationships:

- (a) Feedback on supplier performance on a monthly (or more frequent) and quarterly (or more frequent) basis; and,
- (b) Contact to discuss technical issues relating the products being supplied on a weekly (or more frequent) and monthly (or more frequent) basis.

We also consider four indicators - or knowledge transfer activities which might be considered more developmental:

- (a) The provision of information to the supplier company by the MNE plant relating to other business opportunities within the wider group;
- (b) Assistance provided by the MNE plant to the supplier company to help with the implementation of quality control or assurance systems;
- (c) The auditing of suppliers' manufacturing operations by staff from the MNE plant; and,
- (d) Collaboration between the supplier and MNE plant on new product development.

We believe these indicators provide a good indication of the extent and intensity of MNE-supplier contacts and span the range from normal day-to-day interaction to more project based 'developmental' activity.

Finally to measure the impact of knowledge transfer activities on the business performance and competitiveness of local suppliers. This is a methodologically challenging exercise. Without a detailed analysis of individual supplier firms, which was beyond the resources of this study, it is difficult to make an objective assessment of these impacts. Acknowledging the limitations of the approach from the outset, we sought to address this issue by asking managers at our sample of MNE plants about their *perceptions* of their impact on local suppliers. Specifically we asked them to assess their impact, though the supplier relationship, on four areas of business performance and four aspects of competitiveness, using a five-point rating scale (ranging from “no impact” to “very significant impact”).

5. Are Irish MNE Plants World-class?

In this section we consider whether the technological profile of MNE plants in Ireland, North and South, is in line with international best practice. If this is the case the potential for 'learning' by local supplier companies is likely to be greater than if Irish MNE plants are using less advanced technologies. As a reference point against which each MNE plant is measured we use best practice within the group of plants to which the MNE belongs. Specifically, we identify knowledge gaps between the utilisation of each M&CS by Irish MNE plants and by the plant which is considered to represent group best practice. It is important to recognise, however, that the assessment of these knowledge gaps is based on the subjective judgements of Irish MNE plant managers rather than any more objective assessment. This may lead to an overstatement of the true state of advance in the Irish MNE plant but it is difficult a priori to know how significant any such bias is likely to be¹³.

¹³ It may also be the case that Irish MNE plants may not aspire to match best practice within their group. In relation to its use of CAD/CAM, for example, one electronics plant in our sample commented: 'There are different levels of utilisation in different areas, depending on what they are doing. I am sure it is being used more extensively

Table 3 summarises the average knowledge gaps in months between group best practice and Irish MNE plants for each of the management and control techniques. Positive numbers in the table indicate that - on average - Irish MNE plants lag behind group best practice. For example, in the South, MNE plants lag an average of 2.2 months behind group best practice in their use of CAM. Both North and South, average knowledge gaps of around 3-4 months are evident between group best practice and local MNE plants (Table 3). However, these knowledge gaps are only statistically significantly different from zero in the case of TQM in the South and SFDC and TQM in the North¹⁴. No significant North-South differences are evident between knowledge gaps from group best practice to local MNE plants.

The mean knowledge gaps reported in Table 3, however, hide significant variations between individual MNE plants. To illustrate this the distributions of knowledge gaps are given in Figure 1 where the gaps for each M&CS are combined for each area and type of inter-plant comparison. As in Table 3, positive values indicate situations where group best practice is ahead of the Irish MNE plant and negative values indicate situations where the Irish MNE plant is ahead of other plants in its group. The first obvious point suggested by the distributions is their strong modality around zero. In other words, many Irish MNE plants considered their utilisation of each M&CS to be in line with group best practice. This suggests both the effectiveness of intra-group knowledge transfers in the dissemination and adoption of best practice and also that MNE plants do provide a reservoir of world class knowledge in the use of the M&CS. Indeed, in a significant number of cases the Irish plants of the various MNEs indicated that they represented best practice within the group and were sometimes significantly ahead of other group plants. The distributions also suggest the strong similarity between the technological capabilities of MNE plants, North and South, a factor

in some areas. Yet, while we may be slightly behind that does not necessarily mean that we want to catch up!

¹⁴ T-tests comparing each knowledge gap to zero are as follows. For knowledge gaps between the MNE plant and group best practice in the South: CAM $t= 0.641$, $\rho= 0.526$; CIM $t= 1.079$, $\rho= 0.289$; SPC $t= 0.171$, $\rho= 0.865$; SFDC $t= 1.423$, $\rho= 0.164$; JIT $t= 0.656$, $\rho= 0.517$; TQM $t= 2.722$, $\rho= 0.010$; EDI $t= 1.466$, $\rho= 0.152$. And between the MNE plant and group best practice in the North: CAM $t= 0.905$, $\rho=$

which is also reflected in the lack of any significant difference in the measured knowledge gaps.

6. Assessing the Potential for Local Learning

One indicator of the potential for local learning by supplier businesses is whether Irish MNE plants are more advanced in their use of the M&CS than their local suppliers. To capture this we again measure the knowledge gaps between each Irish MNE plant and their best (or most technologically advanced) local supplier for each of the M&CS considered earlier. Again it is important to bear in mind that our data on knowledge gaps represent the subjective judgements of MNE plant managers rather than a more objective assessment. This may be leading to an overstatement of the true knowledge gap between the MNE plant and its supplier businesses. It is also important to recognise that to make the analysis feasible we focus on the *best* local supplier which an MNE has in terms of each M&CS. Our results are therefore likely to underestimate the real knowledge gaps between MNE plants and their 'average' local supplier.

Table 4 gives the average knowledge gaps in months between MNE plants and their best local suppliers. Positive numbers in the table indicate that - on average - suppliers lag behind Irish MNE plants. For example, in the South MNE plants on average lead their local suppliers by 1.4 months in the use of CAD. Average knowledge gaps between Southern MNE plants and their suppliers are around 4 months, with larger mean knowledge gaps - 10 months – evident between Northern MNE plants and their best local (i.e. Northern Ireland) suppliers. The mean knowledge gaps are statistically different from zero, however, only in the cases of SFDC, SPC and EDI in the South and SFDC and EDI in the North¹⁵. Also, despite the difference in the mean knowledge

0.376; CIM $t = -0.766$, $\rho = 0.454$; SPC $t = 0.568$, $\rho = 0.575$; SFDC $t = 2.073$, $\rho = 0.051$; JIT $t = 0.617$, $\rho = 0.545$; TQM $t = 2.666$, $\rho = 0.014$; EDI $t = 1.451$, $\rho = 0.165$.

¹⁵ T-tests comparing each knowledge gap to zero are as follows. For knowledge gaps between MNE plants and their best local supplier in the South: CAM $t = -0.401$, $\rho = 0.692$; CIM $t = -1.532$, $\rho = 0.142$; SPC $t = -3.077$, $\rho = 0.005$; SFDC $t = -2.096$, $\rho = 0.048$; JIT $t = 0.642$, $\rho = 0.527$; TQM $t = 0.066$, $\rho = 0.948$; EDI $t = -1.284$, $\rho = 0.210$. For knowledge gaps between MNE plants and their best local supplier in the North: NI CAM $t = 0.168$, $\rho = 0.869$; CIM $t = -1.555$, $\rho = 0.154$; SPC $t = -1.417$, $\rho = 0.184$; SFDC $t = -2.309$, $\rho = 0.050$; JIT $t = -1.336$, $\rho = 0.206$; TQM $t = -1.126$, $\rho = 0.279$; EDI $t = -3.012$, $\rho = 0.013$.

gaps, North-South differences are only statistically significant in the case of EDI (Table 4)¹⁶.

The larger average knowledge gaps evident in the North are also suggested by the combined distributions of knowledge gaps to local suppliers in Figure 3. Positive values indicate where the Irish MNE plant reported being ahead of its best local supplier in each M&CS. The most obvious difference between these distributions and those in Figure 2 is the much greater variation in MNE plant-supplier knowledge gaps than in the MNE plant-group best practice knowledge gap. This has two direct implications: First, it suggests that intra-group knowledge management or knowledge sharing is more effective than that between MNE plants and their supplier businesses; and, second, it suggests that improving knowledge flows along the supply chain may create the potential for local learning by both supplier companies and MNE plants, North and South. The potential for local learning by supplier businesses is clearly indicated by the weight in the right-hand tails of the knowledge gap distributions in Figure 3. The potential for learning by MNE plants, however, is also suggested by the significant number of cases in which the MNE plants indicated that their local suppliers were ahead in the utilisation of each M&CS.

7. Local Knowledge Transfer

The evidence of the previous sections suggests (a) that effective intra-group knowledge transfers mean that Irish MNE plants are broadly in line with international best practice; and (b) that more significant knowledge gaps exist between Irish MNE plants and their local suppliers. In this section we profile the current level of knowledge transfer activity between MNE plants and their local suppliers. That is, we examine knowledge transfer activity between MNE plants in the North to their Northern suppliers and that from MNE plants in the South to their Southern suppliers.

¹⁶ An additional note of caution is necessary here relating to differences in the timing of the survey fieldwork, North and South. In particular, adoption of EDI has accelerated sharply over the last 2-3 years and as the Northern fieldwork was conducted earlier than that in the South this might be contributing to this difference in knowledge gaps.

As indicated previously, however, it is difficult to monitor or observe knowledge transfers directly and we therefore focus on firms' participation in activities which may lead to knowledge transfer. Figure 3 summarises the percentage of MNE plants engaging in each knowledge transfer activity with their local suppliers. In terms of such activities which might be regarded as incidental to normal trading: 45-61 per cent of MNE plants actually provided feedback to their local suppliers on a quarterly basis, while 66-70 per cent were in contact each month at least to discuss technical issues. Of the more developmental knowledge transfer activities, auditing suppliers manufacturing processes was most common, having been undertaken by 78-91 per cent of MNE plants, while 72-78 per cent of MNE plants were involved in collaborative product development with their suppliers. Assistance with quality assurance systems was least common being undertaken by 58 per cent of MNE plants in the South and only 37 per cent in the North (Figure 3).

What was clear from our interviews, however, was that the incidental and more 'developmental' contacts with suppliers are not independent. For example, one company commented that:

‘When a company becomes a supplier you have to look at it and audit what they do. These meetings will probably not continue unless there is a serious deterioration in service performance and then, obviously there would have to be a very serious meeting’.

‘They [audits] are done when they become a supplier and then they are done, well, they are supposed to be done every so often after that but in reality what happens is that somebody sees a problem and then an audit is done. On the whole I would say every year an audit is carried out’.

Also interesting is a marked difference between the profile of MNE-supplier interaction, North and South. In the North, contacts as part of normal trading relations are more common than in the South, while each of the more developmental contacts is more common in the South (Figure 3). (These differences are only statistically

significant, however, in terms of assistance with quality assurance systems and the frequency of contacts to discuss technical issues). On one level, these different profiles of MNE-supplier interaction may be seen as counteracting one another suggesting perhaps a similarity in the overall potential for knowledge transfers. An alternative interpretation, however, is suggested by a quote from one MNE plant:

‘We normally review suppliers on a yearly basis, however, if there were problems it is actually given as per batch where there’s a problem. So if there is a batch rejected they are advised immediately and a counter measure to the problem is requested’.

In other words, the greater frequency of contact regarding technical issues and feedback on performance in the North might be indicative of more problems within the MNE-supplier relationship (see also Crone and Roper, 1998). From another perspective, this profile of knowledge transfer activity is also particularly disappointing from a Northern perspective. As we have already noted there is a relatively low level of local sourcing in the North. This means that while Northern knowledge transfer activity is most common as part of normal trading relations, such relations are themselves relatively weak in the North. The overall impact will be to further reduce the scope for knowledge transfer activity between Northern MNE plants and their local suppliers.

It is also of some interest to examine whether different types of MNE plants are engaged in more or less interaction with their suppliers. US companies, for example, might be more strongly engaged in supplier development type activity than their European counterparts. Table 5 therefore summarises the percentage of MNE plants in each area engaging in the various knowledge transfer activities by nationality of ownership and manufacturing group. Compared to other MNE plants, North American owned MNE plants are (significantly) less likely to be in very frequent contact with their suppliers but are more likely to have regular monthly meetings and/or provide quarterly feedback on performance. They are also more likely to audit suppliers' manufacturing processes, assist with quality assurance and provide other information about business opportunities (Table 5). One North American electronics company commented for example:

'There are monthly meetings with suppliers to the warehouses - not just to do with contract components but meetings that would happen anyway and are used to discuss product and process development issues. It is on the operational side but also strategic in nature as well in terms of where their processes are evolving towards and where we would like them to be. These meeting would also include supplier performance'.

Notably, one area where North American owned MNE plants are less likely to collaborate with suppliers than other MNE plants is new product development (Table 5). This may reflect the dominance of North American MNE plants' intra-group technology transfers which may be acting as a substitute for local product development collaboration (see also Roper and Love, 2001). In general terms, however, the suggestion is that local knowledge transfers - particularly relating to manufacturing process and quality issues - may be stronger from North American MNE plants than MNE plants owned elsewhere.

In sectoral or industry terms, a difference again occurs between contacts which might form part of MNE plants' regular trading activities and the more developmental collaborations. MNE plants in the engineering sectors are most likely to be engaged in more developmental collaborations, while those in other sectors are likely to have more intensive contacts with their suppliers as part of their normal trading activities (Table 5). MNE plants outside engineering are, in particular, much less likely to audit their suppliers' manufacturing processes or provide assistance with quality assurance than engineering MNEs. Collaboration in new product development is only marginally more common among engineering MNEs, however. These differences are statistically significant in terms of the frequency of feedback on supplier performance, auditing suppliers' manufacturing processes and the provision of assistance with quality assurance systems.

The suggestion is that engineering MNEs more commonly adopt a developmental approach to their suppliers' processes and systems compared to MNE plants in other sectors. For these plants MNE-supplier relations are more commonly dominated by

normal trading contacts and product development. These different relationships suggest that the potential for process and system related local knowledge transfers is probably greater from engineering MNEs, while transfers of tacit knowledge (through learning by doing or more intense contact as part of normal trading activity) may be greater in other sectors.

8. Impact of Trading With MNE Plants

For suppliers, trading with an MNE plant, and benefiting from potential knowledge transfers may have substantial competitiveness advantages. Often the MNE plant will be a significant customer enabling the supplier to obtain economies of scale and reduce unit cost both for the MNE itself and for other customers. This may enhance its competitive position elsewhere, alongside any reputational benefits obtained from serving a high-profile customer. To assess the significance of these trading advantages, the sampled MNE plants were asked to assess the significance of their impact on various aspects of the business performance and competitiveness of their local suppliers. In each case, plants were asked to judge the significance of their impact using a Likert scale (ranging from 1 "no impact" to 5 "very significant impact"). The obvious shortcoming of this approach is that it relies on the perceptions of managers at the MNE plants, who may tend to over-emphasise the scale of their impact on suppliers. However, in the absence of an extensive survey of suppliers to MNE plants, it is not possible to arrive at a more objective assessment on the impact on local suppliers.

Figure 4 summarises the results of this question, reporting the proportion of MNE plants suggesting that they had had a 'significant' or 'very significant' effect on each aspect of supplier performance. For example, 30 per cent of Northern MNE plants indicated that they thought they had had a significant impact on the productivity of their local suppliers (Figure 4). Evidence on the perception of a beneficial impact and of positive spill-over effects resulting from trading with MNE plants is provided by the following two quotes:

“Ten years ago, they would not have known how to do it; now they have gained expertise and are a good supplier”.

“We have seen a significant culture change with our Irish suppliers over the last ten years. A willingness on their part to embrace international standards. Again, as a little anecdote, when we first came here we had great difficulty getting printers to print posters to the standards that we wanted, we had some great tussles with them and as a result the people that we worked with did improve their techniques, did improve their process controls, did improve their investments in equipment. Now, ten, twenty years on, they would eat our work from a policy point of view, it is easy stuff by comparison and they have really moved forward but I think we were instrumental in some way in motivating them to do that. And we’ve benefited from the results of course’.

Perhaps the most striking element of these figures, however, is the very clear, North-South pattern. In terms of each variable, Southern MNEs were more likely to think that they had had a significant effect on their suppliers than Northern MNE plants (Figure 4). Moreover, in each case with the exceptions of lead times and cost reduction the difference between areas was statistically significant (Figure 4). Bearing in mind that this result represents the view of MNE plant managers, this suggests that Southern suppliers have derived greater benefits than their Northern counterparts from the presence of local MNE plants. This is perhaps little surprise given the earlier discussion of lower (and falling) levels of local sourcing in the North, and lower levels of developmental collaboration between Northern suppliers and their MNE customers. It is disappointing, however, given the larger average knowledge gaps between Northern suppliers and their MNE customers.

In terms of ownership and sector the proportions of MNE plants indicating that they had had a significant impact on their local suppliers largely reflects the pattern of knowledge transfer activity. That is, a larger proportion of North American owned MNE plants indicated that they had a significant impact on each aspect of supplier performance (Table 5). (These differences were statistically significant in the case of productivity, investment and employment). Engineering MNEs, and particularly those

in electrical and electronic engineering, more commonly had a significant impact on their suppliers than MNE plants in other sectors. These differences were only statistically significant in the case of employment (Table 5).

9. Discussion and Conclusions

For a region or nation, maximising the wealth creating potential of knowledge requires its effective diffusion and application throughout the whole economy. Multi-national plants located in Ireland, North and South, are a potentially important channel through which world-class knowledge can flow into Ireland and stimulate innovation in other local businesses. Local supply-chains are an important medium through which knowledge can flow and may provide the motivation for MNE plants to share knowledge beyond their company boundaries.

The very different history of inward investment in Ireland, North and South, has contributed to important differences in the characteristics of Southern and Northern MNE plants. For example, recent US investments mean that the population of MNE plants in the South is dominated by electronics and engineering plants with significantly more clothing, textiles and food plants in the North. Similarly, more Southern MNE plants (61.7 per cent) have an in-house R&D capability than in the North (39.4 per cent) while, on average, MNE plants are older in the North. In addition, Southern MNE plants are more strongly embedded in the local economy than those in the North, evidenced by a higher and increasing level of local sourcing (21 per cent). In the North, local sourcing has *decreased* since the 1980s and is now around 11 per cent of the material input purchases of MNE plants.

Our first hypothesis concerned the technological status of Irish MNE plants and suggested that, because of intra-group knowledge management, Irish MNE plants should be broadly in line with international best practice in their use of different business systems. Our evidence, provided by the managers of Irish MNE plants suggests that generally no significant knowledge gaps exist between the utilisation of M&CS by MNE plants in Ireland and best practice within their group. (The only

exceptions are TQM in the South and North and SFDC in the North). This provides considerable support for Hypothesis 1 and does suggest that MNE plants in Ireland are 'world-class' in terms of their use of a range of business systems. Moreover in a significant number of cases we were informed that the Irish MNE plant itself represented group best practice in the use of some business systems and that other group plants lagged somewhat behind. Also notable is that despite the differences in the populations of MNE plants, North and South, both groups match international best practice in terms of their use of business systems.

The central implication of this result is that MNE plants in Ireland, North and South, represent a potential reservoir of knowledge which matches international best practice and provide examples of world-class manufacturing activity. This highlights the potential for learning by local supplier companies and also suggests the value of inward investment businesses as both benchmarks for business excellence and potential exemplars of best practice. As the discussion in section 2 emphasises, however, the simple presence of such quality plants within the Irish economies is not sufficient to guarantee significant local benefits (Dicken, 1992; Dunning, 1993). This will depend both on the degree to which MNE plants participate in local supply chains, develop links to other local business or support organisations, and are willing to share their knowledge and expertise.

The potential for local learning will also depend, however, on whether local suppliers lag behind MNE plants in their utilisation of business systems etc. This is the focus of hypothesis 2. To examine this issue we identified knowledge gaps in the utilisation of business systems between MNE plants and their best local suppliers. The results suggest larger average knowledge gaps between MNE plants and their best local suppliers than between MNE plants and group best practice with Northern supplier companies are - on average - 9.9 months behind their local MNE customers in the use of the same management and control systems compared to an average lag of 3.6 months in the South. These knowledge gaps are only statistically different from zero however in terms of SFDC, SPC and EDI in the South and SFDC and EDI in the North. In terms of these business systems our study therefore provides direct evidence of the potential for local learning in the supply chain and support for hypothesis 2. It

is important to acknowledge, however, that this result relates to MNE plants' *best* local suppliers. As knowledge gaps will be larger to MNE plants' average or below average local suppliers (and probably also to those local businesses with no MNE customers) the potential for local learning for these businesses may cover a wider range of business systems and applications.

The distributions of knowledge gaps between MNE plants and their supplier companies also emphasise however the potential benefits from knowledge coordination in the supply chain to the MNE plant itself (Roper and Crone, 2001). In the majority of cases it is clear that MNE plants lead even their best local suppliers in terms of the utilisation of all or the majority of business systems and learning will benefit the supplier business. In a significant number of cases, however, suppliers were said to be ahead of their MNE customer in terms of their utilisation of some business systems. In these cases the benefits of potential learning may accrue to the MNE plant itself. This potential 'knowledge sourcing' from suppliers reflects recent developments in the empirical and theoretical literatures on inward investment examining the possibility that a motivating factor for FDI might be the desire to gain access to new knowledge or technology (e.g. Almeida, 1996; Kuemmerle, 1999; Serapio and Dalton, 1999). In the majority of cases, however, such investment is associated with investment from low R&D intensity economies to areas of higher R&D intensity.

Our third hypothesis concerns the relationship between knowledge gaps and MNE plants' knowledge transfer activity and asserts that where knowledge gaps to suppliers are greatest knowledge transfer activity is likely to be more intensive. Identifying and measuring knowledge transfers directly, however, is difficult if not impossible. We therefore focus instead on the nature and intensity of interaction between Irish MNE plants and their suppliers, activities which might provide the means for knowledge transfer. Based on Hypothesis 3 and the greater average size of MNE plant-supplier knowledge gaps in the North, we might have expected to find more intensive knowledge transfer activity in the North than that in the South. In fact, we do identify more frequent MNE plant-supplier interactions in the North as part of firms' normal trading relations; however, more developmental interactions, however (e.g.

collaboration on product developments, assisting suppliers with quality assurance systems) are more common in the South. This provides at best only partial support for Hypothesis 3.

Together with a lower level of local sourcing, the lower level of developmental interaction between MNE plants and their suppliers in the North than in the South mean that local knowledge transfers along the supply chain in the North are likely to be weakest. In the main, this difference reflects the relatively small size of Northern Ireland, and the consequent lack of availability of some inputs required by local MNE plants. (This is also suggested by the relatively significant level of cross-border sourcing by MNE plants in the North and the lack of similar sourcing by Southern MNE plants). Other supply-side influences may also be important, however, if Northern suppliers are less willing or capable of supplying MNE plants (see Crone and Roper, 1999, pp. 40-45). The implication, however, is that Northern suppliers are less likely to be benefiting from local knowledge transfers from MNE customers. This is not of course to say that Northern suppliers will not be receiving knowledge transfers from customers elsewhere, only that the *local* element of such transfers from MNE plants are likely to be weaker than in larger regions.

For the North, this study highlights again the weakness of local supply chains and suggests the relatively limited scope for their development. It does, however, suggest the potential benefits of - and justification for - public intervention to create other mechanisms for the development of capability within the local supplier base. In particular, Northern MNE plants do represent a potentially valuable knowledge resource. Maximising the local wealth creating potential of this knowledge base will require its wider application. This view underlies many of the general recommendations about capability building made in Best (2000) such as those relating to open networks and the diffusion of technology management capabilities. Crone and Roper (1999) suggest some more specific policy instruments which might be used are demonstration events, staff secondments or exchanges, mentoring and the development of knowledge transfer networks (p. 91-92).

In the South, the same potential for enhancing the scope of knowledge transfers is also evident. A particular focus might be on US electronics and electrical engineering plants which are both the most likely to have adopted each best practice technique and to be willing to contribute to supplier development activities. A lack of availability of suitable inputs in the South - highlighted by a large majority of MNE plants - is, however, likely to restrict the potential level of local sourcing to something akin to its current level.

Table 1: Target Population and Final Sample of Large MNE Plants

	South		North	
	Target Population	Sample	Target Population	Sample
By Ownership (% of plants)				
North American	54.5	57.4	67.3	36.4
European and Other	45.5	42.6	50.0	63.6
Total	100.0	100.0	100.0	100.0
By Sector (% of plants)				
<i>Engineering, Chemicals etc</i>	54.5	52.5	34.6	42.4
Of which:				
Chemicals, Pharmaceuticals, Rubber and Plastics	26.5	27.9	15.4	12.1
Metals, Mech. Engineering	28.0	24.6	19.2	30.3
<i>Electrical and Electronic Engineering</i>	28.0	37.7	21.2	18.2
<i>Other Manufacturing</i>	17.4	9.8	44.2	39.4
Of which:				
Food, Drink and Tobacco	12.1	6.6	15.4	12.1
Textiles and Clothing	3.0	3.3	25.0	21.2
All Other Manufacturing	2.3	0.0	3.8	6.1
Total	100.0	100.0	100.0	100.0
Total (number of plants)	132	61	52	33

Note: Chi-square tests for the distribution of the observed and expected samples are as follows: ownership South, $\chi^2(1)=0.197$; North, $\chi^2(1)=0.0004$. For industry: South, $\chi^2(5)=5.293$; North, $\chi^2(5)=3.309$. Critical values at 5 per cent are: for ownership 3.841 and for industry 11.07.

Sources: See text.

Table 2: Strategic and Functional Characteristics of Large MNE Plants

	South	North
Local Sourcing (%)	21	11
Responsibility for Undertaking Sales and Marketing Activities		
All sales to group sites (% of plants)	39.3	30.0
Plant has full responsibility (% of plants)	18.0	39.0
Shared with other group sites (% of plants)	26.2	12.0
Done elsewhere in group (% of plants)	16.4	18.0
R&D Activity		
R&D department in Plant (% of plants)	53.3	39.4
No. of man years in R&D (mean % of total employment)	3.01	2.36
Type of R&D		
Pure Research on New Product Technologies (% of plants)	23.3	6.0
Design/Development of New Products (% of plants)	50.0	27.3
Modification/Upgrading of Existing products (% of plants)	56.7	48.5
Adaptation of products for customers/markets (% of plants)	50.0	42.4
Product Innovation		
New Products (% of Sales)	35.4	25.4

Notes

Independent sample t-test for percentage local suggests $t=2.936$, $\rho = 0.005$. A Mann-Whitney test comparing the distribution of values of percentage local between areas suggests $Z=-2.164$, $\rho = 0.030$. Sales and Marketing - Chi-square tests based on a comparison of the three categories in the table between areas are as follows: Sales $\chi^2(2) = 22.510$, $\rho < 0.000$; Marketing $\chi^2(2) = 26.710$, $\rho < 0.000$. R&D - independent sample t-tests were as follows: R&D department in the plant, $t = -1.285$, $\rho = 0.202$; Number of man-years of R&D $t = 0.464$, $\rho = 0.144$; New products as percentage of sales, $t = -1.227$, $\rho = 0.244$. Comparison of the types of R&D being undertaken between areas suggests: $\chi^2(3) = 7.120$, $\rho = 0.068$.

Sources: See text.

Table 3: Mean Knowledge Gaps Between Group Best Practice and Irish MNE Plants
(Positive numbers denote lag between MNE plant and best practice)

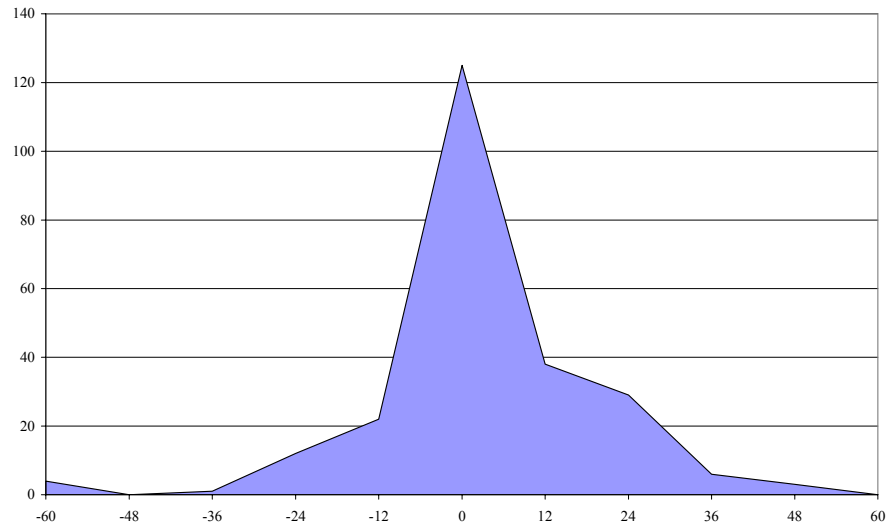
	Knowledge Gaps (months)	
	South	North
CAM	2.2	4.0
SFDC	4.7	8.1
CIM	3.5	-1.9
SPC	0.4	2.1
JIT	1.7	1.3
TQM	4.7	8.5
EDI	3.3	3.7
Mean	2.9	3.9

Notes

Independent sample t-tests comparing knowledge gaps between group best practice and the MNE plant between areas suggest: CAD $t = -0.326$, $\rho = 0.746$; SFDC $t = -0.657$, $\rho = 0.515$; CIM $t = 1.322$, $\rho = 0.192$; SPC $t = -0.373$, $\rho = 0.711$; JIT $t = -1.05$, $\rho = 0.916$; TQM $t = -1.036$, $\rho = 0.307$; EDI $t = -0.117$, $\rho = 0.908$. Distributional comparisons using a Mann-Whitney test for the same knowledge gaps suggest: CAD $Z = -0.151$, $\rho = 0.88$; SFDC $Z = -0.581$, $\rho = 0.562$; CIM $Z = -1.371$, $\rho = 0.17$; SPC $Z = -0.299$, $\rho = 0.765$; JIT $Z = -0.075$, $\rho = 0.941$; TQM $Z = -0.849$, $\rho = 0.396$; EDI $Z = -0.106$, $\rho = 0.916$.

Figure 1: Distributions of Knowledge Gaps between Group Best Practice and Irish MNE Plants

(a) South



(b) North

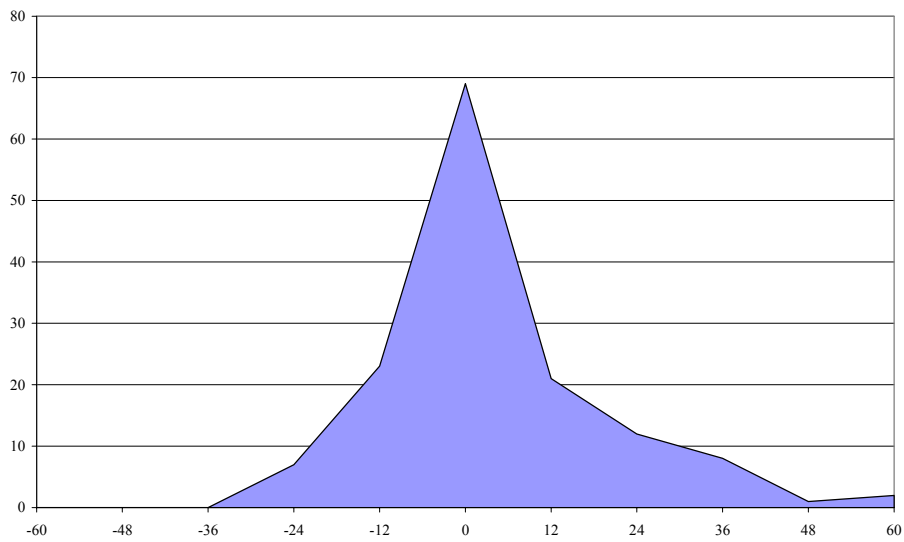


Table 4: Mean Knowledge Gaps from MNE plants to best local supplier

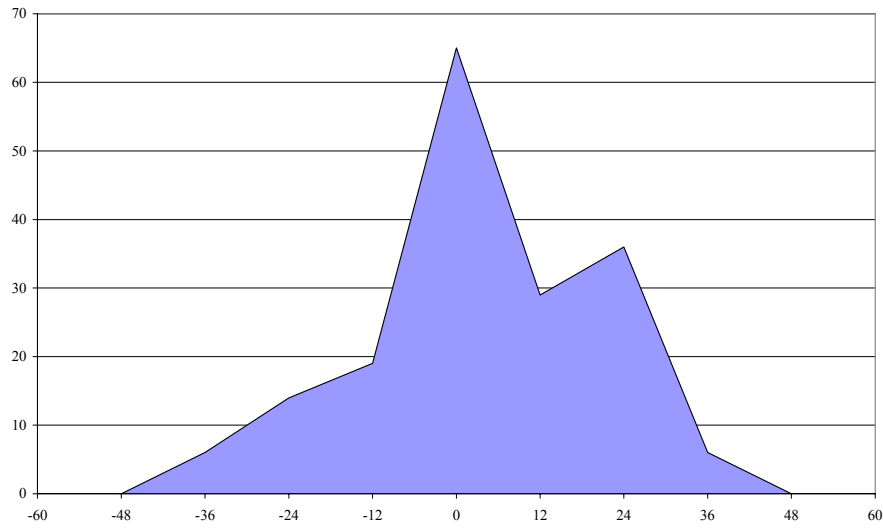
Knowledge Gap (months)		
	South	North
CAM	1.4	-0.9
SFDC	7.6	16.0
CIM	6.0	14.4
SPC	8.9	10.0
JIT	-2.0	7.4
TQM	0.2	7.2
EDI	4.5	20.7
Mean	3.6	9.9

Notes

Independent sample t-tests comparing knowledge gaps between MNE plants and their best local supplier suggest: CAD $t = -0.367$, $\rho = 0.716$; SFDC $t = 1.068$, $\rho = 0.305$; CIM $t = 0.835$, $\rho = 0.419$; SPC $t = 0.146$, $\rho = 0.886$; JIT $t = 1.482$, $\rho = 0.155$; TQM $t = 1.045$, $\rho = 0.308$; EDI $t = 2.09$, $\rho = 0.053$. Distributional comparisons using a Mann-Whitney test for the same knowledge gaps suggest: CAD $Z = 0.629$, $\rho = 0.654$; SFDC $Z = 0.207$, $\rho = 0.219$; CIM $Z = 0.241$, $\rho = 0.267$; SPC $Z = 0.926$, $\rho = 0.94$; JIT $Z = 0.205$, $\rho = 0.231$; TQM $Z = 0.255$, $\rho = 0.28$; EDI $Z = 0.031$, $\rho = 0.033$.

Figure 2: Distributions of Knowledge Gaps between Irish MNE plants and Best Local Suppliers

(a) South



(b) North

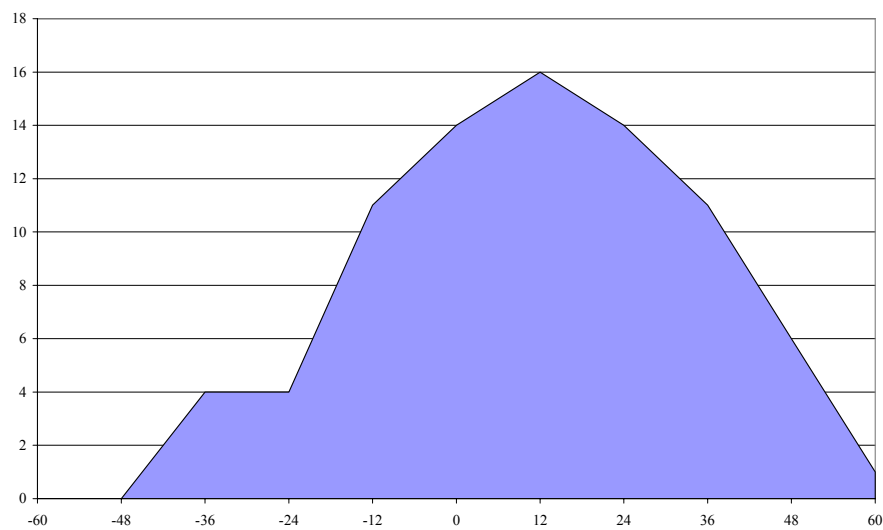
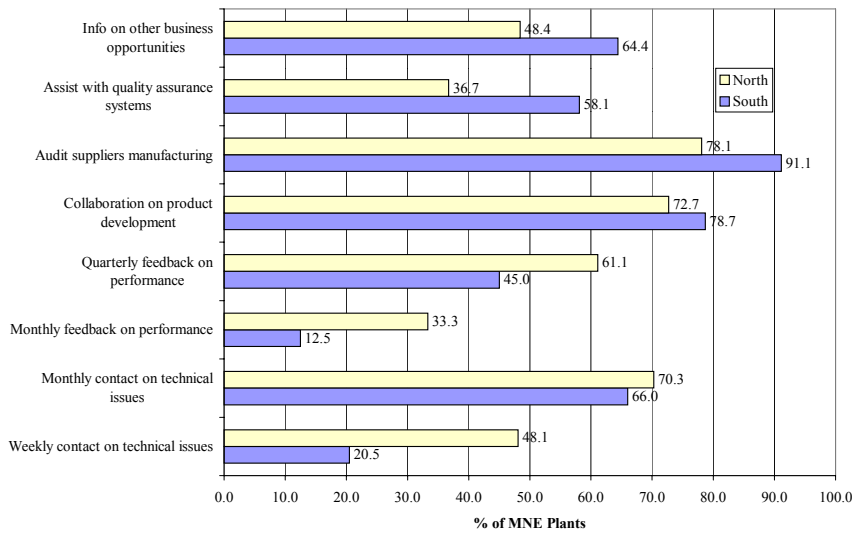


Figure 3: Local Knowledge Transfer Activity by MNE Plants



Notes

Comparison of the proportion of MNE plants engaging in each knowledge transfer activity with their local suppliers suggests: Information on other business opportunities $\chi^2(1) = 2.154$, $p = 0.142$; Assist with quality assurance systems $\chi^2(1) = 3.595$, $p = 0.058$; Audit suppliers manufacturing $\chi^2(1) = 2.576$, $p = 0.109$; Collaboration on product development $\chi^2(1) = 0.302$, $p = 0.582$; Feedback on performance $\chi^2(3) = 3.697$, $p = 0.296$; Contact on technical issues $\chi^2(3) = 6.733$, $p = 0.081$.

Table 5: Local Knowledge Transfer Activity by MNE Plants: By Ownership and Sector

	North America n	Other	Electrical and Electronics	Other Engin.	Other Sectors
	% Plants	% Plants	% Plants	% Plants	% Plants
Weekly contact on technical issues	20.8	21.1	17.6	21.7	25.0
Monthly contact on technical issues	54.2	42.1	47.1	30.4	50.0
Monthly feedback on performance	8.7	17.6	5.0	19.4	57.1
Quarterly feedback on performance	52.2	35.3	45.0	48.4	71.4
Collaboration on product development	76.0	81.0	72.7	79.4	76.9
Audit Manufacturing Processes	70.0	56.5	52.0	47.2	28.6
Assist with quality assurance systems	60.0	58.3	57.7	58.5	22.2
Info on other business opportunities	73.3	57.1	59.3	62.2	50.0

Notes:

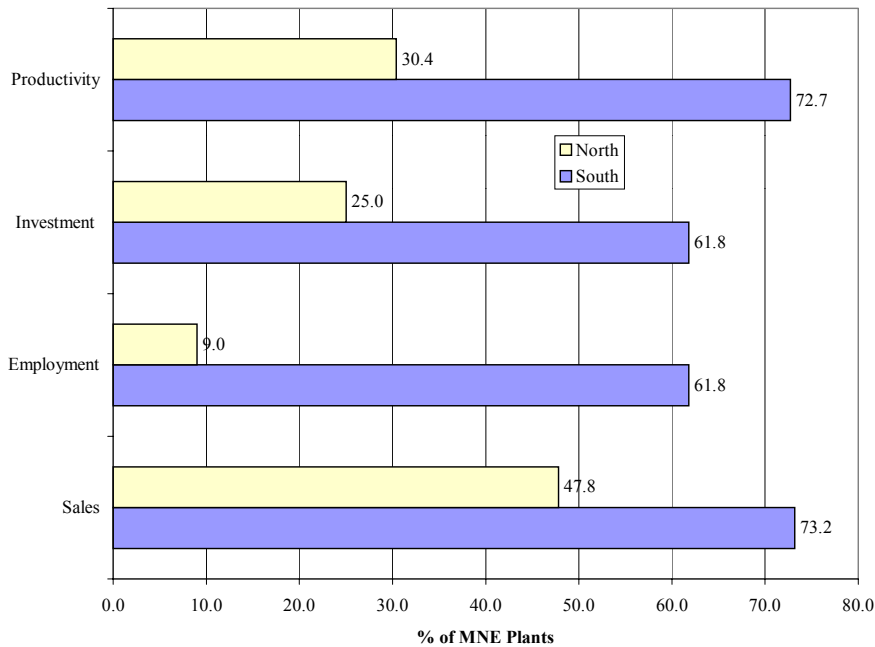
Comparison of proportion of plants in different ownership categories undertaking each knowledge transfer activity suggests: Contact on technical issues $\chi^2(1) = 12.074$, $\rho = 0.007$; Feedback on performance $\chi^2(1) = 1.37$, $\rho = 0.713$; Collaboration on product development $\chi^2(1) = 0.254$, $\rho = 0.614$; Audit suppliers manufacturing $\chi^2(1) = 0.866$, $\rho = 0.352$; Assist with quality assurance systems $\chi^2(1) = 0.013$, $\rho = 0.911$; Info on other business opportunities $\chi^2(1) = 1.147$, $\rho = 0.284$.

Comparison of proportion of plants in different industries undertaking each knowledge transfer activity suggests: Contact on technical issues $\chi^2(2) = 0.682$, $\rho = 0.995$; Feedback on performance $\chi^2(2) = 16.352$, $\rho = 0.012$; Collaboration on product development $\chi^2(2) = 0.335$, $\rho = 0.846$; Audit suppliers manufacturing $\chi^2(2) = 6.368$,

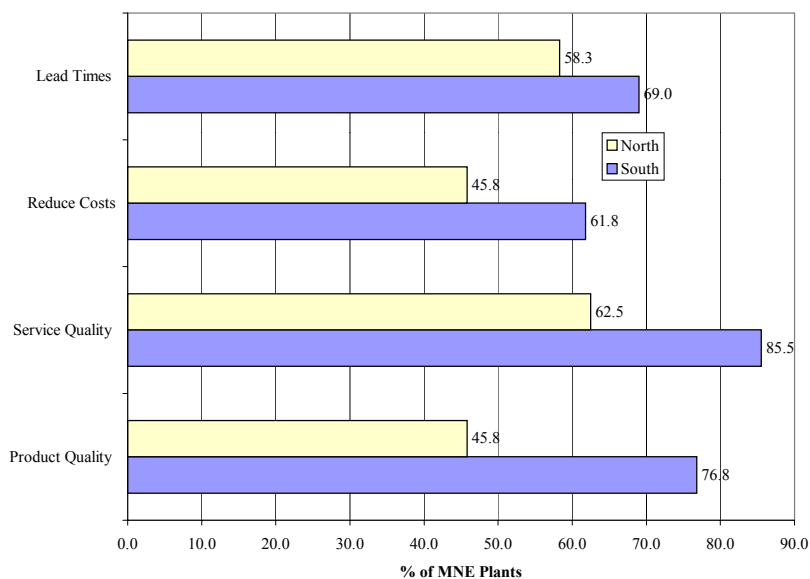
$\rho = 0.041$; Assist with quality assurance systems $\chi^2(2) = 7.355$, $\rho = 0.025$; Info on other business opportunities $\chi^2(2) = 0.796$, $\rho = 0.672$.

Figure 4: Percentage of MNE Plants Reporting Significant Impacts on Local Suppliers

(a) Performance Indicators



(b) Competitive Indicators



Note: Comparisons of the proportion of plants saying they had significant effects between areas suggests: Productivity $\chi^2(1) = 12.113$, $\rho = 0.001$; Investment $\chi^2(1) = 9.062$, $\rho = 0.003$; Employment $\chi^2(1) = 18.416$, $\rho = 0.001$; Sales $\chi^2(1) = 4.671$, $\rho = 0.031$; Lead times $\chi^2(1) = 0.86$, $\rho = 0.354$; Reduce Costs $\chi^2(1) = 1.742$, $\rho = 0.187$; Service Quality $\chi^2(1) = 5.017$, $\rho = 0.025$; Product Quality $\chi^2(1) = 7.054$, $\rho = 0.008$.

Table 6: Percentage of MNE Plants Reporting Significant Impacts on local Suppliers: By Ownership and Manufacturing Group

	MNE Ownership		Manufacturing Sector		
	Rest of The World	North America	Electrical and Electronic Engineering	Other Engineering	Other Man.
Performance Indicators					
Sales	57.8	73.2	72.0	65.8	56.2
Employment	31.6	60.0	60.0	51.4	12.5
Investment	38.5	62.5	52.0	52.6	43.7
Productivity	45.0	76.3	64.0	64.9	43.7
Competitiveness Indicators					
Quality	61.5	72.5	70.8	69.2	56.2
Service	71.8	84.6	91.3	74.4	68.7
Reduce Costs	51.3	62.5	58.3	58.9	50.0
Reduce Lead Times	61.5	70.0	83.3	61.5	50.0

Notes

Comparison of proportion of plants suggesting they had a significant impact on their suppliers by ownership suggests: Sales $\chi^2(1) = 2.046$, $\rho = 0.153$; Employment $\chi^2(1) = 6.339$, $\rho = 0.012$; Investment $\chi^2(1) = 4.565$, $\rho = 0.033$; Productivity $\chi^2(1) = 7.98$, $\rho = 0.005$; Product Quality $\chi^2(1) = 1.075$, $\rho = 0.3$; Service Quality $\chi^2(1) = 1.88$, $\rho = 0.17$; Reduce Costs $\chi^2(1) = 1.014$, $\rho = 0.314$; Lead times $\chi^2(1) = 0.628$, $\rho = 0.428$.

Comparison of proportion of plants suggesting they had a significant impact on their suppliers by industry suggests: Sales $\chi^2(1) = 1.076$, $\rho = 0.584$; Employment $\chi^2(1) = 9.622$, $\rho = 0.008$; Investment $\chi^2(1) = 0.383$, $\rho = 0.826$; Productivity $\chi^2(1) = 2.295$, $\rho = 0.317$; Product Quality $\chi^2(1) = 1.085$, $\rho = 0.581$; Service Quality $\chi^2(1) = 3.493$, $\rho = 0.174$; Reduce Costs $\chi^2(1) = 0.399$, $\rho = 0.814$; Lead times $\chi^2(1) = 5.37$, $\rho = 0.68$.

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