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Görg, Holger; Ruane, Frances P.

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Linkages between multinationals and indigenous firms: evidence for the electronics sector in Ireland

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Linkages between Multinationals and Indigenous Firms: Evidence for the Electronics Sector in Ireland

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Holger Görg,
Department of Economics,
Trinity College,
Dublin 2.
email: georgh@tcd.ie

Frances Ruane,
Department of Economics,
Trinity College,
Dublin 2.
email: fruane@tcd.ie

Abstract

This paper analyses the concept of linkages and studies the development and the determinants of inter-firm linkages between electronics firms in Ireland and domestic sub-suppliers using firm level data for 1982 to 1995. We discuss the concept of inter-firm linkages and the effects of linkages. We argue that the concept of linkages developed by Hirschman (1958) is an inter-sectoral concept which can arise as a result of underlying inter-firm linkages. Our empirical analysis indicates that foreign-owned electronic firms in Ireland source, on average, 24 per cent of their inputs in Ireland, which compares favourably with an estimate for foreign firms in Scottish electronics industries. In an econometric estimation, using panel data techniques, we find that firms in the Irish electronics sector increase their backward linkages over time; that foreign firms have lower linkages than Irish-owned firms; and that large and expanding firms have lower linkages than other firms.

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1 Introduction

The growth performance of the Irish economy has been the subject of considerable analysis recently. Many argue that the huge inflow of foreign direct investment (FDI) into the economy and, connected to this, the rising significance of foreign multinational companies (MNCs) has been a major factor in explaining this growth performance (Krugman, 1997; Leddin and Walsh, 1997; Sachs, 1997). MNCs may be expected to have several positive effects on the host economy. In addition to creating output and employment directly, they may create forward or backward linkages through customer and supplier relationships with indigenous firms, leading to indirect increases in output and employment in these firms. By generating markets for indigenous firms in upstream and downstream industries, linkages may enable domestic firms to develop more successfully in the same or in related industrial sectors as foreign firms. Furthermore, linkages between multinationals and indigenous firms may lead to industry agglomerations, and to the introduction of new technologies in the host country through spillovers from MNCs.[1]

The aim of this paper is to analyse the extent and the determinants of backward linkages between multinationals and indigenous firms in the Irish electronics sector, using econometric analysis of panel data. We focus on the electronics sector because it has become increasingly significant for the Irish economy, and because its origins seem to be closely linked to the establishment of multinational companies in this sector in Ireland (Ruane and Görg, 1997).

[1] Arguably, the presence of multinational companies can also have adverse effects on the host economy. See Barry and Bradley (1997) for a discussion of possible negative effects of MNCs for the Irish economy.

The remainder of the paper is structured as follows. We discuss the concept of inter-firm linkages as well as the possible positive effects of linkages in Section 2. In Section 3 we review briefly earlier studies which have estimated econometrically the determinants of backward inter-firm linkages in the Irish manufacturing sector. Section 4 analyses backward inter-firm linkages for a sample of firms in the Irish electronics sector using panel data for the period 1982 to 1995, attempting to relate the scale of linkages to firm characteristics. Finally, Section 5 summarises our main results and draws some conclusions.

2 Concept of Inter-Firm Linkages

Many studies in the recent literature have attempted to determine whether individual firms create backward linkages with domestic suppliers through the purchase of inputs in the local market or whether they create forward linkages through selling output as intermediate inputs to other local firms (see Caves, 1996 and Lall, 1993). One reason for this increasing interest in inter-firm linkages is the increasing globalisation of production and the importance of multinational companies and foreign direct investment for host countries (see UNCTAD, 1997).

The crucial question is whether foreign multinationals create linkages with the host economy or whether they operate in so-called "enclave sectors" with no links to the domestic economy that surrounds it. This issue is important in an open economy framework where many inputs and outputs can be internationally traded. In such a context it seems important to establish whether firms create backward or forward linkages with the local economy or whether they import and exports most or all of their inputs and output respectively.

Furthermore, the issue of backward inter-firm linkages becomes important when analysing local content requirements in international trade agreements. Regional trade blocks, like the EU or NAFTA, frequently impose minimum requirements of domestic inputs which foreign firms must use in their production (see, for example, Davidson *et al.*, 1985; Richardson, 1993 and Lopez-de-Silanes *et al.*, 1996). An analysis of backward inter-firm linkages shows the extent of local buying and may indicate whether or not local content requirements are met by foreign multinationals in the host economy.

In a perfectly competitive market environment with firms facing constant returns to scale, inter-firm linkages would not have any net effect on the economy; firms would just produce their profit maximising output at zero profits in equilibrium. However, in a world with imperfect competition and economies of scale, inter-firm linkages can have positive effects on the firms concerned through the emergence of externalities. This issue has attracted considerable attention in the recent literature, and various positive effects of inter-firm linkages have been identified.

For example, Markusen and Venables (1997) show that inter-firm linkages between multinationals and indigenous suppliers may encourage the establishment and growth of indigenous companies in the same or different sectors in the host country. This model, in the spirit of "new economic geography", assumes that the production of final goods and intermediate goods takes place under conditions of imperfect competition and increasing returns to scale. Thus backward linkages, created through the purchase of intermediate goods by final good producers, can reduce the costs of intermediate good producers by increasing the scale of their production. These reduced costs imply, in turn, that final good producers have to incur less costs for intermediate products, which is the forward linkage. In such a setting, multinationals develop backward linkages with indigenous suppliers.

These indigenous intermediate good suppliers, in turn, establish forward linkages with indigenous final good producers and, thus, foster the development of indigenous final good production.[2]

If this positive effect materialises itself between firms of sector *A* and sector *B*, the Markusen and Venables model formalises the inter-sectoral linkage as discussed by Hirschman (1958), although the model can also lead to intra-sectoral linkages, i.e., linkages between firms in the same sector *A* if one perceives suppliers and final good producers to be in the same sector.[3]

Hirschman (1958) defined an inter-sectoral concept of linkages, which conceptualised the means by which the development of certain industrial sectors would induce the creation and development of other sectors which had not previously existed. Linkages from a "leading sector" *A* to a "following sector" *B* allow sector *B* to develop; without linkages, sector *B* would not have come into existence. However, Hirschman does not indicate how he expects the inter-sectoral linkages to work in practice, i.e., he does not explain the underlying mechanism. This is where the concept of inter-firm linkages enters the stage. It is the linkage between individual firms in different sectors that create inter-sectoral linkages and because of the existence of imperfections in the market, these linkages can have a positive effect on economic development, i.e., firms in the "leading sectors" induce the development of firms in "following sectors".[4]

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2 Rodríguez-Clare (1996) looks at a similar mechanism in a more aggregate two-country model with countries specialising in the production of different goods. Multinationals can help develop domestic supplier industries which in turn leads to the development of indigenous final-good producers.

3 The issue of whether linkages are inter- or intra-sectoral depends crucially on the level of aggregation.

4 As such, the forces behind this development effect of linkages can be traced back at least until Marshall's (1920) discussion of external effects. Marshall argued that input-output relationships between firms are one of the advantages of localised industry, since "subsidiary trades grow up in the neighbourhood, supplying it [the firm] with implements and material, organizing its traffic, and in many ways conducing to the economy of its material" (p. 271). Thus, Marshall suggests that there be positive effects of inter-firm linkages on economic development.

In models similar in nature to the one proposed by Markusen and Venables, Krugman and Venables (1995) and Venables (1995, 1996) also discuss the possibility that firms which are linked through production inputs may tend to agglomerate geographically, an issue also discussed by Porter (1990) from a viewpoint orientated more towards international business studies and international management.[5]

The importance of inter-firm linkages has also been stressed in the literature on technology spillovers from multinationals to indigenous firms. As Blomström and Kokko (1996) point out, in the case where firms are inter-linked, "local firms may be able to improve their productivity as a result of forward or backward linkages with MNC affiliates [or] may imitate MNC technologies" (p. 1). This may lead to the introduction of new technologies in the host country as indigenous firms "learn" through the presence of foreign firms in their country.

Inter-firm linkages can also have positive effects on the creation of secondary (or indirect) employment generated in supplier firms. If firms are linked through seller-supplier linkages, sellers will have a role to play for employment in the supplier firms. This effect of linkages has been stressed by Rodríguez-Clare (1996) who argues that one should measure "the ratio of employment generated in upstream industries [...] to the labor hired directly by the firm" (p. 854).

3 Empirical Studies of Inter-Firm Linkages in Ireland

Turning to empirical studies of inter-firm linkages, we focus on the measurement of backward linkages and ignore forward linkages. A glance

[5] The significance of agglomerations has also a long tradition in economics. For example, Marshall (1920) argued that the pooling of inputs or the existence of technology spillovers may lead to localisation of industries. See O'Donnellan (1994) and O'Gorman *et al.* (1997) for a discussion of industrial clusters in Irish manufacturing industries and in the Irish indigenous software industry, respectively.

at the existing literature suggests that backward linkages have been the focus of most studies while there seems to be only little empirical work on forward linkages.[6] This absence of empirical studies is in part due to the difficulty of determining the value of a firm's output that serves as an intermediate input in production in other firms rather than as final demand. Another reason why most empirical studies focus on measuring backward linkages is that they seem to be of more interest to policy makers, given the concerns of whether some manufacturing firms operate in enclave sectors which are not linked through any supplier linkages to other indigenous firms in the economy.

There seems to be some confusion in the literature about the measurement of backward linkages. Some authors link their analysis of inter-firm linkages back to the inter-sectoral concept developed by Hirschman (1958). In doing so, there is a potential confusion since one does not distinguish the actual inter-firm linkage itself and possible effects of the linkages on, for example, economic development in the same or related sectors. As argued above, the inter-sectoral linkages, i.e., the development of new sectors in the economy induced through linkages from leading sectors, is a result of inter-firm linkages between firms in different sectors.

Stewart (1976), for example, analysing data for the period 1964-70 from a random sample of 43 foreign and indigenous firms in the West of Ireland, examines inter-firm linkages between foreign and domestic firms and indigenous suppliers in the host country Ireland. He calculates the proportion of locally-sourced inputs relative to a firm's output, where inputs include raw materials plus other inputs, i.e., manufacturing and services

[6] Twenty years ago, Lall (1978) also came to the conclusion that "there appears to be hardly any empirical work on forward linkages" (p. 218). The papers by Stewart (1976), McAleese and McDonald (1978) and O'Farrell and O'Loughlin (1980) include some attempts at measuring forward linkages in Irish manufacturing.

inputs. While he links his empirical estimations to Hirschman's concept of inter-sectoral linkages, he, in effect, measures inter-firm linkages rather than inter-sectoral linkages since the inputs can be sourced from firms within the same sector or from other sectors. Also, his estimates of linkages indicate only that there exists an interdependence between firms though he does not analyse the issue of causality, i.e., whether firm *A* induced the development of firm *B*, which is a crucial point in Hirschman's linkage concept.

The same issue arises in the papers by McAleese and McDonald (1978) and O'Farrell and O'Loughlin (1980, 1981) which are concerned with estimating the extent of backward linkages between firms in Irish manufacturing and their domestic suppliers.[7] While these are by no means the only studies on linkages in Ireland (see, for example, also O'Malley, 1989, Chapter 7; Kennedy, 1991 and Crowley, 1996) they are, to the best of our knowledge, the only papers using econometric techniques in order to analyse the determinants of inter-firm linkages.[8] Since we intend to look at an econometric approach using panel data, we concentrate on these earlier econometric studies.

McAleese and McDonald (1978) use data from a large survey of manufacturing firms in Ireland undertaken in 1974 (see McAleese, 1977) to estimate the determinants of backward linkages between manufacturing firms and indigenous suppliers. Their sample comprises a cross-section of 269 manufacturing firms that were in operation in 1974. O'Farrell and O'Loughlin (1980, 1981) carry out a similar analysis for 1976, selecting a sample of 360 firms from a list of 466 firms, which had been grant-aided by

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[7] Other studies of inter-firm linkages, mainly undertaken by authors associated to geography or regional planning departments do not link their work to Hirschman's concept of linkages. Rather, they base their work on concepts developed in the area of economic geography where, as Angel (1994) points out "the organization and geography of inter-firm linkages has been a persistent object of inquiry" (p. 187).

[8] The study by O'Loughlin and O'Farrell (1980) reports a regression analysis similar to the papers by O'Farrell and O'Loughlin (1980, 1981).

the Industrial Development Authority (IDA) under the IDA New Industry grant programme.

These studies find that, *inter alia*, foreign firms tend to have lower linkages than indigenous firms, controlling for sectoral and size differences. Including a variable for the age of a firm they also find that more established firms have higher linkages than newer firms. However, since their data are cross-section it cannot be inferred that linkages at individual firm level increase over time since the data look only at different types of firms at a single point in time. We attempt to clarify this issue below, using panel data rather than a cross-sectional analysis.

4 Analysing Inter-Firm Linkages for the Electronics Sector

In this section we analyse the extent and the determinants of backward inter-firm linkages between final good producers and domestic suppliers in the electronics sector in Ireland, using data from the *Forfás Irish Economy Expenditure Survey* data base.[9] Our study contrasts with the earlier papers on backward linkages in Ireland discussed above in several respects.

Firstly, we cover a more recent period, namely 1982 to 1995 and we use panel data rather than cross-sectional data. Secondly, we limit our study to the electronics sector, which is regarded by policy makers as having the largest potential for linkages (Crowley, 1996). As such, it has been targeted specifically by the IDA in seeking to attract foreign direct investment into Ireland, with the result that the electronics sector has become increasingly significant for the Irish economy in terms of output, exports and employment (Ruane and Görg, 1997). Thirdly, unlike earlier studies of inter-firm linkages in Ireland, which distinguished sectors at a fairly high level of

[9] Unfortunately, this data set does not allow us to distinguish whether the inter-firm linkages are intra- or inter-sectoral.

aggregation, we distinguish different sub-sectors of electronics, thus allowing us to focus on different activities within the sector.

For the purpose of this study we define linkages as the percentage of total raw material and components sourced in Ireland, as in O'Farrell and O'Loughlin (1981).[10] We exclude linkages with services suppliers for two reasons. Firstly, since a large number of services are not as easily tradable as material inputs, such linkages may say little about the competitiveness of local suppliers but may simply reflect the high transaction costs of sourcing services inputs outside the local economy. Secondly, and more importantly, while the survey includes several questions related to service inputs, the response rate to this question is relatively poor.

4.1 Data Source

The data used are taken from the *Irish Economy Expenditure Survey* which is collected by Forfás, the policy and advisory board for industrial development in Ireland. The survey is undertaken annually and includes output and employment data as well as detailed information on each firm's expenditure on labour, material and services inputs. It also asks each firm for information about capital employed but it has been found that only a small proportion of the firms respond to these questions. The survey does not include the total population of firms in Ireland but is only sent out to a sub-sample of firms, *viz*., firms with thirty or more employees. It is not compulsory for firms to take part in the survey, but response rates are generally good, normally around 60-80 per cent (O'Malley, 1995). The *Forfás Employment Survey*, on the other hand, includes all existing manufacturing firms in Ireland irrespective of size and response rates are

[10] McAleese and McDonald (1978) define backward linkages as the ratio of current expenditures in Ireland relative to total current expenditures by a firm. It, thus, includes expenditures on materials plus expenditures on services and labour costs.

usually over 90 per cent (Strobl, 1996), i.e., it can be seen as including the whole population of firms in Ireland. We use data on firm numbers and employment in firms in the electronics sector available from the *Employment Survey* to discuss whether our sample of firms taken from the *Irish Economy Expenditure Survey* can be considered representative of the total population.

The data available to us for the period 1982 to 1995 include all firms surveyed in the electronics sector, distinguished by nationality of ownership. The electronics sector itself is classified by Forfás into 12 sub-sectors which cover manufacturing and services: Computers, Consumer Electronics, Electronic Components, Instrumentation, Networking & Data Communication, PC Board Assembly (PCBA), Peripherals & Media, Semiconductors, Software Development, Software Production, Telecommunications, and Services, which includes IT related services not included in the other sub-sectors, such as Systems Integration, IT Consulting and training and education.

Overall, our sample includes observations for 215 firms which were in existence in 1995, 150 of which are foreign-owned. These generate a total of 1,223 observations which are used for the descriptive statistics below. The *Forfás Employment Survey* data show that there were 800 electronics firms in Ireland in 1995, 458 Irish-owned and 342 foreign-owned firms. Our IEE sample is not a balanced panel since most of the firms did not respond to the survey continuously; in fact, only five firms were in the sample for each year during the whole period 1982-1995.

We can not regard our sample as being necessarily perfectly representative of the total population of firms in the electronics sector for two main reasons. First, the fact that small firms are excluded from the IEE may bias the results. Our sample includes 44 per cent of all foreign firms in the electronics sector and 14 per cent of all indigenous firms in the electronics

sector. However, as the figures in Table 1 show, sample firms account for 72 and 56 per cent of employment in foreign and Irish-owned firms in that sector respectively in 1995, which implies that large firms are over-represented in the sample.[11]

Second, as the data in Table 1 indicate, the sample's coverage of the total electronics industry in Ireland in terms of employment differs widely between foreign and Irish-owned firms and across years and sub-sectors. This implies that our results and the conclusions drawn are only valid for the analysed sample though they may, nevertheless, be regarded as offering an insight into the development and the determinants of linkages in the Irish electronics sector as a whole.

4.2 Descriptive Statistics

In order to give an overview of the development of linkages in sample firms we calculate linkages distinguished by sub-sector. Since, based on the results by McAleese and McDonald (1978) and O'Farrell and O'Loughlin (1981) one would expect linkages in indigenous firms to be higher than in foreign-owned firms we calculate the figures for foreign and indigenous firms separately. We compare the extent of linkages (i) with a result obtained for the Scottish electronics industries and (ii) over time.

Table 2 indicates that indigenous firms in the electronics sector appear to have higher linkages with domestic suppliers than foreign firms, although the gap between these groups has narrowed over time, and especially since the early 1990s. In 1991, foreign firms in the electronics sector sourced 24 per cent of their raw material inputs locally, which compares favourably with an estimate for foreign firms in Scottish electronics industries. Turok (1993)

[11] The exclusion of small firms from the sample could be ignored if their behaviour was similar to that of large firms and we have no way of knowing whether or not this is in fact the case.

examines backward linkages, defined as the percentage of material inputs sourced in Scotland, between electronic firms and domestic suppliers in Scotland, using data from three surveys undertaken by the Scottish Development Agency in 1986, 1988 and 1990 and an own survey undertaken in 1991. His results show that foreign electronics firms in Scotland sourced 14 per cent of their material inputs in the Scottish economy in 1991 which compares with 24 per cent for foreign firms in Ireland in the same year.

Linkages in foreign firms have increased since 1982 and reached 23 per cent in 1995.[12] However, while linkages increased steadily between 1982 and 1991, they appear to have remained at a relatively constant level since then.[13] Policy makers are concerned as to what explains this "levelling-off". Is there an effective limit to the extent to which MNCs can link locally and that this has now been achieved? Have linkages in some firms actually declined, perhaps due to domestic supply constraints? Does this figure reflect no real change in pattern but rather indicate the increasing numbers of new firms which have yet to establish local linkages? We look at these questions in more detail in the econometric analysis below.

The table also shows that there are big differences between the extent of linkages in particular sub-sectors. This may be due to the fact that firms in different sectors are at different stages of the production process. For example, firms producing semiconductors are at a very upstream stage of production, i.e., they produce intermediate products which will be used in

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[12] Note that the figures in Table 2, especially at the sub-sectoral level, fluctuate considerably over the years. This is due to the changing number of firms responding to the survey which would, in particular, affect sub-sectors with only a very small number of respondents. However, the general trend of increasing linkages in foreign firms is also confirmed in the published figures in Forfás (1996) where the percentages of Irish-sourced raw materials for non-food manufacturing firms are reported. These fluctuations should not pose a problem for the econometric analysis in Section 4 since we use firm level data for this estimation.

[13] While the ratio of domestically sourced inputs to total inputs has remained constant, the absolute value of domestically purchased inputs may well have increased.

other electronics sectors, such as Computers or Peripherals. They would, therefore, be *a priori* expected to have a relatively low backward linkage potential, while this potential would be higher in downstream industries, such as Computers or Peripherals.

4.3 Model Specification

In the spirit of McAleese and McDonald (1978) and O'Farrell and O'Loughlin (1981) we attempt to relate the extent of backward linkages (*BL*) in a firm to a vector of firm characteristics (*FC*), a relationship that can be represented as

$$BL_{it} = FC_{it} b + e_{it} \qquad (1)$$

The dependent variable is defined as the ratio of locally sourced raw material purchases to total raw material purchases per year which is in line with O'Farrell and O'Loughlin (1981). Firm characteristics considered are nationality, firm size and growth, time, export ratio, growth of total inputs and a sub-sector dummy. They are discussed in turn.

We include a dummy variable to account for nationality of ownership differences in the extent of linkages (1 if a firm is foreign). On the basis of the results obtained in earlier studies (McAleese and McDonald, 1978 and O'Farrell and O'Loughlin, 1981) we would expect a negative relationship between this variable and the extent of linkages.

Also, as in O'Farrell and O'Loughlin (1981) we include average employment as a proxy for firm size.[14] Furthermore, a simple annual growth rate of

[14] Another possible proxy for firm size would be output. Our data set includes manufacturing turnover as a variable. In preliminary regressions, however, we found that this variable does not lead to any meaningful results which may be due to firms under- or overstating their figures or due to artificially inflated turnover figures due to transfer pricing. In line with Ruane and Görg (1997) who suggest that "the employment figures [...] can therefore be seen as giving a more conservative measure" (p. 79), we use employment as a proxy for size in our final regressions reported below.

employment is an independent variable in the estimation. We would expect both variables to be negatively related to the extent of a firm's linkages to the domestic market. As O'Farrell and O'Loughlin (1981) point out, large firms might be expected to have lower linkages because (i) economies of scale make them more self-sufficient than smaller firms and (ii) large size may be the result of vertical integration. On the other hand, the recent trends towards out-sourcing of activities and down-sizing of production in firms may suggest that smaller firms may be more likely to have higher linkages than large firms.

A time variable which is set equal to one once a firm enters the sample for the first time and then increases by one every year is included in the regression to account for the development of linkages over time.[15] Since earlier studies suggested that firms increase their linkages over time, we would expect this variable to be positively related to the development of linkages. In other words, having controlled for other firm characteristics, we would expect a firm's linkages to increase over time.

We also include a firm's export ratio in the estimation which we expect to be negatively related to the extent of linkages created. O'Farrell and O'Loughlin (1981) argue that firms with high propensity to export may be more accustomed to dealing with foreign customers and may also be more aware of foreign sources of supply than firms that sell mainly on the indigenous market. However, they did not find a statistically significant result for the export variable in their estimation.

Furthermore, we include the annual growth rate of a firm's total purchases of raw materials and components. The rationale behind this is that we want to

[15] In order to capture the effect that firms at different stages of their life cycle could have on the creation of linkages we would, ideally, like to include an age variable for each firm. However, such data are not available to us at present.

test whether a firm with growing total input purchases also increases its domestic purchases, i.e., increases domestic linkages or *vice versa*. If a firm which expands total purchases decreases its linkages with domestic suppliers, i.e., the percentage of inputs sourced in Ireland, this may indicate that the firm prefers to source additional inputs abroad.

This may indicate indigenous supply constraints, i.e., that domestic firms are not able to satisfy the demands of foreign companies. This could be due to the scale of production of Irish-owned suppliers, which does not allow them to respond adequately to changes in final-good-producers' demands. However, a change in purchasing behaviour after increases in total input purchases could also be solely due to the fact that the firm alters its production process and, therefore, increases input purchases.

Finally, the regression includes 11 sectoral dummies to control for differences across sub-sectors in electronics; the reference sector is Networking & Datacommunications.

Given the difference between foreign and indigenous electronic firms in their linkage development we follow O'Farrell and O'Loughlin (1981) and estimate this equation (i) for the total sample of firms, i.e., both foreign and indigenous and (ii) for foreign firms only. The first equation allows us to examine the development of linkages for firms in the electronics sector over all, while the second equation focuses particularly on the performance in foreign firms.

4.4 Estimation Techniques

We use panel data regression techniques to estimate the model described above. As discussed in, for example, Baltagi (1995) we assume that the error term in the regression is composed of two components, *viz.*,

$$e_{it} = x_i + e_{it} \qquad (2)$$

with x_i capturing a firm specific permanent and unobservable effect, such as the influence of a particular technology or management practice, and e_{it} being the remaining period specific error term, assumed to be independent across firms and over time. The model can be estimated using random effects (RE) or fixed effects (FE) techniques. In the latter case, the firm specific effect x_i is assumed to be an estimable fixed parameter, whereas the former specification assumes the x_i to be random.

In our case we estimated the equation using the RE technique for three reasons. First, our aim is to estimate, *inter alia*, the effect of time invariant variables, namely, nationality and sectoral dummies. The nature of the FE technique, however, does not allow the estimation of such time invariant variables. Second, as Baltagi (1995) points out, the FE model is appropriate if one looks at the same firms in each period, while the RE model is more applicable in the case of randomly selected individuals from a large population. In our case, we do not examine the same firms each period, rather the number of firms changes over time due to differing response rates. Third, the estimation of FE is less efficient than RE since FE peruses only variations *within* each firm over time, while RE also takes into account variations *between* firms in the same year.

4.5 Estimation Results

While our total sample includes 1,223 observations from 215 firms the nature of the survey does not allow us to use all these observations. Given the fact that even if firms responded to the survey they did not necessarily respond to all questions, our econometric estimation uses a total of 495 observations from 125 firms for which all the necessary information were available. Of these, 391 observations relate to 90 foreign firms. Also, the number of firms in the sample differs across years; as apparent from Table

3, the number of firms in the sample used for the econometric estimation increased steadily between 1982 and 1995. There are no observations for the year 1982. Table 4 gives summary statistics for the sample used for the econometric analysis. All estimations were performed in Stata (StataCorp, 1997) and the results for the estimation pooling foreign and indigenous firms together are presented in Column 2 of Table 5.

The dummy variable controlling for the impact of nationality has the expected negative and statistically significant sign, which suggests that, other things being equal, foreign firms tend to have lower linkages than domestic firms. This result confirms the descriptive statistics in Section 4.2 and coincides with the results in McAleese and McDonald (1978) and O'Farrell and O'Loughlin (1981).

Furthermore, the employment-size and employment-growth variables turn out to have statistically significant negative signs. This indicates that large firms and expanding firms have lower linkages than other firms, *ceteris paribus*. As noted above, this may be due to large or growing firms being better able to internalise their operations, i.e., expand vertically rather than create more backward linkages, or it may reflect the fact that Irish suppliers do not have the necessary scale for supplying big firms, especially where corporate policy is to source inputs globally from a small number of suppliers. Thus, while Irish suppliers may be able to meet needs of firms based in Ireland competitively, scale prevents their meeting the needs of corporate groups which operate and source inputs on a world-wide scale.

We find a positive and statistically significant relationship between a proxy for a firm's linkage development over time and the extent of its linkages. This suggests that firms increase their linkages over time, concurring the interpretation of cross-section results in McAleese and McDonald (1978) and O'Farrell and O'Loughlin (1981). As suggested above, that may indicate

that foreign firms, once they get accustomed to the local market also source more of their inputs locally, i.e., the transaction costs of sourcing inputs locally decrease over time relative to the transaction costs of purchasing inputs abroad. In the light of the apparent "levelling-off" of total linkages in the electronics sector in Ireland in the early 1990s, as discussed above, this result appears to suggest that this is primarily due to new firms establishing in Ireland in this period. Initially, new firms can be expected to have relatively low linkages due to their unfamiliarity with the host economy. Over time, however, we would expect these firms to increase their linkages with domestic suppliers.

The coefficients for the export-ratio and growth-of-total-input-purchases variables turn out to have insignificant coefficients, i.e., there is no apparent relationship between these variables and the extent of a firm's linkages with domestic suppliers. However, these results may be just due to the fact that the variables are correlated with other variables. As Table 6 shows, the export ratio is positively correlated with the nationality dummy, while the input growth variable is positively correlated with employment growth. The correlation between the nationality dummy and export ratio suggests that foreign firms tend to have higher export ratios than domestic firms. The correlation between input growth and employment growth indicates that firms which expand employment, i.e., their domestic production, also tend to increase their input purchases. This implies that firms which increase their input purchases have lower linkages than other firms, since our results show that growing firms have lower linkages than other firms.

The only sectoral dummy which turns out to have a statistically significant coefficient is the one for the Software Production sector. Its coefficient is positive, all other coefficients are statistically insignificant.

Column 3 of Table 5 presents the results of the estimation for foreign firms only. Compared with the results in Column 2, the variables for size, employment growth, and development over time show the same results as for all firms. Large firms and growing firms tend to have less linkages than other foreign firms and foreign firms seem to increase their linkages over time. The latter result contrasts with the finding by O'Farrell and O'Loughlin (1981) who did not find a statistically significant relationship between an age variable and the extent of linkages in the case of foreign firms only.

In contrast with the result for all firms, the coefficient of a foreign firm's export ratio is statistically significant and negative. This indicates that foreign firms with high export ratios have lower linkages than other foreign firms, other things being equal. The difference in the result for the estimation including all firms and the one including only foreign firms may not be surprising since foreign firms have, on average, higher export ratios than Irish-owned firms, as shown in the summary statistics in Table 4.

The coefficient of the growth of total inputs variable is negative and statistically significant at the ten per cent level. This result is different from the result for all firms in Column 2 where we did not find a statistically significant relationship between this variable and the extent of linkages. This suggests that foreign firms, but not indigenous firms, reduce their percentage of inputs sourced in Ireland as they increase their total input purchases. As discussed above, that may indicate that there are supply constraints for indigenous suppliers who cannot expand at the same rate as the demand for inputs in the foreign firm does.

5 Summary and Conclusions

Studies of inter-firm linkages in the Irish economy by McAleese and McDonald (1978) and O'Farrell and O'Loughlin (1980, 1981) found that

foreign firms tend to have lower linkages than domestic firms and that there were sectoral differences in the extent of linkages created. They also found that the extent of linkages is positively related to a firm's age. Their results, however, are based on cross-sectional data which do not allow one to conclude on a time trend.

Our empirical study of backward linkages in the Irish electronics sector over the period 1982 to 1995 adds to the literature on inter-firm linkages in Ireland by (i) updating the results obtained in previous studies and (ii) focusing explicitly on the time dimension, using a panel of firm level data rather than a cross-sectional data set as used by McAleese and McDonald (1978) and O'Farrell and O'Loughlin (1980, 1981). Our finding that, in the sample of electronics firms (both foreign and indigenous) analysed, firms seem to increase their linkages over time supports the tentative conclusion of a positive time trend drawn in the earlier papers discussed. This suggests that one may expect new firms attracted to Ireland to start off with relatively low linkages which, however, will increase over time.

We also find in all estimations that, *ceteris paribus*, foreign firms have lower linkages than indigenous electronics firms. Such a result was to be expected since, in general, indigenous firms would be more likely to source inputs in the local economy than firms from another country. Furthermore, our results show that large firms and expanding firms have lower linkages than other firms. If these low linkages are due to the fact that indigenous suppliers do not have the necessary scale to provide large amounts of inputs, there is clearly scope for policy intervention targeted at developing small indigenous sub-supply industries and assisting them in growing with their customers. Such a question is beyond the scope of this paper and requires detailed case-study-type evaluation.

Existing empirical studies of inter-firm linkages fail to set their results in a conceptual context. No consideration is given to the economic impact of linkages, i.e., whether high backward linkages translate into high employment effects or whether they lead to industry agglomerations, technology transfers or even the development of new indigenous industries. These shortcomings make it difficult to interpret the results obtained in the empirical studies and it is hard to conclude about the extent to which, if at all, policy should encourage the creation of linkages. This issue has priority in our future research agenda. We attempt to put our estimations of backward linkages into a wider context, analysing, for example, whether higher linkages translate into increasing indirect employment in Irish suppliers or lead to the development of new indigenous firms in the electronics sector in Ireland.

A Tables

Table 1: Employment in sample firms as percentage of employment in all existing firms in the sector, 1982-1995

	1982	1984	1986	1988	1990	1991	1992	1993	1994	1995
Total Foreign	**0.59**	**0.74**	**0.77**	**0.73**	**0.70**	**0.85**	**0.79**	**0.81**	**0.74**	**0.72**
Components	0.62	0.60	0.76	1.00	0.81	1.11	1.01	1.10	1.18	0.79
Computers	0.91	0.97	0.91	1.04	1.22	1.33	0.94	0.83	0.23	0.27
Consumer Electronics	0.47	0.51	0.49	0.49	0.60	0.49	0.53	0.58	0.59	0.64
Instrumentation	0.18	0.29	0.52	0.29	0.69	0.74	0.75	0.76	0.61	0.62
Networking/Data Com	0.00	0.00	0.00	0.03	0.12	0.30	0.64	0.86	0.73	1.19
PCBA	0.00	0.50	0.00	0.00	0.42	0.56	0.88	0.47	1.39	1.27
Peripherals & Media	0.52	0.89	0.97	0.96	0.99	0.99	0.96	0.98	0.49	0.63
Semiconductors	0.12	0.72	0.95	0.92	0.88	0.83	0.73	0.91	1.01	0.94
Services	0.00	0.00	0.05	0.08	0.08	0.23	0.59	1.01	0.64	0.63
Software Development	0.80	0.85	0.51	0.23	0.00	0.27	0.32	0.79	0.57	0.46
Software Production	0.00	0.00	0.00	0.00	0.21	0.87	0.82	0.18	0.86	0.88
Telecommunications	0.59	1.03	1.48	1.19	1.07	1.35	1.19	0.94	1.08	0.97
Total Irish	**0.10**	**0.38**	**0.19**	**0.27**	**0.47**	**0.48**	**0.55**	**0.60**	**0.61**	**0.56**
Components	0.20	0.20	0.24	0.40	0.54	0.66	0.66	0.77	0.74	0.65
Computers	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Consumer Electronics	0.11	1.01	0.22	0.10	1.09	0.73	0.64	1.32	1.28	0.86
Instrumentation	0.00	0.00	0.00	0.00	0.00	0.16	0.25	0.25	0.16	0.09
Networking/Data Com	0.00	0.42	0.96	0.69	0.73	0.22	0.88	0.86	0.29	0.37
PCBA	0.12	0.24	0.38	0.77	0.91	0.81	0.96	0.77	0.79	0.76
Peripherals & Media	0.70	0.00	0.30	0.62	0.00	0.35	0.41	0.00	0.52	0.64
Semiconductors	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Services	0.00	0.00	0.00	0.00	0.23	0.37	0.29	0.47	0.66	0.78
Software Development	0.00	0.00	0.00	0.00	0.00	0.23	0.35	0.18	0.22	0.23
Software Production	0.00	0.00	0.00	0.00	0.00	0.46	0.62	0.64	1.33	1.32
Telecommunications	0.00	0.17	0.00	0.25	0.78	0.40	0.61	0.65	0.74	0.73

Note: Some of the percentages are greater than 1. This may be due to the fact that Employment Survey data are collected in November while the IEE Survey is carried out in May. One may, therefore, expect small discrepancies between the employment figures obtained in the two surveys.

Source: Own estimates derived from *Forfás Irish Economy Expenditure Survey* and *Forfás Employment Survey* data

Table 2: Linkages by Sample Firms in the Electronics Sector in Ireland, 1982-1995

(Percentage of raw materials and components purchased in Ireland)

	1982	1984	1986	1988	1990	1991	1992	1993	1994	1995
Total Foreign	**0.09**	**0.08**	**0.08**	**0.10**	**0.16**	**0.24**	**0.25**	**0.17**	**0.24**	**0.23**
Components	0.09	0.07	0.06	0.11	0.13	0.14	0.14	0.13	0.13	0.16
Computers	0.08	0.06	0.06	0.07	0.11	0.13	0.14	0.19	0.14	0.27
Consumer Electronics	0.09	0.16	0.12	0.16	0.19	0.22	0.22	0.19	0.22	0.24
Instrumentation	0.13	0.30	0.16	0.34	0.24	0.22	0.14	0.18	0.28	0.30
Networking/Data Com	-	-	-	0.20	0.14	0.05	0.15	0.18	0.10	0.13
PCBA	-	0.00	-	-	0.08	0.12	0.06	0.10	0.13	0.13
Peripherals and Media	0.14	0.13	0.10	0.17	0.26	0.31	0.19	0.18	0.20	0.15
Semiconductors	0.00	0.03	0.03	0.03	0.04	0.03	0.06	0.09	0.08	0.09
Services	-	-	0.00	0.85	0.27	0.28	0.22	0.04	0.19	0.25
Software Development	0.08	0.22	0.08	0.04	0.00	0.87	0.86	0.09	0.35	0.48
Software Production	-	-	-	-	0.90	0.99	0.99	0.99	0.98	0.93
Telecommunications	0.16	0.27	0.30	0.30	0.38	0.39	0.30	0.27	0.25	0.22
Total Irish	**0.25**	**0.19**	**0.33**	**0.42**	**0.25**	**0.28**	**0.33**	**0.26**	**0.32**	**0.32**
Components	0.00	0.08	0.05	0.30	0.39	0.46	0.44	0.25	0.27	0.26
Computers	-	-	-	-	-	-	-	-	-	-
Consumer Electronics	0.35	0.08	0.49	0.26	0.19	0.13	0.19	0.25	0.23	0.14
Instrumentation	-	-	-	-	-	0.46	0.45	0.57	0.56	0.69
Networking/Data Com	-	0.23	0.44	0.35	0.34	0.00	0.18	0.19	0.00	0.00
PCBA	0.00	0.27	0.25	0.15	0.28	0.20	0.22	0.11	0.22	0.26
Peripherals and Media	-	-	0.20	0.77	-	0.50	0.37	-	0.54	0.54
Semiconductors	-	-	-	-	-	-	-	-	-	-
Services	-	-	-	-	0.52	0.63	0.34	0.38	0.42	0.41
Software Development	-	-	-	-	-	0.00	0.37	0.09	0.10	0.12
Software Production	-	-	-	-	-	0.56	0.45	0.34	0.56	0.46
Telecommunications	-	0.88	-	0.89	0.13	0.41	0.44	0.34	0.28	0.31

Note: The considerable fluctuations at the sub-sectoral level in some cases are due to the changing number of firms responding to the survey which would, in particular, affect sub-sectors with only a very small number of respondents.

Source: Own estimates derived from *Forfás Irish Economy Expenditure Survey* data

Table 3: Number of Firms in sample for econometric estimation by year

1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	Total
24	27	26	31	31	33	41	42	47	46	54	44	49	495

Source: Own estimates derived from *Forfás Irish Economy Expenditure Survey* data

Table 4: Summary Statistics for sample used for econometric estimation

	Number of Observations	Mean	Standard Deviation	Minimum	Maximum
Linkage					
All Firms	495	0.1942	0.1939	0	0.99
Foreign	391	0.1701	0.1848	0	0.99
Irish	104	0.2850	0.2010	0	0.89
Export Ratio					
All Firms	495	0.8446	0.2573	0	1
Foreign	391	0.9180	0.1698	0	1
Irish	104	0.5686	0.3332	0	1
Employment					
All Firms	495	213.7336	257.0333	12	1681
Foreign	391	253.4177	275.5795	22	1681
Irish	104	68.5926	56.8709	12	318

Source: Own estimates derived from *Forfás Irish Economy Expenditure Survey* data

Table 5: Regression Results for Panel Data Estimation

(Random Effects Model)

Variable	All Firms	Foreign Firms
constant	0.26150	0.35210
	(0.10154)***	(0.12315)***
nationality	-0.10111	--
	(0.04422)**	
employment size	-0.00011	-0.00009
	(0.00005)**	(0.00005)**
employment growth	-0.00747	-0.00638
	(0.00293)**	(0.00294)**
time	0.00832	0.00927
	(0.00158)***	(0.00163)***
export ratio	0.04108	0.11693
	(0.04367)	(0.05932)**
input growth	-0.00005	-0.00013
	(0.00007)	(0.00007)*
sectoral dummies:		
Components	-0.06572	-0.13615
	(0.10386)	(0.11210)
Computers	-0.11005	-0.14669
	(0.11385)	(0.11430)
Consumer Electronics	-0.01487	-0.08084
	(0.10933)	(0.11681)
Instrumentation	0.01253	0.04511
	(0.11083)	(0.11412)
PCBA	-0.09465	-0.17722
	(0.11557)	(0.14040)
Peripherals & Media	-0.01060	-0.07585
	(0.11034)	(0.11334)
Semiconductors	-0.09962	-0.14044
	(0.13086)	(0.12410)
Services	-0.01845	-0.03225
	(0.13019)	(0.13909)
Software Development	-0.06637	-0.10338
	(0.12011)	(0.12656)
Software Production	0.34577	0.75977
	(0.14019)**	(0.15304)
Telecommunications	0.02142	-0.06527
	(0.11141)	(0.11758)
Number of observations	495	391
Number of firms	125	90
χ^2_{17}	67.12	111.17
Probability > χ^2	0.000	0.000
R^2	0.159	0.257

Note: Standard Error in parentheses
statistically significant at *** 1 per cent ** 5 per cent * 10 per cent level

Table 6: Test for Multicollinearity

dependent variable	independent variable	Coefficient
export ratio	nationality	0.281 (0.043)***
input growth	employment growth	6.19 (2.03)***

Note: Standard Error in parentheses
statistically significant at *** 1 per cent ** 5 per cent * 10 per cent level

References

Angel, David P. (1994): "Tighter Bonds? Customer-Supplier Linkages in Semiconductors". *Regional Studies*. Vol. 28. No. 2. pp. 187-200.

Baltagi, Badi H. (1995): *Econometric Analysis of Panel Data*. Chichester: John Wiley and Sons.

Barry, Frank and Bradley, John (1997): "FDI and Trade: The Irish Host-Country Experience". *Economic Journal*. Vol. 107. pp. 1798-1811

Blomström, Magnus and Kokko, Ari (1996): "Multinational Corporations and Spillovers". Working Paper Series in Economics and Finance, No. 99. Stockholm School of Economics.

Caves, Richard E. (1996): *Multinational Enterprise and Economic Analysis*. Second Edition. Cambridge: Cambridge University Press.

Crowley, Martin (1996): *National Linkage Programme: Final Evaluation Report*. Dublin: Industry Evaluation Unit.

Davidson, Carl; Matusz, Steven J. and Kreinin, Mordechai E. (1985): "Analysis of Performance Standards for Direct Foreign Investment". *Canadian Journal of Economics*. Vol. 18. No. 4. pp. 876-890.

Forfás (1996): *Annual Survey of Irish Economy Expenditures: Results for 1994*. Dublin: Forfás.

Hirschman, Albert O. (1958): *The Strategy of Economic Development*. New Haven: Yale University Press.

Kennedy, Kieran A. (1991): "Linkages and Overseas Industry". In: Foley, Anthony and McAleese, Dermot (eds.): *Overseas Industry in Ireland*. Dublin: Gill and Macmillan. pp. 82-105.

Krugman, Paul R. (1997): "Good News from Ireland: A Geographical

Perspective". In: Gray, Alan W. (ed.): *International Perspectives on the Irish Economy*. Dublin: Indecon. pp. 38-53.

Krugman, Paul R. and Venables, Anthony J. (1995): "Globalization and the Inequality of Nations". *Quarterly Journal of Economics*. Vol. 110. pp. 857-880.

Lall, Sanjaya (1978): "Transnationals, Domestic Enterprises, and Industrial Structure in Host LDCs: A Survey". *Oxford Economic Papers*. Vol. 30. No. 2. pp. 217-248.

Lall, Sanjaya (1993): "Introduction: Transnational Corporations and Economic Development". In: Lall, Sanjaya (ed.): *Transnational Corporations and Economic Development*. United Nations Library on Transnational Corporations. Vol. 3. London: Routledge. pp. 1-27.

Leddin, Anthony and Walsh, Brendan (1997): "Economic Stabilisation, Recovery and Growth: Ireland 1979-1996". *Irish Banking Review*. Summer 1997. pp. 2-18.

Lopez-de-Silanes, Florencio; Markusen, James R. and Rutherford, Thomas E. (1996): "Trade Policy Subtleties with Multinational Firms". *European Economic Review*. Vol. 40. No. 8. pp. 1605-1627.

Markusen, James R. and Venables, Anthony J. (1997): "Foreign Direct Investment as a Catalyst for Industrial Development". NBER Working Paper No. 6241.

Marshall, Alfred (1920): *Principles of Economics: An Introductory Volume*. eighth edition. London: Macmillan.

McAleese, Dermot (1977): *A Profile of Grant-Aided Industry in Ireland*. Dublin: Industrial Development Authority.

McAleese, Dermot and McDonald, Donogh (1978): "Employment

Growth and the Development of Linkages in Foreign-Owned and Domestic Manufacturing Enterprises". *Oxford Bulletin of Economics and Statistics*. Vol. 40. No. 4. pp. 321-339.

O'Donnellan, Niall (1994): "The Presence of Porter's Sectoral Clustering in Irish Manufacturing". *Economic and Social Review*. Vol. 25. No. 3. pp. 221-232.

O'Farrell, P.N. and O'Loughlin, Brian (1980): *An Analysis of New Industry Linkages in Ireland*. Dublin: Industrial Development Authority.

O'Farrell, P.N. and O'Loughlin, Brian (1981): "New Industry Input Linkages in Ireland: An Econometric Analysis". *Environment and Planning A*. Vol. 13. No. 3. pp. 285-308.

O'Gorman, Colm; O'Malley, Eoin and Mooney, John (1997): *The Irish Indigenous Software Industry: An Application of Porter's Cluster Analysis*. Research Paper Series No. 3. Dublin: National Economic and Social Council.

O'Loughlin, Brian and O'Farrell, P.N. (1980): "Foreign Direct Investment in Ireland: Empirical Evidence and Theoretical Implications". *Economic and Social Review*. Vol. 11. No. 3. pp. 155-185.

O'Malley, Eoin (1989): *Industry and Economic Development: The Challenge for the Latecomer*. Dublin: Gill and Macmillan.

O'Malley, Eoin (1995): *An Analysis of Secondary Employment Associated with Manufacturing Industry*. General Research Series Paper No. 167. Dublin: Economic and Social Research Institute.

Porter, Michael E. (1990): *The Competitive Advantage of Nations*. London: Macmillan.

Richardson, Martin (1993): "Content Protection with Foreign

Capital". *Oxford Economic Papers*. Vol. 45. pp. 103-117.

Rodríguez-Clare, Andrés (1996): "Multinationals, Linkages, and Economic Development". *American Economic Review*. Vol. 86. No. 4. pp. 852-873.

Ruane, Frances and Görg, Holger (1997): "The Impact of Foreign Direct Investment on Sectoral Adjustment in the Irish Economy". *National Institute Economic Review*. No. 160. pp. 76-86.

Sachs, Jeffrey D. (1997): "Ireland's Growth Strategy: Lessons for Economic Development". In: Gray, Alan W. (ed.): *International Perspectives on the Irish Economy*. Dublin: Indecon. pp. 54-63.

StataCorp. (1997): *Stata Statistical Software: Release 5.0*. College Station: Stata Corp.

Stewart, J.C. (1976): "Linkages and Foreign Direct Investment". *Regional Studies*. Vol. 10. No. 2. pp. 245-258.

Strobl, Eric (1996): "Essays on Labour Dynamics in Ireland". unpublished Ph.D. thesis. Trinity College, Dublin.

Turok, Ivan (1993): "Inward Investment and Local Linkages: How Deeply Embedded is 'Silicon Glen'?". *Regional Studies*. Vol. 27. No. 5. pp. 401-417.

UNCTAD (1997): *World Investment Report 1997: Transnational Corporations, Market Structure and Competition Policy*. New York: United Nations

Venables, Anthony (1995): "Economic Integration and the Location of Firms". *American Economic Review*. Vol. 85. No. 2. pp. 296-300.

Venables, Anthony J. (1996): "Equilibrium Locations of Vertically Linked Industries". *International Economic Review*. Vol. 37. pp. 341-359.