View metadata, citation and similar papers at core.ac.uk
brought to you by CORE
provided by Archive of European Integration

ESRI
www.esri.ie

Working Paper No. 347

June 2010

Corporate Expenditure on Environmental Protection*

Stefanie A. Haller and Liam Murphy

Subsequently published in "Corporate Expenditure on Environmental Protection", Environmental and Resource Economics, Vol. 51, No. 2, February 2012, pp.277-296

Abstract: We examine the determinants of firm's current environmental expenditure and firm's capital investment in equipment for pollution control using a Heckman selection model. As regards current environmental expenditure, we find that larger, exporting firms and firms subject to the Integrated Pollution Prevention and Control directive are more likely to spend resources at all. Once the decision to commit resources has been taken, larger firms, firms that are foreign-owned, and firms that report low shares of water and refuse charges in turnover have higher absolute levels of environmental expenditure. With respect to investment in equipment for pollution control, we find that energy intensive and exporting firms are more likely to invest at all. Once the decision to invest has been taken, larger firms and firms that report high water and refuse charges invest more in equipment for pollution control. This suggests that the firms for whom environmental concerns are most costly in terms of production and image do most to address them.

Corresponding Author: liam.murphy@esri.ie

Keywords: environmental expenditure, capital expenditure on pollution abatement, firm-level analysis, manufacturing.

* This work makes use of data from the Central Statistics Office (CSO) which is CSO copyright. The possibility for controlled access to the confidential micro data set on the premises of the CSO is provided for in the Statistics Act 1993. The use of CSO data in this work does not imply the endorsement of the CSO in relation to the interpretation or analysis of the data. This work uses a dataset which may not exactly reproduce statistical aggregates published by the CSO. We thank Kevin Phelan from the CSO for support with the data. We gratefully acknowledge funding from the EPA Strive Program. We thank Seán Lyons, Laura Malaguzzi Valeri, Richard Tol and seminar participants at the ESRI and at the Conference of the Irish Economic Association in Belfast for helpful comments and suggestions. All remaining errors are our own responsibility.

ESRI working papers represent un-refereed work-in-progress by researchers who are solely responsible for the content and any views expressed therein. Any comments on these papers will be welcome and should be sent to the author(s) by email. Papers may be downloaded for personal use only.

Corporate Expenditure on Environmental Protection

1. Introduction

Under European regulations, Ireland agreed to cut greenhouse gas emissions to 20% below 1990 levels by 2020, one of the strictest targets in the European Union and indeed the world. Ireland also controls pollutants of air, soil and water. Industry is a significant contributor to climate change and environmental pollution; in 2007 the manufacturing sector (excluding transport) in Ireland accounted for 23% of CO_2 emissions. Regulation has most certainly been the largest factor in driving firm's environmental expenditure and capital investments in equipment for pollution control. The European Union's Emissions Trading System (ETS) for CO_2 permits came into force in January 2005. According to Jaraite et al. (2009) internal (staff) and capital costs accounted for most of the expenditure associated with the introduction of the ETS in Ireland. Certain large-scale industrial and agriculture activities have been subject to the Integrated Pollution Control (IPC) licensing scheme for pollutants of air, soil and water since 1994; in 2003 this scheme was amended and strengthened which gave effect to the Integrated Pollution Prevention Control (IPPC) Directive. The costs firms have to incur in order to comply with IPPC regulation are capital expenditure to install new equipment, operating costs (e.g. monitoring, external consultant's fees) and costs associated with switching to less polluting inputs (Clinch and Kerins, 2002). The bulk of the capital costs are incurred when the firm first becomes subject to a license subsequently regular administrative and monitoring costs accrue. Unregulated firms may also incur environmental expenditure or decide to install less polluting equipment if it lowers their production cost. In addition, the trends of firm's displaying increased corporate social responsibility and consumers becoming increasingly green-conscious are likely to be another important contributing factor.

In this paper, we examine two types of expenditure towards pollution control; first we look at firm's current non-capital expenditure on environmental protection and second at firm's capital additions of plant and equipment for the purposes of pollution control. For both types of expenditure we first examine which factors are the key determinants of whether any such expenditure occurs and in a second step we explain how much is spent on each type of expenditure given that it occurs. We analyze recent data from a small open economy, Ireland. The first studies in this area in the 1980s focused on the implications of the introduction of the Clean Air Act in the United States. More recent work has been industry-specific or based on small samples from developing countries. This paper examines the determinants of environmental expenditure in the entire manufacturing sector in Ireland, a developed small open economy. Using data from 2006 and 2007 we capture activity in a market where regulation is mature enough not to be the only factor driving environmental expenditure. Moreover, Ireland is an interesting case to study how its openness in terms of trade and foreign direct investment interacts with environmental expenditure.

Jaffe et al. (1995) survey the early literature on environmental regulation and find a mainly negative relationship between regulation and competitiveness of U.S. manufacturing. While compliance with environmental standards is costly for firms, Shadbegian and Gray (2003) find that they are associated with large social returns in the U.S. Over time the literature has examined different factors that affect firm's environmental expenditure or expenditure on pollution abatement; a lot of this literature focuses on the introduction of the Clean Air Act in the U.S. in 1970. Lee and Alm (2004) and references cited therein look at the impact of uncertainties surrounding the enactment and the enforcement of environmental legislation on firm's investment in air pollution abatement equipment. Becker (2004) shows that community characteristics may have an impact on pollution abatement expenditure once firm characteristics are controlled for. In another paper, he also shows that heavy emitters of the substances subject to more stringent regulation generally had higher pollution abatement expenditures (Becker, 2005).

Aden et al. (1999) consider the importance of firm-specific, community and regulatory factors in explaining pollution abatement expenditure in a small sample of Korean manufacturing plants. They find that plant characteristics are more important than plant-specific regulatory sanctions and community characteristics in explaining plant's expenditure on pollution abatement. Collins and Harris (2002, 2005) examine whether foreign-owned firms are more likely to spend and whether they spend more than domestic firms on pollution abatement in the UK metal manufacturing and chemical industry. Controlling for other firm characteristics, they find that the nationality of ownership has different effects on different types of pollution abatement expenditure. Kaiser and Schulze (2003) also focus on the importance of international competition either in the form of foreign ownership or export status on environmental expenditure in Indonesian manufacturing plants. While these factors matter, other firm characteristics are at least as important. A somewhat separate literature analyses the largely firm-specific factors that determine firm's decisions to join voluntary environmental standards or schemes, see Alberini and Segerson (2002) for a survey; Cole et al. (2006) and Bracke et al. (2008) provide two recent examples for Japanese and a sample of large European firms, respectively.

Our paper relates most closely to the first set of papers described in the previous paragraph. We examine the effects of firm characteristics and regulatory measures on environmental expenditure and investment by Irish manufacturing firms. In contrast to much of the literature, our dataset covers firms in all subsectors of manufacturing. Our data set covers 2006 and 2007, more recent than the data used in the literature surveyed above. Changes in firms' and consumers' attitudes to pollution and the environment may well have changed the determinants of firms' environmental expenditure. We are able to distinguish between different types of environmental expenditure: we focus in particular on current environmental expenditure and capital investment for pollution abatement equipment. The determinants behind the two types of expenditure are likely to differ.

Only a small fraction of firms in Irish manufacturing report positive values for environmental protection: 28% of firms report a positive figure for current environmental expenditure and 10% for capital investment in pollution control. Larger, more energy intensive, and exporting firms are more likely to spend current resources at all. The same holds for firms under the Integrated Pollution Prevention and Control directive. Once the decision to commit resources has been taken, larger firms, firms that are foreign-owned, and firms that report low shares of water and refuse charges in turnover have higher current environmental expenditure. Exporting firms are more likely to invest in pollution control equipment. Once the decision to invest has been taken, larger firms and firms that report high shares of water and refuse charges invest more in equipment for pollution control. Taken together, this suggests that regulatory, cost and image factors are currently driving Irish manufacturing firms' environmental expenditure.

The remainder of the paper is set out as follows: Section 2 outlines data sources and methodology, Section 3 presents our results, Section 4 discusses robustness and Section 5 concludes.

2. Data and Methodology

Our data set is the Census of Industrial Production (CIP) for the Republic of Ireland. The CIP is conducted annually by the Central Statistics Office (CSO). The CIP covers all firms with 3 or more persons engaged in the mining, manufacturing and utilities sectors. The analysis here focuses on the core manufacturing NACE Rev. 1.1 sectors 15-37. The CIP is conducted at enterprise and local unit level. The information of interest to us is collected only in the enterprise data. The main variables collected in the CIP are turnover, exports, purchases, fuel, additions to capital assets, sales of capital assets, indirect taxes, employment, earnings, other labour costs. There are two questionnaires – one for firms with between three and twenty persons engaged (Form C) and one for firms with twenty or more persons engaged (Form F). Questions on current environmental expenditure and on capital investments in equipment for pollution control have been collected since 2006 and are only included in Form F. We use the two most recent years of available data – 2006 and 2007.

There are 9,658 observations from 5,864 firms in the full CIP in these two years. There are 1,777 firms that filled in form F in these two years. However, due to changes in the workforce some firms incorrectly fill in form F while others incorrectly fill in form C. We exclude those firms that filled in form F despite being below the 20 employee threshold from the analysis. This reduces the potential sample to 3,225 observations.[1] Further, despite the response to the census being compulsory by law, the response for the 2007 CIP was 69.2%. However 80% of non-respondents had less than 20 employees (Central Statistics Office, 2009). The CSO estimates and imputes data for non-respondents and incomplete returns; we exclude these entries from our analysis. This reduces the available sample further to 2,664 observations. We further exclude observations that report zeros for turnover or the number of persons engaged. The final sample comprises of 2,528 observations from 1,491 firms for 2006 and 2007. This final working sample covers 78.72% of turnover, 72.58% of employment and 79.45% of fuel used of the overall CIP in 2007.

As only 28.03% and 10.06% of firms report positive values for environmental expenditure and for capital investments in equipment for pollution control, respectively, a large number of observations are censored. We therefore use a Heckman selection model. The equations are as follows:

Selection Model:

$$\begin{aligned} sel_{it} &= \alpha + \beta_1 \log(size_{it}) + \beta_2 \log(age_{it}) + \beta_3 \operatorname{exp}ort_{it} + \beta_4 foreign_{it} + \beta_5 en\operatorname{int}_{it} \\ &+ \beta_6 watersh_{it} + \beta_7 IPPC_{it} + \beta_8 ETS_{it} + \lambda_t + \lambda_I + \lambda_R + \varepsilon_{it} \end{aligned} \qquad (1)$$

Regression Model:

$$\begin{aligned} \log(Y_{it}) &= \alpha + \beta_1 \log(size_{it}) + \beta_2 \log(age_{it}) + \beta_3 \operatorname{exp}ort_{it} + \beta_4 foreign_{it} + \beta_5 en\operatorname{int}_{it} \\ &+ \beta_6 watersh_{it} + \lambda_t + \lambda_I + \lambda_R + v_{it} \qquad if \quad sel_{it} = 1, \\ \ln(Y_{it}) &= 0 \qquad otherwise. \end{aligned} \qquad (2)$$

[1] We examine the characteristics of firms that should have filled in other forms in order to examine potential biases to our results from this in Section 4.

Y_{it} is environmental expenditure $environ_{it}$ in our first model and capital investment in equipment for pollution control $capoll_{it}$ in our second model. sel_{it} is equal to 1 if the firm reports a positive value for environmental expenditure or capital investment in equipment for pollution control, respectively.

We consider firm *size*, firm *age*, *export*ing status, *foreign* ownership, energy intensity (*enint*) and the share of water and refuse charges in turnover (*watersh*) as explanatory variables. We also control for time λ_t, industry λ_I and region λ_R specific effects. As the panel only consists of 2 years, the time dummy refers to 2007; there are 13 industry dummies, these follow the grouping of NACE 2-digit industries in the environmental accounts (Central Statistics Office, 2007) and 8 region dummies at the NUTS3 level. Means and standard errors of all variables can be found in Table 1; a full description of all variables can be found in the Appendix. If the correlation ρ between the error terms $(\varepsilon_{it}, \nu_{it})$ is statistically significant, the two decisions on whether to spend and how much to spend are related. In this case, estimating an equation only for the decision how much to spend would induce sample selection bias. This can by avoided by estimating the two equations jointly (Heckman 1979). In the estimation of our model, we adjust the standard errors for clustering at the firm level.

We expect firm size to have a positive impact both on a firm's propensity to spend on the environment/invest in pollution abatement and the amount it spends. Other things equal, larger firms are more likely to be more polluting and there may be economies of scale in environmental expenditure. The effect of firm age might be ambiguous. Older firms might have lower resource constraints both in terms of recorded assets and in their ability to obtain funding. Although staff mobility is present in these industries, older firms are also likely to possess a more experienced staff profile. This experience should lead to a more efficient production process, all other things equal. In contrast, younger firms' machinery should be more recent with some new technology already incorporated. This new technology is likely to take account of the increasingly demanding environmental standards. As a result it may be cheaper for them to invest in additional measures.

Exporting and foreign-owned firms are subject to pollution regulation in several countries. While Irish standards are similar or identical to European Union standards, which tend to be high compared to the rest of the world, firms may still be exporting to countries where standards are yet more stringent. It also appears to be the case that more environmentally conscious firms are more likely to export (Galdeano-Gomez, 2010). Thus, the direction of causality between exporting and environmental expenditure could go both ways and we expect a positive correlation. Moreover, exporting firms tend to be more productive than non-exporters (e.g. Ruane and Sutherland (2005) for Ireland). Hence, if more productive firms use more advanced technology, this would be another reason to expect a positive relationship between exporting and spending on the environment or investing capital in pollution control. The subsidiaries of foreign-owned multinationals also tend to be more productive than domestic firms (e.g. Barry et al. (1999) for Ireland), therefore a similar argument holds. Besides, foreign multinationals may apply the same standards across their operations in all (Western) countries, these could be higher than those prescribed by Irish legislation. Multinationals are also likely to be subject to more public scrutiny regarding their efforts to protect the environment. Both of these arguments also point towards a positive correlation.

We expect firms that are more energy intensive to require more current environmental expenditure or capital investment in pollution reduction due to the emissions created by their typically high use of fossil fuels. We also include the share of water and refuse charges in turnover on the assumption that firms who report significant charges in these areas are likely to commit expenditure to lower these charges.[2] Clinch and Kerins (2002) document that in the food and drink sector, the bulk of IPPC-related expenditure is for water treatment in their analysis of the composition of expenditure of 46 Irish manufacturing and construction firms subject to the Integrated Pollution Prevention and Control (IPPC) directive between 1996 and 1999.

For the estimated Heckman model to be meaningful the selection equation requires at least one “instrument” that determines a firm’s choice of spending on the environment or investing capital in pollution control but not how much is spent. We use two such variables, *IPPC* and *ETS*. These variables are designed to capture, respectively, the firm being under the Irish Environmental Protection Agency’s Integrated Pollution Prevention and Control scheme (*IPPC*) and the firm being a member of the European Union’s Emissions Trading Scheme (*ETS*). Firms under the IPPC are constrained on the amount of pollution they can emit. Firms face the option of reducing emissions (either through a more environmentally friendly production process or through less production) or punishment (e.g. fines or possibly even closure) by the regulator for breaking the terms of their emission permit. The IPCC has greater scope than the EU ETS which solely targets carbon dioxide

[2] We include the share of water and refuse charges in turnover rather than the level of water and refuse charges in logs because a non-negligible fraction of firms report zeros for this variable.

emissions (Environmental Protection Agency, 2010b). Assuming the constraint is binding the firm either faces the choice of committing resources towards pollution abatement or reducing output. We assume the marginal cost of pollution abatement to be lower than the cost of reducing output (at least at low pollution abatement levels) and hence expect firms within this scheme to commit to spending on pollution abatement.

The CIP does not directly record regulation by IPPC or ETS, so we form proxies instead. Based on the legislation published by the EPA (Department of Environment, 2006) and the firms subject to the licensing scheme listed on the EPA website (EPA, 2010) , we identify five NACE 2-digit sectors and twelve separate NACE 3-digit sectors to which IPPC could potentially apply. We are able to estimate likely levels of employees above which firms would be required to be in IPPC. We placed a low turnover constraint of €100,000 and an employee constraint of 30/40 people depending on the industry (see Table 4). The employee threshold level depends on the sector. For sectors where we have a large number of observations we are more confident and hence form a lower threshold of thirty employees. For all other sectors we apply a threshold of forty employees. All firms in the requisite sectors confirming an employee level above the threshold record an *IPPC* value of one and zero otherwise.

We also form a proxy for the Emissions Trading System. There are only four NACE 2-digit sectors to which the ETS may apply (Pulp/Paper/Printing, Coke/Refined Petroleum Products/Nuclear Fuel, Other Non-Metallic Products and Basic Metals/Fabricated Metal Products). We estimate their emissions due to use of fossil fuels. The CIP reveals the cash value firms have spent on energy sources over the year. We divide these values by 2006 wholesale prices from the Irish Commission for Energy Regulation (Commission for Energy Regulation, 2006) to get the unit amounts of the energy sources purchased. We separate electricity into its constituent parts as reported by the generators (i.e. oil, gas, coal, renewables) assuming emissions from renewable energy are negligible (Commission for Energy Regulation, 2009). We then multiply this value by the unitary carbon dioxide emission outputs of each fossil fuel. By then summing these figures we form an estimate of the firm's total fuel related carbon dioxide emissions. Ireland determines membership of ETS by a combination of energy inputs and manufactured products (Environmental Protection Agency, 2010). As the CIP does not contain detailed data on products we are unable to use these thresholds in forming the ETS proxy. Instead we use the British determinant of membership of ETS: annual carbon dioxide emissions in excess of 10,000 tonnes (Graus and Voogt, 2007). The figures obtained from the CIP are based on market prices which include the cost of generation and the supplier's markup. In order to eliminate the supplier's markup, we scale the UK's 10,000 tonnes of carbon dioxide emissions threshold to 4,700 tonnes of CO_2 in Ireland as the Irish Electricity Supply Board's costs for electricity generation accounted for 47% of revenue in 2006 (Electricity Supply Board, 2007).[3] All firms recording total fuel related carbon dioxide emissions in excess of 4,700 tonnes and a NACE code in one of the four relevant sectors are assigned a value of one for our ETS proxy.

3. Results

Descriptive Statistics

Table 1 shows summary statistics of environmental expenditure and capital investment in pollution control. Only 22.47% of firms report positive environmental expenditure in 2007 and the share of firms that invest in equipment for pollution control is even smaller at 4.52%. Overall mean expenditure on the environment was €23,490 in 2007, among firms that report spending positive values it was €104,480.[4] There is some variation across industries, with firms in the chemicals, non-metallic minerals and food, beverages and tobacco sectors reporting the largest values. The share of industry environmental expenditure in industry turnover (shown in Figure 1) is tiny at an average of 0.02%. The chemicals sector still reports the largest share. The shares in the machinery and equipment, office and data machinery, electrical instruments and transport goods sectors are about half those in the remaining sectors. There is little geographical variation in environmental expenditure with the percentage of firms reporting environmental expenditures ranging only from 7% to 21% across the NUTS3 regions. Regarding capital investment in equipment for pollution control, mean expenditure is €22,670 and €522,900 for those that report positive investments. Again the chemicals sector is prominent as well as the food, beverages and tobacco and the machinery and equipment reporting somewhat larger than average values. Relative to total capital investment in the sector, sector-wide investment in equipment for pollution control is highest in the wood and transport goods sectors (see Figure 2).

Regression results

[3] Our results are robust to a using the UK threshold of 10,000 tonnes of carbon dioxide emissions.
[4] Clinch and Kerins (2002) argue that current environmental expenditure may be quite high because the administrative work involved with IPPC is considerable. Where firms are unable or unwilling to run a permanent section concerned with environmental matters, they often employ consultants when necessary to carry out, *inter alia*, the monitoring of emissions and preparation of reports.

Table 2 shows the Heckman selection models for current environmental expenditure and for capital investment in equipment for pollution control. First we shall focus on the model with current environmental expenditures as the dependant variable which is the leftmost set of results. The selection model for environmental expenditure indicates that, other things equal, larger, energy intensive, exporting firms and firms that are under the IPPC are more likely to have positive values of environmental expenditure. The year dummy is negative: in 2007 a somewhat smaller fraction of firms report a positive value for environmental expenditure than in 2006. Along the sectoral dimension, firms in the wood and transport equipment industries have a higher propensity than firms in the food, beverages and tobacco sector to spend on the environment. Only one of the region dummies is significant suggesting that there is little geographic variation in environmental expenditure. The proxy for whether firms are subject to the Integated Pollution Prevention and Control directive (IPPC) is significant but the proxy for regulation by the EU Emissions Trading System (ETS) is not significant. The correlation between the error terms of the selection and the regression equations is statistically significant. This indicates that the two decisions on whether to spend and how much to spend are related.

For firms that have decided to dedicate resources to environmental expenditure, our results suggest that firm size and foreign-ownership have a positive effect on the amount of expenditure, whereas the share of expenditure on water and refuse charges has a negative effect.[5] Note that the coefficient for firm size is significantly smaller than one. That is, larger firms spend more in absolute terms, but less in relative terms. There year dummy is positive. Firms in the paper and pulp, office equipment, electrical and optical equipment and transport equipment sectors are less likely to spend large amounts on environmental expenditure than firms in the food, beverages and tobacco sector. The fact that we find a positive effect of the IPPC variable in the selection equation suggests that what firm's record as environmental expenditure is more likely to be linked to pollution abatement in terms of chemical substances covered under the IPPC scheme rather than the reduction of CO_2 emissions. One explanation for this finding is that firms are better able to pass on the increased costs due to the imposition of the ETS scheme than those associated with the IPPC scheme. There are two possible explanations for the negative correlation between environmental expenditure and water and refuse charges. One is that the administrative and monitoring costs associated with water

[5] Arguably our 2-digit level industry dummies are rather crude, thus our measure for water and refuse charges might identify a small subset of firms specific to narrowly defined sectors. However, if we include 3-digit industry dummies instead our results remain qualitatively unchanged.

treatment for those firms subject to the IPPC directive are lower than those for other substances. The other explanation is that water and refuse charges are really a specific type of environmental expenditure and therefore for firms with high water and refuse charges other types of environmental expenditure are second order.

The results from the selection equation for capital investment in equipment for pollution control as presented in the second column of Table 2 suggest that exporting and energy intensive firms are more likely to invest at all. The year dummy again reflects that there were fewer firms in 2007 than in 2006 that invested in equipment for pollution control. Firms in the non-metallic mineral and the paper and pulp sectors were less likely than firms in the food, beverages and tobacco sector to invest in equipment for pollution control. The correlation between the error terms of the selection and the regression equations is not statistically significant in this model, suggesting that the decision on whether to invest is largely independent of the decision on how much to invest.[6] For firms that decided to invest there is a positive correlation between water and refuse charges and the amount they invest. Firms in the metal sector are less likely than firms in the food, beverages and tobacco sector to invest large sums in equipment for pollution control. The results are indicative as investment in pollution control equipment is limited to very few firms in Irish manufacturing industries only. This could be because capital investments are lumpy in nature. While high water and refuse charges are associated with lower current environmental expenditure, the incentive for these firms to install new equipment to reduce these expenses may still be large. Clinch and Kerins (2002) state that since the introduction of the IPPC directive in 1994 a significant number of wastewater treatment plants have been built, this process may still be ongoing.

In terms of firm size our results are in line with related work by Kaiser and Schulze (2003) for Indonesia, Aden et al. (2006) for Korea and Becker (2005) for the US. Thus, environmental expenditure is more feasible to large companies due to a combination of greater economies of scale (the coefficient on firm size is significantly smaller than one) in the provision of the services and the greater likelihood of both image benefits and regulation enforcement on large firms. In contrast to much of the literature we do not find a significant effect for firm age in either the selection or the regression model. This may be because with the lower bound on firm size of 20 employees in our sample there are too few very young firms to obtain sufficient variation.

---

[6] From an econometric point of view this implies that we could have estimated the two models separately. Results from a probit model on the decision whether to invest and an OLS regression on the amount invested yield qualitatively similar results; results are available on request.

While Kaiser and Schulze (2003) find a positive effect of exporting status on a firm's propensity to have environmental expenditure and a negative effect on the amount they spend, our results suggest that exporters are more likely to commit resources to environmental expenditure and also to capital investment for pollution control. As Irish-owned exporters are more productive than Irish-owned non-exporters (Ruane and Sutherland, 2005) this might indicate that they invest in new technology more frequently or that their products are subject to higher environmental standards than those of non-exporters. Foreign ownership has a positive effect on the amount of environmental expenditure. This is in line with Kaiser and Schulze (2003), but Aden et al. (2006) find that domestic Korean firms spend more on pollution abatement and for Collins and Harris (2002, 2005) the results differ by type of expenditure, nationality of foreign ownership and industry. Kaiser and Schulze (2003) argue that this may be because these firms are more environmentally conscious or because they apply more efficient and environmentally friendly technologies company wide.

Kaiser and Schulze (2003) find a positive and significant effect of energy intensity both on the firm's propensity to spending on the environment as well as on the amount they spend. In our regressions energy intensity only plays a marginal role in the decision to invest in equipment for pollution control. As indicated above, the fact that being subject to IPPC licence is a significant determinant of environmental expenditure in our models suggests that environmental expenditure in the Irish context is much more likely to be associated with pollution from substances other than CO_2.

4. Robustness [7]

One source of bias in the data could be due to firms receiving the wrong survey form. Form C should only be completed by firms with less than twenty persons engaged. Form F should only be completed by firms with twenty or more persons engaged. Errors may arise due to firms changing their workforce so that they cross the twenty persons engaged threshold. Firms with more than 20 persons engaged who received Form C could not report their environmental expenditure or capital spending on equipment for pollution control. This may bias our results if there are substantial structural differences between the firms who received the wrong survey form and the firms who

[7] The results that are described in this section but are not reported are available from the authors on request.

received the correct form. Table 3 shows means and standard deviations of the firms in the sample, firms that incorrectly filled in form C and firms that incorrectly filled in form F.

Apart from the inherent differences in firm size, both groups of firms that received the wrong forms are on average younger than the firms in the sample. The firms with more than 20 persons engaged that incorrectly filled in Form C have an average age of just half that in the sample suggesting that this is a group of young fast-growing firms. In the two groups that did not fill in the correct form there are fewer foreign-owned firms than in the sample. In all instances the differences between the two groups that received the wrong forms are smaller than the differences between each group and the averages in the sample used. Only a small percentage (5.2%) of firms who incorrectly completed form F record a value of one for our IPPC proxy. This is related to the high probability of these firms being relatively small. If we expanded the IPPC proxy to potentially include firms who completed form C incorrectly, only a few additional firms would record a value of one. The sectoral split of the firms who incorrectly filled out forms C and F is not significantly different from each other or from the overall dataset. Given the similarities between firms that incorrectly completed forms C and F we do not expect these sampling issues to be associated with large inherent biases in our analysis. As the information on environmental expenditure and on capital investment in equipment for pollution is provided by the firms with less that 20 persons engaged that filled in form F, we estimate a specification of our models where we include these firms. The results from these separate regressions are not significantly different from the results reported in Table 2.

We varied the threshold limits to examine the sensitivity of our results to the definition of the IPPC and ETS variables. In the main regression in Table 2 the thresholds are: turnover greater than €100,000 and total staff level of greater than 30 or 40 persons depending on the industry. In two different scenarios, we changed this threshold to universal 20 or 40 employee rules keeping the turnover threshold constant. The results from the different specifications are qualitatively similar.

It may be the case that some of the explanatory variables in our main regressions are not exogenous to the firm's choice to spend and how much to spend/invest on the environment. To address this we estimate a specification where we include the regressors with a 1-period lag with respect to the dependent variable. As the main variables in the Census of Industrial Production have been collected in their current form since 1991 we can do this for all variables except expenditure on water and refuse charges which are only available for 2006 and 2007. We lose a small number of observations for firms that are observed for the first time in 2006 or 2007, but the results from this alternative specification are qualitatively similar.

5. Summary and Conclusions

This paper examines the determinants of environmental expenditure and investment in equipment for pollution control among Irish manufacturing firms in 2006 and 2007. As regards environmental expenditure we find that larger firms, firms that export and firms that are subject to the IPPC directive are more likely to spend resources at all. Once the decision to commit resources has been taken, larger firms, firms that are foreign-owned, and firms that report a low share of water and refuse charges in turnover have higher environmental expenditure. With respect to investment in equipment for pollution control we find exporting and firms with a high energy intensity are more likely to invest at all. Once the decision to invest has been taken, larger firms and firms that face higher water and refuse charges invest more in equipment for pollution control.

Taken together this suggests that regulatory factors are an important driver of environmental expenditure. This is particularly the case for current environmental expenditure, suggesting that the monitoring and administrative costs necessary to comply with regulation are important. In terms of firm characteristics, size, export status and foreign ownership are significant determinants of environmental expenditure. These firms are likely to have more resources, but they may also be subject to more public scrutiny regarding their efforts to reduce pollution either through stock markets or by customers abroad. In this regard, the openness of the Irish economy appears to be associated with higher environmental expenditure. High water and refuse charges are associated with lower current environmental expenditure but higher capital investment in equipment for pollution control. This is consistent with Cinch and Kerins' (2002) finding that the bulk of environmental expenditure goes towards reducing pollution from one main firm- or sector-specific substances covered by the IPPC directive.

Current environmental expenditure and capital investment in pollution control is mainly directed at reducing air and water pollution rather than carbon dioxide emissions. The introduction of IPPC licenses has clearly driven the reduction in water and air pollution, yet in contrast to CO_2 emissions no target levels have been set for these other pollutants. As our measures of environmental expenditure are silent on the associated reduction in pollution achieved, the paper offers a snapshot of the factors that currently drive firm’s environmental expenditure. Next to regulation image and cost concerns appear to be crucial.

References

Aden, J., Kyu-hong, A., & Rock, M. T. 1999, "What is Driving the Pollution Abatement Expenditure Behavior of Manufacturing Plants in Korea?", World Development, vol. 27, no. 7, pp. 1203-1214.

Alberini, A. & Segerson, K. 2002, "Assessing Voluntary Programs to Improve Environmental Quality", Environmental & Resource Economics, vol. 22, no. 1, pp. 157-184.

Barry, F., Bradley, J., & O'Malley, E. 1999, "Indigenous and Foreign Industry: Characteristics and Performance," in Understanding Ireland's Economic Growth, F. Barry, ed., McMillan, London, pp. 45-74.

Becker, R. A. 2004, "Pollution Abatement Expenditure by U.S. Manufacturing Plants: Do Community Characteristics Matter?", Contributions to Economic Analysis & Policy, vol. 3, no. 2, pp. 1-21.

Becker, R. A. 2005, "Air Pollution Abatement Costs Under the Clean Air Act: Evidence from the PACE Survey", Journal of Environmental Economics and Management, vol. 50, no. 1, pp. 144-169.

Bracke, R., Verbeke Tom, & Dejonckheere, V. 2010, "What Determines the Decision to Implement EMAS? A European Firm Level Study", Environmental & Resource Economics, vol. 41, no. 4, pp. 499-518.

Central Statistics Office 2007, Environmental Accounts for Ireland 1997-2005, Stationery Office, Dublin.

Central Statistics Office 2009, Census of Industrial Production 2007, 1 edn, Stationery Office, Dublin.

Clinch, J. P. & Kerins, D. 2002, "Assessing the Efficiency of Integrated Pollution Control Regulation", European Environment, vol. 12, no. 5, pp. 269-283.

Cole, Matthew A. & Elliott, Robert J.R. & Shimamoto, Kenichi, 2006. "Globalization, Firm-Level Characteristics and Environmental Management: A Study of Japan," Ecological Economics, Elsevier, vol. 59(3), pages 312-323, September

Collins, A. & Harris, R. I. D. 2002, " Does Plant Ownership Affect the level of Pollution Abatement Expenditure?", Land Economics, vol. 78, no. 2, pp. 171-189.

Collins, A. & Harris, R. I. D. 2005, "The Impact Of Foreign Ownership And Efficiency On Pollution Abatement Expenditure By Chemical Plants: Some UK Evidence", Scottish Journal of Political Economy, vol. 52, no. 5, pp. 747-768.

Commission for Energy Regulation 2006, 2006 Commission Newsletter, Commission for Energy Regulation, Dublin.

Commission for Energy Regulation 2009, Fuel Mix and CO2 Emission Factors Disclosure 2007, Commission for Energy Regulation, Dublin.

Dellink, R., Hofkes, M., van Ierland, E., & Verbruggen, H. 2004, "Dynamic modelling of pollution abatement in a CGE framework", Economic Modelling, vol. 21, no. 6, pp. 965-989.

Department of Environment 2006, Environmental Protection Agency Act 1992 (Established Activities) Order 2006, Department of Environment, Dublin.

Electricity Supply Board 2007, ESB Annual Report and Accounts 2006, Electricity Supply Board, Dublin.

Environmental Protection Agency 2010, Integrated Pollution Prevention Control (IPPC) Licensing, Environmental Protection Agency, Dublin.

Galdeano Gomez, E. 2010, "Exporting and Environmental Performance: A Firm-Level Productivity Analysis", World Economy, vol. 33, no. 1, pp. 60-88.

Graus, W. & Voogt, M. 2007, Small Installations Within the EU Emissions Trading Scheme, European Commission Directorate General for Environment, Brussels.

Heckman, J. J. 1979, "Sample Selection Bias as a Specification Error", Econometrica, vol. 47, no. 1, pp. 153-161.

Jaffe, A. B., Peterson, S. R., Portney, P. R., & Stavins, R. N. 1995, "Environmental Regulation and the Competitiveness of U.S. Manufacturing: What Does the Evidence Tell Us?", Journal of Economic Literature, vol. 33, no. 1, pp. 132-163.

Jaraite, J., Convery, F. and Di Maria, C. (2009) Assessing the Transaction Costs of Firms in the EU ETS: Lessons from Ireland. Working Paper, APREC.

Kaiser, K. & Schulze, G. G. 2003, "International Competition and Environmental Expenditures: Empirical Evidence from Indonesian Manufacturing Plants", HWWA Working Paper No.222, HWWA, Hamburg

Lee, A. & Alm, J. 2004, "The Clean Air Act Amendments and Firm Investment in Pollution Abatement Equipment", Land Economics, vol. 80, no. 3, pp. 433-447.

Ruane, F. P. & Sutherland, J. 2005, "Export Performance and Destination Characteristics of Irish Manufacturing Industry", Review of World Economics (Weltwirtschaftliches Archiv), vol. 141, no. 3, pp. 442-459.

Shadbegian, R. J. & Gray, W. B. 2003, "What Determines Environmental Performance at Paper Mills? The Roles of Abatement Spending, Regulation, and Efficiency", Topics in Economic Analysis and Policy, vol. 3, no. 1, art. 15

	Environ			Environ if Environ>0			Capoll			Capoll if Capoll>0		
	N	**Mean**	**SD**	**N**	**Mean**	**SD**	**N**	**Mean**	**SD**	**N**	**Mean**	**SD**
Year												
2006	1269	25.33	146.91	338	95.11	273.05	1269	13.43	123.06	80	213.08	447.19
2007	1259	23.49	140.56	283	104.48	282.21	1259	23.67	379.44	57	522.90	1722.97
NACE 2-digit sectors												
Food, Beverages and Tobacco (15–16)	460	19.89	105.96	136	115.45	169.45	460	24.03	198.92	37	298.78	648.17
Textiles, Clothing and Leather (17-19)	75	102.93	17.57	13	29.40	33.61	75	1.08	5.37	4	20.25	13.94
Wood (20)	130	6.95	64.09	40	64.65	103.05	130	16.66	65.22	13	166.62	136.61
Paper and Printing (21-22)	261	65.55	32.09	51	39.03	64.06	261	1.10	10.88	4	71.75	59.19
Chemical (24)	214	9.51	340.62	76	289.83	524.03	214	108.91	888.75	22	1059.39	2637.58
Rubber and Plastic (25)	183	0.62	23.43	38	33.49	42.27	183	10.56	110.31	9	214.67	476.99
Non-metallic minerals (26)	148	34.13	350.60	41	236.60	640.51	148	10.99	123.51	4	406.75	729.98
Metal, Metal Prod. (27-28)	305	5.10	23.71	49	35.01	50.10	305	0.67	4.80	16	12.81	17.38
Machinery and Equipment (29)	182	7.63	43.95	37	46.77	89.00	182	19.80	163.93	9	400.33	660.79
Office machinery (30)	36	5.63	1.90	6	3.72	3.37	36	0.00	0.00	0	0.00	0.00
Electrical and Opt. Equipment (31-33)	278	10.97	46.14	70	43.57	84.30	278	7.66	83.50	10	212.87	407.48
Transport Equipment (34-35)	63	8.93	18.24	26	21.63	23.23	63	4.65	22.91	4	73.25	64.37
Other Manufacturing (23,36-37)	193	5.05	28.70	38	25.65	61.08	193	0.87	6.77	5	33.40	29.02
Region												
Border	346	22.92	92.93	90	88.11	166.33	346	18.90	159.98	23	284.35	567.85
Midlands	178	8.96	25.80	49	32.56	40.86	178	12.36	101.79	15	146.70	331.48
West	210	13.96	61.68	52	56.39	114.69	210	3.24	20.27	12	56.73	67.04
Dublin	630	15.06	70.06	132	71.89	139.46	630	3.66	60.11	19	121.48	333.37
Mideast	279	37.80	222.81	85	124.08	391.74	279	5.56	38.88	15	103.40	138.50
Midwest	231	32.02	157.13	58	127.54	295.35	231	85.30	843.06	10	1970.40	3746.56
Southeast	307	33.62	240.32	62	166.50	516.95	307	11.67	116.10	20	179.20	430.66
Southwest	347	33.15	150.67	93	123.67	272.13	347	29.63	228.21	23	447.09	789.90
Total/Average	2528	24.41	143.76	621	99.38	277.07	2528	18.53	281.60	137	341.98	1167.06
Monetary values are expressed in 1,000€.												

Table 1: Descriptive Statistics

Dependant Variable	Log(Environ)			Log(Capoll)		
Log(Size)	0.715	(0.076)	***	0.723	(0.212)	***
Log(Age)	-0.008	(0.079)		0.264	(0.222)	
Foreign	0.290	(0.156)	*	0.779	(0.491)	
Export	0.036	(0.212)		-0.451	(0.408)	
Enint	0.018	(0.024)		0.018	(0.039)	
Watersh	-15.116	(7.828)	*	20.021	(5.268)	***
Year2007	0.165	(0.083)	*	0.097	(0.307)	
Textiles, Clothing and Leather	-0.415	(0.451)		-0.760	(0.635)	
Wood	-0.068	(0.268)		0.483	(0.526)	
Paper and Printing	-0.487	(0.278)	*	0.892	(0.622)	
Chemical	0.476	(0.267)	*	0.185	(0.613)	
Rubber and Plastic	-0.401	(0.321)		0.053	(1.006)	
Non-metallic minerals	0.043	(0.287)		-0.078	(1.159)	
Metal, Metal Prod.	-0.031	(0.280)		-1.165	(0.464)	**
Machinery and Equipment	-0.582	(0.275)	**	0.943	(0.662)	
Office machinery	-1.958	(0.511)	***			
Electrical and Opt. Equipment	-0.869	(0.233)	***	-0.574	(0.842)	
Transport Equipment	-1.762	(0.319)	***	1.127	(0.516)	**
Other Manufacturing	-0.341	(0.285)		0.544	(0.706)	
Border	-0.216	(0.221)				
Midlands	-0.583	(0.251)	**			
West	-0.271	(0.274)				
Mideast	-0.175	(0.219)				
Midwest	0.104	(0.279)				
Southeast	0.332	(0.242)				
Southwest	0.136	(0.208)				
Constant	1.560	(0.693)	**	1.323	(2.393)	
Selection	Environsel			Capollsel		
Log(Size)	0.109	(0.044)	**	0.093	(0.058)	
Log(Age)	0.060	(0.037)		0.041	(0.047)	
Foreign	0.004	(0.093)		-0.182	(0.129)	
Export	0.588	(0.092)	***	0.307	(0.126)	**
Einten	0.031	(0.018)	*	0.030	(0.016)	*
Watersh	-0.703	(3.263)		2.672	(3.822)	
IPPC	0.214	(0.094)	**	0.134	(0.200)	
ETS	0.243	(0.165)		0.174	(0.247)	
Year2007	-0.128	(0.038)	***	-5.271	(0.179)	***
Textiles, Clothing and Leather	-0.322	(0.233)		-0.172	(0.070)	**
Wood	0.378	(0.173)	**	-0.080	(0.269)	
Paper and Printing	-0.182	(0.146)		0.342	(0.216)	
Chemical	-0.027	(0.153)		0.114	(0.204)	
Rubber and Plastic	-0.184	(0.157)		-0.121	(0.220)	
Non-metallic minerals	-0.156	(0.188)		-0.680	(0.239)	**
Metal, Metal Prod.	-0.393	(0.151)	***	-0.736	(0.260)	**
Machinery and Equipment	-0.196	(0.155)		-0.105	(0.219)	
Office machinery	-0.502	(0.341)		-0.156	(0.213)	
Electrical and Opt. Equipment	-0.109	(0.144)		-0.254	(0.212)	
Transport Equipment	0.314	(0.219)		-0.006	(0.284)	
Other Manufacturing	-0.046	(0.157)		-0.352	(0.235)	
Border	0.062	(0.123)				
Midlands	0.172	(0.147)				
West	0.110	(0.140)				
Mideast	0.249	(0.124)	**			
Midwest	0.136	(0.144)				
Southeast	-0.052	(0.128)				
Southwest	0.119	(0.119)				
Constant	-1.859	(0.239)	***	-2.240	(0.329)	***
Rho	-0.804	(0.079)	***	-0.485	(0.394)	
Log Pseudolikelihood	-2256.4			-745.5		
Wald (Chi2, p)	2424.690	0.000		1.060	0.304	
Number of Obs (Total, Censored)	2528	1907		2528	2391	

Standard errors in parenthesis. ***, **, * indicate significance at 1, 5, 10%, respectively. Standard errors adjusted for clustering at the firm level. Omitted categories: 2006, Dublin and Food, Beverages and Tobacco.

Table 2: Heckman Selection Models

	Firms Who Incorrectly Filled Out Form C*		Firms Who Incorrectly Filled Out Form F**		Firms in Sample	
Observations	**231**		**136**		**2528**	
	Mean	SD	Mean	SD	Mean	SD
Environ	N/A	N/A	1.88	6.79	24.41	143.76
Capoll	N/A	N/A	0.24	1.40	18.53	281.60
Size	27.72	21.28	14.89	4.28	130.61	255.98
Age	13.81	14.88	18.55	19.48	23.92	19.94
Foreign	0.05	0.21	0.14	0.35	0.28	0.45
Export	0.47	0.50	0.51	0.50	0.72	0.45
Enint	2.60	4.20	2.55	3.17	2.27	2.99
Watersh	N/A	N/A	0.00	0.02	0.00	0.01
IPPC	0.05	0.22	0.00	0.00	0.31	0.46
ETS	0.04	0.20	0.01	0.09	0.04	0.20

* Firms with 20 or more employees (and hence who should fill out form F) who filled out form C.
** Firms with less than 20 employees (and hence who should fill out form C) who filled out form F.

Table 3: Analysis of Potential Biases

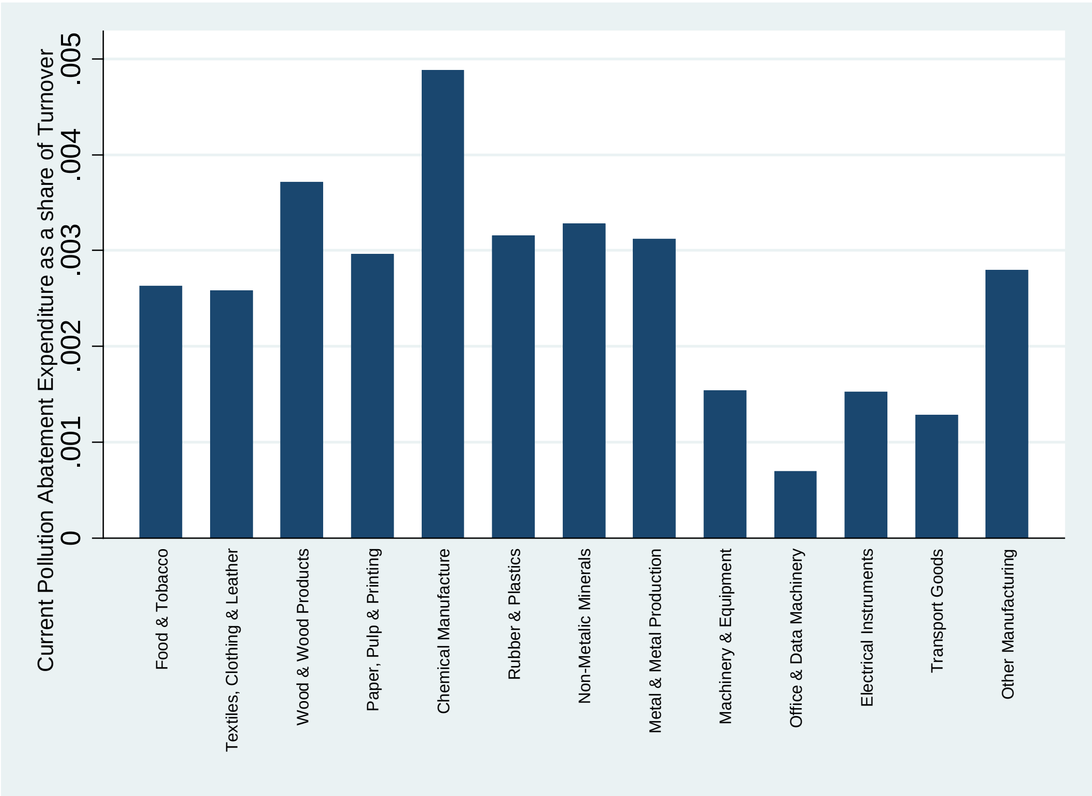

Figure 1: Current Pollution Abatement Expenditure Share by Sector in 2007

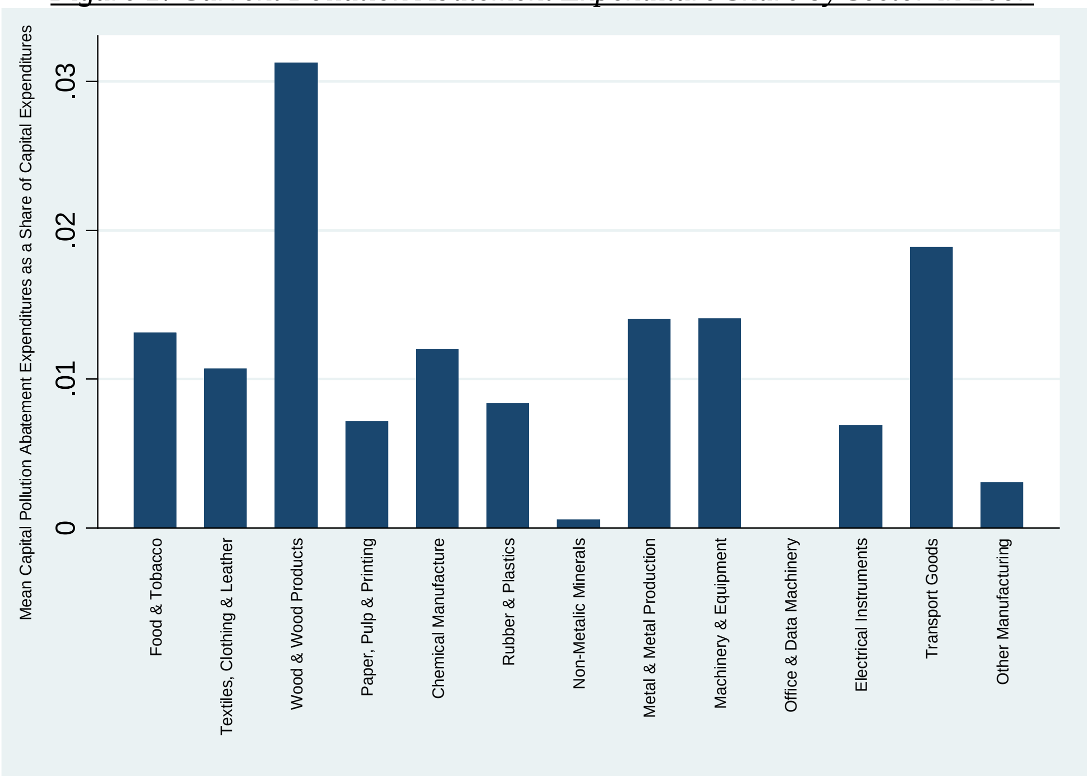

Figure 2: Capital Pollution Abatement as a share of Capital Expenditures by Sector in 2007?

Appendix

Variable Descriptions

environ: Total current expenditure on environmental protection in 1,000€.

environsel: A dummy variable equal to 1 if environ is greater than zero.

capoll: Total capital expenditure on pollution control and anti-pollution accessories in 1,000€.

capollsel: A dummy variable equal to 1 if capoll is greater than zero.

size: Total number of persons engaged in the firm.

age: Firm age (earliest year of incorporation recorded is 1900)

export: A dummy variable equal to 1 if the firm reports a positive share of exports.

foreign: A dummy variable equal to 1 if the location of the ultimate benefactor of the firms activities is outside Ireland.

enint: Energy intensity = total fuel used/total turnover.

watersh: Total expenditure on water and refuse charges as a share of turnover.

ETS: A dummy variable equal to 1 if the firm is predicted to be a member of the European Union’s Emissions Trading Scheme. Details are set out in Section 2.

IPPC: A dummy variable equal to 1 if the firm is predicted to be a member of the Irish Environmental Protection Agency’s Integrated Pollution Prevention and Control scheme. Details are set out in Section 2 and Table 4.

NACE Code	Sector	Employee Threshold
15.1	Production, processing and preserving of meat and meat products	40
15.2	Processing and preserving of fish and fish products	40
15.3	Processing and preserving of fruit and vegetables	40
15.4	Manufacture of vegetable and animal oils and fats	40
15.5	Manufacture of dairy products	40
17.1	Preparation and spinning of textile fibres	40
19.1	Tanning and dressing of leather	40
22	Publishing, printing and reproduction of recorded media	40
23	Manufacture of coke, refined petroleum products and nuclear fuel	40
24.1	Manufacture of basic chemicals	30
24.2	Manufacture of pesticides and other agro-chemical products	30
24.5	Manufacture of soap and detergents, cleaning and polishing preparations, perfumes and toilet preparations	30
24.4	Manufacture of pharmaceuticals, medicinal chemicals and botanical products	30
24.6	Manufacture of other chemical products	30
26	Manufacture of other non-metallic mineral products	40
27	Manufacture of basic metals	40
28	Manufacture of fabricated metal products, except machinery and equipment	30
In addition to the employee thresholds a threshold on turnover of 100,000€ applies in all sectors.		

Table 4: Proxy Constraints for EPA IPPC Membership

Year	Number	Title/Author(s) ESRI Authors/Co-authors *Italicised*
2010		
	346	Female Labour Supply and Divorce: New Evidence from Ireland Olivier Bargain, Libertad González, *Claire Keane* and Berkay Özcan
	345	A Statistical Profiling Model of Long-Term Unemployment Risk in Ireland *Philip J. O'Connell, Seamus McGuinness, Elish Kelly*
	344	The Economic Crisis, Public Sector Pay, and the Income Distribution *Tim Callan,* Brian Nolan (UCD) and *John Walsh*
	343	Estimating the Impact of Access Conditions on Service Quality in Post *Gregory Swinand, Conor O'Toole* and *Seán Lyons*
	342	The Impact of Climate Policy on Private Car Ownership in Ireland *Hugh Hennessy* and *Richard S.J. Tol*
	341	National Determinants of Vegetarianism *Eimear Leahy, Seán Lyons* and *Richard S.J. Tol*
	340	An Estimate of the Number of Vegetarians in the World *Eimear Leahy, Seán Lyons* and *Richard S.J. Tol*
	339	International Migration in Ireland, 2009 *Philip J O'Connell* and *Corona Joyce*
	338	The Euro Through the Looking-Glass: Perceived Inflation Following the 2002 Currency Changeover *Pete Lunn* and *David Duffy*
	337	Returning to the Question of a Wage Premium for Returning Migrants *Alan Barrett and Jean Goggin*
2009	336	What Determines the Location Choice of Multinational Firms in the ICT Sector? *Iulia Siedschlag, Xiaoheng Zhang, Donal Smith*

335	Cost-benefit analysis of the introduction of weight-based charges for domestic waste – West Cork's experience *Sue Scott* and *Dorothy Watson*
334	The Likely Economic Impact of Increasing Investment in Wind on the Island of Ireland *Conor Devitt, Seán Diffney, John Fitz Gerald, Seán Lyons* and *Laura Malaguzzi Valeri*
333	Estimating Historical Landfill Quantities to Predict Methane Emissions *Seán Lyons,* Liam Murphy and *Richard S.J. Tol*
332	International Climate Policy and Regional Welfare Weights Daiju Narita*, Richard S. J. Tol,* and *David Anthoff*
331	A Hedonic Analysis of the Value of Parks and Green Spaces in the Dublin Area *Karen Mayor, Seán Lyons, David Duffy* and *Richard S.J. Tol*
330	Measuring International Technology Spillovers and Progress Towards the European Research Area *Iulia Siedschlag*
329	Climate Policy and Corporate Behaviour *Nicola Commins,* Se*án Lyons,* Marc Schiffbauer, and *Richard S.J. Tol*
328	The Association Between Income Inequality and Mental Health: Social Cohesion or Social Infrastructure *Richard Layte* and *Bertrand Maître*
327	A Computational Theory of Exchange: Willingness to pay, willingness to accept and the endowment effect *Pete Lunn* and Mary Lunn
326	Fiscal Policy for Recovery *John Fitz Gerald*
325	The EU 20/20/2020 Targets: An Overview of the EMF22 Assessment Christoph Böhringer, Thomas F. Rutherford, and *Richard S.J. Tol*

324 Counting Only the Hits? The Risk of Underestimating the Costs of Stringent Climate Policy
Massimo Tavoni, *Richard S.J. Tol*

323 International Cooperation on Climate Change Adaptation from an Economic Perspective
Kelly C. de Bruin, Rob B. Dellink and *Richard S.J. Tol*

322 What Role for Property Taxes in Ireland?
T. Callan, C. Keane and *J.R. Walsh*

321 The Public-Private Sector Pay Gap in Ireland: What Lies Beneath?
Elish Kelly, Seamus McGuinness, Philip O'Connell

320 A Code of Practice for Grocery Goods Undertakings and An Ombudsman: How to Do a Lot of Harm by Trying to Do a Little Good
Paul K Gorecki

319 Negative Equity in the Irish Housing Market
David Duffy

318 Estimating the Impact of Immigration on Wages in Ireland
Alan Barrett, Adele Bergin and *Elish Kelly*

317 Assessing the Impact of Wage Bargaining and Worker Preferences on the Gender Pay Gap in Ireland Using the National Employment Survey 2003
Seamus McGuinness, Elish Kelly, Philip O'Connell, Tim Callan

316 Mismatch in the Graduate Labour Market Among Immigrants and Second-Generation Ethnic Minority Groups
Delma Byrne and *Seamus McGuinness*

315 Managing Housing Bubbles in Regional Economies under
EMU: Ireland and Spain
Thomas Conefrey and *John Fitz Gerald*

314 Job Mismatches and Labour Market Outcomes
Kostas Mavromaras, *Seamus McGuinness*, Nigel O'Leary, Peter Sloane and Yin King Fok

313 Immigrants and Employer-provided Training
Alan Barrett, Séamus McGuinness, Martin O'Brien and *Philip O'Connell*

312 Did the Celtic Tiger Decrease Socio-Economic Differentials in Perinatal Mortality in Ireland?
Richard Layte and *Barbara Clyne*

311 Exploring International Differences in Rates of Return to Education: Evidence from EU SILC
Maria A. Davia, *Seamus McGuinness* and *Philip, J. O'Connell*

310 Car Ownership and Mode of Transport to Work in Ireland
Nicola Commins and *Anne Nolan*

309 Recent Trends in the Caesarean Section Rate in Ireland 1999-2006
Aoife Brick and *Richard Layte*

308 Price Inflation and Income Distribution
Anne Jennings, Seán Lyons and *Richard S.J. Tol*

307 Overskilling Dynamics and Education Pathways
Kostas Mavromaras, *Seamus McGuinness*, Yin King Fok

306 What Determines the Attractiveness of the European Union to the Location of R&D Multinational Firms?
Iulia Siedschlag, Donal Smith, Camelia Turcu, Xiaoheng Zhang

305 Do Foreign Mergers and Acquisitions Boost Firm Productivity?
Marc Schiffbauer, Iulia Siedschlag, Frances Ruane

304 Inclusion or Diversion in Higher Education in the Republic of Ireland?
Delma Byrne

303 Welfare Regime and Social Class Variation in Poverty and Economic Vulnerability in Europe: An Analysis of EU-SILC
Christopher T. Whelan and *Bertrand Maître*

302	Understanding the Socio-Economic Distribution and Consequences of Patterns of Multiple Deprivation: An Application of Self-Organising Maps Christopher T. Whelan, Mario Lucchini, Maurizio Pisati and *Bertrand Maître*
301	Estimating the Impact of Metro North *Edgar Morgenroth*
300	Explaining Structural Change in Cardiovascular Mortality in Ireland 1995-2005: A Time Series Analysis *Richard Layte, Sinead O'Hara* and Kathleen Bennett
299	EU Climate Change Policy 2013-2020: Using the Clean Development Mechanism More Effectively *Paul K Gorecki, Seán Lyons* and *Richard S.J. Tol*
298	Irish Public Capital Spending in a Recession *Edgar Morgenroth*
297	Exporting and Ownership Contributions to Irish Manufacturing Productivity Growth Anne Marie Gleeson, *Frances Ruane*
296	Eligibility for Free Primary Care and Avoidable Hospitalisations in Ireland *Anne Nolan*
295	Managing Household Waste in Ireland: Behavioural Parameters and Policy Options *John Curtis, Seán Lyons* and *Abigail O'Callaghan-Platt*
294	Labour Market Mismatch Among UK Graduates; An Analysis Using REFLEX Data *Seamus McGuinness* and *Peter J. Sloane*
293	Towards Regional Environmental Accounts for Ireland *Richard S.J. Tol , Nicola Commins, Niamh Crilly, Sean Lyons* and *Edgar Morgenroth*
292	EU Climate Change Policy 2013-2020: Thoughts on Property Rights and Market Choices *Paul K. Gorecki, Sean Lyons* and *Richard S.J. Tol*
291	Measuring House Price Change

David Duffy

290 Intra-and Extra-Union Flexibility in Meeting the European Union's Emission Reduction Targets
Richard S.J. Tol

289 The Determinants and Effects of Training at Work: Bringing the Workplace Back In
Philip J. O'Connell and *Delma Byrne*

288 Climate Feedbacks on the Terrestrial Biosphere and the Economics of Climate Policy: An Application of *FUND*
Richard S.J. Tol

287 The Behaviour of the Irish Economy: Insights from the HERMES macro-economic model
Adele Bergin, Thomas Conefrey, John FitzGerald and *Ide Kearney*

286 Mapping Patterns of Multiple Deprivation Using Self-Organising Maps: An Application to EU-SILC Data for Ireland
Maurizio Pisati, *Christopher T. Whelan*, Mario Lucchini and *Bertrand Maître*

285 The Feasibility of Low Concentration Targets: An Application of FUND
Richard S.J. Tol

284 Policy Options to Reduce Ireland's GHG Emissions Instrument choice: the pros and cons of alternative policy instruments
Thomas Legge and *Sue Scott*

283 Accounting for Taste: An Examination of Socioeconomic Gradients in Attendance at Arts Events
Pete Lunn and *Elish Kelly*

282 The Economic Impact of Ocean Acidification on Coral Reefs
Luke M. Brander, Katrin Rehdanz, *Richard S.J. Tol*, and Pieter J.H. van Beukering

281 Assessing the impact of biodiversity on tourism flows: A model for tourist behaviour and its policy implications

Giulia Macagno, Maria Loureiro, Paulo A.L.D. Nunes and *Richard S.J. Tol*

280 Advertising to boost energy efficiency: the Power of One campaign and natural gas consumption
Seán Diffney, Seán Lyons and *Laura Malaguzzi Valeri*

279 International Transmission of Business Cycles Between Ireland and its Trading Partners
Jean Goggin and *Iulia Siedschlag*

278 Optimal Global Dynamic Carbon Taxation
David Anthoff

277 Energy Use and Appliance Ownership in Ireland
Eimear Leahy and *Seán Lyons*

276 Discounting for Climate Change
David Anthoff, Richard S.J. Tol and Gary W. Yohe

275 Projecting the Future Numbers of Migrant Workers in the Health and Social Care Sectors in Ireland
Alan Barrett and Anna Rust

274 Economic Costs of Extratropical Storms under Climate Change: An application of FUND
Daiju Narita*, Richard S.J. Tol, David Anthoff*

273 The Macro-Economic Impact of Changing the Rate of Corporation Tax
Thomas Conefrey and *John D. Fitz Gerald*

272 The Games We Used to Play
An Application of Survival Analysis to the Sporting Life-course
Pete Lunn

2008

271 Exploring the Economic Geography of Ireland
Edgar Morgenroth

270 Benchmarking, Social Partnership and Higher Remuneration: Wage Settling Institutions and the Public-Private Sector Wage Gap in Ireland
Elish Kelly, Seamus McGuinness, Philip O'Connell

269 A Dynamic Analysis of Household Car Ownership in

	Ireland *Anne Nolan*
268	The Determinants of Mode of Transport to Work in the Greater Dublin Area *Nicola Commins* and *Anne Nolan*
267	Resonances from *Economic Development* for Current Economic Policymaking *Frances Ruane*
266	The Impact of Wage Bargaining Regime on Firm-Level Competitiveness and Wage Inequality: The Case of Ireland *Seamus McGuinness, Elish Kelly* and *Philip O'Connell*
265	Poverty in Ireland in Comparative European Perspective *Christopher T. Whelan* and *Bertrand Maître*
264	A Hedonic Analysis of the Value of Rail Transport in the Greater Dublin Area *Karen Mayor, Seán Lyons, David Duffy* and *Richard S.J. Tol*
263	Comparing Poverty Indicators in an Enlarged EU *Christopher T. Whelan* and *Bertrand Maître*
262	Fuel Poverty in Ireland: Extent, Affected Groups and Policy Issues *Sue Scott, Seán Lyons, Claire Keane,* Donal McCarthy and *Richard S.J. Tol*
261	The Misperception of Inflation by Irish Consumers *David Duffy* and *Pete Lunn*
260	The Direct Impact of Climate Change on Regional Labour Productivity Tord Kjellstrom, R Sari Kovats, Simon J. Lloyd, Tom Holt, *Richard S.J. Tol*
259	Damage Costs of Climate Change through Intensification of Tropical Cyclone Activities: An Application of FUND Daiju Narita, *Richard S. J. Tol* and *David Anthoff*
258	Are Over-educated People Insiders or Outsiders?

	A Case of Job Search Methods and Over-education in UK Aleksander Kucel, *Delma Byrne*
257	Metrics for Aggregating the Climate Effect of Different Emissions: A Unifying Framework *Richard S.J. Tol,* Terje K. Berntsen, Brian C. O'Neill, Jan S. Fuglestvedt, Keith P. Shine, Yves Balkanski and Laszlo Makra
256	Intra-Union Flexibility of Non-ETS Emission Reduction Obligations in the European Union *Richard S.J. Tol*
255	The Economic Impact of Climate Change *Richard S.J. Tol*
254	Measuring International Inequity Aversion *Richard S.J. Tol*
253	Using a Census to Assess the Reliability of a National Household Survey for Migration Research: The Case of Ireland *Alan Barrett* and *Elish Kelly*
252	Risk Aversion, Time Preference, and the Social Cost of Carbon *David Anthoff, Richard S.J. Tol* and Gary W. Yohe
251	The Impact of a Carbon Tax on Economic Growth and Carbon Dioxide Emissions in Ireland *Thomas Conefrey, John D. Fitz Gerald, Laura Malaguzzi Valeri* and *Richard S.J. Tol*
250	The Distributional Implications of a Carbon Tax in Ireland *Tim Callan, Sean Lyons, Susan Scott, Richard S.J. Tol* and Stefano Verde
249	Measuring Material Deprivation in the Enlarged EU *Christopher T. Whelan, Brian Nolan* and *Bertrand Maître*
248	Marginal Abatement Costs on Carbon-Dioxide Emissions: A Meta-Analysis Onno Kuik, Luke Brander and *Richard S.J. Tol*
247	Incorporating GHG Emission Costs in the Economic

Appraisal of Projects Supported by State Development Agencies
Richard S.J. Tol and *Seán Lyons*

246 A Carton Tax for Ireland
Richard S.J. Tol, Tim Callan, Thomas Conefrey, John D. Fitz Gerald, Seán Lyons, Laura Malaguzzi Valeri and *Susan Scott*

245 Non-cash Benefits and the Distribution of Economic Welfare
Tim Callan and *Claire Keane*

244 Scenarios of Carbon Dioxide Emissions from Aviation
Karen Mayor and *Richard S.J. Tol*

243 The Effect of the Euro on Export Patterns: Empirical Evidence from Industry Data
Gavin Murphy and *Iulia Siedschlag*

242 The Economic Returns to Field of Study and Competencies Among Higher Education Graduates in Ireland
Elish Kelly, Philip O'Connell and *Emer Smyth*

241 European Climate Policy and Aviation Emissions
Karen Mayor and *Richard S.J. Tol*

240 Aviation and the Environment in the Context of the EU-US Open Skies Agreement
Karen Mayor and *Richard S.J. Tol*

239 Yuppie Kvetch? Work-life Conflict and Social Class in Western Europe
Frances McGinnity and *Emma Calvert*

238 Immigrants and Welfare Programmes: Exploring the Interactions between Immigrant Characteristics, Immigrant Welfare Dependence and Welfare Policy
Alan Barrett and Yvonne McCarthy

237 How Local is Hospital Treatment? An Exploratory Analysis of Public/Private Variation in Location of Treatment in Irish Acute Public Hospitals
Jacqueline O'Reilly and *Miriam M. Wiley*

236 The Immigrant Earnings Disadvantage Across the

Earnings and Skills Distributions: The Case of Immigrants from the EU's New Member States in Ireland
Alan Barrett, *Seamus McGuinness* and *Martin O'Brien*

235 Europeanisation of Inequality and European Reference Groups
Christopher T. Whelan and *Bertrand Maître*

234 Managing Capital Flows: Experiences from Central and Eastern Europe
Jürgen von Hagen and *Iulia Siedschlag*

233 ICT Diffusion, Innovation Systems, Globalisation and Regional Economic Dynamics: Theory and Empirical Evidence
Charlie Karlsson, Gunther Maier, Michaela Trippl, *Iulia Siedschlag,* Robert Owen and *Gavin Murphy*

232 Welfare and Competition Effects of Electricity Interconnection between Great Britain and Ireland
Laura Malaguzzi Valeri

231 Is FDI into China Crowding Out the FDI into the European Union?
Laura Resmini and *Iulia Siedschlag*

230 Estimating the Economic Cost of Disability in Ireland
John Cullinan, Brenda Gannon and *Seán Lyons*

229 Controlling the Cost of Controlling the Climate: The Irish Government's Climate Change Strategy
Colm McCarthy, *Sue Scott*

228 The Impact of Climate Change on the Balanced-Growth-Equivalent: An Application of *FUND*
David Anthoff, *Richard S.J. Tol*

227 Changing Returns to Education During a Boom? The Case of Ireland
Seamus McGuinness, *Frances McGinnity, Philip O'Connell*

226 'New' and 'Old' Social Risks: Life Cycle and Social Class Perspectives on Social Exclusion in Ireland
Christopher T. Whelan and *Bertrand Maître*

	225	The Climate Preferences of Irish Tourists by Purpose of Travel *Seán Lyons, Karen Mayor* and *Richard S.J. Tol*
	224	A Hirsch Measure for the Quality of Research Supervision, and an Illustration with Trade Economists *Frances P. Ruane* and *Richard S.J. Tol*
	223	Environmental Accounts for the Republic of Ireland: 1990-2005 *Seán Lyons, Karen Mayor* and *Richard S.J. Tol*
2007	222	Assessing Vulnerability of Selected Sectors under Environmental Tax Reform: The issue of pricing power *J. Fitz Gerald*, M. Keeney and *S. Scott*
	221	Climate Policy Versus Development Aid *Richard S.J. Tol*
	220	Exports and Productivity – Comparable Evidence for 14 Countries *The International Study Group on Exports and Productivity*
	219	Energy-Using Appliances and Energy-Saving Features: Determinants of Ownership in Ireland Joe O'Doherty, *Seán Lyons* and *Richard S.J. Tol*
	218	The Public/Private Mix in Irish Acute Public Hospitals: Trends and Implications *Jacqueline O'Reilly* and *Miriam M. Wiley*
	217	Regret About the Timing of First Sexual Intercourse: The Role of Age and Context *Richard Layte*, Hannah McGee
	216	Determinants of Water Connection Type and Ownership of Water-Using Appliances in Ireland Joe O'Doherty, *Seán Lyons* and *Richard S.J. Tol*
	215	Unemployment – Stage or Stigma? Being Unemployed During an Economic Boom *Emer Smyth*
	214	The Value of Lost Load *Richard S.J. Tol*

213 Adolescents' Educational Attainment and School Experiences in Contemporary Ireland
Merike Darmody, Selina McCoy, Emer Smyth

212 Acting Up or Opting Out? Truancy in Irish Secondary Schools
Merike Darmody, Emer Smyth and *Selina McCoy*

211 Where do MNEs Expand Production: Location Choices of the Pharmaceutical Industry in Europe after 1992
Frances P. Ruane, Xiaoheng Zhang

210 Holiday Destinations: Understanding the Travel Choices of Irish Tourists
Seán Lyons, Karen Mayor and *Richard S.J. Tol*

209 The Effectiveness of Competition Policy and the Price-Cost Margin: Evidence from Panel Data
Patrick McCloughan, *Seán Lyons* and William Batt

208 Tax Structure and Female Labour Market Participation: Evidence from Ireland
Tim Callan, A. Van Soest, *J.R. Walsh*