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Creating backward linkages from multinationals: Is there a role for financial incentives?*

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Abstract:
We investigate whether government subsidies to local input manufacturers encourage procurement from foreign firms. We use a comprehensive panel data of Irish firms from 1983 until 2002. Our data shows a spontaneity about linkages and relative insensitivity to grant aid, although it may be the quality rather than quantity of linkages that matters. The longevity of a foreign firm's stay is one consistent driver of linkages where foreign firms need time to find out about local suppliers. Our results hold even when controlling for the possible joint determination of grants and linkages and the boundedness of the linkage variable.

Keywords: multinational enterprises, backward linkages, subsidies

JEL classification: F23, O14, H25

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1 Introduction

There is widespread agreement in the international economics literature that backward linkages between multinational enterprises (MNEs) and domestic suppliers are good for the domestic economy (Rodríguez-Clare, 1996; Markusen and Venables, 1999; Javorcik, 2004; Alfaro et al., 2006). Benefits to the domestic economy from linkages arise for a number of reasons. First, linkages may bring about increased demand for inputs inducing employment and growth in domestic upstream firms; see Markusen and Venables (1999). Related to this, Rodríguez-Clare (1996) argues that MNEs typically produce more complex products than domestic firms, which acts as a further spur to local suppliers to upgrade their own technology base.[1] A similar intuition underpins Chung and Kim's (2003) analysis on changes in innovation rates of Korean suppliers in the automobile and electronics industries. Secondly, although MNEs are likely to displace some local domestic firms, as shown by Alfaro and Rodríguez-Clare (2004), their ability to create employment in upstream domestic industry often more than offsets this displacement loss.[2] Finally, evidence from Javorcik (2004), Blalock and Gertler (2007), and Girma et al. (2008) for various countries suggests that linkages stimulate the upgrading of domestic suppliers where demand for highly specialised inputs increases, opening up the potential for knowledge spillovers from multinationals.[3]

While backward linkages may have these positive effects on domestic firms they are by no means automatic results of an influx of foreign multinationals. Indeed, research has pointed out that linkages are created, and produce benefits, only when certain conditions are met (Chung and Kim, 2003; Larraín et al., 2000; Belderbos et al., 2001; Alfaro et al., 2006). For example, local suppliers need to be able to manufacture inputs at a sufficiently high capacity before they can hope to secure the custom of foreign MNEs. Others have pointed out that local suppliers have to be sufficiently advanced technologically to absorb

[1] An example of this spur to domestic producers is given in Larraín et al. (2000) who conclude that the decision of Intel to locate in Costa Rica in 1997 meant that; '…the development of local producers has been fast and ambitious, thanks to a coordinated effort by the government' (p. 32).

[2] One could worry that domestic firms are disadvantaged by the entry of foreign firms if increased demand for local inputs bids up their price, however, Larraín et al. (2000), in their discussions with local Costa Rican firms concluded that any negative general equilibrium effects were perceived as short term as suppliers adjusted to cope with increased demand.

[3] Moran (2001) provides a number of interesting case studies to further illustrate this potential benefit of foreign direct investment (FDI) for local economies.

knowledge spillovers and deal with the demand for specialised inputs. This latter reason is why backward linkages are most often a feature of FDI from industrialised home countries to industrialised host countries. In this case, local procurement markets are well developed. Similarly industrialised countries usually possess well functioning capital markets enabling domestic upstream firms to set-up, expand and upgrade their operations as suppliers of inputs to foreign MNEs (Alfaro et al., 2006).

The above points make it clear that, from a policy perspective, governments interested in maximising the benefit from linkages need to understand why and how MNEs form backward linkages. Yet, despite the strong and growing interest in linkages from multinationals, there remain some gaps in this regard. Particularly under researched is the extent to which foreign MNEs respond to government incentives by setting up backward linkages – a highly important question from a government perspective. The aim of this paper is to fill this gap in the literature. More specifically, we explore how affiliates of foreign multinationals respond to government incentives in the form of subsidies by creating linkages with upstream domestic suppliers using the case study of Ireland. As far as we are aware, this question has not been addressed in formal econometric work in the literature.[4]

Another novel contribution of our paper is to establish whether there is heterogeneity in the effect of government incentives on foreign affiliates depending on the country of origin of the multinational. The theoretical model by Rodríguez-Clare (1996) predicts that MNEs have a greater propensity to generate linkages, and have a greater impact on the domestic economy as the cultural and/or geographic distance increases. Therefore, the effect of grants in motivating MNEs to create linkages with domestic industry may also be likely to differ according to the origin of the FDI.

Arguably Ireland is a particularly suitable case study for the questions at hand. More precisely, the steady stream of FDI into Ireland during the mid-eighties to early nineties

[4] In somewhat related work, Belderbos et al. (2001) have, inter alia, looked at the impact of local content requirements for linkages by Japanese affiliates overseas and have found a positive but modest relationship. There is also a more general literature looking at the role of government policy for attracting FDI, see Bobonis and Shatz (2007) and Harding and Javorcik (2007). Furthermore, a number of papers look at the determinants of linkages by multinationals but do not take into account government policy, e.g., Alfaro and Rodriguez-Clare (2004) for Latin American countries. Görg and Ruane (2000) also investigate the determinants of linkages using a limited data set for the electronics industry in Ireland for 1990 to 1995. They focus on a comparison of domestic and foreign firms and do not consider any aspect of government policy.

was accompanied by an increase in sales by domestic suppliers of 83 percent, a productivity increase of 36 percent and employment of 33 percent. Some of these domestic suppliers went on to become international subcontractors (Condron, 2007). In fact the Irish success story in tying in MNEs with local firms is such that currently Irish policy makers are being invited to give tips on how this success story can be repeated in newly emerging markets like the former Soviet Block countries.

Our empirical analysis is based on a unique plant level data set for Irish manufacturing firms covering the period 1983 to 2002. This data set was created by linking information from an official comprehensive survey of plants (which provides data on production, employment and input sourcing, among others) with exhaustive plant level information on government subsidies provided in Ireland.

The most interesting of our findings from a policy perspective is that multinationals that are not European and non-US, labelled here Rest of the World (ROW), respond positively to government subsidies in terms of linkage creation, whereas US and European MNEs in Ireland develop backward linkages quite independently of government grants. The degree to which these foreign firms decide to embed into the local economy is more likely therefore to be governed by different factors which override government efforts to influence embeddedness directly through subsidies.

The policy implication of our findings is twofold. First, our results suggest that governments should not apply a 'one-size-fits-all' approach to incentivising foreign MNEs. ROW firms are clearly sensitive to grant provision and only in the case of ROW firms can it be said that grants deliver value in generating linkages. Secondly, the formation of backward linkages with domestic suppliers is importantly influenced by factors other than financial incentives. In particular, there seems to be a negative relationship between a multinational's export intensity and the degree of linkage creation. We do not rule out however, the importance of more hands-off policies to bring about linkages e.g. the provision of information to foreign affiliates about prospective local suppliers. In fact, it appears that information is a major factor in establishing linkages because as our regressions show, over time individual firms increase their embeddedness as their information about local supplier markets improves.

Our paper is structured as follows. The first section provides some background on the Irish grant system and the role of foreign linkages in the Republic of Ireland. Then follows a section describing our plant level panel data and also summarising the extent of local procurement by affiliates of foreign firms in Ireland. The Methodology section specifies our subsequent regressions. The Analysis section follows and some concluding remarks are provided in a final section.

2. Foreign firms in Ireland and domestic suppliers

Ireland has been hailed as a country which has prospered from having attracted FDI from flagship companies in various export oriented sectors. Examples of these firms being Intel and Dell (ICT sector), Abbott and Eli Lilly (pharmaceuticals), Herz (International and financial services sector) and Whirlpool and Braun (Engineering and Consumer goods sector). Ireland has not always enjoyed such success in exploiting FDI, however, and has only maximised its benefits from FDI by shaping and reshaping policy on the basis of experience.

In the early 80's, Irish policy makers conceded that Irish suppliers were failing to make the most of their potential to supply affiliates of foreign firms (NESC, 1982). The National Linkage Programme delivered by the Industrial Development Agency (IDA) was introduced to make more of these opportunities.[5] This programme focused in its initial phase mainly on the purchase of raw materials and other inputs (backward linkages) and on the sales of intermediate goods (forward linkages) between indigenous firms and foreign affiliates.

The National Linkage Programme targeted potential purchasers and sub-suppliers in the most promising export oriented sectors (e.g. Electronics) and identified potential 'winners'. This programme created a better environment for the suppliers of inputs to multinationals and assisted them in upgrading technology and quality standards. Given their expertise, Irish policy makers are now working in an advisory capacity for similar schemes for South East Europe (Condron, 2007). Of course, the presence of trustworthy, high quality and

[5] See Ruane (2001) and Condron (2007) for a description of Irish linkage policy.

skilled suppliers is only one prerequisite for backward linkages to take place. If a sound local procurement market is absent, giving incentives to foreign affiliates is arguably of little use in stimulating and deriving benefit from linkages with domestic firms (Rodríguez-Clare, 1996; Belderbos et al, 2001).

Given the presence of the right fundamentals, however, government policy may provide additional incentives for multinationals to generate linkages with the domestic economy. While the National Linkage Programme was mainly aimed at providing assistance to domestic suppliers, the Irish government has also made extensive use of financial incentives for multinationals. Although the generation of new employment has been the overriding rationale for this type of government intervention, there have also been other objectives, arguably with a view to creating linkages. Indeed, grants were awarded in Ireland on the basis of linking foreign firms into the local economy. One qualifying reason for grant support was that the project could tap into skill-intensive indigenous supplier firms, reflecting the aim that the supported multinational should aid to create or maintain employment in the economy "that would not be maintained without assistance and will increase output and value added within the economy" (KPMG, 2003). This, hence, reflects the objective of linkage creation between multinationals and domestic suppliers.

It is important to make clear, however, that the data on grants we consider are general production related subsidies, rather than financial incentives made specifically for linkage creation. Why should one expect such grants to have any influence on linkage creation? Firstly, one objective of grant support for multinationals is explicitly linked to the generation of linkages between multinationals and domestic suppliers, as pointed out above. Hence, grants are given on the understanding that local sourcing has to take place. Secondly, in our empirical analysis we control explicitly for a number of other factors, as well as specifically for the potential endogeneity of grant receipt. Hence, assuming the validity of our empirical approach, the identification of any effect of subsidies on linkages suggests that there is a causal relationship between these two variables. This would reflect that, although firms may use grants also for other purposes, at least partly they are used to foster linkages with the domestic economy.

We therefore proceed to investigate whether grants have had any impact on the generation of backward linkages by multinationals. Specifically, we look at grants administered by the

industrial development agency IDA Ireland which now has responsibility for promoting foreign firms. While there have been some changes in the provision of grants over time, provision within the time frame encompassed by our data can be summarised as follows: projects successful in obtaining grant aid had to, in addition to the objectives stated above, either involve the production of goods with an export bias, be of an advanced technological nature or have involvement with skilled supply firms within Ireland. Additionally, grants could be extended to sectors facing stiff international competition (see KPMG, 2003). Total grant levels were negotiated bilaterally between the company and IDA but did not generally exceed certain capital cost thresholds, usually between 45 and 60 percent.[6]

3. Data description

For our analysis, we utilise information from two data sources collected by Forfás, the policy and advisory board with responsibility for enterprise, trade, science, and technology in the Republic of Ireland. These data cover the period 1983 to 2002.

The first data source is the Irish Economy Expenditure (IEE) survey, collected from 1983 until 1998, which then became the Annual Business Survey (ABS) and to which we have access until 2002. This is an annual survey of manufacturing plants located in Ireland with at least 20 employees, although a plant, once included is generally still surveyed even if its employment falls below this threshold. The coverage for foreign multinationals is generally over 80 per cent of the total population. The data provides information on intermediate inputs and distinguishes domestically procured from imported inputs. We use this information to calculate a linkage indicator as the ratio of material and components inputs sourced locally over total inputs (in line with, e.g., Görg and Ruane, 2000; Kennedy, 1991; Cohen, 1973).[7] Further data available from this source that is relevant to the current paper are total sales (as a measure of output), employment, value of exports, the age of the plant, nationality of ownership, home country of the foreign owner, and four digit sector of

[6] See Meyler and Strobl (2000) for a more detailed discussion of grant provision in Ireland.

[7] While this has been an established measure of linkages in the literature, based on the concept by Hirschman (1971), Rodriguez-Clare (1996) argues that the indicator of locally sourced inputs over total inputs may not be an appropriate indicator of local linkages for the purpose of gauging multinationals' effects on local development. Assuming that multinationals are likely to be more intensive users of intermediates than domestic firms he shows in his theoretical model that in order to measure the relative importance of multinationals' local linkages what matters is the ratio of domestically sourced inputs relative to employment in the plant. We consider this measure of linkages in a robustness check below.

production.[8] The foreign ownership information relates to the last year in the data and does not vary over time. However, this is not a large problem in the case of Ireland as most FDI is in the form of greenfield investment, i.e., ownership did generally not change over our sample period.

Importantly for the question to be addressed in this paper, Forfás also has an exhaustive annual database on all grant payments that have been made to plants in Irish manufacturing since 1972. This information can be linked to the IEE/ABS via a unique plant identifier maintained by Forfás. By linking information across data sources our sample consists generally of plants of at least 20 employees for the years 1983-2002. Our analysis focuses on plants of foreign multinationals located in Ireland, for which we cover 1,069 of such affiliates in our data.

Before delving into our data it is worth noting a few preliminary points on the composition of Irish industry. Irish industry is dominated by large multinational firms who account for much of overall output and exports (Lane and Ruane, 2006). Many of these firms are highly active in a small number of knowledge intensive, export oriented manufacturing sectors including electrical and electronic equipment, medical instruments, chemicals and pharmaceuticals.

Table 1 gives a breakdown of the key variables in the Forfás data by nationality of the foreign plants. As can be seen, the vast majority of plants are either European or US with comparable numbers of affiliates for each. Among these multinationals US affiliates are the largest both in terms of employment and sales. They are also the largest recipients of grants both in absolute terms and when measured relative to turnover. What is interesting is that all MNE groupings have a similar mean linkage ratio, which is defined as domestically sourced materials relative to total material inputs, where plants typically procure 29-30 percent of their total inputs on domestic markets.

[8] Forfás defines foreign plants as plants that are majority-owned by foreign shareholders, i.e., where there is at least 50 per cent foreign ownership. While, arguably, plants with lower foreign ownership should still possibly considered to be foreign owned, this is not necessarily a problem for the case of Ireland since most inward foreign direct investment has been greenfield rather than acquisitions of local firms. Note that our data only provide a dummy based on this definition rather than a percentage of ownership.

Figures 1 and 2 provide a preliminary view of the relationship between grant receipt and the extent of domestic linkages.[9] The kernel density plots in Figure 1 show how the distribution of material linkages varies according to whether plants receive grant assistance. Plot 1 includes affiliates which do not receive such grants. For firms receiving grants, one can observe that the distribution of linkages based on whether grant assistance is classified as medium (plot 2) or high (plot 3). All plots bear a striking similarity to each other. They are U-shaped as most plants have no, or very low, linkages with domestic upstream plants. On the basis of Figure 1, the tendency for plants to conduct comparatively little procurement from domestic suppliers, does not appear to be influenced by grant assistance. Figure 2 further controls for the different nationalities of foreign affiliates, viz., European, US or ROW. Again we observe a U-shaped distribution with the majority of plants conducting little or no local procurement.

In order to quantify to what extent the origin of FDI has any effect on domestic linkages, we estimate several simple regressions with FDI origin dummies to see whether backward linkages differ according to the origin of FDI, where the baseline category is European FDI (Table 2). There are no significant differences across the FDI categories, leading us to conclude that European, US and ROW affiliates in Ireland conduct similar levels of procurement with Irish suppliers. The negligible effect of FDI origin on the magnitude of domestic linkages is robust to the technique used, OLS, random effects or a random effect Tobit. Of course, this is just a preliminary look at the data in which we do not control for other covariates. In order to do so we now turn to a more formal modelling of the determinants of linkages, paying particular attention to grant receipt and nationality of the foreign affiliate.

4. Methodology

Our model sets out to estimate the impact of grants on the amount of local procurement by foreign plants. We estimate equations of the following form:

$$linkage_{it} = \beta_1 grants_{it} + \beta_2 X_{it} + d_t + d_s + \mu_i + \varepsilon_{it} \qquad (1)$$

[9] The raw correlation between linkages and grants is very low, as indicated in the correlation matrix reported in the Appendix.

where the dependent variable is the linkage ratio of plant *i* at time *t*, as defined in Section 3. In our baseline specification, *grants ratio*, is defined as the value of grants received in time *t* relative to the annual turnover of the affiliate. In alternative specifications we also included the (log) absolute value of grants, *grants*, this did not lead to any significant changes in results.[10]

The covariates used in the vector *X* are all chosen in view of other work on domestic linkages and what was available from the data. Logged employment size, *employment*, has been used in other work as a control variable (Görg and Ruane, 2000). Large plants are expected to have lower linkages because scale economies make them more self-sufficient than smaller plants. Several papers also confirm the importance of length of time the foreign affiliate has operated in the host market as a covariate, where affiliate age has been found to have a positive effect on linkages with domestic suppliers (Görg and Ruane, 2000; Belderbos and Capannelli, 2001; Alfaro and Rodríguez-Clare, 2004). This expectation is in line with the ideas by Rauch and Watson (2003) who argue that firms may start with low levels of local sourcing in an unfamiliar environment, but that this may increase over time as customers learn about the quality and reliability of domestic suppliers over time. We measure this effect via the inclusion of *age*, i.e., the number of years the multinational has been located in Ireland.

The productivity of the foreign affiliate is another covariate in our model. Girma and Görg (2004) find that more productive establishments have a higher ratio of purchased inputs (either sourced locally or abroad) to value added. On this basis, highly productive foreign plants may have a differing capacity to outsource locally than their less productive counterparts. Accordingly, we include the productivity (defined as sales per employee), *productivity*, of the foreign affiliate as a control covariate.[11]

The export orientation of multinationals may also matter for their extent of linkage generation. In this regard, Moran (2001) highlights the fact that the extent of linkages is

[10] Because the grants administered by the Industrial Development Agency (IDA) in Ireland are usually paid in pre-specified instalments and successive instalments subject to periodic reviews, it helps that we have a reasonably long panel (almost two decades) to chart the potential impact of grants on the formation of backward linkages.

[11] We do not have reliable capital data in order to allow us to calculate more sophisticated measures of total factor productivity.

likely to be smaller if the multinational is part of an international network via export platform FDI, as the network likely provides a relatively large share of inputs. Given the fact that much of the foreign direct investment in Ireland is export oriented we control for this possibility by including the export ratio of the foreign affiliate (defined as exports over total turnover), *exports*, as an additional covariate. Finally, the estimation includes a full set of time and sector dummies (d_t and d_s) as well as a plant specific effect (μ_i).[12]

5. Analysis

Table 3 shows the results for our baseline estimations of equation (1) which are implemented using a fixed effect (within-transformation) panel estimator. The important finding in this table is that the grant ratio has no effect on the extent to which foreign firms are embedded in the local economy (cols. 1 and 3). This is robust to defining plant size either in terms of employment (col. 1) or sales (col. 3). Likewise the alternative definition of the grant variable as absolute value of a grant does not produce any statistically significant coefficient (col. 4).

In terms of the other covariates, the fixed effects estimations which produce positive elasticities on the size variable suggest that growth of foreign affiliates leads to higher embeddedess in the local economy, although the coefficient is only statistically significant in col. 2. Consistent with other work, we see from the positive coefficient on age that the longer affiliates are established in the local economy, the more they procure from local upstream firms (Görg and Ruane, 2000; Belderbos and Capannelli, 2001; Alfaro and Rodríguez-Clare, 2004).

Perhaps somewhat surprisingly, productivity improvements are not associated with more local procurement. We have to bear in mind, however, that the FE estimator does not allow for the possibility of endogeneity of this variables, an issue we address later on. Finally we find a negative association between the export ratio and the extent of local linkages, in line with expectation, although this coefficient is statistically insignificant.

[12] In fact, the plant level fixed effect controls also for very disaggregated sectoral heterogeneity, as the sector information in our data is time invariant (it relates to the last year in the sample).

One may argue that our failure to determine an effect of grants on linkages is due the fact that grants take time to have an impact and, hence, regressing the linkage measure on contemporary grants misses this. In order to test for this possibility we, in col. 4 and 5, use lagged grant variables in the regression. As can be seen, this does not change our results, although we lose a large number of observations due to the lagged variable. Hence, in what follows we use the full panel with the contemporaneous grant levels. Additionally, further on below, we instrument properly for the grant variable using lagged values as instruments.

The Appendix shows, as a further robustness check, estimations of the model in col. 1 using different estimators, namely random effects panel and a panel tobit estimator. These confirm that there is no statistically significant relationship between grants and linkages. Note that these regressions include also two time invariant nationality dummies for affiliates from the US and the rest of the world. This shows that, when controlling for other observable plant characteristics, US affiliates have higher linkages than other multinationals.

In Table 3 we constrained the effects of grants on linkages to be uniform over the source of the FDI. However, we recall the Rodríguez-Clare (1996) prediction that the motivation of MNEs to create linkages with domestic industry is not homogeneous but varies for different home countries. Accordingly, in Table 4, we use the full sample and interact each variable with the source of FDI, i.e., EU, US, or ROW. We now observe a significantly positive effect of grants on backward linkages, but only for ROW plants. This effect is robust to the panel estimator used (FE or RE) and the inclusion of other interaction terms (cols. 3 and 4).

Generally, the size, age, and productivity covariates register the same sign as in earlier estimations. We saw earlier in Table 3 that increasing affiliate size was positively associated with backward linkages. Looking for the results using the FE estimator (col. 3) with FDI origin interactions, we see that this effect only holds for US plants (although the sign is also positive for ROW firms). Reassuringly, increasing affiliate time since establishment (age) has a positive effect on the extent of procurement from domestic suppliers in the fixed effects estimations.

The export ratio interaction terms (col. 3) compare to previous findings. A strong negative coefficient for ROW plants further supports the export-platform conjecture that the most

export oriented affiliates (especially from ROW), are not necessarily the most embedded in the local economy. Therefore, while a strong export bias is good for the host country in other ways (such affiliates may be less likely to crowd out domestic industry), we have no evidence to show that such plants are particularly good at creating linkages with the local economy.

The previous analysis by pooling the data but including FDI origin interactions assumed the error terms to be uniform across the origin countries. We now go a further step towards checking the robustness of our findings, by splitting up the sample into the three nationality categories, EU, US and ROW. We estimate each using the fixed effects estimator, see Table 5. What we find is that similar to our previous estimation, only ROW affililates procure more inputs from domestic suppliers in response to higher grant ratios. This finding therefore is relatively robust to the estimation used. Looking at the other covariates in turn shows that growing and/or maturing US firms develop higher linkage intensities. This positive effect is also registered by maturing EU plants. Productivity increases only bring about higher linkages for ROW affiliates, in fact for US affiliates the opposite is true. Finally, the export-platform conjecture only seems to hold true for ROW plants while this effect is statistically insignificant for other plants.[13]

Up to now we have considered the explanatory variables as exogenous in the fixed effects estimation. This may not be a reasonable assumption if grant receipt and linkages are jointly determined by a third variable, and if the thus introduced correlation with the error term varies over time, i.e., is not captured by the fixed effect. Furthermore, arguably productivity, size and the export ratio are also potentially endogenous. In order to deal with this potential problem, we employ a system GMM estimator (Blundell and Bond, 1998) which essentially uses a stacked system of first differenced and level versions of equation (1), where for the former appropriately lagged values and for the latter appropriately lagged differences of the endogenous variables (grants, productivity, size, exports) can serve as valid instruments. The validity of these instruments can be tested using a Hansen J test.

[13] At this point we should make it clear again that this result is unlikely to be due to sectoral heterogeneity between ROW on the one hand and US and EU plants on the other hand. Our FE approach controls for this, as sectoral information is time invariant.

The results of the system GMM estimations are reported in Table 6. Note, firstly, that we fail to reject the null of instrument validity for the US and ROW sample, but not for the European plants, and hence that we need to treat the results for European affiliates with caution. The main result of these regressions is, however, encouraging, as it is in line with previous results: we find a positive effect of grants on linkages only for foreign affiliates from the rest of the world, not for US affiliates.

Another potential criticism of our estimation thus far is that we do not take into account the nature of our dependent variable, which is bounded between zero and one. Hence, the linear estimators employed in the earlier regressions may be biased. In order to take this into account, while simultaneously controlling for the potential endogeneity of regressors, we now employ an instrumental variables technique for Tobit models due to Smith and Blundell (1986). Similar to the GMM estimation we use lagged values of the potentially endogenous variables (grants, productivity, size, exports) as instruments.[14] The estimation of Tobit models with endogenous regressors essentially involves two steps:[15] (i) generate residual terms from linear regressions of each endogenous variable on the instrumental variables and all other exogenous regressors, and (ii) estimate a standard Tobit model by including the residual terms from step (i) in the list of covariates. The residual terms are correction terms for the endogeneity problem, and jointly statistically significant coefficients can be taken as evidence in favour of the hypothesis that instrumented variables are indeed endogenous.

Reassuringly, the result for the grant variable is consistent with results from the previous estimations: higher grant intensities to ROW affiliates lead to higher embeddedness in the local economy and upstream linkages. Interestingly, the signs of all the other covariates are invariant across the different FDI origin countries. Also reassuring is the result for age: plants with longer establishment histories in the host market have higher linkages with domestic suppliers. This positive result for age is consistent with other work (e.g. Alfaro and Rodríguez-Clare, 2004). Similar to Görg and Ruane (2000), we see that it is the

[14] To our knowledge there are no formal tests of the validity of instruments within the context of this endogenous Tobit specification. Nevertheless, in order to gauge the appropriateness of the instruments note that we also use lagged values which have been shown to be valid instruments in the linear context of the GMM model reported in Table 6.

[15] A one-step variant of this estimator involving stronger distributional assumptions is also available (see Newey, 1987). However, the estimator fails to attain convergence in our data. Note also that, in order to obtain convergence for our specification, we replaced the set of time dummies with linear time trend. This type of convergence problem is frequently encountered when there are more than one endogenous regressors.

smaller affiliates that are most linked with local suppliers. It is likely that smaller plants have lower capacity to produce inputs internally and hence source them from domestic suppliers. We now can discern that ex ante more productive plants are those that opt for higher levels of linkages with domestic firms. This result is consistent across the different FDI origin categories. The negative result we have evidenced in previous estimations for the export ratio is also reported here: the firms with the highest export intensities are not the most deeply embedded in the local economy.

A final robustness check of our estimation concerns the definition of linkages. Alfaro and Rodriguez-Clare (2004) argue that measuring domestically sourced inputs relative to employment is a better measure of linkages in order to determine the effectiveness of linkages for local development. In order to take this point into account we re-calculate our linkage ratio as locally sourced intermediates divided by total employment in the plant, and re-estimate equation (1) with this alternative dependent variable. The results, which are reported in Table 8 are, reassuringly, similar in sign and statistical significance to our earlier results: we only find a positive effect of grant receipt on linkages for affiliates from ROW. Interestingly, however, this estimation also produces a negative coefficient on grant receipt for US affiliates. While such a negative coefficient did show up in earlier tables, it is only statistically significant in this particular estimation. Hence, we conclude that this effect is not robust.

6. Conclusion

One clear message from our analysis is the extent to which competing policy goals can be conflicting and the need to distinguish primary from secondary goals. Rodríguez-Clare (1996) on a similar point says that it makes little policy sense to attract FDI to backward regions since linkages are unlikely to form there (neither local industry nor infrastructure is sufficiently developed to support the foreign affiliates). Any potential positive effects from FDI are short-lived unless local suppliers can produce high quality and competitively priced inputs to the foreign firm or be sufficiently advanced to capitalise on technology spillovers. Policy makers ought to therefore distinguish between policies to develop local industry and those designed to attract foreign-owned blue chip industry in order to maximise spillovers to local producers.

A somewhat similar conclusion can be taken from our estimations: we find strong evidence that the plants with the highest export intensities are not those most deeply embedded in the local economy. Hence, attracting export-oriented foreign multinationals to the economy may come at the expense of the development of linkages, a point also stressed by Moran (2001). However, one may want to qualify this pessimistic finding: it may not be the *quantity* of inputs supplied from local producers that matters so much (linkage intensity) as the *quality* of the linkage and if foreign firms with the strongest export bias foster better quality linkages, this problem disappears.[16]

As regards to policies towards multinationals to increase linkages, the main message from analysis for policy makers is clear: avoid a 'one-suit-fits-all' policy when subsidising foreign affiliates. We have shown that in certain cases grants to plants of foreign MNEs do succeed in cultivating backward linkages. However, European and US MNEs are relatively insensitive to grant aid when forming backward linkages with domestic suppliers. From this one can conclude that applying a uniform policy towards foreign MNEs is less beneficial for growth of domestic upstream industry than a tailored approach.

[16] In the same context, Javorcik (2004) has noted that spillovers to upstream firms through linkages arise when both supplier and buyer cooperate on the product. Not all linkages have this feature of close cooperation and therefore it is the quality of a linkage that matters.

Appendix

Table A1: Correlation matrix

	employment	*sales*	*age*	*link_m*	*grant_ratio*	*grant*
employment	1.0000					
sales	0.5295	1.0000				
	0.0000***					
age	0.1334	0.0166	1.0000			
	0.0000***	0.1207				
Linkages	-0.0003	0.0090	0.2413	1.0000		
	0.9789	0.3997	0.0000***			
grants ratio	-0.0086	-0.0037	-0.0129	-0.0123	1.0000	
	0.4215	0.7285	0.2301	0.2523		
grants	0.3813	0.1884	-0.0673	-0.0386	0.0236	1.0000
	0.0000***	0.0000***	0.0000***	0.0003***	0.0275**	

Table A2: Robustness check for Table 3 with different estimators

	(1)	(2)
	re	xttobit
employment	-0.123	-0.043
	(0.372)	(0.248)
age	0.211	0.212
	(0.040)***	(0.012)***
Productivity	-0.911	-0.676
	(0.395)**	(0.265)**
export ratio	-0.039	-0.033
	(0.014)***	(0.008)***
grant ratio	-0.000	-0.001
	(0.000)	(0.001)
Us	4.297	4.266
	(1.981)**	(0.628)***
row	0.100	-1.061
	(2.989)	(0.868)
Observations	8695	8695
Number of plants	1069	1069

Standard errors in parentheses
** significant at 5%; *** significant at 1%
Regressions include constant and year dummies

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Table 1: Breakdown of key variables for foreign firms, by nationality

	EU				US				ROW			
	mean	median	sd	N	mean	median	sd	N	mean	median	sd	N
Number of employees	158	88	216	3917	223	109	356	3815	182	128	161	963
Sales turnover (000's)	23428	8426	44673	3917	89612	13848	404899	3815	40034	13972	73154	963
Age of firm (age)	28	18	26	3917	19	17	13	3815	23	17	22	963
Material linkage	28.7	15.0	31.4	3917	29.3	20.0	28.9	3815	29.9	20.0	29.1	963
Ratio of grants to turnover	1.5	0	9.5	3917	17.6	0	708.8	3815	7.6	0	181.6	963
Grant amount (000’s)	127.1	0	396.4	3917	415.0	0	1988.2	3815	249.8	0	1002.6	963

Table 2: Nationality premia

	(1)	(2)	(3)
	ols	re	re tobit
us	0.334	0.884	0.702
	(0.684)	(1.976)	(0.575)
row	1.050	-2.093	-3.154
	(1.079)	(3.066)	(1.128)***
Constant	28.054	29.420	30.780
	(1.752)***	(1.650)***	(1.050)***
Observations	8695	8695	8695
R-squared	0.01	0.01	
Number of plants	1069	1069	1069

Notes:
Standard errors in parentheses
** significant at 5%; *** significant at 1%
Dependent variable is ratio of domestic purchased inputs to total inputs
Base category is European affiliates

Table 3: Determinants of linkages, basic specification using FE estimator

	(1)	(2)	(3)	(4)	(5)
grant ratio	-0.000		-0.000	0.000	
	(0.000)		(0.000)	(0.000)	
grants		-0.118			-0.072
		(0.076)			(0.079)
employment	0.779	0.841		0.698	0.741
	(0.410)	(0.411)**		(0.472)	(0.475)
age	0.217	0.193	0.217	0.321	0.307
	(0.065)***	(0.067)***	(0.065)***	(0.070)***	(0.071)***
Productivity	-1.187	-1.146	-1.970	-1.496	-1.502
	(0.436)***	(0.421)***	(0.592)***	(0.495)***	(0.494)***
export ratio	-0.011	-0.011	-0.010	0.005	0.005
	(0.016)	(0.016)	(0.016)	(0.018)	(0.018)
sales			0.781		
			(0.418)		
Observations	8695	8695	8695	7214	7214
Number of plants	1069	1069	1069	1004	1004
R-squared	0.01	0.01	0.01	0.04	0.04

Standard errors in parentheses
** significant at 5%; *** significant at 1%
Regressions include constant, year and two-digit industry dummies

Table 4: Nationality differences

	(1)	(2)	(3)	(4)
	fe	re	fe	re
*grant ratio * eu*	-0.020	0.010	-0.031	-0.004
	(0.033)	(0.032)	(0.034)	(0.032)
*grant ratio * us*	-0.000	-0.000	-0.000	-0.000
	(0.000)	(0.000)	(0.000)	(0.000)
*grant ratio * row*	0.009	0.009	0.011	0.010
	(0.003)***	(0.003)***	(0.003)***	(0.003)***
employment	0.818	-0.018		
	(0.410)**	(0.366)		
age	0.214	0.040		
	(0.065)***	(0.044)		
productivity	-1.147	-1.314		
	(0.438)***	(0.395)***		
export ratio	-0.010	-0.022		
	(0.016)	(0.014)		
us		2.657		-13.654
		(1.844)		(5.881)**
row		-0.513		-18.087
		(2.728)		(8.753)**
*employment * eu*			-0.635	-1.364
			(0.681)	(0.603)**
*employment * us*			1.587	0.830
			(0.571)***	(0.507)
*employment * row*			1.287	0.435
			(1.288)	(1.124)
*age * eu*			0.162	0.052
			(0.079)**	(0.048)
*age * us*			0.319	0.060
			(0.082)***	(0.064)
*age * row*			0.044	-0.042
			(0.131)	(0.095)
*productivity * eu*			-1.215	-2.236
			(0.848)	(0.740)***
*productivity * us*			-2.014	-1.757
			(0.569)***	(0.509)***
*productivity * row*			2.385	1.999
			(1.156)**	(1.010)**
*export_ratio * eu*			-0.012	-0.029
			(0.023)	(0.019)
*export_ratio * us*			0.043	0.029
			(0.025)*	(0.022)
*export_ratio * row*			-0.168	-0.154
			(0.042)***	(0.036)***
Observations	8695	8695	8695	8695
Number of plants	1069	1069	1069	1069
R-squared	0.01	0.27	0.01	0.27

Standard errors in parentheses
** significant at 5%; *** significant at 1%
Regressions include constant, year and two-digit industry dummies

Table 5: Separate regressions, FE

	(1)	(2)	(3)
	us	eu	row
employment	1.543	-0.591	1.294
	(0.591)***	(0.676)	(1.181)
age	0.304	0.161	-0.010
	(0.107)***	(0.095)*	(0.177)
productivity	-2.123	-1.170	2.293
	(0.590)***	(0.844)	(1.055)**
export ratio	0.040	-0.014	-0.166
	(0.026)	(0.023)	(0.038)***
grant ratio	-0.000	-0.032	0.010
	(0.000)	(0.034)	(0.003)***
Observations	3815	3917	963
Number of plants	477	468	124
R-squared	0.02	0.00	0.07

Standard errors in parentheses
** significant at 5%; *** significant at 1%
Regressions include constant, year and two-digit industry dummies

Table 6: Separate regressions, System GMM

	(1)	(2)	(3)
	us	eu	row
employment	0.354	0.953	-4.813
	(1.843)	(2.019)	(2.290)**
age	0.262	-0.176	0.071
	(0.244)	(0.174)	(0.270)
productivity	-0.283	-2.923	0.466
	(1.782)	(2.136)	(2.415)
export ratio	0.049	-0.031	0.079
	(0.072)	(0.076)	(0.078)
grant ratio	-0.000	0.076	0.007
	(0.000)	(0.029)***	(0.003)***
Hansen J test (p-value)	1.00	0.00	1.00
AR(2) (p-value)	0.82	0.29	0.15
Observations	3815	3917	963
Number of plants	477	468	124

Robust standard errors in parentheses
** significant at 5%; *** significant at 1%
Regressions include constant, year and two-digit industry dummies

Table 7: Separate regressions, endogenous tobit

	(1)	(2)	(3)
	us	eu	row
employment	-0.699	-1.534	-4.529
	(0.552)	(0.695)**	(1.382)***
age	0.048	0.351	0.432
	(0.048)	(0.026)***	(0.051)***
productivity	1.386	3.179	5.032
	(0.749)*	(0.937)***	(1.260)***
export ratio	-0.077	-0.170	-0.048
	(0.025)***	(0.019)***	(0.044)
grant ratio	-1.209	0.628	2.148
	(0.901)	(0.562)	(1.026)**
Observations	2580	2642	644

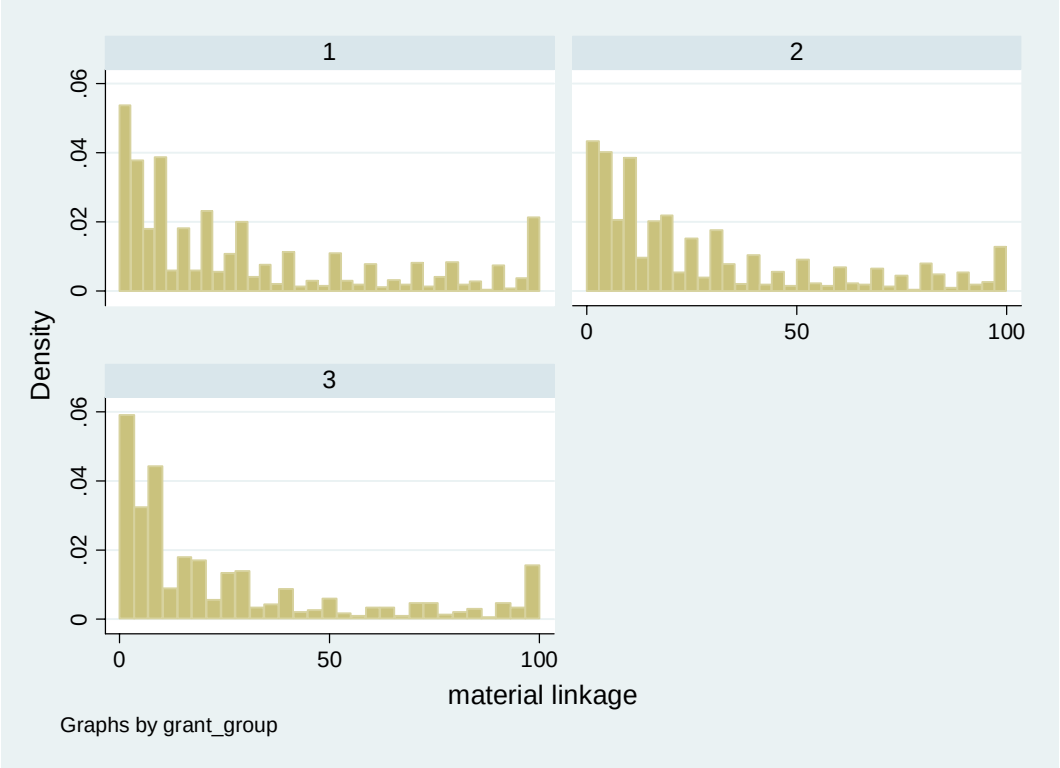
Standard errors in parentheses
** significant at 5%; *** significant at 1%
Regressions include constant and year trend

Table 8: Separate regressions with alternative definition of linkages, endogenous tobit

	(1)	(2)	(3)
	us	eu	row
employment	-0.020	-0.138	-0.145
	(0.024)	(0.028)***	(0.055)***
age	0.000	0.008	0.012
	(0.002)	(0.001)***	(0.002)***
productivity	0.787	1.043	1.176
	(0.033)***	(0.039)***	(0.052)***
export ratio	-0.007	-0.006	-0.005
	(0.001)***	(0.001)***	(0.002)***
grant ratio	-0.138	-0.010	0.088
	(0.043)***	(0.026)	(0.040)**
Observations	2406	2372	600

Standard errors in parentheses
** significant at 5%; *** significant at 1%
Regressions include constant and year trend

Figure 1:



Note: grant group 1: low grant (grant_ratio = 0); grant group 2: medium grant (grant_ratio < 3.48 [90th percentile]), grant group 3: high grant (grant ratio > 3.48)

Figure 2: