(Revised)

Linking FDI Motivation and Host Economy Productivity Effects: Conceptual and Empirical Analysis

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Running Title: Linking FDI Motivation and Productivity Effects

Acknowledgements:

We are grateful for the constructive comments received when this paper was presented at the 3rd Annual JIBS/AIB/CIBER Conference on Emerging Research Frontiers in International Business, Erasmus University, Rotterdam, and at CIBAM, Judge Business School, Cambridge University. The helpful comments of Bruce Blonigen and three anonymous referees are also acknowledged.

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Abstract

We develop a taxonomy which relates FDI motivation (technology and cost-based) to its anticipated effects on host countries' domestic productivity. We then empirically examine the effects of FDI into the United Kingdom on domestic productivity and find that different types of FDI have markedly different productivity spillover effects, which are consistent with the conceptual analysis. The UK gains substantially only from inward FDI motivated by a strong technology-based ownership advantage. As theory predicts, inward FDI motivated by technology sourcing considerations leads to no productivity spillovers.

Keywords: FDI motivation, productivity spillovers, technology.

1. Introduction

Two of the most important and most researched questions in international business are what determines foreign direct investment (FDI), and what effects FDI has on the economies of host countries. Both of these topics have given rise to an enormous quantity of both theoretical and empirical research: intriguingly, however, there is very little literature which directly links these two strands of research. This is in part because of the dichotomy which often exists between the international business and economics literature. Much of the analysis of the effects of FDI on host economies has been concerned with econometric studies of the externality or spillover effects of FDI on domestic productivity of host nations. While such studies have become increasingly sophisticated in recent years, they rarely have any direct link with the substantial body of research in the international business journals concerning the motivation for FDI. As a result, in the empirical literature on spillovers, FDI is usually treated as a homogeneous exogenous factor, without consideration of its motivation (Aitken et al 1997; Aitken and Harrison 1999; Barrell and Pain 1997; De Mello 1999; Head et al 1995).

Whatever the reason for the lack of interaction between these two strands of research, it is clearly unsatisfactory that the literatures on the impacts of FDI and its determinants are so divorced. Technology plays an important part here, as it seems plausible to hypothesise that productivity spillovers will be determined, at least in part, by the nature of technology employed by the multinational and domestic firms. Further, it has long been understood that firm or industry technology differences are strongly related to FDI flows, with technology a key source of Dunning's ownership advantage. Technology has also been linked to location advantages, particularly in the context of technology sourcing. Evidence already exists that FDI motivated by the desire to source technology in the host economy technology has markedly different effects on domestic productivity from that which exploits an existing ownership advantage of the incoming multinational (Driffield and Love 2006).

However, focussing solely on technology or knowledge to link FDI motivation and effect is not enough. For example, the ability of the multinational enterprise (MNE) to respond to factor price differentials across countries is used to explain FDI within theoretical or conceptual models[1], but such issues are often ignored in studies seeking to analyse effects of FDI on host or source countries. While the focus on technological development as the main source of firm-specific advantage flows naturally from Dunning's eclectic paradigm, it is also important to allow for other sources of firm- specific advantage within the analysis of the MNE.

The purpose of this paper is to develop a conceptual link between the motivation and spillover effects of FDI, and to test whether FDI motivated by different factors does indeed have different effects on the domestic productivity of a host economy. The paper therefore incorporates two clear advances on previous literature: first, it both develops a conceptual link between FDI motivation and effect and generates testable hypotheses; and second, it allows the *ex ante* classification of FDI motivations to be tested for their *ex post* effects, unlike previous literature which infers motivation from effects (e.g. van Pottelsberghe and Lichtenberg, 2001; Hejazi and Pauly, 2003).

The paper proceeds as follows. We first develop a taxonomy of FDI motivation, building on the key distinction between technology exploiting and technology sourcing, but also allowing for the locational effects of factor price differentials. We then develop hypotheses relating FDI motivation to domestic productivity effects. Finally we test whether the different motivations have different spillover effect using a large dataset of inward investment into the UK. We find that FDI motivated by different factors does indeed have systematically different spillover effects on host economy productivity, and that these are broadly in line with the predictions of theory.

2. The Motivation for FDI

We begin by developing a conceptual taxonomy of motivation for FDI, building on the theoretical and empirical literature. This taxonomy allows for both ownership and

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[1] See, for example, the growing empirical literature linking FDI flows to international labour market conditions (e.g. Sethi et al 2003), informed by the conceptual work of Buckley and Casson (1998, 1999).

locational influences on FDI flows, and was initially developed in the context of intra-industry FDI flows in Driffield and Love (2005a).

The classic 'ownership' advantage involves some form of technological superiority; thus where a company has some competitive advantage over its rivals, and where for reasons of property rights protection licensing is unsafe, a company will set up production facilities in a foreign country through FDI, as long as there are specific advantages in the host country which make FDI preferable to exporting. (Buckley and Casson 1976; Dunning 1979, 1988, 1993).. More recent literature, based on Cantwell (1989, 1991) or Pearce (1999) has characterised such advantages as being generated through R&D, and linked to the exploitation of economies of scale. Indeed, recent applied work in this area attempting to characterise ownership advantages in a given location suggests that new technology and quality of the capital stock are key variables (see, for example, Oulton 2001, Griffith 1999, Griffith and Simpson 2001 and Criscuolo and Martin 2004).

This is the *technology exploiting* motivation. However, recent theoretical work has given renewed impetus to something long recognised in the literature, that a possible motive for FDI is not to exploit proprietary technology, but to access it: thus *technology sourcing* may be the motive for FDI. Fosfuri and Motta (1999) question the need for firm-specific advantages to give rise to multinational activity, and provide a formal model of FDI in which the motivation is not to exploit existing technological advantages in a foreign country, but to access such technology and transfer it from the host economy to the investing multinational corporation via spillover effects.[2]. The literature on the internationalization of R&D suggests that there is a growing willingness to locate such facilities close to leading centres of research and innovation specifically with a view to absorbing learning spillovers from geographical proximity to such sites (Pearce, 1999; Niosi, 1999). For example, an analysis of foreign R&D direct investment in the United States by Serapio and Dalton (1999) concludes that the nature of such investment is changing, with more emphasis on gaining direct access to American technology and expertise, especially in biotechnology and electronics. Shan and Song (1997) provide supportive evidence in

[2] However, in a detailed analysis of US direct investment flows, Love (2003) finds little evidence of technology sourcing as a motivation for FDI.

relation to US biotechnology, while Pearce (1999) comes to broadly similar conclusions from a survey of multinational corporations' production and laboratory facilities in the UK.

Note, therefore, that technology sourcing need not necessarily imply technological weakness in any absolute sense, simply the recognition that knowledge can be acquired by targeting it in locations which are at least as technologically strong as the investor. This is what Kuemmerle (1999) characterises as 'home-base augmenting' FDI; a similar idea is evident in the 'strategic asset-seeking' behaviour identified by Dunning and Narula (1995) and in the 'diversity sourcing' motive postulatd by Cantwell and Janne (1999) and Chung and Yeaple (2004). The present analysis is consistent with these interpretations; we regard any FDI by a foreign investor as technology sourcing if it involves investment in a host sector which is more R&D intensive than the source sector, regardless of the absolute levels of R&D intensity in each.

The focus on technology in explaining flows of FDI, however, ignores the second pillar of Dunning's (1979) analysis of FDI, *location advantage.* We therefore consider the benefit conferred on the organisation by its decision to operate in a particular host location. This is generally related to country specific phenomena, or, within the international economics literature, the factor endowments of a particular country or region.

The economics literature consistently shows empirically that factor cost differentials, and in particular unit labour cost differentials (wages adjusted for productivity differences), are an important determinant of FDI flows. This is evident even in FDI between advanced industrialised economies (Pain, 1993; Bajo-Rubio and Sosvilla-Rivero, 1994; Barrell and Pain, 1996; Love and Lage-Hidalgo, 2000; Love, 2003). This paper builds on those earlier works by also identifying FDI to and from high and low labour cost locations (at the sectoral level) and then testing for productivity effects generated *inter alia* merely through moving low value added activities to low cost locations. Thus, we have a simple model illustrating the alternative motivations for FDI, based on technology differences and factor cost differences (Figure 1). Crucially, this is at the sectoral level within countries, not merely at the national level.

Technology is measured by R&D intensity (RDI) differentials[3], while costs are measured in terms of unit labour costs.

The quadrants on the top row of Figure 1 both have some technology sourcing element. Quadrant 1 is where the host economy is more R&D intensive and has lower unit labour costs than the source investor (at the industry level). This implies inward investment which is technology sourcing and has the additional advantage of exploiting the host's locational advantage (lower unit labour costs). Quadrant 2 is 'pure' technology sourcing investment, attracted by the host's higher R&D intensity despite its higher unit labour costs. The quadrants on the bottom row both have technology exploitation, that is the traditional ownership advantage, as the key motivational element. Quadrant 3 has the additional advantage of lower host unit labour costs, suggesting an 'efficiency seeking' motivation (Dunning, 1998). The final quadrant (4) is the 'pure' ownership advantage motivation, where source-country R&D intensity is greater than that of the corresponding host sector and FDI occurs despite the host sector having higher labour costs.

[3] There are numerous measures of R&D intensity, such as the share of total national R&D, or the share of worldwide industry level R&D. However, as we wish to compare international R&D intensities at the sectoral level, we use R&D as a proportion of value added, in order to remove size effects.

Figure 1: Taxonomy of motivations for FDI

	ULC host < ULC source	ULC host > ULC source
RDI host > RDI source	(1) technology sourcing / location advantage	(2) technology sourcing
RDI host < RDI source	(3) ownership advantage / efficiency seeking	(4) ownership advantage

We must be aware of the limitations of the four quadrants in Figure 1. For example, labour costs are not the only possible locational advantage, although the empirical evidence reviewed above points to consistent evidence on the importance of unit labour cost differentials in generating FDI flows. Nor are R&D differentials the only source of ownership advantage; but they are a simple and clear indicator of the knowledge basis of much of competitive advantage in a globalised economy, and allow a symmetric treatment of the technology exploiting and technology sourcing motivations[4]. The major advantage of the taxonomy is that it captures the key motivating influences which the literature indicate are important, and – crucially – permits *ex ante* predictions about spillover effects of inward FDI which can be subjected to empirical testing. These a priori predictions are relatively straightforward, in that technology spillovers are essentially linked to R&D differences between home and host country firms, consistent with technology based

[4] The taxonomy outlined in Figure 1 is not incompatible with other classifications of FDI. For example, 'market seeking' FDI will typically be included in quadrants 3 or 4, since this form of investment requires some form of ownership advantage to compete with indigenous firms. The quadrant location of 'resource seeking' FDI would depend on which aspect of host-country resource endowment was being sought (e.g. cheap labour, better technology, natural resources etc.).

explanations of FDI, while other motivations for FDI can be linked to cost differences.[5]

3. Effects of FDI on Domestic Productivity

It is often assumed that FDI brings benefits to host economies through productivity spillovers from multinational enterprises. Spillovers may occur directly through backwards and forwards linkages with indigenous firms, through the licensing of a particular technology, through supplier networks or subcontracting arrangements, or indirectly as knowledge becomes public and spillovers are assimilated by the domestic sector. Secondly, labour mobility may generate technology or knowledge spillovers, as employees moving from the foreign-owned to the domestic sector transfer firm-specific knowledge (Blomström and Kokko 1998). There is also the possibility of indirect productivity effects on local firms arising from foreign affiliates increasing the host country's knowledge of and access to specialised intermediate inputs (Rodriguez-Clare, 1996).

The evidence on productivity spillovers from inward FDI is mixed. While there is a considerable body of evidence suggesting that there are (intra-industry) spillover effects running from MNEs to domestic firms, and that these effects can be substantial (Blomström and Kokko 1998), the conclusions of early cross-sectional industry-level studies have been questioned on econometric grounds (Görg and Strobl 2001). More recent micro-level panel data research has led to mixed results, with some showing evidence of positive horizontal spillovers (Haskel *et al*., 2002; Keller and Yeaple, 2003), while others show evidence of a negative effect of FDI on domestic productivity (Aitken and Harrison, 1999). The latter effect is generally ascribed to the existence of 'market stealing' effects arising from MNE entry. A technologically superior MNE may take market share from domestic enterprises, forcing them to produce at lower output levels with increased unit costs (Markusen and Venables, 1999). Where the market stealing effect dominates the productivity spillover effect,

[5] Our taxonomy therefore goes beyond that of Patel and Vega (1999) which deals exclusively with technology as a motivator for FDI and contains no predictions or analysis of the effects of different FDI types. Le Bas and Sierra (2002) perform a re-analysis of Patel and Vega's classification using European patent data, but again there is no prediction or analysis of likely effects of different FDI types. See Love (2003) for an analysis of the determinants of US FDI using Patel and Vega's more limited taxonomy.

the result may be a net reduction in domestic productivity[6]. This effect is seldom captured beyond the work of Aitken and Harrison (1999), however, due to the restrictive approach employed in much of the literature that simply estimates an 'average' effect of FDI across all industries or firms.

But what of the links between the motivation for FDI and spillover effects? One of the principal attributes of the taxonomy outlined above is that it allows *ex ante* classification of FDI motivations to be tested for their *ex post* effects, unlike previous literature which infers motivation from the effects of foreign investment (van Pottelsberghe and Lichtenberg, 2001; Hejazi and Pauly, 2003).

Table 1 summarises the anticipated impact of different types of FDI on domestic productivity. Types 1 and 2 both involve incoming multinationals with inferior technology to domestic firms, and thus with no anticipated productivity spillovers. In principle the technological laggard is also in a poor position to compete with local or other foreign firms, and therefore market stealing would appear to be an unlikely outcome from this type of FDI. For this reason Sembenelli and Siotis (2002) conclude that 'pure' technology sourcing (i.e. Type 2 FDI) is likely to leave competitive conditions unchanged, and so the likely net effect on domestic productivity is zero. However, in the case of Type 1 FDI, the benefit of reduced labour costs achieved by investment in the host economy may potentially render such investors able to compete effectively with indigenous enterprises, so that some market-stealing effect is possible.

Types 3 and 4 investment both offer the prospect of productivity spillovers to the domestic sector arising from the entry of technologically superior foreign firms. As long as this technology effect outweighs any market stealing effect, the effect on domestic productivity is likely to be positive. However, Type 3 investment also involves accessing lower labour costs within the UK; despite the R&D advantage that the source sector has, this type of investment is potentially less likely to involve the

[6] However, while market stealing can be expected to have a negative effect on productivity in the short run, increased competition may have a positive effect on (domestic or foreign) productivity in the long run, either by encouraging other firms to become more efficient or by forcing the least efficient out of business.

transfer of new technology to the UK because of its being motivated in part by lower factor costs, and thus is less likely than Type 4 FDI to generate large positive technology spillovers.

Table 1. Anticipated effects of inward FDI on domestic productivity

	FDI motivation	Anticipated spillover effect	Rationale
Type 1	Technology sourcing / location advantage	0/-	Technology laggard; may compete on lower labour costs.
Type 2	Technology sourcing	0	Technology laggard; nothing to offer host economy.
Type 3	Efficiency seeking	+	Superior technology; may also compete on lower labour costs.
Type 4	Ownership advantage	++	Superior technology as a basis for productivity spillovers.

4. Data

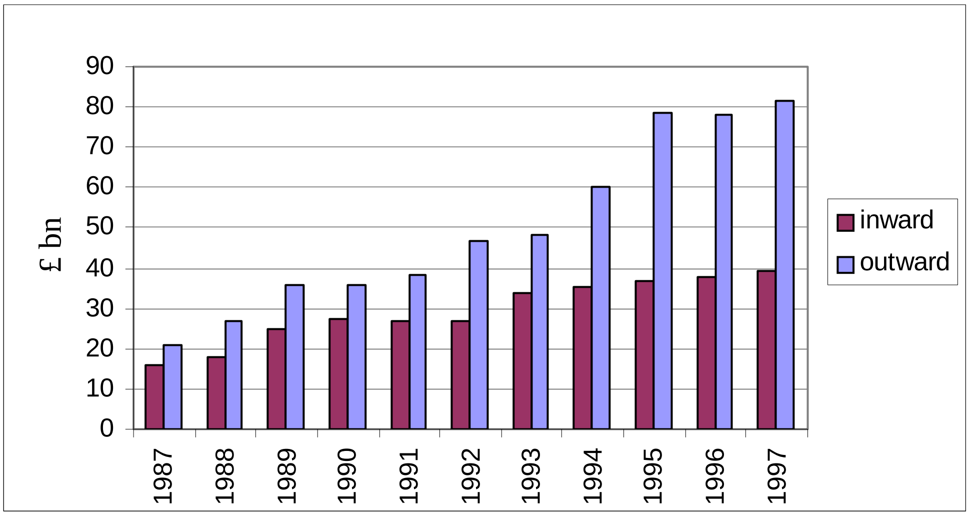
This section describes the data used to test the hypothesised links between inward FDI and its effects on domestic productivity. We employ a comprehensive dataset of FDI flows into the UK, comprising a panel of 30 countries from which the UK received FDI during the relevant period 11 manufacturing sectors and 11 years (1987-97). Details of the countries and sectors are shown in the Appendix. The countries include all of the major direct investors in the UK and in the OECD generally, collectively accounting for 99% of all inward investment into the UK.[7] The manufacturing sectors are at the two digit level, the lowest level of aggregation compatible with combining Office for National Statistics (ONS) and OECD data for the relevant countries. The data for the domestic sectors and FDI inflows were provided by ONS; data on R&D intensities and unit labour cost were derived from the OECD's ANBERD and STAN

[7] The omitted FDI is from countries such as Liechtenstein, or various UK dependencies such as Gibraltar, The Isle of Man or the Channel Islands, where comparing the UK with a 'home' country manufacturing base would be erroneous.

databases, for R&D expenditure and value added respectively[8]. Full details of variable definitions and data sources can also be found in the Appendix. All monetary values are converted to real terms using sectoral level producer price index data, and purchasing power parity data where appropriate for international comparison. Crucially, this enables us to analyse FDI flows in terms of unit labour costs and R&D intensity, not at the country level, but at the sectoral level between countries.

Figure 2 shows the time pattern of UK inward and outward FDI flows from 1987 to 1997. Both inward and outward FDI rose fairly steadily in real terms, but by markedly different amounts: inward FDI doubled while outward FDI quadrupled. The analysis below is restricted to inward FDI flows into the UK.

Figure 2. UK inward and outward FDI flows, 1987-97



[8] The breadth of the sectors is due to the need to find suitable deflators and PPP currency data at the sectoral level, in order to compare R&D intensity and unit labour costs consistently across countries.

Figure 3. UK inward FDI by type, 1987-97

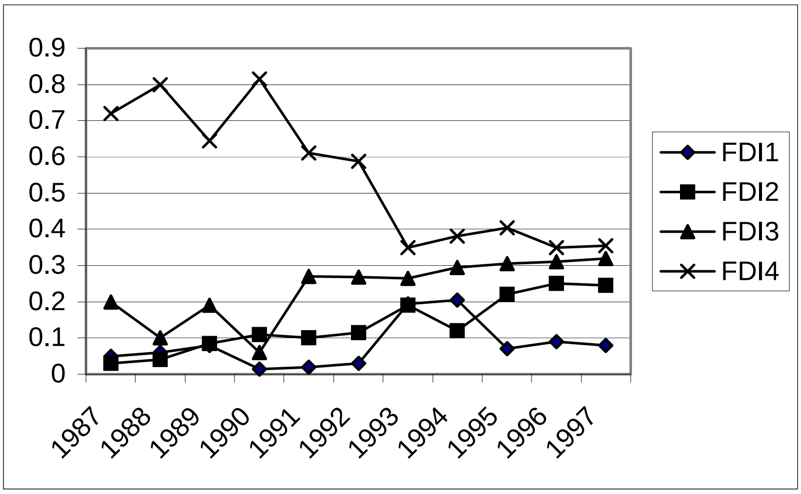


Figure 3 illustrates that, over the time period, most FDI into the UK was in sectors where the UK has a relative disadvantage in terms of R&D intensity (Types 3 and 4), accounting for over 90% of inward investment in the UK at the start of the period. The dominant explanation for inward FDI therefore appears to be the technological advantage of the source sector: this conforms to Dunning's 'ownership advantage' explanation, which has become the predominant explanation for FDI, particularly between industrialised countries. However, it is clear that while this explanation remains important, it has declined in explaining total FDI flows. Inward investment into sectors with R&D intensity below that of the source country, but with higher labour costs (Type 4), declined from around 80% of the total at the start of the period to under 40% by the end. This change is partly explained simply by a movement between 'ownership advantage' motivations (i.e. between Types 4 and 3). But there is also increasing evidence of investment in sectors where the UK has a R&D advantage over the source country, but no labour cost advantage (Type 2), conforming to the 'technology sourcing' explanation for FDI. This shift in investment patterns does not arise simply from a reclassification of sectors/countries at the margin between FDI types during the period of the study (e.g. due to changes in relative unit labour costs between the US and UK). The number of industries classified to each of the FDI types is more stable than the pattern of FDI flows shown in Figure 3 (see Appendix Figure A1), especially with regard to Type 4 FDI. This indicates that the change in the pattern of FDI into the UK has come about mainly because of a genuine increase in the amounts of Types 2 and 3 FDI relative to Type 4.

Between 1987 and 1997 the source of inward investment into the UK changed relatively little. Approximately three quarters of FDI into the UK over this period came from the United States, with almost all of the remainder coming from Western Europe. Given the predominance of the United States and Europe, it is instructive to see the FDI patterns for these two areas in particular (Figures 4 to 7). American FDI entering the UK is dominated by Type 4 investment, where the motivation is to exploit some technological advantage in the UK, despite the higher labour costs in that country (Figure 5). During the 11 year period, however, this form of investment has fallen from around 80% of inward FDI to around half, with some increased evidence of Type 2 technology sourcing investment from the United States.[9]

Figure 4. UK inward FDI flows from the United States, 1987-97

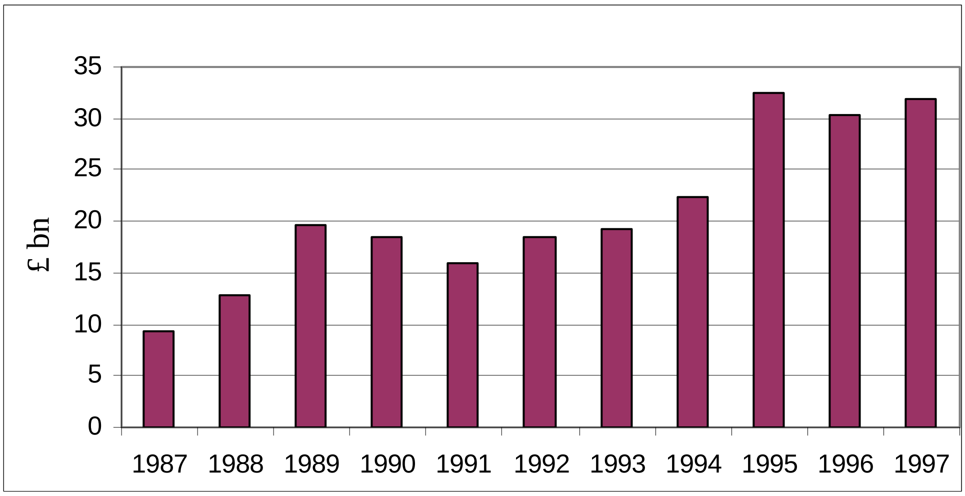
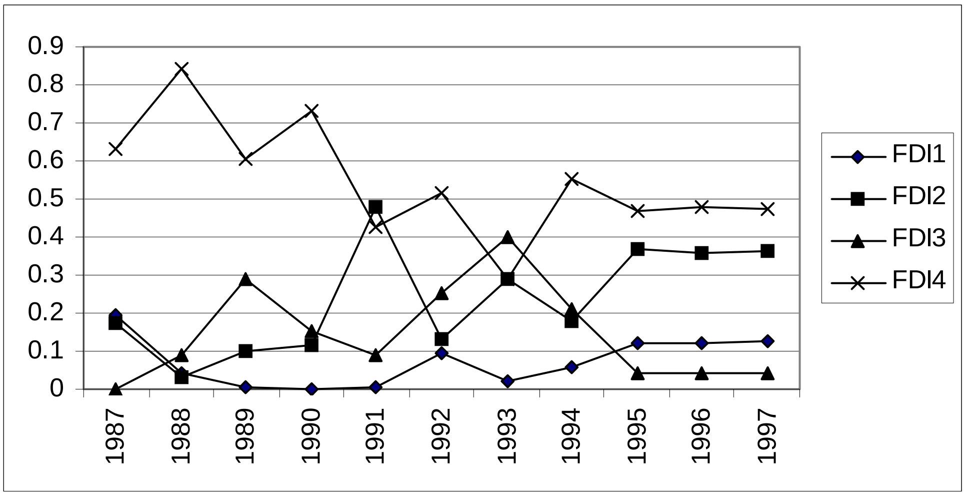


Figure 5. UK inward FDI from the United States by type, 1987-97

[9] It seems likely, in addition, that at least some of the US FDI into the UK will be motivated either by the desire of MNEs to diversify their knowledge portfolio, or simply to achieve greater scale in their R&D activities (Chung and Yeaple, 2004). Neither of these interpretations is inconsistent with the analysis above.



European investment into the UK shows a much more mixed pattern (Figures 6 and 7). Here the technology sourcing motivation is much more apparent, with 'pure' technology sourcing (Type 2) accounting for around one third of all investment over the period, with a further 10-20% coming from technology sourcing enhanced by the UK's labour cost advantage (Type 1). Unlike the US example above, FDI driven solely by ownership advantage considerations (Type 4) is relatively uncommon, accounting for around 15% of total investment from Europe. Overall, therefore, while there is some evidence of increased technology sourcing by American investors in the UK, the increase in Type 2 technology sourcing investment into the UK exhibited in Figure 3 is principally a European phenomenon; broadly speaking, American firms enter the UK to exploit their technological advantage, while European firms show a much more mixed pattern of investment types, but with a significant technology-sourcing element. This is consistent with recent evidence on technology sourcing activity and spillover effects within the foreign-controlled sector of UK manufacturing, which suggests while that foreign firms do absorb spillovers from domestic UK firms, it is mainly European firms which benefit from this. American firms in UK generally source technology from other foreign firms rather than indigenous UK firms. (Driffield and Love 2005b).

Figure 6. UK inward FDI flows from Western Europe, 1987-97

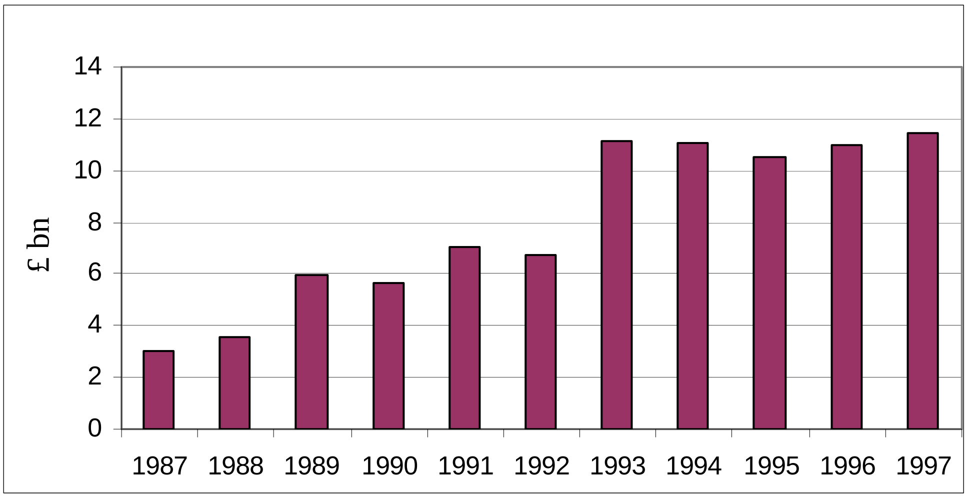
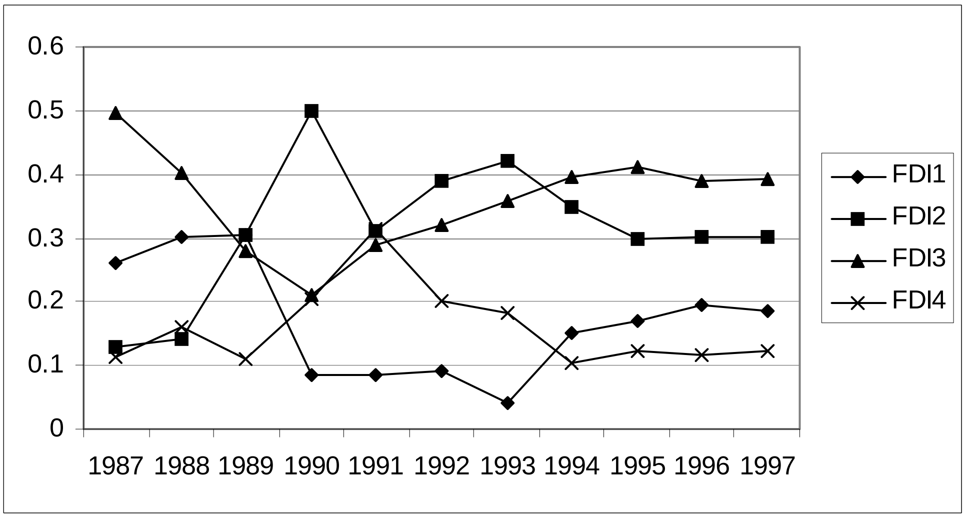


Figure 7. UK inward FDI from Western Europe by type, 1987-97



5. Empirical Analysis

The standard method of estimating externalities (i.e. spillovers) in total factor productivity is to add an externality term to a Cobb-Douglas production function of basic form:

$$Q = AK^{\alpha}L^{\beta} \quad (1)$$

where Q, L and K represent output, labour and capital of the firm, and the estimates of the β terms are derived either through estimation or (more commonly) simply from the relative factor shares of the two inputs. The estimate of total factor productivity can then be regressed against the externality terms within a fixed effects model, including a time trend (or alternative measure of exogenous technical progress) and other explanatory variables.

The method for identifying technological externalities adopted here follows the seminal paper by Griliches (1992), who postulates an augmented production function including both internal and external factors of production. The presence of such external influences on the firm is the consequence of externalities in production, due to formal or informal linkages between firms. The specification is thus:

$$\ln Q_{it} = \alpha + \beta_1 \ln K_{it} + \beta_2 \ln L_{it} + \sum_{p=1}^{r} \mu_p X_{it} + \omega_{it} \qquad (2)$$

Where X is the vector of r externality terms, which is linked (usually positively) to total factor productivity, (i) represents the industry and (t) is time. It is assumed that there may be individual and time effects i.e. $\omega_{it} = \nu_i + \nu_t + u_{it}$ where u_{it} are the random errors, assumed to be iid $\left(0, \sigma_u^2\right)$[10].

This framework has been widely used to test for spillovers from FDI, that is, the extent to which capital investment by foreign owned firms is linked to total factor productivity in the domestic sector. For recent examples of this literature and methodology, see Haskel *et al*. (2002), Harris (2002), Harris and Robinson (2002), Driffield (2001) and the earlier literature summarized in Görg and Strobl (2001).

As Oulton (1997) and Driffield (2001) outline, many studies of externalities suffer from specification error. For example, Oulton (1996) and Basu and Fernald (1995) suggest that if the vector of externalities in a specification such as equation (2) contains output variables, then a change in aggregate demand, impacting simultaneously on internal and external output, may generate spurious 'evidence' of externalities or spillovers where none exist. This arises as a result of the error term in

[10] This is the standard 'fixed effects' model, which is well understood, and is explained for example in Baltagi (2002). This allows for an industry specific component, and a time specific component. The econometric treatment of this is discussed in the text.

(2) being related to aggregate output growth. The problem of spurious externality effects can largely be alleviated by a more precise specification of the externality term. On both theoretical and econometric grounds, the vector of spillovers used here is lagged foreign investment (FDI). In the literature on the scale and scope of spillovers from inward FDI, the most common method of capturing the externality is to use investment by the foreign sector (see for example Barrell and Pain, 1997, 1999; De Mello, 1999). The theoretical justification for this is that technological progress (or technology new to a particular location), or the international transfer of firm-specific assets, is embodied in new capital investment rather than in output, employment, or local R&D expenditure. Where other measures of FDI are used, such as employment, this is often because investment measures are unavailable (Aitken et al, 1997; Liu et al, 2000).

A further consideration in studies of productivity growth and externalities is the importance of learning by doing and the cumulative effects of continuous production. Islam (1995) shows that the appropriate specification within an econometric framework is to relate current total factor productivity to previous levels of output. By definition, this captures the importance of past levels of inputs in the production process. Therefore a dynamic specification is employed in which accumulated experience is captured by a lagged dependent variable, as in (3)[11]. For further discussion of the econometric specification of this problem, see Lee *et al*. (1998) and Pesaran and Smith (1995). Thus, to encompass learning by doing effects, the specification becomes:

$$\ln Q_{it} = \alpha + \gamma \ln Q_{it-1} + \beta_1 \ln K_{it} + \beta_2 \ln L_{it} + \sum_{p=1}^{r} \mu_p X_{it} + \omega_{it} \qquad (3)$$

Using flows of FDI as appropriate measures of externalities yields:

$$\ln Q_{it} = \alpha + \gamma \ln Q_{it-1} + \beta_1 \ln K_{it} + \beta_2 \ln L_{it} + \sum_{z=1}^{4} \phi_z \left(\ln FDI_{it-1} \times D_z \right) + \omega_{it} \qquad (4)$$

where we envisage four possible types of inward FDI (see above and Table 1), and $z=1 \ldots 4$. We therefore define the following four binary indicators:

[11] Q_{it-1} includes all other lagged values of Q, K and L by construction, as Q_{it-1} can be written as a function of $Q_{it-2}, Q_{it-3} \ldots. Q_{it-n}$ thus picking up experience effects. This also effectively allows the effect of past investment to decline over time, whereas accumulated output does not.

Type 1: $\begin{array}{l} D_1 = 1 \quad if \quad (RDI_{UK} > RDI_F) \quad \& \quad (ULC_{UK} < ULC_F) \\ D_1 = 0 \quad if \quad Otherwise \end{array}$

Type 2: $\begin{array}{l} D_2 = 1 \quad if \quad (RDI_{UK} > RDI_F) \quad \& \quad (ULC_{UK} > ULC_F) \\ D_2 = 0 \quad if \quad Otherwise \end{array}$

Type 3: $\begin{array}{l} D_3 = 1 \quad if \quad (RDI_{UK} < RDI_F) \quad \& \quad (ULC_{UK} < ULC_F) \\ D_3 = 0 \quad if \quad Otherwise \end{array}$

Type 4: $\begin{array}{l} D_4 = 1 \quad if \quad (RDI_{UK} < RDI_F) \quad \& \quad (ULC_{UK} > ULC_F) \\ D_4 = 0 \quad if \quad Otherwise \end{array}$

D_z are four binary dummy variables defined in terms of Table 1 above, so if $D_z = 1$ then $D_{\tilde{z}} = 0$ where $z \neq \tilde{z}$. The dummy variables are defined using RDI and ULC at period *t-1*. This means that the motivation for FDI is based at *t-1* and outcomes at time *t*, and so the classification of FDI and its effects are non contemporaneous.

The endogeneity of the 'internal' variables and the lagged dependent variable in a model such as (4) suggests that an instrumental variables approach is required. We therefore employ the GMM estimator suggested by Blundell and Bond (1998) to estimate (4), which generates heteroscedastic-consistent estimates. This involves taking first differences in order to generate a transformed difference equation, then estimating this simultaneously with the levels equation, with lagged levels used as instruments in the difference equation, and vice versa. All explanatory variables are then instrumented with all available lags, as discussed in Arellano and Bond (1988, 1991). A consideration with data and models such as the one presented here is the extent to which lags (and particularly lags of differences) are valid instruments, particularly when considering lags of 5 years or more. It is therefore crucial to be careful in testing for instrument validity in each of the models, and all available lags are used for all years except 1990-1992, where the number of lags is constrained to 5 years on this basis. The Sargan tests for instrument validity are presented in the results tables.

The results of estimating (4) are shown in Table 2. Model 1 shows the results of a conventional estimation, in which FDI is simply treated as a homogeneous block, while Model 2 shows the estimation split into the 4 types of inward FDI. The results for Model 1 indicates that there is some evidence (p=0.028) of a positive overall effect of inward FDI on domestic productivity growth. However, the picture becomes clearer when allowance is made for the different types of FDI (Model 2). In line with the anticipated effects summarised in Table 1, FDI from sectors more technologically advanced than the UK does act to stimulate productivity growth in the UK sector (Types 3 and 4). However, the coefficient on Type 3 FDI is insignificant, while that on Type 4 is highly significant. This suggests either that the spillover effect is significant only where the technological (ownership) advantage of the foreign investor is sufficiently great to offset the disadvantage of higher unit labour costs in the UK, or that any positive effects of Type 3 investment are cancelled out by a market-stealing effect on domestic productivity.

Table 2: Impact of inward FDI on domestic productivity

	Model 1		*Model 2*	
	coefficient	t value	coefficient	t value
$Q_{(t-1)}$	0.0189	4.694	0.0217	3.181
L Skilled	0.5715	10.886	0.5835	6.211
L Unskilled	0.3000	11.503	0.3280	4.270
K	0.1785	3.166	0.1286	2.992
Time trend	0.0375	1.691	0.0420	2.188
Inward FDI $_{(t-1)}$	0.0237	1.919		
FDI 1			-0.0177	-3.521
FDI 2			-0.0131	-0.859
FDI 3			0.0124	0.831
FDI 4			0.0221	3.312
Specification $\sim\chi^2(10)$* (p value)	14.46 (0.153)		13.31 (0.207)	
Sargan p value	0.260		0.209	
Sargan difference test (p value)	10.487 (0.399)		10.008 (0.440)	
AR(1), p value	-0.217 [0.641]		-0.216 [0.641]	
AR(2), p value	1.899 [0.168]		2.004 [0.157]	
N	99		99	

Note: * This is based on testing the Cobb-Douglas specification against a translog specification.

The coefficient on Type 2 FDI is highly insignificant, exactly in line with the hypothesis on the likely impact of technology-sourcing FDI. The negative and significant coefficient for Type 1 FDI indicates that technology sourcing FDI has a significantly negative (i.e. market-stealing) effect only where the foreign investor benefits from lower labour costs in the UK, suggesting that the ability to access cheaper labour offsets the technological gap sufficiently to allow the incoming foreign investor to compete with indigenous UK firms. There is also the possibility of foreign investors accessing technology from other foreign-owned establishments within the UK, whilst competing with UK-owned firms. Since the foreign-owned sector is generally technologically more advanced and more productive than the indigenous sector in the UK (Oulton 2001), it is unsurprising that even 'laggard' MNEs whose principal motivation for FDI is technology sourcing will nevertheless retain the capacity to compete effectively with some UK-owned enterprises whilst simultaneously accessing technology from within the UK's national boundaries, empirical support for which comes from Driffield and Love (2005b).

Table 3: Impact of inward FDI (excluding US) on domestic productivity

	Model 1		*Model 2*	
	coefficient	t value	coefficient	t value
$Q_{(t-1)}$	0.019321	4.580095	0.021937	3.135918
L Skilled	0.57887	10.42742	0.562762	5.913587
L Unskilled	0.299528	11.23237	0.330201	4.137198
K	0.172347	3.059603	0.131197	2.955353
Time trend	0.036098	1.643064	0.040551	2.136303
Inward FDI $_{(t-1)}$	0.020609	1.416516		
FDI 1			-0.019	-3.70341
FDI 2			-0.01339	-0.66409
FDI 3			0.011212	0.671216
FDI 4			0.017821	3.490328
Specification	15.37		12.96	

$\sim\chi^2(10)$* (p value)	(0.119)	(0.226)
Sargan p value	0.274	0.231
Sargan difference test (p value)	10.305 (0.414)	10.185 (0.424)
AR(1), p value	-0.306 (0.580)	-0.244 (0.621)
AR(2), p value	1.961 (0.161)	2.077 (0.150)
N	99	99

Note: * This is based on testing the Cobb-Douglas specification against a translog specification.

Given the dominance of the United States in terms of UK inward investment, and the somewhat different motivational patterns exhibited by US and non-US FDI flows (see Figures 5 and 7 respectively), it is instructive to examine the extent to which the results for the whole sample discussed above are replicated for non-US inward investment. The results (Table 3) indicate that the sign pattern and significance of coefficients on FDI types remains unchanged. The results for the sample overall are therefore not a peculiarity of investment from a single country: they arise from the intrinsic motivational pattern underlying them, not simply from the FDI's country of origin. Overall, therefore, the spillover effects demonstrated by the estimation of equation (4) are very much in line with the hypotheses developed earlier (Table 4).

Table 4. Comparison of anticipated and estimated effects of inward FDI on domestic productivity

	FDI motivation	**Anticipated spillover effect**	**Estimated spillover effect**
Type 1	Technology sourcing / location advantage	0/-	--
Type 2	Technology sourcing	0	0
Type 3	Efficiency seeking	+	0/+
Type 4	Ownership advantage	++	++

6. Discussion and Conclusions

In an empirical study highlighting the importance of FDI spillovers on domestic productivity, Hejazi and Safarian (1999: 504) state "It would be interesting to know if the observed changes in productivity growth vary with the different motives for FDI". This paper represents an attempt to go some way to answering this question by linking the determinants of FDI with an examination of the effects of FDI on a host economy.

The results of the empirical analysis are clear. In terms of domestic productivity, the UK gains substantially only from inward FDI motivated by a strong technology-based ownership advantage. As theory predicts, inward FDI motivated by technology sourcing considerations leads to no productivity spillovers, and the same is true of 'efficiency seeking' inward FDI. Inward FDI by relative technology laggards[12] which is also motivated by accessing cheaper labour costs in the UK can actually lead to reduced domestic productivity presumably through market-stealing competition effects.

Importantly, these effects provide a link between the standard explanations of FDI based on Dunning's eclectic paradigm, and more recent work highlighting the importance of technology sourcing (Cantwell 1999; Chung and Yeaple 2004; Pearce 1999; Shan and Song 1997). FDI that can be explained in terms of inward investors possessing technological advantages over domestic firms introduces new technology to the source country, which importantly generates a productivity effect over and above the simple 'batting average' effect.[13] This phenomenon, outlined perhaps for the first time in Caves (1982), has formed the basis for much of the work seeking to evaluate the technology spillover effects of FDI (Blomström and Kokko 1998; Liu et al 2000). In contrast to the impacts of FDI associated with technological advantages, FDI motivated by technology sourcing or efficiency seeking generates little in the way of technology transfer, and in the short term can even cause domestic productivity to decline.

[12] Or by MNEs seeking either to diversify their knowledge portfolios or to access economies of scale in R&D (Chung and Yeaple 2004)

[13] The batting average effect arises from the tendency for inward investing companies to be more productive than their indigenous UK counterparts (Oulton 2001), thus raising the average level of productivity in the UK merely by the fact of entry.

There have been many attempts to measure spillover effects from FDI in the host country, based on developing, developed and transition economies. Many of these studies are reviewed in various survey papers, such as Blomström and Kokko (1998), Görg and Greenaway (2004)[14] and Görg and Strobl (2001). This large body of literature reports a wide range of differing results, ranging from large positive effects, (Liu et al 2000; Blomström and Kokko 2001), through to significant negative effects, (De Mello 1999), and a large range of studies reporting very small effects (e.g. Haskel et al 2002). More recently however, the literature has begun to highlight other important considerations, such as linkages between the foreign and domestic sectors (Smarzynska-Javorcik, 2004), the relationship between inward investors and pre-existing clusters (De Propris and Driffield, 2006) or technological differences between countries (Driffield and Love 2005b). One may summarise the development of this literature as having moved away from finding uniformly positive or negative spillover effects to arguing that 'it depends'. It is our conjecture that, while other studies have highlighted particular effects, the nature and size of potential spillovers depends crucially on the motivation for FDI (which may in part be captured through examining clusters or linkages). To the best of our knowledge this is the first attempt to link the theoretical explanations for FDI in terms of technological advantage or labour costs to the likely spillover effects of this investment. The various results that we ascribe to the different motivations for FDI may explain why previous work has generated such conflicting results when FDI is simply treated as a homogeneous of activity rather than linked to the theory of international business.

Our results also have policy implications. National and regional governments spend substantial resources in attracting inward investors, at least partly in the expectation (or hope) of capturing productivity spillovers from more productive foreign firms. Our results demonstrate that it should not be simply taken as given that public gains can justify this expenditure, and that much more attention should be paid to the characteristics of the inward investor and the motivation for investing before deciding whether public support is worthwhile.

[14] Görg and Greenaway (2004) provide a table summarising the results from many of the major studies.

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Appendix: Data and Sources

Table A1: Countries in Panel of Inward Investors

Australia
Austria
Belgium
Brunei
Bulgaria
Cyprus
Denmark
Finland
France
Germany
Greece
Hong Kong
Iceland
Irish Republic
Italy
Japan
Malaysia
Netherlands
Norway
Portugal
Romania
Russia
Singapore
South Korea
Spain
Sweden
Switzerland
Taiwan
Turkey
USA

Table A2. Sectors in Panel

Sectors (ISIC 3 codes)
Food, Drink and Tobacco (15+16)
Chemicals (24)
Metal Manufacturing (27)
Mechanical & Instrument Manufacturing (29+33)
Transport Equipment exc. Vehicles (35)
Vehicles (34)
Textiles, Leather and Clothing (17+18+19)
Paper, Printing and Publishing (21+22)
Rubber & Plastics (25)
Electrical Engineering (30+31+32)
Other Manufacturing (20+26+28+36+37)

Table A3: Variable definitions data sources and descriptive statistics

Variable	Definition	Source	Mean	Standard deviation
Q_{it}	Value added (sector i year t).	ONS for UK; STAN for source countries.	£3.78bn	£37.6m
K_{it}	Capital stock	ONS	£1.8 bn	£217m
ML_{it}	Employment of operatives	ONS	123376	41567
NL_{it}	Employment of non-operatives	ONS	65597	27564
FDI_{it}	Foreign direct investment	ONS	£2.4 bn	291m
RDI_{it}	R&D/Q	ANBERD/STAN	0.0394	0.06652
ULC_{it}	Unit labour costs	OECD	0.00613	0.07412
$FDI\ (1)_{it}$	FDI where $RDI_{UK}>RDI_F$ and $ULC_{UK}< ULC_F$	ONS/ANBERD/STAN	£198.5m	£80.211m
$FDI(2)_{it}$	FDI where $RDI_{UK}>RDI_F$ and $ULC_{UK}> ULC_F$	ONS/ANBERD/STAN	£270.1m	£66.51m
$FDI\ (3)_{it}$	FDI where $RDI_{UK}<RDI_F$ and $ULC_{UK}< ULC_F$	ONS/ANBERD/STAN	£385.6m	£84.777m
$FDI\ (4)_{it}$	FDI where $RDI_{UK}<RDI_F$ and $ULC_{UK}> ULC_F$	ONS/ANBERD/STAN	£1.247bn	£147.32m

Notes:

1. The means and standard deviations for RDI and ULC refer to the mean and standard deviation of RDI_{uk} / RDI_F and ULC_{uk} / ULC_F respectively.
2. The means shown above are in nominal terms over the period. However, in the econometric analysis sectoral producer price deflators were used throughout, and OECD purchasing power parity deflators were also employed in calculating relative R&D intensities across countries.
3. All estimations are carried out in log form.

Figure A1. Number of sectors by FDI type