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MODELLING THE FACTORS ASSOCIATED WITH DEADWEIGHT AND DISPLACEMENT: AN EXAMPLE OF IRISH INDUSTRIAL POLICY EVALUATION

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***Abstract*:** Evaluating industrial policy interventions has become a growing theme for academics and policymakers. Evaluation should explore the 'counter-factual'; this involves examining the related phenomena of deadweight and displacement. Research to date has almost exclusively concerned itself with deriving headline estimates of these phenomena (particularly deadweight in the Irish context) and discussing their consequences. The main argument in this paper is that it is no longer sufficient to merely derive estimates of deadweight and displacement and to discuss their consequences; the focus of attention should now turn to establishing specific firm factors (e.g. size of firm; type of firm ownership; type of assistance received) that influence these estimates. It is only then that real policy improvements and learning can occur. To this end, the explicit focus of this paper is to ascertain whether certain firm characteristics are likely to influence the likelihood of deadweight and/or displacement effects. The methodological approach developed has broad-based applicability beyond the Irish context, given that the econometric techniques adopted are adaptable to the evaluation of various types of policy interventions in a variety of contexts.

Keywords: Deadweight effects, displacement effects, industrial policy, evaluation
JEL Classifications: C25, L6, H5, D78.

1. INTRODUCTION

The evaluation of industrial policy is a theme of growing importance for both academics and policymakers in both Ireland and internationally. Nationally, this would appear to be largely driven by the emphasis placed by the European Union (EU) on assessing the impact of significant EU transfers (evaluation) and on ensuring that appropriate financial management systems have been implemented

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(accountability).

For decades, the Irish government have allocated significant resources to various types and measures of industrial policy interventions. Just under €3.3 billion was provided in direct supports by Irish development agencies[1] in the period 1991 to 2002.[2] In this context, it is timely to reflect on the conceptual frameworks driving evaluation studies.

Various changes in the focus of Irish industrial policy have taken place over the years, in many cases without the insights of evaluation. For example, there has been a shift towards intervention through equity investments from 6.5 per cent of all incentive payments to 25.8 per cent in the decade between 1991 and 2001 followed by a slight decrease to 19.6 per cent in 2002[3]. This shift has taken place without reference to many of the factors at work with respect to financial assistance interventions (e.g. exploring the counterfactual scenario (deadweight); displacement and other key components of overall additionality).

This paper engages in a debate in which academics over the years have been slow to partake. Storey (2000) in his much publicised paper "Six Steps to Heaven" argued that academics in general have been rather slow to address issues in this field of research. The current paper aims to encourage more debate by academics and policymakers of this important area.

One has to acknowledge, however, the growing recognition of the need for evaluation in Ireland especially over the last six years. This is highlighted in the work of Honohan (1997; 1998); Industrial Evaluation Unit (IEU) work (1995; 1999; 2000); Lenihan (1999; 2001) Lenihan *et al*. (2003)[4] and Forfás (2003). The focus of all these studies is on evaluating (using the term in its broadest sense ranging from monitoring, to appraisal, to in-depth firm-specific evaluation) industrial policy intervention using a variety of methodological approaches in a variety of contexts.

These previous studies have been useful in terms of understanding and deriving estimates of deadweight and displacement (particularly the former). They have also highlighted the contribution that can be made from detailed evaluations of industrial policy. The key contribution of this paper is to highlight firm-specific characteristics that drive deadweight (impact upon the counterfactual) and displacement estimates. The present paper is concerned with examining the underlying causes of deadweight and displacement. The focus of attention is on establishing the specific characteristics of firms that influence these estimates. In the Irish case, a sufficient amount of evidence regarding the extent of deadweight exists to suggest that this is a worthwhile exercise to undertake. It is now time for evidence to facilitate improvement through more effective policies and programmes.

To examine the underlying causes of deadweight and displacement, this paper develops two predictive logit models (one for deadweight, the other for

displacement) to ascertain whether certain firm specific characteristics (e.g. age of firm; size of firm; firm sector etc.) are likely to influence the likelihood of deadweight and/or displacement. The logit models are estimated employing data from interviews with the relevant personnel (e.g. managing directors, accountants, financial controllers) in firms that received financial assistance from Shannon Development in 1995.[5] The discussion has been set in the context of industrial development policy in a region of Ireland. The methodological approach developed however, will have broad-based applicability beyond not only the Shannon region but also the Irish context, due to the fact that the econometric modelling techniques adopted are adaptable to varying contexts. Whilst the discussion focuses on financial assistance provided by a regional development agency, similar evaluation procedures are appropriate for a much wider range of government programmes. It should be borne in mind that awarding grants to industry is only one part of Shannon Development's remit[6] (as it the case for all development agencies) in the Shannon region of Ireland. Focusing on interventions by means of financial assistance to industry has the advantage, as Lenihan (1999) and Georghiou (2002) have argued, of being more amenable to evaluation than other types of 'softer' supports, due to the fact that money is a measurable input and that a grant may involve dedicated firm personnel.

The next section briefly defines the concepts of deadweight and displacement as employed in this research; it also examines evidence of deadweight and displacement as highlighted by research in the Irish context. Section three describes the methodological approach adopted and provides information regarding the sample size and composition. The penultimate section details the econometric framework developed in the paper regarding the estimation of predictive (logit) models for deadweight and displacement and the final section draws together conclusions and some issues requiring further attention.

2. DEFINITION AND EVIDENCE OF DEADWEIGHT AND DISPLACEMENT

Deadweight, as defined in this paper, refers to the degree to which projects would have gone ahead anyway without financial assistance from the development agency. 'Degrees' of deadweight are measured by time, location and scale. Even if 'zero deadweight' exists there still remains the possibility that assistance allocated to one firm displaces jobs elsewhere in the economy (however defined e.g. local, regional or national economy)[7]. Most commentators would concur with the definitions as outlined above,[8] however, McEldowney (1997) argues that although the concepts have much validity, it is in the application and treatment of such concepts that problems and challenges may occur.

Since the mid-1980s quite a number of evaluative studies[9] have been undertaken in the UK, which have incorporated the related concepts of deadweight and

displacement into their analyses. The impetus in the United Kingdom followed from the introduction of the UK Governments' Financial Management Initiative in 1983. Other non-UK studies have also been undertaken which acknowledged, and in most cases, attempted to estimate deadweight and displacement.[10] In the case of Ireland, recent evaluation studies have also attempted to either estimate, or assume an estimate of deadweight in their analyses. Deadweight estimates in the Irish studies range from around 45 per cent to 80 per cent. Deadweight estimates derived or assumed in various Irish studies can be seen in Table 1.

Table 1: Deadweight estimates derived in Irish Studies

Authors (Year)	Evaluation of What (Focus of Study)	Where	Deadweight Estimate Deadweight Assumption
Forfás (2003)	Start-up project Expansion project High Potential Start-up project	ROI-Greater Dublin region	80% 80% 60%
Forfás (2003)	Start-up project Expansion project High Potential Start-up project	ROI-Rest of Ireland	70% 75% 60%
Forfás (2003)	Start-up project Expansion project High Potential Start-up project	ROI-BMW[1] regions	65% 70% 60%
Honohan (1998)	Key Issues of Cost-benefit Methodology for Irish Industrial Policy	ROI	80%
IEU (1999)	R&D Policy and Interventions	ROI	50%
IEU (1999)	Micro Enterprise Supports	ROI	45%
IEU (2000)	Seed and Venture Capital Scheme	ROI	60%
Lenihan (1999)	1995 Shannon Development Grants (Indigenous firms only)	ROI Shannon Region	78.4%
Lenihan (2001)	1995 Shannon Development Grants (Foreign firms only)	ROI Shannon Region	71.3%
Lenihan (2001)	1995 Shannon Development Grants	ROI Shannon Region	73.2%

Source: Noted in table. Note: ROI=Republic of Ireland.

In the case of all of the Irish studies, deadweight estimates are high by international standards.[11] Whilst many of the national studies also refer to or acknowledge the existence of displacement to date, Lenihan (1999; 2001) are the only studies to have actually derived displacement estimates that are of direct relevance to the Republic of Ireland. Interestingly these estimates are low by international standards,[12] ranging from 3.1 per cent for the full sample of 103 firms that received financial assistance from Shannon Development in 1995, to 4.6 per cent for the indigenous firms in the sample and 0.3 per cent for the foreign-owned firms in the sample. More research is merited to gain a firmer estimate of displacement overtime and across agencies. As a general note, a note of caution needs to be exercised when comparing estimates of deadweight or displacement across studies in that all of the studies adopt a variety of methodologies.[13] Nevertheless, the fact that all of the Irish studies either derive or assume high deadweight estimates would appear to merit further investigation. The same point is relevant internationally where there has been an almost exclusive focus in the relevant literature on the *consequences* as opposed to the *causes* of deadweight.[14]

3. METHODOLOGICAL APPROACH, DATA, AND DESCRIPTIVE STATISTICS

It is the author's view that the only way to estimate the levels of deadweight and displacement associated with Shannon Development assistance was to interview the recipients of the assistance. The combination of face-to-face interviews and file information from the development agency (as employed by Lenihan *et al.* 2003) may have been insightful but this was not an option available to the researcher as the author was not permitted by the development agency to access their files for the specific year in question.[15] In light of the sensitivity of the two concepts, the same detailed level of insight would not in the author's view have been attained by analysing aggregate published data. Deadweight and displacement are also best studied at the level of the individual firm. In summary, the face-to-face interview technique using the 'self-assessment' approach was chosen given that it is useful for examining the underlying processes in operation (i.e. cause and effect).

One of the frequently cited drawbacks to this approach is termed the 'respondents effect', the fact that recipients may exaggerate the impact of assistance given their concerns regarding their perceived eligibility for future funding by the development agency. As McEldowney (1997) outlined:

"...firms in receipt of grant assistance may display a bias towards indicating the positive influence of such assistance in their decision-making, thereby validating in the eyes of policy-makers the need for such grants and arguably their continuation" (p. 186).

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[1] BMW (Border Midlands Western) region.

Other recipients may behave in the completely opposite manner and play down the impact of assistance, preferring to attribute success to their own personal characteristics.

In light of the above, the following steps were taken to ensure that the interviewees provided as consistent a counter-factual as possible:

1. Before the face-to-face interviews, grant recipients were sent a pre-interview letter detailing what they should expect to take place. The pre-letter also emphasised that the discussion during the face-to-face interview would entail an examination of the financial assistance received from Shannon Development in 1995. This level of focus is necessary given the plethora of assistance measures available to firms in the Shannon region from various agencies.

2. Given that the grant from Shannon Development was only received approximately eighteen months previously (interviews were carried out February – June 1997), recall bias was not a major issue given the relatively short time scale involved.

It would be naive to think that some element of response bias did not exist during face-to-face interviews as "Measuring the counterfactual is…..difficult since no direct observations can be made" (Purdon *et al*. 2001 p. 18). That said, it should be borne in mind that this approach is the most appropriate for eliciting sensitive information regarding the highly complex concepts of deadweight and displacement. The aim after all was to capture the complexity of the issues being studied. As Georghoi (2002) outlined:

> "*Conceptually, additionality appears relatively simple on superficial examination. It involves comparison with the null hypothesis or counterfactual-what would have happened if no intervention had taken place"* (p. 1).

In this instance reality is of course far more complex than the conceptual.

3.1 Data and descriptive statistics

The empirical analysis was carried out on a dataset of 103 firms that received financial assistance from Shannon Development in 1995. According to the agency's annual report (Shannon Development 1995), a total of 215 firms[16] received financial assistance from the agency in question for that particular year. This was out of 749 firms in the Shannon region in 1995 that employed 17,803 people[17]. This list was cross-matched with various databases with the aim of establishing the number of firms that were still surviving and to obtain contact details of these firms (as outlined in detail by Lenihan (2001)). By the time the current research project began

(September 1996), 164 firms were deemed by the researcher to be appropriate to sample. A total of 106 companies agreed to take part in subsequent face-to-face interviews, resulting in a response rate of almost 65 per cent.[18]

The surveyed firms were varied in character. Of the 103 firms surveyed,[19] 77 were indigenous with the remaining 26 firms foreign-owned. In excess of two-thirds of firms (69%) were concentrated in the 0-49 employee category (small firms) and 15 per cent in the 50-100 employee category (medium firms); the remaining 16 per cent were in the 100+ category (large firms). In total, 101 firms gave their start-up date and of these 32 per cent were established between 1991 and 1995. As regards industrial activity, 75 per cent of firms were in the manufacturing sector. The average size of grant awarded by Shannon Development in 1995 was at the lower end of the scale, with 46 per cent of firms receiving a grant of up to IR£19,999 (€25,393.49). Some 93 per cent of firms received grants for expansion purposes. Table 2 shows the major grant type received by firms from Shannon Development in 1995.[20]

Table 2: Major grant types received by all 103 sample firms from Shannon Development in 1995

Type of grant	**Percentage of firms receiving a particular grant type**
Feasibility Study	5.83
Employment	22.33
Capital Investment	28.16
Employee Training	11.65
Technology Acquisition/Joint Venture/Licensing Grant	0.96
Management Development	6.80
Research and Development	24.27
TOTAL	**100**

Source: Shannon Development Survey (1997)*, Author.*

The highest proportion of firms received Capital Investment grants and Research and Development grants with both of these summing to 52.4 per cent of the major grant type received by survey firms in 1995. The third most common type of grant was employment, received by 22.3 per cent of firms, followed by Employee Training (11.7%), Management Development (6.8%) and Feasibility Study (5.8%), and Technology Acquisition/Joint Venture/Licensing Grant (1%).

Table 3 provides information on the monetary value of the different types of grants awarded.

Table 3: Monetary value of the different types of grant awarded by Shannon Development in 1995 to the 103 sample firms.

Type of grant	IR£ [a]	Amount (€)
Feasibility Study	73,911.6	93,848.4
Employment	523,860.6	665,165.8
Capital Investment	11,796,545.9	14,978,522
Employee Training	429,368.7	545,185.8
Technology Acquisition/Joint Venture/ Licensing Grant	8,550.0	10856.3
Management Development	177,914.7	225905.1
Mentor [b]	149.0	189.2
Research and Development	1,935,530.5	2457616.7
TOTAL	**14,945,831.00**	**18,977,290.00**
% of Total Grants Awarded in 1995	57.4% [c]	

Source: Shannon Development Survey (1997)*, Author.*

[a] Figures calculated under the various grant headings are rounded off to one decimal place. [b] This is the first mention of Mentor Grant as it is not a major grant type. The £149 awarded in Mentor Grant was to a single company and constituted 10 percent of the total grant awarded to that firm, the majority of which was an Employee Training Grant. [c] According to the "Shannon Development Annual Report", in 1995, 215 firms received grants from Shannon Development. The overall figure awarded to these 215 firms in grants was IR£26,050,498, that is, IR£26.05 million. The total figure awarded to the 103 sample firms in grants was IR£14,945,831, that is, IR£14.95 million which is 57.4% of the overall total figure for grants awarded to firms in the Shannon region by Shannon Development in 1995.

An obvious question to ask at this stage is: are there any major differences between the characteristics of the foreign-owned (26) versus the indigenous (77) sampled firms?

The main difference between the two cohorts of firms is that, as expected, the vast majority of indigenous firms (82%) can be classified as small firms (0-49 employee category). The majority (38%) of foreign-owned firms, on the other hand, are classified as large (100^{+} employee category). The only other striking difference is the fact that the majority (53%) of indigenous firms received a grant at the lower end of the scale (IR£0-19,999 i.e. €0- €25,393.49) from Shannon Development in 1995, compared to the majority (35%) of foreign-owned firms who received a grant at the upper end of the scale (IR£120,000+ i.e. € 152368.57+).

Half of the foreign-owned firms received capital grants compared to approximately 21 per cent of indigenous firms. On the other hand, almost 26 per cent of indigenous firms received employment grants compared to only approximately 12 per cent of foreign-owned firms. The single most striking point however, is that of the overall IR£14.95 million (i.e. €18.98 million) awarded to the sample firms by Shannon

Development in 1995, approximately IR£12.3 million (€15.62) was awarded to the 26 foreign-owned firms with the indigenous firms in the sample receiving approximately IR£2.65 million[21] (€3.36 million).

3.2 Direct questions probed during face-to-face interviews

To assess deadweight directly the following line of questioning was pursued Lenihan (1999). Respondents were asked:

> *"In the absence of grant assistance from Shannon Development in 1995 would you have (choose one option only)?*
> (a) Gone ahead as now unchanged, that is, same scale, time and location.
> (b) Gone ahead at a different location but otherwise unchanged.
> (c) Gone ahead at a later date but otherwise unchanged (that is, delayed the project).
> (d) Gone ahead on a reduced scale but otherwise unchanged.
> (e) Abandoned the project".
> When respondents said that in the absence of the grant their projects would have gone ahead elsewhere, on a smaller scale, or at a later date, they were asked for precise details. These questions facilitated estimates of 'partial' versus 'pure' degrees of deadweight and helped to provide a picture of what was most likely to have happened if the award had not been made" (p. 310)[22].

Option (a) implies 'pure' ('full') deadweight. Options (b), (c), and (d) all imply 'partial' degrees of deadweight; option (e) implies zero deadweight.

The percentage of firms in the pure 'full' deadweight category was 52.4 per cent, with 6.8 per cent of firms in the partial deadweight (different location) category; 10.7 per cent of firms in the partial deadweight (later date) category; 21.4 per cent of firms in the partial deadweight (reduced scale) category and finally, 8.7 per cent of firms in the zero deadweight category. As outlined by Lenihan (1999), other indicators of deadweight were also employed in the research for example, "the incorporation of grants into financial appraisals thus provides another good indicator of deadweight" (p. 312). In this study firms were also asked whether they had undertaken a financial appraisal of the project for which they had received financial assistance. Of the 92 firms who had undertaken a financial appraisal of their project, 57 per cent did not incorporate the financial assistance received from Shannon Development, which would suggest that deadweight is of this magnitude.

Another indicator of deadweight is to ascertain whether recipients really needed the assistance from the development agency or whether they could have obtained the financial assistance from elsewhere. The results are rather alarming. Of the 97 firms who replied to this question, almost all of them replied that they would have found alternative sources of funding. When this indicator is employed, deadweight appears

to be even higher. These findings raise serious questions relating to the value for money of such assistance.

The method for calculating displacement in this paper mirrors that of Lenihan (1999) who calculated displacement by (1) ascertaining the degree to which Shannon Development assisted firms sell their products within the local/regional areas (as opposed to nationally or internationally) and (2) ascertaining the degree to which sales by Shannon Development assisted firms displace output from other local/regional firms rather than national firms or imports. The overall assumption being that where the majority of competitors are known to be located in the local or regional areas that displacement will occur within the assisted area (i.e. Shannon region). On the other hand, where competitors are located abroad, the assumption in this instance is of no displacement of assisted-area jobs.

In summary, as outlined previously in Section 2, displacement estimates were as follows: 3.1 per cent for the full sample of 103 firms; 4.6 per cent for the indigenous firms in the sample and 0.3 per cent for the foreign-owned firms in the sample.

The remainder of the analysis concerns itself with trying to predict certain firm characteristics that are likely to influence deadweight and displacement.

4. THE ECONOMETRIC FRAMEWORK

This section is divided into two sub-sections: Sub-section 1 explores a logit model for deadweight and Sub-section 2, a logit model for displacement. Given its relevance to the Irish economy, the prime concern in this paper is to develop a logit model for deadweight. As outlined in Section 2, given the high deadweight estimates suggested by Irish evaluative research studies to date, the development of rigorous evaluative approaches and methodologies aiming to identify the causes of deadweight would appear to be a useful way forward. As also outlined in Section 2, displacement appears to be a less pressing issue and for this reason the discussion of a predictive model for displacement in this paper is kept brief.[23] It is however worth briefly introducing the logit model for displacement for three main reasons: Firstly, it serves once again to emphasise the point that deadweight and displacement are related phenomena and are best examined together and not in isolation; secondly, the introduction of the displacement modelling serves to highlight the fact that the methodological approach developed in the case of displacement is both rigorous and scientific and has broad-based application across a range of initiatives and policies and thirdly, introducing the displacement modelling serves as an interesting starting point to guide future research and debate in this area.

4.1 A Dichotomous Logit Model for Deadweight

The dependent variable deadweight is dichotomous. It takes the value 1 if deadweight exists and 0 otherwise. As outlined in Section 3, the distribution of the 103 grant-aided firms amongst the deadweight categories is as follows: 54 firms - full (pure) deadweight category; 40 firms - partial deadweight categories and 9 firms - zero deadweight category.

Based on the fact that there are three possible deadweight categories, the obvious choice would be to run a multinomial logit (or probit) model. This was pursued, but given the skewed distribution of firms within specific categories of "deadweight", in addition to the relatively small sample size, this did not prove to be a viable option. Deadweight was subsequently classified into two categories, coded 1 if there was "pure deadweight" (n=54), coded 0 otherwise (n=49).[24] This is an appropriate manner in which to code the deadweight variable, given that there is a significant difference between A (a firm who would have gone ahead anyway with a project *completely* unchanged in the absence of grant aid) and B (a firm which would have gone ahead with a project with a partial change (e.g. at a different location, scale, time period) or have abandoned the project altogether in the absence of grant aid. In both (A) and (B) above a given firm is faced with a significantly different set of circumstances.

The choice of options available to the researcher is to adopt either a logit or a probit model since these models are the appropriate specification for a dichotomous variable.[25] There is little difference between the two qualitative response models as demonstrated in Tables A1 and A2 in the appendix. The logit model has been chosen in this paper to undertake the analysis of evaluating the impact of grant assistance to firms, the prime reason being to allow for ease of interpretation.[26]

Estimating the Dichotomous Logit Model for Deadweight in the Shannon Region

The logit model adopted in this paper is that of Tervo (1990) who defined the model as follows:

Equation 1:

$$p_i \equiv \text{prob}\left(y_i = 1\right) = F\left(x'_i \beta\right) = \frac{e^{x'_i \beta}}{1 + e^{x'_i \beta}} \quad i = 1,...,n \quad (1)$$

where y_i is a binary response variable, which takes the value of 1 if the event (for example displacement occurs) and 0 if it does not. With information on the binary

response variable and on a vector of x' the parameter vector β can be estimated by maximum likelihood method" (p. 622). The logit models in this paper (for both deadweight and displacement) are also specified as equation (1).

4.2 A Dichotomous Logit Model for Deadweight

The explanatory variables included in equation (1) are to a large extent based on the exploratory nature of this research area, although some guidance is provided from the emerging literature in this field of study.

In light of the exploratory focus it was decided to explore the possibility of statistical rationale (employing association tests) for including particular variables as well as the more intuitive and theoretical rationale for including particular variables. The approaches are complementary, not alternative and are used in combination. The statistical analysis will only detail cases where significant results were obtained from analysing the deadweight categories within the data provided. Given the exploratory focus of the research, three types of deadweight variables were utilized to see whether there were any significant univariate associations. Firstly, the binary deadweight categories (i.e. partial and zero deadweight versus pure deadweight)[27] were tested against various explanatory variables to see whether there were any significant associations (this was the deadweight variable used in the final logit models). Secondly, the full categorisation deadweight variable that gives 'full deadweight' to 'zero deadweight' categories[28] was also employed. And finally, the deadweight variable which has three categories, pure, partial and zero deadweight was also examined.

A Logit model was run to include the following determining variables:

- whether the investment appraisal carried out by firm included the grant received from Shannon Development (β_1);
- amount of grant received (β_2);
- grant type (β_3);
- whether the grant received was for start-up or expansion purposes (β_4);
- sector (β_5);
- age of firm (β_6);
- size of firm (measured in terms of number of employees) (β_7);
- percentage employment growth 1995-1997 (slow-growth versus fast-growth firms) (β_8);
- grant amount as a percentage of turnover (β_9);
- type of ownership (β_{10});
- whether grant received was a first time or repeat grant (β_{11});
- turnover (β_{12}).

This author agrees with Heijs (2003) who argued:

> *"From a scientific point of view the logistic regression models are a more sophisticated approach than the association tests and their results should prevail over the association tests"* (p. 457).

Whether the investment appraisal carried out by firm included grant from Shannon Development variable was included given that one would expect *a priori* if a firm fails to incorporate the grant received then it is likely that the financial assistance was not critical to the project (implying that deadweight is likely to be higher as argued by Sheehan 1993 and Allen *et al* 1984). The binary deadweight variable versus *whether the investment appraisal carried out by firm included the grant received from Shannon Development* was very significant (p=0.011). Less 'pure deadweight' companies included the grant received as part of their investment appraisal than would be expected by chance and more 'zero or partial deadweight' companies included grant received as part of their investment appraisal than would be expected by chance. The association is not however particularly strong (Cramer's V = 0.277 – weak). The full categorisation deadweight variable versus 'whether the investment appraisal carried out by firm included grant from Shannon Development' (β_1) gives a very mixed picture (p=0.057, Cramer's V=0.316) but 50 per cent of cells have an expected frequency <5. There is a clearer picture for the trichotomous deadweight variable versus *whether the investment appraisal carried out by firm included grant from Shannon Development* as full deadweight firms are less likely to have included the grant as part of their investment appraisal than expected by chance and partial or zero deadweight firms are more likely to have included the grant received as part of their investment appraisal p=0.028 (Cramer's V=0.279).

Grant type is included. Given the shift away from fixed asset type supports to other forms of assistance such as R&D, equity investment, employment grants and supports aimed at upgrading business capability of firms (e.g. in 1988 fixed asset type supports granted by the development agencies accounted for 68.4 % of total expenditure, by 2001, the percentage had fallen to 29.2%)[29], it would be disappointing to find that these other types of financial assistance resulted in higher levels of deadweight. The association between the binary deadweight variable and grant type[30] was almost significant (p=0.096 – Fisher's exact test). More pure deadweight companies appeared to have received an employment grant than would be expected by chance. However, the association is not very strong – Cramer's V is just 0.184. The full categorisation (5 categories) deadweight variable was not significant but 16/54 firms with full deadweight had received an employment grant and 0/9 firms with zero deadweight had received an employment grant (p=0.173). However, Cramer's V only = 0.249 and also 40 per cent of cells have expected frequency < 5 and so the chi-squared test is not really valid.

When the trichotomous deadweight categorisation was tested against *type of grant* (β_3) received then p=0.091 (Cramer's V=0.216).

The rationale for including *amount of grant received* [31] is that *a priori* one might anticipate that firms receiving small grants are likely to have higher deadweight levels. If the grant awarded is small, one might be justified in assuming that it is likely to have little impact on whether or not the project would have gone ahead anyway. A small grant could however, have a major impact on a small firm, whereas a similar grant size might have little impact on a large firm.[32] Allen *et al*. (1984) found that in the case of Regional Selective Assistance (RSA) "Its influence was greatest in respect of large projects and varied systematically with size of award" (p.8). For this data set the full categorisation (5 categories) deadweight versus amount of grant received is significant (p=0.033) – Cramer's V is 0.319 so it is quite a weak relationship. It provides a very mixed picture. More firms in the full deadweight category received a grant at the lower end of the size spectrum than would be expected by chance. When the trichotomous deadweight variable versus *amount of grant received* is analysed a clearer picture emerges: more full deadweight, fewer partial and even fewer zero deadweight firms received a grant at the lower end of the spectrum than expected by chance. However p = 0.363 and Cramer's V = 0.140[33] so the association is no longer significant and still very weak.

Size of firm[34] was also included. *A priori* one would anticipate that deadweight would be lower for small firms, because larger firms have greater access to alternative avenues for funding which is likely to imply higher deadweight as suggested in Section 3. Allen *et al*. (1984) found that Regional Development Grant (RDG) assistance was more important to small firms. More recently Heijs (2003) in a paper which examined public finance of R&D activities in enterprises in the context of Spanish low interest credits for R&D found that "The exploratory analysis pointed out that the large firms had more financial alternatives than the small ones" (p. 453). More precisely, he found that:

> *"It can be pointed out that the size of the firm is a clear explanatory variable related to freerider behaviour. Large firms are more prone to freeriding, a fact also confirmed by other studies…"* (p. 455). [35]

Just less than a decade previously, Hart and Scott (1994) found that: "For the larger small firm, which is most able to raise finance from the private sector, deadweight is an ever-present problem" (p. 857).

Percentage of employment growth 1995-1997 was included to see whether firms of different growth levels impact differently on the deadweight variable.

Turnover was also included in the equation as it is a useful proxy for firm size. As Roper and Hewitt-Dundas (2001) argued:

> *"Studies have tended to focus on employment growth paying less attention to other important indicators of business performance such as turnover growth or profitability"* (p.101).

Sector was also included. From a policy perspective it would be most informative to discover that different sectors are associated with higher/lower deadweight. Such insights might not only be useful in terms of *ex-ante* appraisal/evaluation work but also on a day to day basis in terms of ensuring that agencies awarding assistance may be more inclined to probe in detail those firms seeking assistance which are concentrated in particular sectors. Honohan (1998) also emphasized that deadweight is particularly relevant to the issue of which sectors should be eligible for grant assistance.

There exists no strong *a priori* reasoning for including *whether grant received was a first time or repeat grant* and is thus included due to the exploratory focus of the research. Two lines of reasoning are possible: firstly, one might anticipate that firms that have been through the process before would have learned from earlier applications. This view is supported by Allen *et al.* (1984), who argue that firms who were first-timers:

> "*…may be assumed to have learned from earlier applications, were much more likely to incorporate RSA at an early stage in the investment decision-making, were much more confident of their understanding of the appropriate procedures and, in general, were more successful in their application"* (p. 10).

On the other hand, the opposing view could also be argued; development agencies may be more inclined to give first-time applicants the benefit of the doubt in light of the fact that they may be newer to the market, not as comfortable financially and may thus be able to make a stronger case (on market failure grounds for example) for assistance even though in reality they may be able to proceed with a particular project anyway. The binary deadweight variable versus *whether grant recipient was a first time or repeat grant recipient* was not significant ($p=0.220$) but appeared to be indicating some association, that is, more 'pure deadweight' firms were first time grant recipients than expected by chance.

The rationale for including *type of ownership* was primarily for exploratory reasons. A priori one might expect that foreign-owned firms might be more likely to have higher levels of deadweight in the sense that generally foreign-owned firms that locate in Ireland tend to be larger than the majority of indigenous firms. As suggested previously, larger firms usually have greater access to alternative sources of funding. Coupled with this, many foreign-owned firms based in Ireland are branch plants to a larger parent company (located abroad) that may be a source of

funding. The full categorisation deadweight variable versus *type of ownership* was almost significant (p=0.055) but 30 per cent of cells had expected frequencies < 5 so the test was not really valid. When the trichotomous deadweight variable was tested against *type of ownership* there was no relationship at all (p=0.479).

There is also no strong *a priori* reasoning for incorporating *age of firm.* One might anticipate that older (more established) firms would be associated with higher deadweight levels. One would imagine that older firms would be more familiar with grant applications and dealing with personnel from development agencies. In this regard, they may be in a position to acquire funding in excess of that which is really necessary, thus implying higher deadweight. Also older firms that have already existed in the market place for a certain period of time might have more credibility and track record with private banks for example, thus implying possible options for alternative sources of funding, thus leading in all probability to higher levels of deadweight.

With the above in mind, various equations including different combinations of the explanatory variables were run.

Table 4 (Option 1) presents the equation with the greatest explanatory power. The modelling approach adopted was a 'general to simple' approach. All variables believed to influence deadweight were included in the models and then subsequently dropped to derive a more parsimonious representation of the underlying data.

Table 4: Logit Estimates—Deadweight (Option 1)

Deadweight					
Variables	**Coeff**	**Std error**	***z*-stat**	**Odds Ratio**	**Std error**
Grant Type (β_3)	2.1545	0.8856	2.433**	8.6232	7.6368
Amount of Grant Received (β_2)	0.7502	0.6905	1.086	2.1175	1.4622
Whether investment appraisal included grant from Shannon Development (β_1)	-1.4249	0.5439	-2.620***	0.2405	0.1308
Whether grant was for start-up or expansion purposes (β_4)	0.4598	1.2489	0.368	1.5838	1.9780
Sector (β_5)	0.5995	0.6336	0.946	1.8213	1.1539
Age of firm (β_6)	0.0265	0.0167	1.586	1.0268	0.0171
Size (No. employees)[2] (β_7)	-1.3010	0.7560	-1.721*	0.2723	0.2058
Amount of grant received as a percentage of turnover (β_9)	0.2028	1.4737	0.138	1.2249	1.8051
Turnover (β_{12})	0.6030	0.8298	0.727	1.8275	1.5165
Type of Ownership (β_{10})	-0.0692	0.7264	-0.095	0.9332	0.6778
Whether recipient was a first-time/ repeat grant recipient (β_{11})	0.9753	0.8280	1.178	2.6520	2.1960
% employment growth of firm 1995-1997[a] (β_8)	-0.7525	0.7531	-0.999	0.4712	0.3548
Constant	0.1924	0.9828	0.196	-	-
n 87 Log likelihood -47.11 Chi-square (12) 25.45					

Source: Author's calculations. Note: Statistically significant variables are denoted as follows: *** denotes variables significant at the 1 per cent level; ** denotes significance at the 5 per cent level; * denotes significance at the 10 per cent level. a : represents slow-growth/fast-growth firms.

[2] ***Size*** (measured in terms of turnover) was included but it was insignificant.

4. 3 The Chi-squared ($\chi^{2)}$ Value and the Significance of Individual Coefficients[36]

The χ^2 statistic for the joint impact of the explanatory variables on the dependent variable is significant. To begin with it is necessary to test the null hypothesis that all regression coefficients in the model are simultaneously zero in the population. If this hypothesis is rejected, it can be concluded that at least one β is non-zero and individual *z*-tests for these β's can reveal which of them are non-zero.

The χ^2 statistic for the 12 independent variables in Table 4 on the dependent variable with 12 degrees of freedom is 25.45. It is beyond the critical value of 21.0261 at the 5% level. One can conclude that these independent variables jointly impact on deadweight. *Grant type* [37] (β_3), *whether investment appraisal carried out by firm included grant from Shannon Development* [38] (β_1) and *size of firm* [39](β_7) all influence deadweight and are significant. In the case of *grant type*, p = 0.015; *whether the investment appraisal carried out by firm included grant received from Shannon Development,* p = 0.009 and in the case of *size of firm* p = 0.085.

From Table 4 the following can be inferred: Firms that received employment grants are more likely *ceteris paribus* to evince deadweight than firms which received grants for other purposes. *Whether firm included grant received from Shannon Development as part of its investment appraisal* also influences deadweight. Firms that did not include the grant they received as part of their investment appraisal were more likely to cause deadweight *ceteris paribus* (as per Sheehan 1993). *Size of firm* impacts on deadweight. Firms with 0-49 employees (smaller firms) are less likely to evince deadweight than firms with >50 employees (larger firms.)

A closer look at the individual coefficients in Table 4 provides the following insights: With respect to -

- *Type of grant received by firm from Shannon Development in 1995*
  A firm being a recipient of an employment grant increases the Logit of deadweight by 2.15 *ceteris paribus*.

- *Whether or not firm included grant received from Shannon Development in 1995 as part of its investment appraisal.*
  A firm including the grant received from Shannon Development is associated with a decrease of 1.42 in the Logit of deadweight *ceteris paribus*.

- *Size of firm*
  A firm with number of employees in the 0-49 size range (smaller firms) is associated with a decrease of 1.30 in the Logit of deadweight *ceteris paribus*.

4.4 Presenting the Findings in terms of Odds Ratios

A positive/negative coefficient on a variable means that the odds ratio increases/decreases with an increase in the value of the explanatory variable. The odds ratio associated with each coefficient are also presented in Table 4.

From Table 4, one can estimate the log odds of causing deadweight given, *type of grant received*; *whether firm included grant received from Shannon Development in 1995 as part of its investment appraisal* and *size* controlling for the other variables in the model (i.e. the conditioning information variables). The estimate of 8.62 for' *type of grant received*' indicates that firms which received an employment grant have odds of causing deadweight that are 8.62 times what would be expected were type of grant received unrelated to deadweight (controlling for whether or not firm included grant received as part of its investment appraisal and size of firm in addition to the other conditioning variables included in the model). The odds of a firm causing deadweight increases for those firms that received an employment grant. There is no strong *a priori* reasoning to expect that the impact of employment grants should be significantly different from other types of grants. Various interpretations are possible: Around the period 1995-1997 (the study period), the Irish economy was really entering an upturn and was moving towards full employment. As argued earlier in this section, one would have to question the additional benefit associated with awarding employment grants in such an economic environment since in all probability one would expect firms to hire personnel anyway due to excess demand for their products. Another interpretation is also possible, on a more general level, it could be argued that hiring employees is seen more as a 'necessity' by many firms (usually takes place if demand for the particular firms' output increases), thus implying that it will be carried out anyway (implying high deadweight) regardless of financial assistance. Engaging in training or innovations in product or process (R&D), on the other hand, may be seen more as a 'luxury' and will at times only be carried out if an incentive policy exists.

The estimate of 0.24 for *whether or not investment appraisal included grant from Shannon Development* indicates that the odds of a firm causing deadweight decreases for those firms which incorporated the grant received as part of their overall investment appraisal. Firms that did not include the grant received were more likely to cause deadweight effects.

The estimate of 0.27 for *size of firm* indicates that the odds of a firm causing deadweight decreases for those firms that are in the 0-49 employee size range (i.e. smaller firms). Firms with number of employees >50 (i.e. larger firms) are more

likely to cause deadweight effects. It should be noted from Table 4, that the variable *age of firm* is almost significant at the 10 per cent level (p=0.113).

Given that all the other variables are insignificant according to Table 4 it was deemed appropriate to exclude them and re-run the Logit equation including only the significant variables and *age of firm* which was almost significant at the 10 per cent level. When this was attempted only the *type of grant* received variable and the variable for *whether or not investment appraisal included grant from Shannon Development* remain significant. Given that as already outlined the *age of firm* variable is not quite significant at the 10 per cent level, it was decided to re-run the Logit equation including only the three significant variables (*type of grant; whether or not investment appraisal included grant from Shannon Development* and *size of firm*), once again the only significant variables are *type of grant* and *whether or not investment appraisal included grant from Shannon Development*. This results in Table 5.

Table 5: Logit Estimates—Deadweight (Option 2)

	Deadweight				
Variables	**Coeff.**	**Std error**	***z*-stat**	**Odds Ratio**	**Std error**
Grant Type (β_3)	1.9396	0.7300	2.657**	6.9562	5.0780
Size (No. of employees) (β_7)	-0.4903	0.4951	-0.990	0.6125	0.3032
Whether investment appraisal included grant from Shannon Development (β_1)	-1.2603	0.4680	-2.693**	0.2836	0.1327
Constant	0.7032	0.4474	1.572	-	-
n 92 Log likelihood -55.53 Chi-square (3) 16.09					

Source: Author's calculation. Note: Statistically significant variables are denoted as follows: ** denotes variables significant at the 1 per cent level.

An interesting outcome emerges: only two of the three originally significant variables are now deemed to be significant. The Logit equation is re-run only including the significant variables. This results in Table 6:

Table 6: Logit Estimates—Deadweight (Option 3)

Deadweight					
Variables	**Coeff.**	**Std error**	***z*-stat**	**Odds Ratio**	**Std error**
Grant Type (β_3)	1.7751	0.7031	2.525*	5.9006	4.1486
Whether investment appraisal included grant from Shannon Development (β_1)	-1.2260	0.4622	-2.652**	0.2935	0.1356
Constant	0.3887	0.3067	1.267	-	-
n 92 Log likelihood -56.03 Chi-square (2) 15.09					

Source: Author's calculations. **Note**: Statistically significant variables are denoted as follows: ** denotes variables significant at the 1 per cent level; * denotes variables significant at the 5 per cent level.

From Table 6 one can estimate the log odds of causing deadweight given *type of grant received* and *whether firm included grant received from Shannon Development in 1995 as part of its investment appraisal*. The estimate of 5.90 for the *type of grant received* suggests that firms which received an employment grant have odds of causing deadweight that are 5.90 times what would be expected were type of grant received unrelated to deadweight (controlling for whether or not firm included grant received as part of its investment appraisal).

The estimate of 0.29 for *whether or not investment appraisal included grant from Shannon Development* indicates that the odds of a firm causing deadweight decreases for those firms which included the grant received as part of their overall investment appraisal. Firms which did not include the grant they received as part of their investment appraisals were more likely to cause deadweight effects.

4.5 Estimating probabilities

From Table 6, it can be seen that logit=0.39+1.78 (whatever value *type of grant received* will take, that is, 1 or 0) –1.23 (whatever value *whether or not investment appraisal carried out by firm included grant received from Shannon Development in 1995* variable will take, that is 1 or 0). Using this equation results in the following predicted probabilities for the logit model:

Example: A firm receiving an employment grant whose investment appraisal did not take into account the grant received.

Logit = 0.39 + 1.78(1) –1.23(0) = 2.17
(display exp(2.17)=8.76 display 8.76/(1+8.76)) = 0.90

This corresponds to a probability of deadweight of 0.90. Since this is a non-linear and non-additive model the deadweight probability value only holds in this particular case. Predictions for individual cases are found by replacing the variables (with their values) for specific cases.

Example: For a firm that received an R&D grant (any type of grant other than an employment grant) which did include the grant it received as part of its investment appraisal, the resulting equation is:
Logit = 0.39 + 1.78(0)-1.23(1) = -0.84
(display exp(-0.84)=0.43 display 0.43/(1+0.43)) = 0.30

This corresponds to a probability of 0.30, which as expected is lower than the previous example.

4.6 Simulation Results for Deadweight

Further transparency can be achieved from the results of the deadweight model by calculating the probabilities of different outcomes in a series of hypothetical scenarios. This offers a type of sensitivity analysis.

Simulation 1: What would happen to the probability of deadweight if all firms received a particular *grant type ceteris paribus*?

When the logit equation is estimated as in Table 6 (Option 3) the average probability of deadweight given the types of grant received by firms and the fact of whether the sample firms incorporated the grant received from Shannon Development as part of their investment appraisal[40] is equal to 0.533 as outlined below:

Variable	Obs	Mean	Std. Dev.	Min	Max
P	92	.5326087	.1958818	.3021049	.8969461

What is the contribution of *grant type*[41] to this deadweight probability estimate?
Assume the following scenarios: (1) all firms received employment grants from Shannon Development and (2) all firms received other grant types.

(1) Assume all firms received employment grants from Shannon Development
This results *ceteris paribus* in an average probability of deadweight = 0.82 as outlined below:

Variable	Obs	Mean	Std. Dev.	Min	Max
P	92	.8194254	.0888715	.7186484	.8969461

(2) Assume all firms received other grant types from Shannon Development
This results *ceteris paribus* in an average probability of deadweight = 0.47 as outlined below:

Variable	Obs	Mean	Std. Dev.	Min	Max
P	92	.4681998	.1464732	.3021049	.5959652

The results support previous calculations suggesting firms which received employment grants *ceteris paribus* are more likely to lead to higher deadweight.

Simulation 2: Suppose *ceteris paribus* that all firms in the sample *did/did not include grant received from Shannon Development in 1995 as part of their investment appraisal*.

As outlined under simulation 1, when the logit equation is estimated as in Table 6 (Option 3) the average probability of deadweight is 0.533.

The following assumptions are made: (1) All firms incorporated grant received from Shannon Development as part of their investment appraisal and (2) All firms did not incorporate grant received as part of their investment appraisal.

(1) Assume all firms incorporated grant received from Shannon Development as part of their investment appraisal
This results *ceteris paribus* in an average probability of deadweight = 0.395 as outlined below:

Variable	Obs	Mean	Std. Dev.	Min	Max
P	103	.3951194	.1743214	.3021049	.7186484

(2) Assume all firms did not incorporate grant received from Shannon Development as part of their investment appraisal
This results *ceteris paribus* in an average probability of deadweight = 0.663 as outlined below:

Variable	Obs	Mean	Std. Dev.	Min	Max
P	103	.6631745	.125959	.5959652	.8969461

The results from the simulations above confirm previous calculations to suggest that firms which did not incorporate grants received as part of their investment appraisal *ceteris paribus* are more likely to lead to higher deadweight.

Creating Interaction Terms

The creation of interaction terms allows one to establish the combined effect of how different variables interact together to impact on deadweight. A Logit equation is run which incorporates an interaction term between *grant type* and *whether or not firm included grant received from Shannon Development in 1995 as part of its investment appraisal* and all other variables originally anticipated to impact on deadweight.

Table 7: Logit Estimates—Deadweight (Option 4)

Deadweight					
Variables	**Coeff.**	**Std error**	***z*-stat**	**Odds Ratio**	**Std error**
Interaction Term	1.4423	1.1799	1.222	4.2304	4.9915
Amount of Grant Received (β_2)	0.4470	0.6099	0.733	1.5636	0.9537
Whether grant was for start-up or expansion purposes (β_4)	-0.0734	1.1011	-0.067	0.9293	1.0232
Sector (β_5)	0.7347	0.6017	1.221	2.0848	1.2545
Age of firm (β_6)	0.0179	0.0161	1.111	1.0180	0.0164
Size (No. of employees) (β_7)	-0.9700	0.6764	-1.434	0.3791	0.2564
Amount of grant received as a percentage of turnover (β_9)	-0.1696	1.3765	-0.123	0.8440	1.1618
Turnover (β_{12})	0.2449	0.7549	0.324	1.2775	0.9643
Type of ownership (β_{10})	0.4685	0.6507	0.720	1.5976	1.0396
Whether recipient was a first-time or repeat grant recipient (β_{11})	1.3908	0.7738	1.797*	4.0181	3.1091
Percentage of employment growth of firm 1995-1997 (slow-growth/fast-growth firms) (β_8)	-0.8179	0.6658	-1.228	0.4413	0.2939
Constant	-0.3884	0.8920	-0.435	-	-
n 87 Log likelihood -53.65 Chi-square (11) 12.38					

Source: Author's calculation Note: Statistically significant variables are denoted as follows:*

denotes significance at 10 per cent.

As can be seen from Table 7 (Option 4), the χ^2 statistic (12.38) for the joint impact of all the variables originally expected to influence deadweight and the interaction term is insignificant. *Whether recipient was a first -time or repeat grant recipient*[42] appears significant for the first time although only at the 10 per cent level. Table 7 suggests the following: Firms that were first-time grant recipients were more likely *ceteris paribus* to impact on deadweight than firms which had previously received grants. Table 8 (Option 5) demonstrates the outcome when all of the variables, including the interaction term, are included in the one equation.

The overall χ^2 statistic is again significant. The variables interact well together to result in an overall significant outcome. The interaction term is insignificant. Although on their own *type of grant received* and *whether investment appraisal included grant received from Shannon Development* influence deadweight, their combined interaction effect is insignificant.

The section which follows employs a similar approach to establish whether certain firm specific characteristics of those firms grant-aided by Shannon Development can predict probable displacement effects.

Table 8: Logit Estimates—Deadweight (Option 5)

Variables	Coeff	Std error.	*z*-stat	Odds Ratio	Std error
Interaction Term	0.8779	1.7151	0.512	2.4058	4.1263
Grant Type (β_3)	1.6877	1.1967	1.410	5.4068	6.4703
Whether investment appraisal inc'd grant from Shannon Develpt (β_1)	-1.5151	0.5754	-2.633**	0.2198	0.1265
Amount of grant received (β_2)	0.7282	0.6879	1.059	2.0714	1.4250
Whether grant was for start-up or expansion purposes (β_4)	0.4841	1.2670	0.382	1.6228	2.0560
Sector (β_5)	0.6253	0.6410	0.976	1.8688	1.1979
Age of firm (β_6)	0.0264	0.0166	1.588	1.0267	0.0170
Size (No. employees) (β_7)	-1.2636	0.7541	-1.676*	0.2826	0.2131
Amount of grant received as % of turnover (β_9)	0.2435	1.4854	0.164	1.2757	1.8950
Turnover (β_{12})	0.5236	0.8381	0.625	1.6881	1.4149
Type of ownership (β_{10})	-0.0697	0.7233	-0.096	0.9327	0.6746
Whether recipient was a first- time or repeat grant recipient (β_{11})	0.9897	0.8311	1.191	2.6903	2.2359
% Employment Growth of firm 1995-1997[a] (β_8)	-0.7492	0.7622	-0.983	0.4728	0.3604
Constant	0.2267	0.9932	0.228	-	-
n 87 Log likelihood -46.98 Chi-square (13) 25.71					

Source: Author's calculations. Note: Statistically significant variables are denoted as follows: ** denotes variables significant at the 1 per cent level; * denotes significance at 10 per cent. [a]slow-growth /fast-growth firms

4.7 A Dichotomous Logit Model for Displacement in the Shannon Region

The dependent variable displacement is binary. It takes the value 1 if displacement occurs, that is, grant-aided firms displace the employment of existing firms and 0 otherwise.

The key explanatory variables in the case of displacement are:
Type of ownership; Size and Sector

Type of ownership is incorporated as one would anticipate that indigenous firms would be more likely to cause displacement effects given their often greater reliance on national, regional and in some cases even local markets for sale of their outputs. Their foreign counterparts on the other hand would be expected to cause less local or regional displacement given their tendency to export further afield.

A priori, one would anticipate that *size of firm* would influence displacement. Small firms may be more likely to cause displacement given that they are generally more likely to sell output within the local or regional markets. Hart and Scott (1994) found that displacement is a greater problem with very small firms and argued that:

"*To minimize displacement, grants should be targeted on projects which involve the prospect of the majority of sales becoming located outside the region"* (p. 857).

An alternative interpretation is also possible, that is, larger firms may be more likely to displace. They may have greater dominance and presence (especially in the more local or regional domain) and may impact on this market to such an extent that they displace the output/employment of already existing local and/or regional firms. Tervo (1990) also found that:

"The results suggest that those firms receiving regional development grants that are large,...are more likely to cause displacement effects in Southern Finland" (p. 625).

Sector was included to establish whether firms in certain sectors are more likely to cause displacement effects. As argued in the case of deadweight, it may have very interesting policy implications were one to discover that *sector* impacted significantly on displacement.

As with deadweight, associations between the binary displacement categories and the independent variables were examined. The only significant association was between the displacement variable and *type of ownership* (p=0.002). Cramer's V was 0.295 so it is still only a weak association. More firms that caused displacement were indigenously-owned than expected by chance.

A Logit model is run which includes the three variables (*type of ownership; sector*

and *size of firm*).[43] Table 9 shows the outcome.

Table 9: Logit Estimates—Displacement (Option 1)

Displacement					
Variables	**Coeff.**	**Std error**	***z*-stat**	**Odds Ratio**	**Std error**
Size (β_7)	-1.1647	0.5911	-1.970*	0.3120	0.1844
Type of Ownership (β_{10})	2.4467	0.7810	3.133**	11.5498	9.0206
Sector (β_5)	-0.3518	0.4885	-0.720	0.7034	0.3436
Constant	-1.4828	0.7459	-1.988	-	-
n 103 Log likelihood -59.77 Chi-square (3) 14.97					

Source: Author's calculations. Note: Statistically significant variable are denoted as follows: ** denotes variable significant at the 1 per cent level; * denotes variable significant at the 5 per cent level.

4.8 A Dichotomous Logit Model for Displacement

According to Table 9, the χ^2 statistic for the joint impact of firm *size*, *type of ownership* and *sector* on the dependent variable, is significant. The χ^2 statistic for the three explanatory variables in Table 9 on the dependent variable with 3 degrees of freedom is 14.97. It is beyond the critical value of 7.81473 at the 5% level. *Type of ownership* is definitely significant with $z = 3.133$ (p=0.002). *Size* of firm is also significant with a z statistic = -1.970 (p=0.049). The results demonstrate that *sector* is statistically insignificant. The results lead us to conclude that those firms grant-aided which are indigenously owned *ceteris paribus* are more likely to cause displacement effects.

Size influences displacement. Table 9 suggests that firms which do not have an employment size in the range 0-49 employees (larger firms) are more likely to cause displacement effects, *ceteris paribus*.

An examination of the individual coefficients in Table 9 provides the following insights: A firm with number of employees in the 0-49 size range (smaller firms) is associated with a decrease of 1.16 in Logit *ceteris paribus*. One can also conclude that a firm being indigenously-owned increases the Logit of displacement by 2.45 *ceteris paribus*.

4. 9 Presenting the Findings in terms of Odds Ratios

The objective is to estimate the log odds of causing displacement given firm ***size*** and *type of ownership*. Given that *sector* is insignificant according to Table 9, it is deemed appropriate to exclude *sector* and re-run the Logit equation incorporating only the significant variables of *size* and *type of ownership*. This results in Table 10:

Table 10: Logit Estimates—Displacement (Option 2)

Displacement					
Variables	**Coeff**	**Std error**	***z*-stat**	**Odds Ratio**	**Std error**
Size (β_7)	-1.1606	0.5886	-1.972*	0.3133	.1844
Type of Ownership (β_{10})	2.4948	0.7751	3.219**	12.1189	9.3930
Constant	-1.7796	0.6256	-2.845	-	-
n 103 Log likelihood -60.03 Chi-square (2) 14.45					

Source: Author's Calculations. Statistically significant variables are denoted as follows: **denotes variables significant at the 1 per cent level, * denotes variables significant at the 5 per cent level.

The estimate of 0.31 (Table 10) for *size* implies that firms with an employment size in the 0-49 employee range have odds of causing displacement that are 0.31 times what would be expected were size of firm unrelated to displacement (controlling for *type of ownership*). Another way of interpreting this is that, the odds of a firm causing displacement decreases for firms with number of employees in the 0-49 range, that is, small firms. Larger firms are more likely to lead to displacement effects (controlling for *type of ownership*).

If a firm is indigenous, it is likely to raise the log odds of causing displacement by 12.12 times (controlling for *size*) compared with what would be anticipated were there no association between *type of ownership* and displacement. The odds for an indigenous firm (controlling for *size*) causing displacement is times 12.12 the odds for a foreign owned firm.

Estimating Probabilities

From Table 10 (Option 2) one can also calculate that Logit = -1.78-1.16 (whatever value size will take, that is, 0 or 1) + 2.49 (whatever value ownership will take, that is, 0 or 1). Using this equation leads to the following predicted probabilities for the Logit model:

For a large (>50 employees), indigenous firm, the resulting equation is:

Logit = -1.78-1.16(0) + 2.49(1) = 0.71

(display exp (0.71) = 2.03 display 2.03 / (1+2.03)) = 0.67

whereas for a small (0-49 employees) foreign-owned firm, the predicted probability is 0.050 which is lower.

Logit = -1.78-1.16(1) + 2.49(0) = -2.94

(display exp (-2.94) = 0.053 display 0.053 (1+0.053)) = 0.050

Thus in summary, the econometric analysis suggests that larger firms (defined in this study as >50 employees) and indigenously owned firms *ceteris paribus* are more likely to cause displacement. As with the deadweight analysis, simulations carried out which sought to estimate the contribution of *size of firm* and *type of ownership* to the overall average probability estimate of displacement confirmed the earlier displacement econometric analysis[44] provided in this section.

5. CONCLUSION

This paper has developed an approach for addressing the question of which firm-specific characteristics are more likely to cause deadweight and displacement. This is an important contribution to the international industrial policy evaluation debate given that to date, the sole focus has been almost exclusively on deriving estimates and discussing the consequences of deadweight and displacement. The overriding belief is that the methodological approach developed has broad based applicability regarding the evaluation of various types of industrial policy interventions in a variety of contexts. The frameworks developed may also be useful for policymakers in terms of providing a type of *ex-ante* appraisal/ evaluation template which may be useful in terms of their internal appraisal/ evaluation procedures. For example, if over time it was to be shown through the types of modelling carried out in this paper that firms with specific characteristics were more associated with deadweight effects, then this should act as a signal to development advisors in the agencies to probe whether such firms genuinely need assistance.

The biggest limitation of the models developed in this paper is that the relatively small sample size limited analysis at the disaggregate level, with the result that in many instances the only available option was to utilize binary dependent and explanatory variables. Nevertheless, the application clearly demonstrates the benefits of the methodological approach employed and highlights some interesting results. It will hopefully encourage further research in this area.

Two specific issues require further attention. The first concerns the notion of firm

survival. Deadweight estimates derived in the Irish context by Lenihan (1999 and 2001) as regards to grants awarded by Shannon Development in 1995 for example, may be high but eight years later it would be interesting to track the 103 assisted sample firms and to ascertain how their growth rates compare to unassisted firms in the same year, that is to carry out a type of 'control group' analysis[45]. Although deadweight levels may have been high among the assisted cohort of firms, it is conceivable that growth rates and survival rates among this cohort of firms may also have been high relative to their unassisted counterparts. On a related issue, future research should try to address the issue of wider benefits that might offset deadweight (e.g. externalities; the possibility that assistance received may act as a leverage to acquire additional finance from elsewhere or that grant assistance may free up not only monetary capital but also human capital that can be used for even more productive and innovative projects etc). The second issue requiring further attention would be to incorporate into future research (econometric modelling) the issues raised in the recent literature on selection and assistance effects[46]. Two types of selection bias need to be accounted for: first, on behalf of the agency which might be maximizing growth prospects by targeting (selecting) firms with the potential and management will to grow (i.e. picking and/or backing winners); and second, bias may come from the fact that firms with certain characteristics (e.g. faster growing firms; firms runs by well-educated individuals; firms runs by highly motivated individuals) are more likely to apply for assistance in the first instance. Roper and Hart (2003) develop an interesting methodology for incorporating 'selection' and 'assistance' effects. The paper concerns itself with modelling the effects of the Business Link network in the UK. The econometric approach involved the estimation of regression models for the productivity growth of assisted and non-assisted businesses.

Considerable progress has been made in recent years in evaluating industrial policy in Ireland. While much of this has been linked to complying with EU regulations, there is a growing awareness of the value of such research, in view of the increased fiscal constraints and the issues of 'value for money' and the fundamental principles of 'opportunity cost' and 'accountability'. It is hoped that this paper provides some timely insights into these issues.

APPENDIX: THE DECISION BETWEEN ADOPTING A LOGIT OR A PROBIT MODEL

A deadweight equation is employed to illustrate that the outcome is the same indifferent of whether logit or probit is used. When assuming that the error term is normally distributed the probit model is used. In cases when it is assumed that the error term is logistically distributed then the logit model is employed. Maximum likelihood procedure is used to estimate the coefficients of both probit and logit models. The normal distribution of the probit model goes a little bit quicker to 0 and 1 than logit probabilities. The difference is usually so small that there is never enough statistical form to distinguish which one fits better.

A scaling difference exists between logit and probit coefficients. Logit simplifies when variance of distribution is set at:

$$\frac{\pi^2}{3} \quad \frac{\pi}{\sqrt{3}} \approx 1.8$$

where units for probit are 1, units for Logit are 1.8

Probit coefficients *1.8 = Logit coefficient.

For example, when the probit model is run to include the *grant type* variable and *whether or not the firm included the grant received from Shannon Development in 1995 as part of its investment appraisal* variable in the deadweight equation, the following output results as demonstrated in the Table A1 below:

Table A1: Probit Estimates - Deadweight

	Deadweight					
Variables	**Coeff**	**Std error**	***z*-stat**	**x-bar**	**df / dx**	**Std error**
Grant type	1.6020	0.3990	2.662	0.1848	0.3700	0.1093
Whether appraisal incd grant	-0.7590	0.2788	-2.693	0.4348	-0.2922	0.1038
Constant	0.2386	0.1895	0.1259		**-**	**-**
n 92 Log likelihood -56.03 Chi-square (2) 15.09					obs. p pred. p	0.5326 0.5431 (at x-bar)
df/dx is for discrete change of dummy variable from 0 to 1						

Comparing the coefficients between *Table 6* [logit estimates – Deadweight (Option 3) *in main paper*] and A2 (probit estimates) gives different results. The procedures are thus different. However, what is of interest here is that as Table A3 below demonstrates the correlations between the sets of predicted values resulting from the logit and probit models estimated are almost identical.

Table A2. Correlations between sets of predicted values (Logit and Probit Models)

	p-hat	l-hat
p-hat	1.0000	
l-hat	0.9998	1.0000

The correlation between the two sets of predicted values = 0.998 implying that both models result in virtually identical predictions.

There are two further means of demonstrating that the results of Probit and Logit models are almost the same:

A. Demonstrate that Probit coefficients * 1.8 = Logit coefficients
B. Calculate predicted probabilities and show that they are virtually identical to the probabilities calculated in the case of the Logit model.

Referring back to *Table 6* [Logit Estimates Deadweight (Option 3) *in the main paper*] the value of the coefficient for the *grant type* variable is 1.7751. As Table A1 demonstrates the corresponding value in the case of the dichotomous probit model is 1.0620.

In the case of the grant type coefficient*:*

Grant type	Probit	Logit
	1.0620	1.7751
	1.0620* 1.8	= 1.9116

In the case of the whether the investment appraisal carried out by recipient firm included grant received from Shannon Development in 1995 coefficients:

Whether investment appraisal included grant received	Probit	Logit
	-0.7509	-1.2260
	-0.7509* 1.8	-1.3516

Computing Predicted Probabilities

What is the probability of deadweight occurring in a firm which received a feasibility study grant for example (any type of grant other than an employment grant) which did include the grant received from Shannon Development in 1995 as part of its investment appraisal.

As can be seen from Table A1 dprobit = 0.24 + 1.06(0) -0.76(1) = -0.52

The corresponding predicted probability is calculated as follows:

display normprob (-0.52) = 0.302

This is almost identical to 0.30 the corresponding probability in the case of the Logit model.

From *Table 6 (in main paper)*, it can be seen that:
Logit=0.39-1.23(1) +1.78(0) = -0.84
(display exp (-0.84)=0.43 display 0.43/(1+0.43)) = 0.30

These results accord well, therefore, with the results of the Logit model.

PSEUDO R^2 FOR DEADWEIGHT

Given the following variables

- whether the investment appraisal carried out by firm included the grant received from Shannon Development (β_1);
- amount of grant received (β_2);
- grant type (β_3);
- whether the grant received was for start-up or expansion purposes (β_4);
- sector (β_5);
- age of firm (β_6);
- size of firm (measured in terms of number of employees) (β_7);
- percentage employment growth 1995-1997 (slow-growth versus fast-growth firms) (β_8);
- grant amount as a percentage of turnover (β_9);
- type of ownership (β_{10});
- whether grant received was a first time or repeat grant (β_{11});
- turnover (β_{12}).

Referring to Table 4 (in the main paper), one can see that:

$$\ln\left(\frac{\hat{P}_i}{1-P_i}\right) = \mathbf{0.1924} + \mathbf{2.1545}\,\beta_3 + \mathbf{0.7502}\beta_2 - \mathbf{1.4249}\beta_1 + \mathbf{0.4598}\beta_4 + \mathbf{0.5995}\beta_5 \ldots\ldots$$

(0.196) (2.433) (1.086) (-2.620) (0.368) (0.946)

$$\ldots\ldots + \mathbf{0.0265}\beta_6 - \mathbf{1.3010}\beta_7 + \mathbf{0.2028}\beta_9 + \mathbf{0.6030}\beta_{12} - \mathbf{0.0692}\,\beta_{10} \ldots\ldots$$

(1.586) (-1.721) (0.138) (0.727) (-0.095)

$$\ldots\ldots + \mathbf{0.9753}\beta_{11} - \mathbf{0.7525}\beta_8$$

(1.178) (-0.999)

Given: $\text{Pseudo}\,R^2 = 1 - \frac{lu}{lr}$

lu = - 47.11 LR = -2 (lr-lu) = 25.45 -2 [lr-(-47.11)] = 25.45 -2 lr – 2(47.11) = 25.45 -2 lr = 25.45 + 94.22 -2 lr = 119.68 lr = -59.84	$\text{Pseudo}\,R^2 = 1 - \frac{lu}{lr} = 1 - \frac{47.11}{59.84}$ = 1 - 0.7873 = 0.2127

Endnotes

[1] Industrial Development Authority (IDA); Enterprise Ireland (EI); Shannon Development and Udarás na Gaeltachta.

[2] The source of this information is from Forfás Business information System (various years).

[3] The source of this information is from Forfás Business information System (various years).

[4] Lenihan H., Hart, M, Roper, S. (2003) *Developing methods to evaluate the impact of Enterprise Ireland assistance-deriving estimates of deadweight and displacement in Enterprise Ireland assisted companies,* Report to Enterprise Ireland (unpublished work in progress).

[5]For a brief description of the focus of Ireland's only dedicated regional development company that was set up in 1959, refer to Lenihan (1999). For more details refer to the company website: http://www.shannon-dev.ie

[6] The agency offers a range of business development solutions, made up of a mix of funded and non-funded services and supports.

[7] For an in-depth discussion of the concepts as outlined above, the reader should refer to Lenihan (1999 and 2001).

[8] The focus on degrees or levels of deadweight is particularly insightful given that the vast amount of studies merely distinguish between 'full' or 'zero' deadweight whereas in reality deadweight may vary along a continuum with various levels of 'partial' deadweight lying along this continuum as measured by time, scale, location etc (refer to Lenihan 1999 and 2001).

[9] See for example Public Sector Management Research Unit (PSMRU) (1988); PA Cambridge Economic Consultants Ltd (1993); Public and Corporate Economic Consultants (PACEC) (1988); Hart and Scott (1994); Sheehan (1993); Monk (1990).

[10] See for example the work of Davenport *et al*. (1998); Felsenstein and Fleisher (2002).

[11] For example, PSMRU (1988) derive a deadweight estimate of 57%; PA Cambridge Economic Consultants Ltd (1993)-21%; PACEC (1998)-38%; Hart and Scott (1994)-8% to 32%; Sheehan (1993)-approx. 59%; Monk (1990)-46% and Davenport *et al* .(1998)-approx. 37.5%.

[12] For example, King (1990) derives a displacement estimate of 27%; Hart and Scott (1994)-40%; Monk (1990)-10%; Tervo (1990)-23%; Robinson *et al.*(1987)- (27%); Felsenstein and Fleisher (2002)-64%.

[13] The main methodological options available to researchers setting out to build the necessary counterfactuals to estimate the additionality of government policy are: Shift-share trend analysis; control groups; cost-benefit analysis and the 'self assessment approach' employing survey techniques (telephone, postal or face-to-face interviews).

[14] Besides the work of Tervo (1990) which examined the causes of displacement and more recently Heijs (2003) who examined the causes of deadweight (although he

used the term 'free-rider behaviour' instead of deadweight) and Lenihan, H. (forthcoming) Evaluating Irish industrial policy in terms of deadweight and displacement: a quantitative methodological approach, *Applied Economics*, which examines the causes of deadweight and displacement.

[15] Nearing the end of an interview with Shannon Development representatives, the author asked whether it would be possible to gain access to Shannon Development's files on firms that did/did not receive grants from Shannon Development in 1995. This was not deemed a viable option with the interviewees responding as follows: '*Our files are confidential to us and the client. We are in a tricky situation here'* and '*We exchange negotiating guidelines with Forbairt and they are definitely exchanged in the strictest confidence, that's the reality in which we work, there are a very clear set of guidelines but they are confidential for obvious reasons because once they are released you have clients writing to the brief rather than how they see the business. To be honest with you I can't see any exception where we would give anyone guidelines and that kind of thing'.* The above was the only interview held with Shannon Development representatives over the research period.

[16] Of the 215 firms, 174 are classified as indigenous and 41 as foreign-owned.

[17] This information was elicited from a Shannon Development representative who retrieved the information from a Shannon Development database on employment in the Shannon region. This information is useful as it provides an insight into the population of firms in the Shannon region in 1995 and the numbers employed in these firms. The 103 firms interviewed for this research employed 6,883 people in 1995, which represents 38.6 per cent of the total number of people employed in the Shannon region in 1995.

[18] A comparison of interviewed and non-interviewed firms suggests the interviewed firms are representative of the broader group in terms of sector, size band, age, type of grant received, amount of grant received and type-of-ownership. The implication being that the analysis here based on the interviewed firms alone will give representative results for the entire sample of firms. The firms who were not willing to be interviewed justified their decision in terms of issues such as: time constraints; firms had taken a blanket approach that they were not going to take part in surveys in a region where they felt there was already survey overload. In two cases, the interview was refused through the secretary or receptionist and no reason was given for the refusal.

[19] The sample size is 103 as the three pilot firms were removed from the initial 106 firms that agreed to be interviewed.

[20] Table 2 shows the 'major' grant type received by firms from Shannon Development in 1995. For example, some firms received two types of grants from Shannon Development in 1995, where this occurred the 'major' type of grant is presented in Table 2 .For example, a specific firm (in the sample) as a percentage of the overall package of grants received from Shannon Development in 1995 received an employment grant-70% and an R&D grant –30%. In this instance only the employment grant appears in Table 2 as this is the 'major' grant type.

[21] According to the "Shannon Development Annual Report" in 1995, 174

indigenous firms received grants from Shannon Development. The overall grant figure awarded to the 174 indigenous firms was IR£8,174,100 i.e. IR£8.17 million. The total figure awarded to the 77 indigenous sample firms was IR£2,655,473 i.e. IR£2.66 million which is 32% of the overall total figure for grants awarded to indigenous firms in the Shannon region by Shannon Development in 1995. 41 foreign-owned firms received grants from Shannon Development. The overall grant figure awarded to the 41 foreign-owned firms was IR£17,876,398 i.e. IR£17.9 million. The total figure awarded to the 26 foreign sample firms was IR£12,290,358 i.e. IR£12.3 million which is 68% of the overall total figure for grants awarded to foreign-owned firms in the Shannon region by Shannon Development in 1995.The 103 sample firms received a total of IR£14,945,831 in grants from Shannon Development in 1995. Of the 103 firms, the 77 indigenous firms received IR£2,655,473 i.e. 17.8% of the overall grants awarded to the sample firms in 1995.The 103 sample firms received a total of IR£14,945,831 in grants from Shannon Development in 1995. Of the 103 firms, the 26 foreign-owned firms received IR£12,290,358 i.e. 82.2% of the overall grants awarded to the sample firms in 1995.

[22] 'you' in the above quote implies the project.

[23] For an in-depth discussion and development/presentation of a Logit model for displacement, readers should refer to Lenihan, H. (forthcoming) Evaluating Irish Industrial Policy in terms of deadweight and displacement: A quantitative methodological approach, *Applied Economics*.

[24] A dichotomous model for 'pure' (54 firms) versus 'zero' (9 firms) was also attempted but given the small sample of firms within the 'zero' category did not turn out to be a viable option when the Logit model was run.

[25] It may be possible in some cases to use a Linear probability model but technically Logit/Probit models are appropriate where there are dichotomous variables. Given the non-linear, non-additive functional form (originating from the binary nature of the dependent variable), it is most appropriate to choose either a Logit or a Probit model.

[26] The Logit model is easy to grasp given that the odds ratio in Logit models represent the partial effects of predictors and are, analogous to partial slopes in regression.

[27] Coded 1=pure deadweight; 0 otherwise.

[28] This is a 5 category variable, coded: 1=pure deadweight; 2=partial deadweight (different location); 3=partial deadweight (later date); 4= partial deadweight (reduced scale) and 5=zero deadweight.

[29] The source of this information was from a Forfás representative.

[30] Coded 1=employment grants; 0, otherwise.

[31] Amount of grant received is coded as follows: 1 if grant awarded was <IR£60,000; 0 otherwise.

[32] To account for this, *grant amount as a percentage of turnover* variable is included in the deadweight equation.

[33] A strong association would be shown only if this value was close to 1.

[34] Measured in terms of numbers of employees.

[35] According to Heijs (2003) free rider firms are 'defined as those supported firms whose innovative efforts do not depend on public aid and probably would or could have carried out the same level of innovative activities without public support' (p. 446). Thus, this definition of free rider is very similar to the definition of deadweight as adopted in the current paper.

[36] In conjunction with Table 4 it can be seen that a pseudo R^2 of 0.2127 results (See appendix for details on how this is calculated). An alternative to R^2 as a measure of goodness of fit for Logit models is the Pseudo R^2

$$\text{Pseudo } R^2 = 1 - \frac{\text{lu}}{\text{lr}}$$

Where lu and lr are the logged maximized likelihoods for the unrestricted and restricted equations respectively. Since lr is always less than lu (just as in case of normal R^2 where R^2 restricted $< R^2$ unrestricted, the pseudo-R^2 must always lie between 0 and 1). The value of 0.2127 for the pseudo R^2 is very low. It should be borne in mind, however, that R^2 is not a very useful measure for models with dependent dichotomous variables. It is only an estimate of the true R^2. Even if it were possible to calculate R^2 it is still not what is needed, since the dichotomous dependent variable can take either one of two values, that is, 1 or 0, thus in the case of dichotomous dependent variables R^2 is not very meaningful due to the nature of the scatter plot. It is not possible to get an R^2 of 1. R^2 varies between 0 and some value. The issue of concern is that there is no way of knowing what this value is. The general view, therefore, is that for logit models the researcher should not become too concerned about goodness of fit. Bearing this in mind, the Chi-squared value as a goodness-of-fit test is utilised, in addition to examining significance tests for the individual parameters.

[37] Coded 1 if firms received an Employment grant from Shannon Development in 1995; 0 otherwise

[38] Coded 1 if investment appraisal did include grant from Shannon Development; 0 otherwise

[39] Coded 1 for firms with employee size in the range 0-49 employees (small firms); 0 otherwise i.e. larger firms

[40] 40 firms incorporated the grant received from Shannon Development in 1995 as part of their investment appraisal, 52 firms did not. The remaining firms did not carry out a financial appraisal in the first place.

[41] The fact of whether firm received an employment grant from Shannon Development in 1995 or another type of grant (e.g. feasibility grant; R&D grant etc).

[42] Coded 1 if firms were first time grant recipients; 0 otherwise

[43] *Type of ownership* is a binary explanatory variable. It takes the value 1 if the firm is indigenous and zero if foreign-owned**.** *Sector* assumes the value 1, if the firm is classified as manufacturing and zero if the firm is classified as services sector. *Size*

is coded as 1 if firms have an employee size in the range 0-49 employees (small firms) and 0 otherwise.

[44] For precise details of the displacement simulations and also the creation of interaction terms in the case of displacement, readers should refer to Lenihan, H. (forthcoming) Evaluating Irish Industrial Policy in terms of deadweight and displacement: a quantitative methodological approach, *Applied Economics.*

[45] This may prove difficult in the Irish context due to the likely issue of 'contamination' given that most firms were probably assisted in or around 1995 if not from Shannon Development, then from some other development agency.

[46] See Storey (2000); Roper & Hewitt Dundas (2001); Roper *et al.* (2001); Turok & Raco (2000) and Wren & Storey (2002).

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