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No. 2921

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INTERNATIONAL TRADE



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August 2001

Centre for Economic Policy Research
90–98 Goswell Rd, London EC1V 7RR, UK
Tel: (44 20) 7878 2900, Fax: (44 20) 7878 2999
Email: cepr@cepr.org, Website: www.cepr.org

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August 2001

ABSTRACT

Firm Interdependence In Foreign Production: Leading UK Firms in 1986 and 1993*

This Paper estimates econometric models explaining the foreign production of leading UK firms in 1986 and 1993. The principle questions addressed are: (i) What effect does one UK firm's foreign operations have on the foreign operations of another UK firm? (ii) What effect does the UK operations of a foreign firm have on the foreign operations of UK firms? I employ a dataset describing the manufacturing production of leading UK firms disaggregated by firm, industry, and geographical region. This is used alongside data on the UK production of leading foreign firms, disaggregated by industry and region of origin. Controlling for industry- and country-specific factors, I investigate the role of interdependence between firms' choices concerning foreign production. The evidence points to the role being significant. More widely found are negative interdependencies and those interdependencies between UK rivals (rather than between UK and foreign firms). Indeed, the negative effect of one UK firm's foreign production on other UK firms' foreign production is a result that is robust through time and across all regions.

JEL Classification: F23 and L13

Keywords: foreign direct investment and strategic interaction

Stephen Pavelin
Department of Economics
University College Dublin
Belfield
Dublin 4
IRELAND
Tel: (353 1) 706 8580
Fax: (353 1) 283 0068
Email: stephen.pavelin@ucd.ie

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* This Paper was written while the author was a post-doctoral research fellow at UCD. This research was funded by that fellowship and previously by the Economic and Social Research Council (ESRC). Thanks are due to Steve Davies, Bruce Lyons, Mike Waterson, Steve Brammer, Liam Aspin, Bruce Rhodes and David Petts for helpful comments – the usual disclaimer does, of course, apply. This Paper is produced as part of a CEPR Research Network on Foreign Direct Investment and the Multinational Corporation: New Theories and Evidence, funded by the European Commission under the Training and Mobility of Researchers Programme (Contract No ERBFMRX-CT98-0215).

Submitted 09 April 2001

NON-TECHNICAL SUMMARY

The aim is to assess empirically the interdependence between leading firms in their choices concerning the location and size of foreign manufacturing. The two key areas of investigation can be summarised by the following questions: (i) What effect does one UK firm's foreign operations have on the foreign operations of another UK firm? (ii) What effect does the UK operations of a foreign firm have on the foreign operations of UK firms?

The data set depicts the production of each leading UK firm disaggregated in two dimensions: industry, and geographical region (including the UK). Geographical regions overseas lie both inside and outside the European Union. Within the EU the sample covers Germany, France, Italy, Holland and Belgium/Luxembourg; the world outside the EU is divided into non-EU European, North America, Central/South America, Africa and Asia/Pacific. The data covers two points in time, 1986 and 1993, and so falls into four parts: EU in 1986, non-EU in 1986, EU in 1993, non-EU in 1993. These four cases are considered separately in order to permit the nature of interdependence between firms' choices to vary through time, and on an intra-EU/extra-EU basis.

An econometric model is used to explain firms' foreign production disaggregated by industry and geographical region. Each observation of the explained variable refers to the extent of firm i 's production in industry j and region k . The hypotheses relate to the firm-, industry- and region-specific influences on firm behaviour. The results from the Tobit estimation of the model exhibit a robust finding that a larger domestic share is conducive to foreign production. There is also less robust evidence that the effect from a UK rival setting up in a particular country is to depress a UK firm's production in that country.

I compare results for the EU with those for non-EU regions in both 1986 and 1993 and highlight the EU/non-EU differences and/or changes through time. The two years – 1986 and 1993 – superficially offer a 'before and after' snapshot of the '1992' legislation. In 1986 the results for the EU and non-EU regions are broadly the same. There is evidence of a negative interdependence between UK rivals and no evidence of such an effect between UK and foreign firms. But the regions differ with respect to the changes that occur over the period. The importance of interdependencies expands far more widely within the EU – perhaps contrary to the expected effect of increased export-platform behaviour. Interaction between UK rivals becomes more influential, and interaction between UK and foreign firms becomes significant over the period.

The results illustrate a real need for a concept which will allow for a variation in the nature of interdependencies between EU and non-EU and between 1986 and 1993. The underlying mechanism behind the apparent divergence between EU and non-EU FDI is unfortunately not to be resolved here. These results do, however, suggest that the regional integration process influences not only the country- and industry-specific determinants of MNE activity (as is commonly found), but also those intra-industry, inter-firm factors examined here.

1 Introduction

The aim is to assess empirically the interdependence between leading firms' in their choices concerning the location and size of foreign manufacturing production. The two key areas of investigation can be summarised by the following questions: (i) What effect does one UK firm's foreign operations have on the foreign operations of another UK firm? (ii) What effect does the UK operations of a foreign firm have on the foreign operations of UK firms? I'll say rather more in section 2 about why one might find these questions interesting. For now I will assert just that it is natural to suspect that an interdependence might exist. I think it is natural to do so because these are large firms that interact, or potentially interact, in the marketplace. Therefore, one should expect each firm's decisions to be in some way related to their rivals' decisions. There are obvious mechanisms by which their output and pricing decisions are related. Less obvious are the mechanisms by which their decisions to set up abroad may be related. However, some such mechanisms are discussed below.

The dataset depicts the production of each leading UK firm disaggregated in two dimensions: industry and geographical region (including the UK). Geographical regions overseas lie both inside and outside the European Union. Within the EU the sample covers Germany, France, Italy, Holland and Belgium/Luxembourg; the world outside the EU is divided into non-EU European, North America, Central/South America, Africa and Asia/Pacific. The data covers two points in time, 1986 and 1993, and so falls into four parts: EU in 1986, non-EU in 1986, EU in 1993, non-EU in 1993. These four cases are considered separately in order to permit the nature of interdependence between firms' choices to vary through time, and on an intra-EU/extra-EU basis.

¹ Thanks are due for financial support in the form of a post-doctoral research fellowship at UCD. The post is part of a CEPR research network: FDI and the Multinational Corporation (contract no.: ERBFMRXCT-97-0585), funded by the TMR programme of the European Commission. Thanks are also due to Steve Davies, Bruce Lyons and Mike Waterson for their helpful comments - the usual disclaimer does, of course, apply.

In the next section hypotheses will be constructed; the dataset is described in section 3; model specification and estimation are discussed in section 4; section 5 presents the results, and is followed by concluding remarks.

2 Hypotheses

An econometric model, specified in section 4, explains firms' foreign production disaggregated by industry and geographical region. Each observation of the explained variable refers to the extent of firm *i*'s production in industry *j* and region *k*. The hypotheses relate to the firm-, industry- and region-specific influences on firm behaviour.

Firm-specific advantages

The association between firm-specific advantage and MNEs is a cornerstone of standard explanations of MNE activity (see Caves (1996, pp 3-5) for a review). Firms holding such advantages are best able to undertake foreign production. The point briefly put is: firm-specific assets enable the serving of foreign markets (by overcoming the disadvantage firms face in foreign markets relative to indigenous firms), and also make it more attractive to internalise any foreign production (owing to the difficulty of arm's-length transactions in intangible assets).

However, it is difficult to directly measure a firm-specific advantage. A proxy might be the prevalence of advertising or research and development (R&D) expenditures. However, this only indirectly glimpses one part of firm-specific advantage, that derived from *successful* advertising and R&D expenditures. Firm-specific advantage can have a myriad of sources and can only be satisfactorily defined in terms of its effect - it is anything that advantages a firm relative to its rivals. So, a proxy that follows most naturally is a measure of just such an effect - I use domestic market share. The thinking is that any advantage a firm could carry with it to foreign production would also advantage it relative to domestic firms; this advantage reveals itself in the form of a relatively large domestic market share². Of course, this is only an imperfect measure of firm-specific advantage as there may be other reasons for a large domestic share to both arise³ and influence the decision to produce abroad⁴. However, the

² This echoes the Demsetzian view that a (set of) firm(s) may only attain a position of dominance in an industry as a result of being, in some way, more efficient than other firms (Demsetz (1973)). Each firm's domestic share reflects the extent of their advantage or disadvantage relative to their rivals, rather than the execution of market power by dominant firms.

³ It would be a rather extreme view to assert that market shares are entirely determined by the degree of firm-specific advantage. For example, it seems likely that hysteresis plays a role in the persistence of dominant positions.

⁴ This kind of relationship between domestic and foreign presence has alternatively been couched in terms of firms' desire for growth. It is argued that growth becomes increasingly difficult to achieve at higher levels of concentration - a firm has to steal market share from larger more efficient firms. Therefore, the larger share a firm has domestically, the more likely it is to find it optimal to grow outside the domestic market.

Indeed, another reason to believe that the two will be positively related is due to the substantial cost of setting up production abroad. This may prove to be prohibitively large, in the face of capital market imperfections, for all but those firms with the largest turnovers. It is also possible that a firm could hold a firm-specific advantage at home that it cannot carry with it to foreign production. However, if one uses the firm's penetration into foreign markets to explain its foreign production one converges on tautology.

following hypothesis will be tested:

hypothesis 1

Leading UK firms exhibit a stronger tendency towards foreign production in industries where they have larger UK market shares.

Interdependence between firms' decisions

Some theoretical work has illustrated the potential for the foreign production of firms to be interdependent. Pavelin (1999) shows this potential between firms based both in the same country, and in different countries. Furthermore, interdependence is generated by two different mechanisms - each giving very different types of interdependence. Firstly, firms compete strategically. Each firm chooses a level of investment in variable cost reduction, and whether to produce abroad. One firm's decision regarding foreign production influences a rival's decision via the former's effect on the rival's optimal output or incentive to invest. This gives a negative interdependence - one firm being multinational makes others less likely to be multinational. Secondly, firms may or may not act collusively depending on whether it is optimal to do so, and interdependence can arise out of the desire to soften competition. This gives a positive interdependence - one firm being multinational makes others more likely to be multinational.

Lets look first at the strategic modelling. Say, firms based in the same country choose whether to set up local production in the same foreign country. A firm has less incentive to be multinational if its rival is an MNE. This is because the rivals' output dedicated to the foreign market is largest as a multinational. Therefore, residual demand, and so the firm's own foreign output, is smallest when it faces an MNE in that market. The smaller is a firm's foreign dedicated output, the less likely it is to find it optimal to produce abroad - as the fixed cost of setting up an extra plant must be recouped over fewer units. Also, the smaller is the firm's output, the less likely it is to find it optimal to incur the *fixed* cost necessary to invest in variable cost reduction. A lack of investment further reduces the firm's incentives to be multinational. This is because the reductions in variable cost from investment would drive up the firm's optimal output. So to summarise, if a rival is an MNE (as opposed to an exporter or domestic firm), the firm's foreign dedicated output is reduced. This both directly, and indirectly (via incentives for investment), reduces the firm's incentives to be multinational.

Say instead it is firms based in different countries that strategically interact. In this case, there is no direct impact on foreign market operations from a rival being an MNE - the two firms' foreign markets are different markets. However the indirect effect outlined above still holds true - if the rival is an MNE, the firm's total (domestic plus foreign dedicated) output is reduced and so it has less incentive to invest. If the firm is dissuaded from investing this will depress the firm's foreign dedicated output - making the fixed cost of foreign production less attractive. Therefore, if a foreign rival sets up production

in a firm's domestic market, this reduces the firm's incentive to be an MNE. The following hypotheses are to be tested:

hypothesis 2

Leading UK firms exhibit a weaker tendency towards foreign production in a particular region, in industries with larger foreign production in the same region by other leading UK firms.

hypothesis 3

Leading UK firms exhibit a weaker tendency towards foreign production in a particular region, in industries with larger UK production by leading foreign-owned firms originating from that region.

It is interesting to delve a little deeper into the nature of inter-firm relationships by investigating whether this type of interdependence is associated with certain industry characteristics. The characteristic to be introduced into this study concerns the role of endogenous sunk cost expenditure. A typology (in the spirit of Sutton (1991) and the tradition of Schmalensee (1992) & Davies & Lyons (1996)) is used that describes whether, in each industry, advertising and/or R&D expenditures carry the potential for firms to gain advantage. Some industries, it is argued, employ only standardised technologies and produce only standardised products. Here, expenditures such as advertising and R&D do not play a significant role - these are to be referred to as type 1 industries. In other industries a potential for vertical and/or horizontal product differentiation offers scope for firms to gain from making these kinds of expenditures - type 2 industries.

This splitting of industries can be used to refine the hypothesised interdependencies. This is because of the corporate-wide investment in type 2 industries. As has already been explained, corporate-wide investment is one mechanism by which the negative relationship between firms' foreign production comes about. Indeed, it is required for there to be such an interdependence between home and foreign firms. Therefore, one would expect the negative relationship between UK firms to be most pronounced in type 2 industries (advertising and R&D being key corporate-wide investments). Similarly, one would also expect that between UK and foreign firms to be disproportionately accounted for by activities in type 2 industries. The following hypotheses are to be tested:

hypothesis 2b

The relationship described in hypothesis 2 is strongest in type 2 industries.

hypothesis 3b

The relationship described in hypothesis 3 is strongest in type 2 industries.

As I mentioned earlier, Pavelin also presents the potential for interdependence to arise from a mechanism relating to collusive behaviour. These models offer some starkly different interdependencies between firms. Firstly, firms based in the same country are shown to potentially have incentives to

undertake follow-my-leader FDI. Here, one firm being multinational may give a rival more incentive to also set up production in that same foreign country. This incentive comes from the multimarket contact that follow-my-leader FDI brings, and specifically, an accompanying improvement in the sustainability of collusion. Such a positive interdependence may also arise from what is commonly termed agglomeration forces. These are anything that acts to geographically concentrate firms' operations. Their presence makes the vicinity of a rival's production site more attractive for a firm's own production than it otherwise would be. Examples of agglomeration forces are:

- (i) The existence of geographically-specific R&D spillovers between firms;
- (ii) An informational advantage of setting up near similar plants in the presence of uncertain foreign productive environments. The success of existing plants is observable, and signals the nature of the local productive environment.

Secondly, firms based in different countries are shown to potentially have incentives for replicated FDI that run along similar lines. If a foreign firm sets up production in a second firm's home market, this may result in the latter having greater incentive to set up foreign production in the former's home. Again it is the promotion of collusive outcomes, from the multimarket contact under reciprocal FDI, that provides the impetus for reaction. The following hypotheses are to be tested:

hypothesis 4

Leading UK firms exhibit a stronger tendency towards foreign production in a particular region, in industries with larger foreign production in the same region by other leading UK firms.

hypothesis 5

Leading UK firms exhibit a stronger tendency towards foreign production in a particular region, in industries with larger UK production by leading foreign-owned firms originating from that region.

Clearly, hypotheses 4 and 5 run contrary to hypotheses 2 and 3. In interpreting the results subsequently presented, it may be possible to infer whether the interaction between firms is best characterised by strategic competition or tacit collusion.

3 Data

As previously stated, the sample consists of leading UK firms. The 'UK market share matrices' of 1986⁵ and 1993⁶, developed at the University of East Anglia, were used to obtain the sample of firms. The criterion for leadership, and so inclusion, for each matrix is: a firm is considered to be leading if it holds a place among the five firms with the largest shares, in at least one (three-digit) manufacturing

⁵ See Davies & Morris (1991).

⁶ See Davies and Petts (1997).

industry⁷. The methodology used in the matrices is to record all included firms' turnover in all manufacturing industries, i.e. those where a firm is a leader, and those where it is not. A firm enters the dataset employed here if it is on either matrix, and it is UK-owned. So from the matrices, we obtain a decomposition of UK production by industry, for each leading UK firm. This UK dataset has been extended by the construction of the 'EU market share matrices' for 1987⁸ and 1993⁹. From these matrices, we obtain consistent data on the non-UK, EU manufacturing of UK firms that are leaders at the EU level, disaggregated by industry and country.

A further two-fold extension was required: (i) to obtain EU data for those UK firms whom were UK leaders, but not EU leaders; (ii) to obtain data for UK leaders' non-EU manufacturing, by industry and region - the world outside the EU was split up into the following five regions: non-EU European, North America, Central and South America, Africa, and Asia and Pacific. I extended the dataset¹⁰ in this way using the UK and EU matrices in conjunction with company accounts to obtain sectoral and geographical residuals. Estimates were arrived at by allocating these residuals from an analysis of company information (concerning the size and activities of subsidiaries) from a variety of sources¹¹. Therefore, for each leading UK firm, the dataset describes total world manufacturing production, disaggregated by industry and geographical region.

Also, the UK matrices give us data on those foreign-owned firms whose production in the UK qualify them to be leaders by the criterion employed. As a result, this part of inward multinational penetration can be disaggregated by country of origin. Therefore, for each 'UK-foreign region' pairing, we have firm-level data, by industry, on both the UK and foreign production of leading UK firms, as well as the UK production of leading foreign firms. It is the multiple dimensions of the data that permit analysis of firm interdependence of choice both between fellow UK firms, and between UK and foreign-owned firms.

At this point, it is worthwhile to outline the way in which the information is organised. Firstly, an explanation of the characteristics of an observation in the dataset - each row contains information on

⁷ The data gleaned from the 'UK market share matrices' are arranged according to the Standard Industrial Classification (SIC 80). All data subsequently described was arranged according to NACE 0. The two are sufficiently similar for the data to be made compatible by a very simple concordance process. The SIC 80 data was transformed onto the NACE 0 classification.

⁸ 1987 data was used as a guide when deriving estimates for 1986. The figures were changed markedly if company information gave reason to believe that the picture altered in such a fashion during 1987.

⁹ See Davies & Lyons (1996). These matrices were created as part of multi-centred research projects. Participants were the University of East Anglia (Norwich), CERIS-CNR (Torino), University of Navarra (Barcelona), Katholieke Universiteit Leuven.

¹⁰ See Appendix: The Generation of the 'Leading UK Firms' Dataset, at the end of this paper.

¹¹ Most notably including company accounts, Who Owns Whom?, Key British Enterprises, CSO Business Directory, AMADEUS and Panorama of EU Industry.

a firm (i), in a particular industry (j), in a particular country or region (k). So, each firm has more observations, the more industries in which it is present somewhere in the world. For each of these industries, it has an observation for each foreign region considered - these are five EU regions (Germany, France, Italy, The Netherlands and Belgium/Luxembourg¹²), and the five non-EU regions. It is important to stress, that a firm is considered to be present in an industry if it has such production in either the UK or abroad¹³. Also, a firm is included in the dataset irrespective of whether it has foreign production - we include UK MNEs and domestic UK firms.

In 1986 the dataset contains 130 firms and shows 832 instances of foreign production, 295 in the EU and 537 outside the EU. In 1993 there are 100 firms and 729 instances of foreign production, with 306 in the EU and 423 outside the EU. The decomposition across the ten regions, is as follows:

table 1

Leading UK firms' foreign production by region

	1986			1993		
	foreign production (£million)	% of regional total	% of total	foreign production (£million)	% of regional total	% of total
Germany	5009.2	31.7	9.3	7975.8	28.9	8.4
France	3315.1	21.0	6.1	8483.6	30.8	8.9
Italy	1289.5	8.2	2.4	2471.8	9.0	2.6
Holland	2141.1	13.6	4.0	2483.4	9.0	2.6
BeLux	1323.5	8.4	2.4	2215.2	8.0	2.3
non-EU Europe	1924.0	5.0	3.6	3473.2	5.2	3.7
North America	22429.8	58.5	41.5	41609.0	61.8	43.9
C & S America	3622.0	9.5	6.7	6432.9	9.6	6.8
Africa	3071.0	8.0	5.7	2933.5	4.4	3.1
Asia/Pacific	7270.0	19.0	13.4	12829.3	19.1	13.5

Thus, most of the leading UK firms' foreign production is carried out outside the EU, where North

¹² These five were chosen from a set of ten EU regions. The excluded five are: Spain, Greece, Denmark, Portugal and Ireland. These were chosen because these are the less common destinations, of the ten within the EU, for FDI by leading UK firms. Due to the computational demands of the estimation procedure there was some reward from keeping the number of observations down to a manageable sample. Country-specific factors, as captured by fixed effects, were thought most likely to dominate in these regions. There was little foreign production by UK firms found in these countries and in each case this lay in only a few industries (over the two years: on average, each region accounted for 0.9% of total foreign production and had positive foreign production in only 11.8 industries).

¹³ The implicit assumption is that a firm does not face the decision of whether to produce abroad in all industries. Rather a firm only faces this decision in some subset of industries. This subset includes only those industries in which the firm is active somewhere in the world (including the UK). The point is that while firms can be very diversified, they are typically potentially associated with only a small set of industries - British Aerospace doesn't wrestle with the pros and cons of producing biscuits in Finland. (This is an assertion on my part, I present no direct evidence of this. The indirect evidence is that such production is not observed in the dataset I use in this paper.) Once a firm is considered active in an industry, it is assumed to face a decision of whether to have foreign production in each of the regions considered.

America appears to be the most popular destination. Within the EU, it is Germany and France that appear to be most popular and account for more than half of the EU total.

4 Model Specification & Method of Estimation

The explained variable for econometric analysis, obtained from this dataset is defined as follows:

$UKMNES_{ijk}$ = Leading UK firm i 's foreign production in industry j and region k ,
deflated by total UK industry size.

The explanatory variables are defined as follows:

$RIVAL S_{ijk}$ = Total production, in industry j and region k , by leading UK firms other than
firm i , deflated by total UK industry size ($RIVAL S_{ajk} = \sum_i UKMNES_{ijk}$ for all $i \neq a$).

$UKMKTS_{ij}$ = Leading UK firm i 's UK production in industry j deflated by total UK industry size.

$FOMNES_{jk}$ = UK production in industry j by leading foreign-owned firms from region k ,
deflated by total UK industry size¹⁴.

Dependent variable

I choose to explain the level of foreign operations rather than the change over the period (1986 to 1993). It can be argued that one would adhere more closely to the theoretical analysis outlined in section 2 by assessing the extent to which a firm's foreign operations change in response to changes in rivals' behaviour. A levels measure was preferred firstly because of the shortcomings of an analysis in changes over only one time period. Given multiple time periods (i.e. three or more observation points), it would be possible to allow for various time lags between an initial move and any response. Here one would hope that any responses over the period were in response to initial moves made during the period - rather than before; and that any initial moves over the period receive their response during the period - rather than after. By adopting a levels measure, one does not restrict one's view to interdependence in moves between 1986 and 1993. Instead one takes a snapshot of the pattern of production and looks for evidence of the footprint from where such interdependence has been. This is to say that the current production decisions of firms can potentially reveal a history of either strategic substitutability or clustering in FDI decisions.

Secondly, the use of a change variable would involve a significant loss of information arising from a loss of observations owing to firm turbulence in the sample. Any firm that enters or leaves the sample over the period must be omitted if using a changes measure. This would mean that information lost from not only the dependent variable but also the $RIVAL S_{ijk}$ independent variable - entering and leaving firms would cease to be both a potential MNE and a potential rival of a potential MNE. Despite these reservations however, the robustness of any interdependence to the use of a change measure would be important for establishing convincing evidence and represents an opportunity for future

¹⁴ In 1986 $FOMNES_{jk}$ contains £25801.7 million of UK production (6097.4 by non-UK EU firms, 19704.3 by non-EU firms). In 1993 $FOMNES_{jk}$ contains £49600.0 million of UK production (12651.9 by non-UK EU firms, 36948.1 by non-EU firms).

research.

Industry-specific factors

If one is to isolate the influence of a firm's behaviour on a rival, all other influences must be swept aside. So, in order to reveal the importance of firm-level effects it is necessary to disentangle them from the cross-industry pattern in multinationality. The method employed to capture the industry-specific factors affecting firms' decisions is somewhat atheoretical: I specify industry fixed effects. This means that model specification includes a set of industry dummy variables, i.e. there is one binary variable (1 if the observation relates to the particular industry, and 0 otherwise) for each industry covered in the sample. The effect is to allow the constant to vary in line with the apparent cross-industry pattern in multinationality.

This is atheoretical because it does not provide an explanation of this cross-industry pattern in multinational production. However, it is not the aim of this study to provide such an explanation. The aim is to investigate the intra-industry mechanisms at work, and these can only be effectively explored once one has controlled for all other influences on firm behaviour. An alternative method of doing so would be to employ observed industry-specific explanatory variables (e.g. measures of economies of scale, market size, transport costs, advertising and R&D expenditures). However, such variables can only do as well as industry fixed effects in explaining the cross-industry pattern, and their explanatory power will almost inevitably be hampered by omitted variables. If not all relevant industry variables are included, those that are included will not do as well as fixed effects in capturing the cross-industry variation in foreign production. As a result, fixed effects offer the best prospects of controlling for industry-specific factors, thereby minimising the pollution of results concerning intra-industry, firm-level, mechanisms.

Firm-specific advantages

According to hypothesis 1, a firm's domestic share in a particular industry will positively affect its foreign production in that industry¹⁵. Thereby predicting a positive coefficient on $UKMKTS_{ij}$.

Interdependence between firms' decisions

The strategic interdependencies predict that a firm's foreign production ($UKMNES_{ijk}$) will be decreasing in its fellow UK-based rivals' foreign production ($RIVAL_{S_{ijk}}$), and also decreasing in its foreign-based competitors' UK production ($FOMNES_{jk}$) - hypotheses 2 and 3. Whereas interdependencies from the promotion of collusive outcomes predict that a firm's foreign production ($UKMNES_{ijk}$) will be increasing in its fellow UK-based rivals' foreign production ($RIVAL_{S_{ijk}}$), and also

¹⁵ Theoretical work outlined previously gives some reason to believe that there is a more complicated relationship between a firm's domestic and foreign production. In the strategic interaction models described in section 2, large foreign output makes it more likely that a firm will invest (as total output is large). If it invests, it is more likely to have a large domestic share (via corporate-wide benefit from investment). Therefore, in a sense, larger foreign production causes larger domestic production via the former's effect on investment. This would potentially be captured by endogenising $UKMKTS_{ij}$ and employing a simultaneous equation econometric model. This offers potential for future research.

increasing in its foreign based competitors' UK production (FOMNES_{jk}) - hypotheses 4 and 5.

Interaction terms are included to test hypotheses 2b and 3b. RIVAL2_{ijk} and FOMNES2_{jk} are interaction terms between TYPE2_j and the firm interdependence variables RIVAL2_{ijk} and FOMNES_{jk} respectively¹⁶. TYPE2_j is a binary dummy variable (1 if industry is type 2, 0 otherwise¹⁷) as used by Davies & Lyons (1996). It is defined in their work as follows:

“A Type 2 industry is one in which typically or innately (i.e. in most countries and in most time periods) firms engage in advertising and/or R&D competition. Roughly speaking, this means industries which have an advertising to sales ratio and/or R&D to sales ratio in excess of 1%. A Type 1 industry is one in which firms engage in neither type of competition.”

Davies & Lyons (1996, p. 28)

Hypothesis 2b would find support from a negative coefficient on RIVAL2_{ijk}. Similarly, a negative effect from FOMNES2_{jk} would provide evidence in support of hypothesis 3b.

Country-specific Factors

There are various reasons why one might expect UK firms to view foreign production in one country very differently from that in another country. There are three ways in which the destination of FDI is determined in the econometric model. Firstly, there are the variables (just outlined) that capture any interdependence between firms' location choices. These permit firms to find either clustering foreign production in the same countries, or avoiding targeting the same destinations, attractive in itself. For example, a firm may choose a particular country as a site for a plant, not because of any characteristic of that country (market size, price of raw materials, skills of local labour etc.) other than the presence there of its UK rivals (or perhaps the UK presence of that country's indigenous firms).

To these influences is added a set of regional dummies to capture the broad attractiveness of that region as a destination. These are the most general types of regional characteristics, in that they are not industry-specific, and are most useful in controlling for regional size differences (if one is to compare production in North America with that in The Netherlands it is necessary to understand that the former would be expected to be larger for reasons not explained by firm or industry factors). Predispositions of UK firms to target particular regions over others for historical and/or cultural reasons (thinking again here of North America) is also potentially captured by regional fixed effects. The aim, however, is not to dig very deeply into these locational factors. I firmly focus upon the interdependence

¹⁶ The interaction terms are defined as follows: RIVAL2_{ijk}=RIVAL2_{ijk} x TYPE2_j and FOMNES2_{jk}=FOMNES_{jk} x TYPE2_j.

¹⁷ Of the 97 industries, 45 are classified type 1, 52 are type 2.

between firms and wish only to *control* for country-specific factors, rather than investigate their nature.

The last of the three ways in which destination is permitted to take on an important role is by allowing the nature of firm interdependencies to vary across regions. Were one to simply estimate a single coefficient for each of $RIVAL_{ijk}$ and $FOMNES_{jk}$, then the implicit assumption would be that firms interact in the same fashion in all regions. Alternatively, one could allow the interdependencies to be specific to each region, but this would bring a large increase in the number estimates generated and would move the focus emphatically away from an investigation of a general tendency. I adopt a compromise between the two, by permitting the coefficients to vary between the EU and non-EU regions.

A priori reasons for supposing that the nature of interdependencies may differ inside and outside the EU arise because the dataset covers the era of Single European Market (SEM) legislation in the EU. The aim was to lower barriers to trade between EU countries to encourage intra-regional arbitrage and eliminate distortions. This impacts on firms' location decisions by augmenting the relative attractiveness of exporting versus foreign production. The prospect of the formation of integrated markets at the EU level may also alter the manner in which UK firms interact with firms based in other EU countries. For example, UK firms may be multinational within the EU, increasingly in order to serve a wider market than that in the host country, i.e. export-platform FDI. This would dilute the importance of country pairings in inter-firm interdependence. It would not simply be host country firms whose home the UK firm would be invading, but also that of firms based in destinations for goods exported from the platform. So interdependence between UK and foreign firms would not be expected to be captured fully by a relationship between UK and host country firms' foreign production in the host country and the UK respectively. Similarly, the full interdependence between fellow UK rivals would not be revealed by a relationship between those firms' production in a particular host. This is because they can interact on the back of FDI not only through host country contact, but also via exports from the host to a third country market.

The coefficients on the firm-level variables are permitted to vary in this way by subsampling. UK firms' foreign production within the EU and UK firms' non-EU production are explained separately. The results can be compared and contrasted.

Time

The dataset covers two points in time: 1986 and 1993. One option is to pool the data and include a time dummy, thereby restricting all other coefficients to be the same in both years. This is a little too restrictive as it reduces the potential for change over the period to a shift in the broadest kind of predisposition to produce abroad. For example, one could interpret a positive time coefficient as evidence that foreign production became more attractive in a non-firm-industry-region-specific way. All other influences upon firms' decisions would be presumed constant over the time period. I instead opt

to split the sample and estimate the model for each year separately. This permits the coefficients on all variables to vary between the years and the results to be compared and contrasted.

So, the model specification employed, is as follows:

$$\text{UKMNES}_{ijk} = \beta_0 + \beta_1 \text{RIVAL S}_{ijk} + \beta_2 \text{UKMKTS}_{ij} + \beta_3 \text{FOMNES}_{jk} + \beta_4 \text{RIVAL S2}_{ijk} + \beta_5 \text{FOMNES2}_{jk} + \beta_6 \text{industry}_i + \beta_7 \text{country}_k$$

The method of estimation required here is Tobit¹⁸ because the explained variable is censored at zero (with UKMNES_{ijk} 93.0% zeros within the EU in 1986, 90.7% in 1993, 87.3% outside the EU in 1986, and 87.1% in 1993).

It is important to recognise the potential for endogeneity. The approach here is to explain the choice concerning one opportunity for foreign production (UKMNES_{ijk}) using the choice taken in another opportunity (RIVAL S_{ijk} and FOMNES_{jk}). If there is interdependence between firms' decisions, there is no one-way causation. It is not only that a particular firm's choice is determined by its rivals' choices, but also that the particular firm's choice influences its rivals' choices. In the case of UK rivals, this poses few problems as all choices feature in both explained and explanatory variables in different observations: all firms' foreign production appears as part of both UKMNES_{ijk} and RIVAL S_{ijk}. The assumption is simply that the nature of the interdependence between UK rivals is the same for all firms in all (type 1 or 2) industries and regions. More problematic is the endogeneity of FOMNES_{jk}. The point is that if FOMNES_{jk} determines UKMNES_{ijk}, it must be true that (unless the UK is in some unique position) UKMNES_{ijk} determines FOMNES_{jk}. The UK is, after all, a foreign country to everybody else. My response is to utilise the time dimension of the dataset. Equations explaining 1993 UKMNES_{ijk} data will be estimated using lagged observations on FOMNES_{jk} from 1986¹⁹ (referred to as 86FOMNES_{jk} in these regression results)²⁰. It is not possible to use lagged values²⁰ in explaining 1986 data as no earlier dataset is available. Results will first be presented for both 1986 and 1993 using contemporary values of FOMNES_{jk}. The estimates obtained using lagged values will then be used as evidence concerning the robustness of results to the greater degree of exogeneity.

Horizontal and Vertical MNEs

¹⁸ The estimation was carried out using the econometric software package, Limdep. Tobit estimation is preferred to the Heckman procedure because of the former's more complete use of information when explaining the choice to become multinational. However, the application of the latter to this dataset represents an opportunity for future research.

¹⁹ The point is that decisions in 1993 cannot be said to influence those taken in 1986. An alternative, and in many ways superior, solution would be to endogenise FOMNES_{jk} within a simultaneous econometric model. This offers an opportunity for future research.

²⁰ The correlation coefficient between 1986 and 1993 FOMNES_{jk} data is 71.6% for the EU, and 74.4% for non-EU regions.

The above hypotheses are based upon models of horizontal multinational production. Thus, an MNE is characterised as a firm that produces the same good in more than one country in order to serve more than one geographical market for that good. There are other types of multinational production, such as that carried out by vertical and diversified MNEs. A vertical MNE locates the stages of a multi-stage production process in more than one country. Diversified multinational production is also carried out by a firm that produces more than one good, but in this case the goods are not vertically related.

How consistent is this kind of MNE activity with the hypothesised explanations of foreign production? The mechanisms underlying the hypotheses given above, rely upon firms serving the local market when producing in that country, as would be expected of horizontal and diversified MNEs. However, vertical MNEs do not generate this kind of interdependence because foreign production does not imply that the firm serves the foreign market for that good. Instead one would typically associate vertical MNEs with exporting those goods produced abroad either back home, or to a third country, so they may either be used as an input in a downstream production process or serve final consumers. Therefore, to the extent that vertical multinational production dominates the dataset, one would not expect the hypothesised interdependence between firms' choices.

What reason is there to think that there is no such preponderance of vertical MNEs? There is general evidence that multinational sales are predominantly horizontal in nature²¹. Indeed, this is more overwhelmingly true of FDI flows between developed countries. Looking at the dataset itself, one can say something about the likely presence of vertical multinational production. Remember that vertical MNEs locate different activities in different countries. Therefore, one would expect their behaviour to be associated with foreign production in activities that are not carried out in the UK. The point of being vertically multinational is that more attractive sites for those particular operations are to be found abroad. This is not to say that vertical MNEs are inconsistent with producing in the same (three-digit) industry in the UK and overseas. However, one would expect that excluding all observations where $UKMKTS_{ij}=0$ focuses the data more closely on horizontal organisation²². So, I present results explaining both all foreign production, and just that in industries where the firm also has a UK presence.

²¹ For example, Brainard (1993) reports that US-owned MNEs import 13% of foreign production back to the US, and non-US-owned MNEs import 2% of their US production back home.

²² The exclusion of observations with $UKMKTS_{ij}=0$ focuses attention upon explaining foreign activities that mirror those carried out in the UK. However, the foreign production excluded from the explained variable is present in the explanatory variable $RIVAL_{ijk}$, i.e. both ' $UKMKTS_{ij}>0$ ' and ' $UKMKTS_{ij}=0$ ' foreign production is included in $RIVAL_{ijk}$. If all of the excluded foreign production is vertically organised, then this fact will act to muddy the waters somewhat. As the vertical MNEs do not typically intend their output to serve the local market (and instead export to a downstream affiliate, or to final consumers), they do not face a horizontal UK MNE also producing in that country (to serve the local market). Therefore, the part of $RIVAL_{ijk}$ made up by vertical MNEs does not signify potential inter-firm interaction in that country, and so if an interdependence is found despite the presence of such noise it represents good evidence of the hypothesised relationships. The excluded production figures remain on the RHS as it would be a rather extreme assertion that all of the excluded observations are vertical multinational production. Scrubbing these operations from the dataset would be a loss of information that is not justified given the expected benign consequences of its inclusion.

It seems quite possible that there would be interdependence between vertical MNEs' in their location decisions. It is the risk of pollution from these interdependencies that is reduced by excluding observations - so long as vertical MNEs do not appear on the LHS, one is not explaining vertical multinationality using other vertical MNEs' foreign production.

The proportion of instances of foreign production by leading UK firms that lies in an industry other than those with accompanying domestic activity²³ is: 12.9% - EU in 1986; 22.2% - non-EU in 1986; 18.3% - EU in 1993; and 18.2% - non-EU in 1993. These percentages are quite high - accounting for as much as around one fifth of all instances of foreign operations. Having constructed a large part of the dataset, my feeling is that this would represent a significant over-estimation of the prevalence of vertical multinationality. One must remember that these figures also include diversified operations. Nevertheless, comparing the results with and without these observations may permit us to gain a feel for any dichotomy concerning firm interdependence between horizontal and other multinationality.

5 Results

The results from the Tobit estimation²⁴ of the model specified in the previous section are shown in table 2²⁵ (t statistics in parentheses²⁶). There are four samples used: UK firms' foreign production (i) within the EU in 1986; (ii) outside the EU in 1986; (iii) within the EU in 1993; and (iv) outside the EU in 1993²⁷.

²³ This is the number of observations for which both $UKMNE_{ijk} > 0$ and $UKMKTS_{ij} = 0$, divided by the number of observations for which $UKMNE_{ijk} > 0$.

²⁴ White's test for heteroscedasticity was carried out for all model specifications presented. No evidence of heteroscedasticity was found.

²⁵ In all regressions shown in table 2 there are 104 independent variables (4 shown, 4 regional dummies and 96 industry dummies).

²⁶ It could be argued that sampling theory is not relevant to this study. This is not a random sample in the conventional sense, i.e. the population is not all firms in all years and my 'random' sample does not just happen to be made up of only UK firms in 1986 and 1993. The justification for using sampling theory is that this is a random sample of all the alternative realities that could have existed given the underlying determining factors.

In table 2 (and all subsequent tables), stars given next to coefficients indicate the level of confidence (90% is *, 95% is **, 99% is ***) that one can reject the null hypothesis that the coefficient is zero, in a two-tailed hypothesis test.

²⁷ The validity of instead pooling the data can be assessed using a Chow test for the presence of structural breaks between the EU and non-EU and/or between 1986 and 1993. I have not performed such a test as computational demands of estimating the model using the pooled sample are prohibitively large. However, the results presented here suggest that pooling the data would conceal a number of inter-regional and intertemporal differences.

table 2
The Basic Model

	1986	1986	1993	1993	1993	1993
	EU	non-EU	EU	EU	non-EU	non-EU
constant	-0.101*** (-10.26)	-0.136*** (-12.39)	-0.184*** (-9.118)	-0.184*** (-9.121)	-0.230*** (-10.17)	-0.230*** (10.15)
RIVAL _{ijk}	-0.218*** (-3.484)	-0.166*** (-5.861)	-0.615*** (-4.394)	-0.612*** (-4.385)	-0.322 (-1.274)	-0.029 (-1.158)
UKMKTS _{ij}	0.191*** (6.998)	0.157*** (5.844)	0.444*** (6.623)	0.445*** (6.642)	0.362*** (5.910)	0.363*** (5.914)
FOMNES _{jk}	0.041 (0.574)	0.025 (0.696)	-0.162 (-0.996)		0.053 (0.672)	
86FOMNES _{jk}				-0.371 (-1.265)		0.030 (0.238)
σ	0.049*** (21.45)	0.066*** (29.80)	0.110*** (23.36)	0.110*** (23.36)	0.125*** (26.50)	0.125*** (26.50)
log-likelihood	-48.4	-176.5	-195.6	-195.2	-247.4	-247.6
no. observations	4240	4240	3290	3290	3290	3290

The key aspects of the results are as follows:

- A robust finding that the sign on UKMKTS_{ij} is positive and highly significant, provides strong evidence that a larger domestic share is conducive to foreign production (hypothesis 1).
- Less robust is the negative coefficient on RIVAL_{ijk} found in both the EU and non-EU regions in 1986 and in the EU in 1993. This provides evidence that the effect from a UK rival setting up in a particular country is to depress a UK firm's production in that country (hypothesis 2).
- Non-EU regions in 1993 yield a coefficient on RIVAL_{ijk} not significantly different from zero. So, in this case there is no evidence in support of either hypothesis 2 or 4, and there appears to be no interdependence of this type between firms.
- The coefficient on FOMNES_{jk} is not significantly different from zero for either the EU or non-EU regions in either 1986 or 1993. Therefore, there is no evidence in support of hypotheses 3 or 5.
- Results for 1993 are robust to the use of lagged values of FOMNES_{jk}.

How does the picture change when one discriminates between industry types in line with hypotheses 2b and 3b? The results presented in table 3²⁸ include RIVAL_{2ijk} and FOMNES_{2jk} (or 86FOMNES_{2jk}). The coefficients on these variables reveal some differences between type 1 and 2 industries with respect to interdependencies between firms. The coefficients on RIVAL_{ijk} and (86)FOMNES_{jk} reflect the relationships in type 1 industries. Whereas, the relationship in type 2 industries

²⁸ In all regressions shown in table 3 there are 106 independent variables (6 shown, 4 regional dummies and 96 industry dummies).

is revealed by the net coefficient, once the interaction variable is also taken into account, i.e. by summing the coefficients on $RIVAL S_{ijk}$ and $RIVAL S2_{ijk}$, and by summing those on $(86)FOMNES_{jk}$ and $(86)FOMNES2_{jk}$.

table 3
Allowing for Differences Between Broad Industry Types

	1986	1986	1993	1993	1993	1993
	EU	non-EU	EU	EU	non-EU	non-EU
constant	-0.098*** (-9.742)	-0.135*** (-12.17)	-0.186*** (-9.145)	-0.184*** (-9.061)	-0.222*** (-9.962)	-0.224*** (10.03)
$RIVAL S_{ijk}$	-0.348*** (-2.738)	-0.228*** (-4.014)	-0.467*** (-3.041)	-0.485*** (-3.158)	-0.292*** (-4.291)	-0.298*** (-4.362)
$UKMKTS_{ij}$	0.191*** (7.011)	0.156*** (5.828)	0.436*** (6.522)	0.437*** (6.552)	0.353*** (5.782)	0.353*** (5.797)
$FOMNES_{jk}$	0.059 (0.540)	-0.121 (-0.665)	-1.429** (-2.050)		-0.468 (-1.605)	
$86FOMNES_{jk}$				-2.765** (-2.048)		-0.198 (-0.392)
$RIVAL S2_{ijk}$	0.165 (1.192)	0.074 (1.276)	-0.619** (-1.986)	-0.567* (-1.832)	0.283*** (4.077)	0.290*** (4.260)
$FOMNES2_{jk}$	-0.032 (-0.234)	0.143 (0.775)	1.334* (1.872)		0.465 (1.564)	
$86FOMNES2_{jk}$				2.666* (1.944)		0.154 (0.302)
σ	0.049*** (21.45)	0.066*** (29.80)	0.109*** (23.36)	0.109*** (23.38)	0.124*** (26.55)	0.124*** (26.55)
log-likelihood	-47.6	17.8	-191.5	-189.7	-236.7	-237.9
no. observations	4240	4240	3290	3290	3290	3290

- The sign on $UKMKTS_{ij}$ is again positive and highly significant in all instances.
- A robust finding in type 1 industries of a negative coefficient on $RIVAL S_{ijk}$.
- In 1986 the interaction variables are insignificant. So there does not appear to be a dichotomy between type 1 and type 2 industries.
- In 1993 there is evidence that, in non-EU regions, the negative effect of $RIVAL S_{ijk}$ is weaker in type 2 industries.
- In 1993 there is evidence that, in the EU, the negative effect of $RIVAL S_{ijk}$ is stronger in type 2 industries.
- In 1993 there is evidence that, in the EU, $FOMNES_{jk}$ has a negative effect that is stronger in type 1 industries.
- Results for 1993 are again robust to the use of lagged values of $FOMNES_{jk}$.

It is interesting to note that the results presented absent the interaction variables (table 2)

showed $RIVAL S_{ijk}$ to be insignificant outside the EU in 1993. This appears to have come about as a result of the negative effect in type 1 industries being masked by the weaker effect in type 2 industries.

What of the interdependence between UK rivals - hypotheses 2, 2b and 4? Table 3 shows negative coefficients on $RIVAL S_{ijk}$ for both the EU and non-EU regions in 1986 and 1993. Indeed, even in the case where $RIVAL S2_{ijk}$ is positively signed, the net coefficient for type 2 industries is negative. Therefore, once one permits a dichotomy between industry types, the weight of evidence in support hypothesis 2 grows. The effect, in all regions and in both years, from a UK rival setting up in a particular country is to discourage a UK firm from producing in that country.

Hypothesis 2b receives no support from the results for 1986, which do not detect a role for industry type. However, evidence from 1993 is rather more mixed. Within the EU, results provide evidence in support of hypothesis 2b - both $RIVAL S_{ijk}$ and $RIVAL S2_{ijk}$ are negatively signed. However, for non-EU destinations, the negative interdependence between UK rivals is not strongest in type 2 industries but rather in type 1 industries. This does not sit well with hypothesis 2b that states the opposite would be the case - that the effect would be strongest in type 2 industries. An explanation for this might lie in the mechanisms underlying hypothesis 4.

The weight of evidence in support of hypothesis 2 runs contrary to hypothesis 4's prediction of a positive relationship. However, the effect of $RIVAL S_{ijk}$ may be weaker in type 2 industries because of a greater tendency in such industries for FDI to be motivated by a desire to soften competition. Thus, the positive sign on $RIVAL S2_{ijk}$ represents the offsetting effect of such motives on the overall interdependence between firms. This is a rather tentative assertion on my part as it is difficult to say what the a priori expectations should be. Advertising and R&D expenditures may affect the prevalence of motives for FDI relating to softening competition in a number of ways. For example, they may cause high concentration that permits collusive outcomes to be potentially attainable; they may lead to product differentiation that makes collusion problematic. Tentative as it is, I think that this may be a glimpse of a tendency toward follow-my-leader behaviour into non-EU destinations that would benefit from further investigation.

What of the interdependence between UK and foreign firms - hypotheses 3, 3b and 5? The coefficients on $(86)FOMNES_{jk}$ and $(86)FOMNES2_{jk}$ are insignificant in all cases apart from the EU in 1993. Therefore, there is no evidence in support of hypotheses 3, 3b or 5 from the EU in 1986 or from non-EU regions. However, the EU in 1993, a negatively signed $(86)FOMNES_{jk}$ is paired with a positive coefficient on $(86)FOMNES2_{jk}$. The net coefficient for type 2 industries is negative but relatively close to zero - evidence of a negative relationship that is found most strongly in type 1 industries. This supports hypothesis 3 but contradicts hypothesis 3b's statement that the effect will be strongest in type 2 industries. Just as was proposed above (for a similar $RIVAL S_{ijk}$ case), an explanation for this might lie

in the motives for FDI associated with the softening of competition (as in hypothesis 5). Despite the weight of evidence in support of hypothesis 3 running contrary to hypothesis 5's prediction of a positive relationship, this may be a glimpse of a tendency toward reciprocal behaviour between UK and EU firms that would benefit from further investigation.

Horizontal and Vertical Multinationals

As anticipated previously, the regressions have been re-estimated excluding those observations with $UKMKTS_{ij}=0$. This focuses attention on horizontal multinationality by explaining foreign production only in those industries in which the firm also has UK operations. Results from the restricted sample turn out to be very similar to those from the whole sample, but there are some differences and these will be discussed in this section - starting with the specification absent 'industry type' interaction variables.

table 4

The Basic Model estimated using the restricted sample

	1986	1986	1993	1993	1993	1993
	EU	non-EU	EU	EU	non-EU	non-EU
constant	-0.108*** (-9.335)	-0.140*** (-11.15)	-0.201*** (-8.452)	-0.201*** (-8.441)	-0.190*** (-9.032)	-0.190*** (9.045)
RIVAL S_{ijk}	-0.297*** (-3.850)	-0.169*** (-5.686)	-0.552*** (-3.708)	-0.548*** (-3.687)	-0.093*** (-2.849)	-0.095*** (-2.881)
UKMK T_{ij}	0.193*** (6.843)	0.157*** (5.844)	0.523*** (6.901)	0.523*** (6.904)	0.431*** (7.406)	0.430*** (7.406)
FOMNE S_{jk}	0.091 (1.166)	0.036 (0.779)	-0.159 (-0.898)		0.012 (0.162)	
86FOMNE S_{jk}				-0.210 (-0.659)		-0.057 (-0.494)
σ	0.048*** (20.16)	0.064*** (26.32)	0.113*** (21.30)	0.113*** (21.30)	0.106*** (24.14)	0.106*** (24.15)
log-likelihood	-11.9	28.6	-147.1	-147.3	-120.3	-120.2
no. observations	3680	3680	2860	2860	2860	2860

The key difference between tables 4²⁹ and 2 concerns the performance of RIVAL S_{ijk} outside the EU in 1993. In table 2, RIVAL S_{ijk} was not significant, whereas here it has a negative coefficient that is significant at the 99% level of confidence. Thus, exclusion provides a sample that exhibits a more pronounced tendency towards the relationships described in hypothesis 2. Now RIVAL S_{ijk} attracts a significant negative sign both inside and outside the EU and in both years.

²⁹ In all regressions for 1986 shown in table 4 there are 101 independent variables (4 shown, 4 regional dummies and 93 industry dummies). In all regressions for 1993 shown in table 4 there are 102 independent variables (4 shown, 4 regional dummies and 94 industry dummies).

Next, the results for this restricted sample incorporating the 'type 1/type 2' dichotomy (table 5³⁰). Again, they are very similar to those found using the whole sample, but with one minor difference.

table 5
Allowing for Differences Between Broad Industry Types: restricted sample

	1986	1986	1993	1993	1993	1993
	EU	non-EU	EU	EU	non-EU	non-EU
constant	-0.107*** (-8.992)	-0.138*** (-10.97)	-0.200*** (-8.424)	-0.201*** (-8.421)	-0.185*** (-8.886)	-0.186*** (8.942)
RIVAL _{ijk}	-0.358*** (-2.659)	-0.241*** (-3.872)	-0.397** (-2.380)	-0.403** (-2.410)	-0.239*** (-3.819)	-0.248*** (-3.948)
UKMKTS _{ij}	0.194*** (6.856)	0.219*** (7.572)	0.518*** (6.874)	0.517*** (6.857)	0.426*** (7.361)	0.425*** (7.361)
FOMNES _{jk}	0.268 (1.360)	-0.079 (-0.420)	-2.697*** (-2.658)		-0.387 (-1.464)	
86FOMNES _{jk}				-2.671** (-2.014)		-0.115 (-0.263)
RIVAL2 _{ijk}	0.086 (0.562)	0.083 (1.326)	-0.672** (-1.999)	-0.626* (-1.868)	0.179*** (2.698)	0.188*** (2.898)
FOMNES2 _{jk}	-0.232 (-1.082)	0.110 (0.573)	2.648*** (2.577)		0.370 (1.376)	
86FOMNES2 _{jk}				2.788** (2.058)		0.016 (0.035)
σ	0.046*** (20.15)	0.064*** (26.32)	0.111*** (21.35)	0.111*** (21.34)	0.105*** (24.17)	0.105*** (24.17)
log-likelihood	-11.0	30.0	-140.0	-141.4	-115.1	-115.8
no. observations	3680	3680	2860	2860	2860	2860

For the EU in 1993, there is a positive net coefficient for type 2 industries on 86FOMNES_{jk} (-2.671+2.788). This differs from the negative sign obtained in the full sample. The net coefficient for FOMNES_{jk} is negative and so is in line with the previous results. This difference between the use of contemporary or lagged values of FOMNES_{jk} is not as great as it may sound - in both cases the net coefficient is relatively close to zero.

The broad consistency between the results from the full and narrowed samples suggests that it is those mechanisms at work on horizontal foreign production that dominate the choices of leading UK firms. Indeed, the results presented in tables 4 and 5 provide striking evidence that the mechanisms include a role for firm interdependence.

³⁰ In all regressions for 1986 shown in table 5 there are 103 independent variables (6 shown, 4 regional dummies and 93 industry dummies). In all regressions for 1993 shown in table 5 there are 104 independent variables (6 shown, 4 regional dummies and 94 industry dummies).

EU Integration

Some previous empirical work has pointed to increased MNE activity from regional integration (Blomstrom & Kokko (1997), Aristotelous & Fountas (1996)). Indeed, a broad range of case studies provide compelling evidence for the coincidence of integration and such a change. The aim here is to investigate whether there appears to have been any impact on the nature of firm interdependencies. I compare results for the EU with those for non-EU regions in both 1986 and 1993 and highlight the EU/non-EU differences and/or changes through time. The two years - 1986 and 1993 - superficially offer a 'before and after' snapshot of the '1992' legislation. However, it would be facile to suppose that the legislation was not in firms' minds in 1986 or that the impact had been fully felt in 1993. Regional integration is a process, and these two years represent two stages of development - i.e. one would merely expect that the integration process is further along in the later year.

In 1986 the results for the EU and non-EU regions are broadly the same. There is evidence of a negative interdependence between UK rivals and no evidence of such an effect between UK and foreign firms. This was equally true of both type 1 and 2 industries. But the regions differ with respect to the changes that occur over the period. For the non-EU regions, there is evidence of decreasing interdependence between UK rivals in type 2 industries. The opposite is true within the EU, where a tendency emerges for the greatest interdependence between UK rivals to lie in type 2 industries. Interdependence between UK and foreign firms fails to be detected in either year in regions outside the EU, but emerges over the period in type 1 industries within the EU.

So, there is some evidence of divergence between EU and non-EU FDI with respect to firm interdependence. Outside the EU, interaction between UK firms becomes more important in type 1 industries (marginal effect is approximately doubled), but becomes of little import in type 2 industries. In contrast, the importance of interdependencies expands far more widely within the EU - perhaps contrary to the expected effect of increased export-platform behaviour. Interaction between UK rivals becomes more influential (marginal effect is more than doubled) especially in type 2 industries (where it is increased more than five-fold). While interaction between UK and foreign firms, concentrated in type 1 industries, becomes significant over the period.

The results illustrate a real need to allow the nature of interdependencies to vary between EU and non-EU and between 1986 and 1993. The underlying mechanisms behind the apparent divergence between EU and non-EU FDI is unfortunately not to be resolved here. However, these results do suggest that the regional integration process influences not only the country- and industry-specific determinants of MNE activity (as is commonly found), but also those intra-industry, inter-firm factors examined here.

6 Conclusion

I employ a dataset describing the manufacturing production of leading UK firms disaggregated by firm, industry, and geographical region. This is used alongside data on the UK production of leading foreign firms, disaggregated by industry and region of origin. Controlling for industry- and country-specific factors, I investigate the role of interdependence between firms' choices concerning foreign production. The evidence points to there being a significant role. More widely found are negative interdependencies (a firm's foreign production being decreasing in its rivals') and those between UK rivals (rather than between UK and foreign firms). Indeed, the negative effect of one UK firm's foreign production on other UK firms' foreign production is a result that is robust through time and across all regions.

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Appendix: The Generation of the 'Leading UK Firms' Dataset

As described in section 3, I obtained the sample of firms and some part of my dataset from the 'UK market share matrices' for 1986 and 1993. A further part was contributed by the 'EU market share matrices' for 1987 and 1993. Together these gave the UK manufacturing production of each sample firm, disaggregated by industry; and the non-UK EU manufacturing production of each sample firm present on the EU matrix, disaggregated by industry and region. Thus in order to obtain a complete disaggregation of sample firms' manufacturing production across industries and regions, a two-fold extension was required:

- (iii) to obtain EU data for those UK firms whom were UK leaders, but not EU leaders.
- (ii) to obtain data for UK leaders' non-EU manufacturing, by industry and region - the world outside

the EU was split up into the following five regions: non-EU European, North America, Central and South America, Africa, and Asia and Pacific.

These extensions were carried out using firm-, industry-, and country-specific information from a variety of sources. The starting point was the firm's accounts as given in the company report. These were used together with the information gleaned from the matrices to arrive at a residual production figure: the firm's total production minus the production described on the matrices. This residual included both the firm's manufacturing production outside the UK (or EU, for EU matrix firms) and its worldwide non-manufacturing production.

This residual was further refined by utilising the geographical breakdown of turnover by origin, invariably given in the company reports of such large firms. Production is generally disaggregated into UK/non-UK turnover, with the non-UK figure split by continents, countries or a mixture of the two. The geographical breakdown was used (i) with the UK matrix figures to estimate UK non-manufacturing production; (ii) with any EU matrix figures to estimate EU non-manufacturing production. These estimates were subtracted from the residual. Thus the turnover unaccounted for then included the firm's manufacturing and non-manufacturing production outside the UK (or EU). Furthermore, this residual was split into any geographical regions given in the breakdown from company accounts.

Also invariably given in the company accounts is a breakdown of total production by activity. This is not by 3-digit NACE industry, but rather according to a more ad hoc scheme that is generally under-defined - but useful nonetheless. The activity categories could be matched to one or a set of 3 digit industries, and so were used to derive activity residuals. These residuals were found by deducting the firm's UK (and EU) matrix production in each activity, from the activity totals given in the company report. Thus for each manufacturing activity, the residual included the firm's non-UK (or non-EU³¹) production in that activity.

These sets of geographical and sectoral residuals acted as all-important guides for extending the database. Clearly however, these two types of information are not together sufficient to achieve a disaggregation of production of the type I aimed for. Firstly, the geographical regions and/or activity groups are not sufficiently refined. More importantly though, regional totals and activity totals do not together give a unique disaggregation by region *and* activity. In order to estimate such a disaggregation, information concerning the subsidiaries of the firm was required - this came from the company report and business directories.

Company reports invariably give a list of major subsidiaries, giving their nationality, principal

³¹ Another useful piece of information from the EU matrix was the production figure from the firm in 5th place in each industry. It gave an upper-bound on any total EU allocation in that industry for a non-matrix firm.

activities and sometimes even turnover. Business directories such as 'Who Owns Whom?' (which gives a comprehensive listing of firms' subsidiaries with the nationality of each) and AMADEUS (which gives detailed financial information for EU subsidiaries) also provide useful data. Together such sources made it possible to reliably allocate large parts of the unaccounted for production and greatly reduce the margin of error when estimating the pattern of production where subsidiary information was incomplete. The extent to which possible errors were reduced was amplified by the joint use of the geographical and activity residuals. Both types of residuals became more refined with each reliable allocation.

It is certainly true that there are very many errors in the database. A figure of £750 million of production for firm i , in industry j and region k may in fact be £720 million or £775 million. However, I am confident that it is not £0 or even say £400 million. So, while I am not confident that every figure is strictly accurate, I am confident that the overall pattern of production shown in the database is representative of reality.